Development of a Decision Support System for Resolving Conflicts in Environmentally Sensitive Areas

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Abstract

The aim of this research is to develop a new methodology to assist decision-makers in assessing and measuring the degree of stakeholder conflict in environmentally sensitive areas. The research tried to answer the following question: How can the understanding of the magnitude and direction of consensus among conflicting stakeholders shape the management of an environmentally sensitive area?

The case study area of Lake Maryout, Egypt, provided a good example of failure in the management of natural resources. It demonstrated that conflict among different stakeholders coupled with contradiction in the current policies and legislation play a role in exacerbating the deterioration of its environmental quality. The methodology therefore, is applied on simplified application of analytical hierarchical structure as an example to identify the main variables underpinning Lake Maryout's stakeholders' conflicting priorities.

The research adopted both a qualitative and quantitative mixed methodology. The underpinning data was collected through expert and stakeholder questionnaires, interviews, public hearings, field survey and remotely sensed data.

The research methodology applies Multi-Criteria Decision Analysis (MCDA), using Analytic Hierarchy Process (AHP), with the support of Geographic Information System (GIS), and the Driving Forces–Pressures–State–Impacts–Responses (DPSIR) analytical framework.

The research has shed light on the dynamics of environmental conflicts, illustrating the formation and direction of disagreements between various stakeholders. Results showed that areas of consensus between various conflicting stakeholders could be identified, measured and located within a uniform scale.

Results provided insight of how different sustainable development pillars interact with respect to the available alternative actions. Research results showed changes in synthesised stakeholder preferences when applying comparative differentiated power. Results indicated that environmental conflicts were exacerbated by the differentiated degree of stakeholder influence ratio.

The analysis of Lake Maryout's environmental policies and legislations highlighted two main concerns. First, Sustainable development is difficult when the available alternatives are conflicting; and secondly, the current Egyptian environmental policies create more environmental conflict than protection of the environment.

The new methodology is intended to assist decision-makers overcome the limitations of the human mind to handle multiple objectives complex problems. It assists decision-makers to prioritise their decisions' elements in order to unveil the various alternatives of compromises and trade-offs.

The research suggests that identifying the root causes and the particular areas of stakeholder conflict can assist decision-makers to take the necessary measures to minimise the possible consequences in order to improve the environmental quality of the natural resource.

Results of this study provide a roadmap to improve policy-making and planning towards better environmental management of Lake Maryout.

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List of Abbreviations

ABA	Alexandria Businessmen Association
ACOSD	Alexandria Company of Sanitary Drainage
ADR	Alternative Dispute Resolution
AHP	Analytic Hierarchy Process
ALAMIM	Alexandria Integrated Management of Lake Maryout project
BEA	Bilateral Environmental Agreements
BOT	Board of Trustees
CDS	City Development Strategy
CE	Choice Experiment
CI	Consistency Index
CPT	Communicative Planning Theory
CR	Consensus Rank
CR	Consistency Ratio
CS	Consensus Scale
CSER	Corporate Social and Environmental Responsibility
CSR	Corporate Social Responsibility
DSS	Decision Support Systems
DPSIR	Driving Forces–Pressures–State–Impacts–Responses framework
DSR	Driving Forces-State-Response model
ECPro	Expert Choice Pro
EDAM	Environmental Decision Analytical Model
EDM	Environmental Decision-Making
EEA	European Environment Agency

EEAA	Egyptian Environmental Affairs Agency
EIA	Environmental Impact Assessment
EMUs	Environmental Management Units
ENP	European Neighbourhood Policy
EPAP	Egyptian Pollution Abatement Project
ESRI	Environmental Systems Research Institute
FA	Fishing Authority or Fishing Association
FAO	Food and Agriculture Organization
FC	Fishing Community
FDI	Foreign Direct Investment
GARD	General Authority for Reconstruction and Agricultural Development
GIS	Geographic Information System
GOA	Governorate of Alexandria
HPM	Hedonic Price Method
IA	Integrated Assessment
IEA	International Environmental Agreements
IEA	Integrated Environmental Assessment
ICT	Information and Communication Technologies
ICZM	Integrated Coastal Zone Management
IPA	Impact Pathway Analysis
IR	Influence Ratio
LCA	Life-cycle Impact Assessment
LGP	Linear Goal Programming
MAB	Man and the Biosphere Programme
MADM	Multi-Attribute Decision-Making

MCA	Multiple Criteria Analysis or Assessment
MCDA	Multiple Criteria Decision Analysis or Multiple Criteria Decision Aids
MCDM	Multi-Criteria Decision-Making
MCDM	Multiple Criteria Decision Models
MCDSS	Multiple Criteria Decision-Support Systems
MEA	Multilateral Environmental Agreements
MEDBRANCH	Mediterranean Building Regional and National Capacity in Hot Spots project
MODA	Multiple Objective Decision Analysis
MODSS	Multiple Objective Decision-Support Systems
MODM	Multi-Objective Decision- Making
MOE	Ministry of Environment
MPS	Merit Point System
MSEA	Ministry of State for Environmental Affairs
MWRI	Ministry of Water Resources and Irrigation
NGOs	Non-Governmental Organizations
OECD	Organization of Economic Co-operation and Development
PD	Presidential Decree
PRA	Participatory Rural Appraisal
PSR	Pressure-State-Response
RBOs	Regional Branch Offices
RDT	Resource Dependency Theory
RI	Random Consistency Index
SADM	Spatial Analytical Decision Module
SAM	Special Area Management

SD	Sustainable Development
SDAM	Stakeholder Decision Analytical Module
SDDM	Sustainable Development Decision Module
SMEs	Small and micro-enterprises
SOE	State of the Environment
UNCED	United Nations Conference on Environment and Development
UNCSD	United Nations Commission for Sustainable Development
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational Scientific and Cultural Organization
UNEP	United Nations Environment Programme
UTM	Universal Transverse Mercator
WHO	World Health Organization
WTP	Willingness to Pay

CHAPTER 1

INTRODUCTION

Chapter 1. Introduction

1.1 Overview

This research investigates the plausibility of developing a new methodology to assist decision-makers in assessing and measuring the degree of stakeholders' consensus in environmentally sensitive areas. The research focuses on identifying the links between the decision-making process, policy, planning, legal frameworks, environmental degradation, and stakeholder conflict.

Because of the complexity of the ecological, social and economic issues, making rational decisions is very challenging. In light of these fundamental complexities, decision support tools are necessary to assist decision makers take structured decisions with respect to natural resource management.

There are several research methodologies, conceptual frameworks, analytical tools for decision analysis, stakeholders' conflict and problem solving techniques. Mendoza and Prabhu (2005) regard Multi-Criteria decision Analysis (MCDA) as a conveniently structured method to facilitate collaborative planning and the decision-making. Saaty (1980a) developed the Analytic Hierarchy Process (AHP), a decision-support structured methodology, based on mathematics and human psychology that provides flexible analysis of complicated, complex decisions. AHP is a measurement theory, used to prioritise the hierarchy and consistency of judgmental data provided by a group of decision-makers (Hsu et al., 2008).

The case study area of Lake Maryout, Egypt, provides an illustration of policy and management failure. It is subject to conflict among different stakeholders as well as contradiction in the current policies and legislation. A simplified application of AHP analytical hierarchical structure of the stakeholders' priorities is applied as an example to identify the main factors that are contributing to Lake Maryout's stakeholders' conflicting priorities.

The research outcomes seek to develop a new methodology to be used as a road map to assist decision-makers in understanding of the magnitude and direction of consensus among conflicting stakeholders that shape the management of an environmentally sensitive area.

1.2 Background

Protection of environmental resources has become vital to humankind in light of the alarming global population growth trend, coupled with unsustainable patterns of consumption and production. Current consumption of environmental resources exceeds our planet's capacity to regenerate them by a full 30 per cent (WWF, 2008). Moderate United Nations scenarios assume that within the next 20 years the world will require the equivalent of "two Earths" to support enough resources for the present population (Global Footprint Network, 2010). The disturbing decline in ecosystems is leading to an ecological credit crunch. Poverty and insufficient energy resources are some of the main alarming symptoms of our collective mismanagement of natural resources.

Wackernagel et al. (2002) cited in Alessandro et al. (2012 p.101) define Ecological Footprint as "a resource and emission accounting tool designed to track human demand on the biosphere's regenerative capacity". Ecological Footprint monitors the collective impact of anthropogenic pressures to understand the environmental consequences that human activities place on the biosphere and its comprising ecosystems (Galli et al., 2011). The current accelerated rate of human activities leads to increase in Ecological Footprint. This has serious implications and impacts. According to Global Footprint Network (2009), the Earth needs one year and six months to regenerate what humans consume in one year. This excess leads to the liquidation of the Earth's resources, which threatens human well-being if these resources are not adequately addressed. This situation results in further competition over limited resources, which consequently lead to the increase of global and local conflicts over natural resources. Sustaining and managing the ecological resources currently available should be considered from different perspectives.

People have always competed over these resources to secure their livelihoods, and on some occasions, to enhance their quality of living (Buckles et al., 1999). This competition, which could lead to potential conflict, has to be analysed, not only at its root causes but also from the stakeholder decision-making perspective. It is important to understand the role of civil society in the decision-making process within the social and political theory as well as through historical evidence (Putnam, 1993). Therefore, a growing number of countries now take a more intelligent and responsible approach towards protecting their natural resources through a collective participatory approach to reach a consensus over the optimal way to sustain these resources. Many have realised that reaching a consensus between the various affected communities and decision-makers is essential in preserving our environment. However, Jurgen Habermas and Michel Foucault highlighted the indispensable tension among consensus and conflict (Flyvbjerg, 1998). Habermas highlighted that the lack of poverty and degradation is crucial to rational decision-making (Power, 1991).

Habermas's theory of communicative action aims to "clarify the presuppositions of the rationality of processes of reaching understanding, which may be presumed to be universal because they are unavoidable" (Habermas, 1985, p.196). Habermas's theory of communicative rationality recalls the consensus-building force of a discourse. The theory assumes that participants rise above their initial subjectively based views in favour of a rationally motivated agreement.

Communicative planning theories (CPT), which are based on public participation, including a wide range of stakeholders who have emerged from the affected communities in the decision-making process, and are mostly guided by the process of consensus-building (Sager, 2009). This development of fairness seeking is no longer a luxury that only a handful of fortunate (powerful) developed nations can afford. It is rather a fundamental necessity, presenting daunting challenges to the realization of human well-being and a more sustainable future.

One main challenge is the rapid rate of population growth coupled with an increase in material aspirations and pressures on environmental resources to satisfy these aspirations.

Managing environmental resources is understandably becoming not only an exigent demand by anthropocentric or bio-centric environmentalist groups, but also a global, regional, and national security concern. Increased competition over these resources, together with an exponential rate of litigation, are indicators of community dissatisfaction, which in turn often results in the emergence of enemy camps (Maser, 1996). Surpassing overall biocapacity will result in serious consequences. Historically, these variables have formed a prescription for internal and external conflicts. Global co-operation is one crucial element to minimise the negative effects of conflicting priorities. One example of how the world can reach a consensus regarding a common objective of environmental protection, is the ratification of numerous International Environmental Agreements (IEA), including more than 1,500 Bilateral Environmental Agreements (BEA) and 1,000 Multilateral Environmental Agreements (MEA) (Mitchell, 2011).

Several agreements have resolved problems, other agreements had partial or no impact, while some have met their targets and objectives when the right conditions were in place (O'Connor, 2005).

Moreover, resolving sub-national environmental conflicts is vital before these local disputes cross national boundaries and constitute yet another emerging risk to the entire world. Achieving a common vision is indeed plausible through understanding the positions and perspectives of other parties.

The most challenging decisions facing humanity are those related to the environment because of their complexity, degree of uncertainty, conflicting priorities, and temporal horizon (Brewer and Stern, 2005). This level of complexity usually results in unstructured decisions by local authorities. This is mainly due to the fact that it is not humanly possible to overlay and take into consideration all the sustainable development layers to develop consistent, well structured, and balanced decisions.

Stakeholder participation in the decision-making process adds another dimension to the decision matrix. Governments are being asked by the international community to involve local communities in the environmental decision-making process.

"One of the first ministers for environment in Western Europe used to say that environmental protection is a school for democracy. His prophecy has justified by the growing importance of public participation in environmental decisions related to the environment" (Nagy and Bowman, 1994, p12).

The Nobel Prize-winning economist, Amartya Sen, points out that among the great diversity of events and developments that have occurred in the twentieth century, the rise of democracy is the most pre-eminent development (Sen, 1999). There is a strong connection between democracy and public participation in environmental decision-making. This is rooted in the fact that citizens are the architects of their future. As such, they have a legitimate right to be consulted to make informed choices. Accordingly, government should operate or function through a participatory approach and deliberative process.

The inclination of researchers to forge a connection between group discussions and democratic processes was apparent in scholarship and pedagogy throughout the twentieth century (Frey et al., 1999). The importance of public engagement in the decision-making process originated from several ideological and pragmatic bases to serve various purposes and motivations (Rowe and Frewer, 2000). Public participation practices are identical to the ideology of civic discovery, where citizens contribute to the piloting and shaping of their future. Civil discovery is a form of public fora where "opinions can be revised, premises altered and common interests discovered" (Reich, 1988, p.144). Public participation has been reflected in the global agenda on environmental policy formulation, which became increasingly dependent on the implementation of this agenda at the local level. The requirements of international conventions have progressively infiltrated local policies, resulting in a more participatory approach in local policy formulation. Full stakeholder awareness and participation, through reliable environmental assessment techniques contribute to credible accepted rules and responsibilities (UNEP, 2009). These assessment mechanisms are the cornerstone in identifying the main driving forces and pressures on the environment. Public awareness of environmental assessment findings is essential to build harmonised responses, and thus build a consensus for facing these challenges. The current environmental assessment processes, which are critical policy tools, require further revision to evaluate their applicability to certain environmental situations resulting from complex social, economic and institutional interactions. It is essential to develop an understanding of the relationship between science, policy and decision-making processes.

Rachel Carson explained the interconnections between the environment, the economy and social aspects in her book "Silent Spring", in 1962, in which she explored the irresponsibility of an industrialized, technological society toward the natural world (Carson, 1962). Despite criticism and strong opposition to her argument — several groups claimed that it neglected evidence-based approaches and that she wanted to bring humanity back to the dark ages. The book is considered a cornerstone in alerting global public concern to irreversible environmental threats. This bears special significance because we live in a globalised economy, where massive investments are being harnessed to stimulate economies. This unprecedented need for accelerated economic development has led those in many regions to overlook the environmental and social impacts of this enhanced and fast-paced growth, and its effect on sustainability.

More than 45 years after the start of the environmental movement and following numerous international and regional conferences, conventions and treaties, it is time for governments, international organizations, politicians, environmentalists and other groups to carefully and responsibly assess the ethical, cultural and practical approaches of environmental conservation within a sustainable development approach. There is, to date, no general consensus on the definition of either environmental conflict or environmental security. There is also, as yet, no agreement on the main causes of environmental conflicts or on whether to consider these environmental conflicts as a distinct form of violence (Hagmann, 2005). The terms environmental conflict, environmental dispute, eco-violence and environmental security are generally used interchangeably.

Thomas Homer-Dixon (1991) argued that pressures on renewable natural resources due to population growth make communities more vulnerable to armed conflicts and civil wars. This argument supports the neo-Malthusian scenario which assumes that exponential population growth and the current overexploitation and scarcity of available natural resources will increase the risk of conflict over these limited resources. Contrary to this argument, resource-optimists present a scenario where advancement in environmentally-friendly technologies coupled with sound economic development will ultimately result in peace, prosperity and stability. This utopian scenario of global peace and co-operation for the welfare of humanity has never been realized throughout human history. Scarcity of natural resources, mismanagement, and inequality of access to these resources are potential causes of conflicts (UNEP, 2004). Competition over scarce resources combined with the increasing demands of emerging civilisations or specific communities has usually led to some form of conflict. The common factor found in the First and Second World Wars, colonization and decolonization wars, as well as in many other recent conflicts, was natural resources (Libiszewski, 1992). Many of the world's domestic conflicts, which were presented as ethnic tensions, had environmental driving forces that contributed to the emergence of these disputes. One example is the civil conflict in Burundi, where interrelation between land scarcity–environmental degradation–conflict has led to a deterioration of economic, social, and physical dimensions (Banderembako, 2006). Other examples of competition over the control of critical resources include Angola, Chechnya, Chiapas, Congo, Indonesia, Liberia, Sierra Leone, Somalia, Rwanda, Zimbabwe and Sudan (Klare, 2001).

Overexploitation of the world's natural resources, the current rate of global environmental degradation, and the exponential increase in human population, are together, a potential recipe for disaster and conflict. According to Robert Kaplan (1994), escalating population growth leads to increased pressures on environmental resources and will ultimately, either directly or indirectly, cause conflicts.

There is also a need to analyse the root causes of environmental degradation as a result of human conflicts over natural resources. Conflicts are often inevitable; however, they can be viewed as something to be avoided (Bracken et al., 1998). Conflicts are a fact of life in human societies, whether they are personal disagreements or armed conflicts.

Environmental conflicts usually result not only from environmental causes but also as a consequence of economic, social and other cultural factors. Ironically, seeds of conflict are rooted within the very pillars of sustainable development. Avoiding or averting certain environmental problems can be achieved by analysing the positions of different stakeholders and locating the areas of consensus as a practical starting point for negotiation. Identification of the social characteristics related to environmental problems is crucial to understanding the impact of any environmental policy and consequently to the evaluation of positions of different stakeholder groups toward this policy. According to Smith (1993), and the environmental conflict resolution model, stakeholder commitment is directly proportional to the degree of participant bargaining power. Susskind et al., (1999) point out that consensus building "involves a good faith effort to meet the interests of all stakeholders". Consequently, stakeholders have to discuss the issues in good faith. This entails hard work in terms of facilitation, mediation, and iteration processes to reach a considerable and desired level of good faith.

Conflicts occur when demand exceeds supply, and when stakeholders of natural resources prevent access to scarce resources (Reuveny et al., 2011).

There are two main methodological limitations to the strong links that exist between scarcity of renewable resources and the emergence of conflicts: insufficient independent and dependent variables, and failure to identify the main factors that lead to the generation of conflicts (Hauge and Ellingsen, 1998).

The ''limits to growth'' report is considered a turning point for the term Integrated Assessment (IA). The report highlighted the fact that the Earth could reach its carrying capacity within a century if the current projection of world population increase holds true, levels of industrial pollution persist, current trends of insufficient food production continue, and degradation of natural resources remain unchanged (Meadows et al., 1972). Environmental Assessment (EA) has become an important tool in environmental management. Integrated Environmental Assessment (IEA) has been utilised to link human development, economic activities, and environmental management within the context of sustainable development (Ambala and Ocholla, 2006). Integrated Assessment is generally used as the basis for land management and decision-making for environmental, ecological, social and economic systems (Rhind et al.,1991). Environmental Assessment is used to ensure that the decision-making process clearly takes into consideration the environmental dimension. In recent years, there has been a shift from the traditional resource and sector-focus frameworks to more integrated methodologies that consider the interplay between social, economic and environmental dimensions. This multi-dimensional assessment can assist in developing an understanding of the root causes of environmental problems. It helps in the identification of the cause-effect relationship and the responses taken by various stakeholders and policy-makers.

According to Simon's theory of bounded rationality, individuals are only to some extent rational, and decision-making is mostly influenced by some subjective factors, including emotions, prejudices and other biased aspects (Simon, 1957). The bounded rationality concept indicates that the decision-making process is controlled by the effects of complexity as a result of the inadequate capabilities of human beings to process outsized quantity of data and information. This constraint causes humans to produce simple-minded solutions to complex problems (Wall, 1993).

Understanding the complex multi-dimensional array of conflicting priorities requires an innovative conflict assessment methodology that is able to identify the environmental, social, economic and other driving forces that shape individual perspectives.

A number of disciplines study the process of decision-making, including economics, operational research and applied statistics. Most of these focus on the descriptive rather than analytical aspects; what the decision-makers should do rather than a rationale as to why they have come up with such decisions (Beach, 1997). Social and behavioural sciences offer a valuable platform for making well studied, sensible choices to complex problems that affect environmental quality (Brewer and Stern, 2005).

Measuring the implication of environmental decision-making processes on sustainability is crucial to comprehending the consequences of these decisions on the environment. Human interventions in the natural environment require taking into account the various environmental, economic and social dimensions. The challenge of measuring sustainability is a continuous effort to identify and aggregate several disparate multi-dimensional phenomena. Over the last decade, a number of measuring initiatives have been conducted to develop sustainability indexes to assess progress towards environmental sustainability at the national level. However, both scholars and national and international institutions have criticised these measurement tools arguing that they do not take into consideration the full spectrum of sustainable development considerations. Environmental Decision Making (EDM) refers to the decision-making process that considers environmental consequences as a result of decisions made. Measuring the impacts of decisions on the environment is a multifaceted issue. The process of EDM by definition has three main dimensions: public participation, decision-making processes and the environment. Environmental decision-making is becoming more complex as it comprises social and economic dimensions (Dale and English, 1999).

The complexity of taking a rational environmental decision is caused by the degree of uncertainty as to how environmental, financial and social aspects are interacting. Various tools to help environmental decision-making have been developed in the last few decades, including Life-cycle Impact Assessment (LCA), Sustainability Indicators, Cost-effectiveness Analysis, Multi-criteria analysis (MCA), and Impact Pathway Analysis (IPA). In spite of the power of these tools, they are not always effective in assessing the versatile interactive trade-offs of environmental policy options.

Moreover, environmental models that measure the degree of environmental conflicts over natural resources are more often than not missing. Environmental assessment is used to make sure that the decision-making process fully considers the environmental dimension. Various environmental assessment tools and techniques developed in the past two decades have helped to evaluate the possible environmental consequences of proposed development actions. However, there is a lack of, and the need for, a methodology to identify the degree of conflicts related to environmental decisions as a result of differentiated priorities of stakeholders. Such a methodology should be able to assess not only the environmental, economic and social dimensions but also to measure the degree and intensity of environmental conflicts that are hindering the sustainability of the affected area and to analyse the main factors that are contributing to environmental degradation.

There is also an attendant need to develop new methodologies to understand the complex interactions between public participation processes and the social and cultural dimensions affecting this participation. Recent and historical research at the global, national and local levels indicates that changes are likely to be rejected when affected communities are not aware or are not being consulted on the objectives of these changes, the methodology to carry out the changes, or their proposed timing. Communities that are mostly affected by action or policy are usually sceptical about solutions generated from high-level technical experts, particularly if they are conducted without a participatory process. It has been demonstrated over and over again that sustained public participation in the decision-making process can assist in minimizing the negative impacts of environmental degradation on affected communities who are, after all, the main stakeholders. In order to involve stakeholders actively in any process, there is a need to analyse the existing established institutional and societal system and to take remedial action.

Deterioration of the environment through depletion of natural resources, destruction of ecosystems, and extinction of wildlife requires a full understanding of the complexity of these interrelated problems. At the same time, recent improvements in environmental science and the use of advanced technology continue to develop new techniques to assist in the collection of up-to-date factual data for monitoring environmental degradation. This is a needs-driven initiative since the frequency and magnitude of environmental degradation due to stakeholder conflict has seen a dramatic rise in recent years and threatens large populations living in environmentally sensitive areas. Anthropogenic global environmental changes have attracted many researchers in the last few decades and have rapidly influenced developed research in the past ten to fifteen years; however, it is still in a formative phase (Matthew et al., 2003).

1.3 Environmental Sustainability

In 1972, the United Nations Conference on the Human Environment in Stockholm, Sweden, was the first major international meeting to discuss the world's complex environmental problems. Arguably, the most significant achievement of the Conference was to bring together for the first time one hundred and fourteen governments to focus on a single issue: a better understanding of each other's many and complex environmental problems. Already more than thirty years ago, after the Stockholm conference, the countries acknowledged the urgent need to respond to the problem of environmental degradation (United Nations, 1972).

In 1987, politicians, civil society and international experts published the Brundtland Report (Our Common Future). The Report highlighted the need for global equity, fair and equal distribution of natural resources, and assistance in the economic development of least developed countries. The report was an alarm bell to the world calling for immediate action to make progress toward sustained economic development without depleting global, regional and local natural resources.

The concept of sustainability is considered highly dimensioned (Bell and Morse, 2001, 2003) and in its somewhat simplistic form, needs to be re-examined. Many sustainable development variables and associated attributes are interlinked in such a way that the impact of any environmentally-related decision will invariably affect other sustainable development pillars.

In addition to this degree of complexity, Bell and Morse (2005) argue that despite the somewhat vague definition of sustainable development, sustainability has temporal and spatial dimensions. It is very unlikely that the least developed nations and marginalised unprivileged groups can sustain their natural resources for future generations when their own existence is at risk today.

Sustaining the environment is a choice that contains many variables. It is therefore necessary to explore situations on the ground where decision-makers have to reconcile their urgent need for development against the need to minimize negative consequences on their natural resources. Their decisions will ultimately have profound impacts on generations to come.

Integrated Assessment appeared in scientific and public policy in the 1970s to understand and manage acid deposition in Europe and North America. (Toth and Hizsnyik, 1998). Environmental assessment has become a key instrument in environmental management. IEA has been used to link human development, economic activity, and environmental management in the context of sustainable development (Ambala and Ocholla, 2006). Integrated Assessment is recognized as the basis for land management and decision-making for environmental, ecological, social and economic systems (Rhind et al., 1991).

Environmental Assessment is used to make sure that the decision-making process fully considers the environmental dimension. The various environmental assessment processes are conducted to ensure that the objectives of relevant environmental policies and legislation at the international, national or local levels are met.

1.3.1 Sustainable Development

The concept of sustainable development (SD) was used widely after the publication of the Brundtland Commission's report. The Brundtland Commission clarified the relationship between economy and environment, using the term Sustainable Development. It defined sustainable development as development that "meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED, 1987).

A few hundred definitions for "sustainable development" have been developed since the concept was introduced (Kobus, 2008). IUCN defines SD as "Improving the quality of human life while living within the carrying capacity of supporting ecosystems" (IUCN/UNEP/WWF, 1991,p.10).

Principle 3 of the United Nations Conference on Environment and Development that was held in Rio de Janeiro, on June 1992, proclaims that "The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations" (United Nations, 1992).

Arguably, the very generic definition of SD has made possible a number of interpretations in literature that in many ways run contrary to the concept itself.

Generally, SD is represented conceptually as three intersected entities: environment, economy and society (see Figure 1-1). This classical, over-simplified and two-dimensional representation does not capture other dimensions either on the same x-y plane, such as culture, or in the z plane, such as time.

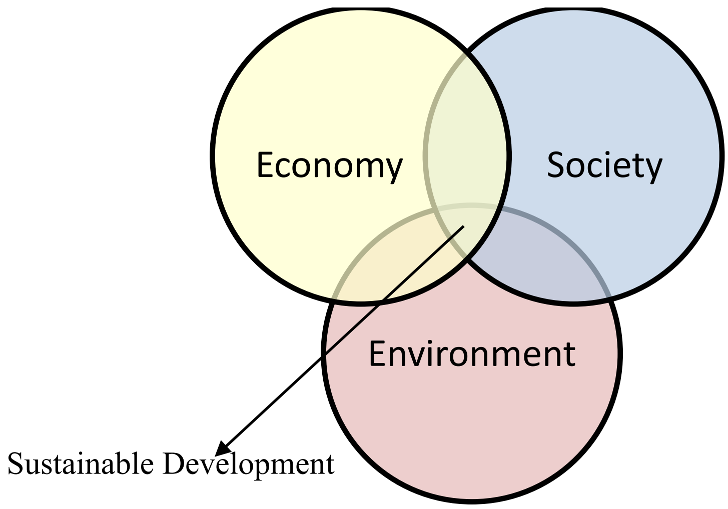


Figure 1-1 Sustainable Development Concept

Over the past two decades, recognition has grown that the current modality of development is unsustainable. Individual countries began to identify their priority areas for sustainable development. These priorities are used to develop environmental action plans and a set of shared principles for sustainable development policy (see Figure 1-2) (SDU, 2008).

Neumayer (2003) proposed various conceptual paradigms of the criteria for fulfilling the definition of sustainability. The Brundtland Commission (WCED, 1987, Article 3 No.53) identified the main concept of sustainability by noting that "the diversity of species is necessary for the normal functioning of ecosystems and the biosphere as a whole".

Sustainable development refers to the type of development that sustains natural systems. Sriskandarajah et al., (1991, p.3) proposed a different perspective:

> *"Sustainability, is better seen as a measure of the relationship between the community as learners and their environments, rather than an externally designed goal to be achieved"*

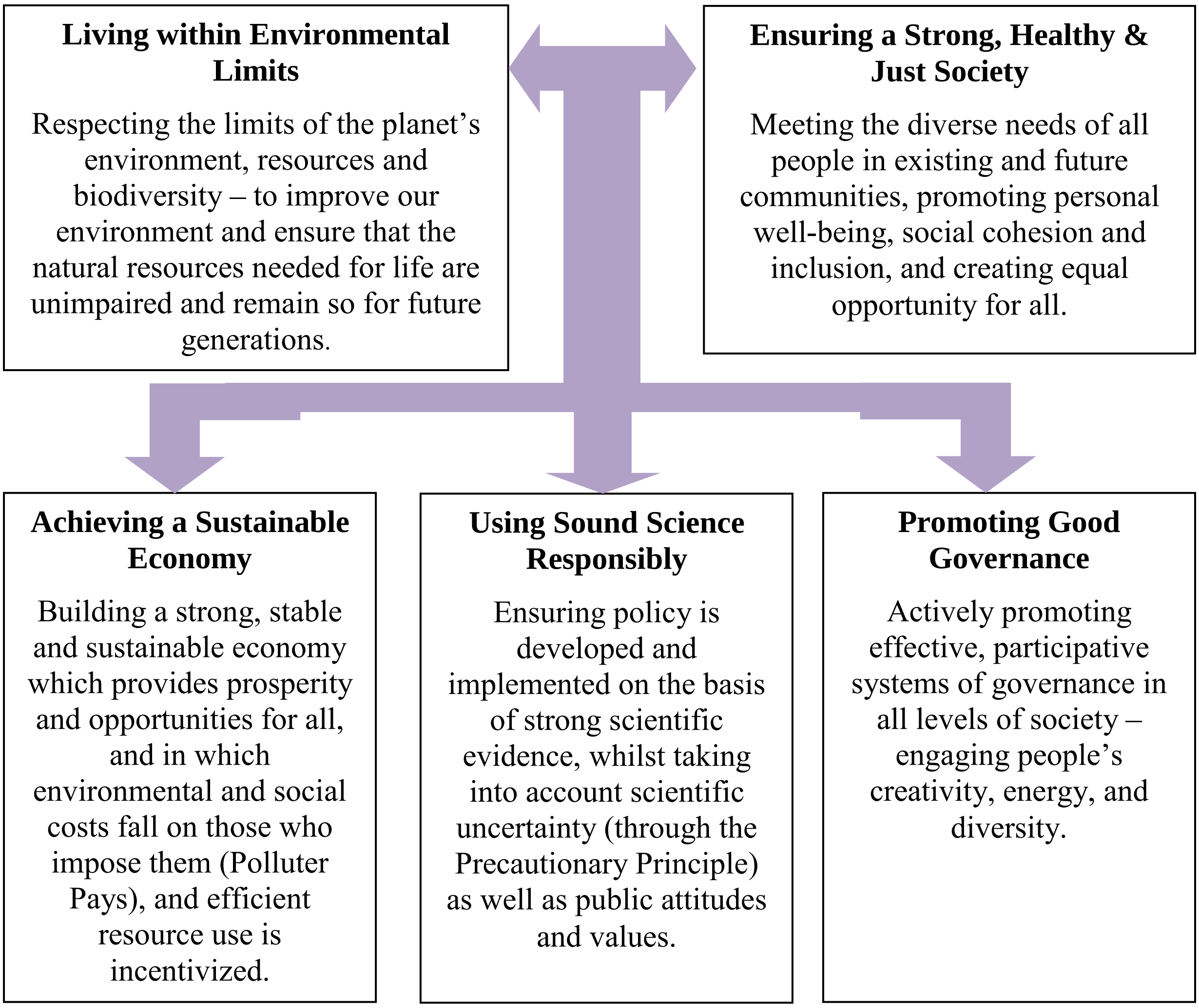


Figure 1-2 Shared UK Principles of Sustainable Development (SDU, 2008)

Sustainable development is not a new concept. Historically, humans have acknowledged, and largely acted upon, the need to harmonise environment, society and economy. What is new is an articulation of these ideas in the context of a global industrial and information society, with global environmental, social and economic concerns and collaborative efforts to sustain natural resources. Bartelmus (2001) and Parris and Kates (2003) pointed out that despite widespread acceptance of the Brundtland definition of SD and its success in building global coalitions of stakeholders, it did not provide enough details on what needed to be sustained, to what extent, and in what timeframes..

Many other research centres, academic Institutions and International Organisations have built on the concept of SD to suit their own objectives. In 1984, The United Nations Educational, Scientific and Cultural Organization (UNESCO) developed the Man and the Biosphere (MAB) programme. The concept was explained to demonstrate the importance of Biosphere Reserves as models of sustainable development (Maldague et al., 1984).

Strandberg and Brandt (2001) proposed a variation to the three-pronged representation of SD, by introducing a fourth element, technology.

In order to have a roadmap for future sustainability, four intersected systems have to be analysed: ecosystem function, economic performance, technological performance and social performance (see Figure 1-3).

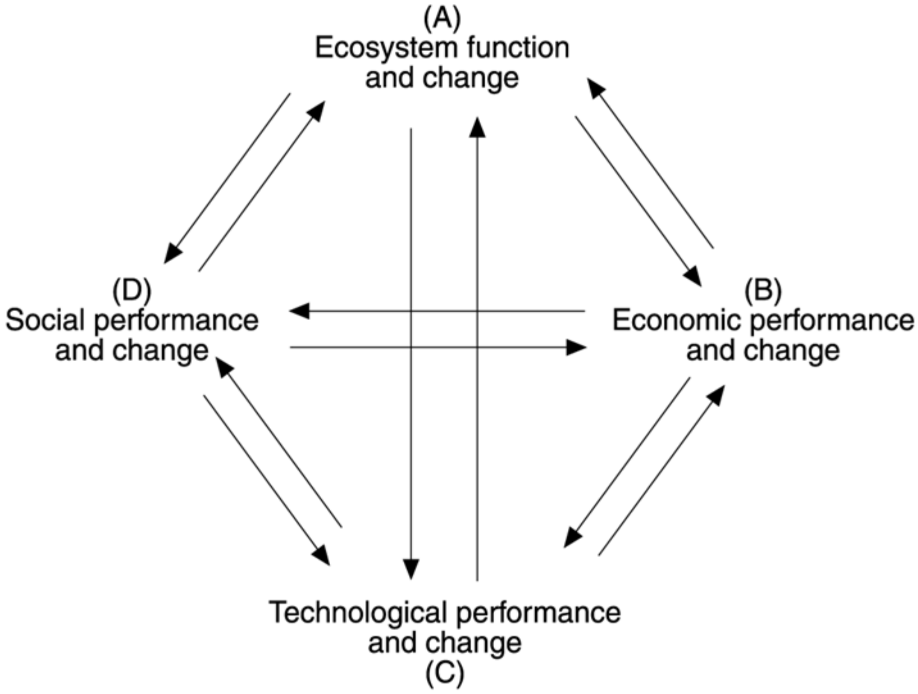


Figure 1-3 The Interrelations Between Ecological, Economic, Technological and Social Activities

1.3.2 Conflicting Objectives in Sustainable Development

Stakeholder conflict in natural resource decision-making over competing and conflicting interests and objectives continues to hinder sustainability efforts (Rockloff and Lockie, 2004).

According to Hasna (2007), sustainability means resolving the conflict among different competing objectives, and entails taking into consideration economic prosperity, environmental quality and social equity. Conflict can be considered the opposite of sustainable development because conflict is intrinsically destructive while SD is constructive. However, global environmental priority issues include global warming, water scarcity, deforestation, soil erosion, water shortages, and rapid population growth, which are contributing and exacerbating the current socio-economic problem, leading to more social and political tensions.

Accordingly, conducting an analysis of environmental conflict should take into consideration the structural development aspects that contribute to the conflict (Tänzler et al., 2004).

The United Nations Development Programme outlined that the integrated concept of human security, includes economic, social health, and environmental aspects (Spector and Wolf, 2000). According to Filho (2002), economic and social aspects, weak governance, and lack of democratic institutions, are some of the main causes of conflicts.

Principle 24 of the Rio Declaration on environment and development states that warfare is integrally damaging sustainable development (Johnson, 1993). Consequently, peaceful settlement of conflicts is essential to achieve sustainable development.

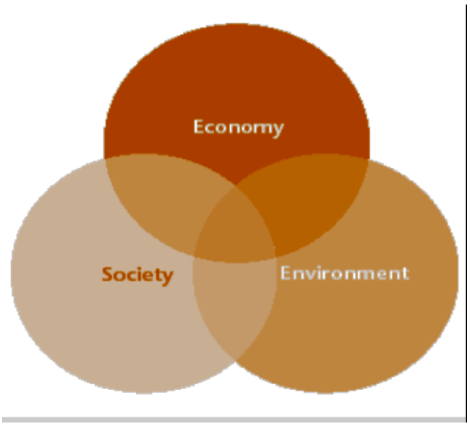
The exact meaning of sustainability is the focus of strong argument among environmentalists and resource economists. Sustainable development is referring to the unprivileged communities as suffering the most from the negative impacts of environmental deterioration (Wagner, 2004). Halle et al., (2004) regard sustainable development as a mechanism that enhances security through preventing violent conflict. Sustainable development sound policies are required to protect the environment from irreversible degradation (FAO, 2000).

Sustainable development, in regard to the sustainable use of natural resources while taking social aspects into consideration, is essential to the prevention of conflict (Switzer, 2002). Sustainable development, however, holds the three elements: environment, social and economic elements that are contributing to the emergence of conflicts. It is therefore, important to analyse the environmental conflict within these dimensions to understand how these dimensions are contributing to the conflict, and hence to better use the proper tools to resolve it.

Conflicting objectives is highlighted in the debate of strong vs. weak sustainability. Both terms entail a centralized decision-making process and a decision-maker who decides on behalf of "society" among alternative programmes and plans (Ayres et al., 1998). This debate is rooted in prioritizing the objectives of each party.

Technology, being one of the objectives, as a form of man-made capital is a major element in arguments of strong and weak sustainability that have strongly emerged within the theoretical debate as to whether man-made capital can substitute natural resources in the long term (Scottish Executive, 2006). Proponents of weak sustainability suggest that it can, whereas the strong sustainability view is that the ecosphere needs to be protected, humans must survive within the current Earth's environmental and ecological boundaries, and man-made and natural capital has to be considered separately. According to the same report, there is widespread agreement among theorists that weak sustainability has formed the conceptual basis for sustainable development. This debate is examined within the framework of environmental assessment, gauging the impacts of economic development on the availability of natural capital. According to Neumayer (2003), this argument can also be evaluated using assessment tools such as Ecological Footprint, in case of strong sustainability, and Genuine Savings and the Index of Sustainable Economic Welfare, in the case of weak sustainability. The strong versus weak sustainability arguments in many ways adopt the perspective of neoclassical economists that is the way in which nations manage their natural resource capital.

Figure 1-4 and Figure 1-5 illustrate a schematic view of strong and weak sustainability (Opio-Odongo and Woodsworth, 2004).



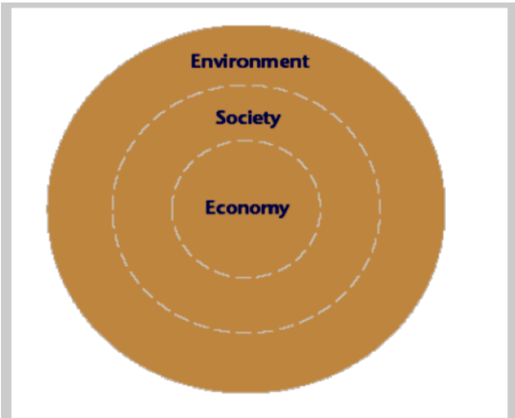


Figure 1-4 Weak Sustainability **Figure 1-5 Strong Sustainability**

Serageldin and Steer (1994) propose four types of sustainability: weak, moderate, strong and absolute. Weak sustainability refers to sustaining its total capital intake regardless of its composition. It suggests that natural capital can be converted into economic capital in the form of goods and services, regulated by environmental policies.

Moderate sustainability suggests taking levels of capital into consideration. Natural capital can be substituted but only within certain critical limits, and certain precautionary standards should be adopted for exploitation of natural resources. Strong sustainability focuses on maintaining natural capital at existing levels. It suggests that resource losses as a result of the current rate of development must be replaced, and damages to the ecological system remedied. Lastly, absolute sustainability refers to non-depleting and non-damaging use of natural resources. Absolute sustainability permits only the net annual increment of renewable resources to be exploited.

Conflicting objectives can be identified within the strong and weak sustainability debate in terms of the perspective adopted, whether eco-centric, anthropocentric (also termed “socio-centric”) or techno-centric (see Figure 1-6). Strong sustainability oriented groups are focusing strongly on the ecosystem as a whole, where all natural systems, nature, the universe are considered and must be protected, not just mankind. Weak sustainability groups tend to be anthropocentric, attributing a certain level of priority to the family, community and nation. Since the industrial revolution, development has been techno-centric (Misra, 2008).

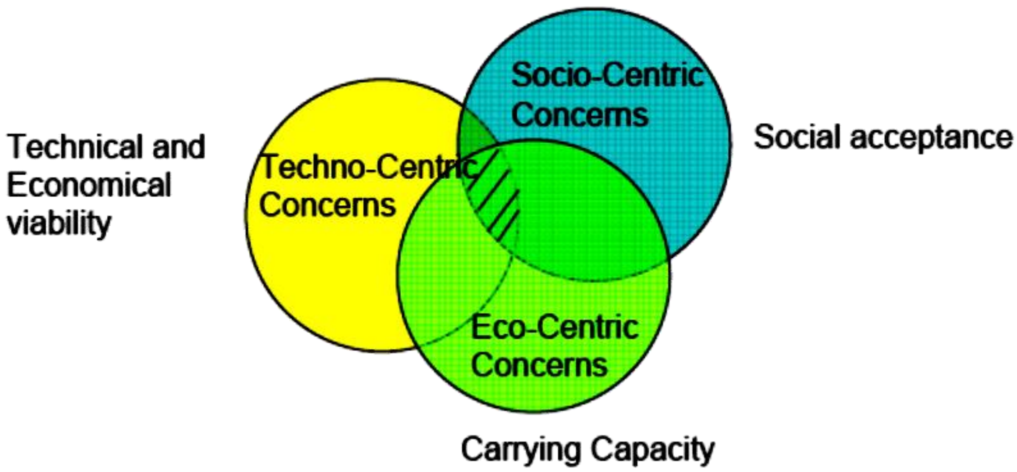


Figure 1-6 The Relation Between Eco- Centric, Techno- Centric, and Socio- Centric Concern (Misra, 2008)

The increasing capabilities of technology in the last two centuries have led to a certain degree of change in our planetary processes, as can be seen in issues like climate change and the global increase of synthetic chemicals (Wennersten, 2008). The role that technology could play in shaping the use of natural resources needs to be examined within the social and environmental domains.

Despite the many attempts to integrate industry and technology into the social and environmental context, including concepts such as Corporate Social Responsibility and management systems like ISO 14001, these processes are still not fully integrated within the environmental-social framework. The influence of these elements needs to be investigated to understand how these dimensions, individually and together, are affecting the decision-making process. This will ultimately assist in monitoring the effectiveness of integration programmes.

According to Brekke (1997), development is considered to be "weakly sustainable" if it is non-diminishing from generation to generation. Intergenerational equity, the prime objective of sustainable development, is viewed as a constraint to economic growth (Pezzey, 1989). At present, the theory that man-made capital can substitute ‘critical’ natural capital is widely considered untenable and this is unlikely to change in the future (Neumayer, 2003).

Harris (2002) considers developing countries successful when they have passed through various stages of maturity starting from traditional society, followed by economic development and reaching high rates of consumption. Rostow (1960) illustrated five stages of economic growth: traditional society, having the preconditions for take-off, take-off, drive to maturity, and the age of high mass-consumption. The developed world is now in its fifth stage as predicted by Rostow.

Sustainability requires a certain level of social and political stability. Engaging the public in the decision-making process is essential to achieving social stability and avoids potential conflicts. Marginalisation of communities and their exclusion from the decision-making process affects their natural environment, and usually results in various degrees of conflicts. In the last six decades, at least forty per cent of domestic conflicts were linked to natural resources and the environment (UNEP, 2009).

Effective management of natural resources coupled with public participation mechanisms can reduce the probability of environmental-based conflicts.

Hagmann (2005) suggests that researchers should call into question the concept of environmental conflict. He argues that it currently represents an unsuitable research strategy to comprehend human-nature interactions.

A methodology is needed to analyse the interaction between environmental pressures and the decision-making process. Analysing the degree of conflict is paramount to understanding at what stage environment-based driving forces could emerge as a potential source of conflict.

The present research attempts to test a situation on the ground where decision-makers have to reconcile their urgent need for development with consequences to their natural environment. Their decisions will ultimately have profound impacts on future generations. The Case Study in chapter 4 presents the main characteristics and context, in order to provide an understanding of the complex environmental issues and their inter-relation with the decision-making process. To a large extent, the case study provides an example of the implications of conflicting objectives and demonstrates stakeholder conflict representing strong vs. weak sustainability in practice.

The research attempts to overlay the decision-making process over hypothetically sustainable decisions to locate the areas of inconsistencies between what is taking place on the ground and what is considered "sustainable".

1.3.3 Environmental assessment frameworks

Environmental assessment frameworks are crucial to describe the cause-effect chains, quantify the natural environment and categorize the interdisciplinary development of indicators. The appropriate framework to use depends on the requirements and priorities of the target users who may be government officials, experts, international organizations, non-governmental organizations (NGOs), researchers and/or decision-makers.

The ultimate objective of any framework is to assess and monitor progress towards sustainable development. EA frameworks are tools to provide information about the progress of national and local programmes with regard to sustainable development. They define the environmental targets to achieve the SD plans. In recent years, there has been a shift from traditional resource- and sector-focused frameworks to more integrated methodologies that consider social, economic and environmental dimensions.

Traditional frameworks may be theme-focused (e.g. land degradation, soil erosion, water and air pollution and waste management) environmental resource-based (e.g. agricultural resources, forests, tourism and energy) or environmental media frameworks which mainly deal with land, air, water and biota (Ambala and Ocholla, 2006).

1.3.4 DPSIR framework

The Driving Forces–Pressures–State–Impacts–Responses (DPSIR) framework is used for assessing the state of the environment. It was developed and presented by the Organisation of Economic Co-operation and Development in the late 1990s as a framework for structuring and organizing indicators in a meaningful method to decision-makers (OECD, 2003). In the DPSIR framework, driving forces, caused by human induced activities or natural phenomena as a result of social, economic or environmental dimensions, lead to pressures on the environment and, consequently, observable changes in its state. The impacts thus caused provoke responses either at the policy level (social responses), or as natural response, or as an ecological reaction (see Figure 1-7).

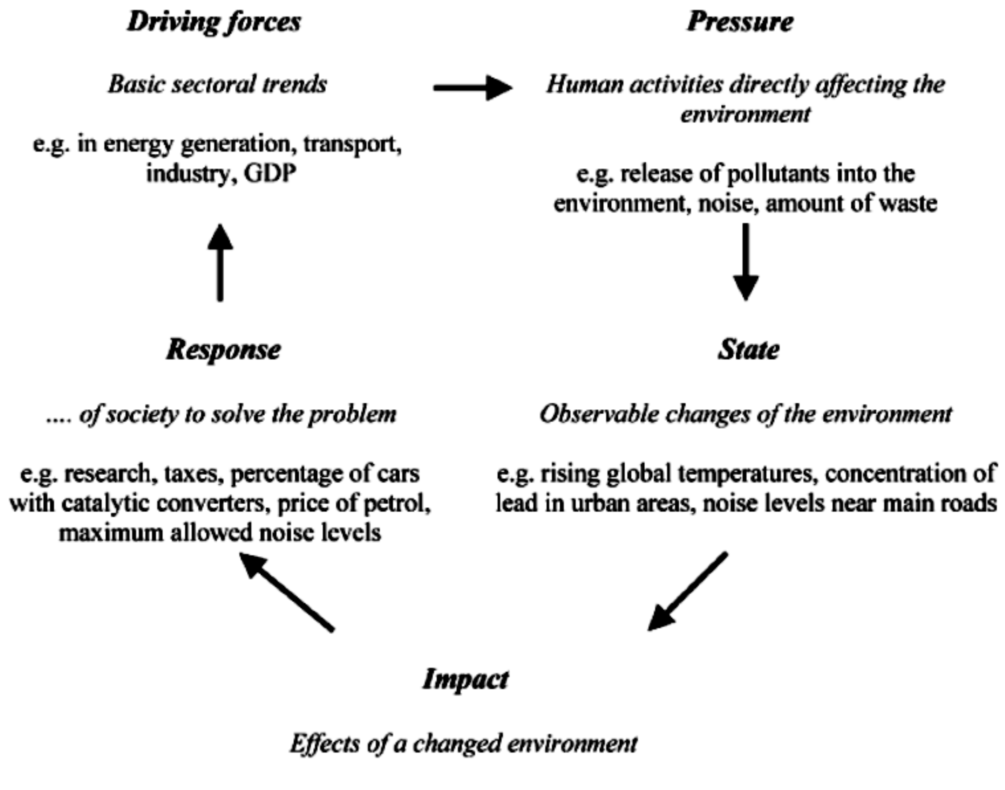


Figure 1-7 Driving Forces-Pressure-State-Impact-Response (DPSIR)

(After Jesinghaus, 1999 as Cited In (Bell and Morse, 2005), Model For Indicators of Sustainable Development

DPSIR is used for both model conceptualization and the structuring of policy relevant research (Svarstad et al., 2008). It uses cause-effect interacting relationships of social, economic, and environmental systems. Responses feed into the driving forces, the developed pressures, the current state, and the impacts on the environment making it an iterative process.

Rapport and Friend (1979) note that the Stress and Response framework, prepared by Statistics Canada in the early 1970s, can be seen as an early development of the DPSIR framework.

The DPSIR conceptual framework has been accepted as a methodology among the academic community and policy-makers for developing policy-relevant environmental research. (Svarstad et al., 2008). DPSIR has gained widespread approval and is used for interdisciplinary indicator development, and for structuring integrated environmental assessments (Walmsley, 2002).

The DPSIR framework appeared in its present form in two studies by the European Environmental Agency (Holten-andersen et al., 1995 as cited in Svarstad et al 2008). Its hypothesis is based on the cause-effect inter-relationships of social, economic and environmental dimensions.

It has been argued that the DPSIR framework's linear and over-simplistic approach means that it does not consider the system dynamics of environmental and social models and cannot truly represent the cause and consequence relationships. (Berger and Hodge, 1998; Rapport et al., 1998; Rekolainen et al., 2003).

The DPSIR is a linear environmental assessment that needs further enhancement to take account of the complexity of human dimensions. Driving forces can be cultural or socio-economic developments. Human population, which has increased from 5 billion in 1987 to 6.7 billion in 2007, is one important driving force exerting major pressures on the natural environmental (UNEP, 2007). Within this framework, population increase is envisaged as an external, human-induced activity that leads to pressures on the natural environment. It is a factor, among other variables, of economic growth, and the abundance of natural resources must exceed the number of individuals able to exploit these resources. The Law of the Minimum demonstrates that population growth is a function of the resource in shortest supply. Since inadequacy of physical and biological resources is a constraint for human population increase, social pressure and human vulnerability should be taken into account in this framework.

The simplicity of the DPSIR framework in identifying what should be considered a driver or pressure might affect assessment results if it is conducted in such a linear way. Social and economic dimensions should not be ignored when applying this type of assessment. Svarstad et al., (2008) showed the importance of further elaborating on DPSIR methodology to take into consideration the attitudes held by stakeholders and the public and their perceived magnitude of the problem.

DPSIR is described as a dependable robust scientific means for tackling and analysing environmental issues (Karageorgis et al., 2005).

The DPSIR is an analytical framework that is structured to integrate all the required indicators to draw a picture of the current state of the environment in any specific area at any scale. It highlights to policy-makers the status of the quality of the environment and the possible impacts of any decision. This multi-scale analytical capability coupled with its ability to assess potential impacts of decisions made render this framework more relevant to this research.

In the main, this research applies the DPSIR framework on a coastal sensitive area, taking into consideration the social dimension in identifying the drivers and pressures exerted on both natural resources and the humans exploiting it. Human vulnerability and economic factors will be incorporated while developing the basic elements of the framework. Various scenarios will be built reflecting different stakeholder perceptions which then feed into the different DPSIR elements. The research will try to identify and delineate the boundaries of sustainable development within those various frameworks.

The Organisation for Economic Co-operation and Development (OECD) adopted the Pressure-State-Response (PSR) model for its State of the Environment (SOE) group.

The PSR framework analyses the pressures that human activities exert on the environment. The OECD PSR model does not analyse the complex interrelation between human activities and the current or future state of the environment (see Figure 1-8).

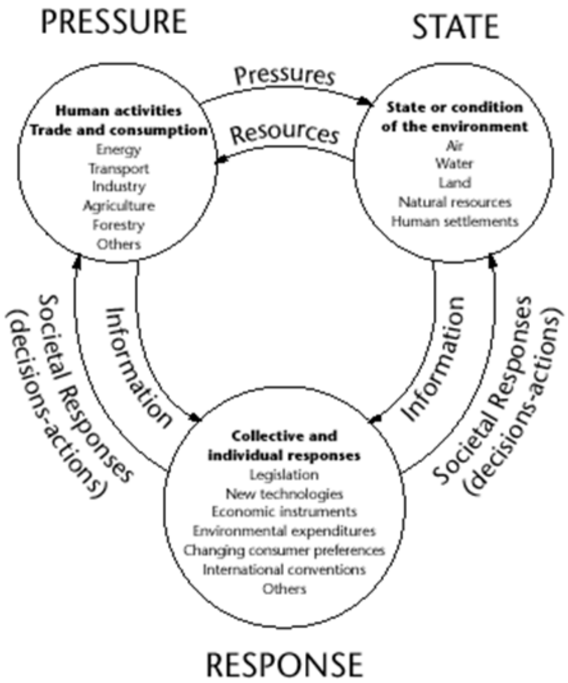


Figure 1-8 Pressure State Response Framework. Source: (ENS, 2008)

The United Nations Commission for Sustainable Development (UNCSD) has adopted the Driving Forces-State-Response model (DSR) approach to take account of non-environmental parameters (see Figure 1-9). In the DSR approach the driving forces is used synonymous to the main function for pressure in the DPSIR framework.

Driving Forces	State	Response
-Wood harvesting intensity	Forest area change	-Managed forest area ratio -Protected forest area as a percent of total forest area

Figure 1-9 UNCSD Indicators of Combating Deforestation (Source: UNCSD 1996).

The United Nations Commission for Sustainable Development (UNCSD) uses the Driving forces-State-Response (DSR) analytical framework to analyse Agenda 21 chapters. UNCSD uses DSP framework to classify the Driving forces, State and Responses indicators under four main sustainable development pillars (social, economic, environmental, and Institutional). UNCSD regards DSR approach as a proved useful in organizing the indicators (see Table 1-1).

Table 1-1 DSR Framework for Sustainable Development Indicators. (United Nations, 2001)

SD Dimension	Chapter of Agenda 21	Driving Force Indicators	State Indicators	Response Indicators
Social				
Economic				
Environmental				
Institutional				

1.4 The Research Problem

The phenomenon investigated is related to the relation between conflicting stakeholder priorities over natural resources and the degradation of the coastal sensitive area of Lake Maryout, Egypt. These types of conflicts tend to lead to decision paralysis on the part of the management authority and ultimately to environmental deterioration. The degree of complexity of environmental conflicts generally obstructs the understanding of the elements leading to the evolvement of the problem. There is a high degree of discrepancy and conflict of interests among stakeholders. Plurality of stakeholders coupled with conflicting policies, lack of coordination and integration, and lack of public participation in the decision-making process is leading to unilateralism of decisions.

Stakeholders’ priorities need to be analysed to understand the social, economic and environmental elements that are contributing to these specific priorities. Current environmental deterioration in Lake Maryout is characterised by a sequence of actions taken by main stakeholders. These actions have resulted from decisions that were taken by various stakeholders. These decisions therefore, need to be analysed to understand the mind-set of stakeholders and other groups, how these decisions were taken, and how differentiated stakeholder power may have affected these decisions. Stakeholders’ priorities not only have to be identified but also need to be analysed to understand the elements that contributed to construct these preferences. Saaty (1980) explains that it is not the precision of measurement on a specific element that determines the validity of a decision, but rather the relative importance that attached to the elements involved. To analyse the stakeholders’ decisions, we need to understand the assigned relative importance to all the contributing elements.

The use of MCDA method to map stakeholders' conflicts provides an effective tool to understand the locations of areas of disagreement and consensus. This allows decision-makers to improve their characterization of the problem and enhance their judgment and understanding. This enhanced understanding through mapping the conflicting priorities is improved by information obtained from the qualitative assessment of the area under investigation.

1.4.1 Description of the Lake Maryout Research Problem

Lake Maryout receives Alexandria's industrial, agricultural and sanitary water discharges. The lake's total area has been reduced from a total area of about 210 km^2 in 1960, providing about 40 per cent of Alexandria's fish harvest, to covering an area of 65 km^2 in 2007 (Helmy, 2007). The Lake is extremely polluted, mainly due to the discharge of raw sewage from Alexandria, untreated industrial wastes and agricultural run-off. Industrial pollution is at an alarming degree (Abdel-Shafy and Aly, 2007).

Industrial discharge is causing serious deterioration to the state of the environment of the Lake, and to the livelihood of the residents living around it. This level of degradation has eventually led to a noticeable decline in the quantity and quality of the fish catch, and thus to social and economic crisis in the fishermen community (El-Rayis, 2005). The research case study area is now the centre of various environmental threats to the city of Alexandria and to Egypt's Delta region. Lake Maryout has a regional strategic significance, being the element keeping the balance of water in the Delta region.

Without Lake Maryout, and without any direct drainage to the sea, the level of water will continue to rise naturally and gradually and will eventually flood wide areas of surrounding land. In addition, due to the scarcity of land for new development in Alexandria, Lake Maryout and its surrounding land has started to constitute an essential window for urban growth, as well as a significant economic resource for the city.

Degradation of water quality coupled with the gradual decrease of fish production is significantly impacting the local community living in Lake Maryout and surrounding areas. Generally, fishing activities are one the most dominant economic activities in the lake. The population that utilizes the lake is dominated by fishermen who rely both on fishery and vegetation to support their socio-economic requirements. Fishing is the sole source of income for the majority of fishermen, and vegetation is used for feeding livestock, making fuel for cooking, and as thatching for living quarters (World Bank, 2005). The fishing community in Lake Maryout is comprised of approximately 6,000 fishermen and consist of a regulated hierarchical structure. The hierarchical structure consists of a head fisherman for all of Lake Maryout, and then a head fisherman for each of the four basins. Each fisherman and/or family has fishing rights assigned in very well defined areas and are not free to fish anywhere they choose within the lake. There is no data that specifies the number of fishermen that utilize the main basin, but based on field observations and the total number of fishermen utilizing the lake, their numbers probably exceed 1,500 daily. This current situation results in a significant impact on the socio-economic resources of the main basin.

According to Abdrabo (2006), there are 2,073 fishing boats in the lake. The fishermen community working and living in and around the lake started to emerge in the late nineteenth century. The ancestors of the fishermen we see today came from different parts of Egypt. At the beginning of the twentieth century, the natural wealth of Lake Maryout, and its proximity to the markets of the then thriving cosmopolitan city of Alexandria seem to have attracted the new comers.

The wealth and prosperity the lake provided to immigrants, is not only proved by the migration of ancestors of the fishermen we see today, but also by their descriptions of the productivity of the lake, before pollution turned some of its parts into sewage dumps (Abdelrehim, 2001). The effective fish-rearing habitat of the lake has been progressively declining through the dewatering process. Silting of the lake bottom and the proliferation of Phragmites and other water reeds are two processes continuously decreasing the volume of the fish-rearing habitat. Since 1983, wastewater discharge into the lake has substantially decreased fishery by creating areas where water quality does not support commercially important species of fish. Another significant factor contributing to the depressed status of fishery is excessive fishing pressure throughout most of the lake. Small-scale commercial fishing remains an important economic activity on the lake.

The economic structure of the area is also affected by the tourism industry. Many new developed houses, hotels, and recreational areas have emerged in the last 10 years around the lake. This development has positive and negative impacts on environmental quality, as well as on the socio-economic aspects of the community. Land prices have risen very rapidly, which have positively reflected on the local community by providing more services. Another dimension of positive impacts is the concern of the tourism industry to have acceptable water quality in the lake. This meets the demands of both fishermen and environmentalists, represented by NGOs and the Ministry of Environment.

Urban expansion is yet another source of income due to the creation of jobs, and the associated services for these new residential areas. However, these new residential areas have been mostly built on filled areas extracted from the lake.

Industries which consist of more than 140 factories around the lake are one of the major contributors for boosting the economy and for providing jobs for local residents. They are, however, the major source of pollution, and are in constant conflict with the fishermen community, NGOs and Ministry of Environment.

This research examines the relationship between existing policy conflict, stakeholder conflict and environmental decision-making in an environmentally sensitive area. It investigates the root causes that shape the emergence of environmental conflicts.

The study analyses the temporal changes of natural resources and the subsequent change in stakeholder perception towards these changes. Environmental conflicts need to be addressed and resolved based on critical analysis of the circumstances, as well as on the social, economic, institutional and cultural aspects that lead to these disputes.

In an attempt to understand the root causes of environmental conflict, we need to assess the driving forces that led to this situation, the attendant pressures resulting from these forces, the current state of the environment, and the human interventions and responses in the form of policy actions or decisions. An environmental assessment encompassing these elements is vital to gain a bird's eye view of the disputed environmental area.

There is a need to develop a methodology to assess environmental conflicts by analysing the existing decisions and strategies of stakeholders that contribute to the degradation of environmentally sensitive areas. Various conceptual paradigms of the definition of sustainability need to be re-evaluated in light of the theoretical debate of strong and weak sustainability, in order to lay the theoretical foundation for locating concrete policy action within any disputed environmental area.

Researchers require an evaluative scientific methodology capable of examining environmental conflicts by analysing the decision-making processes that are contributing to environmental degradation.

1.5 Aim and Objectives

Given the serious consequences of the exponential rate of natural resource depletion at the global, regional and national levels, and the environmental conflicts this engenders, the research aims to develop a decision support methodology to assist decision-makers in assessing and measuring the degree of stakeholder conflict in environmentally sensitive areas.

1.5.1 Research objectives

To achieve the above mentioned aim, the research must achieve the following main objective:

> To develop a new methodology to assess, measure and rank the degree of consensus among stakeholders. The methodology is applied on simplified application of analytical hierarchical structure as an example to identify the main variables underpinning Lake Maryout's stakeholders' conflicting priorities.

1.5.1.1 Research specific objectives

I. To develop an understanding of the environmental, social and economic forces that shapes the direction of various stakeholder environmental decision-making processes.

II. To develop a spatial module capable of mapping preferences and priorities among stakeholders with respect to their identified alternatives to highlight the rationale behind these positions.

III. To provide the foundation for future research concerning the analysis of stakeholder environmental decision-making processes.

The first step in achieving the research aim is to investigate the root causes of the multi-dimensional aspects of any environmentally degraded area that is subject to stakeholder conflict.

The research uses stakeholder analysis techniques to lay another block in the methodology to understand the different perceptions and priorities that lead to environmental conflicts. The study compares the map of hypothetical sustainable development ideal decisions, to the actual decisions taken by various stakeholders in order to understand and compare the spatial consistency between both situations. This step is to evaluate the degree of shift between an ideal management strategy for the sensitive area and the current conflicting situation. Another important block of the methodology is to identify and rank the degree of consensus between various stakeholders in an environmentally sensitive area. The final step is to demonstrate results to various stakeholders and decision-makers to assess the plausibility of formulating different management strategies based on the understanding of other stakeholder conflicting priorities and the knowledge of the degree of severity of the conflict.

1.5.2 Research question

The main research question of the study is: How can understanding of the magnitude and direction of consensus among conflicting stakeholders shape the management of an environmentally sensitive area?

To answer the research question, three sub-questions need to be addressed:

1. What are the contributions of the environmental, economic and social aspects to stakeholder decision-making concerning an environmentally sensitive area?
2. Why does the differentiated influence of stakeholder conflicting priorities impact the environmental quality of a sensitive area?
3. How to measure and rank consensus between the conflicting perceptions of differentiated-power stakeholders?

To achieve the objectives of the study, several concepts and disciplines need to be merged, notably Decision Analysis represented by the Analytical Hierarchy Process (AHP), Geographic Information Systems (GIS), Environmental Assessment (EA), and public and stakeholder conflict management.

1.6 Outline of the Thesis

Chapter one gives an overview of the research topic, provides background information on the research area, brings in the concepts that are used in the research, and identifies the aim, objectives, research questions of the study. The chapter summarises the contents of each subsequent chapter.

Chapter two provides a literature review of public participation in environmental decision-making. It provides theoretical foundation underpinning the main argument of the methodology. The chapter goes on to investigate the various ways of addressing environmental conflicts, more specifically stakeholder conflicts. It analyses environmental decision-making under conflicting objectives. It reviews Multi-Criteria Decision making as a method for ranking of decision alternatives, based on preference judgements on a number of identified criteria. The chapter reviews literature related to the concepts of stakeholder participation in decision-making. It investigates the various types of stakeholder and methods to conduct stakeholder analysis.

The chapter reviews the public participation methods, instruments and techniques in the planning process. The chapter examines the links between decision-making tools, environmental sustainability and public participation techniques.

The chapter examines the environmental sustainability, concepts of sustainable development, and the conflicting objectives in sustainable development.

It reviews environmental assessment frameworks and investigates the applicability of using these frameworks, including the DPSIR framework, to this research as a tool to understand the root causes of environmental problems, and to investigate the inter-relationships between science, policy and decision-making processes.

Chapter three explains the different aspects of the methodology approach. It describes the research methodology, including the derivation of each step, and the methodology for selecting the case study. It demonstrates data collection techniques, the planning and design of the questionnaires used in data collection, the determination of sample size, and data manipulation. It reviews the research methodologies for addressing decision analysis. It examines the methods for participatory decision-making in natural resources management. It provides the key steps for using the research methodologies to develop the decision model. It provides the conceptual design of the decision model, and the utility of each step in the system structure in developing a conceptual design.

Chapter four explores the main characteristics of the Lake Maryout study area. The chapter critically reviews the current environmental, social and institutional status of the area of study in order to understand the main characteristics that led to the current degradation of its environment. The chapter conducts legislative, institutional and policy analyses of the area. The chapter identifies the major stakeholders in the Lake Maryout area and presents the main management challenges within the context of each identified stakeholder group. It introduces the different perceptions and convictions toward existing challenges to attain collaboration and agreement among stakeholders. The chapter conducts stakeholder analysis to identify the key stakeholders. The chapter analyses the stakeholders' priorities to identify the main alternatives.

The chapter investigates the spatial features and changes in the case study area that have occurred over a period of time, and tries to make the connection between these changes and the decision-making process. The chapter looks at the impact of various stakeholder decisions on the spatial characteristics of the area of study. The spatial analysis conducted in this chapter aims at answering one of the questions: What is the impact of stakeholder environmental conflict on the actual state of the environment in the selected sensitive area? The chapter therefore investigates the changes with respect to the identified alternatives.

Chapter five provides the detailed design, structure and results of the Environmental Decision Analytical Model. The chapter utilises and merges several techniques, including Geographic Information Systems (GIS), spatial analysis interpretation, decision analyses through Analytical Hierarchy process (AHP) and Integrated Assessment, to develop a methodology capable of measuring the degree of consensus among conflicting stakeholders and of representing spatially the distribution of consensus. It provides an understanding of how results can reshape the management of an environmentally sensitive area.

Chapter six validates the outcomes of the research model. It compares results to the analysis of the change detection to assess the consistency between the outcomes of the model and the situation on the ground.

The chapter analyses the feedback from stakeholders regarding the results to investigate how the results could be used in the planning process.

Chapter seven discusses the main findings of the research. The research tries to answer the main research question and to illustrate how the research objectives were achieved.

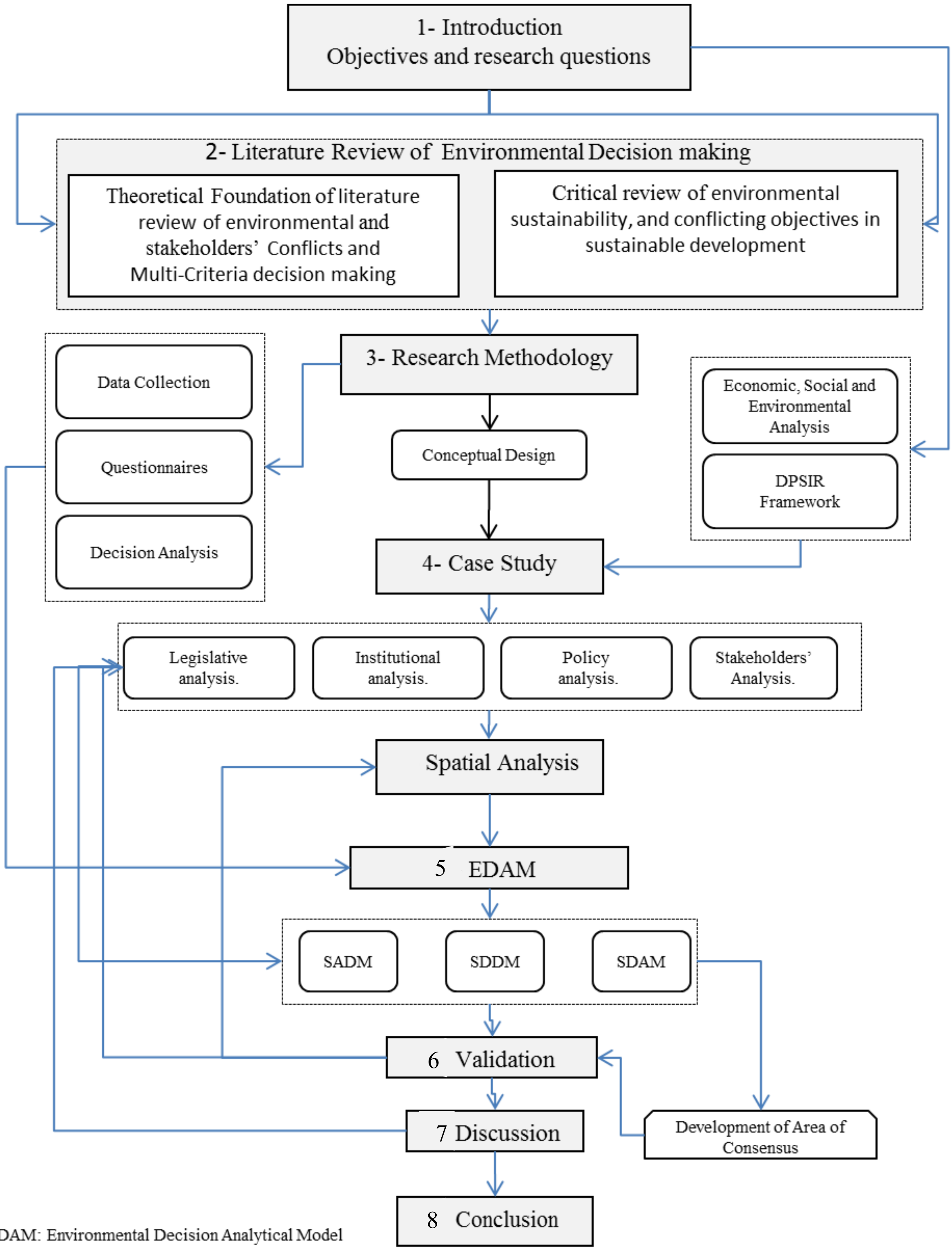
The discussion in this chapter tries to highlight the findings to develop an understanding of the outcomes. Results from different decision modules are discussed and analysed in connection with the findings. The final results are investigated within the wider context of stakeholders, institutional and policy analysis. The chapter tries to conceptualise the findings in a meaningful way that helps to improve policy- and plan-making, and thus assist in the environmental management of Lake Maryout.

Chapter eight wraps up the results and outcomes of the research. It explains the conclusion of the research.

The research concludes the method to develop a tool to measure and rank consensus between the conflicting perceptions of differentiated-power stakeholders. It demonstrates how the findings can help to develop a new methodology to improve the decision-making process. The methodology could assist in the management of environmentally sensitive areas.

The chapter provides a holistic view of the main findings of this research, to underline the constraints and limitations that affect the use of the methodology developed, and to recommend directions for future research.

Accordingly, the thesis followed a logical flow (Figure 1-10).



EDAM: Environmental Decision Analytical Model

SDAM: Stakeholders' Decisions Analytical Module

SDDM: Sustainable Development Decision Module

SADM: Spatial Analytical Decision Module

Figure 1-10 Thesis Flow Diagram

CHAPTER 2

PUBLIC PARTICIPATION IN ENVIRONMENTAL DECISION-MAKING

Chapter 2. Public Participation in Environmental Decision-Making

2.1 Introduction

Environmental decision-making (EDM) refers to the decision-making process that entails environmental consequences as a result of the decisions made. Measuring the impacts of such decisions on both stakeholders and the environment is a complex issue.

EDM is particularly a multifaceted process due to the complexity of the systems considered and the competing interests of multiple stakeholders (Ascough Ii et al., 2008). This complexity is forcing decision-makers to take environmental decisions under different degrees of uncertainty. In the perspective of environmental decision-making the problem of uncertainty largely exists because of the vast diversity of natural phenomena, the dynamic natural processes and the numerous complex interactions between nature and human beings (Sigel et al., 2010).

Therefore, contemporary environmental policies require an evidence-based approach so that prioritised, structured decisions can be taken with confidence by stakeholders (Pollard et al., 2008). In decision-making processes, evidence-based policy requires three essential elements to support its modern conceptions: high-quality information bases, skilled data analysis policy evaluation professionals, and political incentives (Head, 2011).

The process of public and stakeholder participation in environmental decision-making by definition has three main dimensions: public or stakeholder participation, the decision-making process, and the environment. To merge these dimensions into one process is to merge a complex array of established institutional and societal systems. As participation is becoming an accepted characteristic of better environmental decision-making, the tools for participatory decisions to incorporate stakeholder perspectives and priorities have been subject to analysis (Fischer, 1995; Perhac, 1998).

Public and stakeholder participation have been rooted in the environmental movements of the last century, which have led to increasing pressures on the international community to adopt a more global participatory approach in the decisions that affect the global environment. This is reflected in the growing number of countries adopting conventions and treaties that encourage public participation in environmental management.

However, this global trend has rapidly influenced the national environmental policy formulation, leading to more national environmental legislation that enforces the implementation of participatory instruments at the local level (e.g. Principle 10 of The Rio Declaration at the international level, the Aarhus Convention at the regional level, local Agenda 21 and the Access Initiative at the national level). Stakeholder participation is gradually more integrated into environmental decision-making processes, from local to international scales (Stringer et al., 2007).

These changes in environmental policies at the local level have impacted local institutions because there is a need to alter the methods by which the global environmental agenda and international demands are met, either by applying more restricted regulations or by enforcing more participatory processes. Developing and developed countries have experienced several conflicts during international forums because of the way certain countries have developed the cause, nature and solutions to the global environmental problems (Batabyal, 1996). New global political-institutional arrangements aimed at enforcing new environmental regulations have resulted in the emergence of environmental conflicts in the face of recent regulations (Lopes et al., 2007).

Policy and governance may also activate conflicts. Barrow (2010) explains that a subsidy to selected stakeholders may possibly result in overexploitation by other groups. Users may try to expand this advantage if enforcement is insufficient.

Fisher (2000) argues that there are numerous practical benefits for stakeholder participation, such as enhancing the quality and durability of decisions. Reed (2008) claims that these arguments have not been tested, and there is growing cynicism among environmental managers and conservationists who have not seen these claims come true. Fisher however, believes that many others have moved away from these critiques, to build up a more responsive, post-participation approach.

Involving stakeholders in the decisions regarding the planning process is important to ensure that their views have been considered in order to avoid resistance to the implemented plans, and hence to reduce potential conflicts. In this regard, new debatable concepts of planning practices have been recognized during the 1980s and 1990s (Healey, 1992). Healey points out that these new concepts focused not only on culture and consciousness, but also on collectively debating and deciding on subjects of collective concern. Stakeholder definition in this research refers to the group who can, in a positive or a negative way, affect or get affected by the human induced activities in the area of study. These groups can be social groups, governmental agencies, non-governmental organisations, local community, or any other institutions that meet the definition criteria.

The characterization of institutional collective objectives that this research is putting forward is largely in agreement with Healey's definition of institutions, "By institutions is meant the norms, standards and mores of a society or social group which shape both formal and informal ways of thinking and ways of acting. In this perspective, the 'governance' institutions of a society are "those values, norms and ways of acting which shape the realm of collective action – the relations between citizens, the regulation of individual behaviour in relation to wider social norms and the organization of projects of collective endeavour." (Healey, 2004, p.93). According to Ginter (1989), some stakeholders are powerful or influential, others could be influential concerning only specific issues, while others may have little influence and power. These institutions or social groups may exercise their differentiated influence or "power" on the arena they are exploiting, which may ultimately result in a shift in the decision-making process.

Michel Foucault views institutions as means to freeze particular relations of power to allow certain people to benefit from the system (O'Farrell, 1997). Foucault considers power as an enormous complex of different techniques for the disciplining of individuals, and as a means of regulating social groups (Bell, 1992). Power, as an essential idea of political discourse is frequently perceived as a negative connotation of control. However, Foucault (1980) argues that power has both positive and productive dimensions. He explains that power is accepted because it develops things such as pleasure, knowledge, and discourse, which have positive advantages to both individuals and society.

Varella Filho (2002) argues that conflict occurs mainly when individuals or groups experience that their goals, cultures, values, beliefs and interests are endangered by decisions that are taken by other groups. These decisions have not necessarily been taken by governmental authorities. Decisions regarding environmental areas can be taken by conflicting groups that reside and that exercise a certain degree of power in these areas. Foucault (2004) argues that across all of society the state is considered a codification of relations of power. However, Foucault emphasizes that the state is not the primary source of power.

Several key contributions in empirical research on environment-based conflict emerged in the early 1990s. These contributions were characterised by highlighting the importance of empirical evidence and a "process-tracing" methodology applied to several case studies (Hagmann, 2005).

The rapid increase in environmental change has given more attention to environmental security and the possibility of conflict (Halle et al., 2004). Global, regional and local environmental changes are increasingly attracting the attention at the scientific, political and technical levels. For example, the current global trend of urbanization has been highlighted by several United Nations organizations and several research centres, and was internationally acknowledged as a main concern of this millennium (Lopes et al., 2007). This exponential rate in urbanization coupled with rural-urban migration in many developing countries has created many land-use and land tenure conflicts. Environmental conflicts are common and becoming gradually more severe and frequent, as a result of the increase in urban population, coupled with industrial development, and the increase in competition for land use.

Conflicts over natural resources are not only caused by environmental factors. There are strong social and economic elements that contribute to the conflict. According to Mendonça (2004) as cited in (Lopes et al., 2007), the term socio was initially used to demonstrate that a number of environmental problems have a strong social dimension. The term integrates the social and environmental aspects on a scale not mutually exclusive, but complementary, as it is difficult to separate social consequences from environmental issues.

The conflicts in land use incorporate political, economic and environmental dimensions which can only be understood entirely by investigating the historical context within which the problems arose and intensified (Whitlow, 1985).

This research focuses predominantly on links between the decision-making process, environmental degradation, and acute stakeholder conflict in environmentally sensitive areas.

Accordingly, this Chapter analyses the forces that shape the environmental decision-making process, conflicting stakeholder objectives, and the role and influence of stakeholders' participation in this process. It is important to review the literature on public participation from conflict perspectives, to provide the foundation for analysis of stakeholder perceptions and conflicting decisions which are critical for this research. Therefore, the chapter reviews the historical foundation and the genesis of the concept of public participation during the last century. It identifies the prevalent international trends, and reviews the impacts of global agreements adopted on national legislations. It investigates the tools, techniques, origin and components of the participation process and analyses the main constraints for implementation. The chapter critically investigates the fundamental definition of community and public participation. It highlights the dilemma of representation within the community.

The chapter reviews the literature related to environmental conflicts particularly focuses on conflicting land-use of a natural resource and how conflicting priorities in decision-making are impacting the environmental quality of this resource. It highlights the environmental decision-making under confliciting objectives. It presents various tools for mapping environmental conflicts.

This chapter examines both the positive and the negative role of community participation in the implementation of local environmental management programmes. The research investigates the role of stakeholders in the decision-making process. It illustrates the challenges that have emerged as a result of implementing participatory approaches, and further seeks to develop a mechanism for accommodating the different conflicting objectives and perspectives of the community in environmental decision-making.

This chapter develops an understanding of the influence of environmental priorities on the decision-making process. This understanding is an important building block in the research methodology to analyse the environment-related driving forces that lead to these specific choices. Differentiated stakeholder perspectives with respect to the importance of the environmental resources assessed frequently results in differential shift in the decisions taken. Communicative rationality, the relationship between power, knowledge and discourse, collaborative planning and communicative planning theory, existing methodologies and models used for decision analysis are reviewed to provide the scientific basis for the research assumptions and to assist in providing the theoretical foundation for the research methodology.

2.2 Public Participation in the Planning Process

The participatory planning process aims to encourage participation between government authorities and the local communities governed, engaging active citizens to develop a consensus of their common goals, and participate in the planning and decision-making process. Healey (1997) points out that collaborative planning is not an end of the process but rather a pathway to co-existence in shared spaces.

There is an extensively accepted argument that if stakeholders are empowered to be engaged in planning and management the end result is more likely to be sustainable and cause less environmental damage, give better living conditions, and ultimately avoid potential conflicts (Rydin, 2003).

Various participatory planning processes are used in urban development, including communication, collaboration, argumentation planning and consensus building planning processes (Harris, 2002). Planning could be used both as a representation of continuous development based on political consensus and a mechanism for achieving it (Healey, 1974).

Ideally, the planning approach “would involve developing ‘conversations’ between stakeholders from different social worlds” (Healey, 1997, p.219).

Communicative Planning Theory (CPT) has initially been founded on the work of John Rawls and scholars of liberal democracy; however, they built up on Habermas’s (1999) theory of communicative action (Harper and Stein, 2006). According to Sager (2009), communicative planning is focused on informing the public through a process of stakeholder participation in the planning process, and not only by just communication means (Sager, 2009). The main principles of discourse ethics stress that the communicative process has to be transparent. Communicative planning is an open and participatory endeavour to engage a wide spectrum of affected groups in fair, transparent, socially oriented developments of their services, through a consensus-building process within the principles of discourse ethics.

Habermas (1990) formulated the term “open” as the right for everyone to speak and to take part in a discourse, to introduce or question any allegation or statement and to express priorities and needs.

According to Healey (1997), and Jørgensen and Phillips (2002), discourse refers to the method in which actors make sense of specific phenomena, particularly environmental problems, and assist in the understanding of what is happening in the world around us. Part of the discourse theory's basic assumption is that the used language is not a neutral reflection of aspects of the world, but has an active function in creating and changing it. They explained that in a specific discourse, some actions are considered logical whereas others are unthinkable.

Methods of community participation in planning investigate participation theory and practice from architectural, environmental, behavioural and planning perspectives (Yabes, 2000). The World Health Organization (WHO, 1999 as cited in OECD 2002) identifies five stages for planning: 1) need assessment; 2) identifying and approving a common vision; 3) developing an action plan; 4) implementing the plan; and 5) monitoring and evaluating.

Inglehart et al., (1996) show that the current stress on participatory processes is mostly a response to previous methodologies for decision-making that are perceived as inappropriate by today's well-educated and sophisticated public. The traditional, bureaucratic methods of participation in governmental decision-making do not work: they do not achieve actual public involvement in either the planning process or in making informed decisions, and they do not provide sufficient feedback to public officials for them to change their course of action significantly. However, traditional methods do have the advantage of representing the community well, including the unprivileged, and directly involve community members in decision-making. Rather than traditional formal, individualistic approaches, participation processes are increasingly dependent on methods borrowed from social science research, such as public opinion surveys and focus groups. (Innes, and Booher, 2000). Although these methods cannot actually be considered participatory, they can provide government officials or decision-makers with an analysis of public perception of a specific planning procedure. White and Samarkoon (1994) demonstrated that community participation is possible in Special Area Management (SAM); management of a defined geographical area. The planning process must involve people living within the SAM site, whether SAM planning is initiated by an external entity, national or local government, or by the private sector. Chettiparamb (2007) points out that case study-based research indicates there are grounds for both optimism and pessimism regarding effective public participation in planning.

The challenge is to build up a set of procedures and guidelines that fairly and accurately represent the society, and, during the participatory process itself, to eliminate the subjectivity and biases that usually occur during mediation or facilitation and when analysing the data that emerge from the process. The participation process in planning has some disadvantages. Among these advantages that there is no single authority to enforce consensus; the representing group can never perfectly represent the community; the perspectives may be short- rather than long-term; there may be bias and "group think"; lack of accountability when decisions are implemented; and differentiated power or weight for different stakeholder groups.

Planning process requires innovation through the creation of the ground within which programmes of action are prepared, and conflicts are identified and mediated (Healey, 1992). Urban design has to integrate local stakeholder decisions not only of fairness, but also to ensure fundamental quality of the results (Mehaffy, 2008).

Healey (2004, p.101) claims that "futures in complex city regions emerge through the energies of the many, not the designs of the strategic few".

Reviewing the implemented environmental planning policies in light of their impacts is rather important. This could be achieved through analysing the evidence on the ground in the areas where these policies have been implemented to understand the effect each policy on the environment. Wastell (2006) demonstrates the importance of evidence-based policy that is supported by information systems and GIS to the policy process. Remote Sensing techniques and GIS spatial analysis could be used as effective tools for acquiring this evidence.

Evidence-based policy considers exploring why the policy could be effective and what the potential impacts are in case of implementing or not implementing this policy, and its direct or indirect effects. The outcomes are structured decisions that help in improving social, economic and environmental results by relying on trustworthy knowledge and information. Structured decisions in environmental management require the participation of stakeholders of the natural resource affected by these decisions (Mianabadi et al., 2011).

2.2.1 *Public participation methods*

Reviews of public participation methods have concluded that all methods have strengths and weaknesses, depending on the size of the community involved or proportion of panel members in the consultation, the nature of the problem identified, the prevailing legislation and its application, the level of power within different stakeholder groups and the complexity of the decision to be made.

Abelson et al., (2003) conducted a literature review of the participation process, collating and evaluating the most significant multidisciplinary efforts regarding two aspects of public participation: studies related to the empirical aspect of methods of participation, consultation, practice and evaluation; and conceptual frameworks of participation theory with respect to the design and evaluation of the various processes of public participation. There is general agreement among all sectors of the added value of citizen participation in decision-making although controversy remains as to the best way to do it (Rowe, and Frewer, 2000). Reviews of various consultation methods have identified several methodologies for conducting the participation process, including citizens' juries, citizens' panels, planning cells, consensus conferences, deliberative polling, focus groups, consensus building, exercise surveys, public hearings, open houses, citizen advisory committees, community planning, visioning panels, referenda and structured value referenda (Abelson et al., 2001).

Each of these methods has its strengths and weaknesses. A citizens' panel is a group of local citizens that meet regularly to discuss issues of concern to the local community. Membership is rotating and representatives are replaced frequently in order to maximise representation. Citizens' juries have varying structures and mandates. It is an assemblage of indiscriminately chosen, non-elected active members of the general public that should symbolize the targeted community. They are informed about specific policy options in order to discuss it and reach a consensus on a decision. The group acts as a hub between government and the public and enhances communication between the two entities.

Planning cells have an identical function to citizens' juries and are concerned with the decision-making process at the local level. They provide a recommendation report to national authorities. Decision-makers, in turn, have to defend their positions. This method does have some drawbacks, notably the possibility of bias in the group and a tendency to short-term vision in planning.

The consensus conference is a deliberative fora method that consists of gathering citizens from different disciplines to discuss technical and scientific issues. It has two phases, first, to discuss the issues with the experts to build consensus, and secondly, to present recommendations to the general public. The strength of this method is that it provides a solid scientific and technical foundation to the decision-making process. The drawback is that it requires substantial scientific and technical resources. The consensus conference method is different from consensus building. The latter is an exercise that aims to assist in building consensus among citizens using mediation to help people focus on the issues presented. It helps to minimize differences between different stakeholders.

Surveys are effective for understanding the perception of different stakeholders and community representatives concerning a specific subject. The strength of this technique is its ability to reach a wider number of citizens. The weakness is that in some communities, especially in some developing nations and countries with undemocratic political systems, people tend not to express their opinions freely. The results of the surveys are also largely dependent on how well the surveys were designed, how the samples were selected, and how the survey itself was taken.

Public hearings are a method that allows information to be collected directly from representatives of interested citizens and stakeholders groups. The strength of public hearings is that they usually have a good balance of experts, politicians, government representatives, and scientists. The weakness is that hearings may be dominated by one group that has more influence or wields more power, and other interested parties may not be well represented. The process requires a moderator acceptable to all parties who has no preconceived ideas on the issues presented or bias towards any of the stakeholders participating in the hearing.

The effectiveness of participation methods, as discussed above, is dependent on the socio-political system and subject to cross-national variation. Often, survey questions need to be framed differently to gather information, such as questions about family income. This type of information can be gleaned more easily through indirect questions such as the cost of monthly electricity bills.

New approaches to public participation are needed to highlight the interaction between decision-makers and the public sector and to examine the deliberation among participants (Abelson et al., 2003).

2.2.2 *Instruments and techniques for public participation*

Instruments for active community participation originate from the basic principles of public participation, including the right to access information, the right to be consulted and to participate in the decision-making process, and the right to criticize, complain, appeal, and sue the entity that is causing the problem. Other basic elements of the participation process include media campaigns, and the right to protest and conduct demonstrations. Basic elements of democracy form the foundation for the participation process, including voting, electing representatives and participating in national or local referendums.

Tóthné Nagy (1994) identified five different types of instruments for public participation: Notice and Comment Procedures, Advisory Committees, International Treaties, Environmental Impact Assessments, and independent complaint committees. Different techniques are used for the various phases of the decision-making process and depending on the scale (local or national) of the planning process.

Notice and Comment Procedures can be used before decisions or regulations are made final, where the action is subject to review by the citizens. A review mechanism must be in place and an appropriate amount of time given to the public to consider the issue presented, after which the citizens provide written comments to the authorities. Public hearings might then take place to further elaborate on the subject and to brainstorm on the issue in all of its aspects, including social and economic impacts. Government authorities must explain their final decision to the public, and include its analysis of the document presented by citizens.

Advisory committees are formed at the national level. They usually advise central government on important emerging environmental issues. Where these exist, government must seek advice prior to taking conclusive decisions. All sectors of the society can be represented in the committee.

Information is a crucial instrument for the participation process. The public has the right to be well-informed, and publishing data and information is an important step towards involving citizens in the decision-making process. Freedom of information should be enshrined in national legislation and the constitution. Establishing a data-sharing mechanism among civil society, academic institutions, data providers, local authorities and governments is essential to ensuring effective participation.

The World Summit on the Information Society that was held in December 2003 gave a new dimension to public participation. It made a link between technological advancements in Information and Communication Technologies (ICT) and environmental governance. Mrs. Brigita Schmögnerová, Executive Secretary of The United Nations Economic Commission for Europe (UNECE) explained that "electronic information tools can enable us to work collectively for more inclusive political processes, allowing genuine participation of all citizens in all countries and broadening our joint quest for sustainable development". Several governments have demonstrated their new tools for electronic participation, not least the United Kingdom whose Environment Agency developed an online Pollution Inventory, allowing the public to locate information on the release of various substances in their neighbourhoods. (UNECE, 2009)

Font (1998) concluded that instruments of public participation highlighting the role of people do not necessarily resolve the possible conflict between general and specific interests. Participation instruments that are used over a limited time period do not adequately represent issues derived from the diminishing participation curve. However, the study shows that, in general, public participation instruments can improve the level of public deliberation and also develop an effective channel of communication between citizens and governments that ultimately could enhance the legitimacy of public decisions.

International agreements are considered a global participation instrument. Most of the International agreements deal with cross-border environmental issues. International treaties are agreements between governments, not individuals. However, ratification of the treaties must be conducted through national parliaments. This allows representatives of the public to discuss the implications of these agreements at the national and local level. International agreements, when ratified, have direct impacts on the citizens and may lead to changes in national legislation to meet the new regulations.

2.2.3 Standards for public participation processes

The International Association for Public Participation lists seven public participation standards representing the core values of the participation process: 1) when decisions will lead to actions that affect their livelihood, public consultation should take place; 2) the participation and contribution of the community should be able to influence the decision-making process; 3) the participation process should meet the needs of the community represented; 4) the community affected should be involved in the decision-making process; 5) the public should contribute to defining the methods and structure of participation; 6) participating groups should be provided with the required information in order to effectively participate in environmental decisions, and; 7) the public should be informed of the degree to which their involvement has affected the decision.

These core values are a global set of standards, not necessarily associated with specific political systems, religious beliefs, or ideological or cultural traditions (IAP2, 2008).

Arnestein (1969) developed the 'ladder of participation', a typology of methods used in public participation. He identified eight steps on the road from a complete lack of participation, through to participation and power-sharing, to full citizen control in decision-making (see Table 2-1).

Table 2-1 Ladder of Participation (Arnstein, 1969: 217).

8	Citizens Control	Degrees of citizen Power
7	Delegated Power	
6	Partnership	
5	Placation	Degrees of tokenism
4	Consultation	
3	Informing	
2	Therapy	Non-participation
1	Manipulation	

The participation process should meet certain standards in order to be considered a successful endeavour. Petts (1995) and DETR (2000) have identified a set of criteria, originally used to assess decisions taken by local government authorities (see Table 2-2).

Table 2-2 Criteria for a successful participatory process Source: (Petts, 1995 and DETR, 2000).

Criteria	Elaboration
Representatively of the participants	The extent to which the participants were representative of all stakeholders with a potential interest in the assessment of sustainable development
Transparency	The openness of the process, availability of all the background material and objectives to the participants, equal starting point with the organizers.
Early involvement	The stage at which a wider stakeholder-group is involved in the process, how much was decided before their involvement.
Task definition	The clarity of objectives and targets set for the outcome of the public hearings, comment rounds, etc.
Influence/compatibility	The extent to which the programme and the mandate for participation supported the objectives of those participating. This is an issue of the fairness and credibility of the process and ensures that substantive issues are not omitted from the discussion.
Degree of awareness and knowledge achieved	The level of awareness about the issues and the perspectives of the different stakeholders generated by the process. Optimization of consensus requires that those taking part are in an equal knowledge position to reach a conclusion.
Legitimacy of the product	Possible benefit to the decision process from participation and that can be shown (complaints afterwards, possible consensus in the end).

2.2.4 Adoption of participatory approaches

According to Renn et al., (1995), there are various arguments related to public participation. They presented that Webler et al., (1995) argue that public participation directly integrates the values of stakeholders and citizens in the decision–making process. Barber (1984), Saward (1998), and Elster (1998) agree, adding that this participatory approach actually leads to strengthening of democratic values within society.

Sairinen (2000) argues that the term ‘broad public participation’ implies that equivalent participation of different stakeholders representing society equates to environmental corporatism, where all sectors of the community can play a role at the negotiating table.

Different arguments were developed by Rosenström, and Kyllnen, (2007) who proposed that public participation could develop information that might be useful, or even essential, for the decision-making process.

This argument stresses the idea that involving the public in making decisions contributes to the quality and rationality of the decision. This "informational quality of decisions", (OECD, 2001) suggests that more participation from experts and sections of the community is justified because of its positive effects on the decision-making process. However, the question remains as to whether the decision- makers truly consider the opinions of stakeholders.

Smith (1998) proposed eleven reasons for applying public participation approaches at the local level. Table 2-3 illustrates the promoting factors of participatory approaches adapted from Smith (1998).

Table 2-3 Factors Promoting the Adoption of a Participatory Approach

Factors Promoting the Adoption of a Participatory Approach
Growing acceptance of global failures and recognition of the need for a different approach.
Increasing adoption of participatory approaches by institutions
Fulfilling the moral obligation to meet the needs of local people
Increasing recognition that participatory approaches can be beneficial throughout implementation
Recognizing the cost-effectiveness of participatory approaches
Enhancing the reliability and validity of research data
Increasing the knowledge base by including the local perspective
Current trend of transparency of operations and increased accountability to the public
Awareness that participatory approaches often result in increased acceptance and support
Realization that participatory approaches are linked to sustainability
Recognition that community participation ensures a greater likelihood of successful programme implementation

2.2.5 Public Participation in Policy-Making

Environmental policy is defined by the European Environment Agency (EEA) as "Official statements of principles, intentions, values, and objective which are based on legislation and the governing authority of a state and which serve as a guide for the operations of governmental and private activities in environmental affairs" (EEA, 2012a).

Environmental policy in many regions has been suffering from a lack of effectiveness (Lenschow, 1999; Jordan, 2002; Knill and Liefferink, 2007). To overcome this shortcoming, two significant strategies have been suggested and partly implemented; first to adapt the scale of governance to that of the level of environmental issues; and secondly to improve stakeholders participation in environmental policy-making (Newig and Fritsch, 2009).

The multifaceted nature of environmental problems requires decision-making process that takes into considerations a multiplicity of knowledge and principles. Therefore, stakeholder participation in environmental decision-making has been progressively required into national and international policy (Reed, 2008). To accomplish this objective at the national and sub-national levels, stakeholder participation tools are increasingly being implemented in the local policies. International community is providing technical assistance for many developing countries to encourage the participation process as an important instrument for the management of natural resources. As highlighted in chapter one, policy trends is increasingly emphasising sustainable development and stakeholders' participation (Richards, 2004, Younge and Fowkes, 2003).

Contrary to the increasingly trend of the benefits of participation in policy making, it is claimed, that several societal and environmental issues can be dealt with more effectively at higher levels of governance, more particularly in circumstances when local decisions are affecting third parties because of the prevailing interest structures of local actors. This is normally predictable with environmental problems categorized by complex spatial interrelations of social and ecological processes (Meadowcroft, 2002; Renn and Schweizer, 2009). A number of scholars also claim that public participation in the management process can in certain conditions have negative implications (Cooper and Elliott, 2000,; Lawrence, 2003). However, the overwhelming understanding is that the close link between stakeholders' participation and public policy making is highly important and that the main issue for researchers and practitioners is to find techniques of making this link more effective (O'Faircheallaigh, 2010).

2.3 Environmental Conflicts

Pruitt and Rubin (1986) define conflict as a “perceived divergence of interests, or belief that the various stakeholders' current aspirations cannot be achieved simultaneously”. Spillmann and Bächer (2005) views that environmental conflict can manifest as political, social, economic, ethnic, religious or territorial strife or discontent over resources, or national interests.

In the scientific literature, the term "environmental dispute resolution" describes the way of dealing with conflict rather than the nature of conflict itself. Bingham (1986) notes that this term "refers collectively to a variety of approaches that allow the parties to meet face to face to reach a mutually acceptable resolution of the issues in a dispute or potentially controversial situation". He explains that this type of process is usually voluntary in nature, and can "involve some form of consensus building, joint problem solving, or negotiation". Using the work of Jurgen Habermas and Michel Foucault (1998) it can be shown that there is indispensable tension between consensus and conflict (Flyvbjerg, 1998b).

Several studies predict that the increase in the scarcity of natural resources may lead to future environmentally related conflicts (Gleditsch, 2004). Baechler (1998), Thomas Homer-Dixon (1999), and Michael Klare (2001), and many other researchers have stressed on the link between scarcity of natural resources and conflict. Thomas Homer-Dixon (1999) views that environmental change can increase the risk of conflict because of increasing competition over declining resources. Other theories expect that environmental change can lead to more cooperation through addressing a mutual cause (Wolf, 1999). Both Homer-Dixon and Wolf acknowledge the contribution of social aspects and the impact of environmental degradation on the rise of conflicts. They argue that environmental degradation alone does not lead to conflict, but a social incapability to adapt to change does.

Daniel Deudney (1990) as cited in UNEP (2004) suggests that fighting to acquire limited resources is rarely rational, since there are cheaper methods such as conservation, trade, and substitution. Paul Collier and Anke Hoeffler (2002) have disagreed with this argument explaining the social situation, and that violent conflict is more probable to occur if resources are abundant.

Unsuccessful developments can also generate conflict, modify independence of any development that can trigger or relieve problems, and that a development or an unrelated change may bring to light already developing conflict (Barrow, 2010).

Environmental conflicts usually comprise economic, social and cultural elements. The social construction approach has been the main source of intuitiveness for conflicts related to social problems (Schneider, 1985; Spector and Kitsuse, 1977). Identifying the social aspect of an environmental problem is crucial to understanding the impacts of any environmental plans or policies, and hence to evaluate the positions of different stakeholder groups towards these plans.

An inconclusive study suggests that environmental conflicts are largely due to one or more of four factors: knowledge differentials as a result of misapprehension of the public; vested interests leading to unequal distribution of risks and profits; differences in values and in propensity to risk; and, lastly, stakeholder low level of confidence in the group of experts involved, specifically when they represent government or industry (Dietz and Rycroft, 1987).

Different levels of background scientific knowledge are major obstacles in achieving consensus. People representing the local community most affected by an action or policy are usually sceptical about the high-level technical analysis of the problem. Experts experience difficulties in conveying the scientific message of the different impacts of each proposed strategy. This knowledge and communication gap results in different values being assigned to the proposed action. What Dietz and Rycroft (1987) identified as different values, is a function of the degree of economic, social and cultural homogeneity. Analysis of stakeholder priorities and decisions may help to unveil the main causes of environmental conflicts, and can point to the direction where consensus can be achieved.

This research attempts to find a new approach to assess and delineate the degree of stakeholder conflict, and to find a collaborative stakeholder approach to resolve the conflict by identifying the key issues contributing to it. It is therefore crucial to examine different definitions of the two terms and approaches to identify and resolve environmental conflicts.

It is important to differentiate between the terms “conflict” and “dispute”. Burton (1993) argues that “disputes” involve negotiable interests, while “conflicts” are more concerned with issues that are not open to discussion and more related to ontological human needs that cannot be compromised. The Centre for Substance Abuse Prevention (CSAP) identified seven levels of controversy, namely; Difference, Disagreement, Problem, Dispute, Conflict, Violence and War. It claims that disputes occur when more than one party acknowledges the differences and the problem.

Morris (2002) identified three ways for identifying and addressing the nature of disputes: consensual, adjudicative or legislative. He explained that consensual dispute resolution refers to a process where parties in dispute can decide on the process and the outcome. This might involve negotiation, facilitation and mediation. Adjudicative dispute resolution refers to final decisions being made by another group, as is the case in arbitration or court adjudication. The legislative process of dispute resolution is mainly focused on rule-making by a certain group and could be through oppression or force.

Conflict can be viewed, addressed, and resolved by considering the way decisions are made prior to the conflict. Morris (2002) identifies four classifications of decision-making and how they affect relations between stakeholder groups in conflict situations. In “authority-based” decision-making, which is also power-based, the more powerful the group or individual, the more rewards they obtain. This form is very evident in developing countries where democracy is still growing and more authoritative, and centralised forms of government are the rule. It is a reality that affects any stakeholder analysis in these societies, since the weight of each stakeholder is not equal, and the ways to resolve the conflict need to reflect this power disparity. We build on this notion in the identification of “Key Stakeholder” in stakeholder analysis. The second form is “entitlement-based”, where the stakeholder group’s decisions are based on their rights or entitlements. The third is “interest-based”, and here the group tends to be in the domain of win-win negotiation and interest-based mediation. The final form is the rational approach, where the group is inclined towards peace-keeping, building relationships, involvement in group dialogues and reconciliation.

Building on the last form, and to maximise the rational approach, many international organizations have developed programmes to enhance negotiation skills for countries, local communities and individuals (see Figure 2-1). The acquired skills should include methods for effective collaboration, facilitation and mediation, stakeholder group positioning, organisation of public hearings, and using the Delphi method, simulation games, role play and iteration to minimise difference.

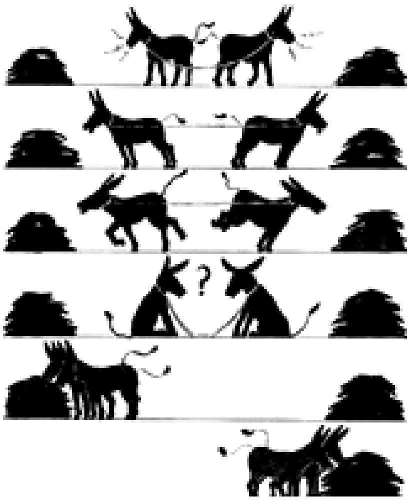


Figure 2-1 Improving Group Negotiations and Conflict Management Skills (UNC, 2002)

2.3.1 Conflicting Land-Uses of Natural Resources

Current increase of pressures on environmental natural resources, coupled with the rising awareness of the importance of these resources, has seen environmental conflicts become major aspects of land use and particularly coastal zone decision-making (Rockloff and Lockie, 2004).

High population density and scarcity of land to meet demand can result in a vicious cycle of increasingly accurate definition of property rights, investment, growth, and failure to act in response to these challenges with the proper institutional innovative measures that can lead to a downward spiral of conflict (Deininger and Castagnini, 2006).

Management of urban fringe is important to avoid the spatial combination of different land uses which can result in unresolved, land-use conflicts and nuisance complaints to government agencies (Henderson, 2005).

Land-use conflicts are considered a major concern for planners, as they need to understand the different aspects of these conflicts so that they can take structured decisions and better management of the conflict (Von der Dunk et al., 2011).

Land-use planning and management frequently expands across many sectors and organizations. This complexity and diversity regarding ecological problems, conflicting stakeholder groups is potentially leading to conflict among different sectors and groups exploiting the area.

Using the work of McGlashan and Williams (2003) it can be shown that there is a distinction between 'institutional stakeholders' which can be categorized as effective participants and organized groups representing a large quantity of interests, including technical expertise, industry, public organizations, local government authorities and state government agencies. The second group identified is the 'local stakeholders' that are usually small groups or individuals with inadequate organizational capabilities and resources to enable them to positively participate in planning processes or influence the decision-making.

Among various conflicting land-use problems there are the issues of resource access and land tenure and ownership. Resolving these issues raises questions concerning who has the right to access the resource, when they have that access, and under what circumstances (Reeve, 2001). Homer-Dixon (1991) points out that proper land-use management is important to reduce the risk of potential conflict.

For example, stakeholders of certain communities might believe that industrial activities are necessary to boost the economy in the area; however, industrial development will only be supported where this can be actually beneficial to the community to compromise environmental quality (Lockie and Jennings, 2002). Accordingly, conflict over development has often paid attention to the mitigation of social and environmental impacts, and to economic benefits, but not to the essential suitability of development to the region (Lockie, 2001).

Understanding the different dimensions of land-use conflicts is crucial for the planning process (Mann and Jeanneaux, 2009). The degree of complexity of land-use conflicts usually hinders the understanding of the issues leading to the situation (Alessa et al., 2008; Gresch and Smith, 1985). Campbell and Stanley (1996) looks at each land-use conflict as an exclusive situation that emerges from specific social, economic, and ecological interactions. Land-use conflicts have to be looked at from a political perspective in view of the fact that land use is highly regulated in most countries (Platt, 2004).

Stakeholder interests should be taken into account at an early stage in order to be considered in the management and project design, which may increase the probability that local needs and priorities are successfully met (Dougill et al., 2006).

Accordingly, in order for decision-makers, planners, agencies or institutions in charge of the management of an area subject to stakeholders conflicting objectives, to critically examine the environmental socio-economic aspects that have led to this situation.

2.3.2 Environmental Decision-Making under Conflicting Objectives

Classical decision theory considers rational decisions as structured decisions that maximize some utility function (Wierzbicki, 1997). Cost-benefit analysis is used as a common method to construct such a function to add a monetary value to all criteria (Christofides et al., 2005). Some criteria cannot be valuated, such as social aspects. For example, stakeholders of an environmentally sensitive area might consider scenery as a high value criterion. Willingness to Pay (WTP) concept is used as a utility function to valuate such criterion. However, it has been suggested that WTP method is not valid in many cases (Wenstøp and Seip, 2001). It has been reported that WTP surveys reflect the prejudices of people who have not been involved in public hearings or stakeholder deliberations (Arler, 2000).

Loomis and Feldman (2003) used another method to place a monetary value to the identified criteria. They used the hedonic price method (HPM), in a study of Lake Almanor, California, by examining the prices of sold houses around the lake and correlating them to the level of the lake at the time those houses were sold. According to Christofides et al., (2005), there are serious questions about the possibility of the HPM method to equalize all the factors. The method also uses a linear function and a simplification of the problem.

MCDA is used to avoid many of the problems associated with cost-benefit analysis and other tools, as its utility function is generally approximated by the weighted sum of the scores of the criteria (Christofides et al., 2005).

This complexity of multiple stakeholder conflicting objectives raises the need for decision-makers to expand their vision to comprehend the impacts of their decisions on other stakeholder groups (Westmacott, 2001). It is unavoidable that the outcomes of decisions and their comparative desirability will be evaluated differently based on the values and objectives of competing stakeholders (Jennings and Moore, 2000).

Diversity of stakeholder objectives and priorities makes it crucial for the decision-making processes to provide a framework for developing consensus and conflict resolution. Success in achieving consensus is dependent on having the proper stakeholder and decision-maker involvement in the process of understanding the root causes of the problem, and supporting negotiation and deliberation (Bingham, 1986).

Simon (1991) explains bounded rationality; individuals are limited by the ideas in their decision-making, the amount of information, the understanding limits of their minds, and the restricted amount of time they have to make decisions. Herbert Simon states that "bounded rational agents experience limits in formulating and solving complex problems and in processing (receiving, storing, retrieving, transmitting) information" (Williamson 1981, p.553). Simon (1957) points out that individuals are only, to some extent, rational while their decision-making is influenced by an amount of non-rational factors including emotions, prejudices and other subjective biases.

Bounded rationality accepts the relative constraints to coordinating knowledge and actions to take full advantage of given ends. Therefore, rationality is not the development of final or best possible strategies, but a ‘‘satisficing’’ or ‘‘bounded’’ exploration for solutions given these constraints (Simon 1957).

Building on Simon’s argument, it is important when managing stakeholder conflict not to try to find the best possible strategy, but rather to explore what is the most acceptable satisfying solution. Multiple Objective Decision Analysis (MODA) can provide an analytical framework to reach to that Satisficing outcome. Multiple objective decisions do not target the best solution in respect to all the identified objectives but rather reach a satisficing compromise (Froger and Munda, 1998).

2.3.3 Mapping Environmental Conflicts

The exploitation of the earth's natural resources in addition to the conservation of our natural environment are two conflicting objectives. In order to approach sustainable development, decision makers attempt to reach a proper equilibrium between these two conflicting objectives (Hipel et al., 1997). Mapping environmental conflicts helps in understanding how these priorities are conflicting. Conflict theorists present general qualitative principles for conflict analysis (Boulding, 1989). Other scholars conduct a comprehensive quantitative micro analytical method to understanding conflict (Deutsch 1973). Some theorists conduct combined types of analysis. Wehr (1994) developed a conflict assessment method that explains specific elements allowing decision-makers to create a roadmap by which a conflict opponent, a third party intervener, can find their way through a specific conflict. Wehr addresses the key elements of mapping of conflicts including; 1) Collect available information about the historical context of the conflict as well as its physical and organizational settings. 2) Conduct stakeholders and institutional mapping. 3) Identify causes and consequences. This could be done within the framework of environment assessment through applying the DPSIR framework as indicated in chapter one. 4) Identification of goals and Interests. This entails understanding the various priorities and preferences of all the conflicting parties. 5) Determination of main functions of a conflict which are its purposes or objectives. 6) Identification of regulation potential. This includes the understanding of the conflict's limiting elements. This could be done through the identification of laws and regulation applied in the conflict area.

Scientific literature provides diverse quantitative methodologies dealing with conflict identification, resolution, managing and mapping in natural resource management. Some are primarily based on stakeholder modelling techniques and agent based simulations (Giordano et al., 2007). These quantitative and combined quantitative and qualitative methods allow the integration of environmental and social systems, thus permitting the disaggregation of human decision making in environmental management (Hare and Deadman, 2004). These techniques allow the development of social structures from the interaction among stakeholders to be modelled (Moss et al., 2001). These models allow the understanding of the complex problems underpinning the environmental conflicts.

The Hocker- Wilmot Conflict Assessment method consists of a series of questions aimed to focus on the components of conflict. The method disintegrate the elements of the conflict as per the nature of the conflict, styles of conflict, degree of power, stakeholders goals, tactics, assessment of conflict, self-regulation and the attempted solutions. Both Wehr and Hocker- Wilmot assessment methods are valuable tools to produce information about the dynamics of specific.

Wehr (1994) provided many possible methods to assess and map conflict patterns. Metaphoric/dramatic approaches are used as a stepping stone for creative management options. Diagramming triangular relations offers valuable information about system dynamics. Sculpting is a nonverbal, spatially-based technique for categorizing patterns of communication within a larger system. Microevents are defined as evident, periodic patterns of behaviour that can be analysed for underlying conflict structure.

Metagame analysis method (Howard, 1971) and the conflict analysis technique (Fraser and Hipel, 1979) are examples of innovative quantitative methodologies to map variety of conflict conditions that can arise in the real-world.

Hipel (1979) outlines the conflict model as a combined systematic structure for describing the main characteristics of a strategic conflict. Fang and Kilgour (1993) highlight the solution concept as a conflict mapping tool that constitutes a mathematical description of a behaviour pattern. The solution concepts can be applied to conflicts having more than one decision-maker.

Advantage of quantitative methods such as multi criteria analysis, particularly AHP method to map conflicts lies in its ability to structure the utility of a system hierarchically in multiple objective frameworks and that the inconsistencies of the conflicting parties can be calculated in a meaningful way. The AHP method's relative advantage is its capability to handle real-life conflicting situations that are too fuzzy, unstructured, and very political to a degree that traditional qualitative methods which cannot measure.

The use of combined qualitative and quantitative method to map conflicts provides an effective tool to understand unstructured conflicting problems. It allows decision-makers to enhance their definition of a problem and enhance their judgment and understanding by the ability to identify areas of inconsistencies.

This improved understanding through modelling the problem is enhanced by information obtained from the qualitative assessment of the situation. It develops understanding of the behaviour of decision-makers, since their judgments are based on knowledge and experience (Skibniewski, 1992).

2.4 Role of Stakeholders in the Decision-Making Process

The term stakeholder has become increasingly fashionable. Ramirez (1999) points out that the word 'stakeholder' was originally documented in 1708, indicating a person who seized the stake or took a bet. In the last five decades, numerous definitions of the term have evolved. Friedman and Miles (2006) collated seventy-five definitions of the term, starting with one in 1963 by Stanford Research Institute in an internal memorandum referring to "those groups without whose support the organization would cease to exist". The historical concept of the term can be traced back to economic salience of stakeholders and to strategic management research relating the term to corporate governance and corporate social responsibility (Mahoney, 2007; Friedman and Miles, 2006b; Holzer, 2008). Freeman (1984, p.52) presented his definition of the term stakeholder as "any group or individual who can affect, or is affected by, the achievement of a corporation's purpose." Leaving aside management research definitions of "stakeholder", Röling and Wagemakers (1998) defined stakeholders within the context of natural resource management as "natural resource users and managers". This definition illustrates the participation issue from an environmental perspective.

Stakeholder theory has witnessed many developments and is considered a cornerstone in developing the analytical framework that assesses the impacts of a firm's activities on various groups (Friedman and Miles (eds.), 2006). In their work, Friedman and Miles distinguish between different types of stakeholder theory. Normative stakeholder theories present ethical foundations for describing how various participating groups should behave. Analytic theories usually present strategic rationale for stakeholder management, also described in literature as instrumental theories, although some is descriptive, focusing on the actual behaviour of stakeholders in specific conditions. The authors categorise normative theories by their degree of normativity or prescription, and analytic theories by whether they are descriptive or instrumental. Both theories are classified as being organisation-centric or stakeholder-centric. One example of organisation-centric stakeholder characterisation is a definition from Freeman (1984, p.34), which is actually a modified version of the Stanford Institute's definition. Freeman defines stakeholders as 'those groups who are vital to the survival and success of the organization'.

Schumpeter (1954) claims that stakeholder theories are related to economic valuation and the distribution of this value. Mahoney (2007) claims that stakeholder theory has its roots in two different varieties of property rights theory, classical property rights theory where ownership is described as residual rights to income (Alchian and Demsetz, 1972; Demsetz, 1967) and modern property rights theory where ownership is associated with residual rights to control (Grossman and Hart, 1986; Hart and Moore, 1990) as cited in Mahoney (2007). Property rights in this sense refer to any authorised behaviour by decision-makers in managing or exploiting resources and their being given the authority to use these resources within the limits of non-prohibited uses. Mahoney (2007, p.3) bases his definition of stakeholder on Clarkson (1995) and Post, Preston and Sachs (2002), defining stakeholders broadly as "those persons and groups who contribute to the wealth-creating potential of the firm and are its potential beneficiaries and/or those who voluntarily or involuntarily become exposed to risk from the activities of a firm". Mahoney's definition concurs with those of strategic management disciplines, where "stakeholders" include shareholders, debt holders, employees, local communities, government and others. It sees stakeholders from the economic perspective of value and wealth creation rather than from a broader "interest" perspective (Blair, 1995). Bowman and Useem (1995) argue that it is empirically foolhardy not to include employees in the stakeholder group. This co-dependence is mirrored in the International Labour Organization which also includes stakeholder representatives from governments, trade unions and businesses (Backstrand, 2006).

There is a strong connection between public participation in decision-making and democracy. The Nobel Prize-winning economist, Amartya Sen, argues that among the many great events and developments that have occurred in the twentieth century, the rise of democracy is the most significant (Sen, 1999).

Participation is defined as "a process through which stakeholders influence and share control over development initiatives and the decisions and resources which affect them." (ADB 2001, p.2). The desire of researchers to make the connection between group discussion and democratic process was apparent in scholarship and pedagogy throughout the twentieth century (Gouran, 1999). The importance of public involvement in the decision-making process originated from several ideological and pragmatic bases in response to various motivations (Rowe and Frewer, 2000). Human rights and environmental awareness have been two major movements that evolved in the second half of the twentieth century. The synchronization of the emergence of these two social issues has led to global recognition of the urgent need to have a collaborative effort to develop environmental legislation at the national and global levels. In the 1960s, public participation concepts emerged as an important notion and were largely approved by decision-makers (Yabes, 2000). Walker (2000) defines the term "public participation" as a pre-decisional communication between an agency or organization, in most cases a government entity, responsible for a decision and other organizational structures pertinent to public community. Walker showed that the term "pubic involvement" is used synonymously with public participation. According to Brown (1995), it is no coincidence that the term “public participation” became very popular in the 1970s, much as the term “sustainable development” did in the 1980s. The relationship is logical, since the participation process became an integral part of sustainable development.

Decision-makers need to have legal instruments to rationalise their decisions. In recent decades, democracy has been linked increasingly to the development of what is known as civil society (Sua´rez et al., 2008). Risse (2004) argues that stakeholder democracy can be identified within the liberal-reformist perspective of the global governance democracy process, leading to more accountability and legitimacy.

The stakeholder participation process is identical to the ideology of civic discovery in which citizens contribute to the shaping of their future. Civil discovery is a form of public forum where "opinions can be revised, premises altered and common interests discovered" (Reich, 1988, p.146). There is a strong connection between democracy and public participation. Citizens have the right to be consulted on the mode in which the government should operate or function. Cortes (as cited in Walker, 2000) showed that “democracy, at its heart, is distinguished by public conversations about the interests of citizens”. Public participation entails two main components, to be well informed and to effectively participate in decision-making. ETU (2002) identified three main areas to assess whether the public is well informed. They should be informed about the main issues and concerns of relevance to their community, know about developments in their broader society and be aware of their legal rights.

At the beginning of the 1970s the right to develop or modify environmental laws was firmly in the hands of ministers, high administrative authorities, legal entities and international treaties. This paradigm has changed and public participation in decision-making became an integral part of the process. There is now general consensus that public participation in environmental decision-making is essential (Webler et al., 2001). These fundamental changes in the attribution of environmental responsibilities were captured in Principle 10 of the Rio Declaration and in Agenda 21. There is broad agreement that public participation can result in improved environmental decisions, but no such agreement on a unified framework of how to measure levels of public participation in the decision-making process. The concept of public participation, where individuals and civil society take part of the responsibility for shaping environmental decisions, now reaches far beyond contributing to national constitutions, existing laws or environmental legislation, to include its function as a civil monitoring system for checking implementation of environmental regulations.

It is common nowadays to find environmental legislation, laws, regulations and policies calling for public participation in the decision-making process (ELI, 1999). Environmental decision-making entails certain obligations on the entities responsible for providing environmental information to the public (Nicholson, 1980). Public participation processes must provide the public with the required information to participate in a meaningful way (Delli, 1997). The need for an increased public role in environmental decision-making was clearly elaborated by the Aarhus Convention, adopted on June 1998 in the Danish city of Aarhus, on Access to Information, Public Participation and Access to Justice in Environmental Matters (United Nations Economic Commission for Europe, 1998). The Aarhus Convention describes the shared responsibility between the public and governments. It is considered not just an environmental agreement, but also a convention illustrating government accountability, transparency and responsiveness (UNECE, 2008). Protecting the natural environment is a collaborative process. It requires cooperation between government institutions, civil society, individuals, and the industrial sector in order to let these groups and society as a whole benefit from this participation. (Nagy et al., 1994). Environmental decisions can only be taken through a process of public consultation and deliberation. Woltjer (2000) looks closely at the participation process and differentiates between classical public consultation and modern participatory interactive policy-making. Expanding on this, Woltjer sees that traditional public participation has gained a legal basis leading to additional formal participation according to agreed regulations for community involvement. The post-UNCED environmental agenda integrates models of liberal environmentalism (Bernstein, 2001). 'Good governance', a term directly related to liberal economics and corporate structures, was seen as the magic bullet for tackling sustainable development challenges. Beginning in the 1990s, the participation process was increasingly regarded as synonymous with good policies and effective institutional frameworks (Lipschutz, 1996; Wapner, 1996).

Stakeholders can participate or be involved in the decision-making process at various levels. Inter-American Strategy for the Promotion of Public Participation in Decision-Making for Sustainable Development (OAS, 2001) identified four levels of participation: Information sharing, Consultation, Collaboration and Empowerment or Ownership.

Information sharing entails sharing knowledge and information about the issue with different stakeholders without involving them in the decision-making. Consultation means that the opinion of the stakeholder group is sought before any decision is taken and this group has the opportunity to express their concerns regarding the issue prior to the decision phase. At the Collaboration level, stakeholders have more influence on the decision-making process and in the formulation of the decision. Empowerment implies that stakeholder groups have the power to make decisions or at least has the power of veto. FAO (1990) developed a similar framework (see Figure 2-2) where having some form of knowledge about the subject and informing the public lies at the lowest level, being informed before decisions are made or being involved as advisory group is in the middle, and having influence on decisions through negotiation and mediation or actually getting involved in making the decisions collaboratively with other authorities is at the top of the scale.

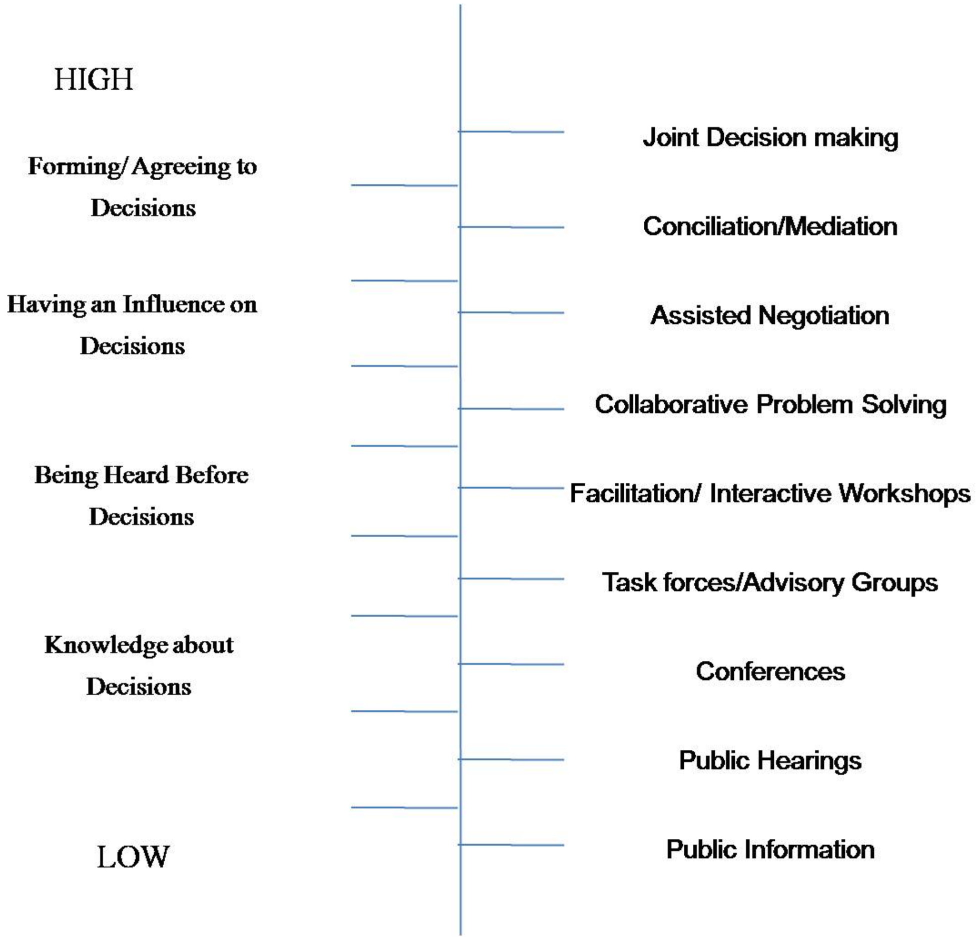


Figure 2-2 The Degree and Methods for Stakeholder Involvement (FAO, 1990).

Holzer (2008) shows that stakeholder participation in decision-making can be looked at from both ethical and strategic perspectives: ethical since the people concerned are those most affected and thus have the right to be consulted (Ulrich, 1998); and strategic, since in order to achieve success, stakeholders' opinions must be taken into account (Freeman, 1984).

Public and community participation is often associated with democracy, because the participating groups and representatives need to have an effective impact on the decision-making process. These concepts are linked to the input and output legitimacy mechanism which can be used in a heuristic manner (Scharpf, 2001). The assumption that participation brings more accountability and legitimacy underpins the 'governance from below' paradigm, in which the participation, stakeholder inclusion, and deliberation mechanisms of the affected community are a main driver and multiplier for developing collective problem-solving, leading to rational decision-making. Habermas highlighted that the lack of poverty and degradation is crucial to rational decision-making (Power, 1991).

The global environmental policy formulation agenda became increasingly dependent on implementation of this agenda at the local level. The requirements of international conventions have infiltrated local policies in recent years, causing a more participatory approach in local policy formulation.

The environmental assessment methodology now functions as an integrated network of research and management, leading to more links between academia, decision-makers and stakeholders to integrate policies and technical knowledge into action. (Beecher, et al., 2005).

OECD (2002) classifies public participation in the decision-making process according to: 1) how the process was institutionalised in national legislation; 2) the timing of the participation process; 3) the techniques and methods applied: and 4) the objectives and functions of the participation process.

Table 2-4 (adapted from OECD, 2002) illustrates different methods of participation and the main characteristics of each of these methods.

Table 2-4 Some Decision Methods and Their Characteristics

Type of decision method	Nature of participants	Characteristics and mechanism
Focus groups	Small group (5-12) representative of the public	Free discussion on general topic with little direction from the facilitator. Used to assess opinions and attitudes.
Citizen advisory committees	Small group selected by the sponsor	Sounding boards to measure community acceptance. Representation of major organized interests. Mainly instituted by local governments, also by certain major industries.
Planning cells	Small group selected by the sponsor	Randomly selected groups of citizens temporarily released from work to discuss certain issues in seminar form.
Citizens' jury/Citizens review panel	Twelve to twenty by stakeholder selected members of public	Panel, consisting of randomly selected group of citizens, studies a certain issue. Citizen's juries are intended to be representative of the community at large.
Regulatory negotiation	Small number of representatives of stakeholder groups	Representatives of various affected interests are brought together to agree on the content of regulations.
Mediation	Representatives of stakeholder groups	Voluntary attempt by parties involved to resolve a dispute normally assisted by a mediator.
Consensus conference	10-16 members selected as representative of general public	A lay panel with an independent facilitator questions expert witnesses chosen by stakeholder panel.
Public hearings	Interested citizens	Loosely structured open forums where members of the public can listen to proposals and respond.
Public surveys	Large samples representative of the population.	Questionnaires for obtaining a representative portrait of public opinion. Use is almost universal, and applied for many issues.
Citizen initiatives	Potentially all members of national or local population	Citizens place issues on the ballot for voter approval.
Referenda	Potentially all members of national or local population, at least a minimum proportion	Vote cast by the population on an issue. Outcome is binding.

Connor (1994) argues that people usually refuse to accept change when they have not been informed, or do not agree on the objectives, methodology, or timing of the proposed change. Connor concludes that not informing the public is often a recipe for disaster. Breggin and Hallman (1999) clearly see that local communities are ever more reluctant to act as sounding boards for entities that have already taken decisions that affect their livelihoods and their community. Development can be considered as a social process (World Bank 1996). This social process involves people in the same way that participation processes involve stakeholders, with an active contribution on their part (Ibid).

Table 2-5 (adapted after Oels, 2001 as cited in OECD 2002) shows the interests of various stakeholder groups and their contribution to the quality of the decision-making process.

Table 2-5 Purpose of Participation and Methods (OECD, 2002)

Articulating the interests of the different stakeholders		Contributing to the quality of decision-making	
Diverse stakeholder groups	Homogenous stakeholder groups	Community-based	Policy-based
Bringing stakeholders together	Involving communities of locality and interest	Monitoring and appraisal by citizens	Seeking informed views of citizens
Public meetings Planning for Real Mediation Consensus-Building Future Search Community Visioning Round Tables	Involving communities of locality. Local Agenda 21 Involving communities of Concern	Community Needs Analysis Priority Search Public Scrutiny Village Appraisal Parish Mapping Community Indicators	Citizens' Jury Consensus Conferencing Focus Groups Deliberative Opinion Poll Citizens' Panel Referendum Teledemocracy

As underlined in Article 6 of the Aarhus Convention, “the public concerned” needs to be given sufficient information as part of the decision-making process in order to carry out their role in an efficient manner (UNECE, 1998).

2.4.1 *Concepts and definitions of stakeholders, public and community participation*

"Community" is a term used to describe a clustered group of individuals having some form of relationship. Communities are considered the main stakeholders and beneficiaries in most public participation research. White et al (1994) showed that there is an evident association between the terms "community" and "participation". Definitions of public and community participation have moved away from the classical definition of community as "residents of an area" (Wolfenden et al., 1995).

Among these definitions is that of Petras and Porpora (1993) where a community is "a self-conscious social unit with a focus on common identity, interests and goals". EEA (2012b) defines "public" in its General Multilingual Environmental Thesaurus as "the community or people in general or a part or section of the community grouped because of a common interest or activity". Renard (1994) sees the community as a group of individuals with "common interests" or "functional links" that cluster them together. This common interest has been also elaborated by Chakalall (1991) explaining that factors uniting a group could include occupation, the area where they live, economic situation, and religion.

Communities are not homogeneous entities; they are to a certain extent diverse and heterogeneous. Accordingly, objectives of the community could also be diverse based on different priorities of stakeholders within each community.

In cosmopolitan societies, many of the new communities do not share the same values, or exert a collaborative effort to accomplish a common goal. In many cases, they are just haphazard groups of residents. This means that traditional definitions of communities have been evolved over time to a meaning closer to stakeholders or interest groups.

It follows that geographical and even historical bonds are not the cornerstone in forming contemporary and future communities, if the current trend remains the same. On the other hand, the fragility of defining community solely on the basis of common interests is its limited temporal dimension and the formation of what could be labelled as "circumstantial communities". Globalisation has also influenced the shape of modern communities, leading to the frequent use of the term "international community".

Intentional community is defined as "any consciously created community that has as its purpose the aim of living together cooperatively in order to foster a shared lifestyle that reflects core shared values." (Progressive Living, 2008). Representation of a specific group or community has to be considered with caution. The World Bank (1996) argues that any representation of the public or a specific sample of the community does not necessarily indicate that the sample perfectly represents the interest of the others.

The term “virtual community” has emerged in recent years as a result of the exponential increase in the use of Internet and communication technologies. Rheingold (1993, p.5) defined *Virtual communities* as “social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyberspace”. The new term has removed the locality from the definition and developed another dimension to the classical spatially delineated clustered group which forms a community.

Civil Society refers to society at large, external to the government, and the term is frequently used synonymously to refer to the NGO community. In practice, civil society comprises other actors of the community such as the academic and research sector, religious groups, trade unions, and community organizations (UN, 2003).

There is abundant literature on public participation, but no single, exact definition of the term (Mushove and Vogel, 2005). The term has been referred to in several works as public involvement. Petras and Porpora (1993) take care to define public participation in a way that is neither very concise nor too generic. They stress that the definition should be located somewhere in the middle. Beierle and Cayford (2002) define public participation as “any of several mechanisms intentionally instituted to involve the lay public or their representatives in administrative decision-making.” The EEA (2008) define public participation as "involvement, as an enfranchised citizen, in public matters, with the purpose of exerting influence", whereas community participation is “involvement in public or private actions, as members or as a member of a particular ethnic, political or social group, with the purpose of exerting influence".

The present research uses the term community in its classical ontology as a material form. It refers to a community as a group of local social residents sharing an identified spatial area. They are not necessarily homogenous, nor do they necessarily share the same interests or values. The research identifies the clustering of this group (community) as a result of exploiting or benefiting from the area’s natural resources.

2.4.2 *Stakeholder analysis*

Stakeholder Analysis is the methodology for identifying and analysing stakeholders. It is a useful tool to identify all actors, including primary and secondary stakeholders, who affect or are affected by current circumstances or proposed changes.

Stakeholder Analysis refers to a number of different tools or a methodology for understanding the structure of a group by identifying the main players and beneficiaries, and by classifying their interrelationships and assessing their interests (Ramirez, 1999).

It is considered an essential instrument in the fields of conflict management and dispute resolution (Smith, 1993; Ramirez, 1999; Swiderska, 2002). Within the natural resource management perspective, Grimble et al., (1995, p.114) defined the stakeholder analysis process as “an approach for understanding a system by identifying the key actors or stakeholders in the system, and assessing their respective interest in that system”.

There is a need to manage the stakeholder's point of view and perception to ensure their active participation. Hut (2008) concludes that stakeholder management is crucial to give stakeholders a sense of accountability, to ensure successful implementation and to promote sustainability (see Figure 2-3).

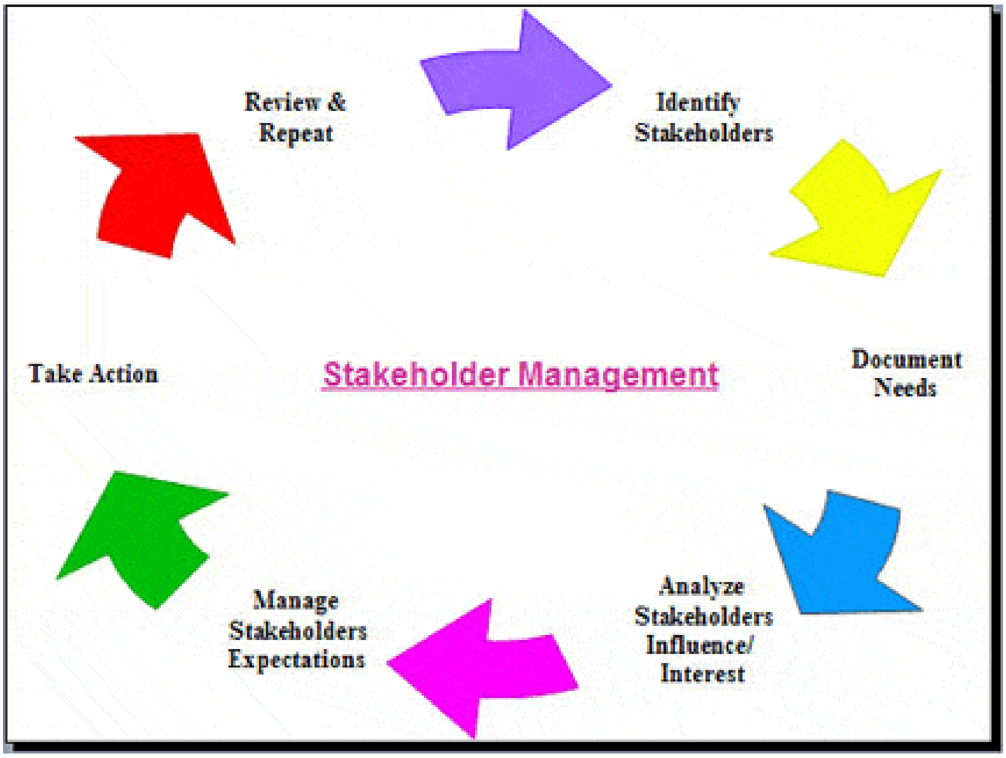


Figure 2-3 Stakeholder Management (Pm Hut, 2008)

Stakeholders' management provides stakeholder groups with a means to articulate their concerns, helps managers identify risks, and provides learning and capacity building opportunities.

Stakeholder influence-mapping is an important technique to understand and study the relative importance of different stakeholder groups and their degree of impact over decision-making (Mayers and Vermeulen, 2005).

The tool arranges different actors within a triangle or pyramid where the closer the group is to the apex, the more influence it wields over the policy-maker (see Figure 2-4).

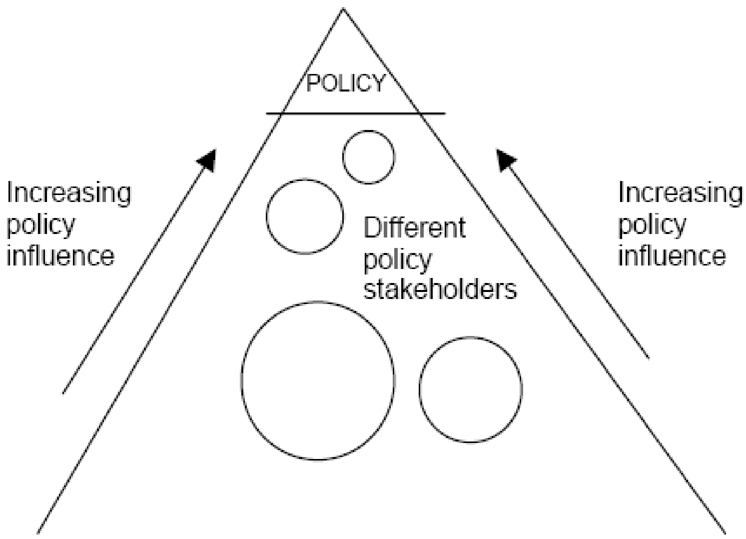


Figure 2-4 Stakeholder Influence Mapping (Mayers, and Vermeulen, 2005)

Stakeholders in policy analysis frameworks are usually selected according to the size of the group, how influential they are in terms of affecting national policies and their inter relationships (Ibid).

2.4.3 Types of stakeholders

Stakeholders can be classified by their power, degree of affectedness, type of influence and level of importance (see Table 2-6). The term "primary stakeholders" usually refers to those who will be directly affected by any type of action, while "secondary stakeholders" are those who are indirectly affected by the course of action. Key stakeholders are groups that possess a high degree of importance and could significantly impact or influence the decision-making process.

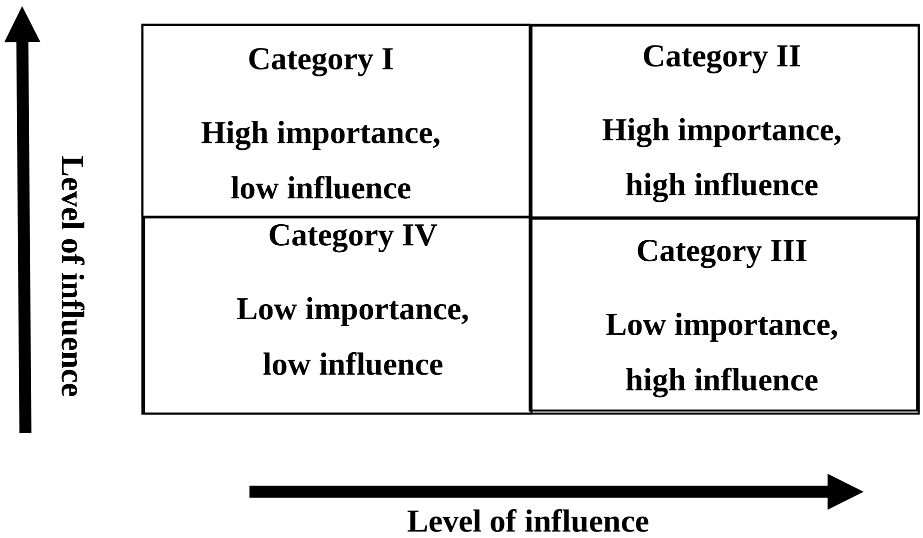
Table 2-6 Relative Importance of Stakeholders (UNEP/GPA 2007)

Influence	Importance					
	Unknown	Little/no	Some	Moderate	High	Critical Player
Unknown						
Little/no						
Some						
Moderate						
High						
Critical Player						

Stakeholder categorisation can include assessment of status, economic strength, place in the social structure and political power. In disputed areas, control over natural resources is another decisive factor.

The Importance-Influence Matrix is a categorisation of different stakeholders based on their level of influence coupled with their relative importance ranked and mapped on a simplified scale (see Figure 2-5).

Figure 2-5 Importance- Influence Matrix (IUCN, 2008)



2.4.4 Stakeholder conflict

Conflicts are inevitable, but they can be viewed as something to be avoided (Bracken et al., 1998). Scarcity of natural resources, coupled with mismanagement and unequal access to these resources, are potential causes of conflicts.

Conflict usually "occurs when one or more parties perceive incompatible goals and then equally perceive interference from the other in their desire to obtain their goal" (Tidwell, 1998). Collaborative approaches refer to ways of managing the conflict, where, as Gray (1989, p.xviii) notes, “those parties with a stake in the problem actively seek a mutually determined solution". Collaborative approaches are occasionally called alternative dispute resolution (ADR). Environmental dispute resolution was introduced in the United States in the early 1970s as part of "a larger trend in American politics toward exploring more cooperative approaches to social, economic and political problems" (Amy, 1987, p33). Fresh water, natural resource management and environmental policy frequently result in conflict ((Bracken et al., 1998). Environmental legislation became more effective during the late 1970s and 1980s, leading to a rise in the number of environmental cases reaching the courts. More environmental 'rights' are recognized, the potential for conflict increases. Courts simply do not have the time to be the exclusive arbiter of these rights.

"Collaborative approaches" related to conflict management are incorporating a variety of techniques in which the affected stakeholders actively look for a mutually determined solution (Gray, 1989). They can, however, face other obstacles such as existing legislation and very diverse conflicting objectives. A collaborative approach is used as a framework that embraces many processes such as multi-stakeholder problem solving or consensus-based decision-making.

Most stakeholder conflicts have a socio-economic and socio-cultural dimension. Smith (1993) argues that in the environmental conflict resolution model, stakeholder commitment is directly proportional to the degree of participant bargaining power. Conflicts are an existing fact of human society, ranging from personal disagreements to armed conflicts.

Modern conflict has changed from being between countries and several countries over ideology, to conflict within local boundaries, between civil groups. These conflicts have economic and social roots (Collier, 2000).

Susskind et al., (1999) point out that consensus building “involves a good-faith effort to meet the interests of all stakeholders”. Accordingly, to minimise differences and work on reaching a sort of consensus, stakeholders have to try their best to discuss the issues in good faith. It takes a lot of hard work, facilitation, mediation and iteration to reach a considerable level of good faith.

In the social integration theory, consensus is considered to be the ordinary situation in social life resulting from two parties interpreting diverse understanding of a situation, and that the social negotiation process is not capable of producing a rational coincidence of meaning (Van Dongen et al., 1996). Social issues such as poverty, inequality, and urbanization are elements of social vulnerability.

Local communities are becoming particularly vulnerable to environmental change, thus raising the possibility of conflict, which in various cases is apparently associated with environmental change and to social vulnerability (Tresman, 2004).

According to Adger (1999), social vulnerability has two dimensions. First, is individual vulnerability, characterised by people's access to natural resources, earnings and by social rank. Secondly, is collective vulnerability characterised by economy, institutions and people's adaptation and response.

Guba and Lincoln (1989, p.41) argue that consensus on all issues `is rarely if ever possible' and that there is a possibility that the articulation of differences and disagreement between stakeholders will lead to impasses, making conflicts visible. They explained that "an impasse is a clash of values, and a clash of values can ultimately lead to good dialogue and good dialectic".

The works of Jürgen Habermas and Michel Foucault shed light on an indispensable tension in modernity (Flyvbjerg, 1998a). Habermas introduced his 'theory of communicative action' and 'discourse ethics'. Habermas's theory of communicative action aims at "clarifying the presupposition of the rationality of processes of reaching understanding, which may be presumed to be universal because they are unavoidable" (Habermas, 1985). Habermas in his "*Philosophical Discourse of Modernity*," used the concept of "communicative rationality" to develop his inter-subjective approach to modernity.

The communicative rationality provides the implications of a non-coercively unifying, consensus-building power of a discourse in which the stakeholders or participants overcome their first subjectively based views in favour of a rationally motivated agreement (Habermas, 1987).

Foucault disagrees with the dialogical ethics in a counter discourse, and expresses that power has to be deconstructed to understand how human interests have a power motivation (Schindler, 2011). The work of Jürgen Habermas and Michel Foucault brings up the question of the effectiveness of empowering civil society on the decision-making process and on the relationship between consensus building and conflict.

Despite the fact that conflict can be a normal situation in social life, it does not necessarily mean that all conflicts are functional (Abma, 2000).

Abma notes that a conflict becomes dysfunctional if the stakeholders are no longer capable of perceiving that the different interpretations are the result of a process of social construction. He argues that where there is a dysfunctional conflict, the participants perceive the differences between them as `real'. For example, biodiversity conservationists and the managers responsible for the development of local communities are in many cases having conflicting objectives (Maikhuri et al., 2000).

Ignoring stakeholders' interests and not engaging them in the planning process, management of local areas and decision-making is the main source of conflicts (Lewis, 1996; Nepal, 2002).

There is considerable research covering topics related to management effectiveness and management planning, and that has been extensively utilised to assess and ensure the appropriateness of environmental sensitive areas, such as protected area management (Hockings et al., 2000; Thomas and Middleton, 2003). However, a few studies have assessed the environmentally protected area-community conflicts, analysing the correlation between social context and environmental attitudes of local stakeholders and the conflicts (Liu et al., 2010).

2.5 Existing Methodologies and Models for Decision Analysis

Decision-making process has been defined as "a dynamic process that involves a complete search of information, full of detours, enriched by feedback, and gathering and discarding information. It is an organic unity of both pre-decision and post-decision stages overlapping over a region of partial decision-making (Zeleny, 1981).

According to Skibniewski and Chao (1992), the process of decision-making consists of 5 main steps; 1) identifying the problem and developing a decision statement, 2) determination of the set of alternatives or potential courses of action; 3) developing a set of criteria for evaluating the alternatives, 4) evaluating the alternatives using the developed criteria and the main available information, 5) making the decision using the best alternative (see Figure 2-6).

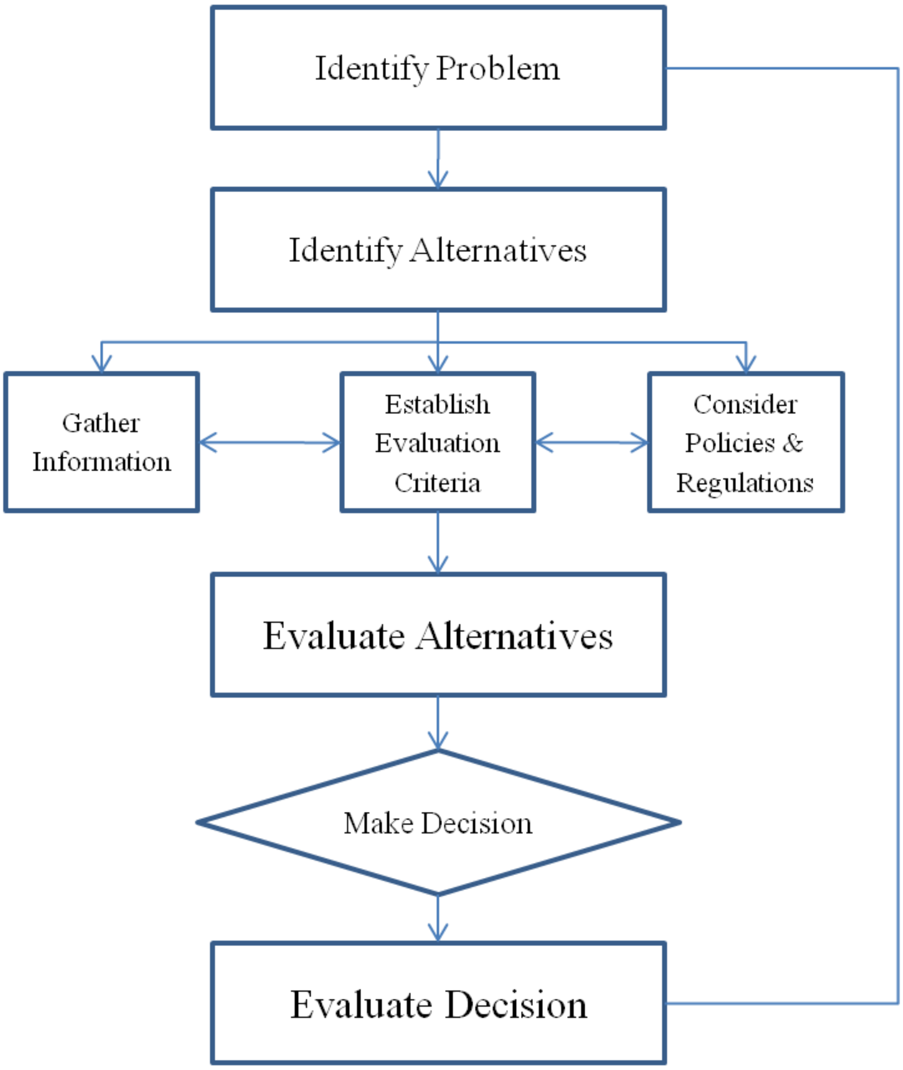


Figure 2-6 Decision-Making Process (J.Skibniewski and Chao, 1992).

Natural resource management involves making choices among alternative courses of actions, particularly taking decisions regarding alternative management plans.

Because of the complexity of the ecological, social and economic issues, making these decisions is very challenging. The decision complexity include the variety of management objectives, the participation of several stakeholders with multiple objectives, and the degree of uncertainty originating from a general lack of information about the ecological processes and relationships involving different ecosystems (Schmoldt, 2001).

Natural resource management entails the participation of a wide range of institutions and stakeholders. Stakeholders are increasingly demanding participation in the decision-making process. Stakeholders have become more knowledgeable, more organized and forceful to implement their objectives.

The decision analysis paradigm starts with the assumption that preferences can be recognized by mathematical models and can be identified explicitly. This function can take uncertainty into account.

In light of these underlying complexities, decision support tools are necessary to assist decision-makers take structured decisions with respect to natural resource management.

There are several research methodologies, conceptual frameworks, analytical tools and principles for studying decision analysis, stakeholder conflict and problem solving techniques.

2.5.1 SWOT analysis

SWOT is a popular applied tool in strategic decision planning. It provides a methodical approach in a decision situation. However, SWOT does not provide analysis to determine the importance of factors or to assess the match between SWOT factors and decision alternatives (Schmoldt, 2001).

2.5.2 Cost-benefit analysis

It is another tool that can be used as a common method to construct such a function to add a monetary value to all criteria (Christofides et al., 2005).

Because of the nature of the addressed problem of stakeholder priorities conflict, the research requires a research analytical method that can address and assess social preferences. Cost-benefit analysis focuses on economic aspects, however, there are other methods have been used to examine the societal preferences in environmental attributes (Ananda and Herath, 2003).

2.5.3 Mental self-observation

An introspection methodology; behaviourism theory based on the proposition that all things organisms do can and should be regarded as behaviours (Skinner, 1945), process simulation by imitating real life situations, and computer modelling. However, certain criteria such as social aspects are complex to a degree that cannot be easily valuated.

2.5.4 The Choice Experiment (CE)

CE is used in investigation of individual preference (Carlsson et al., 2007; Alfens, 2004; Burton and Pearse, 2002 and Burton et al., 2001). The theoretical foundations of CE depend on two main theories: 1) Lancaster's Theory of Value, which suggests that utilities can be broken down into distinguishable utilities for their characteristics or attributes, and 2) Random Utility Theory, which explains the main judgments made between pairs of offerings (Kallas et al., 2011).

2.5.5 Willingness to Pay (WTP) concept

WTP concept is used as a utility function to valuate such criterion. However, WTP method is not valid in many cases that deal with social criteria (Wenstøp and Seip, 2001). WTP surveys reflect the bias of participants who have not been involved in public hearings or stakeholder deliberations (Arler, 2000).

2.5.6 The conventional theory of economic policy

It is generally applies the paradigm of rational decision-making (Hafkamp and Peter Nijkamp, 1986). The majority of models designed for policy analysis assume rational behaviour of recognisable, individual decision-makers or of a collective decision agency. These models deal with a set of axioms for rational decision-makers subject to complex situations. These policy analysis models are mostly normative in nature (Harsanyi, 1979).

2.5.7 Conventional economic evaluation for environmental quality

It depends on contingent valuation to elicit judgments cast as replacement values in dollar terms. Contingent valuation involves posing a hypothetical situation, then asking survey participants how much they would be willing to pay to improve the environmental quality or to prevent environmental degradation. These replacement values are used as inputs into cost-benefit analysis (McDaniels, 1996).

2.5.8 Linear Goal Programming (LGP)

LGP is a mathematical programming decision-making tool. It uses objective functions for each of the criteria that underscore quantitatively what is required to be achieved considering economic, social and political constraints. It is mainly used for finding a solution for decision problem not to synthesise priorities. Liberatore (1978) explained that mathematical programming in general is not used at the professional level.

2.5.9 Merit Point System (MPS)

MSP is utilized for evaluating offers. The MPS method is established on allocating weights to relevant criteria to establish a total score relationship for the offer prices. The method can be tested outside its original boundary; however it lacks the capacity to construct relationships between the different attributes.

2.5.10 Normative, utility-based approaches

These approaches could be applied in cases of structured and simple judgment conventional situations. However, it is hard to apply this method in complex multi-group, multi-level, and multi-attribute decisions in light of conflicting behaviour of actors or stakeholder groups (lsard and Smith, 1983).

2.5.11 Regression models

Regression models can be to analyse stakeholder priorities. According to Schmoldt (2001), regression model provides as other methods, numerical results. The main difference is that the regression model allows an analysis of uncertainties. The work of de Jong, Crawford and Williams (1985), and Alho et al., (1986), Alho and Kangas (1997) proposed a Bayesian method to the regression model, that regression model can present the results in an easy way that can be understood by decision-makers. However, Leskinen and Kangas (1998) showed that it analyses interval preferences data as an alternative to having preferences given as a single number in the Bayesian regression framework.

2.5.12 Research surveys

Qualitative methods based on stakeholders' interviews, public hearings, focus groups, surveys are useful methods for understanding the problem. It is mostly used when communication with stakeholder groups is difficult.

In research surveys, the views of a selected group of experts are surveyed and the results are analysed. Surveys can be mostly useful when the sample size is big. The disadvantage of this method is that interpretation of the analyses is a key factor. Misinterpretation of the provided qualitative information will be reflected of the accuracy of the outcome.

Qualitative methods cannot measure the comparative degree of opinion with respect to another opinion. It can only provide an order of priorities based on the respondent initial judgement. It is hard to analyse components of the decision to understand its environmental, economic and social aspects that are contributing to the formation of these decisions.

2.5.13 The Delphi process

The Delphi process technique is a methodology for acquiring judgments on complex issues where accurate information is unavailable (Skutsch and Hall, 1973). Helmer (1967) showed that the very first applications of the Delphi method were developed by the RAND Corporation (an acronym for Research and Development). The main objective was to assess the direction of long-range trends, particular for science and technology, and their possible implications for society.

Adler and Ziglio (1996) identified the Delphi Method as a structured process for collecting and extracting knowledge from a group of experts by means of a series of combined questionnaires with controlled opinion feedback.

Questions are sent to respondents several times in order that they change their preferences after getting feedback and explanation on previous answers. The final decision is reached through consensus or vote.

This method is not applicable for this research. The study investigate the elements of the stakeholders decisions that led to take these choices and hence to work on the enhancement of the root causes of the conflict rather than trying to reach consensus with the existence of the conflicting current elements.

2.5.14 Decision Support Systems (DSS)

DSS are interactive systems that assist decision-makers to use data and models for resolving unstructured or semi-structured problems (Nelson Ford, 1985). Hicks (cited in Mallach 1994, p.5) used a similar definition of DSS as “An integrated set of computer tools that allow a decision maker to interact directly with computers to create information useful in making unanticipated semi structured and unstructured decisions”. Keen and Wagner (1979) define DSS as a computer based model that managers and immediate staffs use to support managerial decision making. DSS is an information system with a primary objective to provide knowledge workers with the required information on which they can base their informed decisions (Mallach, 1994). Therefore, the design of a DSS includes the end user’s acceptance of the developed DSS (Matthies et al., 2007; van Delden et al., 2007).

Mallach (1994) categorises DSS as either information systems or systems that are used by managers and decision-makers. He explained that DSS are mostly used to support the process of making a decision rather than to replace people.

2.6 Multi-Criteria Decision-Making (MCDM)

Multiple-criteria decision-making comprises making a decision that has more than one criterion. Criteria are the standards and measures that assist decision-makers to meet their objectives. They are the attributes, objectives, or variables which are important for a specific condition by a particular decision-maker (Saaty, 1991).

There are many definitions of Multiple Objective Decision Analysis (MODA), and many other sub-terms describing them, including Multiple Objective Decision-Support Systems (MODSS), Multiple Criteria Decision-Support Systems (MCDSS), Multiple Criteria Decision Models (MCDM), Multiple Criteria Decision Analysis or Multiple Criteria Decision Aids (MCDA), and Multiple Criteria Analysis or Assessment (MCA) (RAC, 1992). MCDM methodology is particularly using the ranking of decision alternatives, based on preference judgements on a number of identified criteria (Beynon, 2005).

Distinction must be highlighted between Multiple Objectives Decision Analysis and a single objective. Multiple objectives refer to a situation where stakeholders have many values and objectives regarding a particular decision, noting that an individual decision-maker can be subject to multiple objectives. Single objective decision-making is optimising only one criterion (Archibugi, 1989).

2.6.1 Multi-Criteria Decision Analysis (MCDA)

In recent years, a number of tools and guidelines for complex decision problems and risk management have been developed and introduced, and these are of strong relevance to stakeholder participation (Can/Csa-Q850, 1997).

An analytical decision tool is required when there are qualitative variables, and stakeholders have to make the best decision from many preferences.

It is recognized that multi-stakeholder decision-making processes are complex and multi-criteria in nature.

MCDA is compatible with several decision analytical tools, particularly AHP method and is widely recognized framework for supporting multi-stakeholder environmental decisions (Teng and Tzeng, 1994; Maguire and Boiney, 1994; Bellehumeur et al., 1997; Regan et al., 2006; Gutrich et al., 2005).
Analytic Hierarchical Process (AHP) is the most commonly used MCDA process for analysing a predetermined number of alternatives (Saaty, 1980). AHP method is an excellent method for analysing decision-making in natural resources management (Schmoldt, 2001).
The implementation of MCDA techniques is essential to analyse and resolve these complicated multi-criteria decisions problems.

MCDA is used to avoid many of the problems associated with cost-benefit analysis and other tools, as its utility function is generally approximated by the weighted sum of the scores of the criteria (Christofides et al., 2005).

MCDA has the capability to take into account conflictual, multidimensional, incommensurable and uncertain effects of stakeholder decisions (Carbone et al., 2000; Munda, 2000; Omann, 2000).

MCDA is compatible with several decision analytical tools, particularly AHP method which is widely recognized framework for supporting multi-stakeholder environmental decisions (Teng and Tzeng, 1994; Maguire and Boiney, 1994; Bellehumeur et al., 1997; Regan et al., 2006; Gutrich et al., 2005).

Belton and Stewart (2002, p.2) define MCDA as, ‘‘an umbrella term to describe a collection of formal approaches which seek to take explicit account of multiple criteria in helping individuals or groups explore decisions that matter’.

Belton and Stewart have identified four characteristics of MCDA namely; 1) ‘‘it takes clear account of multiple, conflicting criteria’’, 2) it assists in structuring the problem, 3) it conceptualises the model that can used for discussion, and 4) it rationalises, justifies and clarifies the decisions.
Mendoza and Martins (2006) point out that the reason why the MCDA models are widely applied is its broad definition stated above by Belton and Stewart, which encompasses three dimensions: 1) the formal approach; 2) the existence of multiple criteria; and, 3) that decisions are taken either by individuals or groups of individuals.

However, MCDA scoring and weighting of criteria is considered to some extent a subjective matter. Bonte et al., (1998) stress that decisions are already subjective actions and the strength of MCDA is that it makes this subjectivity more explicit rather than to present the decision as a black box.

Mendoza and Prabhu (2005) regard MCDA as a conveniently structured method to facilitate collaborative planning and decision-making. This participatory structure provides the engagement and participation of multiple experts and stakeholders.

MCDA is considered a widely accepted framework for supporting multi-stakeholder environmental decisions (Teng and Tzeng, 1994; Maguire and Boiney, 1994; Bellehumeur et al., 1997; Regan et al., 2006; Gutrich et al., 2005).

There are a number of classifications for MCDA. Korhonen et al., (1992) made the distinction between multi-objective decision making (MODM) and multi-attribute decision-making (MADM). They indicated that both methods are based on the quantity of alternatives under evaluation.

While MADM methodology is utilised for selecting discrete alternatives, the MODM method is used specifically for multi-objective planning, when a theoretically countless amount of continuous alternatives are identified by a set of constraints on a vector of decision variables.

Malczewski (1999) as cited in Mendoza (2006) highlighted the main differences between MOAD and MADM (see Table 2-7)

Table 2-7 Comparison of MODM and MADM approaches (Malczewski, 1999)

Type of decision method	Nature of participants	Characteristics and mechanism
Focus groups	Small group (5-12) representative of the public	Free discussion on general topic with little direction from the facilitator. Used to assess opinions and attitudes.
Citizen advisory committees	Small group selected by the sponsor	Sounding boards to measure community acceptance. Representation of major organised interests. Mainly instituted by local governments, also by certain major industries.
Planning cells	Small group selected by the sponsor	Randomly selected groups of citizens temporarily released from work to discuss certain issues in seminar form.
Citizen's juries/Citizens review panels	Twelve to twenty by stakeholder selected members of public	Panel, consisting of randomly selected group of citizens, studies a certain issue. Citizen's juries are intended to be representative of the community at large.
Regulatory negotiation	Small number of representatives of stakeholder groups	Representatives of various affected interests are brought together to agree on the content of regulations.
Mediation	Representatives of stakeholder groups	Voluntary attempt by parties involved to resolve a dispute normally assisted by a mediator.
Consensus conference	10-16 members selected as representatives of the general public	A lay panel with independent facilitator questions and expert witnesses chosen by a stakeholder panel.
Public hearings	Interested citizens	Loosely structured open forums where members of the public can listen to proposals and respond.
Public surveys	Large samples representative of the population.	Questionnaires for obtaining a representative portrait of public opinion. Use is almost universal, and applied for many issues.
Citizen initiatives	Potentially all members of national or local population	Citizens place issues on the ballot for voter approval.
Referenda	Potentially all members of national or local population, at least a minimum proportion	Vote cast by the population on an issue. Outcome is binding.

Multi Criteria Analysis methodology is generally most appropriate not to find solutions for environmental problems but rather to set the conditions for a transparent and informative decision process (Hajkowicz, 2008).

Several tools and applications using MCDM environment have been developed to assist decision-makers. One of the most popular MCDM techniques is the Analytic Hierarchy Process (AHP) (Saaty, 1980).

2.6.2 Analytic Hierarchical Process (AHP)

The generally acknowledged approach is the Analytic Hierarchy Process (AHP) (Paulson and Zahir, 1995; Lipovetsky and Tishler, 1999; Zeshui and Cuiping, 1999). AHP has been identified as potentially one of the most useful techniques for making decisions in the presence of a complex array of criteria (Eastman et al., 1998).

Saaty (1980) developed the Analytic Hierarchy Process (AHP), a decision-support structured methodology, based on mathematics and human psychology that provides flexible analysis of complicated, complex decisions.

AHP methodology is applicable to the decision models of the present research for a variety of reasons. The principles and the philosophy of the AHP theory provide analytical foundations to explain the complex relationships inherent in the research topic and help assess the human-induced influence on natural resources at each decision level of the same order of magnitude, thus enabling accurate comparisons.

AHP methodology is also flexible enough to be integrated with Geographic Information Systems. Multi-Criteria Analysis (MCA) techniques which underpin the AHP methodology are recognized decision-support methods for dealing with complex decisions where economic, ecological and social aspects are functions of the decision matrix.

AHP provides a hierarchy structure that consists of sub-hierarchies allowing each stakeholder group's preferences to be part of the overall decision process by providing each stakeholder with individual sub-hierarchy. Therefore, each stakeholder can develop the decision problem in the way that makes the most sense.

Several scenarios for conducting multi-stakeholders process using the AHP were suggested by Schmoldt et al., (1995). These included: 1) each group individually formulates their own AHP decision hierarchy; 2) all stakeholders create a single hierarchy in a participatory session; or 3) each group creates a sub-hierarchy, which decision-makers use as part of their overall decision hierarchy.

Stakeholder decision hierarchies can be pre-structured by decision-makers, with each group providing only their preferences. These preferences can be acquired without face-to-face meetings, but by the use of surveys (Smith et al., 1995).

By excluding face-to-face meetings, it is likely to alleviate many negative aspects of group dynamics.

The first participatory AHP applications were carried out in nature conservation planning (Kangas, 1994). According to Kangas (1999), Finland has used the AHP process in participatory natural resource decision-making which has attracted a lot of attention, especially within the forestry sector.

Kangas highlights that state-owned forests in Finland cover one-third of all forest land, and AHP method has been widely applied in participatory strategic forest planning.

The AHP has also been applied in forest policy analysis at the province level (Kajala, 1996). AHP has also been used interactively in participatory decision support processes (Pykäläinen et al., 1999).

When AHP is incorporated into the broader context of a participatory planning framework, an interactive AHP serves as a powerful means for successful conflict management (Schmoldt, 2001a). Saaty (1990) shows that AHP can integrate the evaluations of the entire group of decision-makers into one final decision. The integration is conducted without having to extract their utility functions on subjective and objective criteria.

Bhushan and Ria (2004) regards AHP as a very useful methodology when a group of individuals are working on complex problems that involve making decisions that are based on human perceptions and judgments, and that will have long-term repercussions.

AHP is used to prioritise alternatives, to build an added value function, and attempt to emulate and analyse the human decision-making process.

It is a multiple-criteria decision-making methodology that allows both subjective and objective factors to be measured. However, AHP has certain limitations and cannot be used indiscriminately. Tam et al., (2006) have summarised the criticism AHP has received (see Table 2-8).

Table 2-8 Summary on AHP Criticism (Tam et al., 2006)

Author (Year)	Asserted Shortfalls of AHP
Belton and Gear (1983) , Dyer (1990)	AHP suffered from the phenomenon of rank reversal
Belton and Gear (1985)	AHP lacked a firm theoretical basis
Zahir (1991)	Uncertainties in the relative weights of any pairwise comparisons in AHP affected the resulting priorities of the decision elements
Murphy (1993)	AHP suffered from limitations as a result of its application of consistency index
Paulson and Zahir (1995)	Judgmental uncertainty during pairwise comparisons in AHP could lead to rank reversals and weaken decision-maker confidence on the results
Zeshui and Cuiping (1999)	AHP was time-consuming and impractical to deal with the unacceptable consistency ratio

For example, Belton and Gear (1983) argue that AHP suffers from the phenomenon of rank reversal. Zeshui and Cuiping (1999) claim that AHP process is time-consuming and does not deal practically with the unacceptable consistency ratio. Murphy (as cited in Tam et al., 2006) claims that AHP has some limitations resulting from its application of consistency index.

Saaty (1990) argues that for a decision-support theory to be trustworthy there must be a certain level of uniqueness in the representation of judgments, the scales derived from these judgments, and the scales synthesised from the derived scales.

The advantage of the Analytical Hierarchy Process (AHP) is that it is relatively simple to comprehend while still being robust enough to analyse the complexities of various decisions. Analytical Hierarchical Process (AHP) is the most commonly used multi-criteria process for analysing a predetermined number of alternatives (Saaty, 1980). As noted previously, Saaty argues that for a decision support theory to be trustworthy there must be a certain level of uniqueness in the representation of judgments, the scales derived from these judgments, and the scales synthesized from the derived scales. AHP is a multi-criteria technique that uses hierarchical structures combined with aggregation processes, developed to analyse complex problems concerning multiple criteria. It is extensively used in group decision-making (Saaty, 1989).

AHP is used in this research to assign weights to different alternatives in order to analyse the formation of each stakeholder's decision. The system uses the Eigenvector Method to acquire the relative priorities according to the hierarchical composition principle to obtain priorities of the targeted elements of the hierarchy with respect to the overall goal (Saaty, 1980; Bryson, 1996).

Thomas Saaty (1990) has identified four main steps to structure the data into the AHP:

- Breaking down the decision into a hierarchy of decision elements.
- Collecting input data by pairwise comparison of decision elements.
- Checking the consistency of the input data using the Eigenvalue method.
- Computing the relative weights of the decision elements as the Eigenvector of the pairwise judgement matrix.

2.6.3 The Use of AHP in the Management of Natural Resources

Mendoza and Martins (2006) conducted a survey of MCDA methods in natural resource management from the 1970s until 2005. Table 2-9 illustrates the outcome of the survey, which analyses the work that has used real data from different countries, including some applications in developing countries.

The applications in the table are systematized according to country of application, nature and context of the problem and their spatial scale. The survey shows the wide diversity of application of AHP in the management of natural resources.

Table 2-9 MCDA applications (Adapted from Mendoza and Martins , 2006)

Country of application	Nature and context of the problem	Spatial scale
USA	Water allocation conflict	A river basin
USA	Dealing with conflict over oil and gas interests in a national forest	A national forest
Finland	Multi-objective optimisation of land management	A stand
USA	Forest management planning	A 4047 ha sub unit of a national forest
Sweden	Multi-objective forest management planning	About 8000 ha stands aggregated by timber class
Nigeria	Land use allocation in agro-forestry systems	A land unit
USA	Forest management and land allocation planning	Three management units with 18,211 ha
USA	Forest land management planning	A 102,629 ha forest area
Sweden	Multiple use forest management	A 10 ha forest
Finland	Forest management planning	A 31,4 ha forest
Finland	Integrate biodiversity in strategic forest planning	A 320 ha forest
USA	Forest management planning	A national forest
Finland	Strategic forest management	A recreation area
USA	Watershed management	Four watersheds 546 - 121 ha
Taiwan	Watershed land resource allocation	A watershed
Spain	Wildlife management	A 3600 ha forest
Finland	Analysis of forest plans in terms of habitat suitability for black grouse	A 117 ha forest
Kenya	Land resources appraisal	A district
Mexico	Environmental conflict analysis	A region
Philippines	Land-use allocation	A forest reserve
USA	Selection of the best forestry treatment method	Four watersheds
Canada	Selection of the best land use	An undeveloped area of publicly owned suburban land

USA	Conflict resolution on oil and gas leasing on a national forest	A national forest
USA	Watershed management planning towards sustainability	National forest, national park, wildlife refuge, etc.
USA	Watershed management planning towards sustainability	Farm, forest
Italy	Assessment of farm sustainability	A region
Australia	Evaluation of environmental projects	-
Finland	Selection of a tactical forest plan	A 2024 ha forest estate
USA	Ranking forest management alternatives	A 755,873 ha forest
USA	Prioritise watersheds and reaches for protection and restoration	A watershed system
Finland	Strategic natural resources planning	A region
Mozambique	Management of the miombo land	A district
Finland	Strategic forest planning	A region
Austria	Management of protection forest for sustained yield of water resources	A 2294 ha forest
Finland	Forest management planning	A 30 ha forest holding
Greece	Reserve selection	A region
Brazil	Land Allocation	A 2000 ha farm
Finland	Selection of forest reserves	A 10000 ha landscape
Australia	Regional forest planning	A region
Finland	Forest management planning	A 30 ha forest holding
Australia	Wetland management	A 180 ha wetland
Finland	Selection of a tactical forest plan	A 2024 h forest estate
Kenya	Land use planning	A region
Australia	Reserve selection	Land holdings and land systems
The Netherlands	Land use planning	A region
Spain	Selecting forest management plans according to sustainability indicators	A 1156 ha public forest
Finland	Forest management planning	A 128 ha forest
Malaysia	Forest conservation planning	A landscape

AHP specifies the judgments of different stakeholders in terms of their perception of the relative importance of each alternative and how it contributes to achieving the overall goal. A mathematical procedure is used to synthesize the data and assign priorities to the alternatives. Pairwise comparison is used to establish weights for alternatives. Judgments concerning the relative importance of objectives are considered with respect to the parent node in the hierarchy. Judgments concerning the relative preference of alternatives are made with respect to each objective.

AHP has an outstanding advantage as a multi-criteria technique, in that it measures the inconsistency of judgments with an intrinsic approach to the mathematical procedure (MarÍa et al., 2005). AHP depends on elaborate hierarchic structures to represent complex decision problems and is able to handle problems of risk, conflict, and prediction. AHP has the ability to organize, prioritize and synthesize complexity within a rational framework (Saaty, 2008). This ability to analyse complex problems is considered the comparative adavantage of AHP versus classic qualitative analysis using surveys and interviews. Figure 2-7 illustrates a degree of complexity in AHP Hierarchy. The structure analyses a problem of a Dam water level to analyse the variables underpinning a decision of what level should the Dam be kept.

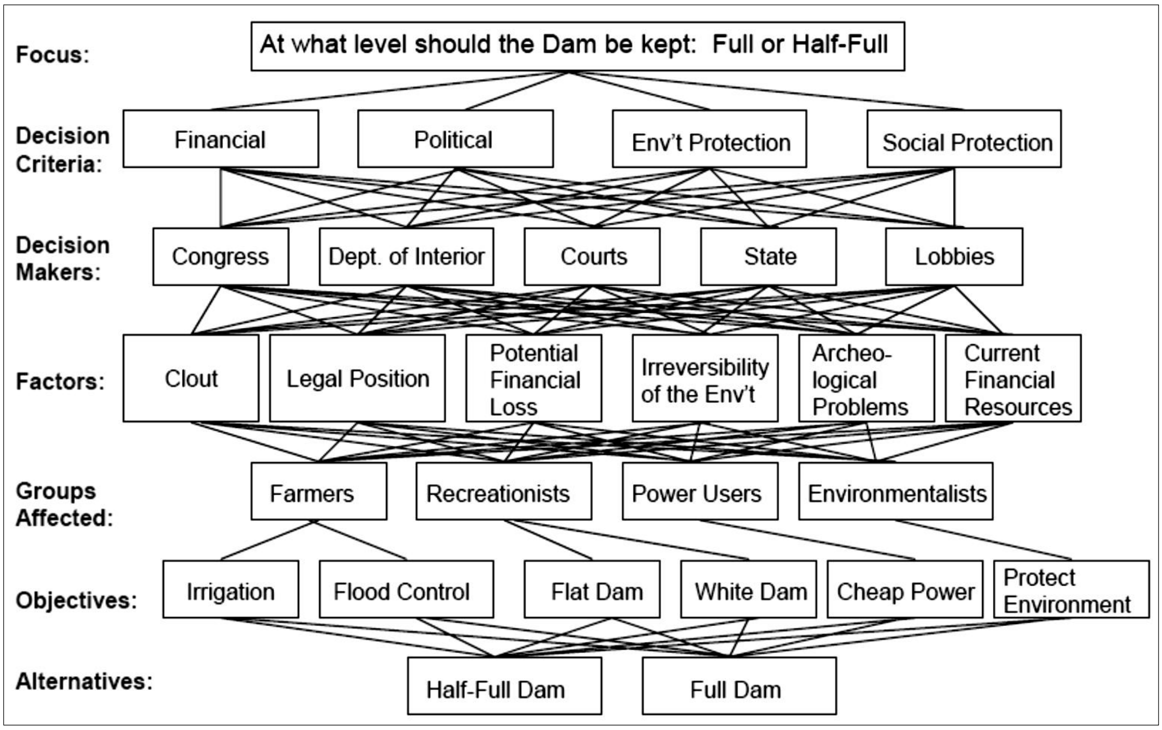


Figure 2-7 Example of AHP Complex Hierarchy level of objectives (Saaty, 2008)

This research attempts to use a simplified level of hierarchical structure as an example to identify the how the main variables underpinning Lake Maryout's problem are contributing to stakeholders' conflict. The methodology tries to highlight the magnitude and direction of stakeholder judgment with respect to the identified alternatives. It will not, however, try to modify their original judgment, but rather to use it to analyse their priorities.

2.7 The Need for New Environmental Decision-Support Methodology

According to Mallach (1994), a decision is a reasoned choice among various alternatives. Decision-makers make decisions regularly based on their logical process of thinking. Logical thinking is comprehensive but its rationality is only localized to the area of study (NOAA, 2012). Logical thinking is both verbal and qualitative. Environmental decision-making is a very complex issue because of the associated complex environmental, social and economic dimensions. Decisions are more complex when dealing with multiple conflicting objectives. Decision-makers are not able to handle the effects of imperceptible influences in an accurate method. Environmental decisions are complex and involve conflicting interests. Most environmental decisions are multi-criteria in nature. Decision-makers are unable to deal with too many variables contributing to the decision at the same time. Decision-makers require an aiding tool to enhance their understanding of the problem by providing judgments about the elements that are underpinning the problem. A new decision-aiding methodology to synthesise the decision variables is needed to put together all the elements of the decision in an effective way (NOAA, 2012). The new methodology could assist decision-makers in group participation in order to make this process possible and easy. It has to provide a model to process the unavoidably subjective preferences of an individual or group in making decisions (Saaty and Vargas, 2001). Each decision is characterised by three elements; decision statement, a set of possible alternatives and a set of decision-maker criteria (Mallach, 1994). Decision-makers need to prioritise their preferences and their decisions' contributing elements in order to develop an understanding of the various alternatives of compromises and trade-offs. These alternatives are the other possible decisions they can make. It is rather important to provide decision-makers with methodology that could weigh various elements according to identified criteria, map different alternatives, and provide road-map of ways to minimise conflicting priorities among various stakeholders' groups.

2.8 Chapter Conclusion

Public participation in the decision-making process can help minimize the negative impacts of environmental degradation. In order to actively involve stakeholders in any process, the existing established institutional framework and societal system must be analysed. In new, cosmopolitan societies, many modern communities do not share the same values or sustain a collaborative effort to accomplish a common goal. It is therefore important to thoroughly investigate and analyse the economic and institutional mechanisms that underpin the decision-making process of each stakeholder group.

Public participation can lead to more accountability and legitimacy, but only if inclusion and deliberation mechanisms for affected communities are recognised as the main drivers and multipliers for developing collective problem-solving and ultimately for more rational decision-making. Procedures and guidelines need to be established that fairly and accurately select representatives of society, and eliminate the subjectivity and biases common in mediation or facilitation processes and in analysing the data that results from the process.

New techniques for public participation in the decision-making process are needed to accurately assess and evaluate the degree of interaction between decision-makers and the community. Many recent and historical indications at the global, national and local levels show that countries, local communities and the public at large reject changes when they are not aware of, or consulted on, the objectives of these changes, the methodology to carry them out, or the timing of the proposed change and ultimately this might lead to some sort of conflict.

Scarcity of natural resources, environmental degradation and mismanagement are among the key factors that lead to conflicts. Environmental conflicts must be viewed in their economic, social and cultural dimensions in order to comprehend the impacts of any proposed action, and to assess the positions of different stakeholder groups towards this action during the planning process.

Conflicts arise, but in many cases they are avoidable. Jurgen Habermas and Michel Foucault (1998) indicated the indispensable tension between consensus and conflict (Flyvbjerg, 1998b). Classical decision theory considers rational decisions as structured decisions that maximize some utility function (Wierzbicki, 1997). There are many methods used to construct this function such as Willingness to Pay (WTP) concept and hedonic price method (HPM). However, there are serious questions about the possibility of applying these methods in situations where there are multiple objectives. MCDA has been used to avoid many of the problems associated with other tools as its utility function is generally Multiple Objective Decision Analysis (Christofides et al., 2005). Herbert Simon states that "bounded rational agents experience limits in formulating and solving complex problems" (Williamson 1981, p.553). Bounded rationality is not targeting the development of final or best possible strategies, but a ''satisficing'' or ''bounded'' exploration for solutions given these constraints (Simon, 1957).

Multi- Criteria Decision Analysis (MCDA) does not target the best solution in respect to all the identified objectives but rather to reach a satisficing compromise (Froger and Munda, 1998). It could be used as an appropriate analytical framework for stakeholder conflict management where best possible strategy is not the target, but rather to explore what is the most acceptable satisfying solution.

In order for the decision support theory to be trustworthy, there must be a certain level of uniqueness in the representation of judgments, the scales derived from these judgments, and the scales synthesized from the derived scales (Saaty, 1980).

AHP is a multi-criteria technique that uses hierarchical structures combined with aggregation processes, developed to analyse complex problems concerning multiple criteria. AHP is a widely accepted technique in analysing group decision-making (Saaty, 1980). AHP can be used as a tool to locate consensus in the decision matrix.

In the social integration theory, consensus is considered to be the ordinary situation in social life, resulting from diverse interpretation of a situation, and that the process of social negotiation process is not successful (Van Dongen et al., 1996).

Guba and Lincoln (1989) argue that consensus on all issues `is rarely if ever possible' and disagreement between stakeholders will lead to impasses, making conflicts visible.

The work of Jürgen Habermas and Michel Foucault brings up the question of the effectiveness of empowering civil society on the decision-making process and on the relationship between consensus building and conflict.

Habermas (1985) introduced his 'theory of communicative action' and 'discourse ethics'. The theory aims at expounding the assumption of the rationality of processes of accomplishing understanding.

Communicative rationality, however, provides the implications of a non-coercively unifying, consensus-building power of discourse in which the stakeholders can reach rationally motivated agreement (Habermas, 1987). Foucault disagrees with the dialogical ethics, explaining that power had to be deconstructed to understand human interests (Schindler, 2011).

Communicative Planning Theory (CPT) is focusing on well informing the public through a process of stakeholder participation in the planning process. Planning approach has to establish dialogue between stakeholders from different social groups (Healey, 1997).

In order to develop new management plans, introduce new policy; take structured decisions, evidence-based policy should be considered. This will help to explore why the policy could be effective and what are the potential impacts in case of implementing or not implementing this policy, and its direct or indirect effects. This will improve social, economic and environmental results by relying on trustworthy knowledge and information.

Environmental conflicts need to be addressed and resolved based on critical analyses of the circumstances and that the social, economic, institutional and cultural aspects are behind the conflict. In the case of conflicts resulting from stakeholder disputes, it is essential to analyse the various groups' priorities and perceptions. It is also crucial to analyse the decision-making process retrospectively for each of the stakeholders and ascertain what led them to take this position.

Assessment of conflict can be conducted by applying qualitative, quantitative or combined conflict mapping methods. Simulation of real-life conflicts accessed through self-reports of the parties exists. Examples of qualitative methods for conflict assessment include general orientations toward conflict, stakeholders' behaviours, and identification of conflict types and assessment of stakeholders' power.

It is generally accepted that a process of debate among concerned stakeholders should replace the single unilateral environmental decision-making. Therefore, the decision tools have been changing to accommodate this process. The role of decision tools in the context of environmental decision-making processes is changing, that there should be no single decision maker; rather a process of debate should take place among different actors (Pereira et al., 2005).

In this context, decision support tools can play a dual function. They bring together all the knowledge available to enlighten the debate; as well as they can act as the common platform though which this debate is organised and through which they integrate different sources of knowledge (Pereira et al., 2005).

Giordano et al., (2007) explain how the integration of knowledge resulting from the application of ‘‘formal’’ methods, primarily developed through mathematical models, with data derived from stakeholder-based approaches has become an active area of research.

Giordano et al., (2007) states that it is becoming progressively more evident that the classical distinction between resolving ‘‘hard’’ problem and the use of decision support systems, based on rigid quantitative data problem structuring, and ‘‘soft’’ stakeholder based qualitative flexible problem structuring policy design and implementation, has to be overcome. These two methods are becoming complementary rather than being mutually exclusive.

A methodology is needed to analyse the interaction between environmental pressures and the decision-making process. Analysing the degree of conflict is paramount to understanding at what stage environment-based driving forces could emerge as a potential source of conflict.

National and local planning processes should encourage collaboration between government authorities and the local community they govern, to engage active members of the community in developing a consensus of their common goals, and enable them to participate in the planning and decision-making process.

This collaborative mechanism acts as a preventive strategy so that the public is aware of the likely impact of a decision on various sections of the community. However, there is evidence that the traditional bureaucratic techniques of public participation in governmental decision-making are no longer adequate to achieve true public involvement in the planning process, nor do they provide a consistent informative contribution to decision-makers to allow for significant shifts in their unstructured decisions.

Reviews of public participation methods have concluded that each technique has its strengths and weaknesses and the technique chosen will depend on the size of the participating community, the nature of the issue, existing legislation, the relative power of different stakeholders, and the degree of complexity of the required decision. The participation process should meet certain standards, including consultation, collaboration, partnership and citizen control, in order to be considered a successful endeavour.

While environmental protection at the global level should be dealt with in a cooperative spirit by all countries, there are clear examples of global trends positively influencing national-level policies. One of these is the increasing trend of empowering local communities by giving them the legal mandate to assess government performance. This marks a global shift in the national politics of many developing countries that traditionally considered participation a sensitive issue. The international community is now working in a collaborative manner to manage natural resources and encourage countries to adopt an integrated, coordinated approach to their development planning. Government authorities are being urged to join forces through multilateral and bilateral agreements to develop practical tools for providing the public with access to environmental information, participation and justice, in addition to providing timely and reliable access to environmental information to decision-makers in order to take informed sustainable environmental decisions.

Management of the public participation process is essential to give stakeholders a sense of accountability and to promote the sustainability of the process. Stakeholder analysis is a useful management tool to identify the structure of all key players and beneficiaries in the community, including primary and secondary stakeholders; those who are contributing to or being affected by the current circumstances. Stakeholder analysis is an essential element in managing conflicts between stakeholders. Influence Mapping is also a vital tool for understanding the relative importance of groups and identifying the degree to which they are influencing the decision-making process. Stakeholder categorisation should include an assessment of relative economic strength, place in the social structure and political power. It is important to assess the control each stakeholder group has over the resources in the disputed area.

Communities that are mostly affected by an action or policy are usually sceptical about solutions generated by technical experts, especially if they have been arrived at without a true participatory process. Experts find it difficult to convey the scientific message of the impacts of each proposed strategy. Different levels of knowledge lead to divergent perspectives on the same issue in the various sections of the community. The divergence in perspective is not only a function of knowledge but also of the degree of economic, social and cultural heterogeneity of different groups.

New environmental management tools are required to combine the environmental with the social dimension, based on the stakeholders' participation. Moreover, we are witnessing the shifting role of decision-support tools in the environmental management arena, from a single decision-maker perception to a process of debate among different stakeholders (Giordano et al. 2007). Multi Criteria Decision Analysis (MCDA) provides decision analytical tools through which the stakeholders' debate is structured and the different bases of knowledge are integrated.

This research tries to develop a new approach to help in the management of stakeholders by analysing environmental decisions, and assessing and delineating the degree of stakeholder conflict. It also tries to find the area where stakeholder consensus is located. To achieve this goal, a new methodology needs to be developed to resolve the conflict by identifying the key issues that are contributing to it.

In order to assess the main factors contributing to the position of each participating group, an assessment of the state of the environment in the conflicted area must be conducted. DPSIR framework, as indicated in chapter one, is used to determine the root causes of the problem and the impacts of each alternative on other stakeholder groups.

In the following chapters, the research methodology will be identified; the case study of an area of study will be presented. The decision model is designed to examine stakeholder judgments of proposed alternatives within the area, with respect to the overall management goal of the case study. The decision analytical model will analyse each stakeholders' decision and try to identify the main areas of contention.

This central focus of this research is to develop a methodology for better understanding of stakeholder conflict in an environmentally sensitive area, and hence to better manage this situation. This can be explored by developing a methodology that analyses the objectives and priorities for all stakeholders. The methodology entails the identification of the contribution of environmental, economic and social aspects to the stakeholders' decisions. It also has to locate the areas in the decisions where stakeholders have common interests that constitute a common ground for reaching a satisficing solution.

CHAPTER 3

RESEARCH METHODOLOGY

Chapter 3. Research Methodology

3.1 Introduction

This research aims to develop a new methodology to assist decision-makers in assessing and measuring the degree of stakeholder conflict in environmentally sensitive areas. The research attempts to find and analyse principles that explain how the stakeholder decision-making process works and how it contributes to the degradation of the natural resource. The methodology uses a case study area of Lake Maryout, Egypt, which provides an example of policy and management failure. The use of case study in this research is not only to collect data for situational analysis to understand the root causes of the conflict, but also to verify the research results by comparing the decision analytical model outputs against the situation on the ground. The research uses simplified Analytical Hierarchy Process model to examine the methodology.

This chapter details the research approach, including the derivation of each step, the methodology for selecting the case study, the data collection process and the computer software. The data analysis and design of the decision model and the utility of each step to the system structure in developing a conceptual design.

The chapter consists of two sections. Section I is dedicated for identifying the research approach, links the methodology to the research problem, and investigates other tools and selecting research methodology. Section II is dedicated for developing a conceptual design for the decision model using the selected methodology.

3.2 SECTION I - RESEARCH METHODS

3.2.1 Research approach

The research uses different research methods to address different questions. Within experimental methodologies, the combination of “group” designs and research (Campbell and Stanley, 1966) and “single-subject” research (Hersen and Barlow, 1976) could construct a rigorous, single study of human behaviour.

The research uses literature review to explore various approaches of analysing stakeholders’ preferences within the natural resources management domain. Review of research methodologies related to decision analysis, stakeholders’ preferences, stakeholders’ conflict, and decision-making in natural resources management are reviewed. The problem should be clearly identified in order to select the research method that could respond to the problem. Criteria for selecting the methodology and for applying the model should be identified. Steps for developing the model is organised and the structure of the decision model has to be developed. A critical discussion is conducted in chapter eight to evaluate the results and investigates if the objectives of the research were achieved using the decision model. Validation of the research model is conducted through the test on a case study to verify the results. The research approach is presented in Figure 3-1

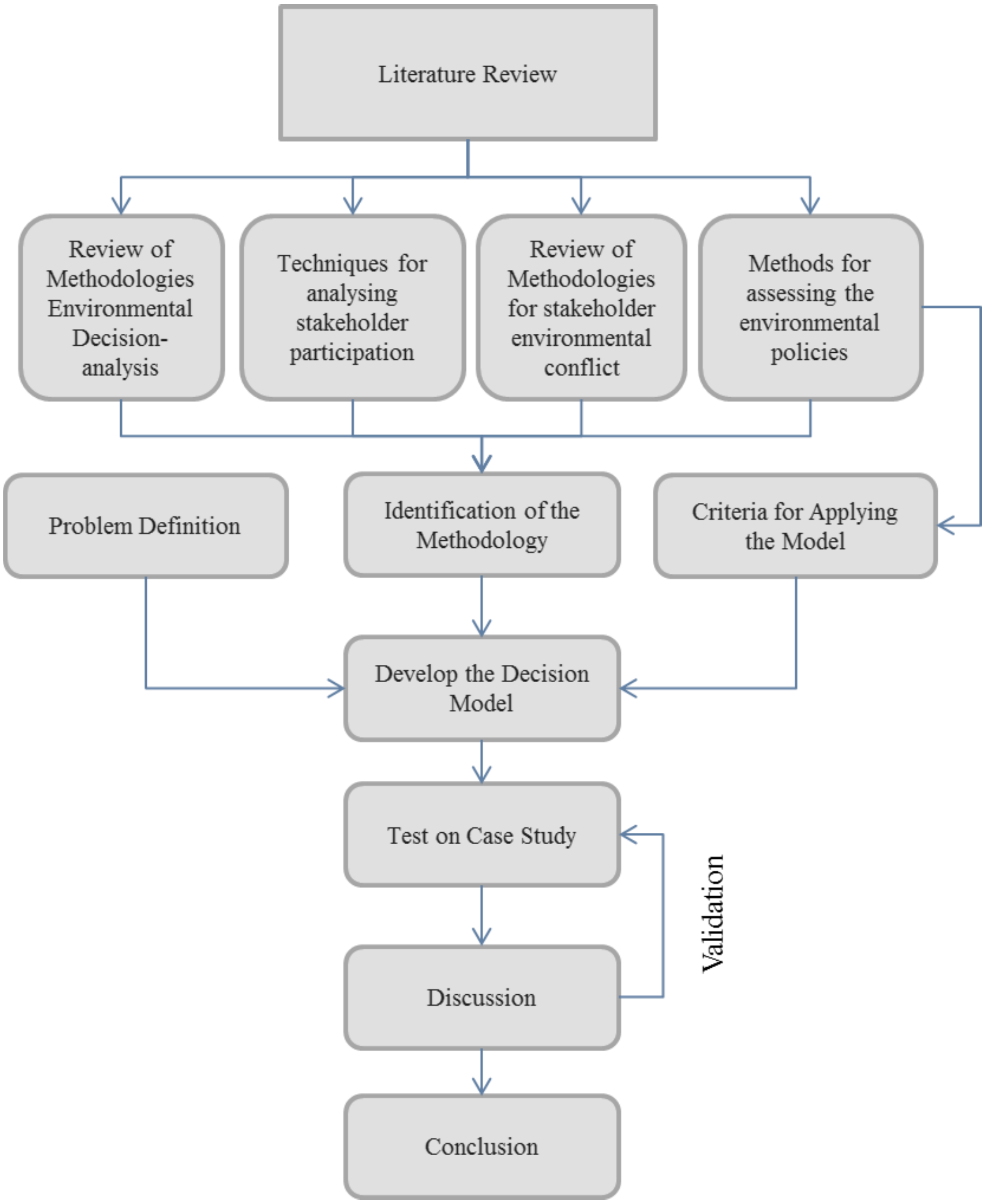


Figure 3-1 The Research Approach

3.2.2 Problem definition

The problem investigated is related to conflicting stakeholder preferences over natural resources in a sensitive area. These types of conflicts tend to cause decision paralysis and policy failure which leads to environmental deterioration.

Lake Maryout has become the reservoir for industrial, agricultural and sanitary water discharges. It is now the centre of various environmental threats to the city of Alexandria and Egypt's Delta region.

Lake Maryout lacks a proper institutional setup capable of applying integrated management techniques. There is a high degree of discrepancy and conflict of interests among stakeholders. Absence of coordination and integration, and lack of public participation in the decision-making process is leading to unilateralism authoritative decisions.

Analysing the existing policies shows that they have conflicting objectives. Policies are contradicting and they assign equal roles and responsibilities to different institutions. Absence of a participatory strategic vision among different stakeholders coupled with the lack of scientific, comprehensive and integrated communicative planning tools are potential factors leading to a failure of the management of the lake, and to a high degree of environmental degradation.

The research therefore, investigates the ways to develop a model to assist decision-makers to assess and identify the degree of conflict, the area and magnitude of conflict and propose ways to manage the conflicting priority areas among stakeholders.

3.3 Criteria for Applying the Research Methodology

The purpose of the selection of research methodology is to find ways for analysing the study's initial research questions, and to develop the strategies for conducting these analyses.

The research problem of stakeholders conflicting priorities over the management of Lake Maryout requires a decision support methodology that is flexible enough to address the multiplicity of factors associated with the research problem.

Therefore, the selected research methodology should meet the following criteria to be able to answer the research questions:

- able to analyse multi-criteria decisions
- able to analyse multi stakeholders objectives
- to be applied for natural resources management
- can be used for stakeholder conflict management
- can be integrated with other tools such as GIS
- can be validated through data from the case study
- can integrate mixed qualitative and quantitative data

3.4 Justification for the Research Modelling Method

The research tries to provide a decision support tool for analysing stakeholder decisions and therefore to assist in the natural resources management. Decision support includes analysis of decision actions to provide some measure of assurance that all relevant issues and information have been properly addressed in decision-making (Schmoldt, 2001).

The research investigates the plausibility of using a decision analytical model capable of analysing conflicting stakeholder objectives and to calculate and rank the areas of consensus among them.

One of the most important phases in decision-making techniques is the precise assessment of the applicable data. This is a problem in many techniques which need to elicit qualitative information from the decision-maker. Very often qualitative data cannot be known in terms of absolute values. It is very challenging, if not impossible, to quantify the comparative judgement of complex problems using qualitative techniques (Triantaphyllou, 1995). Quantitative techniques such as Multiple Criteria Decision Analysis (MCDA) can efficiently support decision making process with regard to complex sustainability issues and can assist to explain a problem. MCDA is used to decompose decisions into its fundamental parts, which are then structured hierarchically. The use of quantitative models can take into consideration conflicting problems.

MCDA, more particularly AHP provides an order of preferences which assists the selection of a policy option.

The methodology chosen is a sequence of actions using classes of data collected and studies conducted, and an analysis of behaviours, beliefs and observations of specific identified stakeholder groups that allows the decision model to be developed. The outcomes of the model are analysed and interpreted to discern patterns and formulate principles that might guide future action, and suggest ways to better manage and resolve predicted stakeholder environmental conflicts. MCDA takes into consideration the stakeholder preferences and the presence of conflict among stakeholder goals, while institutional and procedural aspects of planning can be included through collaborative decision strategies (Rietveld, 1981; Spronk, 1981).

AHP is the most commonly used MCDA process for analysing a predetermined number of alternatives (Saaty, 1980). AHP method is an excellent method for analysing decision-making in natural resources management (Schmoldt, 2001).
Stakeholder voting, or solicitation, of expert judgments via pairwise comparisons is a function of the AHP that is applicable for including multiple stakeholders.

Each stakeholder group can present their own preferences in a hierarchy. Stakeholder preferences can be treated equally or they can be weighted by importance, experience, prominence, or any other characteristic that distinguishes the stakeholder groups (Schmoldt, 2001).

The analysis is conducted retroactively, since the positions of stakeholders have already been assessed through the questionnaires, and the methodology is used to analyse these positions to develop an understanding of how these judgments were made.

It should be noted that analysing a wide range of criteria that have been ranked based on multiple-value weights is, to some extent, a subjective endeavour. It should be noted that in MCDA, the existence of decision-maker conflicting preference, unavoidably introduces subjectivity (Henig and Buchanan, 1999). The use of AHP is particularly valuable when subjective criteria are involved and when the attributes and/or the decision alternatives are unsubstantiated (Javalgi et al., 1989).

Reviews of research on spatial decision-support systems have concluded that it is possible to integrate MCA techniques and GIS (Carver, 1991; Pereira and Duckstein, 1993; Tkach and Simonovic, 1997; Feick and Hall, 1999; Malczewski, 1999; Dai et al., 2001; and in Joerin et al., 2001). AHP uses a pair-wise criteria comparison to construct a scale of preferences among sets of alternatives (Saaty and Vargas, 1991).

MCDA and particularly, AHP have the capability to be integrated with GIS. Itami et al. (2000) described examples of natural resources decision support systems that combined GIS with the AHP. Many examples of integrating AHP with spatial analysis include Jankowski (1995), Jankowski et al. (1997), and Eastman et al. (1998). AHP can take advantage of the spatial analysis to provide more sound information using expert judgments (Store and Kangas, 2001).

Disagreements are most likely to arise among stakeholders as a result of their differences of priorities. Environmental degradation is a sensitive issue profoundly affecting certain stakeholder groups which may hinder efforts of achieving group consensus.

According to Schmoldt (2001), success or failure of management plans depend on having an accountable and insightful way to resolve these differences.

Saaty and Alexander (1989) present various case studies showing the capability of the AHP for resolving conflicts. Mendoza and Prabhu (2000) have also described how a team of experts can be used to arrive at a collective decision with respect to assessing sustainability of forests. Evaluating forest sustainability is a complex process, which requires the involvement of experts from different disciplines.

The use of statistical analysis, SWOT analysis and cost-benefit analysis does not interrupt any principles of the AHP. These methods cannot be integrated with GIS or other spatial analytical tools.

These methods, however can provide supplementary tools for decision support performed within the AHP framework and hence to provide stakeholders and decision-makers with a better view regarding their preferences and choices.

Qualitative analysis of stakeholders' priorities provides a good insight of the perception of each stakeholder towards the identified set of choices. Stakeholders could be asked to provide a list of their preferences, policy actions or alternatives towards proposed management plan. They can provide verbal justification for their choices. However, the purely qualitative analysis method cannot provide the comparative preferences with respect to identified alternatives.

Decision-makers and planners cannot assess the “degree” of comparative acceptance of each stakeholder for each alternative. MCDA methods are initially developed to analyse multiple objectives decisions.

Given the nature of the problem addressed, and the investigation of the decision analytical models, the research concludes that MCDA technique, particularly AHP is the most appropriate modelling process to address the research problem.

Analytic hierarchy process (AHP) method is selected because it’s following characteristics:

1. Capable as a tool for natural resource decision making
2. capacity as a participatory decision making
3. capacity to structure complex problems
4. able to facilitate group decision
5. can be used for consensus building
6. can incorporate qualitative and quantitative data
7. able to assist in conflict resolution

3.5 Using AHP Methodology for the Development of Decision Model

Considering the objective of the research and the qualitative nature of the identified alternatives and the complexity of the variables contributing to stakeholder decisions, MCDA methods are an appropriate framework for evaluation.

The research methodology uses AHP to analyse and evaluate the stakeholders’ preferences with respect to identified alternatives for the management of the case study area. It attempts to use AHP to provide a foundation on which environmental decisions could be analysed, compared, and evaluated in order to understand the root causes leading to the existing state of the environment in any environmentally sensitive area.

The definition of environmentally sensitive area in this research is “An area that is environmentally vulnerable to negative impacts by human induced activities”.

The AHP methodology will be used to develop an analytical decision model to analyse stakeholders’ alternatives. The collected data therefore, is synthesised to determine relative rankings of alternatives.

AHP pairwise comparisons are applied to express the relative importance of one criterion over another.

Building on Saaty (2008), the following steps constitute the principle elements to decompose and organize the decision for building AHP model:

1. The problem has to be clearly defined.
2. Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the alternatives levels to the lowest level
3. The problem hierarchical structure is constructed by constructing a set of pairwise comparison matrices.
4. Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below.
5. The process is continued of weighing and adding until the final priorities of the identified alternatives in the bottom most level is obtained.

The decision problem is broken down into a hierarchical structure before applying the methodology. Elements at each level in the decision tree have influence on those at a higher level (see Figure 3-2).

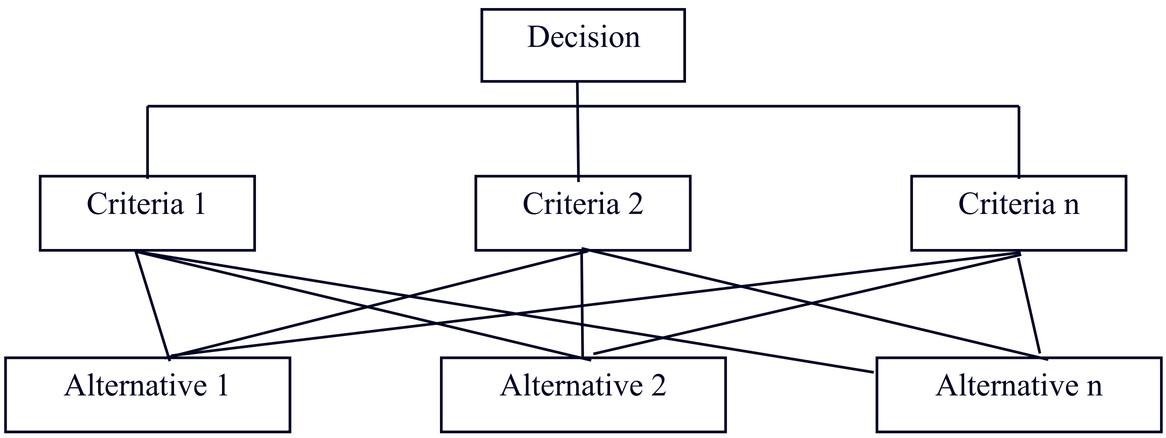


Figure 3-2 Structured Problem With Three Different Hierarchy Levels.

3.5.1 AHP model structure

According to Saaty (1980), the following procedures should be followed when developing AHP based decision model:

1- In AHP, once the hierarchy has been constructed, the stakeholders select their relative importance of the alternatives in the model hierarchy.

Components of a problem on each level are compared. Pairwise comparisons construct a square matrix as shown in figure 3-3

$$A = \begin{bmatrix} a_{11} & a_{12} & . & . & . & a_{1n} \\ a_{21} & a_{22} & . & . & . & a_{2n} \\ . & & & & & \\ . & & & & & \\ . & & & & & \\ a_{n1} & a_{n2} & . & . & . & a_{nn} \end{bmatrix}$$

Figure 3-3 AHP Pairwise Comparison Matrix

2- AHP uses an underlying scale with a values range from 1 to 9 in order to rate relative preferences (see Table 3-1).

The scale of 1 to 9 which is utilised in AHP to represent pairwise comparison judgments is derived from stimulus-response theory (Saaty, 2001).

The AHP scale has been revealed to be a scale that categorises individual preferences with respect to quantitative and qualitative data, as good as, or better than other scales (Saaty, 1980).

It converts individual preferences into ratio scale weights that can be aggregated into a linear additive weight for each identified alternative.

The output weight can be used to compare and rank the alternatives, and therefore, assist the decision- making process (Azman and Abdullah, 2011).

Table 3-1 AHP Scale adapted from (Saaty, 1980)

Definition	Intensity of Importance	Explanation
Extreme	9	The evidence favouring one activity over another is of the highest possible order of affirmation
Very strong to Extreme	8	
Very Strong	7	An activity is favoured very strongly over another; its dominance demonstrated in practice
Strong to Very Strong	6	
Strong	5	Experience and judgment strongly favour one activity over another
Moderate to Strong	4	
Moderate	3	Experience and judgement slightly favour one activity over another
Equal to Moderate	2	
Equal	1	Two activities contribute equally to the objective

3-calculating the stakeholders' judgments result in the construction of matrix of A, n elements are compared to each other with respect to a specific criterion (C). The number of entries is function of the matrix size (n– n / 2).

C	A_1	A_2	A_3	-----	A_n
A_1	1	5	1/4		7
A_2	1/5	1	3		2
A_3	4	1/3	1		1/2
'					'
A_n	1/7	½	2	------	1

4- According to Saaty (1980), and based on the matrix theory, AHP uses the eigenvalue method to calculate the relative weights of the decision. It develops a "reciprocal matrix". The system calculates eigenvalues w, for each w = (w1, w2, w3,…wn)

C	A_1	A_2	A_3	…	A_n
A_1	$\frac{w_1}{w_1}$	$\frac{w_1}{w_2}$	$\frac{w_1}{w_3}$	…	$\frac{w_1}{w_n}$
A_2	$\frac{w_2}{w_1}$	$\frac{w_2}{w_2}$	$\frac{w_2}{w_3}$	…	$\frac{w_2}{w_n}$
A_3	$\frac{w_3}{w_1}$	$\frac{w_3}{w_2}$	$\frac{w_3}{w_3}$	…	$\frac{w_3}{w_n}$
⋮					⋮
A_n	$\frac{w_n}{w_1}$	$\frac{w_n}{w_2}$	$\frac{w_n}{w_3}$	…	$\frac{w_n}{w_n}$

5- According to Saaty (1980), the eigenvector can be calculated according to the geometric means as per the following equations:

$$a = \sqrt[n]{\frac{w_1}{w_1} \times \frac{w_1}{w_2} \times \frac{w_1}{w_3} \times \ldots \times \frac{w_1}{w_n}}$$

$$b = \sqrt[n]{\frac{w_2}{w_1} \times \frac{w_2}{w_2} \times \frac{w_2}{w_3} \times \ldots \times \frac{w_2}{w_n}}$$

$$c = \sqrt[n]{\frac{w_3}{w_1} \times \frac{w_3}{w_2} \times \frac{w_3}{w_3} \times \ldots \times \frac{w_3}{w_n}}$$

$$n = \sqrt[n]{\frac{w_n}{w_1} \times \frac{w_n}{w_2} \times \frac{w_n}{w_3} \times \ldots \times \frac{w_n}{w_n}}$$

$Total = a + b + c + ... + n$, then

$$eigenvector = w = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ . \\ . \\ w_n \end{bmatrix} = \begin{pmatrix} a/total \\ b/total \\ c/total \\ . \\ . \\ n/total \end{pmatrix}$$

Eigenvalues are calculated because the results of the judgments are not regularly reliable and accordingly the consistency of the result must be checked.

6- Checking the consistency Saaty (1980),

Matrix A is consistent where:

$$a_{ij} a_{jk} = a_{ik} \text{ for } i, j, k = 1, \ldots n.$$

$$a_{ij} = \frac{w_i}{w_i} \Rightarrow \mathrm{w_i} = a_{ij} \mathrm{w_j} \text{ for } i, j = 1, \ldots n.$$

Therefore, according to Saaty (1980), the following equation is constructed:

$$Aw = \begin{bmatrix} a_{11} & a_{12} & . & . & . & a_{1n} \\ a_{21} & a_{22} & . & . & . & a_{2n} \\ . & & & & & . \\ . & & & & & . \\ . & & & & & . \\ a_{n1} & a_{n2} & . & . & . & a_{nn} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ . \\ . \\ . \\ w_n \end{bmatrix} = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & . & . & . & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & . & . & . & \frac{w_2}{w_n} \\ . & & & & & . \\ . & & & & & . \\ . & & & & & . \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & . & . & . & \frac{w_n}{w_n} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ . \\ . \\ . \\ w_n \end{bmatrix}$$

$$Aw = \begin{bmatrix} \frac{w_1}{w_1} w_1 + & \frac{w_1}{w_2} w_2 + & . & . & . & + \frac{w_1}{w_n} w_n \\ \frac{w_2}{w_1} w_1 + & \frac{w_2}{w_2} w_2 + & . & . & . & + \frac{w_2}{w_n} w_n \\ . & & & & & . \\ . & & & & & . \\ . & & & & & . \\ \frac{w_n}{w_1} w_1 + & \frac{w_n}{w_2} w_2 + & . & . & . & + \frac{w_n}{w_n} w_n \end{bmatrix} = \begin{bmatrix} w_1 + w_1 + \ldots + w_1 \\ w_2 + w_2 + \ldots + w_2 \\ . \\ . \\ . \\ w_n + w_n + \ldots + w_n \end{bmatrix}$$

$$Aw = \begin{bmatrix} nw_1 \\ nw_2 \\ . \\ . \\ . \\ nw_n \end{bmatrix} = n \begin{bmatrix} w_1 \\ w_2 \\ . \\ . \\ . \\ w_n \end{bmatrix} = nw$$

$Aw = nw$

The eigenvalues λ_i, $i = 1,...n$ are =zero except one single value. This value is $\lambda_{\max}$.

According to Saaty (1980), since A is a reciprocal matrix and all the other values are positive, then all eigenvalues of A are positive and unique.

$\lambda_i = Trace(A) = n$ (5-11) The trace of a matrix is the sum of the diagonal entries.

If the diagonal entries of A are one, then trace of A is n.

resolution that is sought after or aimed at in a specific decision. The term is occasionally used interchangeably with 'criterion' or 'attribute'. In this research, an 'objective' or 'alternative' may encompass several 'criteria' and these in turn may encompass several 'attributes'. Sub-objectives, the third level of the hierarchy, might include, for example, improving water quality.

This could be further decomposed into a detailed fourth level, with sub-objectives such as water circulation, aeration, pumping more fresh water, dredging and elevation of water level.

The term stakeholders' objectives, priorities, preferences and alternatives are used for describing the first level of hierarchy in the AHP decision model. The terms are used interchangeably depending on the case study and the description of the problem. In this research the term preferences is used to describe the outcome of the model while the term priorities or alternatives are mostly used to describe the inputs.

Accordingly, the research intends to use the MCDA methodology, particularly the AHP method to develop a decision model. The proposed model should be able to meet three objectives. First is to assess the stakeholders' preferences using the pairwise comparisons. Secondly, to have the capability to accommodate SD pillars in its hierarchical tree as primary objectives. Thirdly, to be able to export results for further analysis using spatial tools such as GIS. The three functions represent the core sub-modules of the proposed model.

3.6 Added Value of the New Methodology

Environmental decision-making generally entails resolving complex decision problems. Every decision must be developed in three phases (Simon, 1960). These phases are *Intelligence, Design* and *Choice*. Herbert Simon explains that the intelligent phase consists of the identification of the problem that requires a decision. Intelligence in this context refers to the collection of the required information.

The design phase is where the decision-maker develops alternatives. Decision-makers have to understand all the available options. In the choice phase, decision-makers evaluate the identified alternatives. Accordingly, they choose the appropriate alternative.

Simon points out that the cycle of phases is very complex. Each phase has its own complexity. Therefore, taking into consideration all the multiple complex variables within each phase to make a structured decision is humanely hard task to achieve. The structured decision is one for which all the three phases exist (Mallach, 1994). Mallach (1994) points out that organisational decision-making process entails combining rationality and politicality. The new methodology assists decision-makers to structure inputs, outputs and internal processes of the three decision phases. In many cases, decisions involve more than one person and therefore, the interpersonal dimensions can influence the decision-making process.

Environmental conflicts are usually complex and mostly involve several decision-making authorities at different levels of government, irreversible decisions and uncertainty in their environmental implications (Bingham, 1986). This research requires therefore, a methodology that can combine complex decision-making processes with conflict management techniques. The new methodology uses Multi-Criteria Decision Analysis (MCDA), to determine the overall preferences among different conflicting alternatives, where the options are to achieve several objectives. The methodology also integrates a spatial dimension to understand the situation on the ground. This could assist decision-makers to explore trade-offs among various conflicting objectives. It will enable them to explore the various implications of uncertainty and highlight areas of reducing them.

The unstructured conflicting decisions that were taken by various stakeholders need to be analysed to understand the mind-set of decision-makers and other groups, how these decisions were taken, and how differentiated stakeholder power may have affected these decisions. The methodology assists decision-makers to analyse and structure all the complex elements related to the three decision phases and hence to develop structured decisions.

The methodology develops a model of the problem by creating a multi-measure utility function. This allows the decision alternatives preferences to be calculated based on how it impact on a set of evaluation measures. The methodology is intended to assist decision-makers overcome the boundaries of the human mind in dealing with multiple objectives complex problems. It assists to synthesize qualitative and quantitative data obtained from multiple stakeholders. It assists decision-makers to determine their strategic preferences, to build consensus and to ensure that their decisions are strongly aligned.

3.7 SECTION II – MODEL DESIGN

3.7.1 Development of the decision model

This research aims to develop a new methodology to assist decision-makers in making structured decision through the development of a decision-support analytical model, based on MCDA methodology. The research uses AHP not only to identify the priorities for each stakeholder but also to investigate the comparative preference of each stakeholder with respect to the other alternatives.

The core analysis of this research is conducted through the development of the decision model. The research intends to develop **Environmental Decision Analytical Model (EDAM)** which consists of three main sub-modules: the **Sustainable Development Decision Module (SDDM)**, the **Stakeholder Decision Analytical Module (SDAM)**, and the **Spatial Analytical Decision Module (SADM)**.

Outcomes of the EDAM can assist decision-makers towards the development of a road map for the management of environmentally sensitive areas. Trends exhibited in the results could suggest ways to identify the stakeholder area of consensus and hence to better categorize the severity of the environmental conflict.

Understanding the magnitude and direction of stakeholder conflict will potentially lead to better management of stakeholders, shape management plans, and ultimately reduce the degradation of the environmentally sensitive area.

Therefore, the outcomes have to be presented to the stakeholders and decision-makers to investigate if the results can plausibly have any effect on their decisions, to assess how they could perceive results and if understanding the severity and direction of the problem could reshape the future management plans for the study area.

Figure 3-4 illustrates the structure of the EDAM model. It shows the various steps of data inputs and outputs and demonstrates the verification of results and the validation process.

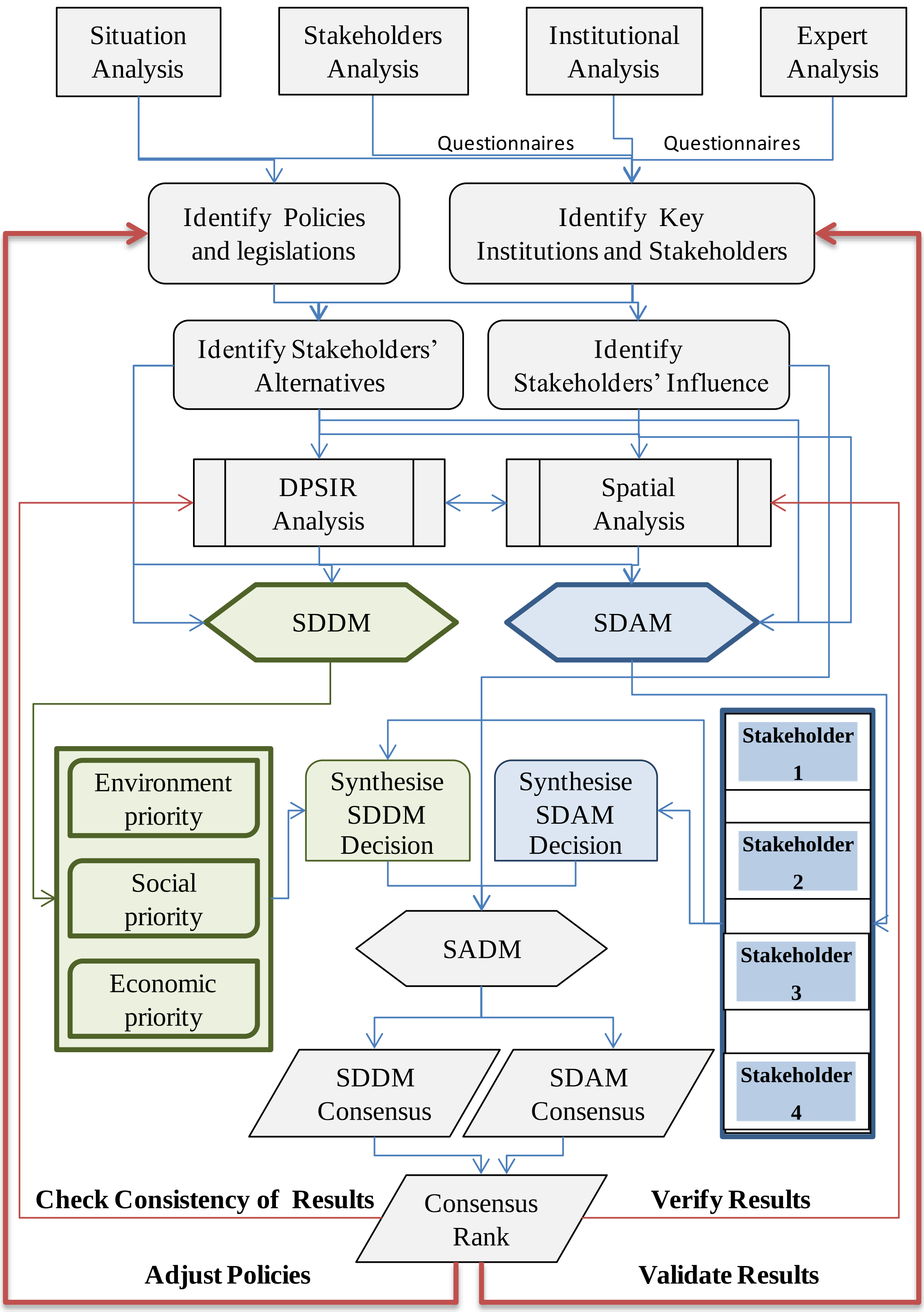


Figure 3-4 EDAM Structure

3.7.2 Identification of the case study that meets the criteria of the methodology

As this research addresses both descriptive and explanatory questions, a case study area is applied to respond to these research questions and finally to examine the decision analytical model. Compared to other methodological approaches, the strength of the case study method is its capability to study, in-depth, a "case" within its "real-life" context (Yin, 2004).

AHP can incorporate qualitative data from the case study into its hierarchical structure. The data is normalised using its utility normalisation function in order to be integrated with other quantitative data.

The case study explored in this research is not only used to extract data for situational analysis to understand the root causes of the problem, but also to verify results by comparing the decision analytical model outputs against the situation on the ground. Stake (1995) suggests that statistical generalization cannot be the primary aim of case studies but rather the opportunity to learn from them.

The use of the case study in this research is also to investigate and analyse an important area not easily covered by other methods. The case study area provides an example of the absence of plausible, rational decisions common to all stakeholders. It also demonstrates an example of mismanagement and policy failure.

The research uses the environmental assessment framework methods through DPSIR analytical framework that was explained in chapter one, to develop an understanding of the choice of stakeholder preferences. The case study demonstrates the role played by conflict between different stakeholders in deterioration of the environmental quality of the sensitive area. Criteria for this selection of case study and its identification as a "sensitive coastal area" is elaborated and explained. The data extracted from the case study will serve as base data for understanding the orientation of the decisions with regard to environment, social and economic aspects and for the validation process. Using the case study in multiple research methods in this context strengthens and validates the argument and takes advantage of their complementarities.

The methodology explores the possibility to develop a tool to measure the degree of consensus between stakeholder decisions in environmentally sensitive areas and to assess the tendency of stakeholder decision towards the three pillars of sustainable development.

Accordingly, to apply this methodology in an area, the following criteria should be met:

1- The area is environmentally vulnerable
2- The area is subject to human induced activities which are negatively impacting the environmentally sensitive area.
3- There are conflicting stakeholder priorities
4- Inability to efficiently implement the existing policies
5- Evidence of environmental deterioration

The research tests the methodology in an environmentally degraded coastal sensitive area in the Northern Coast of Egypt which is subject to multi-stakeholder decision conflict problems. The case study is subject to policy failure and environmental degradation. The fundamental reasons for selecting the case study is to shed light on the presented research argument, to clarify the decision or set of decisions that were taken, to understand why they were taken, and to demonstrate the impacts of their implementation on the case study area.

3.7.3 Identification of current environmental, social and economic conditions affecting the area of study

The area of study should be thoroughly examined. Environmental, social and economic conditions have to be identified to understand the root causes that led to the current state of the environment in the area of study. The analysis includes investigating the history of the area, the social structure of inhabitants, human activities, and economic conditions. This information is used to develop the DPSIR framework and to verify the consistency of decision for each stakeholder.

Conducting change detection is important to understand how this area has changed over time. It also highlights the level, speed and trend of change, and identifies the most affected areas as a result of this change.

3.7.4 Explore the changes on the ground over an identified period of time

Extracting information about environmental and demographic changes is essential to understand the current state and the historical trends of the study area. Remote sensing techniques have increasingly becoming an essential tool for managing natural resources (Kennedy et al., 2009). Remote sensing techniques combined with geographic information systems (GIS), has been identified as a powerful and effective method for detecting changes in land-use (Chen et al., 2005). Change detection is a technique for measuring changes that have occurred over a period of time. It can point out to more substantial insight about the land-use changing process (Ramachandra and Kumar, 2004).

The main objective of this step is to highlight the spatial features and changes that have occurred over a period of time to the case study area, which are to a certain extent affecting the decision-making process. The main objective is to make the link between specific changes on the ground and the previous and current decisions. It also looks at the impact of various decisions on the spatial characteristics of the studied vulnerable area. The outcome is fed into the overall aim of the research to develop a new methodology to assess, measure and rank the degree of consensus among stakeholders. It intends to develop an understanding of the different elements contributing to current environmental conflict through spatially analysing demographic, environmental and social aspects that are shaping the development of the stakeholder decision-making process.

3.7.5 Conducting face-to-face interviews with stakeholders

Interviews with the main identified stakeholders are necessary to develop an understanding of the current and historical background of each stakeholder's position. The main objective of the interview is to clarify stakeholder socio-economic structure, and stakeholder main priorities and requirements. Interview outcomes are important to verify results from stakeholder questionnaires. Qualitative data from the interviews are used as data input for the DPSIR framework analysis. Verification process includes comparing the outcomes with previously available interviews conducted through other development projects in the same case study area.

The degree of difficulty in conducting face to face interviews with stakeholders is different due to the differentiated educational and social background. Conducting interviews with local communities such as fishermen are more difficult than conducting the same exercise with members of the businessmen community or government officials. This is particularly evident in many developing authoritative countries due to the lack of confidence in government and local authorities. Interviewees sometimes envisage the interview as a cover up for an interrogation mechanism. Therefore, the interview could be part of building relations with stakeholders and not only to get information. The following steps are considered when conducting the interviews:

1- Select the interviewers from the same communities when possible.
2- Provide appropriate training to interviewers on how to get information and avoid bias.
3- A team of two interviewers conduct the interview to ensure accurate information.
4- Prepare a list of the primary and secondary stakeholders.
5- Identify a representative sample to be interviewed within each stakeholder group.
6- Prepare a list of clear questions.
7- Prepare the agenda for the interview (date, time, duration).
8- Conduct the interview.
9- Analyse results and prepare a table of the outcomes.

The Samples for interviews are covering all main stakeholders in the case study area. Sample for each stakeholder was based on convenience, on those to whom access was available, and who had the time to participate.

3.7.6 Identification of policies, laws and regulations applied in the area of study.

Existing legislation in the area of study is collected and analysed. The research examines the existing applied policies and tries to investigate the impact of each policy on the area of study. This is fundamentally important for two main reasons: First, is to understand if the policy has led to any enhancement or deterioration in the study area. Secondly, is to use policies as responses within the DPSIR framework. It is also important to have a chronic chart of all policies related to this area and compare the timeline with the trend of state of the environment. This step is essential to identify and explore the available policy alternatives in the area of study. Alternative actions are an integral part of the decision-making process.

3.7.7 Conduct stakeholder and institutional analysis

Stakeholder and institutional analysis is important to map the complexity of stakeholder relations and to understand the structure of stakeholders, and the diversity of the decision-making process. Stakeholder theory describes the main characteristics and the behaviour of institutions (Donaldson, 1995). Many types of stakeholder categorisations have been identified. Clarkson (1995) categorised stakeholders into two main groups: primary and secondary. Sirgy (2002) classified stakeholders into three groups: external, internal, and distal. Henriques and Sadorsky (1999) divided the stakeholder groups into four categories: regulatory, community, organizational, and media.

Based on the type of stakeholders and the research objective of using a primary sample to test the methodology, the research adopted the Clarkson model and categorised the case study stakeholders into primary and secondary groups.

The analysis goes beyond the description of stakeholder social conditions and resources, to provide an understanding of existing challenges and potential disagreements, and the analysis of the key factors that determine the patterns of the case study's resource use and distribution. Accordingly, stakeholder analysis aims to develop an understanding of what the current and future interests of the various stakeholders are in the use and management of the resource. It investigates the needs and expectations of stakeholders, how they use the resource, and the benefits they derive. The analysis explores stakeholder rights and responsibilities, in both a formal and informal way. It identifies the networks and institutions of which each stakeholder is part of. One of the main objectives of this analysis is to identify the potential areas of agreement and shared interests, upon which consensus and collaboration can be developed.

Identified stakeholders have to be analysed in terms of structure, hierarchy of decision-making process, and their priorities within the area of study. Stakeholder analysis is connected to institutional analysis; however, it focuses on individual motivation and/or shared interest, than on structures and procedures (FAO, 2011). Institutional analysis therefore, is a critical element of any planning and management initiative, particularly where a greater degree of integration is required. Food and Agriculture Organization (FAO) defines institutional analysis as "the analysis, in relation to a specific issue or problem, of relevant formal and informal institutions and their relationships, and the structure and procedures (e.g. decision-making, implementation, review) of these institutions" (p 46).

Institutional analysis in this research includes both government agencies such as ministries and governorate's environmental protection bureau and other non-governmental institutions such as businessmen associations and social entities such as the syndicate of fishermen. It is important to explore the mandate of each organization to understand its position in relation to the area of study.

3.7.8 Applying DPSIR analytical framework

Environmental assessment is a methodology used to investigate the possible environmental impacts of any action that affects the natural environment. The assessment may include retroactive analysis of the state of the environment and the trend that led to the current environmental condition. The main objective of environmental assessment is to draw a picture of the current state of the environment, and highlight the potential risks and impacts of current policy trends to decision-makers. An environmental assessment process that is both timely and efficient leads to better informed decision-making.

Environmental assessment is the main tool for understanding the relationship between scientific processes and the different elements of the policy- and decision-making process (UNEP, 2008). The Rio Declaration considers it an important instrument to achieve sustainable development (Braun, 2008). One of the main objectives of Environmental Assessment is to ensure that the decision-making process takes account of the environmental consequences (EC, 2008). Environmental Assessments are generally conducted by stakeholders including governments, international organizations, non-governmental organizations, academia, consulting firms and experts.

Integrated assessments of the state of the environment are usually a process to answer five main questions:

- What are the current changes to the environment and why are those changes occurring?
- What is the impact of these changes on the environment?
- How is society responding or reacting to the changes, and how effective are those reactions
- What option does society have to sustain its natural environment?
- What are the actions and measures that can be taken to reverse any negative implications for the environment? (Ambala, and Ocholla, 2006).

The DPSIR framework is used for assessing the state of the environment. As indicated in chapter one, DPSIR uses cause- effect interacting relationships of social, economic, and environmental systems. In the DPSIR framework, driving forces caused by human induced activities or natural phenomena as a result of social, economic or environmental dimensions, lead to pressures on the environment and, consequently, observable changes in its state. The impacts thus caused provoked responses either at the policy level (social responses) or as natural response or an ecological reaction.

Responses feed back into the driving forces, the developed pressures, the current state, and the impacts on the environment making it an iterative process (EEA, 2001).

The research uses the DPSIR framework in the context to understand the driving forces that are leading to the current situation, the existing pressures on the area of study, the current environmental and socio-economic state, the impacts of these pressures on each stakeholder and the various responses from stakeholders towards these challenges.

3.8 Data Collection and Organization

This section illustrates the data collection strategy and techniques and theoretical foundation of the research data analysis. The section demonstrates how units of analysis are used to blend stakeholder decision conflict, environmental assessment research methods, and prescriptive, behavioural and naturalistic decision theories into this single research study.

3.8.1 Applying mixed research methodology

This research is both quantitative and qualitative in nature. Several qualitative methods rely on expert opinions and also incorporate the concepts of ranking and weighting, and so could be considered semi-quantitative in nature (Ayalew and Yamagishi, 2005).

Terry (1994) points out that on-going discussion over the merits of qualitative versus quantitative analysis is an ineffectual endeavour unless we cautiously specify terms, and once this is done, the two approaches are seen as complementary. The qualitative analysis in this research will address the research questions related to process while the quantitative analysis will address those related to outcomes.

The research uses stakeholder analysis to identify the main stakeholders in the area of study.

Meadows et al., (1972) argues that environmental assessment started with the publication of the ‘‘limits to growth’’ report, as indicated in chapter one, which suggested that the world would reach its limit within a century, based on current trends. Assessment of the state of environment in any particular ecosystem always includes qualitative components, particularly when assessing the environment in relation to stakeholder participation.

The mixed methodology of qualitative and quantitative research as proposed by Lincoln (1991), Reichardt and Rallis (1994), Sechrest (1992), and Yin (1994) embraces much more than the traditional dichotomy between qualitative and quantitative research. Yin showed that the stronger the “mix” of methods within the confines of a single study, the more benefits researchers can derive.

Data analysis for this research is based on the integration of both qualitative and quantitative data. Quantitatively, data are collected from different sources: Geographic Information System (GIS) data; Remote Sensing data as outputs from the change detection results; field surveys conducted over ten years in the case study area; and finally quantitative data from stakeholder analysis. Qualitative data are collected through observation and stakeholder perceptions towards the area of study.

The research methodology entails public consultation at the local level, policy dialogue with key officials in the municipality, representatives from the identified stakeholders, and the affected community where the case study is implemented.

The research explicitly recognises the fact that a variety of objectives may influence stakeholder decisions. MCDA provides techniques for comparing and ranking different outcomes, even where a variety of indictors is used.

The community affected, including the most vulnerable, are consulted to highlight the main problems and identify policy options and alternatives. The research identifies the major stakeholders in the case study area and analyses the main management challenges for each identified stakeholder group. It also aims to show areas of overlap in their different perceptions and convictions regarding existing challenges to extract synergies and areas of potential agreement and cooperation.

An in depth assessment of data related to current policies and legislation is collected to analyse policy failure and analyse the impact of each policy or legislation on the area of study. The analysis assists decision-makers to make rational urban management plans and allow new strategies to be devised for sustainable human settlements.

The methodology enables measurement of the effects of multiple stresses caused by human activities in the case study area.

Several types of questionnaires are developed for this research targeting stakeholders and experts. Structured questionnaires are distributed to all case study stakeholders to assess their preferences and to identify their priorities. Each questionnaire is designed to match the intensity table in the decision module. The data sets were entered in the decision module after being ranked, assigned weights, and scored according to the qualitative impact of the developed criteria.

The expert questionnaires are mainly used for identifying stakeholder influence values, and also to develop the Sustainable Development Decision Module (SDDM). The decision-makers questionnaire is used to assess the impact of the research outcomes on both stakeholders and decision-makers.

Data in this research is categorised into three types based on the source of collection: data from case study, data from performing spatial analysis, and data collected from surveys and questionnaires. Examples of the three categories are:

3.8.2 Data collected from the case study

Quantitative data includes total annual fish production, population of the fishermen community, structure of the economy, climatic data, water discharge, water quality data etc. Qualitative data includes information obtained from field observations in the case study area, interpretation of the stakeholders, and institution structure and objectives.

The flexibility of research plans, and the depth and variety of information gathered during the data collection process, allowed for continuous updating and adjustments of the issues the research covers. Site visits were conducted to properly define the different components of the current urban management system and to undertake scoping of the issues at stake. Collection of current policies and legislation at the study area was conducted.

Based on information derived from policy dialogue and site visits, the research study developed a set of spatially-referenced digital maps using Geographical Information Systems and raster images of the case study area.

Quickbird Satellite images were initially requested for ALAMIM project (Alexandria Lake Maryout Management project) to set up a management unit in the Governorate of Alexandria. The images are used in this research for analysing the changes over time for the case study area.

The analysis and results of change detection are used to develop understanding of the extent and rate of changes in the case study area. Data was derived from the image-processing techniques that are employed to classify land and urban patterns, among other spatial applications.

Vector and raster data is collected from hard copy and digital maps and is linked to attribute data on variables related to the focus of the study. Examples of the attribute data are collected including data series showing demographic growth trends in the study area, physical and temporal changes overtime, required service areas for future expansion and current conditions of the newly-developed areas.

Other than literature review of the subject and previous available research on the area, the data extracted from the case study mainly relied on questionnaires, surveys and fieldwork that was conducted throughout the period from 1997 until 2008, and was updated twice in 2010 and 2011. The data collection is synchronised with in-depth interviews with stakeholders.

The field work was conducted in 1997 as part of Mediterranean Building Regional and National Capacity in Hot Spots (MEDBRANCH) project. This project was implemented jointly by the International Academy for the Environment and the METAP Regional Capacity Building Programme. The interviews were repeated in 2009 within the framework of Alexandria Integrated Management of Lake Maryout project (ALAMIM).

The process of data collection continued in 2011 for verification. The number of interviewees each time exceeded 40 from different stakeholder groups. They met over a period of ten days of intensive fieldwork, and in the context of individual, group and focus group. The objective of the interviews was mainly to develop an understanding of the socio-economic structure of the stakeholder groups.

The interviews are also used to either distribute questionnaires or verify data from the already distributed questionnaires. Questionnaires were distributed during the ALAMIM public hearings/meetings that were conducted in 2008 and 2009. Forms were distributed to stakeholders as per the designated module research.

No part of the collected data and analysis was used for the project as the focus of the public hearing was not data collection but rather to understand the issues and problems related to stakeholders.

Historical data was used to compare the shift, if any, in stakeholder perception towards the identified criteria. The questionnaires were re-distributed in 2011 to verify the results of previous surveys and to identify any shift in the decision-making process over time.

3.8.3 Stakeholder Analysis

The main purpose for conducting a stakeholder analysis in this research is to identify key stakeholders to provide input for the research methodology, to identify the main priorities and objectives with respect to the management of Lake Maryout, which will be used as policy alternative in the research methodology, and to identify the main existing areas of agreement or conflict.

It is essential to realize the need to address the importance of engaging the wide base of stakeholders in the lake's management and decision-making process which attempts to bring all stakeholders together from the local and national levels to inform, support, and agree to implement an integrated management plan. Ramirez (1999) suggests that stakeholder analysis helps in understanding the structure of a group by identifying the main players and beneficiaries to assess their interests and priorities. It is also vital to understand not only the interests but the forces that shape these interests, and result in the current decisions of each stakeholder.

As highlighted in chapter 2, stakeholder analysis is an important tool in the fields of conflict management and dispute resolution (Smith, 1993; Ramirez, 1999; Swiderska, 2002).

The analysis is mainly based upon several sources of information, including public hearings conducted throughout the ALAMIM project in 2007 and 2009. A stakeholder analysis was done during the ALAMIM project in 2007. An updated analysis is required for this project to ensure that the mapping of stakeholders is consistent. The analysis for this research is based on personal interviews, records of discussion forums, telecommunications, electronic information exchanges, previous reports and studies, workshop discussion outcomes, and information gathering from secondary sources.

The stakeholder analysis observed the complexity of stakeholder relations, and is designed to be a focused and well-planned exercise aimed at answering questions that are directly relevant and beneficial to the planning and understanding of the decision-making process. The analysis went beyond the mere description of social conditions and resource-use patterns, to provide an understanding of existing challenges and potential disagreements, and the analysis of the key factors that determine the patterns of Maryout resource use and distribution. Accordingly, stakeholder analysis aimed at developing an understanding of what the current and future interests of the various stakeholders in the use and management of resources were. It investigates their needs and expectations, how the resources are used, and the benefits they derive. The analysis explores stakeholder past and current influence, rights and responsibilities, in both a formal and informal way. It identifies the networks and institutions of which each stakeholder is part of. One of the main objectives of this analysis is to identify the potential areas of agreement and shared interests upon which consensus and collaboration can be developed.

3.8.3.1 Stakeholder categorisation

Stakeholders are categorised according to their level of importance in two main groups: primary and secondary. The two levels would assist in conducting the analysis pertaining to the management of the lake, and the analysis pertaining to stakeholder involvement in the decision-making process. This categorisation is essential to understand the interaction and weight among different decision-making processes.

Despite the fact that Maryout Lake and Valley fall in the geographical zone and under the jurisdiction of the Alexandria Governorate, there is nothing in the organizational structure of the Governorate that allows it to practice direct management of such water bodies. Consequently, the Governorate ownership of Maryout Lake and Valley is ineffective. The current management structures have allowed the conversion of very large areas of the lake into agricultural lands and industrial areas, where mega petroleum and industrial compounds were established. Accordingly, the lake area was dramatically reduced. Moreover, it was not able to halt discharge of liquid industrial and sanitary drainage into the lake over long periods of time, thus leading to the current miserable condition of the lake. Weeds and water plants grow in high densities and are accompanied by heavy alluvium. It is further expected that with the lapse of time such plants and alluvium will completely occupy the water body, giving no opportunity for fish production, the last sole use of the lake.

3.8.3.2 Identification of key stakeholders

Stakeholder identification classifies who has an important role to play in the planning process. The analysis is based upon the identification of several efforts in the Maryout area, current activities of different players, the diversity of functions around the lake, and the consultations with potential future activities. Stakeholder identification within the context of this research is a critical part of the analysis process. Building on WWF (2008) for the identification of stakeholders, the research adapted 9 questions to determine the degree of importance and influence of each stakeholder (see Table 3-2).

The research used direct interviews and analysis of the available documents to explore with stakeholders their main priorities, their degree of involvement in the planning process, and their expectations for proposed management plans regarding Lake Maryout, as well as their existing and potential conflicts with secondary stakeholders. Interviews were conducted in 2008, and again in 2011 to update the data and to detect any changes compared with the older interviews that were conducted in 1998 within the framework of the MEDBRANCH project.

Table 3-2 The 9 point assessment survey

1- Is the stakeholder directly responsible for decisions on issues relevant to the area of study?
2- Does the stakeholder hold positions of responsibility for the management of this area?
3- Does the stakeholder have control over the area of study (both thematic and geographic areas)?
4- Does the stakeholder have the power to affect decisions related to the area?
5- Can the stakeholder be affected by the degradation of the area either at the environment, economic or social level?
6- Can the stakeholder promote/support the management of the area of study, provided that they are involved?
7- Can the stakeholder obstruct/hinder the management if they are not involved?
8- Is the stakeholder directly involved in the area (thematic or geographic)?
9- Does the stakeholder have future plans for this area?

The number of interviewees in 2011 exceeded 110, covering the main 16 institutions, ministries, private sectors, industries, and NGOs representing the identified key players in the area of the lake. The sample included different levels of decision-makers within each group ranging from higher strategic management level, technical level and operational level. For groups such as the fishermen community, the sample included members of the community such as the Fishing Authority, leader of fishermen and individual fishermen.

The interviews in 2011 relied on a working group of volunteers, mostly university undergraduate and post graduate students, to conduct the interviews and distribute the research questionnaires. The working group were instructed to represent the different stakeholder interests. This process assists in preventing any bias that might occur if a single expert or institution conducts the analysis. Therefore, it is essential to engage individuals from different social and educational backgrounds. A total of 15 individuals assisted in the data collection over a period of three months.

Members of the working group were selected from those who had interviewing experience, and able to get answers without imposing their personal biases. They were mostly involved in previous similar projects, and had conducted interviews for other development projects. However, a three-day training period for the volunteers was conducted in January 2011, to familiarise them with the process and to ensure the neutrality of their work.

A survey was conducted for all relevant reports and previous work related to the area including previous stakeholder analysis that was conducted by the MEDBRANCH project in 1997, and ALAMIM project in 2007. A new list was prepared to identify all potential stakeholders who affect or get affected by the current situation in the lake and by applied policies.

Due to the wide scope of the target sample, the outcome was an exhaustive comprehensive list of potential institutions. Since time and resources were limited, the list of potential stakeholders that was required to be interviewed was prioritized. A list of 16 stakeholders was developed which can be categorised into four main categories: 1) governmental ministries; 2) non-governmental organisations; 3) local community representatives; and 4) the private sector. The priorities and objectives are different within each category and across categories.

The analysis used the Importance-Influence Matrix for mapping different stakeholders based on their level of influence and their relative importance.

A standard questionnaire was developed for interviewing the identified list of stakeholders. The influence questionnaires are analysed by identified expert group. However, it is essential to get information about each stakeholder and how important the management plans are. The stakeholder did not fill this influence questionnaire, but the interviewer team member used the questionnaire to direct the conversation while conducting the interview.

Taking into consideration the cultural context, the questionnaire used specific, clear and open-ended questions.

The questionnaire included an introductory paragraph to allow the interviewer to explain the objective of collecting the information, and that was done merely for scientific research on stakeholder conflict management to find the area of consensus to assist in better management of the area (Appendix B).

A set of rules was explained to the interviewer groups during their training. This set of instructions is important to ensure that the collected data is objective, consistent and accurate. The rules are as follow:

1. The interview should not exceed one hour
2. Each interview consists of two volunteers
3. A team member conducts the conversation but both interviewers take notes.
4. The notes should include the exact words said by the interviewee.
5. The interviewee may terminate the interview at any point of time upon his/her request.

Building on the IUCN (2008) stakeholder matrix, the outcomes of the interviews were categorised into four main categories:

Category I stakeholders have high importance but little influence. They impact the lake but do not have direct interest in management. Therefore, they do not influence the decision-making process.

Examples include the Ministry of Agriculture, Alexandria Company for Sanitary drainage, the Ministry of Housing, and the Ministry of Water Resources. Each one has an impact on the lake but do not have a direct interest in the lake. They have higher agendas across the country, with many national problems. Currently they are consulted in issues regarding the mitigation process of the lake but are not directly involved in the management or planning.

Category II stakeholders have high importance and high influence. Examples include those who are taking decisions that are impacting the lake and have direct interest in the management plan. They are directly affecting or get affected by any management plans or policies.

Examples include the Governorate of Alexandria, the EEAA, the Fishermen Community and industries represented by the ABA. These stakeholders are affected directly by any decisions and have the required power to make or change these decisions. They cannot be ignored in any planning process. These are the primary stakeholders in this category and the target of the decision analysis for this research.

Category III stakeholders have low importance and high influence. They do not impact the lake directly, but have a legal mandate or can affect the decision-making process.

This category includes the Ministry of Industry, Ministry of Petroleum, Ministry of Interior and Ministry of Health. According to the analysis all these entities do not directly impact the lake but can affect the decision-making of the lake as they are involved at higher level management of nation-wide planning. The Ministry of petroleum is not directly involved in industrial wastes, but it has the power over local industries around the lake to control these discharges. The Ministries of Interior and Health do not impact the lake, but have the authority to stop the negative impacts caused by other pollutants.

Category IV stakeholders have low importance and low influence, and are unlikely to be strongly involved in management. They do not impact decisions, affect, or get affected by the degradation of Lake Maryout.

An example of this category includes the Ministry of Investment, which promotes investment in this area and has a direct link with other primary or secondary stakeholders. NGOs such as Friends of the Environment in Alexandria monitors the degradation, raises public awareness, promotes mitigation measures. It coordinates with the EEAA and Fishing Authority, but does not directly have influence on decisions.

Examples also include academia and research centres that help in the environmental assessment of the degradation, and provide technical and scientific solutions. They have very little influence on the decisions regarding the management of the lake or formulating policies in the area.

Figure 3-5 illustrates the outcome of stakeholder mapping based on the degree of influence and the importance of each stakeholder.

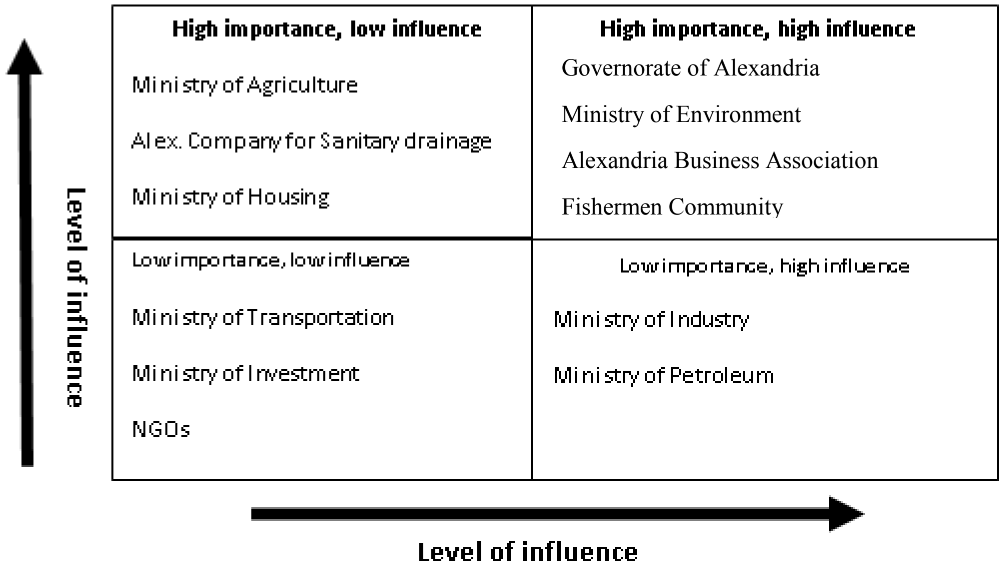


Figure 3-5 Stakeholder Mapping

This outcome was categorised based on the Clarkson (1995) method which categorises stakeholders into two main groups: primary and secondary.

Primary stakeholders: those who depend directly on Lake Maryout and are affected either positively or negatively by any human induced intervention in the area and can affect the decision process. These criteria are falling under category II of the Matrix.

Secondary stakeholders: those who do not directly depend on Lake Maryout but may or may not be affected by the negative impacts, and have a main interest in the management of the lake. Categories I, III and IV can be described as secondary stakeholders.

Accordingly, the following is the list of categorisation of Lake Maryout stakeholders:

- ***Primary Stakeholders***
    - Governorate of Alexandria (GOA)
    - Egyptian Environmental Affairs Agency (EEAA)
    - Fishermen Community (FC)
    - Alexandria Business Association (ABA)

- ***Secondary Stakeholders***
    - Ministry of Agriculture
    - Alex. Company for Sanitary drainage
    - Ministry of Housing
    - Ministry of Water Resources
    - Ministry of Industry
    - Ministry of Petroleum
    - Ministry of Interior
    - Ministry of Health
    - Ministry of Transportation
    - Ministry of Investment
    - NGOs
    - Research Centres

3.8.4 Software tools used for calculating AHP and GIS spatial analysis

The research uses several tools and software to calculate AHP and GIS functions. Spatial Analytical Decision Module (SADM) uses ArcView software platform. Arc View, is developed by Environmental Systems Research Institute (ESRI). It is geographic information system (GIS) software for visualising, managing, creating, and analysing geographic data. The GIS software is used to locate stakeholder priorities in the spatial domain and hence to calculate areas of priorities and areas of consensus.

The research uses Expert Choice Pro (EC Pro) software which is a multi-objective decision support tool based on the Analytic Hierarchy Process (AHP). It is selected to perform AHP SDDM and SADM because it uses a mathematical theory first developed at the Wharton School of the University of Pennsylvania by one of the software founders, Thomas L. Saaty. The software uses both empirical data as well as subjective judgments of the decision-maker. The software, as well as all AHP processes, assists in analysing the decision-making process by providing a structure to organize and evaluate the importance of a choice of objectives and the preferences of alternative solutions to a decision.

Expert Choice is graphically based and structured. The criteria are presented in a hierarchical structure, and decision-makers are able to drill down to their level of expertise and apply their judgments to the objectives deemed important to achieving their respective goals.

A study that analysed AHP software alternatives, selected Expert Choice Pro (ECPro), AutoMan, and HIPRE 3+ as the most credible. The study showed that the three software programmes have a correct transformation of the AHP among all software alternatives because they produce a correct transformation of the specific AHP procedure (Ossadnik and Lange, 1999). According to the same study, the significant advantage of EC Pro is its comprehensive module for building a hierarchy and its capability to perform five different types of sensitivity analysis. The study concluded that EC Pro is "very strongly favourable" to be used in AHP research and applications and is ranked first as per the following rank: EC Pro ≻ AutoMan ≻ HIPRE3+.

Therefore, Expert Choice software is used in academic research by more than 94 universities worldwide as the most credible tool for calculating AHP pairwise comparisons, making numerical and graphical judgments for the alternatives, synthesising results, and performing sensitivity analysis. However, the research uses a developed excel file to perform AHP calculations to verify the results of the software.

3.8.5 Data collected from questionnaires

Examples of quantitative data include preferences collected from questionnaires either from experts or stakeholders, ranks and weights, and degree of stakeholder influence developed by experts. Qualitative data is collected through interpretation of public hearings and interviews.

The pairwise comparison matrix is a commonly used technique in Multi-Criteria Decision Making (MCDM) and particularly in AHP (Pelaez and Lamata, 2003). Data collection in AHP is usually used in a questionnaire format to collect feedback from multiple respondents (Schurr, 2011). AHP has the capability to utilise data collected by team consensus.

The questionnaire survey can be conducted in AHP by email, telephone calls, face to face interviews, or on-line, to collect opinions of decision-makers (Gang Kou et al., 2011). The values of comparisons in single AHP Matrix are gathered from various questionnaire surveys.

Design of questionnaire for survey research, is considered one of the major challenges for survey researchers in terms of the degree of precision in measuring respondent perceptions (Traugott et al., 2000).

According to Jerard (1995) and Downing (2004) as cited in Sato (2011), multiple-choice question format is a traditional method for measuring respondent perceptions which is considered to be well-matched to questionnaire formatting because respondents perceive it as an easy method to answer questions, and allows researchers to easily recognize the main concerns of the respondents.

AHP utilises aggregated data from a decision-makers' judgments through pairwise comparisons, to quantify the degree of importance of each alternative (Sato, 2011). This procedure identifies not only the most important alternative but also the preference for all alternatives for each decision-maker (Crawford and Williams, 1985).

There are four types of questionnaires in this research: Alternatives identification Questionnaire, Sustainable Development Experts Questionnaire, Stakeholder Questionnaire and Decision-Maker Questionnaire.

3.9 Respondents details

The main objective of the multi-stakeholder and group decision approach is to develop understanding regarding the available options. Expert panels, public hearings and other stakeholder consultations could utilise decision support methods such as the Analytic Hierarchy Process (AHP), or other multi-criteria systems to assess alternative policy options against recognized objectives (Linacre et al., 2005). The following sections describe the distribution of the questionnaires and the results obtained from various sources. Results are categorised according to the type of stakeholder, total number of the sent questionnaires, number of replies for each stakeholder, and the calculated percentage of responses.

3.9.1 Distribution of questionnaires

Questionnaires were distributed through interviews and consultation meetings. An introductory section in each questionnaire explains the main objectives. A generic explanation of how the questionnaire will be used was presented to familiarise stakeholders of how the pairwise comparative method can help in prioritising alternatives.

The questionnaires were first distributed in 2009 during public hearings related to ALAMIM Project. Nevertheless, to update the questionnaires and to ensure that there are no biases, a group of volunteers, as explained previously, assisted in the distribution of questionnaires and in collection of the data. They were selected based on their previous experience in conducting interviews and distribution and collection of data through questionnaires. However, they received training so that they can communicate well with stakeholders and able to explain clearly the objectives of this research.

Despite that the objectives are identified by the stakeholders, a clear definition of each term used in the identified alternatives was clearly explained in all the activities where questionnaires were distributed. This was to make sure that all terms are clearly explained and consistent to all stakeholders. The questionnaires were distributed in 2011 through interviews, focus groups and consultation meetings. The sampling size was selected to make certain of equal representation from each stakeholder group. Five types of questionnaires are distributed in addition to results obtained from interviews, consultation meetings and experts' panels namely; Stakeholders' alternatives, Stakeholder influence, sustainable development pairwise, Stakeholder priorities pairwise comparison, and stakeholders' feedback questionnaires. Respondents' details are shown in the following sections.

3.9.2 Identification of main alternatives (Appendix A)

The objective of this questionnaire is to identify Lake Maryout's stakeholders' and other affected groups' priorities towards any proposed development of a management plan for the area.

Stakeholders are asked to identify four priorities that they think should be considered during the planning and management of Lake Maryout.

The four main identified priorities will be used in the pairwise comparison to assess the relative importance for each priority.

Identification of main issues that are affecting Lake Maryout are collected from main stakeholders, various affected groups and from face-to face interviews.

Stakeholder questionnaires are used to identify preferred alternatives. Stakeholders are asked to select number of alternatives that meet their objectives with respect to the management of Lake Maryout.

Expert opinions are considered to evaluate of the selected issues are consistent with scientific literature and their own judgement.

Expert judgments and stakeholder consultations are utilised to evaluate the selected alternatives in terms of its redundancy or plausibility (see Figure 3-6).

Ideally, alternatives should not be restricted to environmental mitigation measures. In order to minimise the complexity of the choices and to facilitate the comprehension of the results for both the stakeholders and decision-makers, this research restricts the analysis to four main selected alternatives. The methodology, however, could use any number of alternatives.

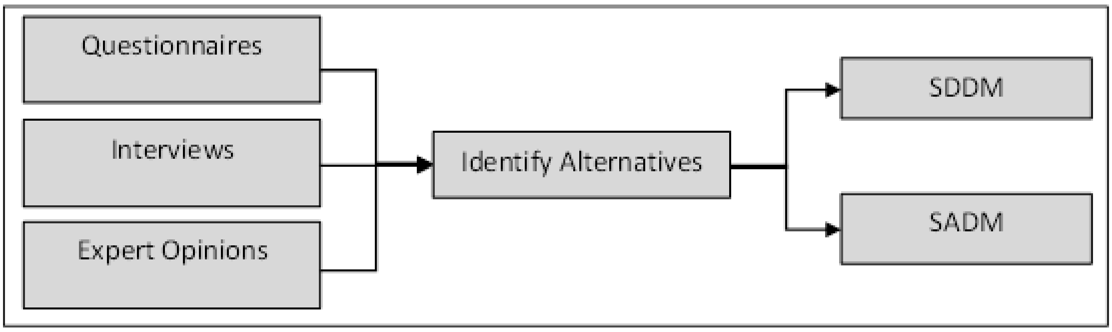


Figure 3-6 Identification of Alternatives

3.9.2.1 Results obtained from main stakeholders

Stakeholders' Alternatives Questionnaires (see Appendix A) were sent to primary stakeholders. The key question in the questionnaire is to identify the main preferences with respect to the planning and management of Lake Maryout. Stakeholders were asked to identify four main priorities that could constitute the foundation of integrated action plan for Lake Maryout. Stakeholders were asked if they can explain briefly the reasons for selecting these priorities. This would help to develop the DPSIR framework and to validate the model analysis.

Questionnaires were sent to 143 primary stakeholders. The collective response rate from all stakeholders was calculated at 70.6%.

Table 3-3 Selection of alternatives illustrates the size of the sample, the percentage of replies from each stakeholder and the total replies according to each alternative.

Table 3-3 Selection of alternatives

Stakeholder	Total Sent	Non-Respondent (NR)	Number Replied	Response rate (%)
GOA	38	13	25	65.78%
MOE	35	9	23	65.71%
FC	35	11	28	80%
ABA	35	9	25	71.42%
Total	143	42	101	70.60%

Identified Alternative	Stakeholder	Replies	Agree	Percentage Agreed %
Enhancing water quality	GOA	25	23	92%
	MOE	23	23	100%
	FC	28	28	100%
	ABA	25	17	68%
	Total	101	91	90.1%
Identified Alternative	**Stakeholder**	**Replies**	**Agree**	**Percentage Agreed %**
Urban expansion	GOA	25	24	96.0%
	MOE	23	13	56.5%
	FC	28	9	32.1%
	ABA	25	19	76.0%
	Total	101	65	64.4%
Identified Alternative	**Stakeholder**	**Replies**	**Agree**	**Percentage Agreed %**
Increasing fish production	GOA	25	10	40.0%
	MOE	23	16	69.6%
	FC	28	28	100.0%
	ABA	25	3	12.0%
	Total	101	57	56.4%
Identified Alternative	**Stakeholder**	**Replies**	**Agree**	**Percentage Agreed %**
Industrial development	GOA	25	7	28.0%
	MOE	23	5	21.7%
	FC	28	3	10.7%
	ABA	25	25	100.0%
	Total	101	40	39.6%
Identified Alternative	**Stakeholder**	**Replies**	**Agree**	**Percentage Agreed %**
Lake dredging	GOA	25	5	20.0%
	MOE	23	1	4.3%
	FC	28	1	3.6%
	ABA	25	0	0.0%

Identified Alternative	Stakeholder	Replies	Agree	Percentage Agreed %
Reduction of reeds	GOA	25	3	12.0%
	MOE	23	2	8.7%
	FC	28	1	3.6%
	ABA	25	0	0.0%
	Total	101	6	5.9%

Table 3-4 presents a summary of the identified alternatives by the main stakeholders.

Table 3-4 Summary of the Identified Alternative by Stakeholders

	Summary of the Identified Alternative by Stakeholders	Replies	Agree	Percentage Agreed %
1	Enhancing water quality	101	91	90.1%
2	Urban expansion	101	65	64.4%
3	Increasing fish production	101	57	56.4%
4	Industrial development	101	40	39.6%
5	Lake dredging	101	7	6.9%
6	Reduction of reeds	101	6	5.9%

3.9.2.2 Results obtained from interviews

As presented in the stakeholders' analysis, the number of interviewees in 2011 exceeded 110. The sample covered 16 institutions, ministries, private sectors, industries, and NGOs representing potential affected groups in the area of the lake. Notes were taken regarding the respondents main four issues that are affecting Lake Maryout.

The sample encompassed diverse levels of decision-makers within each stakeholder group ranging from higher strategic management level, technical level and operational level. The interviews were conducted in 2011 by a group of volunteer students. A total of 15 students assisted in the data collection over a period of three months.

Table 3-5 shows the summary of the identified alternatives by secondary stakeholders' affected groups as collected from interview notes.

Table 3-5 Summary of the Identified Alternatives by secondary stakeholders' affected groups

	Summary of the Identified Alternative by secondary stakeholders' affected groups	Replies	Agree	Percentage Agreed %
1	Enhancing water quality	110	101	91.82%
2	Urban expansion	110	107	97.27%
3	Increasing fish production	110	97	88.18%
4	Industrial development	110	103	93.64%
5	Lake dredging	110	39	35.45%
6	Reduction of reeds	110	23	20.91%

3.9.2.3 Results obtained from experts

The research made use of a group of experienced experts who are familiar with the study area. They are mostly professionals who are involved in projects, research, or social work within the area of study. Experts are considered a group of stakeholder who can provide inputs to identify the main issues affecting Lake Maryout. The stakeholders' alternatives questionnaires are distributed in an expert panel. 19 experts are contributed to this research. The Expert panel is a dedicated meeting for selected experts to discuss and fill three types of questionnaires namely; Stakeholders Alternatives Questionnaire, Stakeholders' Influence Expert Questionnaire, Sustainable development Expert Questionnaire. Table 3-6 presents the results obtained from the expert panel to identify the main alternatives.

Table 3-6 Summary of the Identified Alternative by Experts

	Summary of the Identified Alternative by experts	No of experts	Agree	Percentage Agreed %
1	Enhancing water quality	19	18	94.74%
2	Urban expansion		16	84.21%
3	Increasing fish production		13	68.42%
4	Industrial development		18	94.74%
5	Lake dredging		7	36.84%
6	Reduction of reeds		4	21.05%

Results from main stakeholders' questionnaires, interviews with affected groups and verification from experts' opinions show that four main priorities are identified as follows:

1- Enhancing water quality
2- Urban expansion
3- Increasing fish production
4- Encouraging industrial development

The four identified areas are the main causes for stakeholder conflict. As explained in the institutional analysis, there are large areas of disagreements regarding the current and future management directions between stakeholders. This has halted the development of this area in a collaborative manner.

3.9.3 Stakeholder influence expert questionnaire (Appendix B)

This questionnaire is distributed to the same selected 19 experts in a digital form through e-mail or hardcopies by regular mail. The experts are selected from among experienced professionals who are familiar with the study area. Selected experts are mostly those who are involved in projects, research, or social work within the area of study.

The questionnaires are distributed in an expert panel. Expert panel is a dedicated meeting for selected experts to discuss the relationship between the identified alternatives and the environmental, social and economic aspects. The Expert panel composition has to be diversified in experience to cover these aspects. The completed questionnaires are discussed in the expert panel. The influence ratio is calculated from an analytical matrix based on questions that help rating each stakeholder's degree of power over the management of the study area.

Questions include identification if the stakeholder is directly responsible for decisions on issues relevant to the area of study, if the stakeholder has responsibility for the management or has control over the area of study.

The Influence questionnaire tries to identify how they could affect decisions or how they could be affected by the environmental, social or economic degradation. It includes assessment of stakeholder power to support or obstruct the management of the study area or if they are involved in the future plans in this area.

The research uses WWF Stakeholder Influence Analysis cross-cutting tool. It classifies stakeholders according to their probable influence over decisions to be taken and according to the likely impact of other decisions upon them (WWF, 2008).
The tool is more relevant to this type of research as it takes into consideration the relative importance of each stakeholder in relation to the management of the area.

Stakeholder Influence Analysis cross-cutting tool puts weight on the decision-making process which is the centre of this research objective. Stakeholders are ranked according to their relative importance.

Table 3-7 shows the stakeholder influence table as follows: 0= not important 9= extremely important.

Table 3-7 Stakeholders Influence Table

Stakeholder	Degree of Influence (0-9)	Reason
Stakeholder 1		
Stakeholder 2		
Stakeholder 3		
Stakeholder n		

Outcomes of stakeholder influence questionnaires are entered into the influence table. The values are also categorised through the influence degree matrix for assessment of the degree of influence that each stakeholder has over the area of study (see Table 3-8).

Table 3-8 Degree of Influence

Comparative Influence	Numerical Rating
Extreme Influence	9
Very strong to Extreme	8
Very Strong	7
Strong to Very Strong	6
Strong	5
Moderate to Strong	4
Moderate	3
Little to Moderate	2
Little Influence	1
No Influence	0

3.9.3.1 Results obtained from experts

Questionnaires are sent to the selected group of experts. All experts have filled the forms. The collected replies were discussed in an expert panel to identify the degree of influence for each stakeholder based on the selected criteria.

Experts discussed the collected results and decided collectively on the final degree of Influence (see Table 3-9).

Table 3-9 Stakeholders Influence Questionnaire Replies

Type of Data Source	Target	Number Sent	Number Replied	Input to
Influence Expert questionnaires	Experts	19	19	SDDM Pairwise comparison

Following IUCN (2008) questionnaire (see Appendix B), Experts use the questionnaire to assess the degree of stakeholders influence. Based on the nine questions, the experts assigned values for each stakeholder.

Table 3-10 summarises the final influence values assigned by experts for the key stakeholders.

Table 3-10 Identified Stakeholder Influence Values

Stakeholder	Alexandria Governorate	Ministry of Environment	Fishermen Community	Businessmen Association
Influence Value	9	5	3	7

Results of experts' assessment show that GOA controls most of the influence and importance of the area of study. ABA is also categorised as a very strong stakeholder while MOE is considered a strong stakeholder while FC has only moderate influence.

3.9.4 Sustainable development experts questionnaire (Appendix C)

Data collected from sustainable development expert questionnaires is mainly used for Sustainable Development Decision Module (SDDM).

The main function of sustainable development expert questionnaire is to analyse expert judgments against the three pillars of sustainable development to identify the overall goal with respect to the main objectives, which are environment, economic and social integration to achieve sustainable management of the study area.

The numerical comparison table is designated to select the comparative importance to the identified alternatives with relation to the three pillars of sustainable development. Numerical judgments are made in the form of tables. Two indicators are compared with respect to the experts' opinion using a numerical scale. The numerical value is inserted to indicate which judgment is preferred and the strength of that preference. The numerical equivalents of the judgments are equal to the overall identified AHP scale.

Table 3-11 shows the number of experts involved in the SDDM questionnaires.

Table 3-11 SDDM Experts' Questionnaires

Type of Data Source	Target	Number Sent	Number Replied	Input to
SDDM Experts' Questionnaires	Experts	19	19	SDDM Pairwise comparison

3.9.5 Stakeholder pairwise comparison questionnaire (Appendix D)

Stakeholders' alternatives are identified through main alternatives questionnaires and to some extent, prioritised. However, the relative importance to each stakeholder towards these alternatives is unknown. The relationship between stakeholder objectives and the sustainable development component is also not clear. These are two important elements that managers and resource planners should know while developing a management plan for the sensitive area. This research is exploring if the EDAM could provide answers to these questions by identify these important elements in the management process.

The main objective of Stakeholder pairwise comparison questionnaire is to use the numerical comparison table to understand stakeholders' comparative importance to the identified alternatives.

The questionnaire was designed to assess the relative preferences of each stakeholder towards the main identified alternatives. It uses pairwise comparisons to establish and evaluate the relative importance (weight) of variables that contribute to the formation of the institution's decision with respect to specific identified alternatives. The data collected through the questionnaires assesses the weights of alternatives and compares every possible pairing (by rating rows relative to columns) and applying the Analytic Hierarchy Process and entering the ratings into a pairwise comparison matrix.

Table 3-12 summarises the number of sent questionnaires and number of collected replies. SDAM questionnaires were given to all primary stakeholders. The number of distributed questionnaires was 105. The number of correctly filled questionnaires was 81. The percentage of replies was 77.14%.

Table 3-12 Summary of respondents of Stakeholders Pairwise Comparison Questionnaires

Stakeholder	Total Sent	Non-Respondent (NR)	Number Replied	Response rate (%)
GOA	27	6	21	77.78%
MOE	27	6	21	77.78%
FC	26	7	19	73.08%
ABA	25	5	20	80.00%
Total	105	24	81	77.14%

The decision matrix developed from the data input necessarily includes values with a degree of subjectivity, such as personal judgment as to what should be done to the lake, which creates some bias in the mind of the individual.

Data was organised based on the judgments expressed in questionnaires, using pairwise comparisons. One option was to start with the identified goal (management of Lake Maryout) and work down to the alternatives (top-down). Another was to make judgments about the alternatives before making judgments about the objectives (bottom-up). The bottom-up approach was selected, and hence reflected in the questionnaire, because of the insights the stakeholders could gain about trade-offs between alternatives, which are helpful in making judgments about the importance of the objectives.

The questionnaire was designated using the standard format developed for AHP research studies. Data collected from stakeholder questionnaires are mainly used for Stakeholder Analytical Decision Module (SADM). Questionnaires are sent by regular mail, e-mail, face to face interviews, or as part of the conducted public hearings. The target sample is the identified primary stakeholders.

Therefore, the questionnaires were sent to each group prior to the focus group meeting to allow for institutional consultation. The pairwise comparisons do not reflect or target the individual opinions but rather the institutional position regarding these alternatives.

The questionnaires were discussed during focus group meetings. The questionnaire structure and objective is clarified to stakeholders before entering the judgments. A generic explanation of the overall function of the questionnaire must be presented to familiarise stakeholders of how the pairwise comparative method can help in prioritising alternatives.

A clear explanation of each term used in the identified alternatives is clearly explained in the questionnaire and during the focus group. Number of focus groups is a function of the identified primary targeted stakeholders. The sampling size is selected to make certain of equal representation from each stakeholder group. Details of stakeholder population, identified sample size for each group, and the overall response rate as indicated above.

Numerical judgments are categorised in excel sheet tables. The values are entered the AHP software calculator and the Expert Choice software for verification. Two alternatives are compared with respect to stakeholder priority using the developed AHP numerical scale. The numerical value is inserted to indicate which judgment is preferred and the strength of that preference. The numerical equivalents of the judgments are equal to the overall identified AHP scale.

Accordingly, it is important to roughly map the areas of agreement and disagreement as per the outcomes of the interviews and questionnaires for two reasons. First, is to develop an understanding of the extent and direction of the existing stakeholder conflict. The second reason is to use this information for validating the outcomes of the decision model.

3.9.6 Stakeholder feedback questionnaire (Appendix E)

This questionnaire is targeting stakeholders and decision-makers to assess the applicability of using the outcomes of the research at the practical level. The questionnaire is sent to all identified primary stakeholders, highlighting the main outcomes and the synthesised proposed overall management decision.

As the questionnaire is assessing the feedback of the same stakeholder group, the same target sample size of the stakeholder pairwise comparison questionnaire was used.

The questionnaire investigates if the outcomes may have any influence in shaping future legislation or in affecting the future management plans. Feedback from stakeholders helps in fine tuning the design and structure of the research.

A sample of 115 questionnaires was distributed between February and April of 2011 to primary stakeholders. The sample represents the decision-makers population within each stakeholder group. No financial incentives were given to any respondent throughout this research. The questionnaires were distributed by e-mail, regular mail and by hand. An introductory section was inserted at the beginning of the questionnaire to explain the objectives and the results. The total response rate is 84.3%.

Table 3-13 shows the final numbers and percentages of respondents and response rate. Analysis of stakeholders' responses concerning their priorities, consensus rank and the synthesised decisions is detailed in chapter 6.

Table 3-13 Stakeholder Feedback Statistics

Stakeholder	Non-Respondent (NR)	Respondent (R)	Total	Response rate (%)
GOA	5	25	30	83.33%
MOE	5	20	25	80.00%
FC	2	28	30	93.33%
ABA	6	24	30	80.00%
Total	18	97	115	84.35%

3.9.7 Data collection from other development projects

The area of study witnessed the implementation of several projects either by the national government or by the international development agencies. The research made use of the published data and reports related to the same case study over the past decades to develop a trend analysis of the social, economic and environmental changes over time.

The researcher was mainly responsible for data collection of two main development projects (ALAMIM and MEDBRANCH). Working in these two projects constituted the initial idea for the researcher regarding the need for further investigation to develop an understanding of the decision-making process in environmentally sensitive areas. Both projects, as described below, have different objectives. However, none was targeting the development of any decision-analytical tool to understand the rationale behind the sequence of events leading to the current policy failure. Both projects focused on developing practical measures to mitigate the current situation through capacity building programmes or proposing new management plans for the centralised decision-makers.

The objectives of both projects were not to analyse the decisions of stakeholders or look retroactively to investigate causes of such decisions or policies. The objectives were to find mitigation measures and capacity building.

3.9.7.1 Mediterranean Building Regional and National Capacity in Hot Spots (MEDBRANCH) (1996-1999)

Mediterranean Building Regional and National Capacity in Hot Spots (MEDBRANCH) project was implemented jointly by the International Academy for the Environment (IAE) and Mediterranean Environmental Technical Assistance Program (METAP) during the period from 1996 until 1999. Six hot spots were selected to assess capacity building needs. Hot spots include Oued-El-Harrach (Algeria), Lake Maryout (Egypt), Zarqa Basin (Jordan), Casablanca-Mohamedia (Morocco), Aleppo-Sheikh Said (Syria), and Lac Sud de Tunis (Tunisia). MEDBRANCH is a Regional Programme for Capacity Building aimed at building national water management and pollution abating capacities in sensitive areas. The overall objectives of the project were to a) strengthen the institutional capacity required to manage environmental issues; b) prepare a strong portfolio of priority environmental projects in order to accelerate and catalyse investment in environmental activities in the region; and c) formulate a set of focused key policy factors affecting the Mediterranean environment (Whitford and Ennabli, 2005).

The researcher was responsible within this project for the Egyptian case study of Lake Maryout. During this project, three public hearings were conducted 1997, 1998 and 1999 where stakeholders' conflict was evident. Public hearings were useful during MEDBRANCH project to understand the overall problems of the case study area and to start developing the need for further research. Interviews with stakeholders were only conducted through MEDBRANCH projects during 1997-1998. It was useful for understanding the historical background of the existing problems particularly regarding the fishermen community.

This type of conflict of interest between stakeholders of a natural resource was also clear in other hot spots in the Mediterranean with different intensities. However, there was no available methodology or tool to measure, evaluate or compare the severity of the conflict.

Despite the fact that almost similar management plans were developed for Egyptian and Tunisian hot spots, the outcomes of the plans after more than 10 years are very different.

Lac Sud in Tunisia has been developed and turned into a point of interest and a commercial and cultural attraction while the environmental quality of Lake Maryout has severely deteriorated. Therefore, outcomes of this project constructed the basic foundation for the researcher to start investigating the possibility of having a scientific methodology to analyse the impact of stakeholders' conflict, measure and rank the degree of conflict and to uncover the areas of common agreement.

Public hearings were useful during MEDBRANCH project to understand the overall problems of the case study area and to start developing the need for further research.

3.9.7.2 Alexandria Integrated Management of Lake Maryout Project (ALAMIM) (2006-2009)

ALAMIM project aimed at promoting sounder and more sustainable development of the Coastal Zone of Alexandria through the promotion of an integrated management approach for Lake Maryout. The project adapted a sound participatory integrated development action plan for Lake Maryout, with a focus on environment protection, economic development.

The project activities targeted the main stakeholders of Lake Maryout namely; Alexandria Governorate, the Regional Bureau of the Egyptian Environmental Affairs Agency (EEAA) representing the Ministry of Environment, relevant local and national authorities, industries, local communities, NGOs, private sector, investors, and visitors.

The project's main activities included (i) the participatory development of an Integrated Action Plan (IAP) for the Lake zone; (ii) the design and institutionalization of Lake Maryout Management and Monitoring units at Alexandria Governorate and the regional bureau of EEAA; and (iii) developing the necessary methodological, technical and financial instruments for implementation; (iv) implementing capacity building activities and public awareness programmes for stakeholders and local and provincial authorities (CEDARE, 2009).

The research made use of ALAMIM project activities such as public hearings, stakeholders' platform, analysis of the state of environmental of the area of study, stocktaking analysis, water discharges and pollution data, meteorological data and fish production.

Public hearings during the ALAMIM projects were used to distribute the research questionnaires for both experts and stakeholders in 2009. In Egypt, as well as in many other authoritative countries, it is not allowed to organise public platforms or distribute questionnaires to measure public opinion without prior approval from local authorities.

Therefore, it was essential for this research to use the already approved European Commission project of ALAMIM to collect stakeholders' priorities and judgements regarding specific alternatives. After collecting the permissions of project partners, public hearing sessions and stakeholders' platforms were used to distribute the Stakeholders and experts' questionnaires specifically developed for this research. Determination of stakeholders' influence ratio was also conducted through the ALAMIM project. However, the exercise with repeated to make sure that the outcomes of the ALAMIM influence weights are consistent with the research influence values. Accordingly, the influence questionnaires were re-sent to experts.

Quickbird Satellite images were initially requested for ALAMIM project and were used by authorities to develop a new integrated action plan. The research used the acquired images to perform change detection for the case study area. The analyses and results of change detection were used in this research for verification of stakeholders' decisions. Permission from European Commission was requested to use the GIS and remote sensing data for this research. The EC granted the request and encouraged other researchers, Universities and other academic institutions to make use of any available data. The outcome of ALAMIM activities were used as well for post graduate research for University of Stuttgart and Alexandria University.

3.9.8 Data organisation

Data from Interviews, public hearing, expert panel, and field work is collected and organised. The different types of questionnaires are organised in excel sheets to facilitate the data entry in the model. Figure 3-7 illustrates data sources and data flow diagram.

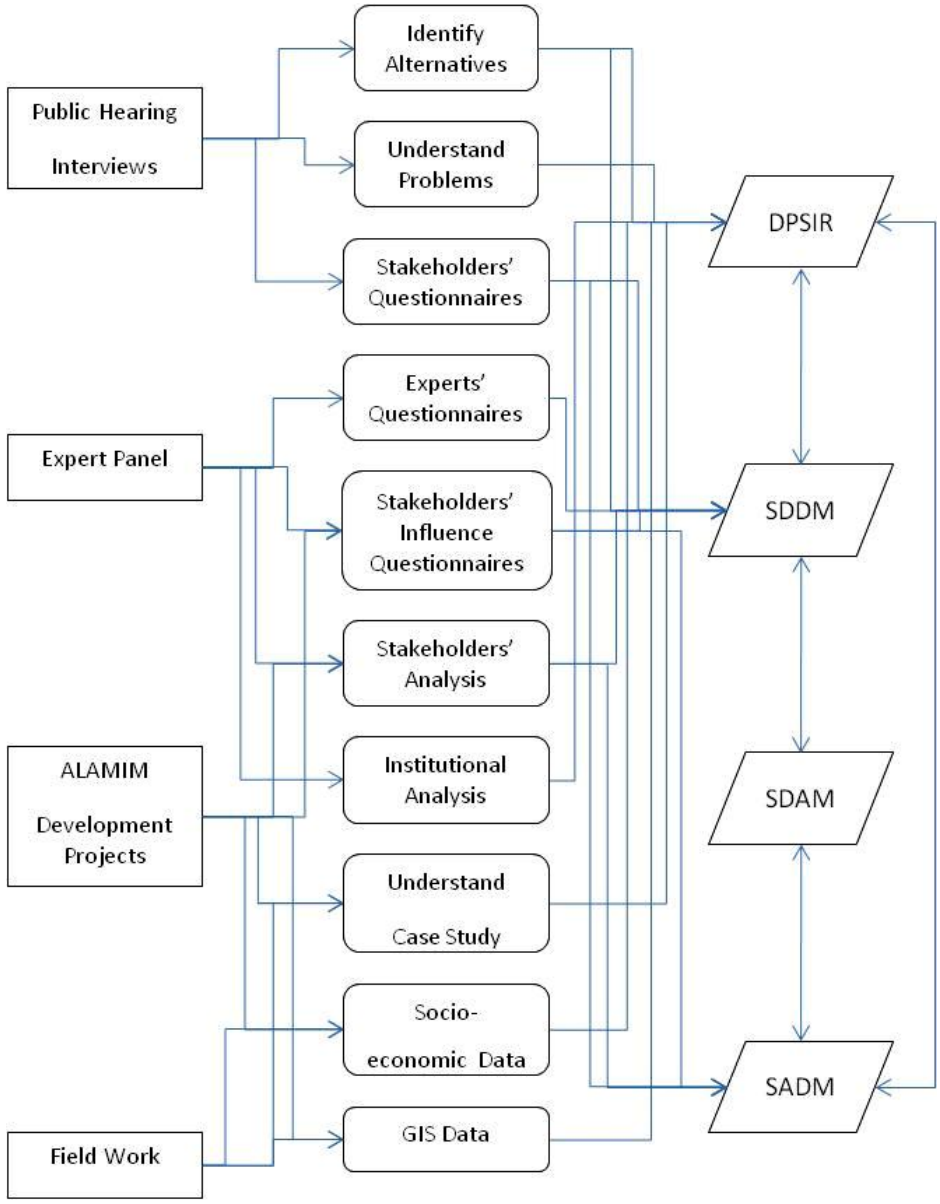


Figure 3-7 Data Flow Diagram

Table 3-14 summarises the data collection techniques that are used in this research. It details the type of collected data, the methods and the techniques that are utilised to analyse the data. The table also summarises the main objectives of using these types of analyses and the main outcomes for each data type.

Table 3-14 Data Collection Techniques

Type	Method	Technique	Objectives	Outcome
Literature Review Quantitative Qualitative	Analysis of historical data Analysis of published documents	-Collecting data related to the area of study -Identification of policies, laws and regulations applied in the area of study	reviewing all readily available materials to understand the environmental, social, policy and institutional framework of the area of study	Problem identification
Field Research Quantitative	Acquiring satellite Images and develop GIS data	-Spatial analysis -Change detection technique	To understand the current condition of the case study. To compare the results with respect to changes on the ground	Validation of research model
Field Research	Use of case study	-Collection of data for intensive analysis -Stakeholders' analysis -Institutional analysis -DPSIR framework assessment -Test the empirical model	To provide an example of failure in the management of natural resources. It demonstrated how conflict among different stakeholders coupled with contradictions in the current policies and legislation play a role in exacerbating the deterioration of its environmental quality.	Illustrating the policy and management failure. It highlighted conflict among different stakeholders and contradiction in the current policies and legislation. Verification of the model results against the actual state of the lake.
Field Research Qualitative research	Stakeholders' Interviews	-Data categorization of the current and historical background of each stakeholder's position -Analysis of stakeholders' socio-economic structure, and stakeholder main priorities and	To get in-depth and comprehensive information during the initial stages of a research project to investigate the main alternatives. To understand the economic, social and environmental conditions.	understanding the positions behind stakeholders decisions verify results from stakeholder questionnaires

		requirements. -Analyse Qualitative data from the interviews are used as data input for the DPSIR framework.		
Field Research Quantitative	Stakeholder influence expert questionnaire (Annex B)	-Expert Panel /Expert Judgements - Decision matrix -Rating each stakeholder's degree of power using IUCN influence matrix	For rating each stakeholder's degree of power /influence over the management of the study area	Identification of the comparative influence that each stakeholder has over any proposed management plan.
Field Research Quantitative	Sustainable development experts questionnaire (Annex C)	-Experts' judgments -Decision matrix -Pairwise comparison	To analyse how the identified priorities affect the three pillars of sustainable development to understand how each objective contribute to the sustainability of the lake.	Identification of the overall sustainable goal with respect to the main objectives, to achieve sustainable management of the lake.
Field Research Quantitative	Stakeholder pairwise comparison questionnaire (Annex D)	-Pairwise comparisons -Stakeholders' consultation	to collect the pairwise preferences of the criteria and alternatives for individual stakeholders	Development of an understanding of stakeholder comparative importance to the identified alternatives.
Field Research Quantitative/Qualitative	Stakeholder feedback questionnaire (Annex E)	-Stakeholders opinions -Statistical analysis of feedback	Assessment of the applicability of using the outcomes of the research at the practical level.	Investigation of how the outcomes could have influence in shaping future legislation or in affecting the future management plans Feedback from stakeholders helps in fine tuning the design and structure of the research.

3.10 Conceptual framework for Sustainable Development Decision Module (SDDM)

The main objective of analysing the existing Sustainable Development Management decision is to examine stakeholder decisions with respect to the environmental, social or economic dimensions. The main goal is broken down into a hierarchy of criteria and alternatives.

The core function of the SDDM is to analyse stakeholder judgments against the three pillars of sustainable development. For each module, the goal must be stated, the criteria have to be defined, and the alternatives need to be identified.

The module identifies the overall goal with respect to the main objectives, to achieve sustainable development of the area of study.

The function of the SDDM is to analyse stakeholder judgments against the three pillars of sustainable development.

The model takes inputs from stakeholders, institutional and expert analysis. It uses the identified stakeholders' in the alternative level while the three pillars of SD in the criteria level. AHP matrix is developed then the Normalised matrix is calculated. The module adjusts inconsistency and synthesise the results. The following sections will provide details for each of the above-mentioned steps.

Figure 3-8 illustrates the structure and flow chart of SDDM.

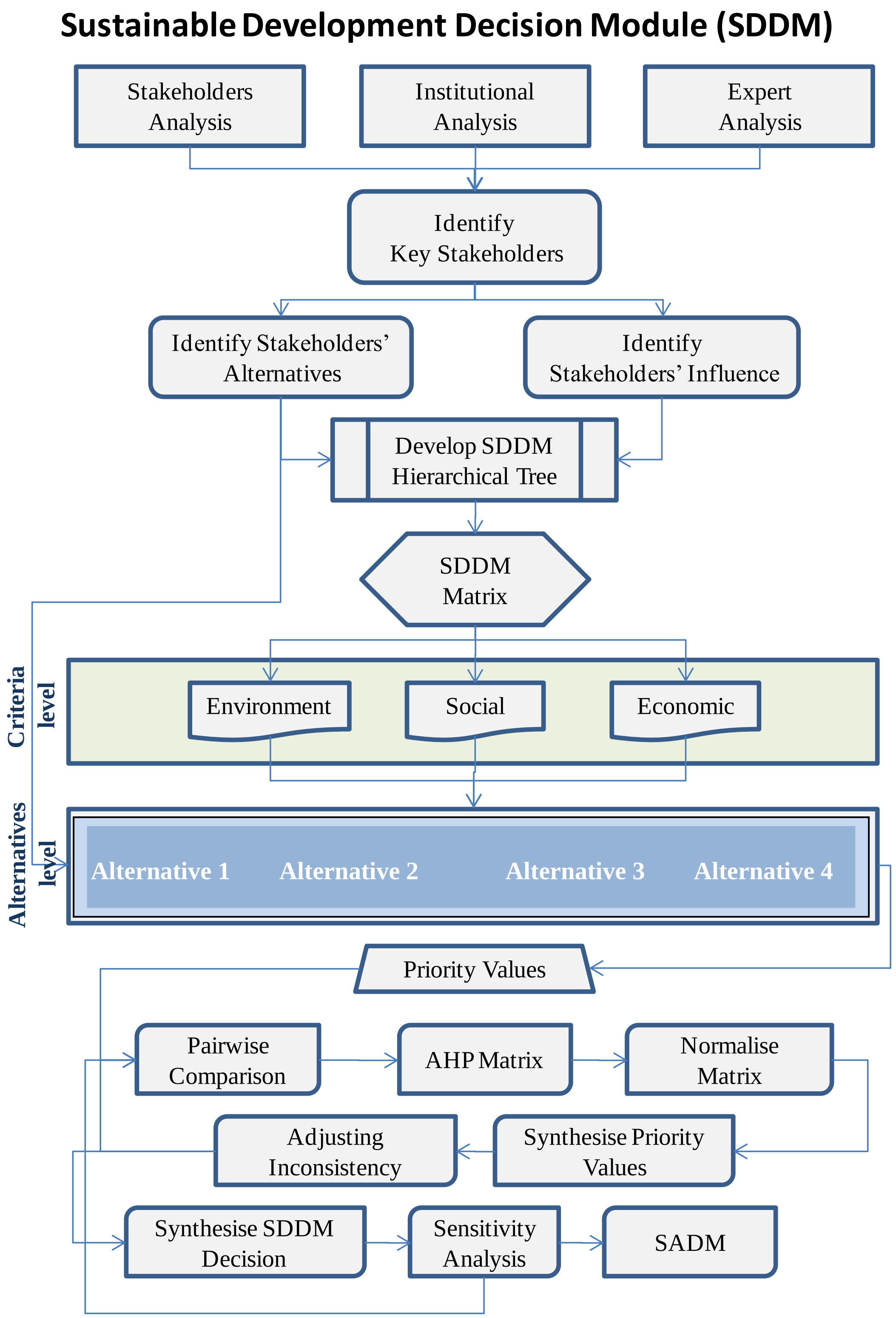


Figure 3-8 SDDM Structure

3.10.1 Development of SDDM hierarchical tree

The overall goal for EDAM and all sub-modules is sustainable management of the area of study. Building on AHP methodology developed by Saaty (1980), the module uses the three pillars of sustainable development (environment, social and economic) at the criteria hierarchical level and proposes the identified alternatives at the alternatives level (see Figure 3-9).

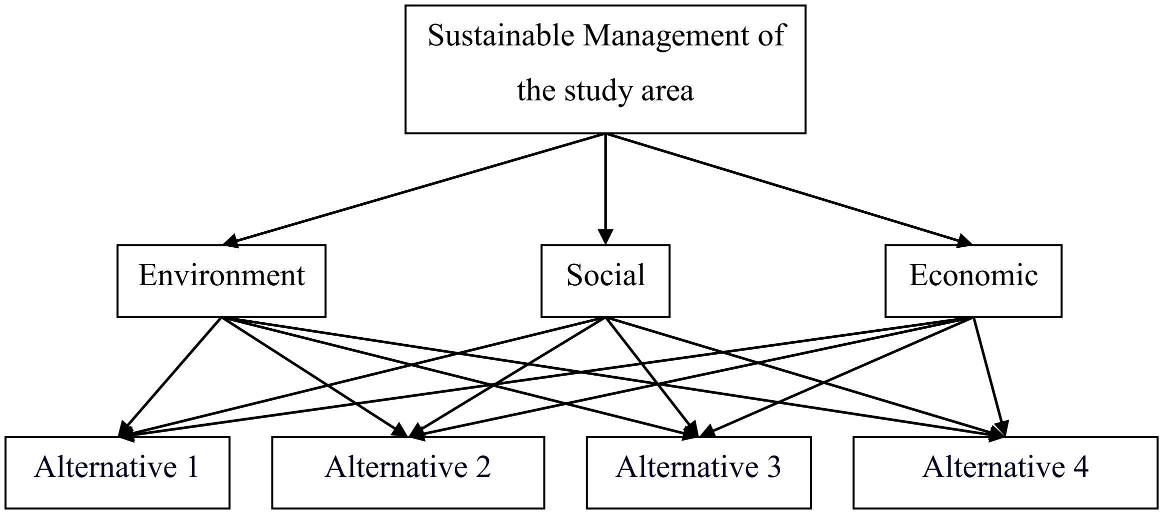


Figure 3-9 Structured SDDM with Identified Three Hierarchy Levels.

3.10.2 Experts pairwise comparison

SDDM assumes that environment, social, and economic criteria have equal importance in the management of the area of study and hence have the same weight (1.0). Therefore, the strategy for managing the area of study equally encompasses all the aspects of sustainable development (see Table 3-15).

Table 3-15 SDDM Relative Importance With Respect to Goal

Goal: Sustainable Management of Lake Maryout			
	Environment	Social	Economic
Environment		1.0	1.0
Social			1.0
Economic			

The SDDM uses the main alternatives that were identified through stakeholder consultations, questionnaires and expert panels. The information is arranged into a hierarchical tree. SDDM calculates the relative preference with respect to each objective; environment, social or economic dimension (see Table 3-16).

Table 3-16 Relative preference in respect to objective (environment-social-economic)

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Alternative 1				
Alternative 2				
Alternative 3				
Alternative 4	Inconsistency =			

In SDDM, according to the identified alternatives, 4 by 4 matrix is used. Table 3-17 illustrates data sheet for entering the comparison values for each stakeholder. Results of the reciprocal matrix and priority vectors are calculated.

Table 3-17 SDDM AHP Reciprocal Matrix

SDDM Reciprocal computation Matrix				
Reciprocal Matrix for Stakeholder 1→n				
Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Alternative 1	1.00			
Alternative 2		1.00		
Alternative 3			1.00	
Alternative 4				1.00
Sum	1.00	1.00	1.00	1.00
Alternative 1→ Alternative n = Identified Alternatives				

Table (3-17 continued) NORMALISED MATRIX					sum	priority vector
	1.000	0.000	0.000	0.000	1.000	25.00%
	0.000	1.000	0.000	0.000	1.000	25.00%
	0.000	0.000	1.000	0.000	1.000	25.00%
	0.000	0.000	0.000	1.000	1.000	25.00%
sum	1.000	1.000	1.000	1.000	4.000	100.0%
		lambda max	1.0000		n =	1
		consistency index (CI)				
		consistency ratio (CR)				

3.10.3 Identification of priorities with respect to sustainable development

Data is taken from expert questionnaires, where experts assessed the relative importance of the identified alternatives choosing between equal, moderate, strong, and very strong as well as the intermediate choices of the AHP scale, with respect to each criteria (environment, social or economic). This data are entered into the SDDM module which calculates judgments with respect to the objectives.

The next step in the modelling process is to formulate judgments/pairwise comparisons between the identified alternatives, to derive priorities for the objectives with respect to the overall goal of management of the area of study, and with respect to each objective. Figure 3-10 displayed below shows the potential output of the analysis.

Values represent the overall score of alternatives with respect to each pillar of sustainable development. The analysis is repeated for the three pillars.

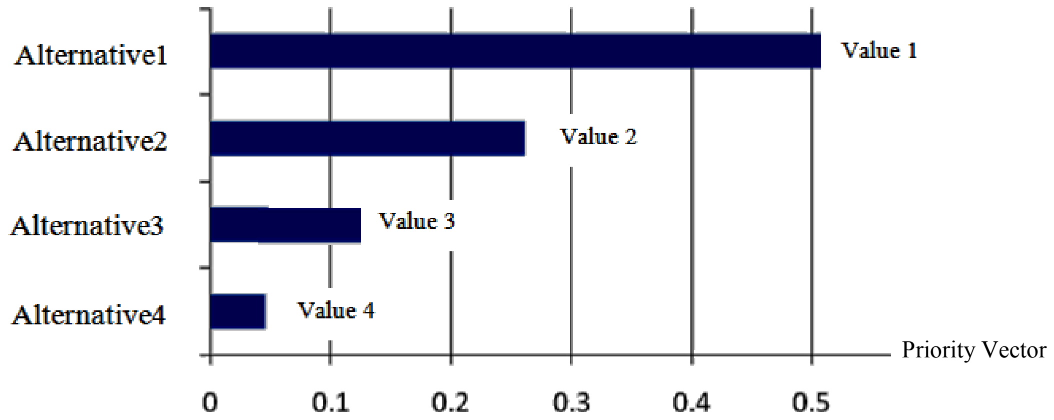


Figure 3-10 SDDM Identified Priorities With respect to Environment, Social or Economic

The judgments used are based on the information presented in previous chapters, and on various expert opinions. The module uses this empirical data as subjective judgments of the management authority of the area of study.

3.10.4 Presenting the SDDM priorities in SDAM

Eigenvalues from SDDM are entered into SDAM for spatial analysis. The output diagrams represent the orientation of each SD pillar with regard to the identified alternatives. The procedure is repeated for all SD dimensions (see Figure 3-11).

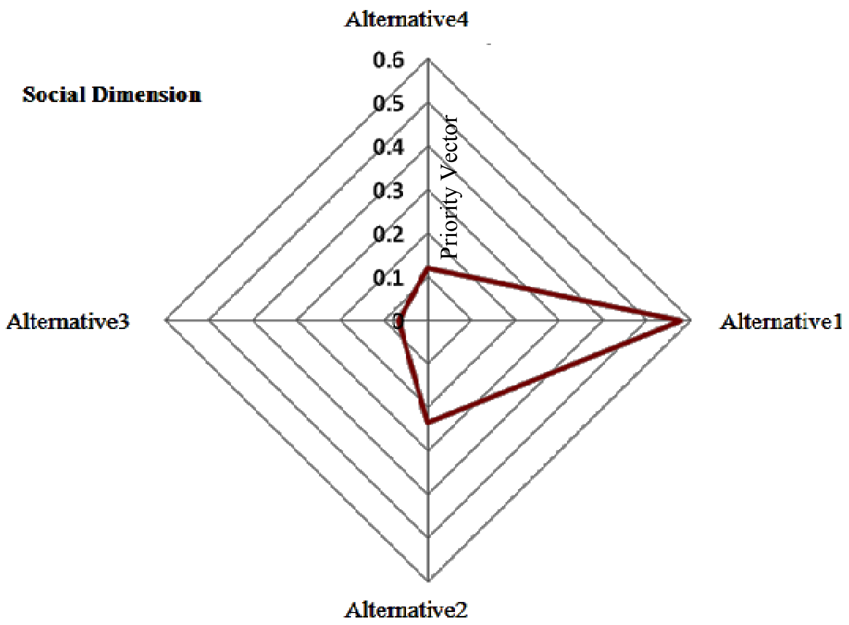


Figure 3-11 SDDM Priority Diagram

The GIS Spatial Decision Analytical Model (SDAM) calculates the areas of the three layers using the exact unit outputs of the SDDM. The SDAM creates three new layers for the intersections between the environment, social and economic objectives. This is done by clipping the intersection bilaterally between each pair of layers. Synthesised results from the SDDM are converted to GIS layers to allow for spatial analysis. Three layers are created: environment, economic and social (see Table 3-18).

Table 3-18 SDDM Preference with respect to Alternatives

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Environment				
Social				
Economic				

SDAM overlays the three diagrams and calculates the areas of intersection between environment, social and economic objectives in relation to the identified alternatives (see Figure 3-12).

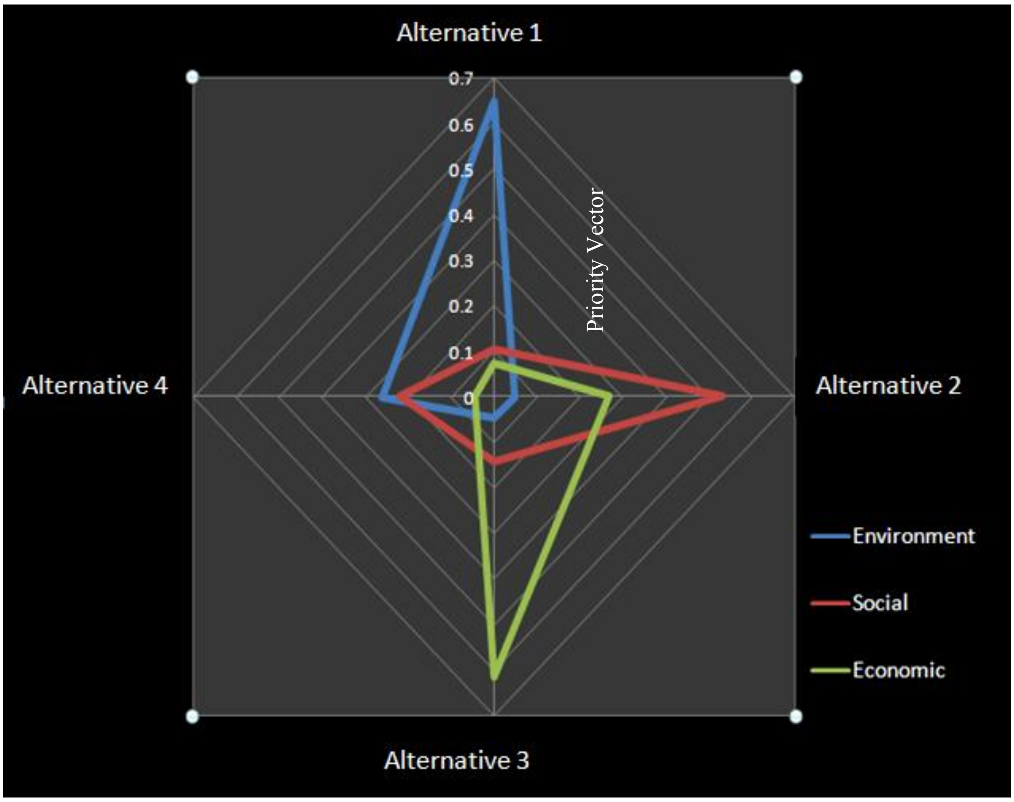


Figure 3-12 SDDM Overlay Diagram

SDAM calculates the spatial area of the intersections, and the areas of each pair of intersected themes. The final step is to calculate the percentage of these areas compared to the total areas of the intersected themes as shown in Table 3-19.

Table 3-19 SDDM areas of Intersections

	Area of Consensus	Total Area	Percentage
Social-Environment			
Economic-Environment			
Social-Economic			

In order to calculate the SDDM area of consensus, the three pillars of sustainable development have to be overlaid.

Areas of the three decisions need to be combined by uniting the three layers as shown in Figure 3-13. The intersected area (area of consensus) of the three layers is measured. The area of consensus is overlaid on the SDDM (see Figure 3-14) and the percentage of the intersected area in relation to the total SDDM area is calculated (see Table 3-20).

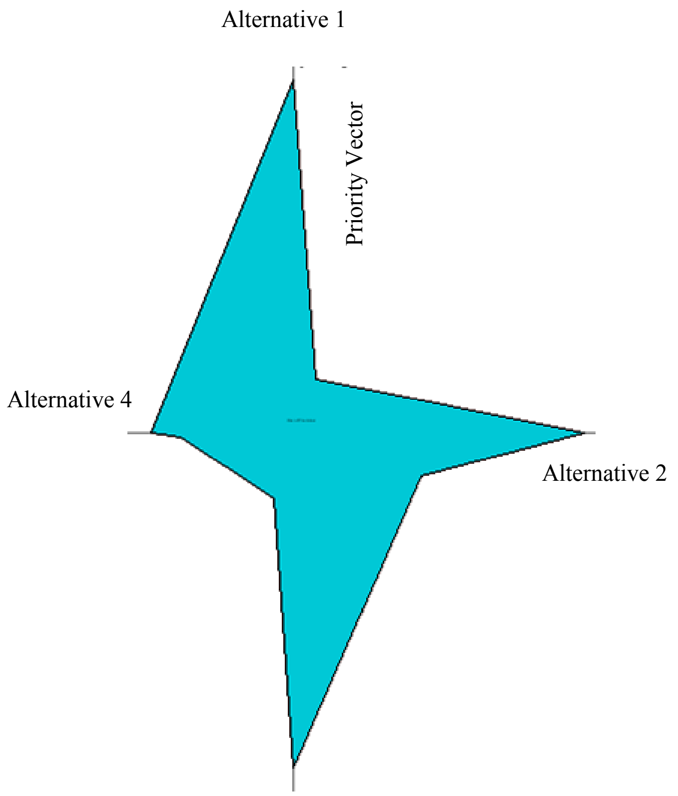


Figure 3-13 Combined area of the SDDM

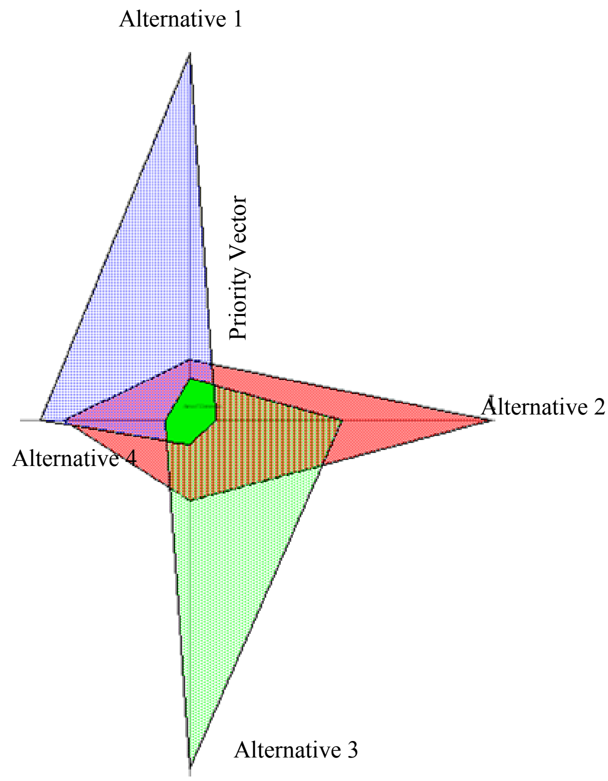


Figure 3-14 Area of Consensus for the SDDM

Table 3-20 SDDM percentage of area of consensus

	Value	Percentage of Consensus
Total Area of SDDM		
Area of Intersection		

The identified percentage of consensus is ranked in the final analysis to indicate the orientation of the problem with respect to sustainable development. It assists decision-makers in identifying if the problem in hand leading to stakeholder conflict is of economic, social or environmental pattern. This allows prioritising the mitigation measures and management plans towards the main sources of conflict and hence to design programmes that respond to the identified dimension.

3.11 The Function of Spatial Decision Analytical Module (SDAM)

SDAM is a GIS tool that allows analysis of the outputs of the AHP process in a spatial domain. The main objective of the SDAM is to perform spatial analysis for the input stakeholder judgments to spatially represent the analysed decisions and locate the areas of consensus.

The SDAM is performing statistical analysis of the results and uses GIS spatial capability to easily calculate spatial functions such as clipping areas or find overlap between shapes. However, the modeller can use other statistical tools to get to the same results such as MatLAb or SAS or SPSS.

SDAM takes the outputs of SADM and SDDM and converts judgments to Geographic Information System shape files to allow for spatial analysis. It calculates the spatial area of each decision using the same units from the output AHP values. This allows the standardisation of all units. The system uses geographic projection, as it does not require any affine transformation for values or measurements.

SDAM overlays stakeholder judgment values and uses the spatial union function to merge pairs of stakeholders in order to measure the area of both decisions subtracted from the intersected area. It uses the same procedure after applying the influence values. Clip function is used to extract and calculate the areas of intersections.

The system locates and calculates the area of consensus located within the entire spatial domain of judgments. The calculated normalised Eigenvalues are entered in this module for calculating areas of consensus. The research uses ESRI ArcView software to locate the values. However, this procedure can also be done through any specialised mathematical software that can perform numeric computation such as MatLab to create a radar chart with values that range from 0-1, calculate areas, and represent and calculate the relative priority of the alternatives.

3.12 Conceptual framework of Stakeholder Analytical Decision Module (SADM)

The objective of SADM is to analyse each stakeholder's decisions towards the management of the study area, to examine the degree of inconsistency in their preferences, and overlays their choices over the SDDM to identify the orientation of their decisions with respect to sustainable development.

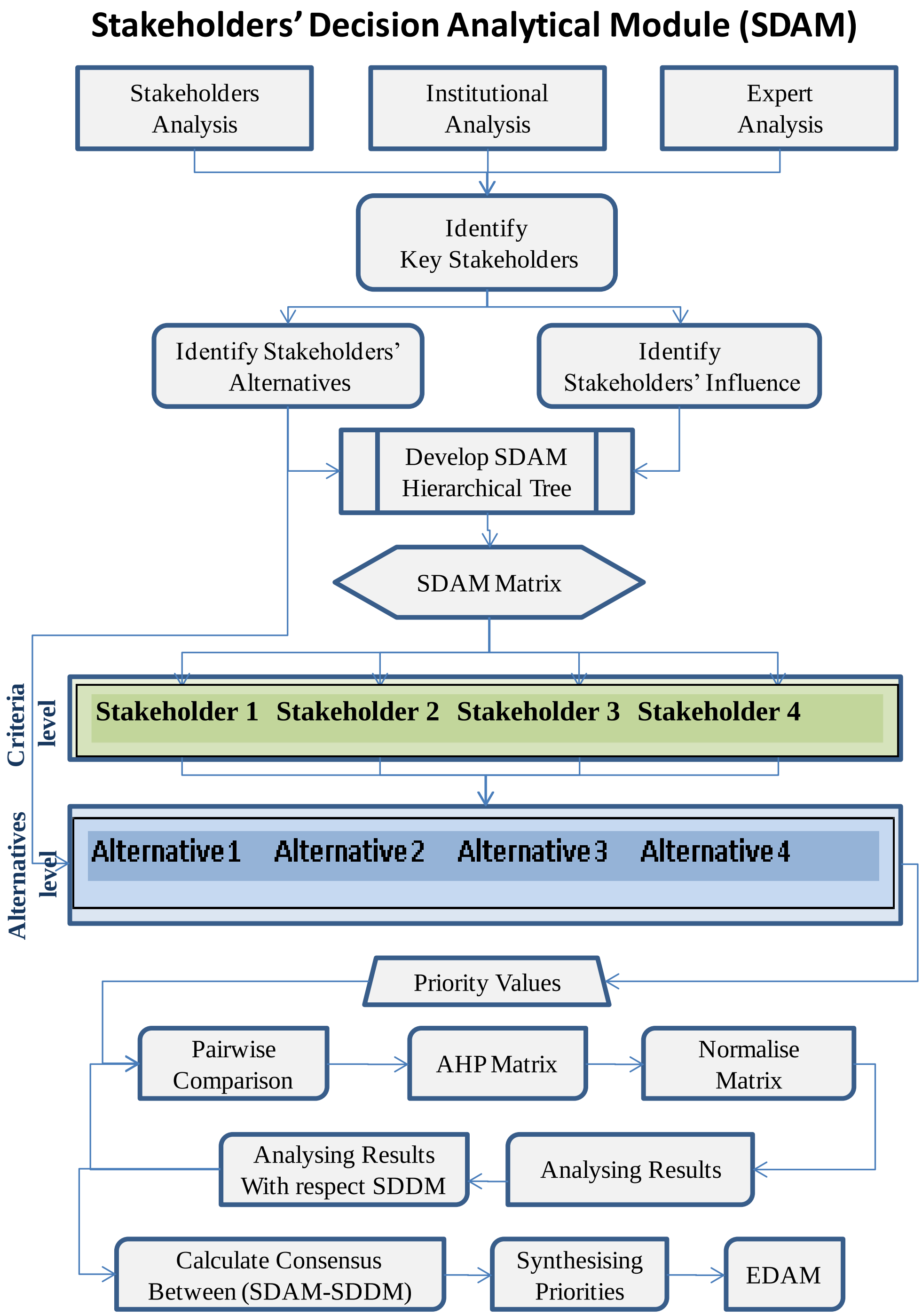


Figure 3-15 SDAM Structure

SADM compares all strategies and analyses the areas of conflict. SADM develops a synthesised decision for all identified primary stakeholders.

Figure 3-15 illustrates the structure and flow chart of SDDM.

3.12.1 *Development of SADM hierarchical model*

The management of the area of study is the main consistent goal in all EDAM sub-modules and placed at the goal level in the SADM hierarchical model.

Key stakeholders are identified through stakeholder analysis. The model uses the primary stakeholders at the criteria hierarchical level and proposes the identified alternatives that are used in the SDDM at the alternatives level (see Figure 3-16).

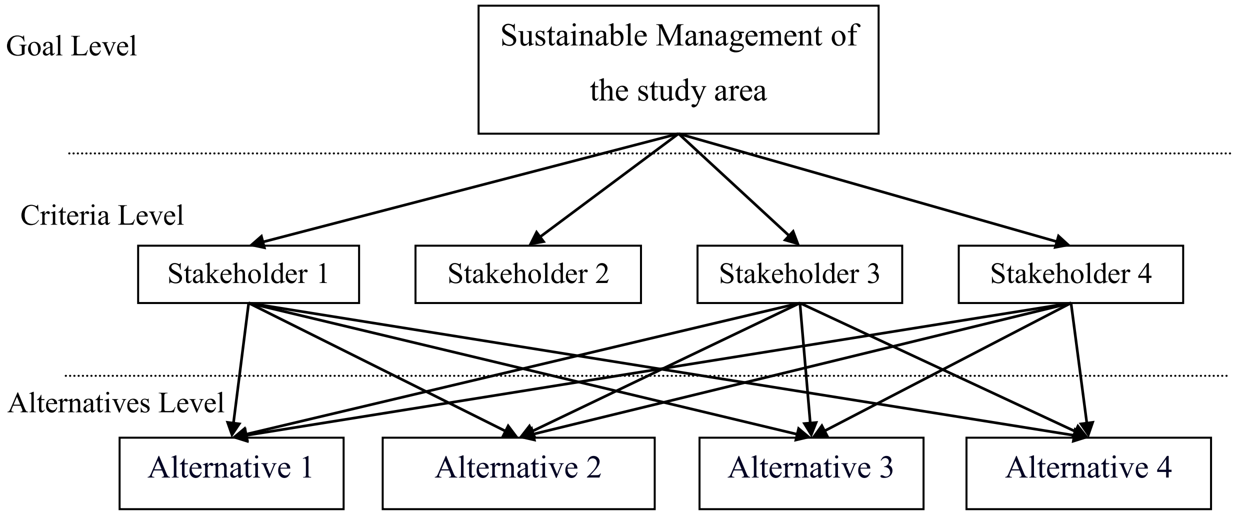


Figure 3-16 Structured SADM with Three Hierarchy Levels

3.12.2 *Stakeholder pairwise comparison*

Data from stakeholder questionnaires is categorised for each stakeholder to develop a reciprocal matrix.

SADM assumes in its initial analysis procedure that all stakeholders have the same weight (see Table 3-21).

Table 3-21 Relative Importance with Respect to Public Participation Goal

Criteria	Stakeholder 1	Stakeholder 2	Stakeholder 3	Stakeholder 4
Stakeholder 1		Equal	Equal	Equal
Stakeholder 2			Equal	Equal
Stakeholder 3				Equal
Stakeholder 4				

In SADM, according to the identified alternatives, 4 by 4 matrix is used. Table 3-22 is an excel file developed to enter the comparison values for each stakeholder, and then to normalise the results of the reciprocal matrix, and calculate priority vectors.

Table 3-22 SADM AHP Reciprocal Matrix

SADM Reciprocal computation Matrix				
Reciprocal Matrix for Stakeholder 1→n				
Criteria	A 1	A 2	A 3	A 4
A 1	1.00			
A 2		1.00		
A 3			1.00	
A 4				1.00
Sum	1.00	1.00	1.00	1.00
A1→An = Identified Alternatives				

NORMALIZED MATRIX					sum	priority vector
	1.000	0.000	0.000	0.000	1.000	25.00%
	0.000	1.000	0.000	0.000	1.000	25.00%
	0.000	0.000	1.000	0.000	1.000	25.00%
	0.000	0.000	0.000	1.000	1.000	25.00%
sum	1.000	1.000	1.000	1.000	4.000	100.0%
		lambda max	1.0000		n =	1
		consistency index (CI)				
		consistency ratio (CR)				

Results of analysing the preferences of each stakeholder present the ranking of priorities with respect to the analysed alternatives.

3.12.3 Examining inconsistency

The inconsistency ratio should be checked to examine if it is within the acceptable limit. Acceptable value of Consistency Ratio (CR) is less than or equal to 10%. If CR is greater than this value then stakeholder subjective judgment needs to be revised. Stakeholders are required to repeat the pairwise comparison questionnaires so that Consistency Index would not be far from 0 as possible. The results must be verified against the actions and responses identified in the environmental assessment and the stakeholder analysis.

Number of comparisons is function of the number of alternatives. Therefore, the calculated number of comparisons for each stakeholder is 6 (Equation 1).

Equation 1 SDAM Number of Comparisons

$$\text{n (number of comparisons)} = \frac{n(n-1)}{2} \qquad n = \frac{4(4-1)}{2} = 6$$

3.12.4 Calculating and ranking stakeholder priorities

Each stakeholder alternative is investigated to identify the ranking of priorities (see Figure 3-17).

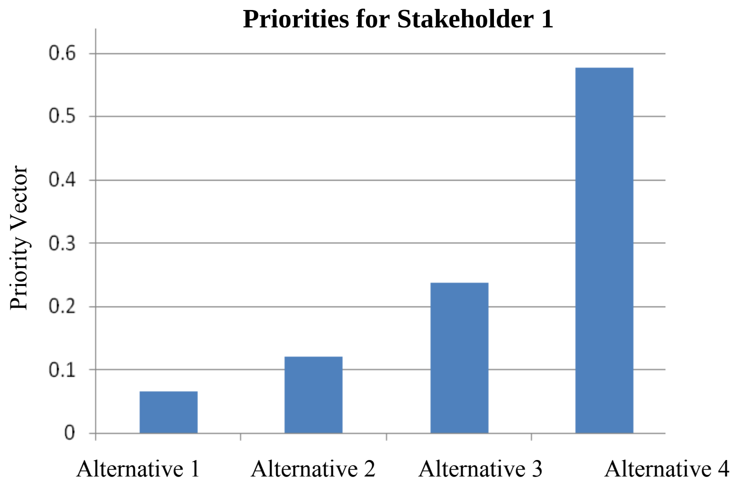


Figure 3-17 Stakeholder Priorities with Respect to Alternatives

3.12.5 Calculating stakeholder priority diagram using SDAM

The output priority values are used as inputs for the SDAM to identify priority orientation and decision area of each stakeholder (see Figure 3-18).

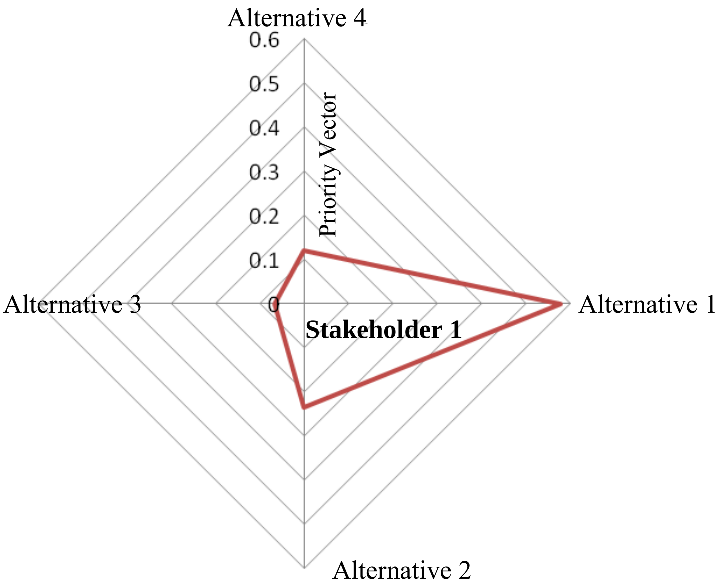


Figure 3-18 Representation of Stakeholder Priority Diagram in SDAM

3.12.6 Identification of stakeholder priorities with respect to SDDM

The stakeholder Priorities Diagram is overlaid on the SDDM Diagram to understand the orientation of each stakeholder towards environment, social or economic dimension.

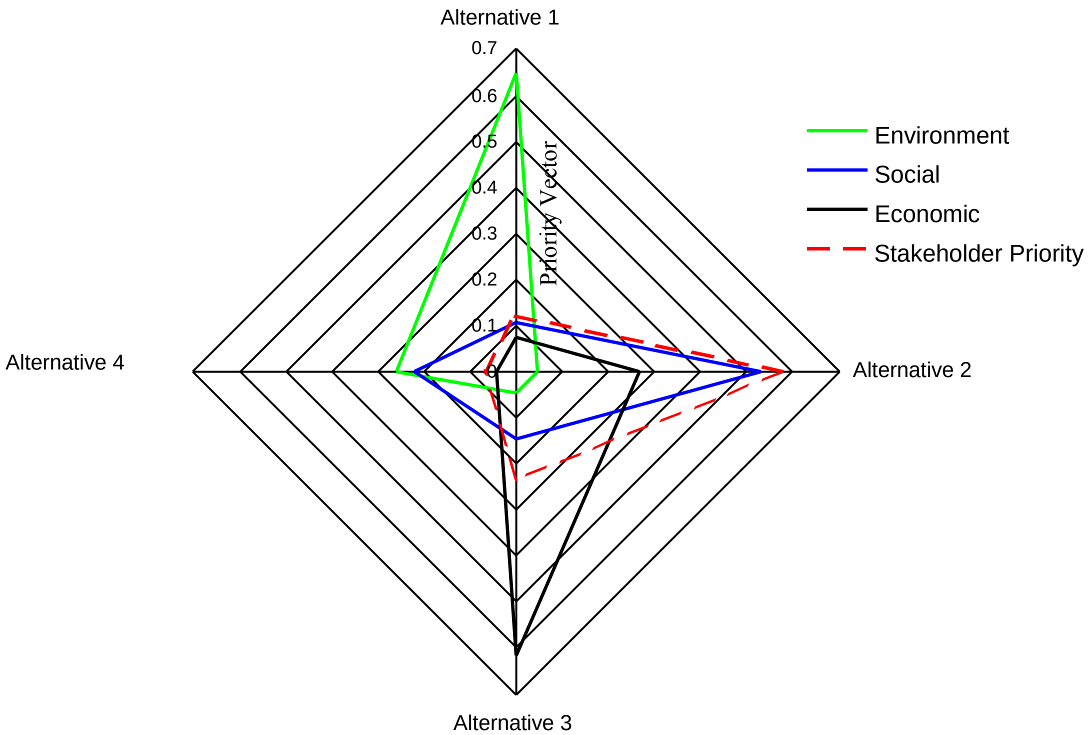


Figure 3-19 Stakeholder Priority against SDDM Diagram

The synthesised values of a combined decision are then checked and compared with the SDDM. The area of intersection (consensus) between each stakeholder priority with respect to each pillar with the SDDM is calculated (see Figure 3-19).

Table 3-23 comparative preferences between SDDM and Stakeholder

	Area of Consensus	Total Area	Percentage
Stakeholder 1-Environment			
Stakeholder 1-Social			
Stakeholder 1-Economy			

Table 3-23 shows stakeholder overall preferences in relation to the identified alternatives. The SDDM calculates the percentage of consensus between the stakeholder and the social, environment or economic objective and identifies the highest overall areas of consensus.

The procedure is repeated using relative weights based on the stakeholder influence analysis to assess the impact of differentiated power on the decision-making process. SDAM calculates the overall areas of all stakeholder preferences and finds the area of consensus.

3.12.7 Analysing stakeholder consensus

The objective of analysing consensus among the stakeholders is to examine the area where all stakeholders have agreed with respect to the identified objectives. The results need to be compared with the influence decision-making model where differentiated weights are assigned to the stakeholders based on the stakeholder analysis. This step is essential to investigate the degree to which power is impacting the overall decision-making process.

Table 3-24 Summary of Stakeholder overall judgments

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Stakeholder 1				
Stakeholder 2				
Stakeholder 3				
Stakeholder n				

Identifying the area of consensus is essential in both cases to determine whether the influence diagram for the case study area contributes to consensus or to conflict between stakeholders.

Table 3-24 shows the organization of the overall judgments of all stakeholders.
Figure 3-20 demonstrates the SADM output diagram that compares different stakeholder judgment with regard to the identified objectives.

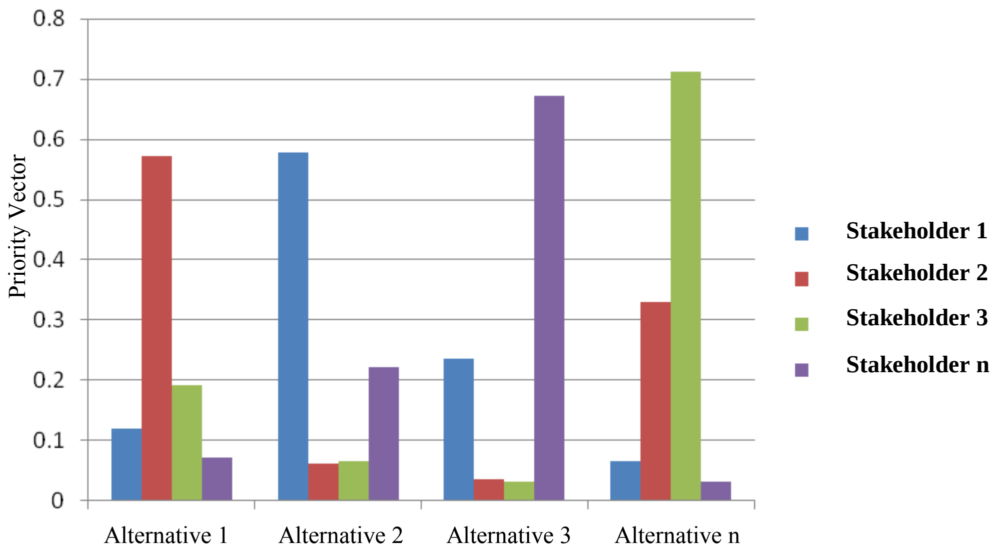


Figure 3-20 Stakeholder priorities with respect to Alternatives

The four primary stakeholder priorities are used as inputs in the SDAM module to be located spatially in the SDAM diagram.

The Diagram shows the orientation of each stakeholder with respect to the identified alternatives.

Areas of intersection between stakeholders are calculated (see Figure 3-21).

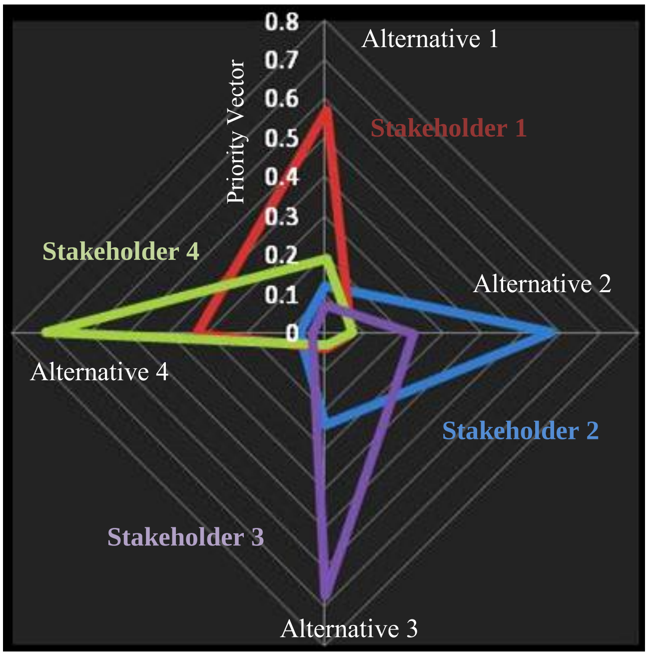


Figure 3-21 Identifying areas of Consensus

3.12.8 Impact of applying the influence ratio (IR) on decision-making

Research on stakeholder influence has used either a demographic approach for the categorisation of stakeholder attributes, or a more structural approach to examine the relationship between the examined institutions and the identified stakeholders (Frooman and Murrell, 2005).

Research examining the influence and power possessed by organizations started as early as 1974 (Akbari, 2005).

Several techniques are available to present the relative influence that various stakeholders have over the decision-making process (Mayers and Vermeulen, 2005).

Mayers and Vermeulen have simulated influence by assessing the relative proximity of circles to the policy peak, and the degree of consensus or conflict is represented by the relative proximity and overlap of the identified circles.

Pfeffer (1981) looks at organizational success in terms of how organizations maximize their power in Resource Dependency Theory (RDT). RDT mainly investigates the interaction between organizations, and more specifically, internal and external coalitions within the organisation.

RDT is therefore not applicable to this research, as internal influence within the organization and the exchange of resources between organizations are irrelevant.

This research analyses the decision-making process of each identified stakeholder when presented with specific alternatives and then compares all of these processes to examine the areas of consensus.

The influence of each stakeholder greatly affects the overall synthesis of all stakeholders. The research attempts to measure the extent of this influence over the synthesised decision.

The methodology of developing Stakeholder Influence Diagram starts by building the AHP hierarchy (Figure 3-22) and assigning the influence ratio identified in Stakeholder Analysis (Tale 3-25). Stakeholder Influence value is entered in the SDAM as comparative ratio as per the following equation:

Pairwise Comparative Influence value = Influence Value of Stakeholder n1 - Influence Value of Stakeholder n2

Values n is based on the AHP numerical scale and converted to pairwise verbal comparison. Relative importance influence matrix of the identified stakeholders is used as inputs to the first level of AHP structure, the second level being the identified alternatives.

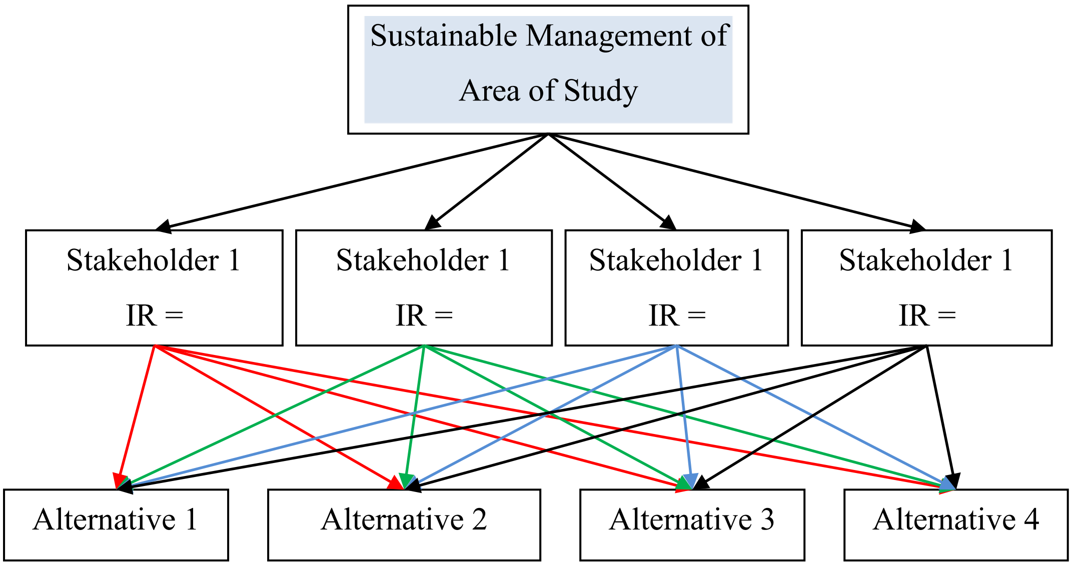


Figure 3-22 Structured AHP using influence in the criteria level

Tale 3-25 Identified Stakeholders' Influence Values

Stakeholder	Stakeholder 1	Stakeholder 2	Stakeholder 3	Stakeholder 4
Influence Value				

The output of the Influence ratio diagram, illustrates the changes of the synthesised values for the alternatives. The comparative influences of stakeholders leads to a change in the overall synthesis of the group-decision.

The module identifies the potential shift in priority of the synthesised decision after applying the influence values (see Table 3-26). The influence values only affect the synthesised results, not the individual stakeholder judgments, nor the areas of consensus between different stakeholders. The final area of consensus between stakeholders remains unchanged.

Table 3-26 Comparison between equal and influenced participation

Objective	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Influenced participation				
Equal Participation				

3.12.9 Calculating area of consensus between all stakeholders

SADM calculates the area of priority for each stakeholder and the area of intersection between all stakeholders (see Table 3-27). The percentage of consensus is calculated as per the following steps:

Equation 2 Total Area of Judgments

Total Areas of Judgments = Area of Stakeholder n1 + Area of Stakeholder n2

Equation 3 Area of Consensus

Area of Consensus = Area of Intersection between Stakeholder n1 and n2

Equation 4 Net Area

Net Area = Total Area of Judgement – Area of Intersection

Equation 5 Net percentage of Consensus

Net percentage of Consensus = (Area of Consensus/Net Area) * 100

Table 3-27 Calculation of Stakeholder Areas of Consensus

Stakeholders' Intersection	Total Areas of Judgements	Area of Consensus	Net Area	Net percentage of Consensus
Stakeholder 1-Stakeholder 2				
Stakeholder 1-Stakeholder 3				
Stakeholder 1-Stakeholder 4				
Stakeholder 2-Stakeholder 3				
Stakeholder 2-Stakeholder 4				
Stakeholder 3-Stakeholder 4				

Area of Consensus is calculated based on the intersections between all stakeholders. The outputs values of stakeholder priorities diagram are used as inputs to the SDAM.

Consensus Scale is constructed to rank the final percentage of consensus relative to the total net areas of compared decisions (see Table 3-28).

Table 3-28 Consensus Scale

Percentage of Consensus	Description
0 – 20	No or Poor Consensus
20 – 40	Moderate Consensus
40 – 60	Strong Consensus
60 – 80	Very strong Consensus
80 – 100	Extreme Consensus

Percentages of consensus between environment, social and economic results which identified in the SDDM are ranked according to the identified scale (see Table 3-29).

Table 3-29 Comparative Preferences between SDDM Components

SDDM Components	Percentage	Consensus Rank
Social-Environment		
Economic-Environment		
Social-Economic		

Percentages of consensus between different stakeholders and the three pillars of sustainable development are identified to show how each stakeholder is in harmony with environmental, social or economic component of sustainable development (see Table 3-30).

Table 3-30 comparative preferences between SDDM and each Stakeholder

	Percentage	Consensus Rank
Stakeholder n-Environment		
Stakeholder n -Social		
Stakeholder n -Economy		

Final results for stakeholder consensus are identified to illustrate the degree of synthesised consensus between different stakeholders with respect to the identified alternatives (see Table 3-31).

Net percentages of stakeholder consensus are ranked to show the degree of consensus between all stakeholders.

Table 3-31 Final Stakeholders' Consensus Results

Stakeholders' Intersection	Net percentage of Consensus	Consensus Rank
Stakeholder 1- Stakeholder 2		
Stakeholder 1- Stakeholder 3		
Stakeholder 1- Stakeholder 4		
Stakeholder 2- Stakeholder 3		
Stakeholder 2- Stakeholder 4		
Stakeholder 3- Stakeholder 4		

Area of consensus among all stakeholders is calculated through the SDAM. SADM builds on the outcomes of SDDM and SDAM, to calculate spatially the areas of decision, compare them with the spatially-located areas of consensus and finally locate the area of consensus among all stakeholders.

SADM is used to spatially locate the area of consensus for all stakeholder judgments. The located area in relation to the total decisions areas is categorised according to the identified consensus scale (see Table 3-32).

The final identified consensus rank between stakeholders develops an understanding of the degree of consistency in the decisions taken by various stakeholders and the severity of the stakeholder conflict.

This mapping of stakeholder degree of agreement or disagreement is presented to decision-makers as a decision-support tool in stakeholder management in the area of study.

Results must also be presented to all stakeholders and decision-makers to evaluate the impact of highlighting the degree and direction of the stakeholder conflict on the policy formulation and on the management of the area of study.

Table 3-32 Final Overall Area of Consensus

	percentage of Consensus	Consensus Rank
Area of Consensus among all stakeholders		

3.13 Validation

The application of the Analytic Hierarchy Process (AHP) methodology needs a degree of knowledge and understanding about the real-world situation where the methodology is applied and about the issues being examined. In AHP based models, the validation process is conducted through finding examples with measures in a scale that is already known.

Saaty (2007) pointed out that there are two ways to validate AHP results. One is to regard the objectives as influences to get the outcome, and the alternatives of the model regarded as this outcome which can be compared to some data reflecting the situations on the ground from the real world. In this case AHP is used as an analytical tool. The other validation method is to use the AHP as a decision-making tool to determine the best option to use to reach a desired situation.

In this research, AHP is used as an analytical decision tool and therefore, the first validation method is used. The stakeholders are used in the criteria/objective level that steer the decision-making process while the available alternatives are the outcomes of these decisions. According to Saaty (2007), the results of stakeholder pairwise comparisons should be validated against their real-world actions.

There are several levels of validation for the EDAM results. The first level is to perform sensitivity analysis to examine how priorities attributed to alternatives change when the priority of objectives increases or decreases. The outputs of the sensitivity validation process should match the logical investigation of the stakeholder, institutional and environmental analyses.

The second level of validation is conducted through comparing the outputs of the EDAM methodology against the change detection results to evaluate if the actions on the ground are, to some extent, consistent with the decision analysis resultant from the developed methodology.

The third level is to present the results to decision-makers to understand how these results may assist them in better management of the stakeholders in the area under investigation. Decision-makers and managers of the environmentally sensitive areas should have the knowledge about the severity of the conflict and the nature of the problem in terms of being environmentally, socially or economically rooted. The research explores if the methodology would assist in shaping the interventions and the policy formulation in the area under investigation.

3.14 Chapter Conclusion

Mendoza and Martins (2006) point out that the MCDA models are widely applied because it encompasses three dimensions: 1) the formal approach; 2) the existence of multiple criteria; and, 3) that decisions are taken either by individuals or groups of individuals. MCDA is a conveniently structured method to facilitate collaborative planning and decision-making. The method provides participatory structure to engage multiple experts and stakeholders.

Multi-Criteria Analysis methodology is generally most appropriate not to develop answers for environmental problems but rather to set the conditions for a transparent and informative decision process (Hajkowicz, 2008).

Several tools and applications using MCDA environment have been developed to assist decision-makers in analysing the priorities of stakeholders such as SWOT analysis, cost-benefit analysis, willing to pay method and other qualitative methods of ranking priorities.

One of the most popular MCDA techniques is the Analytic Hierarchy Process (AHP) (Saaty, 1980). The comparative advantage of AHP is its ability to highlight the comparative preferences of stakeholders. Several purely qualitative methods could provide an order of stakeholder preferences according to a feedback of distributed questionnaires. However, they do not have the ability to synthesise the results according to stakeholder comparative judgments. AHP also has an outstanding advantage as a multi-criteria technique, to measures the inconsistency of judgments with an intrinsic approach to the mathematical procedure (MarÍa et al., 2005).

The research methodology applies MCDA, using Analytic Hierarchy Process (AHP), with the support of Geographic Information System (GIS), and the Driving Forces–Pressures–State–Impacts–Responses (DPSIR) analytical framework.

Building on AHP methodology, the research develops conceptual framework to analyse stakeholder preferences. Research methods include the use of a case study to test the developed model. The case study area of Lake Maryout, Egypt, provides a good example of policy and management failure.

This research is both quantitative and qualitative in nature and therefore it uses mixed methodology. Data is collected through expert and stakeholder questionnaires, interviews, public hearings, field survey and remotely sensed data.

The research methodology assists in building a model to answer the research question of how can the understanding of the magnitude and direction of consensus among conflicting stakeholders shape the management of an environmentally sensitive area in order to assist decision-makers develop a roadmap for better management of natural resources.

The research uses AHP methodology to develop an Environmental Decision Analytical Model (EDAM). EDAM will consist of three main sub-modules: the Sustainable Development Analytical Module (SDDM), the Stakeholder Decision Analytical Module (SDAM), and the Spatial Analytical Decision Module (SADM).

Sustainable Development Analytical Module (SDAM) will be built to compare stakeholder positions against the three pillars of sustainable development (environment, social and economic). The module intends to provide an understanding of the direction of each stakeholder position within the environmental, social or economic domain. This module is important to provide insight of how these positions are reflected on the ground. It investigates if these decisions are contributing – or not – to the sustainable development of the area of study.

The second sub-module is the Stakeholder Decision Analytical Module (SDAM), which analyses stakeholder preferences against one another and synthesises the results into one hypothetical group decision. This sub-module intends to analyse the positions of each stakeholder with respect to the identified alternatives to highlight the rationale behind taking these positions.

The third cross-cutting sub-module is the Spatial Analytical Decision Module (SADM), which takes the inputs from the two sub-modules to spatially calculate the areas of decisions, compares them against the spatially-located areas of consensus, and finally locates the area of consensus among all stakeholders.

Results from the SDAM will be transferred according to a developed scale into verbal descriptions with reference to the calculated areas of consensus for both the SDAM and SADM in order to measure the degree of consensus or conflict contributing to the current environmental, social and economic situation.

CHAPTER 4

CASE STUDY: LAKE MARYOUT

Chapter 4. Case Study: Lake Maryout

4.1 Introduction

This chapter highlights the main characteristics of the study area. Lake Maryout is located at the south-western border of the city of Alexandria, Egypt, on the Mediterranean Sea. Over the past 50 years Lake Maryout has deteriorated more than any other Egyptian Nile Delta lake (Prenner, 2006; Ibrahim et al., 2006).This shallow Lake and its surrounding land have been subjected to continuous degradation.

While conflicts over natural resources are neither a new phenomenon nor inevitable, it is the methodologies and tools applied to manage them that could make a difference between consensus and conflict.

The case study provides an example to demonstrate stakeholder conflict and the associated failure in the management of resources. It also shows the incapability of previous and current policies to manage acute stakeholder power struggles or to mitigate environmental degradation.

Planning and management of development in Lake Maryout extends across different sectors and institutions. Consequently, in the lake's surrounding landscape, with its multifaceted ecological, social and economic problems, diverse stakeholder interest groups and multiple resource users, there is a considerable degree of conflict among resource users exploiting this area.

The chapter is a critical review of the current environmental, social, and institutional status of the Lake Maryout area that is leading to the current degradation of its environmental stipulation. It highlights the main reasons behind the urgent need to analyse the various decisions and policy actions to prevent stakeholder conflict, which is leading to the current deterioration of this area, prevent un-planned growth, and improve basic services provided for its residents. The most evident mismanagement is the absence of any clear strategy for the lake (World Bank, 2005). Integrating the lake into the urban fabric will not only address the acute environmental crisis, but also will provide an opportunity to absorb the natural growth of Alexandria.

The chapter gives an in-depth analysis of the institutional aspects as well as the legal and economic relations of stakeholders which will lay the foundation for the analysis of the next chapter. The chapter analyses the relationship between environmental degradation and impoverishment in an urban context. The case study chapter looks at the process of environmental degradation in relation to the political reality, to the specific power situation between those affected by environmental degradation, and those causing it. In such a context, it demonstrates that impoverishment, which an ecological disaster inflicts upon a community, is mainly a result of certain political, and hence institutional, conflicting situations.

The chapter aims to analyse the legal, institutional, and policy aspects that are affecting the study area. It explores the main causes for the current management and policy failure in relation to the on-going power struggles and stakeholder conflicts.

The chapter identifies the major stakeholders in the Lake Maryout area and presents the main management challenges within the context of each identified stakeholder. It also aims to introduce and explain the different perceptions and convictions toward existing challenges to obtain collaboration, agreement and cooperation among stakeholders. Results and outputs of this chapter will develop an understanding of the main reasons behind stakeholder decisions and hence be used to verify the decision analytical model results in chapter five.

4.2 Overview of Lake Maryout

Lake Maryout is one of the four main northern lakes in Egypt. The Lake extends along the Mediterranean coast and designates the southern borders of the city of Alexandria (see Figure 4-1). Lake Maryout represents a vital economic resource to the Governorate of Alexandria. Lake Maryout has a strategic importance at the regional and local level.

It plays an important role in the water balance of the Egyptian Delta region. Without its direct drainage to the sea, the level of water would continue to rise, which would eventually flood wide areas of land. In addition, due to the scarcity of land for new development in Alexandria, the Lake Maryout area and its valley are now viewed as prime land for urban expansion, as well as a significant economic resource for the city (World Bank, 2005).

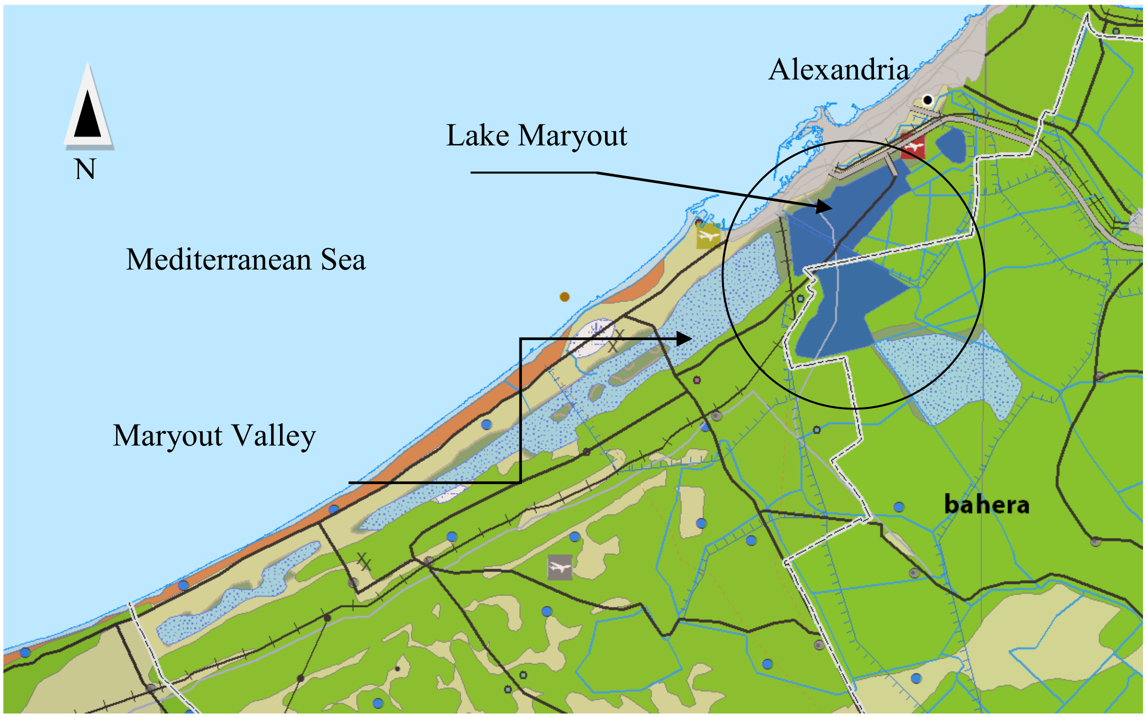


Figure 4-1 Overview of the Location of Lake Maryout

As a result of extreme pollution, Lake Maryout has become a hazard to the ecological equilibrium of Alexandria and the Egyptian Delta region, as well as to the health of the inhabitants of the city and its environment (Loizeau and Stanley, 1994). It is the most polluted lagoon in the northern Nile Delta (Saad et al., 1984; El-Sokkary, 1992).

Lake Maryout is now divided into a number of sub-basins. Domestic pollution coupled with heavy industrial discharge, large volumes of untreated waste, and an increasing load of agricultural run-off is discharged into the lake via canals and drains (Wahby and El-Moneim, 1979; Saad et al., 1984).

Fishing is one of the major activities in the Maryout area and was characterized in the past by large fish harvest rates with reputed quality. Over 2,000 fishing boats are owned and used by about 6,000 fishermen representing an estimated community of about 25,000 to 30,000 inhabitants (considering an average family of 4 or 5) (Kafafi, 2007). This community relies solely on fishing as the only profession known and practiced for many years.

The community's adaptability and willingness to explore and engage in new earning venues are very remote. The total annual fish catch has declined from 14,059 tons in 1980 to 5,320 tons in 2006 (Desouky, 2007). It has been declining steadily due to the deterioration of water quality and the drying of vast areas due to land acquisition. Around the lake there is a wide area of reclaimed land which includes various residential, industrial, commercial, recreational, and other activities (see Figure 4-2).

Figure 4-2 Quickbird 2007 Satellite Images of Lake and Valley of Maryout

The diversity of these combined activities, human and industrial, are the main source for Lake Maryout's current and future vitality.

4.3 Description and location

Description of the study area is important to understand its current problems. The current stakeholder power struggle for control and use of the lake is reflected on the ground through the continuous filling of parts of the lake, or though the sub-division of small basins for fish farms, agricultural activities, or the construction of roads for new development areas or to serve industries. Geography therefore, plays an important role in shaping the management of the lake and the decisions of stakeholders.

The lake is located between 31° 01´ 48″ and 31° 10´ 30″ North and 29° 49´ 48″ and 29° 57´00″ east along the Mediterranean coastline of Northern Egypt (see Figure 4-3). It lies on the south-western boundary of the city of Alexandria. The current lake extends more than 40 km southeast and 70 km southwest along the Mediterranean coast. The current width of the lake is estimated at 24.5 km, while its length is approximately 44.5 km.

The Lake is a shallow water body; its average water depth is around 1 metre. The total surface area of the lake (aquatic plants and open water) is changing over time and estimated at around 71 km2 (ALAMIM, 2008 a). Many portions of the lake are covered with large aquatic plants that represent around 60 per cent of the total area of the lake. Most of this vegetation cover is the Phragmites australis and Ecchornia crassipes. The vegetation cover occupies significant portions of the surface area of Lake Maryout sub-basins. Most of the Phragmites australis is fixed in place, either by roots or by attachment to traps set by fishermen. The surface water level is about -3 metres compared to average sea level. The lake is divided into five basins which are interconnected to each other by several breaches in the dykes of El-Umoum Drain and El-Nubaria Canal (Abdelrehim, 1997).

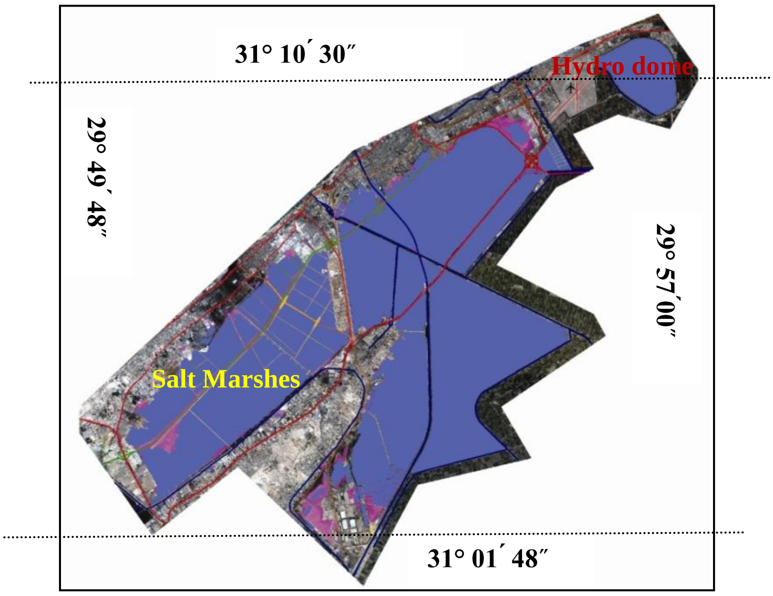


Figure 4-3 Geographic Location of Lake Maryout

The lake's four main basins are named after their original approximate areas, which have been reduced over time; however, the names of each basin remain the same. The local unit for measurement of an area is the Feddan. It is mostly used in Egypt, Sudan, Syria and other North African countries. It is equivalent to 4,200 square metres, 1.038 acres or 0.42 hectares. The basins are the 6,000 Feddans Basin (Main Basin), 5,000 Feddans Basin (South Basin), 3,000 Feddans Basin (West Basin) and the 1,000 Feddans Basin (Aquaculture Basin). These basins are currently dissected by roads and embankments.

The main basin is heavily polluted by industrial wastes from El Kalaa drain, and untreated sewage from municipal and industrial outfalls. Two other sources of water discharge into this basin are the El-Nubaria Canal (such as tin from paint of barges and ships), and the West Wastewater Treatment Plant effluent.

This basin is bordered in the north by the International Road and from the south by the Cairo-Alexandria Road. The West Wastewater Treatment plant is located also north of this basin. It is surrounded by many industrial factories and extensive human activities from the Kabary region.

The south-western Basin, adjacent to salt marshes produces 1,000,000 kg of untreated salt per year. It is surrounded by many industrial and petrochemical companies.

The Southern Basin is partially divided by El-Nubaria canal, although breaks in the canal embankments allow water to pass from one sub-basin to the other. This basin is very shallow and average water depths are 0.68 metres.

The main source of water is El-Omoum Drain and El-Nubaria Canal. Along the length of the El-Omoum, a series of breaches allow flow to leave the drain and enter the basin. Along the western boundary, a series of breaches allow exchange of water between the basin and the El-Nubaria Canal.

This basin consists of heavily vegetated areas and fish farms. Also, considerable wetland loss in this portion of the basin was recorded. Many petrochemical and petroleum companies such as Amreya and Misr Petroleum companies discharge their wastes into the northern part of this basin.

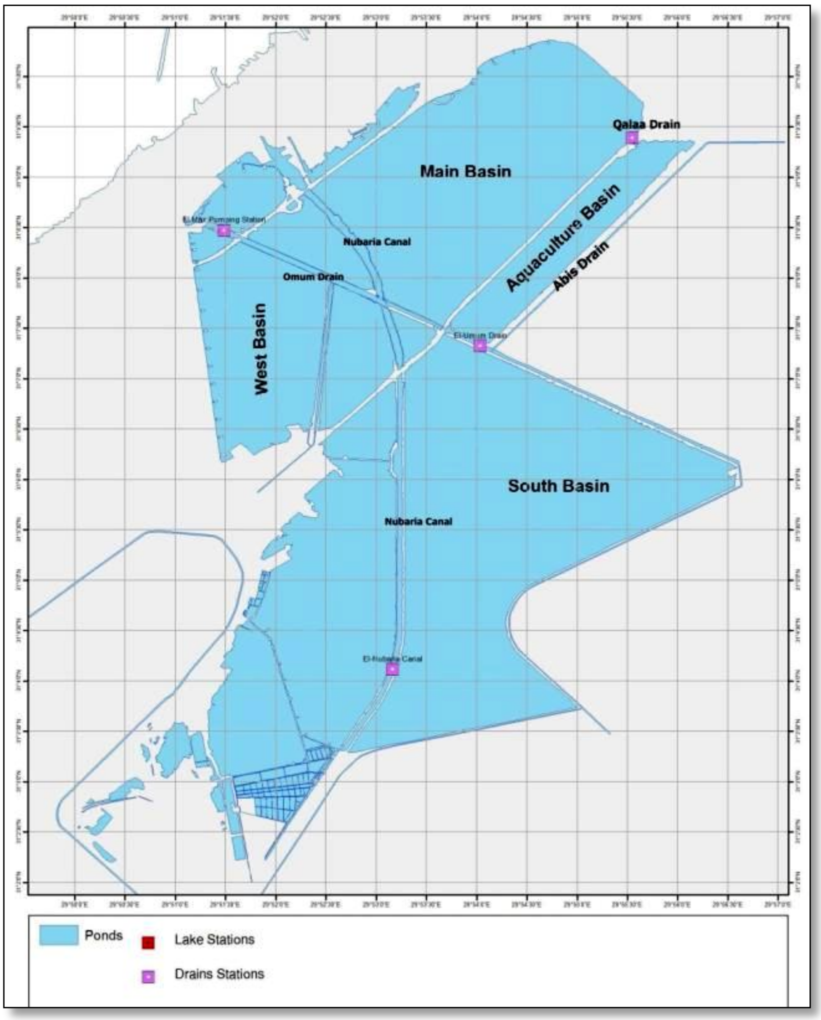


Figure 4-4 Lake Maryout Sub-basins

The (Fisheries) Aquaculture Basin consists of a series of small basins separated by earthen berms (see Figure 4-4). This facility is a research centre for fish farming and is operated by the Alexandria Governorate. There are two sources of water for this facility. One is a small pump station which pumps 400,000 m^3 /day, coming mainly from Abis Drain. The other source is from small openings of El-Omoum Drain.

The research uses remote sensing and GIS to accurately calculate the area of the lake, including each basin. This is essential to identify the changes that took place in recent years, as well as identify the directions and causes of these changes.

4.4 Analysis of Legal, Policy, Planning, and Institutional Context

The case study area of Lake Maryout represents a model of failure in the management of natural resources. It provides an illustration of conflict among diverse stakeholders coupled with contradiction in the current policies and legislation. The lack of a comprehensive communicative planning plays a role in exacerbating the deterioration of its environmental quality. Several unsuccessful attempts to develop a comprehensive plan for Lake Maryout were carried out during the past four decades (Hassouna 2007).

The analyses of the legal, policy, planning and institutional aspects shed light on the link between various types of conflicts and the environmental quality of the environmentally sensitive area.

Unsustainable management of the resources in the lake area, accompanied by exponential population growth and increased levels of economic and social activity, has led to significant changes in land-use patterns in Lake Maryout.

In many of the developing countries, and particularly in Egypt, populations tend gradually to concentrate in urban areas, in major cities and metropolises. This has aggravated variances between rural and urban settlements, leading to several forms of inequalities in resource allocation for the area's infrastructure and social services.

Egypt implemented policies which profoundly varied from developed countries and had to be nationally customised and prioritised differently because of budgetary and political reality. The environment protection has not been a priority for Egypt as being in tension with economic development (Baraka, 2012).

Contrasting the grassroots environmentalism of the West, Egypt's environmental initiative was initiated with the state, following pressures from the international community (Gomaa, 1997). Hafez (1996) has identified a combination of factors that have been blamed for the environmental policy failure. These factors include the lack of capacity in the field of formulation, evaluation and implementation of policies, political and government corruption, bureaucratic structures overloaded with conflicting policies that are hindering implementation and lack of government commitment to environmental policies.

Policy responses to environmental pressures play an important role in influencing the future shape of the area. Therefore proper response to these pressures by policy and decision-makers must take into consideration the complexity of environmental issues and the interconnections between them and other socio-economic issues. It is essential to develop an environmental strategy and action program aiming at promoting mainstreaming environmental policies and concerns into local socio-economic development policies in order to integrate environmental concerns. Policy options have to include the expansion and adoption of new policy approaches to address the current conflicting environmental problems. It is urgently required to find workable solutions for the area's conflicting emerging environmental problems before these conflicts reach irreversible turning points.

This section examines the impact of current policies and legislations on the differentiated conflicting stakeholder priorities. The analysis of Lake Maryout's environmental policies and legislations has to highlight two main issues. First, the contribution of policies on the lake's sustainable development; and secondly, to understand how the current Egyptian environmental policies contributes to environmental conflict than protection of the natural resource.

4.4.1 Legal context

Egypt legislative system consists of elected people's assembly, mostly controlled by the ruling party, and has currently no ability to change the government or amend the legislations. These changes come from higher rank official and always approved unanimously by all members of the assembly. This has of course negative impacts on the motives and types of legislations submitted by the ruling party.

At the local level, Egypt is divided into 26 Governorates. Governorates are divided into cities and towns. This system was initiated in 1975 stipulated two types of local organizations: an elected council and executive local commission (Hafez, 1996).

The local council has the authority to take related decisions concerning the governorate (Arab Republic of Egypt, 1975). The governor heads the local council which gives him the authority over other governmental institutions and ministries while the executive local commission has actually no power because the absence of real elected members. It just approves the local council's decisions.

Two main laws govern Egypt's legislation regarding water quality. According to Abdelnasser (2011), Law 48/1982 and Law 4/1994 are the main applied laws with respect to inspection and protection of the water quality. Law 48/1982 is mainly for protection of the Nile River and waterways from pollution, which regulates the discharge of wastewater into the Nile and other waterways.

The second is Law 4/1994 on Environmental Protection, which constitutes the main legislative body in the field of environment to formulate the general policy and prepare the necessary plans for the protection and promotion of the environment (EEAA, 2009).

Several government Institutions currently conduct environmentally related inspection (Genena, 2002). This results in duplication of efforts and inefficiency from the government side and confusion and discomfort from the industry side.

Despite that the EEAA is responsible for the environment countrywide, Law 4/1994 retained most of the monitoring authority for inland waters with the Ministry of Water Resources and Irrigation (MWRI) and the Ministry of Interior (EEAA, 2009). Ministry of State for Environmental Affairs has developed the water policy in cooperation with Ministry of Water Resources and Irrigation and other concerned authorities (EEAA, 2009b). Legislation affecting Lake Maryout has been on-going since the existence of the lake and Roman rule over Egypt. According to EEAA (2012), Egypt's Law No. 4/1994 for the environment (as amended by Law 9/2009) includes articles defining the coastal zones (art. 39) and the Integrated Coastal Zone Management (art. 40 and 48). It is important to mention that Lake Maryout is considered adjacent water to the Mediterranean, according to article 20 of law no. 4 of 1994, thus, all the laws, resolutions, international treaties which are issued to control pollution in the Mediterranean should be applied herein.

Lake Maryout and its surrounding land, like all other lakes in Egypt, is a public domain. In other words, it is owned by the state and is subject to the laws regulating the protection of state-owned lands. Accordingly, the Governorate of Alexandria (GOA) is the authority representing the state in the ownership of Lake Maryout and its surrounding land. Therefore, the Agency for the Protection of State-owned lands in the governorate is responsible for executing all the legal procedures related to disposal of that property (selling, leasing, use-of-right, etc.).

In 1983, the following Presidential Decree number 465/1983 was issued (Alahram, 1983). According to this decree all the water bodies in Egypt were placed under the jurisdiction of the General Authority for Fish Resources Development, an agency affiliated with the Ministry of Agriculture and Land Reclamation and directed to have a coalition with the syndicate of fishermen.

According to EEAA (2012), Law No. 4 for the year 1994, the Ministry of the Environment represented by the Egyptian Environmental Affairs Agency (EEAA) is the legal authorised body that protects the environment.

The Ministry of State for Environmental Affairs (MSEA) also referred to as the Ministry of Environment (MOE) and its executive authority, the Egyptian Environmental Affairs Agency (EEAA), have a major role to play as an assigned 'coordinating' government entity responsible for environmental quality, and protection (EEAA, 2009). Law 4/94 assigns varied tasks and duties to the Ministry of Environment in that field, and includes clear penalties for environmental violations. However, the Ministry is required to coordinate with the relevant executing authorities to enforce these penalties.

The first full-time Minister of State for Environmental Affairs was assigned upon Presidential Decree No. 275/1997 (Abdelnasser, 2011). Since then, the Ministry, in cooperation with all development partners, focused on determining the environmental vision, the guidelines of environmental policies, and priority action plans in light of economic and social variables, as well as the development challenges witnessed by Egypt (ALAMIM, 2008b).

By examining the Governorate of Alexandria, the Fishing Authority, and the Ministry of Environment from a legal perspective, it was found that two agencies (EEAA and Fishing Authority) are responsible for protection, and the third (GOA) is mainly responsible for supervision. It is striking to discover that there are no laws or legislations that determine the role of the Ministry of Water Resources and Irrigation as a stakeholder despite the fact that such a Ministry controls the water levels via the agricultural drain network of the West Delta and the pumping stations to El-Mex Bay on the Mediterranean. Currently, coordination and integration among stakeholders is not sufficient, mainly due to the fact that each stakeholder has a different affiliation. Conflicting objectives have led to conflict in the development of laws and regulations in this area.

Legislative action in Egypt can be defined as the action taken by Parliament, which includes the People's Assembly (the body issuing the law), and council's offices, various departments and committees (Arab Republic of Egypt, 1975). Whereas administrative action is defined as the action taken by the administrative authority regardless of the content of the action or the procedure, as two resolutions might be similar or united in the subject, one of them is legislative and the other is administrative. It depends on the authority issuing the resolution.

Therefore, any action is considered administrative when it is undertaken by an administrative authority whatever the content, whether it includes a general legal rule such as a regulation, or it is directed to a particular individual such as the administrative resolution. An action is considered legislative when it is issued by a legislative authority, regardless of whether it includes general and abstract rules such as laws regulating the legal status of state and public sector employees, or whether it is related to a particular case such as the law authorizing public laws and the budget law.

Currently, some governmental decisions, particularly administrative-related legislations, are not available, either because they have been issued earlier, or intentionally not documented. This is seen particularly in decisions taken by the Governorate of Alexandria concerning allocated lands in Lake Maryout and its surroundings, issued by the State Lands Protection Authority in Alexandria. For instance, the Governorate does not allow the provision for administrative decisions in the allocation of lands in the case of Carrefour shopping Mall and the Alexandria International Park. Both Park and Mall are built over Lake area by filling process (ALAMIM, 2008a). This is also the case in the decisions regulating national projects issued by Presidential Decree no. 108 of the year 2000. For example, the decision for the establishment of the International Coastal Road, which has a direct negative impact on the lake, is not available for public scrutiny, and can only be obtained through a court order.

Therefore, the conflict between stakeholders has reached the court of law. The local community filed a lawsuit against the Governorate of Alexandria because of its allocation of parts of the lake for urban expansion. This was followed by a number of lawsuits by fishermen, NGOs, and individuals against factories and construction of residential areas and roads. Another lawsuit filed was by residential compounds against fishermen, accusing them of using illegal methods, particularly explosives. The Governorate of Alexandria did not use the court of law, but used police force to remove some of the fishermen in fishing production areas as construction occurred without legal permission.

4.4.1.1 Analysis of the impacts of laws and regulations on Lake Maryout

There is an overlap of government authorities, which conducts inspection and concerning laws and regulations that governing Lake Maryout (Genena, 2002). The following section highlights the impacts of the applied regulations on the current state of the Lake:

Law 35/1946 limiting the discharge of industrial and public wastewater into the public sewage system (Arab Republic of Egypt, 1946). This law has a direct impact on reducing the amount of industrial waste discharged into the lake.

Law 196/1953 allowing discharge of public, commercial, and industrial wastewater into the sewage system (amended by law no. 33 of 1954) (Arab Republic of Egypt, 1954). The law increased the pollution due to insufficient treatment.

Law 29/1956 stating that any small canal or private drain may be considered a public canal or drain if it is directly connected to the Nile or lake and flows in any of them (Arab Republic of Egypt, 1956). This law has a direct effect represented in removing the encroachments on public drains such as El Omoum and El Qalaa drains.

According to Arab Republic of Egypt (1962) Law 93/1962 discharging liquid wastewater into the sewage system requires that wastewater and liquid wastes discharged from public, industrial sewage, and others cannot be discharged without permission. The law identified the rules that ensure causing no harm to water canals. The law has no impact on the lake, as the authority entrusted with implementing the law is the ministry of housing who is the owner of the sanitation company that needs to be monitored. The end result that the law has never been applied

Law 53/1966 prohibits the importation of some plants, living organisms, agricultural products, soil suitable for cultivation or soil that contains organic materials and residues of plants and agricultural products, to protect agricultural wealth (Arab Republic of Egypt, 1966). The law does not have a direct or an indirect impact, because the plants which the lake contains were already brought to Egypt from North America before applying the law. The increase of harmful plants in the lake resulted in spread of freshwater lobster, which in turn affected fish production.

Law 48/1982 Concerning the protection of adjacent coastal zones, the Nile River, canals and fresh and salt water surfaces from pollution (Arab Republic of Egypt, 1982). This Law has no impact on the land surrounding the lake; however, it has direct impact on reducing the amount of industrial drainage discharged into the lake. According to the same law, The Ministry of Irrigation is the authority to give permission to discharge or dispose of solid, liquid and gas wastes. This permission has never been granted by the Ministry of Irrigation as the Ministry of Environment (EEAA) and Ministry of Health have the technical tools to assess the request. The health authorities do not perform regular measurements and assign the EEAA with the role of the Ministry of Health.

According to Law 48/1982, The Ministry of Irrigation ensures that no facilities may be established which result in wastewater discharged in water canals. The Governorate of Alexandria (GOA) has refused to apply this law. It performs the licensing procedures. The Law states that The Ministry of Irrigation should take into consideration the types of chemicals used to control weeds, due to the fear of contamination of water canals. This law has direct conflict with the Ministry of Agriculture which is assigned by law to control agricultural chemicals. The result is that there is no implementation to the law.

According to Arab Republic of Egypt (1982), The Ministry of Health should perform regular analysis of treated liquid waste samples, taken from the facilities that obtained licenses for discharging into water canals. Regular analysis and sampling is regularly conducted by EEAA. Licenses are obtained by the GOA. Conflict between two bodies has always prevented any legal actions against these facilities. The Ministry of Irrigation is the competent authority for issuing licenses for establishing new floating facilities and renewing the old ones. The law is conflicting with the Fishing Authority as the main source of boat licensing. This resulted in unregulated fishing boats exploiting the lake for recreation and fishing.

Law 124/1983 prohibits the backfilling or draining of any part of the lake, and imprisons and fines anybody who does this (Arab Republic of Egypt, 1983). This law has a positive impact on the removal of constructed encroachments and back filling of the lake. The law states that Governmental authority, organization, company, local unit, cooperatives, or individuals may not drain any part of a lake without a report determining its inappropriateness for economic usage. The law creates more conflict as it opens doors for filling parts for economic activities such as urbanisation, industry and tourism.

According to the same law, the land surrounding the lake is under the authority of the General Authority for Reconstruction and Agricultural Development (GARD). Complete conflict with the GOA that has the authority on land properties within its governorate which is already in conflict with the General Authority for Public Planning (GOPP).

Law 12/1984 allows Ministry of Irrigation to regulate the irrigation and drainage system. The law has a negative impact on reducing the water level in Lake Maryout, and hence to reduce fish production (Arab Republic of Egypt, 1984). The Ministry of Irrigation uses the lake as a reservoir for excess drainage water from agriculture drains and therefore, want to keep the water level as low as possible

Law 145/1988: Law of local management system amending law no. 43 of the year 1979, amended by law no. 50 of the year 1981 (Arab Republic of Egypt, 1988). The governorate's public local council, within the State's general policy, monitors the different facilities and works within the jurisdiction of the governorate according to the article. It is conflicting with other regulations, assigning the monitoring to Ministry of Environment, Ministry of Irrigation and Ministry of Health. It should be a committee from members of these agencies. Lack of coordination has negative impact on the monitoring system.

Law4/1994 Protecting the land, water, and air environment against pollution. Law no. 4 of 1994, amended by law no. 9 of 2009 and its executive regulation prevents some encroachment cases on the lake, such as back filling, improves water quality, monitors industrial drainage, and increases fish production (EEAA, 2009). It considers the lake among the adjacent waters which makes the Mediterranean Agreement applicable herein.

The Egyptian civil law prohibits the privatization of public wealth for public benefit, such as lakes, streets, squares, beaches, public parks and historical monuments. The lake is subject to some privatization development, including extracting areas for fish farming, urban development and industrial construction.

4.4.2 Planning and policy context

Egypt's public policy is predominantly controlled by the President, his cabinet and institutions of the executive branch (Arab Republic of Egypt, 1975). The prominent members of these institutions are the key players in the process of public management through which the legislation and programmes are prepared. Egypt has paid attention to environmental issues after the Stockholm Conference on Human Environment in 1972. The government started then to formulate a national body responsible for the environmental protection. The first national environmental policy was developed in mid 1980s. The national policy was translated to environmental action plan. The actions or programmes took note of the sustainable development directions. However, and depending on the level of power and influence of the institutions and interest groups, the government is compelled to tackle the environmental problems (Hafez, 1996).

External and internal pressures have been escalating to enfranchise other bodies and non-governmental interest groups who are not participating in the government decision-making process.

To understand Egypt's national policies, it is necessary to analyse the government structures to examine the processes that constrain or facilitate the policy making process.

Egypt's policy formulation and implementation are affected by a number of factors. These factors include the governmental and bureaucratic systems (Hafez, 1996).

Policy can be defined as a system of goals, planned activities, and regulatory measures. However, it may be essential to pass a law to activate these courses of action and to develop the institutional and legal frameworks required to achieve these goals.

The research identified most of the available policies, laws and regulations that are related to the study area. The outcomes can be categorised into four main policies: 1) improving water quality; 2) Urban expansion; 3) Increasing fish catch and; 4) encouraging industrial activities.

Analysing the implemented and planned policies pertaining to the above categories shows that they are responding to social, economic and environmental requirements. Improving the lake's water quality is an environmental and socially sound policy. Urban expansion is economic-social policy which responds to the acute demands of Alexandria's population to find alternative areas for urban expansion. Increasing fish catch is social policy to assist the fishermen and local community regain their economic stability that was downgraded during the last two decades. However, industrial expansion is an economic policy that was driven by members of the businessmen's association represented in the local council and in the People's Assembly.

An example of policy failure is the decision to divert the Alexandria's domestic wastes from the Mediterranean Sea into the lake. According to the World Bank (2003) this policy aimed at reducing the pollution on Alexandria's coast. This resulted in a continuing expansion of industrial and domestic discharge waste to the lake.

Analysing these policies shows that they have conflicting objectives. Expanding urban areas and industrial activities will have a negative impact on the lake's ecosystem, fish production and water quality.

4.4.3 Institutional context

Egypt's constitutional convention of 1971 has developed a government of several powers. It is however, created a system of separate institutions that carries a pronounced inequitable significance.

It is important to analyse the institutions that are either in charge of management of the study area, affecting decisions, get affected by adopted decisions, or have some legal mandate within the area. The analysis should include the identification of their interests, priorities, and "power".

Nobel Prize winner Douglass North explains, "Institutions are not always, or even usually, created to be socially efficient; rather they are created to serve the interests of those with the bargaining power to create new rules" (North, 1994, p.360).

Michel Foucault describes institutions as means to assign power to certain groups to benefit from the system (O'Farrell, 1997). According to Lipschutz (1996), and Wapner (1996), public participation was increasingly regarded as an indicator of good policies and effective institutional frameworks.

The collaborative planning approach has turned out to gradually be more accepted in environmental decision-making, specifically in situations where there are multiple actors with conflicting interests (Wondolleck and Yaffee, 2000).

The new institutionalism theory has increasingly attracted attention in the field of environmental management and change, both in the social sciences and in the law (Hukkinen, 1999; Young et al., 2008).

As presented in the previous section, there are many governmental authorities that are connected by legislation to Lake Maryout. These conflicting roles and responsibilities have created a management paralysis concerning the lake.

One of the reasons behind this legislative chaos is that the central government is trying to apply international agreements by introducing new laws. Egypt has rectified many international and regional agreements related to environmental conservation, freshwater resources, marine environment, coastal and wetland protection, and pollution and hazardous substances. Within the framework of the Barcelona convention, Egypt is a major player in the Union for the Mediterranean, and is implementing the Horizon 2020 Initiative which aims at de-pollution of the Mediterranean Sea by the year 2020.

As indicated in chapter 2, new global political-institutional arrangements aimed at enforcing new environmental regulations have resulted in the emergence of environmental conflicts in the face of recent regulations (Lopes et al., 2007).

McGlashan and Williams (2003) highlighted the distinction between ‘institutional stakeholders’, which are the effective participants and organized groups such as public organizations, local government authorities and state government agencies, and ‘local stakeholders’, which are usually smaller groups with fewer capabilities to influence decision-making.

Healey (2004, p. 93) defines institutions as “the norms, standards and mores of a society or social group, which shape both formal and informal ways of thinking and ways of acting. Institutions, therefore, are an integration of those values, norms, and ways of acting which shape the realm of collective action. Applying this definition to the case study, it shows that the conflict of interest between the existing institutions cannot result in collective action. It is rather adding to stakeholder confusion and to the existing conflict.

The following section provides overview of the main stakeholders’ institutional setup and objectives with respect to the area of study.

4.4.3.1 Governorate of Alexandria (GOA)

The Governorate of Alexandria manages its property via the State Property Protection Agency. Such conditions similarly apply to the lake and surrounding lands since the Governorate may be considered the legal owner. Therefore, Lake Maryout and its surrounding areas fall under the category of public use or state-owned lands, and the GOA collects revenue accordingly. The Governorate, in coordination with the central government, coordinates the different uses of the lake and surrounding lands, whether such lands are allocated to the supreme interest of the state (national security), public interest or other purposes. It bears the first and foremost responsibility with regards to providing responses for the investigation sessions conducted by the legislative authority (People's Assembly) in cases of people or agency grievances against any harm inflicted upon them due to reasons related to the lake. Moreover, it bears the first and foremost responsibility with regards to the living conditions of the lake's inhabitants, inclusive of housing, utilities, public health, education, economic and social activities and security. It is also responsible for the design and implementation of a comprehensive sustainable development strategy for the lake area.

The GOA holds the prime responsibility for the Governorate's development. It is the highest authority where all decisions concerning the governorate are debated and issued. Employment opportunities, public health, social security, infrastructure, and planning are all parts of this complex responsibility. It is also the local authority responsible for managing Lake Maryout activities. This responsibility is complemented with coordination with a variety of official entities and authorities relevant to development activities, with varying levels of authority and influence. The Governor of Alexandria issued decree No.244-2004 on July 17, 2004, forming the Alexandria City Development Strategy (CDS) team, and established its roles and responsibilities. The CDS committee is chaired by the Secretary General of Alexandria Governorate, and includes three sub-groups in charge of Local Economic Development, Lake Maryout Development, and Informal Settlements Upgrading and Development.

The Governorate receives internationally-funded support in various activities with Lake Maryout as one of its top priorities. The World Bank and a number of foreign aid organizations are the major supporters of the city development activities. A donor coordination unit is formed within the governorate to organize and coordinate the activities of various programmes. The Lake Maryout Committee comprises the chairman of the Alexandria Company of Sanitary Drainage ACOSD, the head of the Egyptian Environmental Affairs Agency (EEAA) Regional Branch office for West Delta, head of the regional fisheries authority, an NGO, and the lead Governorate advisor.

The priority of the Governorate towards the management of the lake focuses on two directions. First, is to fill part of the lake's shallow areas for urban expansion. Second, is to expand on treatment of domestic wastes in order to enhance water quality and accordingly to increase the opportunity for the development around the lake.

Despite all of the Governmental efforts to unify management of the lake under the umbrella of the Governorate of Alexandria, these efforts were not successful. This was mainly due to the lack of capacity within the governorate, absence of supporting data and insufficient institutional capacity to carry out the mitigation programmes. Despite the hierarchical structure of the Governorate, the decision-making process is centralised, and management decisions regarding the lake have to be cleared with the Governor.

4.4.3.2 The Fishermen Community

The fishermen community inhabiting the Lake Maryout area is a significant factor in any decision-making process. According to their own estimate, they comprise about 6,000 fishermen with their families.

The actual number of fishermen in Maryout varies in many reported documents according to the source and objective of the study report. However, it is reasonable to agree with the research survey numbers, which are based upon the close agreement of the concerned community. According to the survey, the origin of the society was formed as a result of migrations from different parts of Egypt, including Burullus, Edco, Mataria, Rasheed, and Aswan. The fishermen community working and living in and around the lake started to emerge in the late nineteenth century. The ancestors of the fishermen we see today came from different parts of Egypt. The provinces of es-siadden's ancestors, which they are named after, and which present the most important basis of identity among them until today, are Damietta, Upper Egypt (Saeed), Mattarya (in Daqahlyah), El-Borrols (in Kafer El-Sheikh), Bedouins from the adjacent western deserts of Egypt, Rosetta and Edco (both in Behira).

With the exception of fishermen of Bedouin origin, Maryout's fishermen are mostly residents of Alexandria's metropolitan area. They are concentrated in the south-western parts of the city, and other areas that all enclose the lake, and mostly fall within the boundaries of Moharram Bey's district of Alexandria.

The "urban fishermen" seem to lead a life of urban dwellers. Fishermen of Bedouin origin as commonly known among fishermen, mostly live outside the urban setting of Alexandria, and lead a life of an unmistakable rural character. The evidence of wealth and prosperity the lake provided to immigrants, is not only proved by the migration of the ancestors of the fishermen we see today, but also by the fishermen’s descriptions of the lake's productivity before pollution turned some of its areas into sewage dumps. Based on field visits conducted from 2000 to 2011, the fishermen settlement (Maw’a El-Sayadeen) continues to suffer from extreme poverty levels and vulnerability. The settlement also contains illegal housing with no access to fresh water facilities or sanitation services.

The issuance of Law no. 4 in 1994, meant to tackle environmental problems, presents a turning point in the lake's history. Starting then, protecting the lake from further pollution and trying to reverse the process of its degradation became one of the main concerns of Alexandria's office of Environmental Affairs, a body affiliated with the Alexandria Governorate. Only in 1994, sewage water and industrial waste coming into the lake with it, was subjected to primary treatment, a necessary preliminary though insufficient step. On the other hand some of the drainage canals that used to flood the lake with industrial waste were closed. These procedures ended 8 years of down pouring the lake with untreated biological and industrial waste.

The Lake's environmental degradation and depletion as a natural source of fishing that provided a living for thousands of fishermen and their families entered a very critical stage in 1986 (see Figure 4-5).

Figure 4-5 Selling Fish in Maryout (Abdelrehim, 2008)

This stage was reached as a result of turning the lake into the "sewage dump" of Alexandria. The lake receives most of the city's sewage, which formerly used to go into the Mediterranean, without any form of treatment.

The city's sewage contains a considerable percentage of chemical pollution, added to the growing toxic pollution caused by numerous factories located around the lake, many of which used the lake to dispose their waste. Currently, industrial waste presents the most dangerous component of the lake's pollution. Industrial pollution is mainly coming through agricultural drainage canals and through the city's sewage system. Agricultural drainage canals, which bring water that is heavily polluted with pesticides, come second in significance. Least harmful is the biological component of the sewage water.

In spite of the fact that the Governorate undertook considerable efforts to upgrade the lake environmentally, it is still responsible for a number of acts that are both environmentally damaging and economically harmful as far as the lake's community of fishermen is concerned. The Governorate's efforts to dry more and more of the lake's area for "developmental" purposes are still in progress.

While the decline of Lake Maryout is an environmental concern, a matter of ethical commitment and political belief, for many in and outside Alexandria, it is a matter of life and death for the lake's fishermen, for the descendants of those who came to live and work in what used to be a bountiful area. It is difficult for the fishermen to find a logical explanation for what happened to the lake and what they were exposed to.

Despite the existence of the fishermen social organisation, their influence in the decision-making process is still limited. Their priorities are, to some extent, conflicting with those of the Governorate of Alexandria's, and to a great extent with the businessmen and industries around the lake. However, they still have a major power on the ground as they have territorial control over the lake's area.

The fishermen community is coordinating with the Ministry of Agriculture-Fisheries Authority in strategies and plans concerning Lake Maryout. The Fishing Authority is authorized by law (124/1983), to regulate fishing activities and provide licenses to fish farms. It has definite leverage in current and future development activities. The fisheries authority statistics estimated an annual fish consumption in Alexandria of about 50,000 tons, with 15,000 being harvested within Alexandria (with Lake Maryout's share of 4,500 tons or about 30 per cent of Alexandria's total fish harvest), and the balance is sourced from other producing governorates. This represents one of the strongest rationales supporting the necessity of preserving and enhancing the vitality of Lake Maryout.

4.4.3.3 Ministry of the Environment (MOE)

The Ministry of the Environment and its executive authority, the Egyptian Environmental Affairs Agency (EEAA), have a major role to play as an assigned ‘coordinating’ government entity responsible for environmental quality and protection. Law 4/94 assigns varied tasks and duties to the Ministry of Environment in that field, and includes clear penalties for environmental violations; however, the Ministry is required to coordinate with the relevant executing authorities to enforce these penalties.

The first full-time Minister of State for Environmental Affairs was assigned upon Presidential Decree No. 275/1997. Since then, the Ministry, in cooperation with all development partners, focused on determining the environmental vision, the guidelines of environmental policies, and priority action plans in light of the economic and social variables, as well as the development challenges witnessed by Egypt (ALAMIM, 2008b).

MOE in cooperation with various governorates has established the Regional Branch Offices (RBOs) within the jurisdiction of the Ministry of Environment. These branches work closely with the Environmental Management Units (EMUs) in each governorate to coordinate environmental protection activities.

Encouraging Integrated Coastal Zone Management (ICZM) in Egypt, particularly after amendments of the executive regulation of law 4/94, and the potential issuance of ICZM regulations, which are being prepared, will give the Ministry a much higher leverage, allowing for noticeable coordination activities, as well as increased legal authority. A proposed higher ICZM committee, chaired by the Minister of Environment would assume the responsibility of such coordination. Accordingly, the EEAA’s role could align all active entities to agree on a common vision for the lake’s development.

MOE is hosting the previously mentioned EPAP II project, which is led by the World Bank, with the objective of addressing air emissions and industrial wastewater by providing technical and financial assistance to various industries willing to establish treatment units for their emissions/effluents. The project has been launched, and the Maryout area is on its agenda concerning industrial wastewaters.

The Board of Directors of the Egyptian Environmental Affairs Agency is established under the chairmanship of the Minister of Environment and membership of the Executive Director of EEAA, who acts as deputy to the head of the board of directors. The Board of Directors consists of environmental experts, NGOs, Council of State, Public Enterprise Sector, universities and scientific research centres.

The organizational and institutional structure of the Ministry of State for Environmental Affairs or the Egyptian Environmental Affairs Agency includes a department for Coastal and Marine Zones Management affiliated to the Environmental Administration on the national level, yet there is no mention of specific lakes. All eight branch offices of EEAA stand on equal footing whether they have lakes or not. Each Branch office includes 4 departments: Environmental Information and Education Department, Environmental Quality Department, Environmental Development Department, and Financial Affairs Department.

4.4.3.4 The Alexandria Business Association (ABA)

The Alexandria Business Association is a non-governmental, not-for-profit organization based in Alexandria, Egypt. ABA presents and protects the interests of industries and businesses in Alexandria. It provides small and micro-enterprises (SMEs) with credit and supports their enlargement. The foundation offers loans with flexible loan repayment plans, and hands-on technical assistance to businesses (UNESCO, 2011).

The ABA aims to assist in the economic development and improvement of the business climate in Alexandria through research development, support, and upgrades to human resources. It is also a major player in community development (Alexandria Businessmen Association ABA , 2011).

The ABA has a major role in the management of the Lake Maryout area, as all industries and businesses are represented in ABA. Ministries of Industry, Investment, Housing and Petroleum are members in ABA. The ABA has a major conflict of interest with the Fishing Authority and EEAA regarding the industrial wastes that are being dumped in Lake Maryout. Spatial Analysis of Lake Maryout

Wetlands can provide enormous valuable services to people in the form of water supply, fish production, agriculture support, wildlife resources, facilitate transportation, and create opportunities for recreational activities and tourism.

According to Kashaigili et al., (2006), wetlands are frequently mismanaged and misused by people's interventions that are causing changes and degradation to these important natural resources. Studies of wetland degradation are mostly based on site investigations or remote sensing analysis (Rogers and Kearney, 2004).

Change detection provides a practical tool to investigate the rapid changes in the Lake Maryout area. All the detected changes are based on stakeholder decisions to make these interventions. Analysing these decisions highlights the relative importance of stakeholders with respect to their multiple objectives.

The objective of this section is to map and assess the temporal and spatial evolution of Lake Maryout and its surrounding areas through detecting the changes with respect to stakeholder identified priorities that were identified. The identified priorities that are selected for analysis are: enhancing water quality, urban expansion, increasing fish production and industrial development.

Change detection is conducted in this research by using multi-temporal analysis of high-resolution QuickBird Satellite images. Change detection analysis is used for detecting spatial and temporal variations in the water body, urban areas, industrial activities and fishery resources. Furthermore, the results of change detection are used as inputs within the DPSIR framework to provide evidence of the state of each priority, and to analyse the responses of stakeholders on the ground for better understanding of the cause and effects relationship of Lake Maryout changes. Identifying the actual changes in Lake Maryout will be used to verify stakeholder decisions and powers and to validate the results of the EDAM. The analysis includes integrating Environmental Assessment DPSIR framework with results of change detection and spatial analysis, to understand the impacts of these pressures on the area of study. The spatial analyses aim at unveiling the main factors and driving forces contributing to the increased pressure on both the environment and the local community, leading to greater vulnerability of residents in Lake Maryout and the surrounding area. It investigates the positive and negative responses to these environmental threats.

Analysing the responses is vital to understanding the decision-making process that either contributes to a deterioration of the Lake's environment or tries to mitigate some of this degradation. Identifying the land-use conflict is important to understand how stakeholder conflicting priorities are shaping the environmental quality of Lake Maryout on the ground. The spatial analysis highlights the changes that have taken place in the case study area over a period of time, and have been caused by certain decisions that have also affected the decision-making process. The spatial analysis tries to make the link between specific changes on the ground and previous and current decisions. The chapter also looks at the impact of various decisions on the spatial characteristics of vulnerable wetlands. It tries to look at how conflicting objectives have led to changes on the ground in the study area. It uses the DPSIR framework to understand the root causes of these changes in order to map the areas of agreement and disagreement. The outcomes assist in the interpretation of the results of the decision methodology.

The findings helps to understand how the magnitude and direction of consensus among conflicting stakeholders shape the management of an environmentally sensitive area. The chapter examines different elements contributing to current environmental conflict through spatially analysing demographic, environmental and social aspects that are shaping the development of the stakeholder decision-making process. The spatial analysis conducted in this chapter aims at developing an understanding of what the impact of stakeholder environmental conflict is on the actual state of the environment in an environmentally sensitive area. To understand these complex inter-linkages, a set of spatial reference maps have to be created.

The analysis has to cover the thematic priority areas that have been identified in chapter four.

Applying DPSIR framework will shed light on the main causes behind stakeholder selection of these alternatives. Urban expansion, reduction or increase in water body, area of fishing and industrial expansion are critically analysed to develop an understanding of the magnitude and impact of any action on the ground and to a certain extent assess the differentiated powers of stakeholders that enable each stakeholder group to implement its agenda.

4.5 Selection of the Examined Area

Lake Maryout and a buffer zone of 500 metres around the coastline of the lake were selected for detecting the changes. The buffer zone is important to locate the human induced activities around the area of study (see Figure 4-6). The buffer zone gives a bird's eye view of the social conditions of the community around the lake. Detection of Land use offers valuable data and information about the socio-economic activities. Spatial analysis of the area provides essential information about certain environmental conditions. Understanding the environmental, social and economic conditions on the ground helps in finding answers to the research questions. Analysing the decision-making process based on the findings of the actual conditions contributes to the identification of the root causes of these decisions.

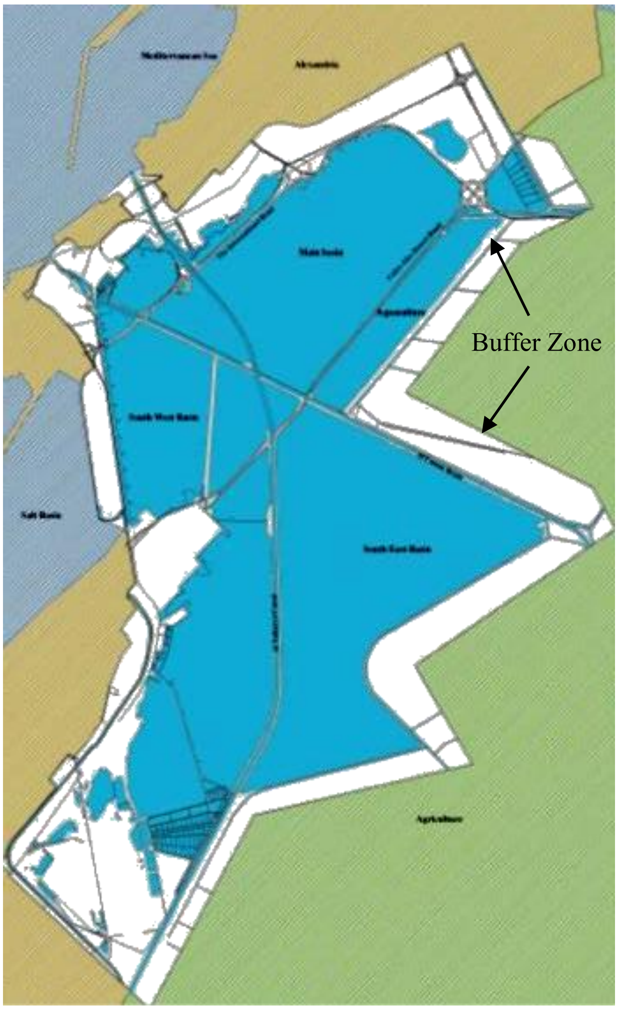


Figure 4-6 Location of the study area

4.6 Data Preparation and Image Processing

Image processing is one of the spatial analysis techniques. It is an integral part of a decision-making process, which requires the use of geographic databases. Image processing uses mathematical operations to develop an enhanced image. It is used to extract specific information about features within the acquired image. It is a decision aiding process to answer questions related to spatial complex problems.

The goal of satellite image processing and radiometric corrections is to enhance the visual interpretability by increasing the visible characteristic of the required features in the acquired scenes. Enhancement functions are applied to scenes after the proper restoration process is conducted. Atmospheric correction is vital to enhance the visibility of the images to minimise any potential noise. All satellite data enhancements and radiometric corrections are performed using PCI Geomatica software solution version 10.1.3 and FOCUS module which contains image enhancement capabilities and atmospheric correction function suitable for the QuickBird imagery.

Pre-processing of the images include the process of feature extraction, radiometric correction, image enhancement, geometric correction, and map projection. It is essential to identify a number of control points that will be used to geometrically correct the acquired images. The ground control points are collected using a Garmin GPS 12 series. The identification includes major road intersections, railroad intersections, special land features, known urban features and identified electrical stations in the study area.

The main objective of performing image processing in this research is to extract information about the environmental and urban features on the ground of the case study area.

4.6.1 Data acquisition

QuickBird satellite images were required because of the high resolution they provide. Two satellite images were available through ALAMIM project and were given to the Governorate of Alexandria management unit for base line monitoring of future changes (see Figure 4-7).

The images provide resolution of 0.60 cm at the panchromatic and 2.4 metres for multispectral. The Satellite is Sun-synchronous, revisiting the same location every 3 days. The single image covers an area of 16.5 km by 16.5 km. Accordingly, for the study area, a single image was sufficient to cover the entire lake Maryout and surrounding required buffer zone. To analyse the temporal changes, two dates were selected; 2002 and 2007. This allows the calculation of changes in areas of the lake, as well as monitors the urban development that has occurred during this period.

The projection used for the analysis is Universal Transverse Mercator coordinate system (UTM). The study area is located in Zone 36 R. UTM system uses the WGS84 ellipsoid to model the curvature of the Earth within its coordinate system.

The analysis of this chapter made use of the remotely sensed data that was available from the European Commission SMAP III (Short and Medium-Term Priority Environmental Action Programme) Alexandria Lake Maryout Integrated Management project (ALAMIM). The research has requested the European Commission to use the images for this research purpose and the request was granted.

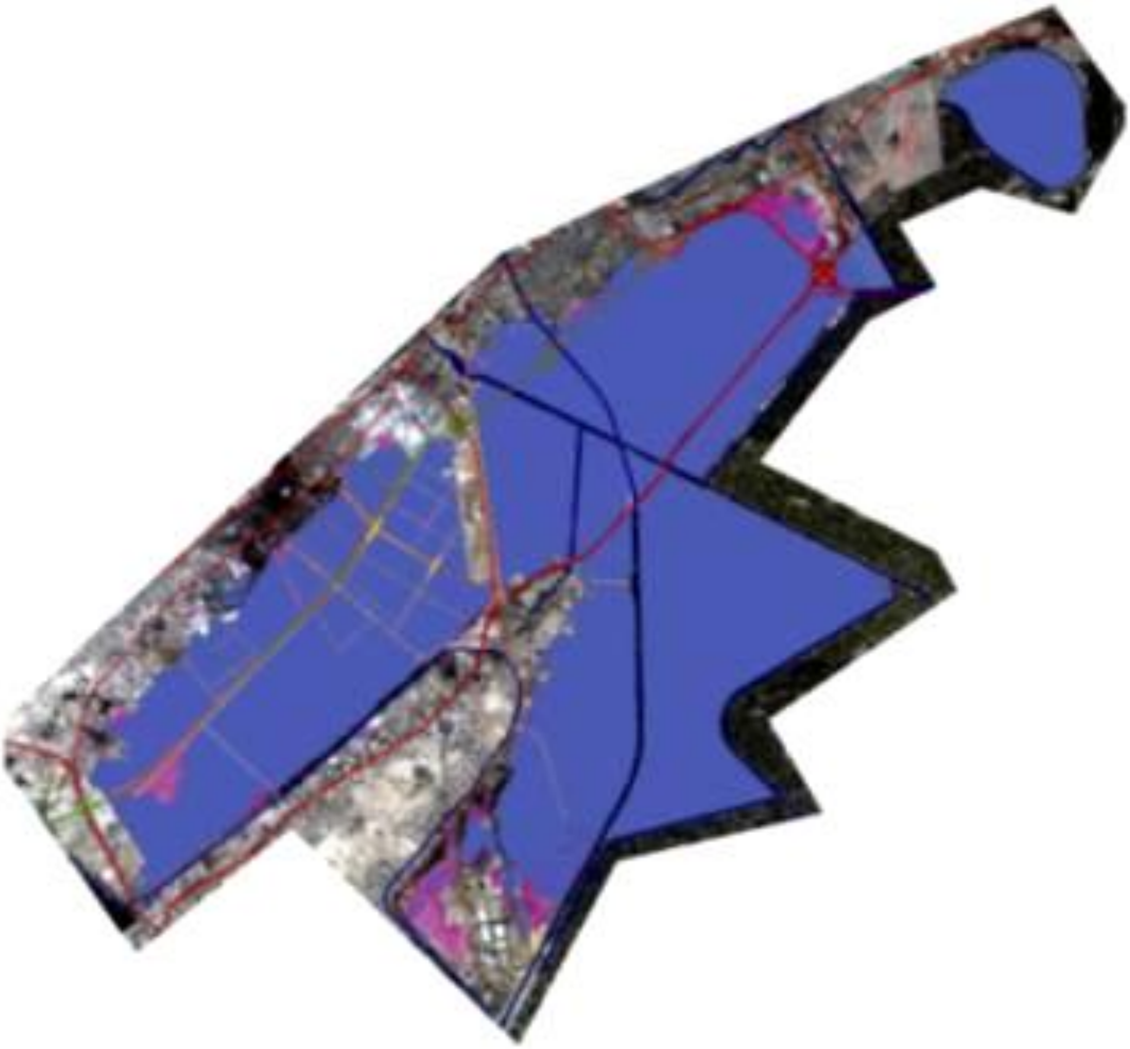


Figure 4-7 Boundaries of the Area of Acquired Images

4.6.2 Geometric correction and mosaicing

Pre-processing functions of any remote sensing operation is categorised as image restoration (Estes, 1983). Radiometric correction is performed to illuminate undesirable influence of the image atmospheric interference (Campbell, 1987). The function is conducted within the acquired images for both years using special filters in ERDAS Imagine Software to help in the classification process. The process is to geometrically correct the 2002 mosaic image from the 2007 image, and use edge matching to make the two images accurately identical.

Mosaicing is the process of combining several images into a single composite image. The mosaicing process is conducted to merge the pan-sharpened images together in order to create one uniform image for the year 2002 and the same process is required for the years 2007 and 2006. Geometric correction is conducted using the ground control points for both QuickBird satellite images for 2002 and 2007. Additional manual image processing techniques are applied to correct any mismatched data.

4.6.3 Satellite data enhancements

The pan-sharpening image processing technique is used to combine high resolution black and white (panchromatic) image, which has a resolution of 60 centimetres, with colour (multi-spectral) image which has a relatively lower resolution of 2.4 metres. This operation is required in order to develop a higher resolution multi-spectral image. The QuickBird multi-spectral image consists of four bands. The pan-sharpened process requires only 3 bands while the fourth band is used as a reference.

The output digital file of sharpened images is an enhanced visual interpretation of the two original images. It is used to visually extract information about spatial pattern on the ground. The pan-sharpen process is conducted using the PCI Geomatica pan-sharpening process. It is designated through a comprehensive analysis of existing fusion techniques and results. The system supports the new generation of high-resolution satellites, and uses algorithm that is automatable, and preserves both the spatial and spectral integrity of acquired images in this research.

4.6.4 Image classification

Image classification process is conducted to assign targeted pixel to identified classes (Campbell, 1987). The classification is usually conducted through unsupervised or supervised classification. Unsupervised classification can be defined as the identification of targeted cluster groups of image features in the multispectral image. Campbell (1987) has identified four advantages and three disadvantages of unsupervised classification. Advantages include its ability to minimise human errors, it provides more uniform classification in respect to spectral composition, its ability to identify very small unique areas that could be neglected by supervised classification, and finally that this process requires no prior knowledge of the studied area.

Disadvantage of the unsupervised is the limitation of the automated process to control the classes of specific identity, inconsistency between informational classes and spectral classes and the problem of matching spectral classes to the informational required categories. As the research has already gathered on the ground information from the case study area as presented in chapter four, it was essential to perform supervised classification to ensure the accuracy of the information. This is essential to analyse the decision-making process related to each studied category.

Supervised classification is a process of matching the identified sample on the ground to their correspondence pixel value in each image. The advantage of performing this process is that the analysed sample has been already categorised within the informational categories gathered from the ground. The process enables the researcher to identify any possible errors in the pixel values leading to mismatch with the identified category. Supervised classification is more accurate and reliable in respect to the identification of urban and environmental features within limited area.

Change detection of the identified targeted features is conducted to calculate changes that took place during the period from 2002 to 2007.

4.6.5 Data collection

The field survey data collection is mainly targeting urban classes, infrastructure of the study area, water bodies and water channels. Four main categories representing the main identified priorities need to be analysed: urban development, expansion or deduction in water areas, areas dedicated for fishery production and industrial areas.

Revision check is performed to all the collected data sets in order to ensure the accuracy and the coverage of collected data to answer the relevant research questions. In order to perform this, on the ground data needs to be collected in terms of verifying the main causes of these changes on the ground.

4.6.6 Satellite image interpretation and digitization

Manual satellite image interpretation and digitization is performed in this research. Visual interpretation and digitizing from both the satellite image data and the collected hard copy maps is performed. Comparison between the hardcopy maps and the acquired images is continuously conducted during the interpretation process to ensure the verification of the output maps, and temporal changes are recorded.

Area of study geo-database is developed using ESRI's Arc Catalogue software. Data sets include the required feature classes. Building classes include the development of attribute table which includes both fields for the domains and fields for data entry.

4.7 Change Detection

The first stage in the production of the change detection layer is to superimpose the two satellite images (2002 and 2007).

Two satellite data images are superimposed in order to prepare the land use/land cover layers. Editing process is conducted by interpreting the satellite image of 2002 and detecting the changes with the land use/land cover layer that was produced by the satellite image of 2007. Identified changes between the two images are recorded, clipped and measured using spatial analyst module of ArcGIS. A final change detection layer is developed to show the actual areas that were changed or modified between the two acquired dates (2002 – 2007).

4.7.1 Producing land use/land cover GIS layers

Land use can be defined as the usage of an area of the land with emphasis on the inter-relation between the role of the land and economic activities functions (Campbell, 1987). To understand the recent development in the area of study, Land use/Land cover GIS layers of the different extracted land use classes have to be developed.

The QuickBird satellite data and the field data collected during the field survey are used to develop the GIS layers. The developed land use map provides information about who the main stakeholders of the area are by analysing the type of activities on the ground.

Analysis of remote sensing images shows that Lake Maryout is surrounded from the eastern and southern parts by agricultural areas. These areas are mainly occupied by farmers who have no direct connection, socially or economically, with the fishermen community. Urban areas extend from the northern part to the southwest.

Changes in the Lake Maryout area are categorised and grouped under four main activities: expansion in urban areas, changes for industrial expansion, increase in some water areas and in fish farms.

The total urban areas in the study are calculated to add up to an amount of 10.1 km^2. Areas of industrial activities are 9.2 km^2. The detected increased water area is 0.347 km^2 and areas added for fish farming is 0.1369 km^2 (see Table 4-1).

Table 4-1 Areas of Major Land Use Activities

Urban Area	Area km^2
Commercial	0.522067
Services	5.451003
Cemetery	0.04227
Religious	0.037578
Residential	3.957119
Total Urban	10.01
Industrial Area	Area km^2
Industry	9.200576
Increased Water Area	0.347
Added Fishing Area	0.1369

General overview of the area of study shows that 6 categories within urban development can be identified: commercial, services, cemetery areas, religious designated areas (mosques and churches), and residential areas. Lack of a general master plan for these areas has led to the interconnectivity of these land uses.

Analysing the overall current land use as of 2007 shows that industrial activities occupy 47.9% of the total studied land area around Lake Maryout. Services activities ranked next in the percentage of areas with 28.4%, followed by residential areas which occupy around 20% of the total area.

Cemeteries and religious buildings represent a small fraction of 0.4% of the areas around the lake (see Figure 4-8).

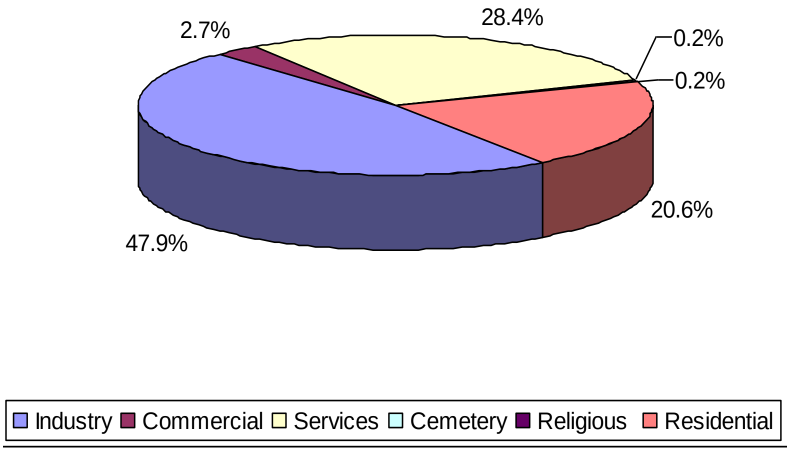


Figure 4-8 Percentages of Activities to the Total Land Area

Satellite image and field visits show that the area of study is connected with a network of roads, railways and bridges. The development of this network belongs mainly to facilitate the movement of goods and services from Alexandria western harbour and other industrial areas to major cities in Egypt. Many newly constructed roads are built to serve the tourist compounds in the northern coastal areas. Cairo Alexandria Road is dividing the Lake into two main parts. It has also created a thin narrow strip known as the 1000 Feddan basin. This basin is now the prime target for filling for urban expansion. Agricultural areas are located to the south and eastern southern part while the industrial and urban areas are mostly located at the Northern and western parts of the Lake area

4.8 Analysis of Changes With Respect to Thematic Areas

Four identified thematic areas in this research are analysed to calculate the changes, namely; increased water, areas increased for urban development, areas added for industrial expansion, and status of assigned fishing areas.

The objective of conducting such analysis is to understand the magnitude of the changes of each thematic area and hence to link these changes to the decision-making process. Investigation and ground trothing were conducted to associate these changes to the main driver/stakeholder that cause them. The analysis covers the identified four primary stakeholders to explore their actions or decisions on the ground. The primary stakeholders as identified in chapter 4 are namely; Alexandria Governorate (GOA), Ministry of Environment (MOE), Community of Fishermen (FC), and Alexandria Businessmen Association (ABA) that is representing the industrial factories around Lake Maryout area and represents a lobbying power in the local council.

4.8.1 Assessment of changes in Lake Maryout

It is essential to understand the environmental implications of stakeholder decisions on the sustainability of the area of study. Chapter one highlighted how the DPSIR is a helpful tool to support decision-making by presenting concrete evidence with alternatives and decision options, rather than by presenting predetermined solutions (Tscherning et al., 2011). Chapter 3 explained the use of DPSIR in this research as a tool for understanding the relationship between scientific processes and the different elements of the policy- and decision-making process.

Environmental Assessment ensures that decision-making processes take account of environmental consequences (EC, 2008). Environmental Assessment offers a methodology for assessing whether or not the decision-making process considers environmental impacts. Assessment of the situation using DPSIR will develop an understanding of the link between the detected changes on the ground and the main drivers that pressured to conduct these changes.

Applying the DPSIR framework assists in exploring the main forces and drivers that shape the decision-making process in the case study area. The consequence of this process is environmental impact, which mostly results in specific (political, economic, socio-cultural) responses by society (Haase and Nuissl, 2007).

This entails identifying the main driving forces, examining the pressures, and assessing the types of changes. This is done through field work to ensure that features detected in the satellite images represent the identified land use (ground truthing).

Change detection results are important to evaluate the impacts that these pressures are exerting, and inspecting the responses to understand the logic behind stakeholder decisions. Ecological modelling investigates and analyses a number of complex variables, and provides understanding of the ecological problems. However, this research does not intend to examine the different ecological factors and interactions shaping the current environmental status of Lake Maryout. It rather focuses on identifying and selecting the most significant environmental, social and economic issues contributing to the decision-making process and hence leading to the current state of environmental degradation.

When analysing the main factors leading to the current state of the lake, it was seen that the main sources of lake degradation are mostly man-made. Water contamination, poor water quality, significant and continuing reductions in the main area of the lake, lower water levels, urban sprawl and filling in parts of the lake can all be traced back to human activities. This has led to serious impacts on the fishermen community living and working around the lake. Accordingly, DPSIR framework on the identified categorised changes can provide answers to why these changes took place in these specific locations and what the link between the changes and the power struggle between key stakeholders is.

4.8.2 Change detection results with respect to stakeholders

Activities identified in the land use data of Lake Maryout were classified to calculate the areas that were changed with respect to stakeholders. Field trips were conducted in the area to relate the land use change to specific stakeholders. This was done by interviewing and asking people on the ground on who has the authority of each specific identified change. Supervised and unsupervised classification was conducted to relate each change to the stakeholder that caused this change. Results are classified to show the percentage of each change with respect to stakeholders (see Table 4-2). Analysis for each alternative will be conducted in the next section.

Table 4-2 Percentage of Changes With Respect to Stakeholders

Area of Change	GOA	MOE	FC	ABA
Water Area	13%	74%	13%	0%
Urban Area	64%	2%	9%	25%
Industrial Area	21%	0%	4%	75%
Fishing Areas	2%	24%	74%	0%
Total	100	100	100	100

4.9 Mapping Stakeholder Conflict

Four main objectives and directions for policy interventions have been identified through the analysis of the main priorities of primary and secondary stakeholders. The analysis shows a considerable amount of overlapping in stakeholder priorities. These differences in objectives have reached a point of conflict, in which stakeholders feel that other policy options, which do not meet their objectives, are considered a threat to their businesses or livelihood. This has been reflected into a power struggle over gradually degrading natural resources. Communication, consensus building, and dialogue are totally absent.

The use of power is also associated to communication and discourse. Power is on the other side of communication and discourse, which are considered complementary concepts for agency (Pütz, 2011). Habermas's (1985) theory of communicative action views governance and spatial development processes as defined by power and discourse.

To analyse the unequal distribution of power resources that lead to conflict, we need to also identify the main stakeholder priorities and the associated power resources they are exercising.

4.10 Conflict over Urban Expansion

Urban expansion or urban sprawl defined as "Range from local patterns of land use and development to aggregate measures of per capita land consumption for given contiguous urban areas"(Sutton, 2003, p.353). Galster identified four basic types of sprawl-definitions in terms of urban form, density, changes in land use and the impacts of sprawl.

Urban expansion in this research refers to extracting and filling parts of the main body of Lake Maryout for urban development.

Alexandria suffers from a lack of availability of land suitable for urban expansion. The city is unable to expand neither to the north as there is the Mediterranean Sea, nor to the east due to the presence of agricultural areas and proximity to other small towns. To the west of the city there is a strip of touristic recreational areas that extend along the Mediterranean coast to the border of Libya. South and southwest are the only available expandable areas. These areas are parts or basins of Lake Maryout.

Therefore, the GOA views these parts as potential logical extensions to the city and could be filled for urban expansion. The GOA policy conflicts with both EEAA and FC priorities. The EEAA and FC view filling as a threat to the wetlands that should be protected and even expanded to gain some of its historic areas.

However, the FC while viewing urban expansion as a threat, obtain parts of their income by selling their catch to the new nearby rich urban areas. They claim that freight costs are a considerable constraint that deprives them of their competitive edge.

The ABA views urban expansion as a good policy for creating new jobs and opportunities for attracting more investments. However, they expressed their willingness to keep a "considerable" area required for dumping Alexandria's domestic, agricultural and industrial wastes.

The ABA on the other hand, has internal conflicting objectives that stem from its concerns that pollution may negatively impact investments, their consistent agenda of supporting existing industries, and their on-going power struggle with the local community which may affect their future plans.

4.10.1 Changes in urban area

To understand and manage stakeholder conflict, we need to critically analyse the forces that are shaping the position of each stakeholder. As explained in previous chapters, land value around Lake Maryout is at the root of the current position of many stakeholders, and paradoxically the high value of the land is contributing to the lake's degradation.

To understand this phenomenon, we need to examine the interaction of all factors. This is done by analysing the relationship between the lake's area and water quality. We need to consider the impacts of new urban developments on lake boundaries and on water circulation. It is also important to evaluate the stresses caused by human-induced activities, such as tourism, on the lake.

This section not only investigates all these variables, but also highlights how they contribute to the position of each stakeholder and on their impact on the decision-making process.

Total urban land area including industrial, commercial, services, cemetery, religious, and residential around Lake Maryout is estimated, according to the Land use map to be 19.2 km^2.

Change detection analysis reveals that an area of 6.96 km^2 has been deducted from the original area of the lake from 2002-2007. Urban area represents 62% of the total changes to sum an area of 4.3 km^2. Most of these areas are occupied by residential housing, commercial centres, transportation network and other services (see Figure 4-9 and Figure 4-10).

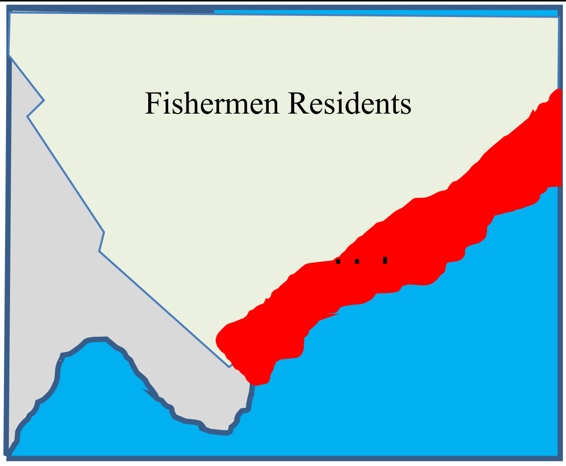


Figure 4-9 Urban Expansion by Fishermen

Urban Changes By Fishermen

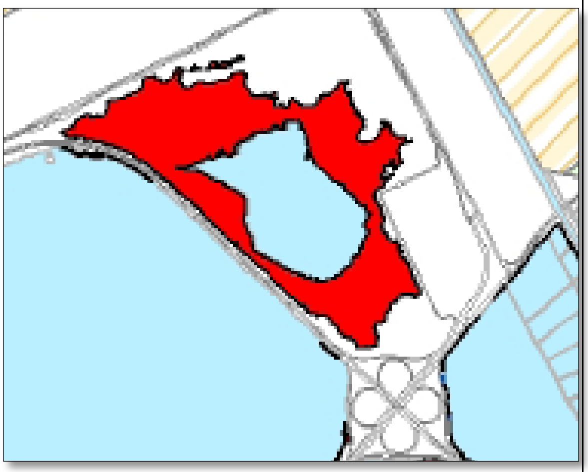


Figure 4-10 Urban Expansion by GOA

Urban Changes By GOA

GOA mainly conducts expansion for urban development either in the form of new housing areas or for selling the land to commercial centres (see Figure 4-11).

Industry and factories represented by the ABA has contributed to the urban expansion by 25% in the form of filling parts of the lake for residential accommodation for company employees.

Figure 4-11 Filling for Urban Expansion

GOA represents 64% of the total change in urban areas (see Figure 4-12).

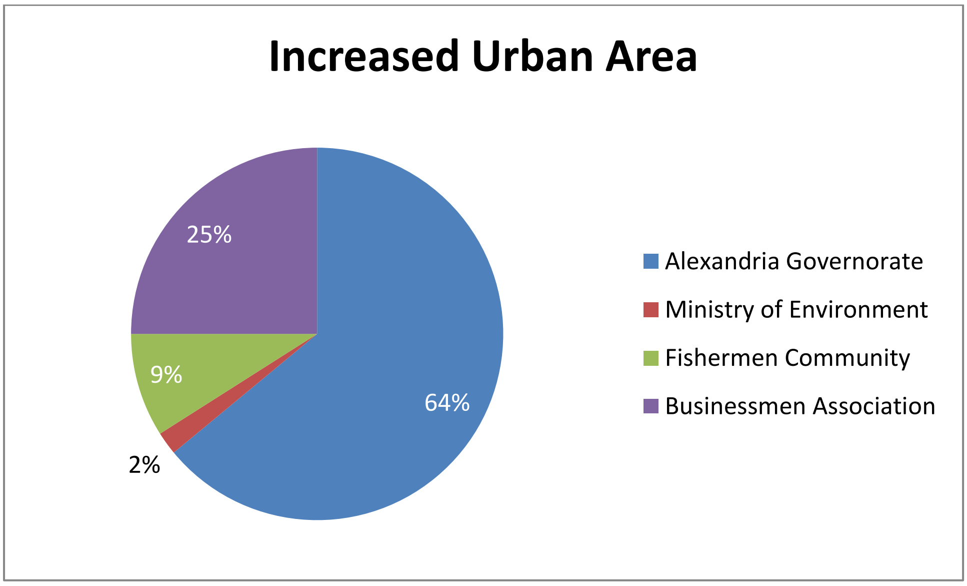


Figure 4-12 Percentage of Increased Urban Areas With Respect to Stakeholders

Fishermen have expanded their residential area by 0.84 km^2 representing 9% of the change of the total urban filling. The Ministry of Environment has occupied a small area for a monitoring facility.

4.10.2 Driving forces for urban area

Urban expansion over water areas is one of the main reasons behind the deterioration of the environmental quality of Lake Maryout. At the root of this pressure is another driving force: population growth.

Alexandria City is confined by the Mediterranean coast to the North, agricultural areas to the east and south east, Lake Maryout and salt marshes to the south, and already existing tourist villages to the west. These constrictions have led the population and businesses to view Lake Maryout as the only extension available to accommodate the growth of the city.

Population growth is one of the main driving forces leading to the increasing environmental pressures on the lake.

Alexandria's population has changed from 2.927 million inhabitants in 1986 to 4.124 million inhabitants in 2006 with an increasing ratio of 40.9%.

According to CAPMAS (2011), the population of Alexandria in 2010 is 4,362168 inhabitants and it is expected to reach nearly 6.152 million inhabitants in 2026.

The total area of Alexandria Governorate is 2299.77 km^2 (EEAA, 2008a). According to IDSC (2008), the average family size in Alexandria is 4, with an average 1.2 in each room. In 2010, the population per inhabited area was 2604 km^2 (CAPMAS, 2011).

4.10.3 Pressures on urban areas

Urban development around the lake, both formal and informal, includes diversified activities such as housing, industrial, commercial and tourism activities that exert major pressure on the local government.

Population growth is pressurizing city planners into expanding the inhabited area of the city. Increasing land value within Alexandria due to the limited availability represents a great pressure on residents and policy-makers to find new areas for expansion.

Figure 4-13 shows the changes in the Lake Maryout water body and surrounding areas in 2002-2007.

Figure 4-13 Lake Maryout Changes 2002-2007 (Badawy, 2008)

4.10.4 State of urban areas

Urban development is currently the fastest growing activity among all services in the Lake Maryout area. According to the results of change detection, total urban areas are calculated to add up to an amount of 10.1 km^2. This area represents 62% increase in 2007 compared to the existing areas in 2002. Services activities occupy 28.4%, followed by residential areas, which occupy around 20% of the total area. Road construction is dividing the lake into sub-basins creating water quality and ecological problems.

Villages of fishermen suffer from an increasing population while they are not permitted to expand their urban areas. There are however, a few areas which were illegally taken from the lake for expanding fishermen residential areas (see Figure 4-14). These areas are estimated to be 0.84 km^2 representing 9% of the change of total urban filling.

Figure 4-14 Fishermen community of Lake Maryout

4.10.5 Impacts on urban areas

The impact of urban expansion has two dimensions. First dimension is the reduction of the water area by continuous filling. Secondly, it turns the lake into sub-basins which negatively affect water circulation and fish reproduction.

The population that utilizes the lake is dominated by the community of fishermen, and they are the most impacted. They rely on both the fishery and the vegetation to meet their socio-economic needs. Fishing is the sole source of income for the majority of the fishermen, and the vegetation is used for feeding livestock, making fuel for cooking, and as thatching for living quarters (World Bank, 2007). Filling activities and road construction are major threats to the quantity of fish catch and generally to their livelihood.

The impact of the urban sprawl is evident from the increased pressure on municipal services, larger amounts of domestic waste, and the higher numbers of informal settlements.

Heavy urbanisation and industrial development has led to significant losses of biodiversity through degradation of the lake's habitat. Water pollution has negatively influenced biota. Squatter and semi-formal residential areas have appeared on the outskirts of the city and in bare plots of land over the past few decades.

4.10.6 Responses to changes in urban areas

It is important to analyse the responses in order to understand the position of each stakeholder towards the issue of urban expansion over the lake area and hence understand why approval has been given to filling in parts of the water body. Both citizens and government have responded to the pressure of urban expansion. Citizens have found their own ways, by rapidly developing informal settlements around the lake and multiplying available floor space by adding more floors to existing buildings or expanding out of permitted areas (see Figure 4-15).

Figure 4-15 Alexandria's informal settlements (El-Refaie 2008)

As land value became increasingly high in the Alexandria area, businesses have tended to put more pressure on the government to allow either for expansion over the nearby Lake Maryout or onto agricultural lands.

Responses from government came in the early 1980's when it constructed new residential areas to the west of Alexandria. In absence of any communicative planning process, this planning procedure was not successful and nearly all the houses are still vacant to date. The reason for this failure was primarily the distance of the site from the city, compounded by the lack of regular transportation. This decision by government represents a clear example of the policy failure due to lack of participatory approaches in the planning process.

El-Refaie (2008) argues that if land filling activities of Lake Maryout continue, the Lake will shrink dramatically, resulting in serious impacts on the stability of the region, including more unpleasant smells and air pollution, degradation of the coastal shore and beaches and eutrophication of the marine ecosystem. It is therefore necessary to develop and implement a participatory management plan for the area.

There are a number of benefits to be gained from having a successful communicative planning process: increased fish productivity and income, better health for the local population, increased land value, more attractive beaches and shoreline, increased tourism and recreational activities, and more aesthetic surrounding areas.

Figure 4-16 and Figure 4-17 show some of the planned projects for the rehabilitation of Lake Maryout area. These projects are controversial among the local population as they would definitely contribute to the local economy, but they would also destroy part of the lake, and open the door to more formal and informal land filling activities.

Proposed projects are entirely aimed at urban development over parts of the lake, and target the development of new residential and commercial areas.

This might benefit the local economy, but decreases the water area and has possible negative environmental impacts. These projects take licence from the GOA, even though they do not comply with environmental Law 4/94 to submit EIA to MOE for approval before starting projects.

Figure 4-16 Alexandria's proposed development areas (El-Refaie 2008)

Figure 4-17 New development area (El-Refaie 2008)

4.11 Conflict over Water Quality

Water quality, as defined by The European Environment Agency (EEA) refers to "A graded value of the components (organic and inorganic, chemical or physical) which comprise the nature of water" (EEA, 2009). The term is simplified and explained in the interviews and in the explanatory section of the questionnaires. The term is generally used by the public to describe the general visible characteristics of water, including its colour, turbidity, odour, taste and clarity.

Water quality represents one of the major conflicting priorities among all stakeholders. The quality of water is an indicator of other existing problems such as fish catch. It has an effect on land value and tourism. Areas with better water quality such as the Maryout Valley have higher land value. Investment and urban expansion is targeting these areas which puts more pressure on the already vulnerable ecosystem.

The GOA has a systematic policy for encouraging the filling process. During interviews they indicate that filling is considered a good solution as it reduces the negative effects of bad odours and polluted water. This argument has always been rejected by the EEAA, FC, NGOs and research centres. The fishermen consider water quality their top priority, as any water quality deterioration reflects negatively on their fish catch. The degree of agreement or disagreement between the GOA and the ABA with respect to water quality remains unclear.

The GOA is trying to upgrade water quality by pumping fresh water from El-Nubaria canal into the main basin. This helps in enhancing the BOD levels and reduces pollution. Therefore, the GOA position with respect to enhancing water quality is clear and positive. However, this position compared with other objectives of filling and encouraging industrial expansion remains indistinguishable.

The EEAA exerts efforts to reduce pollution levels and upgrade water quality. The EEAA regional office in Alexandria is located near the Lake Maryout area, and conducts as explained earlier, continuous monitoring and sampling of water. The EEAA is in total agreement with the FC regarding water quality.

Water quality represents the fishermen community's first priority. They have a conflict with the GOA, ABA, Alexandria Sanitary Drainage Company, Ministry of Agriculture, Ministry of Housing and local industries. Results from interviews, public hearings and questionnaires show that fishermen are having internal conflicts concerning both urban development and industrial expansion. These two activities represent some sort of income to the region and assist their businesses and create more jobs. Therefore, their overall decision regarding some of these developments remains unclear.

The ABA has always viewed water bodies as reservoirs for its wastes. This is the result of the 1952 revolution in Egypt that called for social reform and encouraged and collected all available resources to build as many new factories as possible. It was a political decision to provide more jobs and to achieve social justice. Environmental quality was not an issue and the Ministry of Environment did not exist. Today, the 140 factories around the lake claim that the value they provide for society and for the country is far more important than enhancing water quality by removing these businesses from the region. They claim that the financial implication for moving or changing the existing technologies to meet the required acceptable level of treatment is unbearable.

4.11.1 Changes in water area

Water quality is a major indicator for the mitigation process implemented in the lake. It also indicates the degree of deterioration in the lake's environmental condition.

Lake Maryout continuously receives substantial amounts of untreated domestic sewage and industrial waste. Considerable amounts of pesticides and fertilizers also enter the lake via drainage waters. Consequently, the lake is subject to heavy enrichment of nutrients, predominantly phosphates. Vegetation cover is also negatively impacting the water quality as it prevents natural water circulation, decreasing BOD levels.

In the eighties, most of Alexandria's domestic sewage and industrial wastes were discharged directly into the Mediterranean Sea. The local authorities decided to divert those discharges into Lake Maryout in order to prevent pollution of beaches and inshore waters. The direct discharge of the sewage and industrial effluents created highly eutrophic conditions and pollution from various chemicals, and provided an important route for the transfer of metals into the food chain.

4.11.2 Driving forces on water area

The high population growth is affecting Lake Maryout's water body. The increase of industrial, agricultural and domestic wastes represents the main driving force that is negatively affecting the water quality. Urban expansion and filling activities significantly reduce the area of the lake and contribute to increased levels of pollutants in water. Decreasing the water level is a driving force for the degradation of water quality. Increase of vegetation cover in the lake reduces the BOD level and prevents the circulation of water.

4.11.3 Pressure on water area

Pressures result mainly from the heavy load of organic matter leading to the deterioration of BOD levels. Dissolved oxygen in most regions of lake water is lower than the guideline levels cited by the US EPA for the protection of aquatic life. This is putting high pressure on the lake's ecosystem. Decreased water level and water areas are considered a major pressuring factor in the degradation of the lake's water quality. Increase of vegetation cover in the lake is considered a major pressure on the water quality because it reduces the BOD level and prevents the circulation of water.

4.11.4 State of water area

The lake's water quality shows significant water pollution, low BOD levels, depletion of dissolved oxygen (DO) and enrichment by nutrient salts, such as phosphorus and nitrogen, and DO in most regions was less than the international standards (see Figure 4-18). The changes in the zooplankton community are supposed to be a consequence of the concurrent and frequent changes of different ecological conditions in the lake, resulting from variable types of human activities. Eutrophication is increasing as a result of the growing numbers of Protozoa and Rotifera.

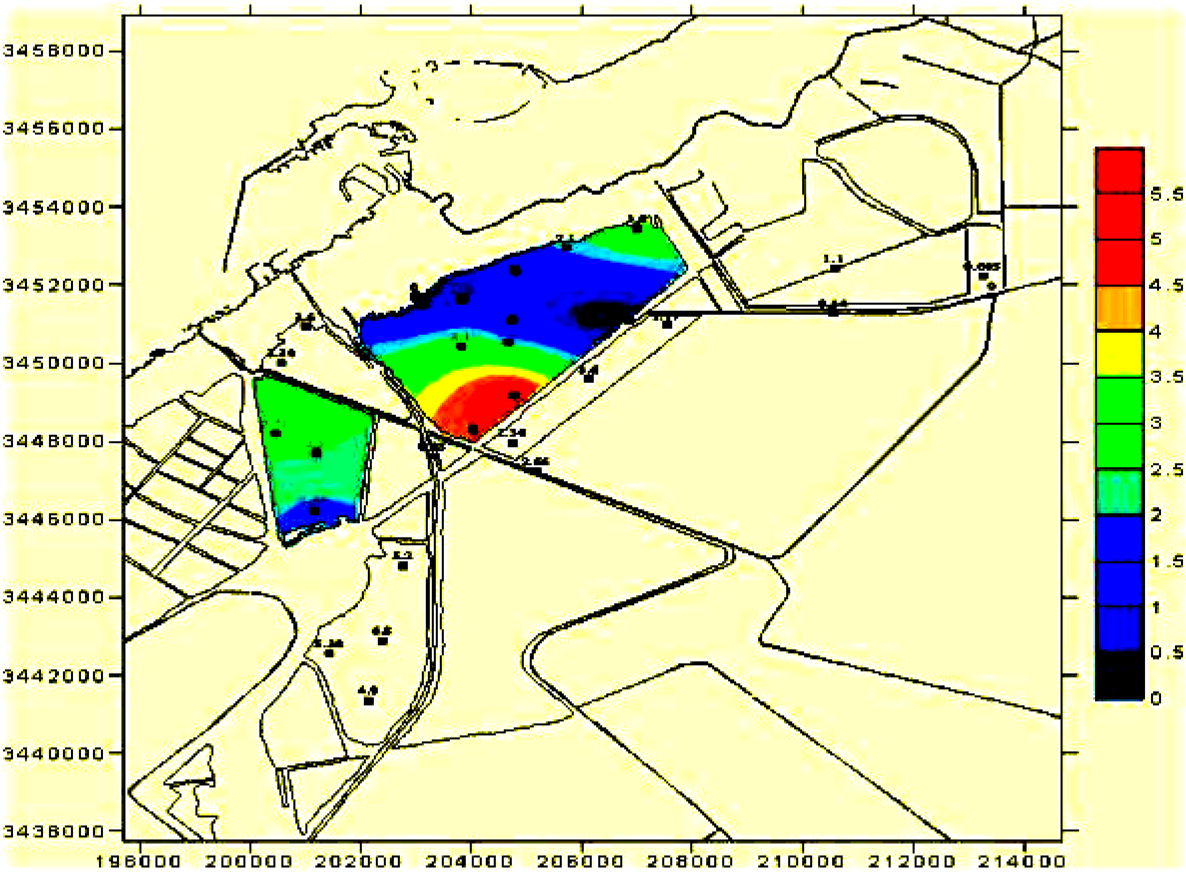


Figure 4-18 DO concentrations in Lake Maryout (EEAA, 2008b)

Distribution of dissolved oxygen (DO) in lake water showed a considerable wide range of variations (0.0-19.14 mg/l). A complete depletion of dissolved oxygen was detected in more than one location, particularly in the east and south of the main basin in day and night time reflects the effect of drainage water on the lake. The highest value of dissolved oxygen is recorded in Aquaculture and South Basin. Dissolved oxygen showed remarkable decrease during night time in all basins due to its consumption by living microorganisms (Fishar, 2008).

Change detection results show that there is a 0.3475 km^2 increase in new water areas. This is an insignificant value compared to the deducted areas of water, which is 3,752 km^2 within a period of 5 years.

4.11.5 Impacts on water area

Impacts of water quality deterioration are mostly on the fish catch. As presented in Chapter 4, there has been a sharp decline in fish production. Water pollution also affects the migratory route of birds that use the lake as a major water body to settle in, en route from Europe to Africa. Hydrogen Sulphate gas caused by water pollution causes unpleasant smells and air pollution and affects the tourism industry around the lake area. Such conditions have negatively affected the health of the residents of the informal settlements surrounding the lake (150, 000 persons).

The degradation of the water quality has affected the quality of investment in the area. A number of high value projects have been reduced because of the polluted waters, as well as the instability of management plans and conflicting legislations.

4.11.6 Responses to changes in water areas

Different objectives, institutions, Ministries, NGOs, the local community, fishermen, businesses and universities have responded to the current deteriorating conditions of the lake's water quality by organizing public hearings, media campaigns, raising the issue in parliament and taking legal action against the government.

The lake's main basins have been aerated to increase the DO levels. Vegetation has been partially removed to improve water circulation (see Figure 4-19). The local community has put more pressure on local council and relevant ministries to enforce regulations to minimise the filling process. New water treatment plants were built to decrease pollution loads.

Figure 4-19 Increasing vegetation in Lake Maryout

As a response to the deterioration of water quality, few areas were added to the current water body due to the MOE, Fishermen and GOA efforts to gain more water area (see Figure 4-20).

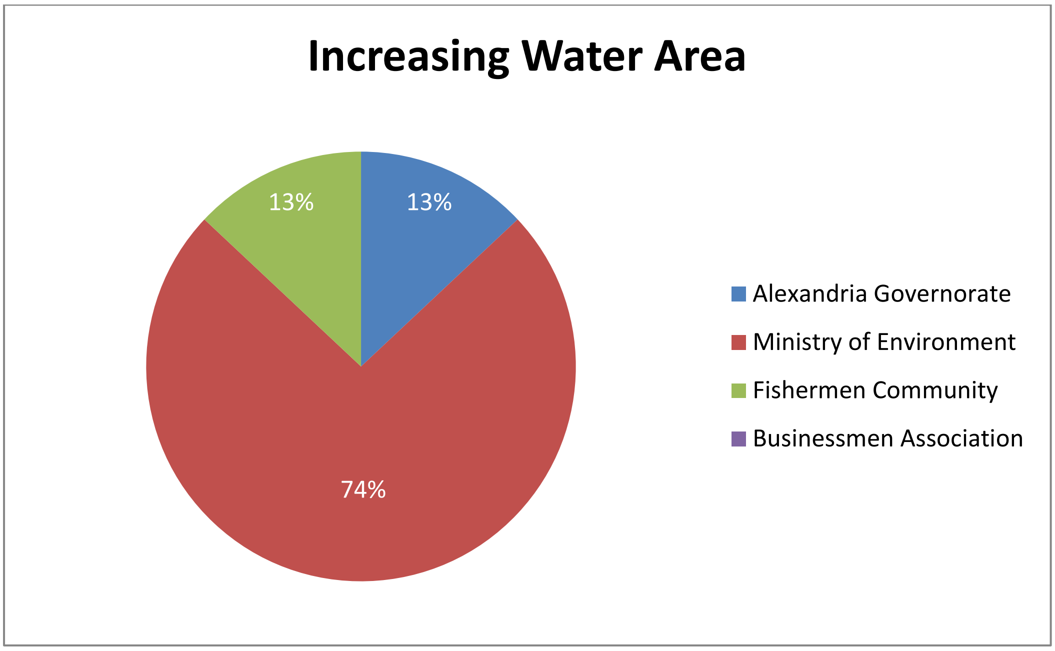


Figure 4-20 Percentage of Increase in Water Areas With Respect to Stakeholders

Changes in water quality were mainly conducted through the changes of the vegetation cover inside the lake area to allow for better water circulation. Results show that 74% of the newly added water areas were due to efforts of the Ministry of Environment. Fishermen community and Governorate of Alexandria have equally contributed to the remaining 26%.

4.12 Conflict over Industrial Development

Alexandria is home to 40 per cent of Egypt's industrial investments and a well-established, dynamic and diverse industrial sector, which employs about 30 per cent of the total Alexandrian labour force (World Bank, 2007).

There are more than 140 factories and industrial firms around the lake, mainly to the north and eastern part. Heavy industry is the dominating sector; mostly Petroleum and Petrochemical industries (El-Refaie, 2008). Light Industries are textile and food production. Building material industries are also present in the area.

The GOA position with respect to industrial expansion has two conflicting dimensions. First, is to encourage the expansion of industries and investment and second, is to limit degradation of water quality by investing in costly water treatment plants and pumping fresh water to polluted areas. This paradoxical position is reflected in these conflicting decisions regarding allocation of new areas for industrial expansion, and investing in dredging and aeration systems to enhance BOD levels.

Fishermen have also another paradoxical perception regarding industrial development. They are fully aware that industrial wastes are a major threat to their fishing activities, but on the other hand, it is a source of income to members of their families, particularly for women who are working in the nearby textile factories.

Further analysis is required to understand how much this element contributes to their overall decisions, and how much they can compromise in case they are part of a collaborative planning approach for the area.

4.12.1 Changes in industrial area

Alexandria Governorate is home to 40% of Egypt's industrial investments, and a well-established, dynamic and diverse industrial sector, which employs about 30% of the total Alexandrian labour force (World Bank, 2007). The number of industrial investment projects reached 2704 projects in 2009 with an increase ratio of 17.8% (CAPMAS, 2011).

Results show that an area of 2.641 km^2 was filled for industrial expansion. This area represents 38% of the total change in Lake Maryout between the years 2002 to 2007. Seventy-five per cent of the total change for industrial expansion was conducted by a member of the ABA and mainly for petrochemical factories (see Figure 4-21).

Twenty-one per cent of the areas allocated for industries were assigned by the Governorate of Alexandria, while the remaining 4% were small industries for related fish production factories constructed by the local fishermen community.

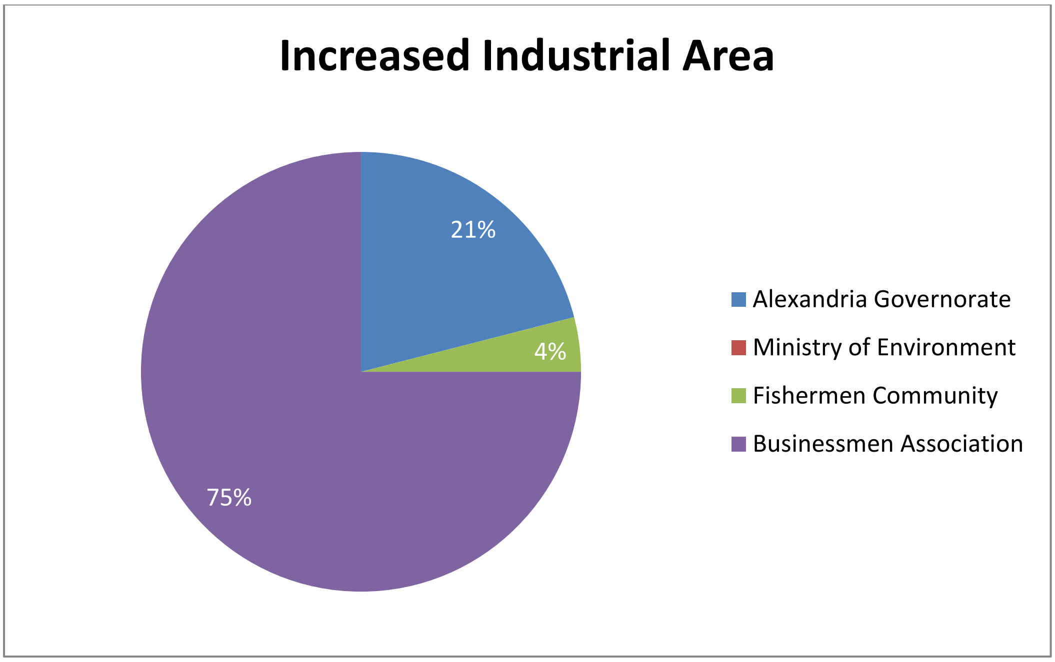


Figure 4-21 Percentage of Increased Industrial Areas With Respect to Stakeholders

4.12.2 Driving forces for industrial area

Increased demand for new industries, coupled with the need to locate them within acceptable distance from the harbour, led to the concentration of industries in the Lake Maryout area.

Most of the industries are chemical and petrochemical production facilities and refineries, textile companies, oil refineries, steel production, and pharmaceuticals.

4.12.3 Pressure on industrial area

Increased demand for land for either new industrial areas or expanding existing factories is the foremost pressure on the lake area. Businesses around Lake Maryout and in surrounding areas are the sole source of income for many families exploiting the area, and they contribute greatly to the economy of Alexandria.

The mutual interest between the economy and the local community is the most important pressure on the decision-making process to avoid curtailing the activities of local industries polluting the area. The current expansion in industrial activities put more pressure on the already vulnerable ecosystem.

4.12.4 State of industrial area

Lake Maryout is surrounded from the north and west sides with numerous industrial sites (see Figure 4-22). Currently there are three main sources of industrial wastewater discharges in Lake Maryout.

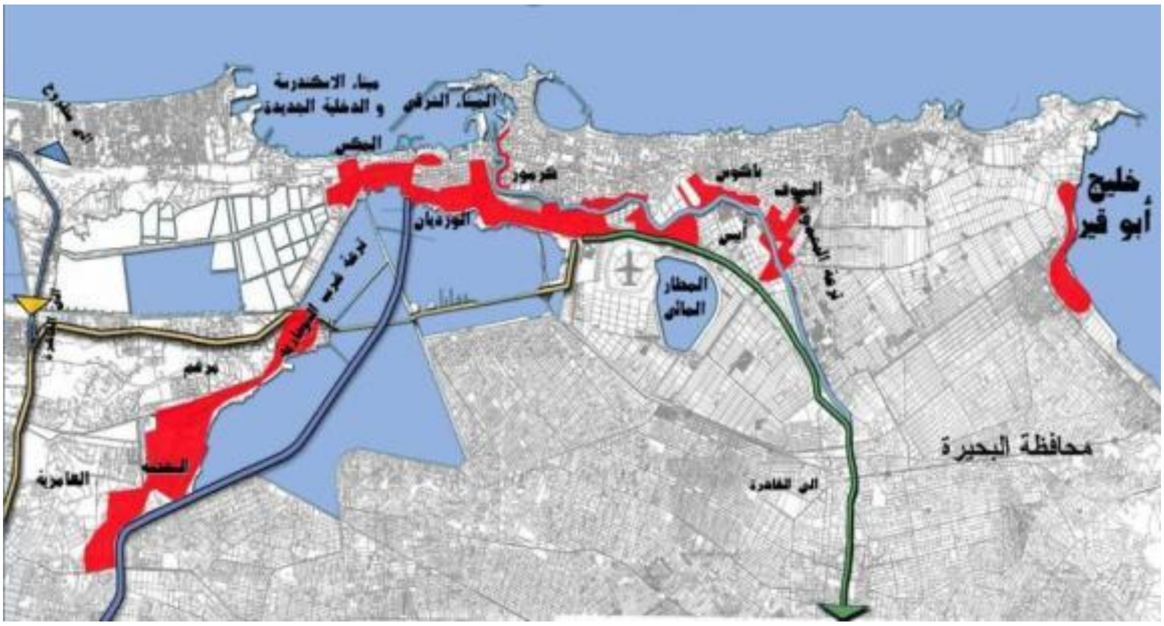


Figure 4-22 Industrial Areas in Alexandria

The direct discharge point for petrochemical factories as well as several other main industries result in total direct discharges equal to 48,155 m^3/day.

According to the EEAA (2008), the following sources are recorded (see Figure 4-23):

- El Amreya Petroleum Refinery Company (9.6 M m^3/day), (direct discharge into 3000 basin)
- Misr Petroleum Company (44,000 m^3/day, direct discharge into 3000 basin)
- Petrochemical Company (25,000 m^3/day, discharge via vegetation canal)
- Misr Amreya Spinning and Weaving (12,000 m^3/day, discharge via vegetation canal)
- Salt and Soda Company (120,000 m^3/day, discharge via vegetation canal)

- Sidi Krair Petrochemical Company (365,000 m3/day, discharge via vegetation canal)

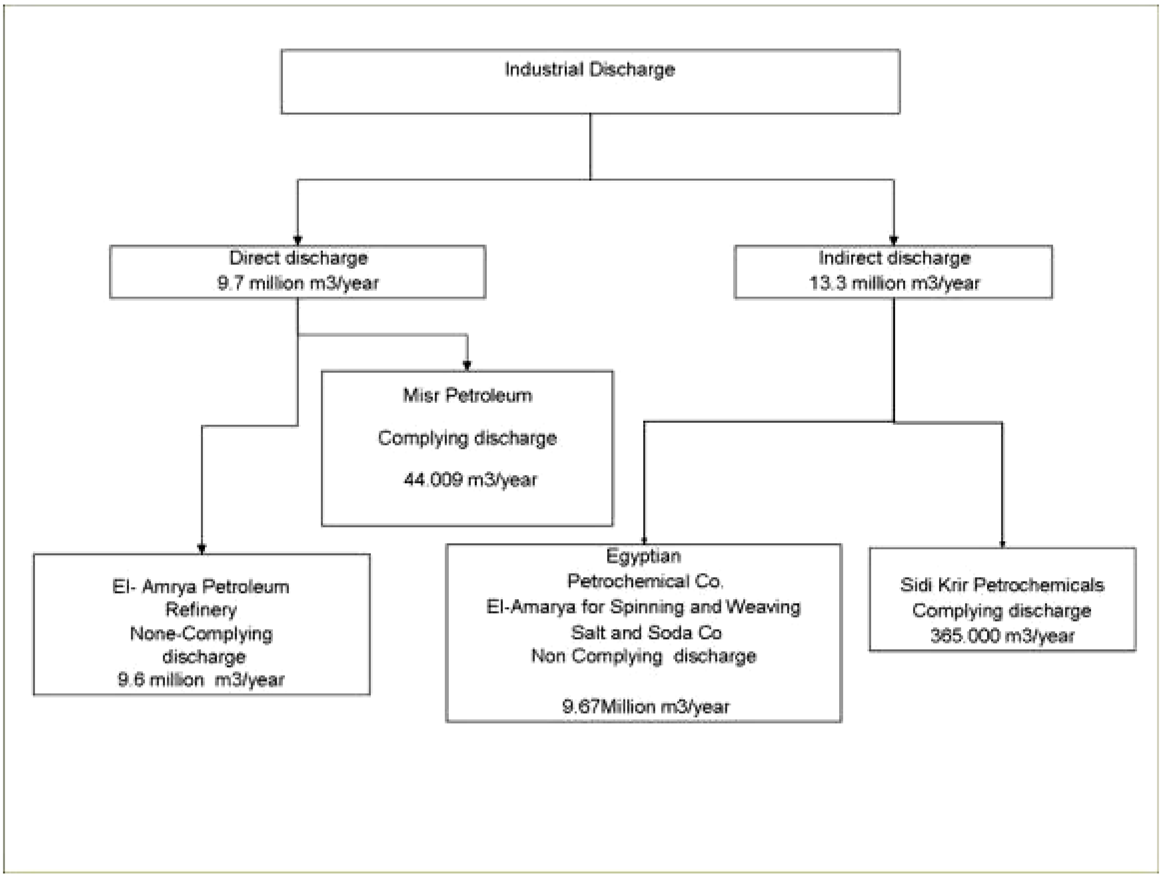


Figure 4-23 Industrial Discharges in Lake Maryout (EEAA, 2008b)

The second main industrial discharge flow is observed from the Western Treatment Plant (WTP). It discharges directly into Alexandria's sewer system. Other sources include Spinning and Weaving, Food Industry, Chemical, and Metal fabrication. WTP treats sewage waste with a total (primary treatment) capacity of 350,000 m^3/day, 66% of which is industrial waste (210,000 m^3/day).

The third source of industrial discharge is coming from the flow from the Eastern Treatment Plant (ETP) through El-Kalaa drain, which is equal to 429,000 m^3/d and is 90% domestic sewage.

4.12.5 Impacts on industrial area

As explained throughout Chapter 4, industrial pollution has a significant impact on the lake's ecosystem, ultimately impacting fish production, land value, and the health of people exploiting this area, especially the fishermen community.

4.12.6 Responses to changes in industrial area

Pressure on authorities to relocate some of the industries has been unsuccessful and has failed to move any of the existing industrial activities. Lake Maryout is an ideal location for industries due to its proximity to Alexandria harbour and to the presence of a large water body for the discharge of waste. Businesses are understandably reluctant to move their factories away from this strategic cross road location. Government authorities have allocated huge funds to construct water treatment plants in the east and west side of the lake. It has planned for various proposed projects that have positive impacts on the water quality and fish catch. However, these projects have not been implemented due to lack of funding.

4.13 Conflict over Fishery Resources

The fishery resources of Lake Maryout are essential to the well-being and livelihood of several thousand fishermen and their families. Lake Maryout fishery resources have been exploited by subsistence and commercial fishermen for hundreds of years. Government policy in the early 1970s, during expansion of the country's fishery resources led to the increase of the lake's catch from 1,650 tons in 1920 to a maximum of 17,000 in 1974 (see Table 4-3). This exponential increase can be explained by the growing number of fish farms during this period. The sharp decrease between 1964 and 1974 can be explained by the decision to lower the water level of the lake to be ready for any flash flood that might occur in the region. This decision had a negative impact on fish reproduction and fish catch. The gradual decrease of fish catch during 1982-1983 can be explained by another policy of the gradual increase of dumping domestic wastes as a result of the Alexandria Governorate's decision to change the dumping of domestic wastes from Sea to Lake. The slight increase after 1991 was due to the decision to pump water from the El-Nubaria canal into the main basin, due to NGO awareness and efforts by the Egyptian Environmental Affairs Agency (EEAA) (see Figure 4-24).

The absence of integrated long-term planning, and frequent changes in governmental priorities have harmed local communities, particularly fishermen as they are the most affected groups.

Table 4-3 Recorded Fish Catch 1920-2006 (Compiled and Updated From Hassouna, 2008)

Year	Ton	Year	Ton	Year	Ton
1920	1,650	**1945**	1,971	**1981**	10,161
1921	2,182	**1946**	1,896	**1982**	11,300
1922	3,780	**1947**	2,233	**1983**	7,643
1923	4,000	**1948**	2,300	**1984**	7,537
1924	5,435	**1949**	2,104	**1985**	5,831
1925	4,300	**1950**	1,712	**1986**	5,630
1926	3,819	**1951**	1,208	**1987**	4,453
1927	4,587	**1952**	1,235	**1988**	3,040
1928	1,985	**1953**	1,566	**1989**	2,137
1929	1,041	**1954**	1,344	**1990**	1,706
1930	832	**1955**	2,521	**1991**	1,956
1931	1,003	**1956**	2,817	**1992**	3,100
1932	958	**1957**	1,693	**1993**	3,437
1933	817	**1958**	2,536	**1994**	3,631
1934	737	**1959**	2,603	**1995**	3,466
1935	818	**1960**	3,803	**1996**	4,000
1936	1,740	**1962**	7,800	**1997**	4,500
1937	2,211	**1964**	8,478	**1998**	4,521
1938	1,804	**1967**	1,900	**1999**	5,235
1939	1,449	**1972**	3,900	**2000**	6,378
1940	1,603	**1974**	17,000	**2001**	6,200
1941	1,429	**1976**	10,797	**2002**	5,303
1942	1,703	**1977**	13,200	**2003**	4,861
1943	1,860	**1978**	13,985	**2004**	5,024
1944	1,936	**1979**	13,577	**2005**	5,292
		1980	14,059	**2006**	5,320

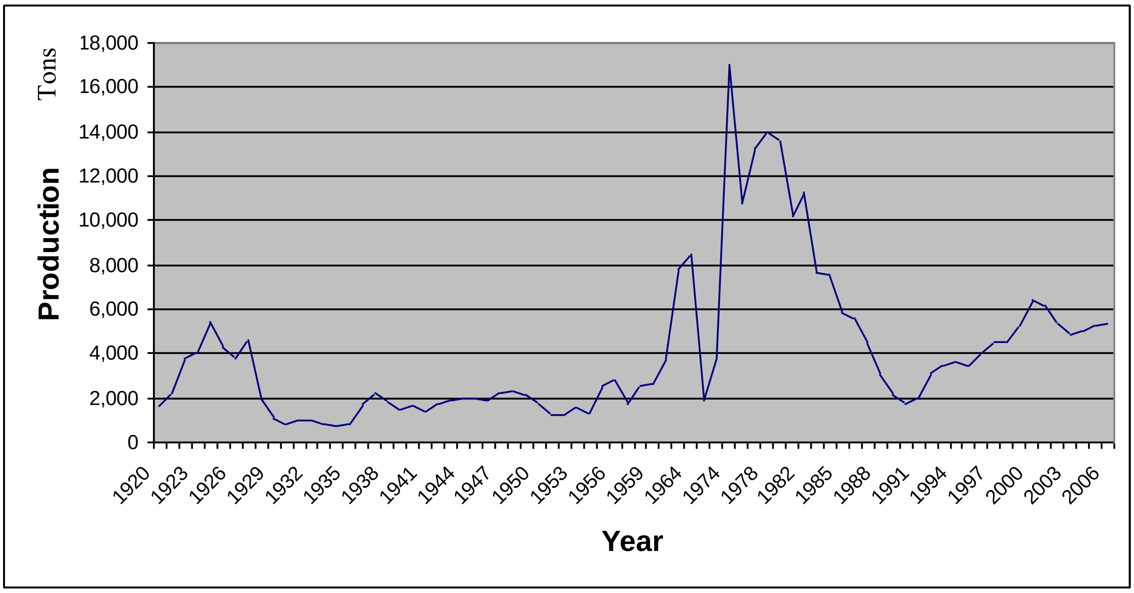


Figure 4-24 Distribution of Fish Catches 1920-2006

The GOA's policy is to assist fishermen to upgrade their quality of life. There were frequent efforts by government officials to assign land for farming in nearby reclaimed areas. These requests were completely denied by all fishermen. They argue that this has been their profession for many generations, and is not acceptable to change it.

Fishermen are currently expanding on fish farming to overcome the reduction of fish catch. The fishermen have obtained permission through the fishing authority. The GOA does not approve such a decision and views new farms as illegal constructions. This issue is also being filed in the court house.

The EEAA monitors the water quality and ecosystem of Lake Maryout. This includes trying to keep indigenous species under review. Conflicting priorities between the EEAA and both the GOA and ABA with respect to fishery resources is based on the EEAA's mandate to conserve the environment and not for increasing fish catch.

The ABA's priorities do not include increasing fish catch. The overall decisions by the ABA regarding the management of the lake is clear; however, it is not clear how much this particular element is considered within the ABA's decision process.

4.13.1 Changes in fishing area

Fishing areas and fish farms are located mostly at the Fishery Basin and in scattered locations in Lake and Wadi Maryout. The fishermen community, Fishing Authority and other private sector investors are expanding some of the land areas to install their fishing setup. Fish farms are allocated closed areas, mostly in a form of nets or land, designated to farm fish.

4.13.2 Driving Forces on fishery resources

Degraded water quality, population growth and economic situation are the main drivers. Increased demand for urban expansion and industrial development are major driving forces for the existing changes in water areas.

Increased awareness by NGOs, the EEAA and research centres have formed a collective driving force for finding mitigation measures to enhance the environmental condition for fish production. The increasing demand for fish in the city of Alexandria is another economic driver.

International treaties for environmental conservation represent a driving force for mitigating the current deterioration in Lake Maryout, which endangers the bird migration route and existing fish species.

4.13.3 Pressure on fishery resources

Overfishing represents a main pressure on the fishery resources, since it does not allow for the reproduction process. Illegal use of fishing methods by using unauthorised nets and explosives has put more pressures on the fragile fishery resources.

Increased demand for fish farming puts another pressure by extracting areas restricted for private use. This allows fish farms to introduce new species in the lake which negatively affects indigenous species.

4.13.4 State of fishery resources

Change detection results show that there is significant decrease in fishing areas due to the decrease of the total water body of Lake Maryout. The lake area was reduced from 71,588 km^2 to 67.836 km^2. This reduction represents 5.2% of its area in only 5 years.

Fish production has not changed since 2002 with an average production of 5000-6000 tons. The expansion of fish farms has balanced the decrease in fishing areas.

4.13.5 Impacts on fishery resources

The most significant impact is the expansion of the use of illegal fishing methods. The deterioration of fish production has resulted in economic and social impacts on the fishermen community. The increasing number of fish farms is an impact of these pressures.

Change detection analyses show that 74% of the total new fishing areas are developed by the fishermen community (see Figure 4-25).

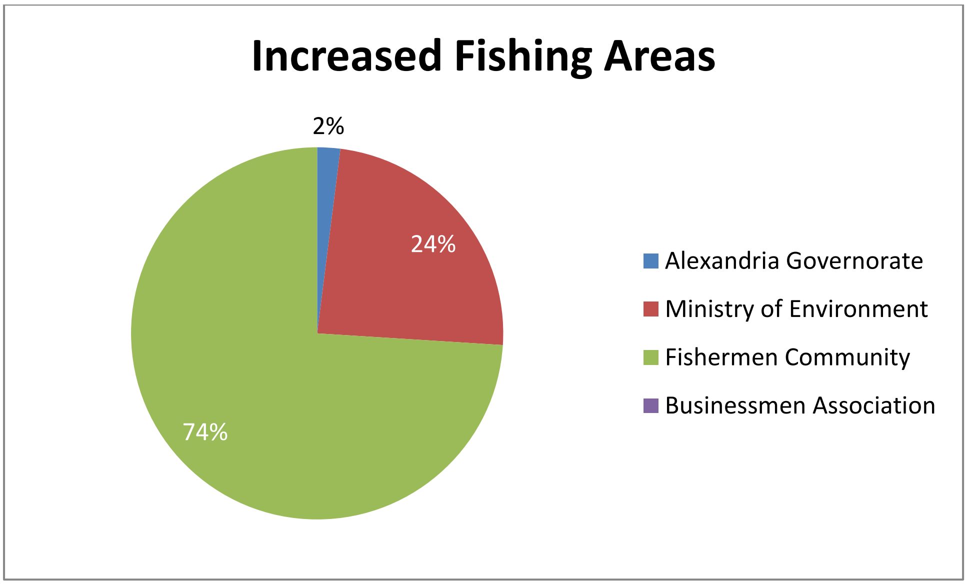


Figure 4-25 Percentage of Changes in Fishing Areas With respect to Stakeholders

4.13.6 Responses to changes in fishing areas

The Ministry of Environment in coordination with the Fishing Authority has expanded an area to the north of the Aquaculture basin for fish farming. While the above shows the areas that were added to the fishing area representing 3% of the original fishing area, the final change detection results show that an area of .76 km^2 was deducted from the Fishery Basin (see Table 4-4).

Table 4-4 Changes to Fishery Basin 2002-2007

Aquaculture Basin	2002 (m^2)	2007 (m^2)	Change (m^2)
Deducted Areas	4,556,344.64	4,479,872.47	76,472.17
Added Areas		136,690.67	

4.14 Analysis of Change Detection Findings

The main objective of change detection is to map and assess the changes in Lake Maryout and its surrounding areas. The analysis was conducted through acquiring two QuickBird high resolution satellite images 2002-2007 to compare the changes within this period. Field surveys were conducted to identify these changes on the ground. Data was classified to understand the percentages of change and who is responsible for these changes.

Analysis for the main identified alternatives was conducted to detect the changes in each category.

Results show that the total calculated area of Lake Maryout including the Hydro-Dome is 104.48 km^2. The study area, which is the main water body of Lake Maryout including the main four basins, is 67,836 km^2. Percentage of change as of 2007 is 5.2% of the Lake's area of 2002 (see Table 4-5).

Table 4-5 Calculated Areas and Changes in Lake Maryout 2002-2007

Basin	2002 (m^2)	2007 (m^2)	Change (m^2)	Change %
Main Basin	20,169,103.12	18,536,374.18	1,632,728.95	8.1%
Aquaculture	4,556,344.64	4,479,872.47	76,472.17	1.7%
Southeast	37,812,869.60	35,830,104.60	1,982,764.99	5.2%
Southwest	9,050,447.57	8,990,345.00	60,102.58	0.7%
Total	71,588,764.94	67,836,696.25	3,752,068.68	5.2%

The highest percentage of change was recorded in the salt basin (9.4%) as a result of industrial expansion and filling parts for road construction (see Table 4-6).

The second reduction in the area was recorded in the main basin (8.1%) due to extensive filling for urban expansion, due to the high land value in this area due to its proximity to the city of Alexandria.

The southeast basin is subject to filling for industrial expansion and its area was reduced by 5.2% while the aquaculture basin has not been significantly affected by the filling, as it is productive land and continuously monitored.

Table 4-6 Changes of Sal Basin and Hydro-dome

Basin	2002 (m^2)	2007 (m^2)	Change (m^2)	Change %
Salt Basin	34263634.58	31055810.07	3207824.51	9.4
Hydro-dome	5590232.5	5591954.4	-1721.9	≈ 0.0
Total	111,442,632.01	104,484,460.72	6,958,171.30	9.56

Current calculated urban area of the case study shows that it is approximately 19.2 km^2. Large urban areas are already occupied by industrial activities. However, the investigation differentiates between industrial activities and other forms of urban land uses. Services and residential areas have the second and third stage respectively.

Degree and extent of land use changes in the period from 2002 to 2007 vary throughout the lake depending on the proximity to the city, to existing activities, how visible and monitored these areas are, and how much they are economically productive.

Investigating the results to understand the main driving forces that are causing the current changes on the ground revealed that the Governorate of Alexandria (GOA) has been the main stakeholder behind most of the urban development in and around the Lake area.

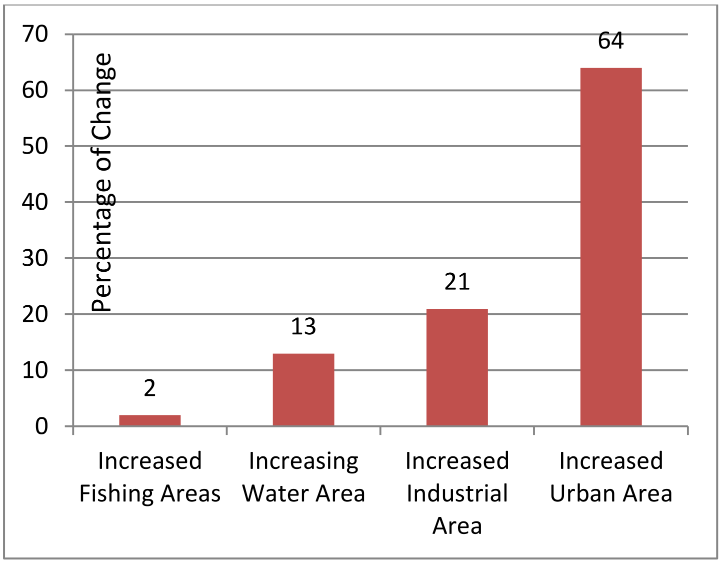


Figure 4-26 Percentage of Changes by GOA

Actions on the ground show that GOA has placed high priority to solving Alexandria's persistent housing problem by filling parts of the shallow areas for urban expansion. GOA has also contributed in coordination with Alexandria Businessmen Association (ABA) and Ministry of Petroleum to fill some areas for industrial expansion (see Figure 4-26).

GOA helps local industries to expand over the lake area to create new jobs and to enhance the local economy. It places less priority to enhance the fishery resources of the lake or to upgrade the water quality.

Ministry of the Environment has the biggest share in increasing the water quality due to its mandate of upgrading the natural environment of the Lake.

Change detection results show that 74% of the total MOE activities recorded were related to increasing the area of water body while 24% was to increase the designated fishing areas (see Figure 4-27).

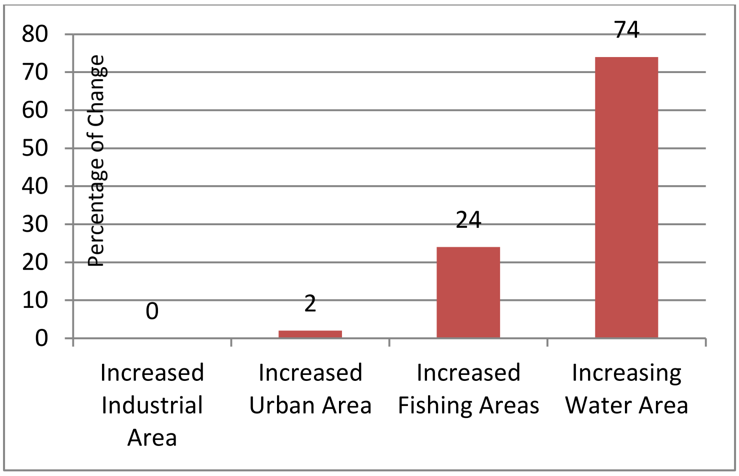


Figure 4-27 Percentage of Changes by MOE

Field investigations of the results of image processing and analysis of the change detection show that the fishermen community has increased their fishing areas in several locations to develop fish farms. Historically, this was not required at any period due to the abundance of fish in their fishing territories. Analysis reveals that 13% of the total recorded fishermen's activities were to increase the water quality through expanding the water areas. Only 9% change was recorded for expanding their residential area. Fishermen are responsible for 4% of industrial related activities which mostly are associated with fish production (see Figure 4-28).

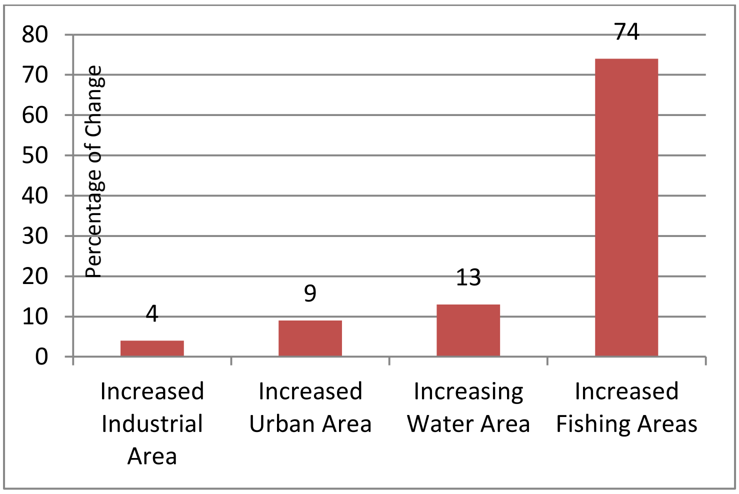


Figure 4-28 Percentage of Changes by Fishermen Community

Alexandria Businessmen Association (ABA), which represents most of the big industries around Lake Maryout area, was not involved during the indicated period, in any activity related to the increase of fishing or water areas. On the contrary, 75% of their identified activities were towards filling areas of the lake for industrial expansion. Filling for building residential areas for accommodation of workers for the new expansion represents 25% of ABA's recorded activities (see Figure 4-29).

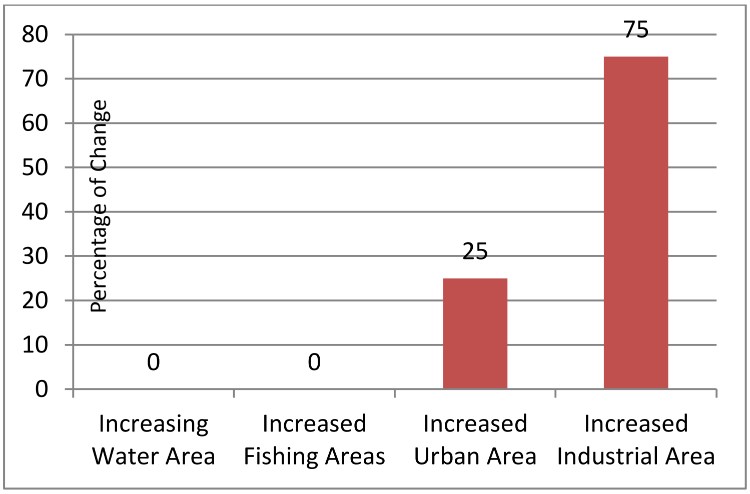


Figure 4-29 Percentage of Changes by ABA

Despite the fragmented activities and the differentiated stakeholders priorities, analysing the changes on the ground reveal that the majority of changes were assigned to two main activities, namely; residential and industrial expansion. These changes were conducted by only two of the main stakeholders, which are the Governorate of Alexandria and Alexandria Businessmen Association. The results show the differentiated stakeholder power which was reflected on their decisions and actions on the ground.

Population increase in the city of Alexandria represents one of the main drivers that challenge managers and city planners. The urgent need for expansion in a limited confined urban land in the absence of enforced regulations or clear communicative planning has resulted in urban sprawl, deterioration of water quality, and reduction of fish production.

There are environmental, social, and economic impacts to this situation. Environmental degradation, impoverishment of the fishermen community, health problems, financial overload to mitigate the pollution, and reduction of investments are some of these impacts.

Responses to these impacts range from proposed projects for water treatment, aeration to enhance water quality, expanding fish farms to substitute the reduction of fishery resources, and filling for urban and industrial expansion to attract investments.

These conflicting responses highlight the urgent need for a framework for prioritising the multiple stakeholder objectives through a communicative dialogue engaging all stakeholders in the planning process.

4.15 Chapter Conclusion

Lake Maryout has become the reservoir for industrial, agricultural and sanitary water discharges. It is now the centre of various environmental threats to the city of Alexandria and the Delta region. Environmental pollution as a result of high concentrations of heavy metal and depleted dissolved oxygen in the lake is causing increased rates of fish death and destroying other essential organic elements. Municipal, industrial and agricultural wastes are being poured into Lake Maryout, causing severe degradation to water quality as a result of depletion of dissolved oxygen.

The increase of fertilizers in the water has led to a huge increase in the growth of reeds and other water plants. Plants cover around 70 per cent of the area of the lake. This large area of vegetation prevents water movement and hinders fishing activities. This significant portion of the vegetated surface area has negative effects on water quality as it prevents water circulation, while it has positive effects on absorbing some pollutants. The increase in the density of such plants will gradually transform the lake into a swamp and destroy its natural habitat and ecosystem. The huge increase of organic load has caused a decrease in the aeration level of the lake, which has a negative impact on fish reproduction. The instability in the water level of the lake and the decrease in oxygen are also contributing to the continuous decrease in the lake production of fish while the number of fishermen population is growing.

The rise of Hydrogen Sulphate gas in the air, with its unpleasant smell, causes environmental pollution and negatively impacts the investments around the lake. Such conditions have also impacted the health of the squatter residents surrounding the lake (150, 000 persons) and prevents any flourishing tourism industry. This state affects any development decision and paves the way to alternate decisions of filling parts of the lake for other activities.

Analysis of the case study reveals that urban expansion is the most prominent phenomenon leading to considerable decrease of total lake area. Urban developments include the construction of commercial, residential, and industrial new sites. The Governorate of Alexandria supports the expansion in co-operation with local industries and ABA. All efforts of other Lake Maryout's stakeholders including Ministry of Environment, non-governmental organisations, academia and Fishermen Community and Fishing Authority have failed to influence the decision-making process to prevent or slow down the filling process.

Industrial pollution is a major threat to both the lake's environment and to human health. Analysis of industrial activities and pollutant discharges shows that there is a systematic increase in municipal, industrial and agricultural sewage flow into Lake Maryout, causing serious deterioration of water quality and depletion of dissolved oxygen.

Deterioration of water quality has major implications at the environmental, social and economic levels. The Ministry of Environment, as an integral part of its mandate, is elevating this issue at the higher political agenda. Degraded quality of water due to elevated concentration of heavy metals and depleted dissolved oxygen is resulting in decreased amounts of fish production and destruction of essential organic elements. Despite the continuous efforts by the EEAA and the local community, which is affected by the negative impacts of deteriorated water quality, there is no significant increase in the quality of water.

Fish catch and fish value have dramatically deteriorated over time. Efforts exerted by local council, non-governmental organisations, the Fishing Authority and fishermen community have failed to implement measures to increase fish production.

There is no institutional organization that includes all stakeholders and achieves integrated management. Healey (1992) points out that the new concepts of planning practices have been recognized during the 1980s and 1990s to consider culture, consciousness aspects, and also on collectively debating and deciding on subjects of collective concerns. These concepts of collaborative planning do not exist in the management and policies regarding Lake Maryout.

According to Filho (2002), conflicts happen primarily when individuals or groups experience that their goals, cultures, values, beliefs and interests are threatened by decisions that are taken by other groups. The conflicting situation in the area of study is along the lines of Filho's description of the emergence of certain conflicts. Stakeholders exploiting Lake Maryout area are being affected by decisions that were taken by other influential groups. This resulted in resistance to any mitigation measures or any implementation to any proposed policy. Since the last three decades, the current conflict of stakeholder objectives is the key element of no-action policy. Current policies are partially implemented to serve influential sectors of the community. The decision-making process is sharply shifted toward economic development, attracting investments, and creating more jobs as a result of a lack of integrated management and communicative planning process. Lobby groups represented by businessmen, industries, land developers and real-estate companies are contributing to the current status. Environmental objectives such as water quality, preserving eco-system and conserving endangered species have not been visualised as priorities for the decision-makers perspectives.

The lack of institutional organization that coordinates stakeholder activities coupled with the monopolisation of decision-making by influential stakeholders has led to the stagnation of any significant mitigation process.

There is a lack of a proper institutional organization capable of applying integrated management techniques. There is a high degree of discrepancy and conflict of interests among stakeholders. Plurality of stakeholders coupled with lack of coordination and integration, and lack of public participation in the decision-making process is leading to unilateralism of decisions. Lack of a common strategic vision among different stakeholders and the absence of scientific, comprehensive and integrated communicative planning tools are leading to a failure of the management of the lake, and hence to a high level of environmental degradation. With the current rates of degradation and land filling of Lake Maryout, the lake will shrink dramatically with serious impacts on the stability of the region.

Stakeholder management is the key to develop a communicative planning mechanism able to implement agreeable policies. To achieve this, an understanding of the various elements that are contributing to the current stakeholder positions is essential. Public hearings, interviews, and analysis of stakeholder questionnaires provide a partial understanding of what is the current position of each stakeholder with respect to identified objectives. Full understanding of how multiple objectives are contributing to this position remains unclear. Considering the complexity of the conflicting objectives, Multi Criteria Analysis methodology is considered most appropriate not to find solutions for environmental problems, but rather to set the circumstances for a clear and informative decision process (Hajkowicz, 2008).

Multi Criteria Decision Analysis (MCDA) is regarded as a widely accepted tool for supporting multi-stakeholder environmental decisions (Teng and Tzeng, 1994; Maguire and Boiney, 1994; Bellehumeur et al., 1997; Regan et al., 2006; Gutrich et al., 2005).

Understanding the synthesised overall decision of each stakeholder with respect to his identified multiple objectives will assist decision-makers, policy-makers, and planners to have the full view of the decision map of stakeholders and hence to better develop the conditions for a transparent and informative decision process. Paradoxical conflicting decisions by Lake Maryout's stakeholders coupled with the current conflicting policies raise a question of the required approach for understanding the magnitude and direction of stakeholders' priorities. This will help decision-makers develop structured well informed collaborative management plan for the area.

CHAPTER 5

RESULTS OF THE ENVIRONMENTAL DECISION ANALYTICAL MODEL (EDAM)

Chapter 5. Results of Environmental Decision Analytical Model (EDAM)

5.1 Introduction

The identified research problem entails multi-criteria, multiple objective stakeholder environmentally-related decision process. Accordingly, the research has developed a multi-criteria decision-analytical model to analyse this problem.

Decision making generally and particularly with respect to environmental problems involves setting priorities. Situations in reality are complex and entail vested interests and conflicting values. Most decision problems are multi-criteria in nature. Environmental decision making nowadays is a science. Stakeholders have complex decisions to make and they need assistance because various livelihood conditions may be involved, the sustainability of natural resources depends on making the right decision. Environmental decisions are so complicated that the variables which underpin a decision are beyond limited human ability to identify, prioritise and use them effectively to reach a structured decision. MCDA provided considerable experience in the past thirty years to assist decision-makers structure and prioritize thousands of decisions in various aspects of life.

The methodology presented in chapter 3 provides a tool for assist decision makers to evaluate, prioritise and rank the variables that contribute to stakeholders'' preferences in order to understand the direction and magnitude of the environment-socio-economic problem. EDAM methodology uses Lake Maryout case study as a simplified example to test the methodology and to illustrate the functions and interpretation.

EDAM uses the first three levels of problem hierarchy as inputs in the model to evaluate stakeholders' preferences with respect to the identified alternatives. For example a fourth level can be inserted in the model to take into consideration the variables contributing to each third level objective. Water quality could be disintegrated into several variables which constitute the stakeholder decision about this specific objective.

Water quality is a function of Lake dredging, remove water reeds, aeration, increase water level as well as many other functions. EDAM therefore, has the ability to take all the variables into account and assist decision makers in understanding how these elements are contributing to each stakeholder decision. This degree of complexity cannot humanly be structured and prioritised to understand how the importance of each element is contributing to the overall decision. This research uses three level simplified hierarchy to illustrate in a meaningful way how these elements are contributing to Lake Maryout's stakeholders' conflict.

Chapter 3 has explored different types of research methodologies. Criteria for selection the modelling process were illustrated. The chapter concluded that MCDA technique, particularly AHP is the most appropriate modelling process to address the research problem. Analytic hierarchy process (AHP) is selected because its characteristics as an advantageous tool for natural resource decision making, its capability as a participatory decision making, its capacity to structure complex problems.

AHP has ability to facilitate group decision, consensus building, incorporate qualitative and quantitative data; assist in conflict resolution, and as a decision support tool.

The EDAM model follows the conceptual design provided in chapter 3. This model is tested through the implementation of Lake Maryout stakeholders' conflicting objectives. This chapter presents the steps for implementation and the model results.

This chapter analyses stakeholder decisions by using the Analytic Hierarchical Process (AHP) in combination with results from spatial analysis DPSIR framework analysis. The analytical decision-support model assists decision-makers and planners to better understand stakeholder conflict in environmentally sensitive area and hence to develop a better planning for the area in light of this understanding.

The chapter investigates the plausibility of identifying the areas of consensus between conflicting stakeholders over an environmentally sensitive coastal area. The analysis of this chapter tries to develop a new approach to analyse environmental degradation by assessing and delineating the degree of stakeholder conflict. The research examines the plausibility of using a methodology for analysing environmental decision-making through applying the Analytic Hierarchy Process (AHP). This chapter investigates whether the identification of the areas of agreement or disagreement among identified priorities, can help minimize the negative impacts of environmental degradation on the affected communities, defined here as the main stakeholders. The chapter also investigates the degree to which differences in stakeholder power, affect the overall decision-making.

Critical reviews of environmental decision-making, communicative planning theory, DPSIR framework, public participation techniques, environmental conflict theories, evaluated in previous chapters, have been used to analyse the case study.

Results from the DPSIR analytical framework, which was introduced in chapter four to identify the environmental conditions and the driving forces that are shaping stakeholder decisions as well as the spatial analysis of the area of study are used to validate the outcomes of the developed methodology.

Spatial Analysis and DPSIR analytical framework provides understanding of what the current changes to Lake Maryout's environment are, and why those changes are occurring. The analysis identifies the impacts of these changes on the environment and on the affected community. The analysis investigates how society is responding or reacting to these changes and how effective those reactions are.

This chapter tries to explore the options stakeholders have to sustain and manage Lake Maryout. It attempts to find what actions and measures could be taken to enhance consensus and to reverse any negative implications of the current situation.

The chapter attempts to identify a standardised scale in order to rank the percentage of consensus areas calculated and hence to understand the degree of consensus or conflict between different stakeholders with respect to identified alternatives.

EDAM uses the analysis and data from the case study in Chapter four to develop an understanding of stakeholder decisions and alternatives. DPSIR conceptual framework presented in Chapter four is applied to the area of study to investigate the state of the environment of the area and understand how economic, social and environmental aspects are affecting the decision-making process. These analyses are verified against the results of the spatial analysis that demonstrate the actions and decisions on the ground.

Environmental Decision Analytical Model (EDAM) outcomes are presented to stakeholders to get their feedback and reactions to their synthesised preferences, the calculated consensus ranks and the overall synthesised preferences.

This chapter provides the results of the Environmental Decision Analytical Model (EDAM). It explains the functions and outputs of the three sub-modules that construct the EDAM, namely the Spatial Decision Analytical Model (SDAM), the Sustainable

Development Decision Model (SDDM), and the Stakeholder Analytical Decision Model (SADM).

The EDAM model Geographic Information System (GIS) tools, decision analysis using Analytic Hierarchy Process (AHP) to construct a methodology capable of measuring and scaling the degree of consensus among conflicting stakeholders. The methodology uses spatial capability to spatially locate the area of consensus.

The chapter introduces the EDAM methodology by analysing stakeholder decisions. It re-introduces the identified primary stakeholders and the thematic areas that represent the alternatives, which each stakeholder wants to achieve.

5.2 Applying (EDAM) to Lake Maryout

5.2.1 Overview of the Model

The decisions that have been taken by Lake Maryout's stakeholders need to be analysed to understand the factors that have contributed to these decisions, why these decisions were taken and how differentiated stakeholder power may have affected these decisions. The analysis is conducted retroactively, since the preferences of stakeholders have already been assessed through the questionnaires, and the methodology is used to analyse these positions to develop an understanding of why these judgments were made.

5.2.2 Identifying the overall Goal of the analysis

The overall goal of the methodology is the integrated management of Lake Maryout. The basic assumption is that better management of Lake Maryout through reversing environmental deterioration is the overarching objective of both the community of stakeholders and anybody with management authority over the lake. However, there are differentiated degrees to which stakeholders are willing to achieve this objective. The Environmental Decision Analysis Methodology (EDAM) tries to measure the degree of willingness to achieve this objective by analysing the different variables contributing to the decision-making process for each stakeholder. It also tries to identify and locate the area where stakeholders, policy-makers and local authorities can prioritise their intervention.

5.2.3 *Identifying the main primary stakeholders and alternatives*

In Chapter four the main characteristics of the study area were thoroughly investigated and the root causes of degradation were identified. DPSIR analytical framework was applied to assess the state of the environment of the lake and to identify driving forces, the current state of the environment, the impacts of the current pressures and the explored responses from different stakeholders.

In order to identify the alternatives, it was essential to identify the main key players that are affecting or contributing to the current state. Stakeholder analysis was conducted to identify the main key institutions and groups and their objectives and priorities towards the management of the lake.

Stakeholder analysis identified 16 main stakeholders. Four main stakeholders were selected for further analysis: Governorate of Alexandria, Ministry of the Environment represented by the Egyptian Environmental Affairs Agency, the fishing community represented by the Fishermen's Association and Industries represented by Alexandria Businessmen Association (see Table 5-1).

The selected stakeholders represent the diversity and priorities of most other secondary stakeholders. The stakeholder influence analysis conducted in chapter four shows a marked difference in the degrees of power and influence they wield.

Table 5-1 Summary of all Stakeholders and their Degree of Influence

	Stakeholder	**Degree of Influence**
1	Alexandria Governorate	9
2	Fishermen Association	3
3	Ministry of State for Environmental Affairs	5
4	Alexandria Businessmen Association	7

Stakeholder alternatives were selected based on the outcomes of the interviews, questionnaires and the investigation of the case study in Chapter four.

The identified objectives are presented in Table 5-2.

Table 5-2 Identified Stakeholder Priorities

Identified Priorities
1- Enhancing water quality
2- Urban expansion
3- Increasing fish production
4- Encouraging industrial development

The four identified alternatives are thoroughly investigated in this chapter to develop an understanding of how they contribute to the objectives of stakeholders.

5.3 Sustainable Development Decision Module (SDDM)

The module identifies the overall goal with respect to the main objectives, which are environment, economic and social integration to achieve sustainable development of the study area.

Synthesised SDDM decision is used to compare stakeholder judgments against environment, social and economic objectives.

SDDM strategy for managing the lake equally encompasses all the aspects of sustainable development. Therefore the SDDM decision problem is broken down in a hierarchical structure assuming that the three pillars have the same weight (1.0) (see Table 5-3). Checking the differentiated weight of the primary level is conducted through performing the sensitivity analysis which answers what-if questions.

Table 5-3 Comparison of the Relative Importance With Respect to Goal

Goal: Sustainable management of Lake Maryout			
	Environment	Social	Economic
Environment		1.0	1.0
Social			1.0
Economic			

The main objective of analysing the existing sustainable development management decision is to examine the current assumed sustainable management policies on the environmental degradation of the lake and the impact of having different biases for stakeholders towards environmental, social or economic priorities.

5.3.1 Developing SDDM Hierarchical Tree

A hierarchy is a structural form which is used to analyse a decision problem. It uses a top-down approach, starting with general categories or objectives and moves down to more specific sub-objectives.

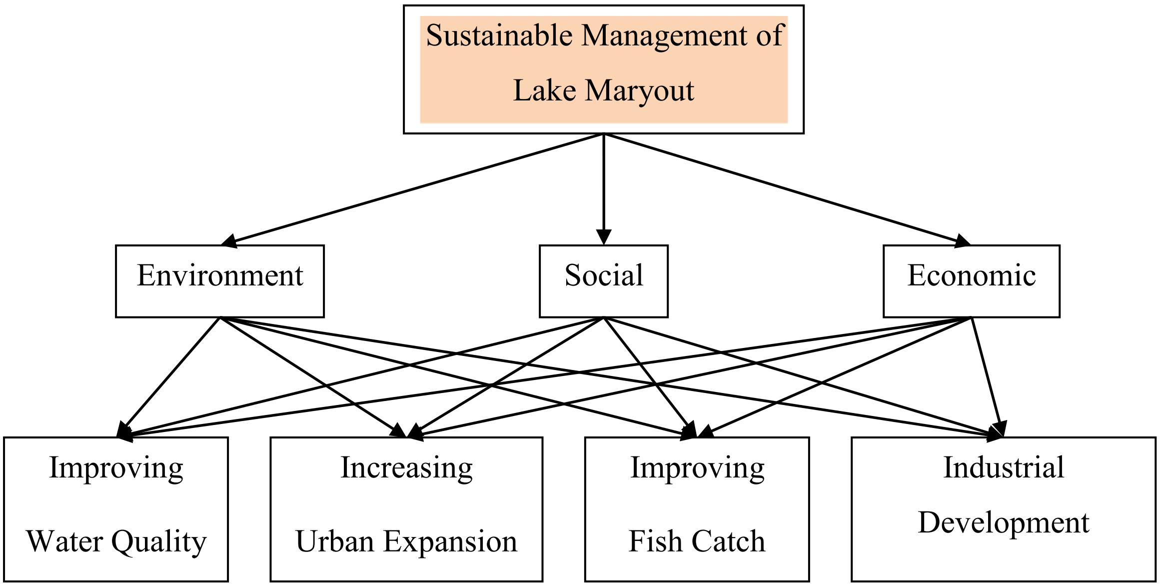


Figure 5-1 Structured AHP Problems with Identified Three Hierarchy Levels.

The model as shown in Figure 5-1 consists of three levels of hierarchy; the overall Goal of the model which is the sustainable management of Lake Maryout; the second level which is the criteria or objectives; and the third level which is sub-objectives.

The term objective in this context refers to an issue whose resolution is sought after or aimed at a specific decision. In SDDM the objective is to achieve environmental, economic and social sustainability of Lake Maryout.

The term objective is occasionally used interchangeably with ‘criterion’ or ‘attribute’. In this research, an ‘objective’ may encompass several ‘criteria’ and these in turn may encompass several ‘attributes’. Sub-objectives, the third level of the hierarchy, might include, for example, improving water quality, pollution control and lake dredging.

The decision analysis could get more complex by adding another level. The third level could be further broken down into a detailed fourth level, with sub-objectives such as enhancing policy measures or provide technical solutions (see Figure 5-2). As explained, the EDAM breaks down the stakeholders' conflicting objectives up to the third level to test the model and to allow for deep analysis of the results with respect to the case study and the DPSIR framework.

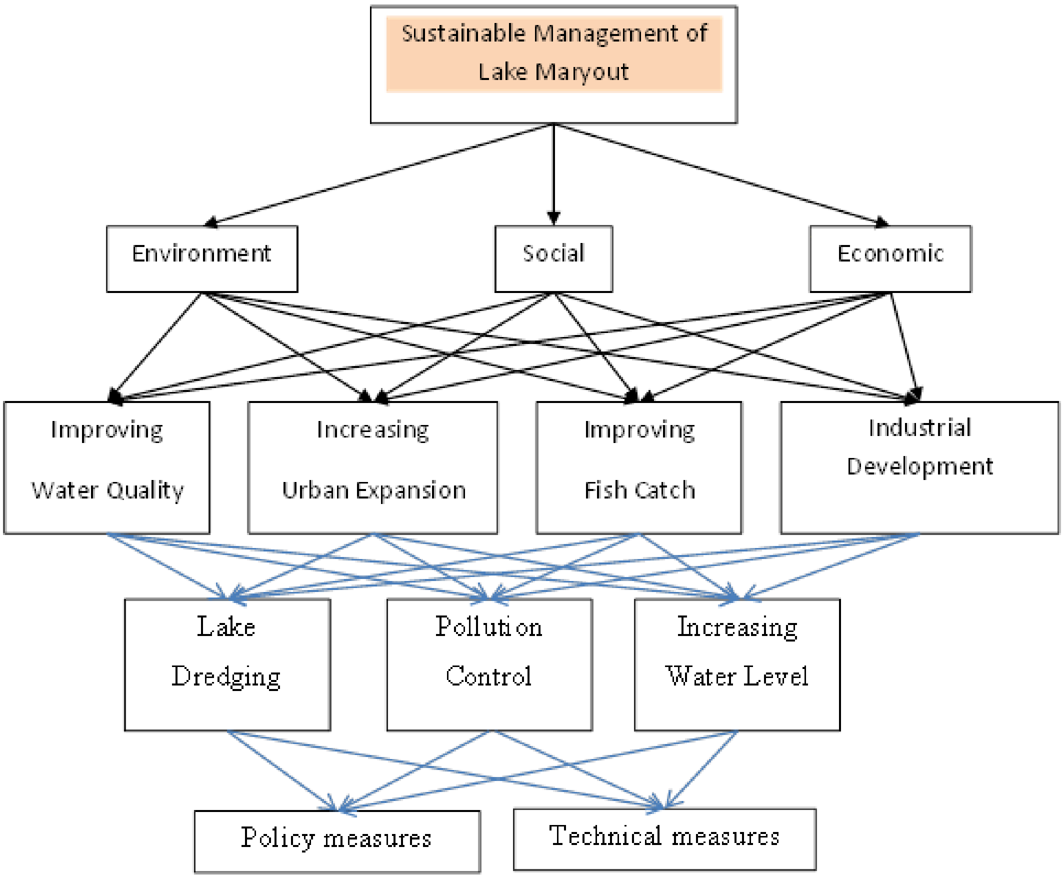


Figure 5-2 Integrated management of Lake Maryout using AHP

5.3.2 Development of SDDM Matrix

As discussed earlier in this chapter, data was entered in the AHP model assuming that the three pillars of sustainable development have the same priority or weight. Data was extracted from SDDM expert Questionnaire's and entered into the AHP SDDM.

This step was done in both the developed AHP Excel Matrix calculator that was developed for this research and in Expert Choice Pro software. The objective is to compare and validate the outputs of SDDM AHP Reciprocal Matrix.

The pairwise comparisons of the objectives of alternatives selection generate a matrix of relative priority rankings for each level of the hierarchy. As explained in chapter 3, the number of developed matrices is function of the number of alternatives at each level.

As SDDM hierarchical tree has 3 objectives, the system construct a (3*3) Reciprocal Matrix (see Table 5-4).

Table 5-4 SDDM Objectives Matrix

AHP computation Size 3 by 3			
SDDM objectives reciprocal matrix			
Objectives	Environment	Social	Economic
Environment	1.00	1.00	1.00
Social	1.00	1.00	1.00
Economic	1.00	1.00	1.00
Sum	3.00	3.00	3.00

The SDDM objectives output matrix values are normalised as shown in Table 5-5.

Table 5-5 SDDM Normalized Objectives Matrix

NORMALIZED MATRIX				sum	priority vector
	Environment	Social	Economic		
Environment	0.333	0.333	0.333	1.000	33.33%
Social	0.333	0.333	0.333	1.000	33.33%
Economic	0.333	0.333	0.333	1.000	33.33%
sum	1.000	1.000	1.000	3.000	100.0%
Lambda	1	1	1	3.000	principal Eigenvalue
n	3	CI		0.000	
		CR		0.0%	Consistency

Accordingly the system assigns a value of 0.333 to each pillar as shown in Figure 5-3. Inconsistency is a measure which the model calculates in order to identify probable errors and real inconsistencies in judgments. It is an important measure to examine if the expert or stakeholder has made rational judgments.

The inconsistency ratio checks if the comparative choices follow a reasonable logic. Generally the inconsistency ratio has to be between 0 and 0.1 to be considered logically consistent.

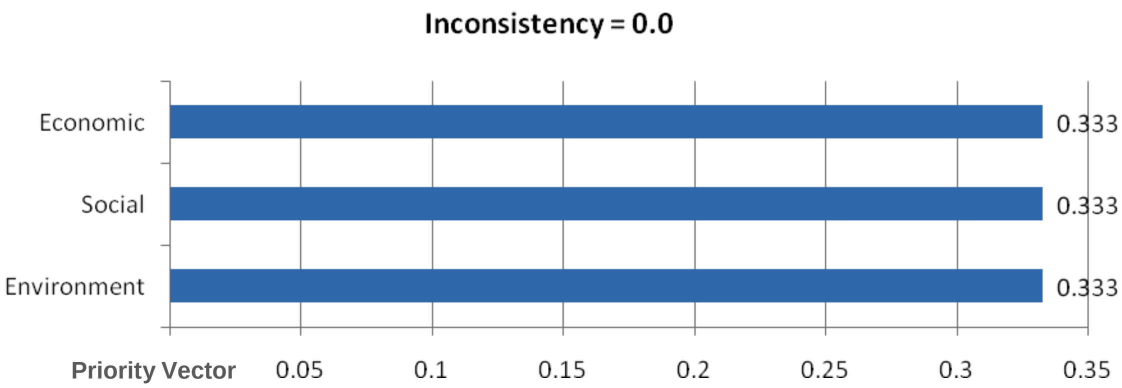


Figure 5-3 Calculated Priorities in SDDM With Respect to Goal

AHP model uses pairwise comparisons process to derive precise ratio scale priorities. The system evaluates the inputs by making pairwise comparisons. The pairwise comparison process compares the relative preference of two objectives with respect to another issue in the higher hierarchical level.

The alternatives identified in the third level (urban development, industrial development, water quality and fish catch) are entered in the SDDM.

Data is taken from one questionnaire where experts assessed the relative importance of two alternatives (e.g. water quality vs. urban expansion) choosing between equal, moderate, strong, and very strong as well as the intermediate choices of the AHP scale, shown in Table 5-6.

This data is entered into the model which calculates judgments with respect to the objectives.

Table 5-6 SDDM AHP Scale

Preference	Numerical Rating
Extreme	9
Very strong to Extreme	8
Very Strong	7
Strong to Very Strong	6
Strong	5
Moderate to Strong	4
Moderate	3
Equal to Moderate	2
Equal	1

The following step in SDDM modelling process is to formulate judgments/pairwise comparisons between the identified alternatives to derive priorities for the objectives with respect to the overall goal of management of the study area, and priorities for the alternatives with respect to each objective.

The judgment of the model is based on the information presented in previous chapters, on various expert opinions, and on the questionnaire distributed to various experts. The module uses this empirical data as subjective judgments of the hypothetical management authority of the area of study.

In the bottom-up approach, judgments or pairwise comparisons of alternatives are conducted before judgments about objectives. The bottom-up approach is preferred because insight about the trade-offs between the identified alternatives can enhance judgments concerning the importance of the objectives.

Pairwise comparisons were done to evaluate the preference of each alternative with respect to each objective. Accordingly, the four identified alternatives were compared interchangeably to environment, economic and social objectives.

5.3.2.1 Relative preference with respect to Environment

For the Environmental dimension, the preferences are selected with respect to the impact of alternatives on the environmental quality of the study area.

DPSIR analysis shows that the state of the lake's environment is deteriorating as a result of shrinking water body, deterioration of water quality and spread of vegetation cover. These pressures negatively impact the ecosystem of the lake and its surrounding areas.

1- SDDM Environment Pairwise Comparison Table

Judgments from Sustainable Development Experts' Questionnaires are entered into SDDM using Expert Choice software to calculate the SDDM environment dimension reciprocal matrix (see Table 5-7).

The text in red refers indicates that the selected preference is not in favour of this alternative.

A (4*4) Reciprocal Matrix is developed for SDDM relative preference in respect to the environment component.

Table 5-7 Relative preference in respect to Environment

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality		Extreme	Extreme	Strong
Urban Development			Equal	Very Strong
Industrial Development				Extreme
Fish Catch	Inconsistency = 0.11			

2-SDDM Environment Matrix

Table 5-8 shows the 4*4 SDDM environment component matrix.

Table 5-8 AHP SDDM Environment Matrix

	Water Quality	Urban Development	Industrial Developme	Fish Catch
Water Quality	1	**9**	**9**	**5**
Urban Development	1/9	1	**1**	**1/7**
Industrial Development	1/9	1	1	**1/9**
Fish Catch	1/5	7	9	1
SUM (col)	1 3/7	18	20	6 1/4

3-SDDM Normalised Environment Matrix

Normalised Eigenvalues are calculated in respect to their pairwise comparison. Table 5-9 shows the normalised principle Eigenvectors for SDDM preferences with respect to identified alternatives.

Table 5-9 SDDM Normalised Environment Matrix

	normalized matrix				symthesis
Water Quality	0.7031	0.5	0.45	0.799	61%
Urban Development	0.0781	0.0556	0.05	0.023	5%
Industrial Development	0.0781	0.0556	0.05	0.018	5%
Fish Catch	0.1406	0.3889	0.45	0.16	28%

Results are synthesised by assigning the full weight of each objective to the best (highest priority) alternative for each covering objective. The other identified alternatives receive weights under each covering objective proportionate to their priority relative to the best alternative under each covering objective. The weights/priorities for all the alternatives are then normalized so they add up to 1.0.

4-SDDM Environment Synthesised Priority Values

Table 5-10 shows the synthesised values of priorities of environment objective with respect to the four identified alternatives.

Table 5-10 SDDM-Environment synthesised values

	Water Quality	Urban Development	Industrial Development	Fish Catch
Environment	61%	5%	5%	29%

Table 5-10 above illustrates these inputs showing that high comparative values were selected for water quality and fish catch. Both industrial and urban development has the lowest preference. Industrial development and urban development have the same comparative value.

Referring to DPSIR framework, a possible interpretation of this is that urban development entails filling and reducing the total area of the lake, with irreversible impacts on the environment. Industrial development also has serious implications for water quality and for species living in and around the lake area.

Figure 5-4 shows the alternatives with respect to the environment. It clearly highlights the importance of water quality to the environment dimension, represented by the inclined decision area towards the water quality alternative.

Figure 5-5 illustrates the direction of the environment component towards the water quality.

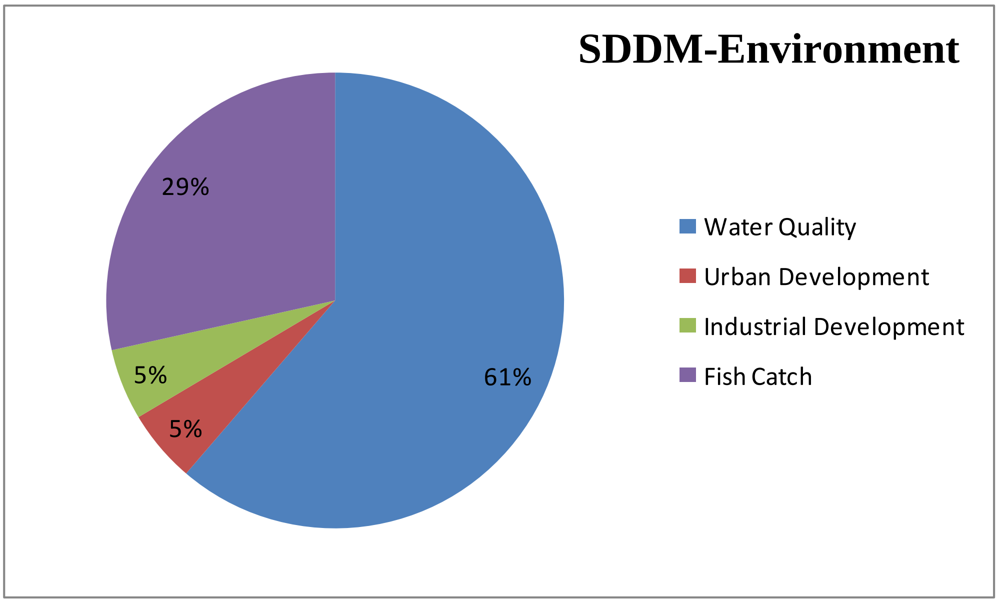


Figure 5-4 Percentages of Priorities with respect to Environment

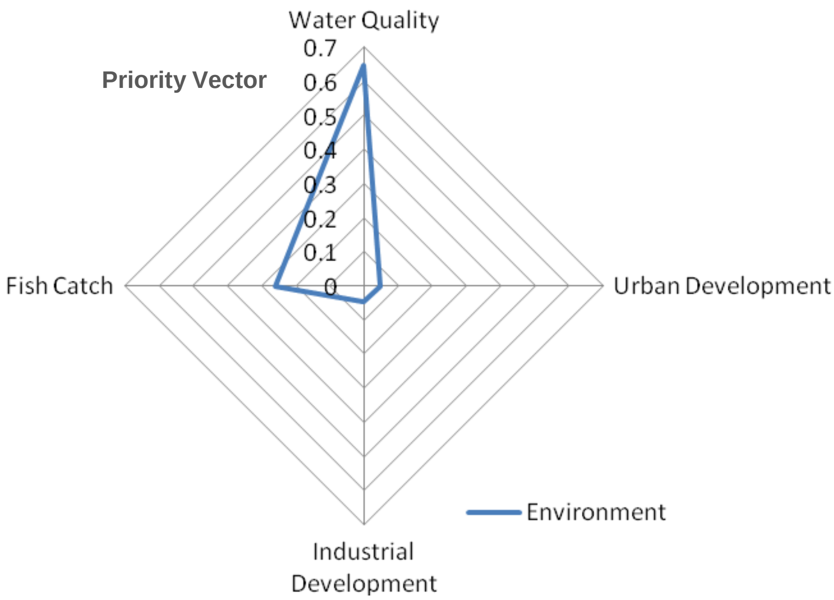


Figure 5-5 Alternatives with respect to Environment

5-Adjusting SDDM Environment Inconsistency

The calculated inconsistency for the environment priority is equal to 20.6%, which is greater than the ratio considered reasonably consistent (10%). This indicates possible errors in judgments. It is not the objective of this research to correct or modify the inputs that were originally identified by experts but rather to analyse these inputs (see Table 5-11).

Table 5-11 Environment component consistency

Lambda	0.9828	1.1683	1.279	1.1257	4.557	principal Eigenvalue	
n	4			CI	0.186		
				CR	20.6%	Consistency	

It is, however, essential to understand the areas of misjudgements. The model allows for identification of possible errors and suggests plausible modification to the judgment. This procedure highlights the areas where decision-makers have made incorrect judgments (see Table 5-12).

Table 5-12 Adjusted preferences in respect to Environment

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality		Extreme	Extreme	Equal to Moderate
Urban Development			Equal	Strong
Industrial development				Strong to Very Strong
Fish Catch	Inconsistency = 0.0			

The adjustment suggests that the comparative preference between water quality and fish catch should be equal to moderate in favour of water quality. It also suggests that the preference urban development/fish catch should be adjusted from very strong to strong (from 7.0 to 6.0) in favour of fish catch.

The preference between industrial development and fish catch needs to be adjusted from extreme preference to strong/very strong (from 9.0 to 6.0).

Figure 5-6 shows the adjusted priorities with respect to environment goal. The calculated inconsistency ratio after these adjustments is equal (0.0).

Figure 5-6 Adjusted Priorities with respect to Environment Goal

5.3.2.2 Relative preference with respect to the Social Dimension

The social dimension includes creation of new jobs, upgrading the quality of life for the local community, upgrading existing healthcare systems and decreasing the number of inhabitants affected by environmental degradation. Social aspects also include finding new areas to build new homes for both the local community and the population of the city, as well as increasing fish catch to maintain the quality of life and income for fishermen.

1-SDDM Social Pairwise Comparison Table

Investigation of the results of the comparative preference with respect to the social dimension revealed that higher preferences were selected for urban development followed by fish catch then industrial development while water quality had the lowest priority (see Table 5-13).

Table 5-13 Relative preference in respect to the Social Dimension

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality		Moderate	Equal	Strong
Urban Development			Moderate	Strong
Industrial development				Equal
Fish Catch	Inconsistency = 0.19			

2-SDDM Social Matrix

Table 5-14 shows the 4*4 SDDM environment component matrix.

Table 5-14 Social component Matrix

	Water Quality	Urban Development	Industrial Developme	Fish Catch
Water Quality	1	**1/3**	**1**	**1/5**
Urban Development	3	1	**3**	**5**
Industrial Development	1	1/3	1	**1**
Fish Catch	5	1/5	1	1
SUM (col)	10	1 6/7	6	7 1/5

3-SDDM Normalised Social Matrix

Normalised Eigenvalues are calculated in respect to their pairwise comparison.
Table 5-15 shows the normalised principle Eigenvectors for SDDM social preferences with respect to the identified alternatives.

Table 5-15 SDDM Normalised Social Matrix

	normalized matrix				symthesis
Water Quality	0.1	0.1786	0.167	0.028	12%
Urban Development	0.3	0.5357	0.5	0.694	51%
Industrial Development	0.1	0.1786	0.167	0.139	15%
Fish Catch	0.5	0.1071	0.167	0.139	23%

4-SDDM Social Synthesised Priority Values

Table 5-16 shows the synthesised values of priorities of social objective with respect to the four identified alternatives.

Table 5-16 SDDM-Social Synthesised Values

Inconsistency = 0.19	Water Quality	Industrial Development	Fish Catch	Urban Development
Social	12%	15%	22%	51%

Figure 5-7 shows the alternatives with respect to the social dimension. It is clearly evident from the results that urban development contributes strongly to the social objectives.

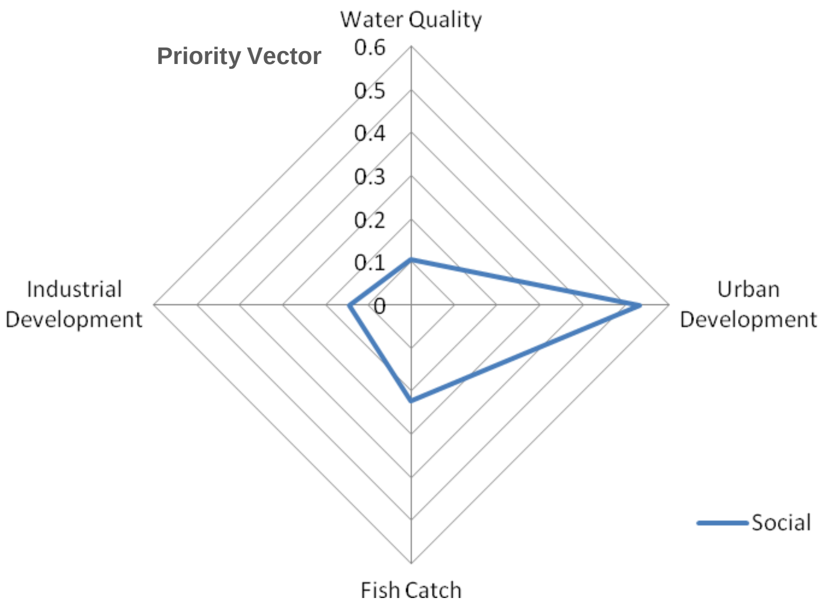


Figure 5-7 Alternatives in respect to the Social Dimension

Increasing fish production comes as a second priority while both industrial development and water quality have lower contribution to the social component.

Urban development represents 51% of the total social priorities, fish catch represents 22%, industrial development represents 15%, and water quality has a comparative priority of 12% (see Figure 5-8).

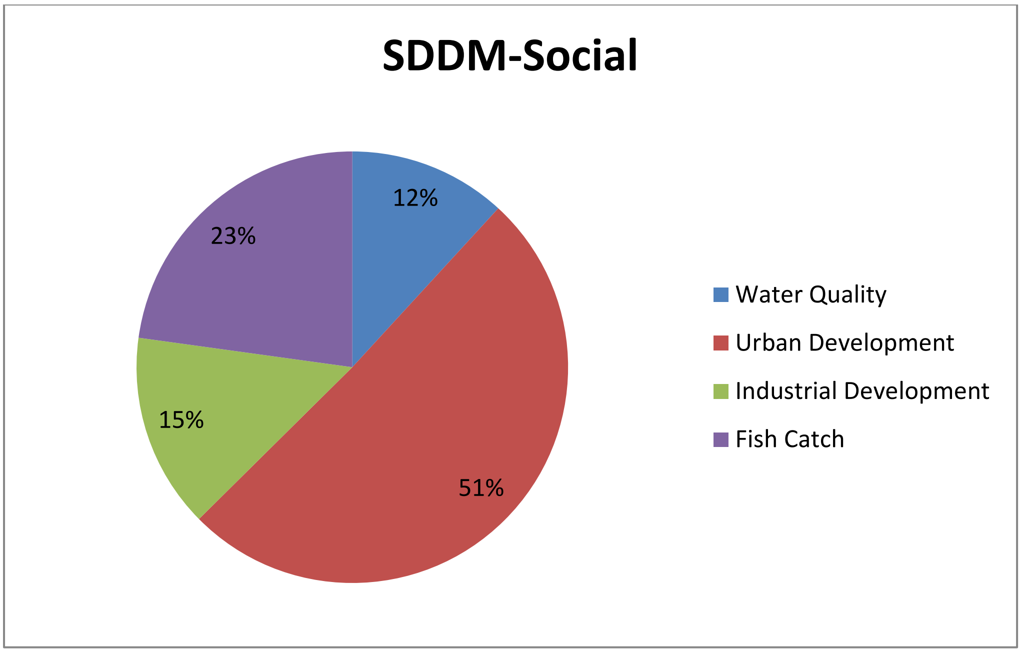


Figure 5-8 Percentages of Priorities with respect to Social Dimension

5-Adjusting SDDM Social Inconsistency

The calculated inconsistency ratio in data for the social dimension is 0.19, indicating highly inconsistent judgments. Table 5-17 shows the adjusted values.

Table 5-17 Adjusted preferences in respect to Social

	Water Quality	**Urban Development**	**Industrial Development**	**Fish Catch**
Water Quality		Moderate	Equal	Moderate
Urban Development			Moderate	strong
Industrial development				Equal
Fish Catch	Inconsistency = 0.01			

Adjusting the inconsistency only affects the comparative value of fish catch while the priorities are not affected (see Figure 5-9).

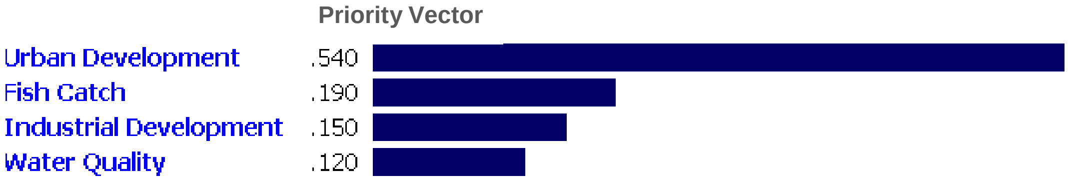


Figure 5-9 Adjusted Priorities with respect to Social Goal

5.3.2.3 Relative preference with respect to the Economy

Economic development in the area of study is based on four main sources: industries and factories in the area, urban development that attracts investments to construct new communities, tourism and fish production.

1-SDDM Economy Pairwise Comparison Table

Investigation of the results of the comparative preference with respect to the economic dimension revealed that very strong preferences were selected for industrial development and urban development (see Table 5-18).

Results show that with respect to the economy, industrial development has the highest priority followed by urban development. This result could be analysed based on knowledge of the economy of the study area, as investigated in chapter four.

Lake Maryout's industrial economy, as described in chapter 4, depends on industrial development, principally chemical and petrochemical production facilities and refineries, textile companies, oil refineries, steel production and pharmaceuticals. These factories create most jobs for the local community.

Table 5-18 Relative preference in respect to Economy

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality		Very Strong	Very Strong	Moderate
Urban Development			Strong	Very Strong
Industrial development				Very Strong
Fish Catch	CR= 28.2%			

Urban development also contributes to the economy as the expansion of tourist and residential areas provide great opportunities for the lake and its surrounding areas. While land-filling is not a preference favoured by the fishermen community, it does provide high economic value as many fishermen own parcels of land whose value would increase if high-income urban development occurred. Urban development also entails a number of services that could be provided by the local community.

2-SDDM Economy Matrix

Table 5-19 shows the 4*4 SDDM economic components Matrix

Table 5-19 SDDM Economy Matrix

	Water Quality	Urban Development	Industrial Developmei	Fish Catch
Water Quality	1	**1/7**	**1/7**	**3**
Urban Development	7	1	**1/5**	**7**
Industrial Development	7	5	1	**7**
Fish Catch	1/3	1/7	1/7	1
SUM (col)	15 1/3	6 2/7	1 1/2	18

3-SDDM Normalised Economy Matrix

Normalised Eigenvalues are calculated in respect to their pairwise comparison.

Table 5-20 shows the normalised principle Eigenvectors for SDDM economy preferences with respect to the identified alternatives.

Table 5-20 SDDM Economy Matrix

	normalized matrix				symthesis
Water Quality	0.0652	0.0227	0.096	0.167	9%
Urban Development	0.4565	0.1591	0.135	0.389	28%
Industrial Development	0.4565	0.7955	0.673	0.389	58%
Fish Catch	0.0217	0.0227	0.096	0.056	5%

4-SDDM Economy Synthesised Priority Values

(Table 5-21) shows the synthesised values of priorities of the economic objective with respect to the four identified alternatives.

Table 5-21 SDDM-Economic synthesised values

	Water Quality	Urban Development	Industrial Development	Fish Catch
Economy	9%	28%	58%	5%

Synthesised results show that water quality has no direct impact in the short-term on the current economy, as it is dominated by industrial activities. Managers and experts did not see it as a major contributor to the economy but rather an environmental or social concern. However, from the expert's economic perspective, water has a long-term impact on the economy as a pre-requisite for any urban development whether for tourism or residential areas. Figure 5-10 shows the comparative preferences values of alternatives with respect to the economic dimension.

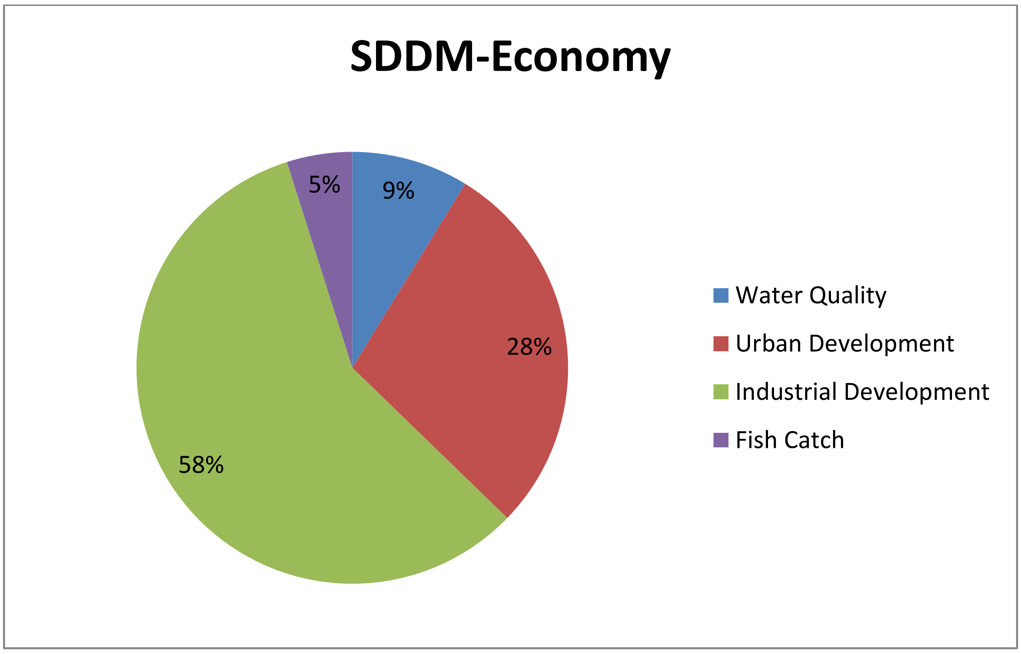


Figure 5-10 Percentages of Priorities with respect to Economy

The outcome of economic synthesised priorities show that water quality represents 9% of the total economic priorities, while fish catch is only 5%, ranked last as an economic priority. Fish catch is regarded by experts as not relatively contributing to the economy compared with other sources. It was not seen as a major contributor to the local economy since the quantity and value of fish production has declined significantly in the last two decades due to environmental degradation. The resource was seen by managers as a social concern to support the local fishing community rather than a contributor to the local economy. Figure 5-11 shows the orientation of economic component towards industrial development.

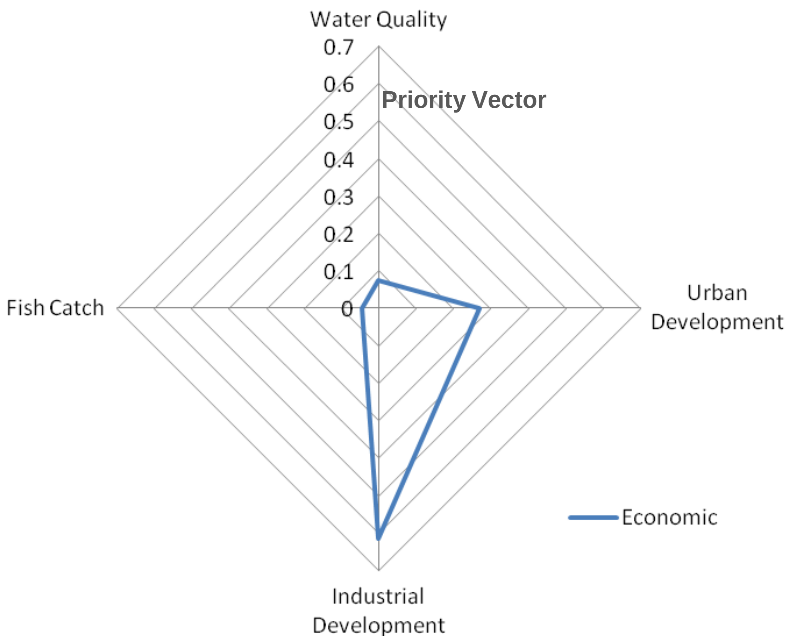


Figure 5-11 Alternatives with respect to Economy

The calculated inconsistency ratio of 28.2% indicates highly inconsistent judgments. The analysis revealed that this is mainly due to the urban development/industrial development ratio. This ratio needs to be adjusted to equal preference instead of a strong preference for industrial development in order to adjust the overall consistency of the judgments (see Table 5-22).

Table 5-22 Adjusted preferences in respect to Economy

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality		Very Strong	Very Strong	Equal
Urban Development			Equal	Very Strong
Industrial development				Very Strong
Fish Catch	Inconsistency = 0.0			

Adjusting the inconsistency ratio results show that both urban and industrial developments are equally contributing to the economy. Water quality and fish catch have less impact on the economic development compared to other objectives.

5-Synthesised SDDM Results

In order to synthesise the results, the model assigns the weight of the identified objective to the highest priority alternative for each of the lowest level objectives in the hierarchy. The other alternatives receive weights under each objective covered in proportion to their priority. The model calculates the best alternative under each lowest level objective in the hierarchy.

The synthesised results from expert input show that urban development contributes most to the management objective and presents the highest priority within the existing assumptions, followed by industrial development, with water quality in third place and fish catch in last (see Figure 5-12).

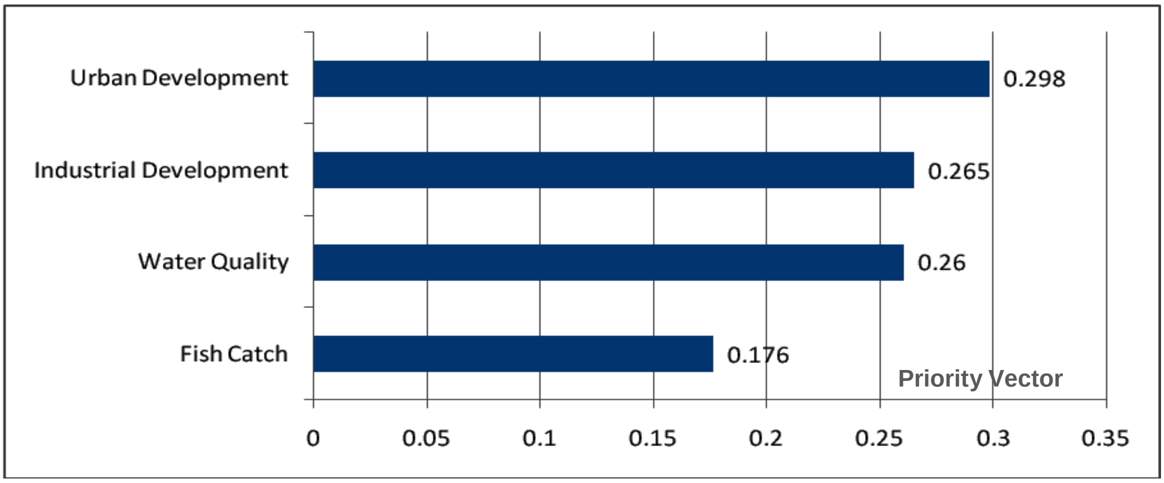


Figure 5-12 Synthesis of Sustainable Development with respect to Goal

6-Adjusting the Inconsistency of the Results

Synthesis of the adjusted zero-inconsistency model results in subsequent changes to overall preferences. Figure 5-13 shows the calculated overall synthesis of the model after adjusting the input judgments to minimise inconsistencies in all the alternatives.

This result shows that if the input has followed a consistent logic in prioritising the objectives with respect to the overall goal, urban development would be the first preference, followed by water quality, then industrial development, and lastly fish catch.

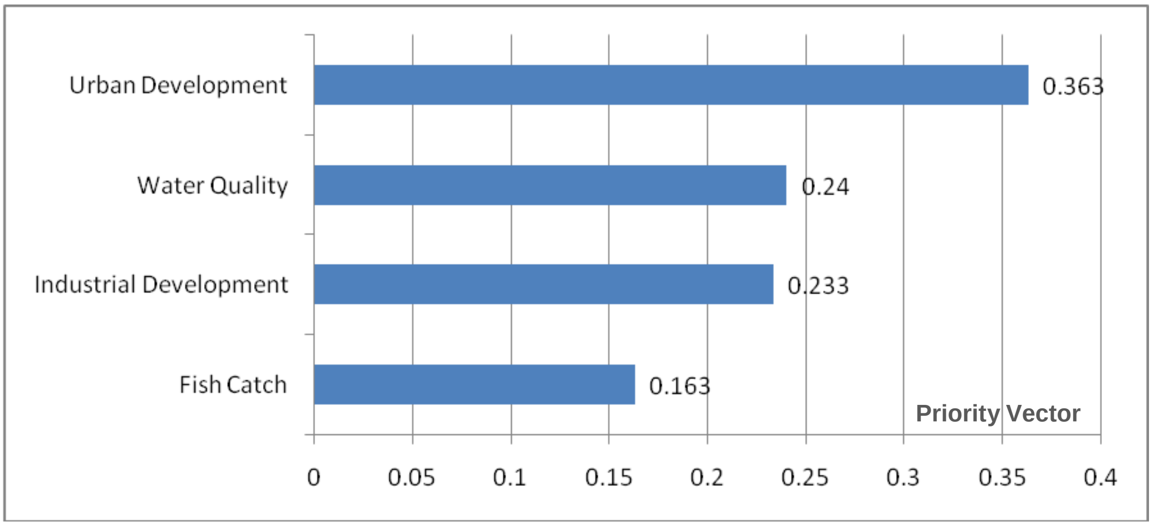


Figure 5-13 Synthesised Consistent Overall Priorities

Figure 5-14 shows the percentages of Priorities with respect to overall synthesised adjusted Preferences.

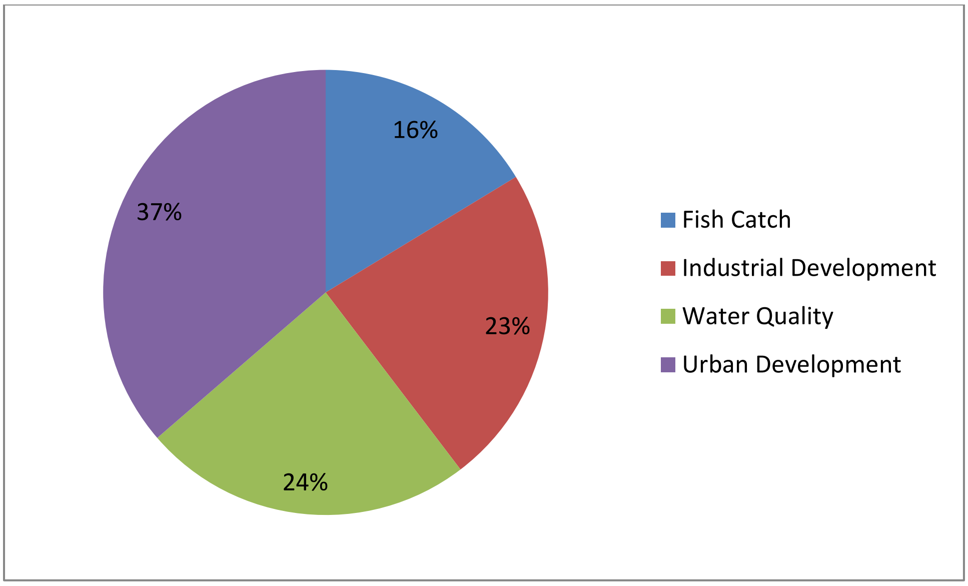


Figure 5-14 Percentages of Priorities with respect to overall synthesised adjusted Preferences

5.3.3 SDDM Sensitivity Analysis

Sensitivity analysis is conducted to show the sensitivity of the identified alternatives with respect to all the objectives (environment, economic, social) below the main goal of Lake Maryout management. Sensitivity analysis is performed by changing the percentage allocated to these objectives and observing how the priorities of the alternatives change. It works as a "what if" scenario and validates if the results are meaningful and in line with the analysis of the case study and DPSIR framework.

Performance sensitivity (see Figure 5-15) shows that while urban development does not represent an environmental priority, it coincides strongly with both the economic and social agendas. Water quality has very high priority for the environment but moderate to low priority on both social and economic levels. The industrial development alternative has a very low priority for environment, but is moderately preferable at the social level and very high priority at the economic level. Fish catch is considered a high priority for both environment and social dimensions, but low priority for the economy due to its current state of degradation.

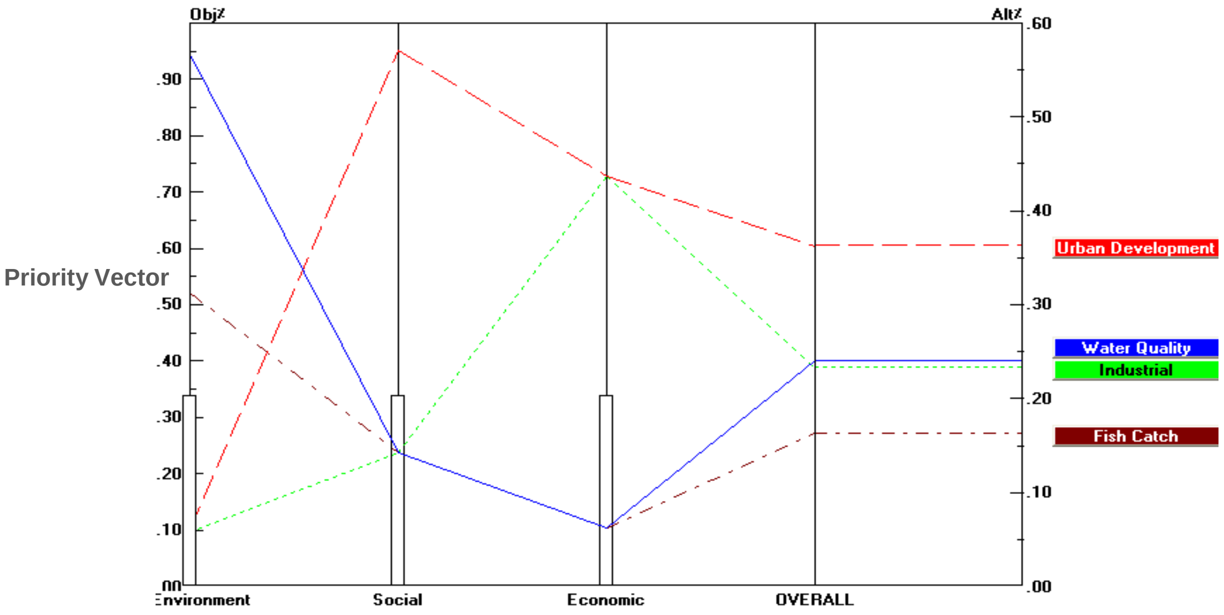


Figure 5-15 Performance sensitivity with zero inconsistency

The final synthesised results show that given equal comparative weights for environmental, social and economic objectives, urban development achieved 36.3%, industrial development 23.3 %, water quality 24%, and fish catch 16.3 % (see Figure 5-16).

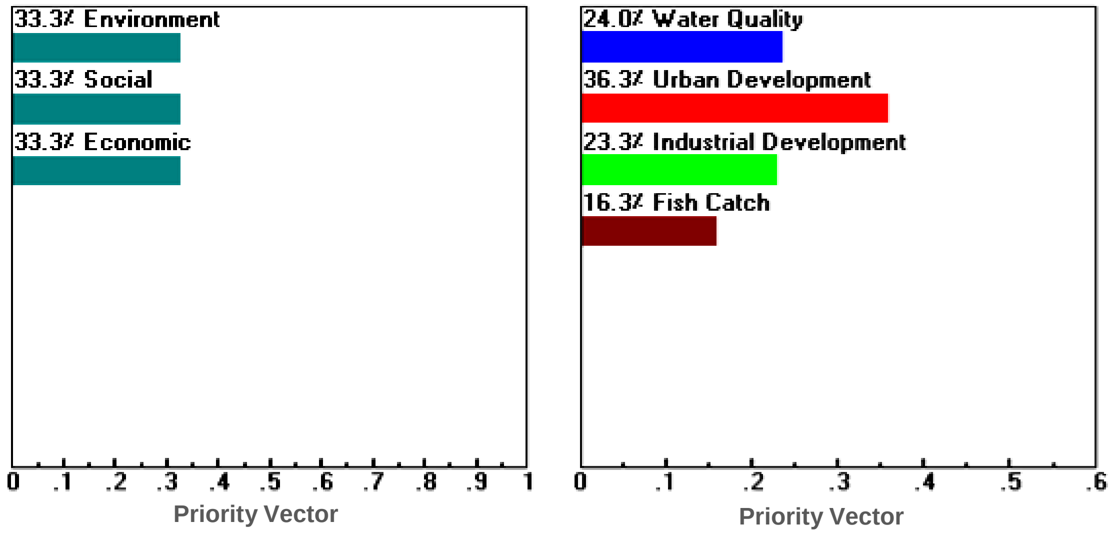


Figure 5-16 Sensitivity Analysis for SD Model

By assigning 100% to this objective, sensitivity analysis for the environment objective shows that water quality remains the top priority with 56.7% of total scores, fish catch is ranked second with 31.3%, urban and industrial development are comparatively low priorities with 6.1% and 5.9% respectively (see Figure 5-17).

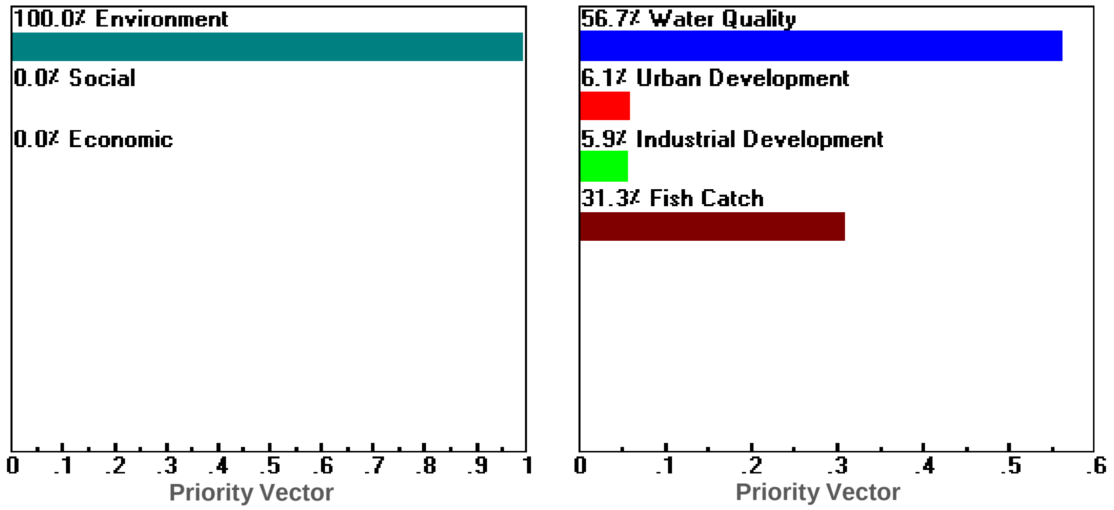


Figure 5-17 Sensitivity Analysis when Maximising the Environment

If we assign 100% weight to the social objective, urban development dominates preferences with 57.1%. Urban development, fish catch and industrial development are equal at 14.3% (see Figure 5-18).

These results show that if the social dimension is preferred over environment and the economy, urban development is the highest contributor to social upgrading, followed by all other alternatives.

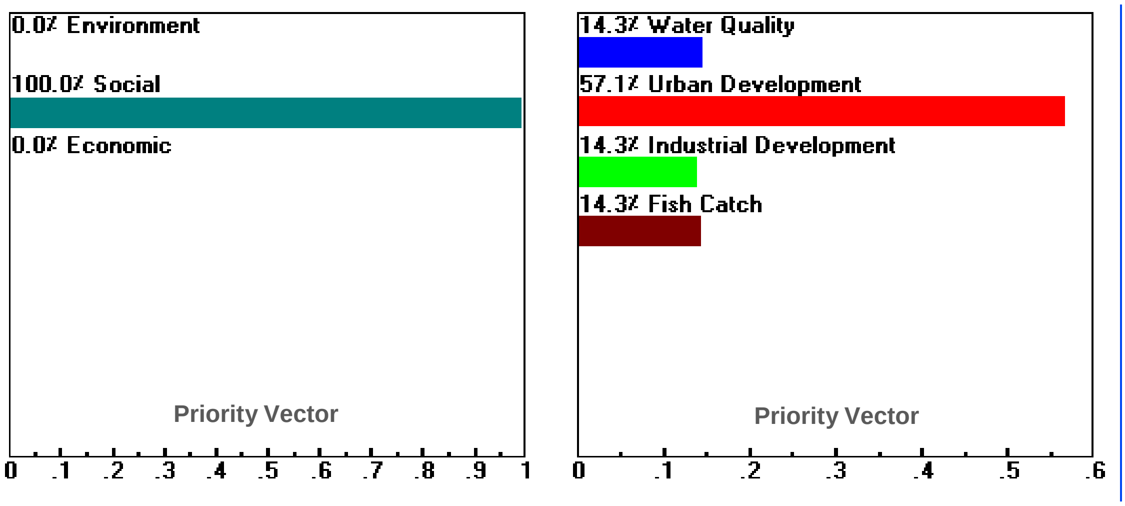


Figure 5-18 Sensitivity Analysis when Maximising the Social

Maximising the weight of the Economy objective to 100% reveals that industrial development and urban development dominate with 43.7% of total scores, followed by water quality and fish catch equally at 6.3% (see Figure 5-19).

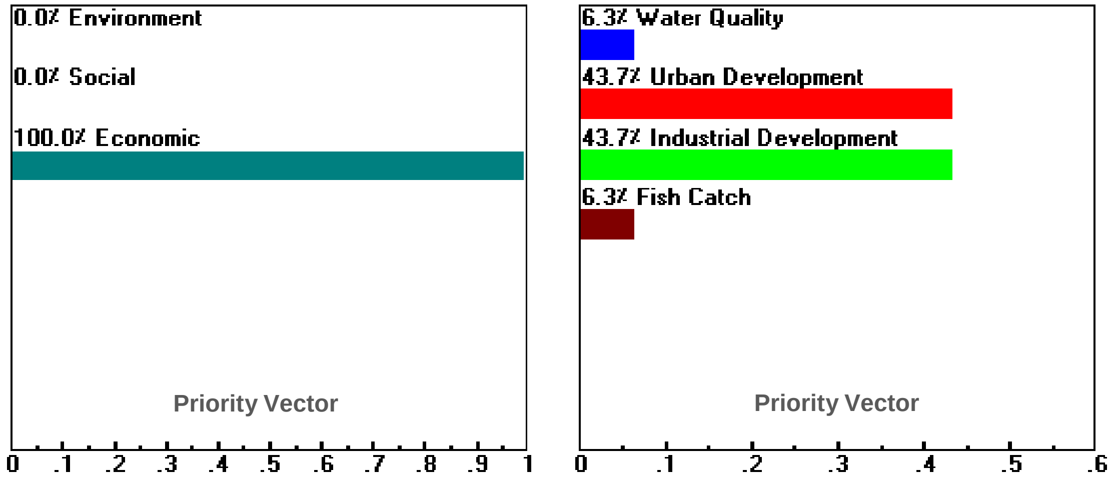


Figure 5-19 Sensitivity Analysis when Maximising the Economy

5.4 Stakeholder Decision Analytical Module (SDAM)

Primary stakeholders are identified in chapter four and selected for analysis: Governorate of Alexandria (GOA), Ministry of the Environment represented by the EEAA, the fishing community (FC), and the local industry sector in the Lake Maryout area, represented by the Alexandria Businessmen Association (ABA). The model uses these stakeholders at the criteria/objectives hierarchical level and proposes the identified alternatives that are used in the SDDM. This means that SDAM, bearing a primary goal of management of Lake Maryout explores the overall management decision or strategy that meets the requirements of stakeholders within their identified alternatives.

To achieve this goal, SADM analyses each stakeholder's comparative preferences towards the management of the study area. Structure of SDAM is shown in chapter 3.

SADM examines the degree of inconsistency in these preferences, and then compares all strategies to analyse the areas of consensus or conflict. SADM gets inputs from stakeholder questionnaires, constructs SADM hierarchical level, pairwise comparison table, SADM matrix and inconsistency ratio. It analyses stakeholder decisions and finally calculates stakeholder consensus and synthesises priorities.

5.4.1 Development of SADM Equal Weighted Hierarchical Tree

SADM hierarchical tree consists of three levels. The first level contains the criteria level which is represented by the identified stakeholders. The second level contains the four identified objectives (see Figure 5-20). The three-level hierarchical structure is used to simplify the functions and for easier interpretation of the results. However, as explained earlier in this chapter and as illustrated in chapter 2, the real life situations are more complex. Stakeholders' interests are functions of many variables. The added value of the EDAM is its ability to measure the degree that each variable is contributing to the overall preference of each stakeholder. This allows decision-makers to plan for mitigation processes based on informed map of the overall stakeholders' priorities. It will also develop an understanding of the stakeholders conflicting areas.

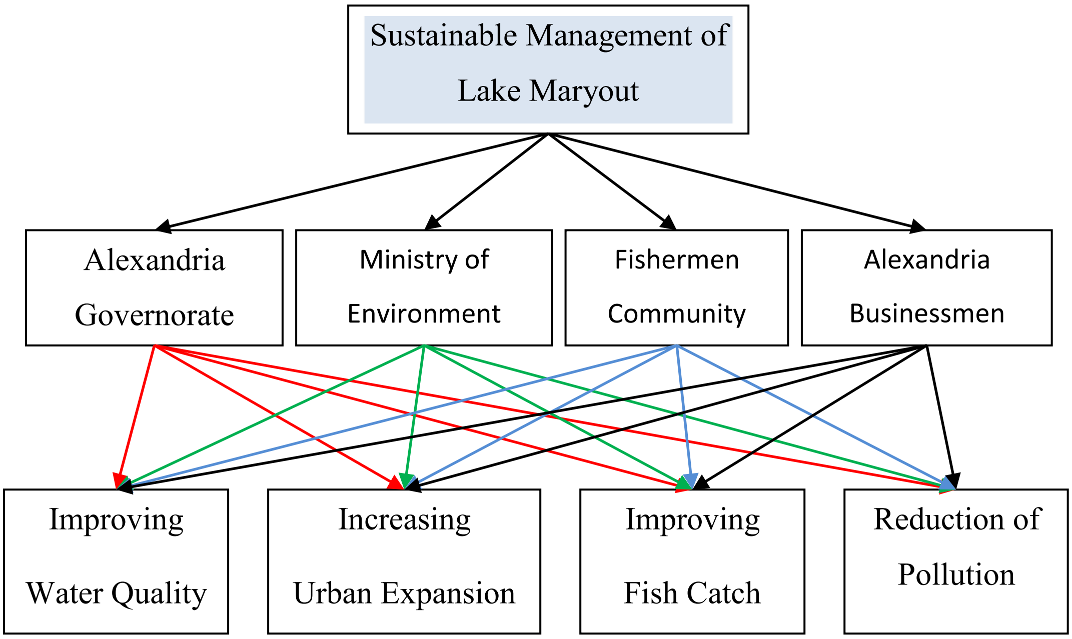


Figure 5-20 Equal weighted SDAM Hierarchical Structure

5.4.2 Development of SADM Pairwise Comparison Table

SADM assumes in its initial analysis that all stakeholders have the same weight (see Table 5-23).

Table 5-23 Relative Importance with Respect to Participation

	Alexandria Governorate	Ministry of Environment	Fishermen Community	Business Association
Alexandria Governorate		Equal	Equal	Equal
Ministry of Environment			Equal	Equal
Fishermen Community				Equal
Businessmen Association				

5.4.3 Development of SADM AHP Matrix

(Table 5-24) shows the AHP SDAM equal weighted stakeholder matrix, while

Table 5-24 SDAM Equal Weighted Stakeholder Matrix

	Water Quality	Urban Development	Industrial Developme	Fish Catch
Water Quality	1	**1**	**1**	**1**
Urban Development	1	1	**1**	**1**
Industrial Development	1	1	1	**1**
Fish Catch	1	1	1	1
SUM (col)	4	4	4	4

5.4.4 Development of SDAM Normalised Matrix

Normalised Eigenvalues are calculated for SDAM in respect to their pairwise comparison. Table 5-25 shows the normalised principle Eigenvectors for SDAM preferences with respect to the identified alternatives. The SDAM assigns equal weights for each stakeholder which results in equalised values in the normalised matrix.

Table 5-25 SDAM Normalised Equal Weighted Stakeholders' Matrix

	normalized matrix				1st
Water Quality	0.25	0.25	0.25	0.25	25%
Urban Development	0.25	0.25	0.25	0.25	25%
Industrial Development	0.25	0.25	0.25	0.25	25%
Fish Catch	0.25	0.25	0.25	0.25	25%

5.4.5 Calculation of Consistency Ratio (CR)

SDAM assigns equal weights to stakeholders. Therefore, the calculated inconsistency ratio is equal to 0.0% (see Table 5-26).

Table 5-26 SDAM Inconsistency Ratio

Lambda	1	1	1	1		**4.000**	**principal Eigenvalue**
n	**4**			CI		0.000	
				CR		**0.0%**	**Consistency**

5.4.6 Analyses of Governorate of Alexandria (GOA) Preferences

SDAM analyses the synthesised decision for all stakeholders, then assigns relative weights based on the stakeholder influence analysis to assess the impact of differentiated power on the decision-making process.

The methodology analyses each stakeholder individually, to identify the direction of its decision. The values are used as inputs for the SADM to calculate the area of each stakeholder and the decision intersection or consensus with the SDDM.

The synthesised values of a combined decision are then checked and compared with the SDDM. SDAM calculates the overall areas of all stakeholders and finds the area of consensus.

5.4.6.1 Development of GOA Pairwise Comparison Table

Data from GOA Stakeholders Pairwise Comparison Questionnaires are organised and entered into the SDAM module. A GOA matrix is created based on the identified comparative values (see Table 5-27).

Table 5-27 Relative Preferences with Respect to GOA Preferences

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality		Strong	Moderate	Moderate
Urban Development			Moderate to Strong	Strong
Industrial Development				Moderate to Strong
Fish Catch				

5.4.6.2 Development of GOA AHP Matrix

Table 5-28 SDAM GOA AHP Matrix

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality	1	**1/5**	**1/3**	**3**
Urban Development	5	1	**4**	**5**
Industrial Development	3	1/4	1	**4**
Fish Catch	1/3	1/5	1/4	1
SUM (col)	9 1/3	1 2/3	5 4/7	13

Table 5-28 above shows GOA's AHP matrix.

5.4.6.3 Development of SDAM GOA Normalised Matrix

Normalised Eigenvalues are calculated for GOA in respect to their pairwise comparison. Table 5-29 shows the normalised principle Eigenvectors for GOA preferences with respect to the identified alternatives.

Table 5-29 SDAM GOA Normalised Matrix

	normalized matrix				
Water Quality	0.107	0.121	0.06	0.231	13%
Urban Development	0.536	0.606	0.716	0.385	56%
Industrial Development	0.321	0.152	0.179	0.308	24%
Fish Catch	0.036	0.121	0.045	0.077	7%

5.4.6.4 Calculation of GOA Consistency Ratio (CR)

The inconsistency ratio is equal to 13.2% (see Table 5-30). This shows the high inconsistency in the GOA's decision towards the management of Lake Maryout.

Table 5-30 GOA Inconsistency Ratio

Lambda	1.1005	0.9874	1.0679	1.2014	4.357	principal Eigenvalue		
n	4			CI	0.119			
				CR	13.2%	Consistency		

5.4.6.5 *Analysing GOA overall Results*

Results of analysing the preferences of the Governorate of Alexandra show that urban development presents the most favourable alternative (56%), followed by industrial development (24%), then water quality (13%), and finally fish catch (7%).

The results match the actions and responses identified in the DPSIR and the stakeholder analysis, since filling in parts of the lake is a consistent strategy for the Governorate of Alexandria, arguably justified by enormous public pressure to find new residential areas for the growing population. This is reflected by the GOA judgments that are mostly in favour of urban development in comparison with most of other alternatives (see Figure 5-21).

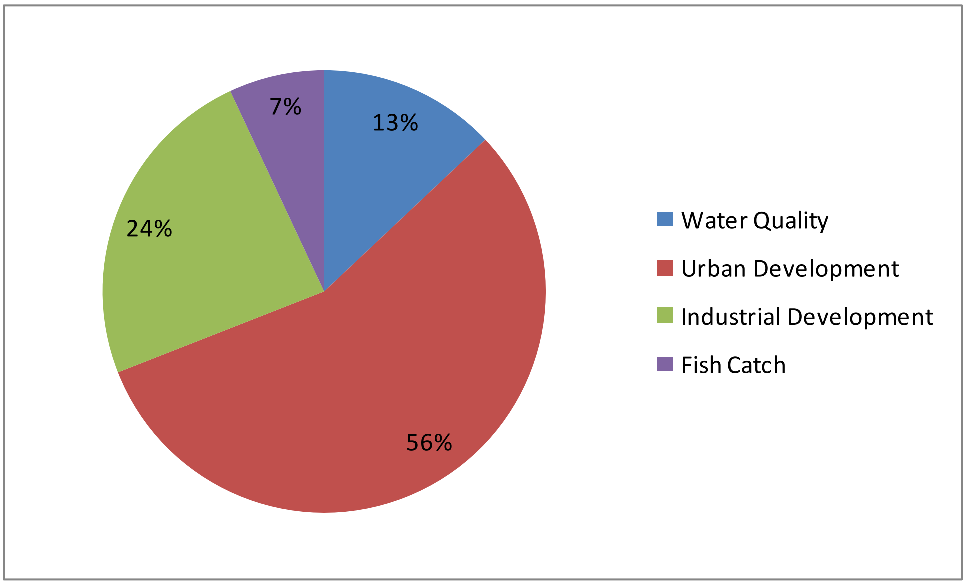


Figure 5-21 Alexandria Governorate's Priorities

5.4.6.6 *Analysing GOA Results with Respect to SDDM*

Overlaying the overall priorities diagram of Governorate of Alexandria (see Figure 5-22) over the SDDM reveals that the Governorate's decision-making process is more oriented towards resolving the social aspect of the problem (see Figure 5-23).

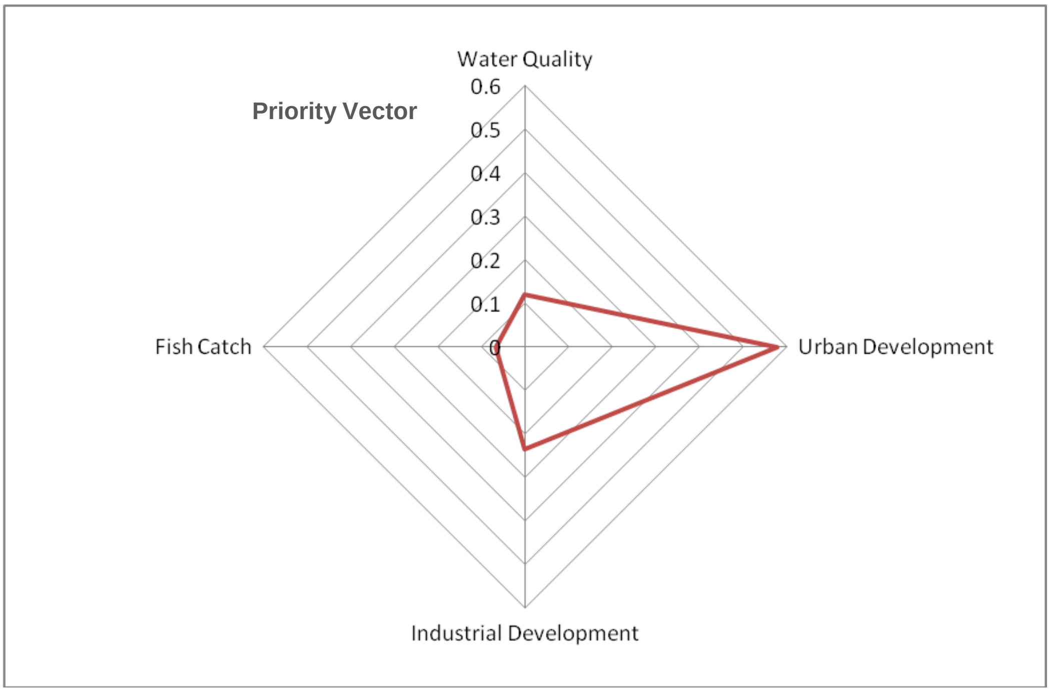


Figure 5-22 Alexandria Governorate overall Priorities Diagram

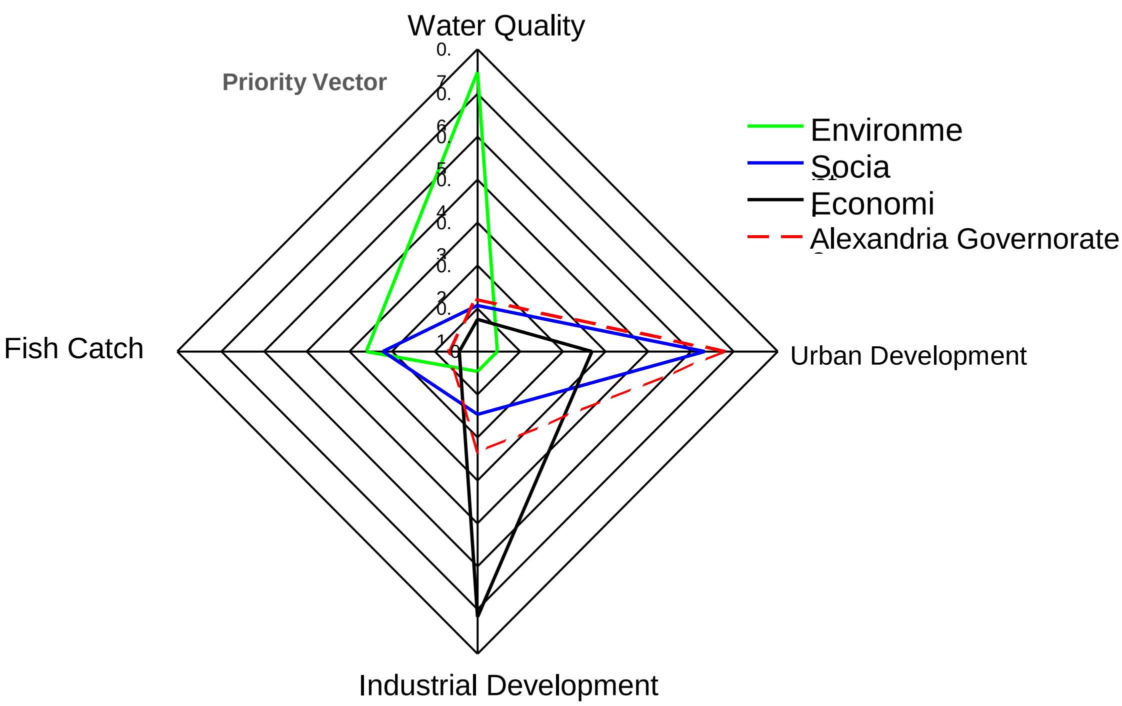


Figure 5-23 Relation between SDDM and GOA

5.4.6.7 Calculating GOA Consensus between SDAM and SDDM using SDAM

Outputs of GOA SDAM are spatially overlaid on the SDDM using the SDAM GIS spatial functions. The objective is to examine the consensus between GOA and the SD components. The area of intersection between GOA preferences and SDDM objectives, illustrate the degree of harmony in the decision orientation of the GOA with the social dimension (see Figures Figure 5-24, Figure 5-25 and Figure 5-26).

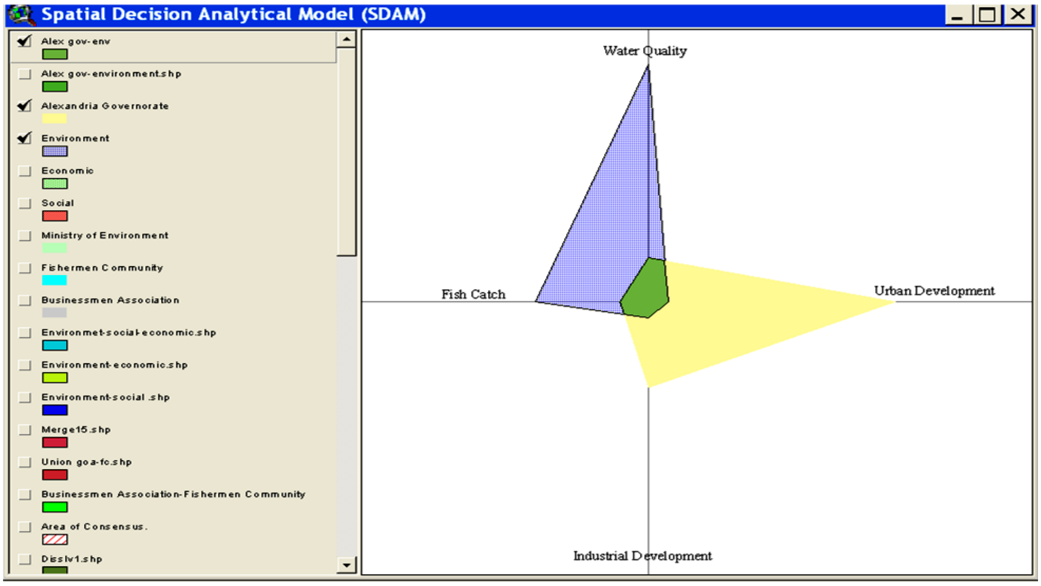


Figure 5-24 Intersection between GOA and Environment

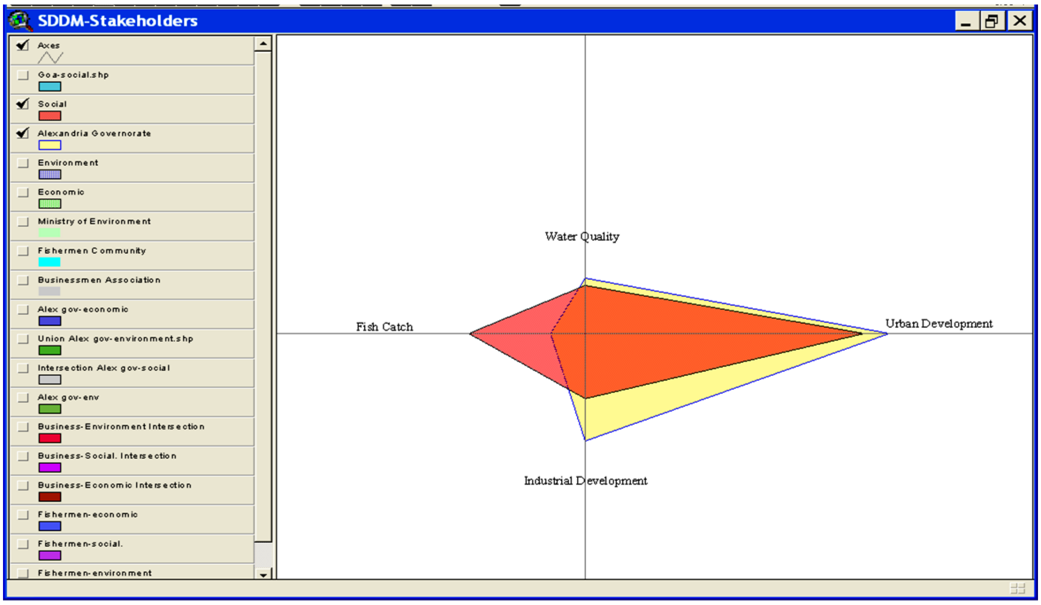


Figure 5-25 Intersection between GOA and Social

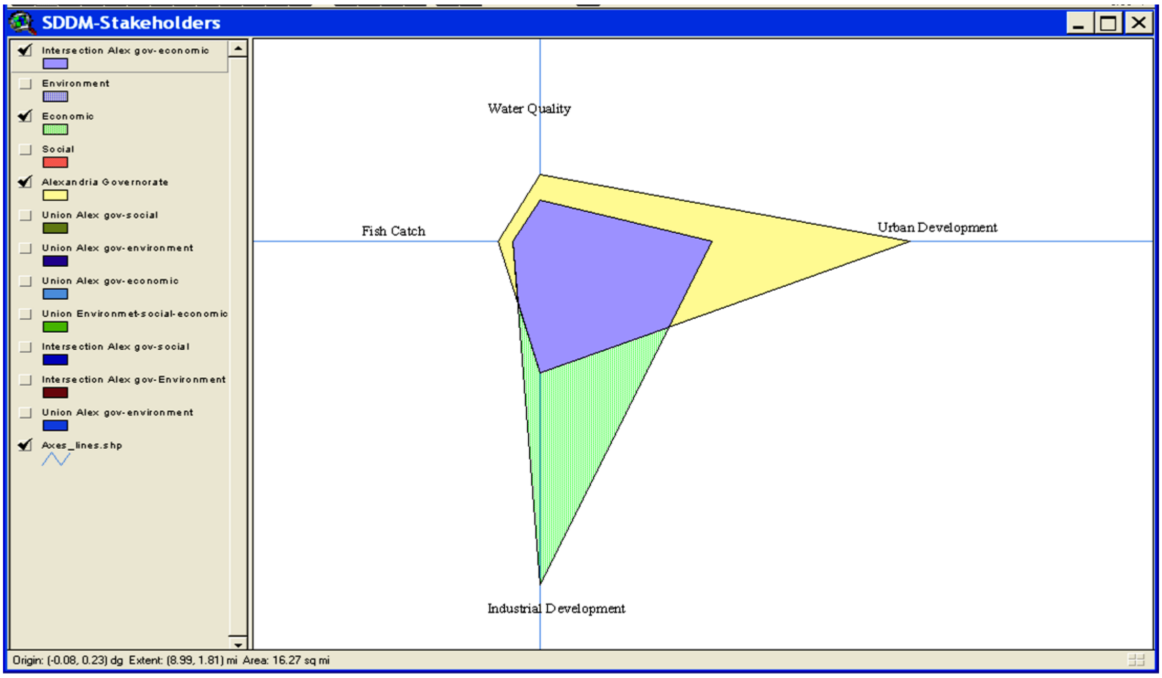


Figure 5-26 Intersection between GOA and Economy

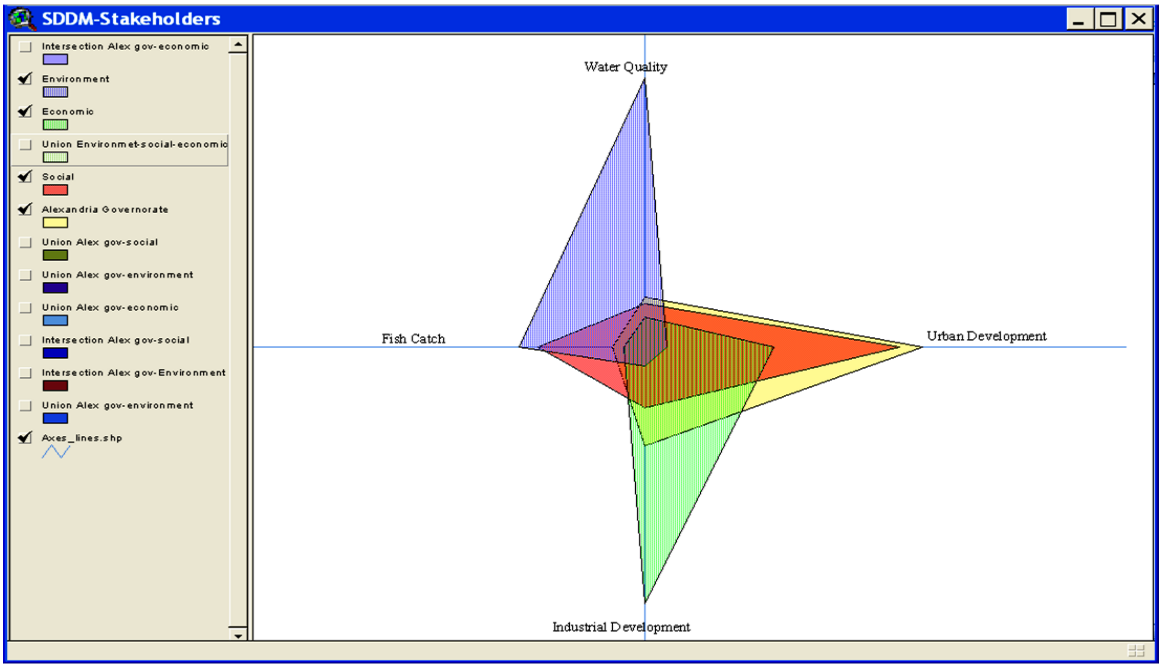


Figure 5-27 Alexandria Governorate's area of consensus with SDDM

Area of Consensus between GOA and SDDM is calculated through the SDAM (see Figure 5-27).

Table 5-31 shows the Governorate of Alexandria's overall preferences in relation to the identified alternatives compared.

Table 5-31 comparative preferences between SDDM and GOA

	Area of Consensus	Total Area	Percentage
GOA-Environment	0.0124	0.20861	5.94%
GOA-Social	0.0762	0.13175	57.84%
GOA-Economy	0.0522	0.1594	32.75%

The results show that the percentage of consensus between the GOA and the social objective is equal to 57.84%, followed by the economic objective at 32.75%, and finally the environment with 5.94% of the overall areas of consensus (see Figure 5-28).

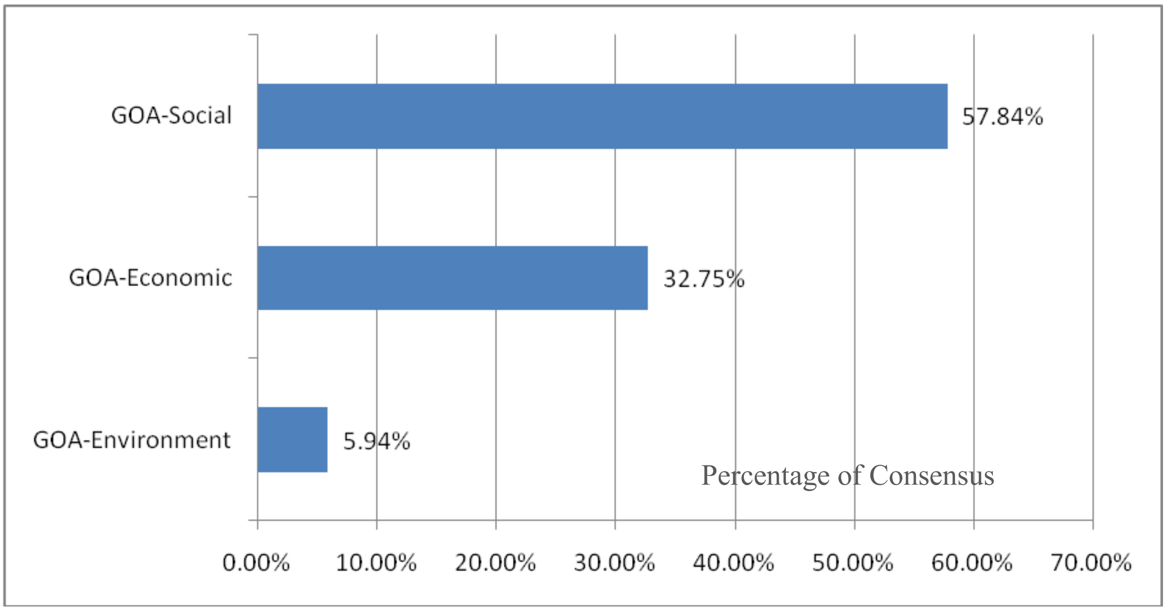


Figure 5-28 Percentages of Governorate of Alexandria Consensus in respect to SDDM

5.4.7 Analysis of Ministry of the Environment (MOE) Preferences

5.4.7.1 Development of MOE Pairwise Comparison Table

Data from MOE questionnaires are organised and entered into the SDAM module. A GOA matrix is created based on the identified comparative values.

Table 5-32 shows that the Ministry of Environment has extreme negative comparative judgments towards water quality in comparison with both urban development and industrial development. These judgments are logical because both alternatives have severe implications for the environmental quality of the lake, while the Ministry has no social or economic marginal objective.

Table 5-32 Relative Preferences with Respect to Ministry of Environment

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality		Extreme	Extreme	Moderate
Urban Development			Moderate	Extreme
Industrial Development				Extreme
Fish Catch				

5.4.7.2 Development of MOE AHP Matrix

Based on the above table, SDAM developed the MOE preferences matrix (see Table 5-33).

Table 5-33 SDAM MOE AHP Matrix

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality	1	**9**	**9**	**3**
Urban Development	1/9	1	**3**	**1/9**
Industrial Development	1/9	1/3	1	**1/9**
Fish Catch	1/3	9	9	1
SUM (col)	1 5/9	19 1/3	22	4 2/9

5.4.7.3 Calculating SDAM MOE Normalised Matrix

Table 5-34 shows the calculated AHP normalised matrix of MOE and the resultant percentages of principle Eigenvectors.

Table 5-34 SDAM MOE Normalised Matrix

$$
\begin{array}{r}
\\
\text{Water Quality} \\
\text{Urban Development} \\
\text{Industrial Development} \\
\text{Fish Catch}
\end{array}
\begin{array}{c}
\text{normalized matrix} \\
\begin{pmatrix}
0.643 & 0.466 & 0.409 & 0.711 \\
0.071 & 0.052 & 0.136 & 0.026 \\
0.071 & 0.017 & 0.045 & 0.026 \\
0.214 & 0.466 & 0.409 & 0.237
\end{pmatrix}
\end{array}
\qquad
\begin{pmatrix}
56\% \\
7\% \\
4\% \\
33\%
\end{pmatrix}
$$

5.4.7.4 Calculation of MOE Consistency Ratio (CR)

The calculated inconsistency ratio is equal to 17.1%, showing a high degree of inconsistency in the Ministry's judgments (see Table 5-35).

Table 5-35 MOE Inconsistency Ratio

Lambda	0.9885	1.2118	1.2205	1.0403	4.461		principal Eigenvalue		
n	4			CI	0.154				
				CR	17.1%		Consistency		

5.4.7.5 Analysing MOE overall results

Analysis of the judgments of the Ministry of Environment reveals that enhancing the water quality is comparatively the most favoured alternative (56%), followed by fish catch (33%), then urban development (7%), and lastly industrial development (4%) (see Figure 5-29).

Results are consistent with DPSIR and stakeholder analysis results, where water quality was identified as a key factor in upgrading the environmental condition of the lake while fish catch was needed to maintain the biological balance and ecosystem of the lake.

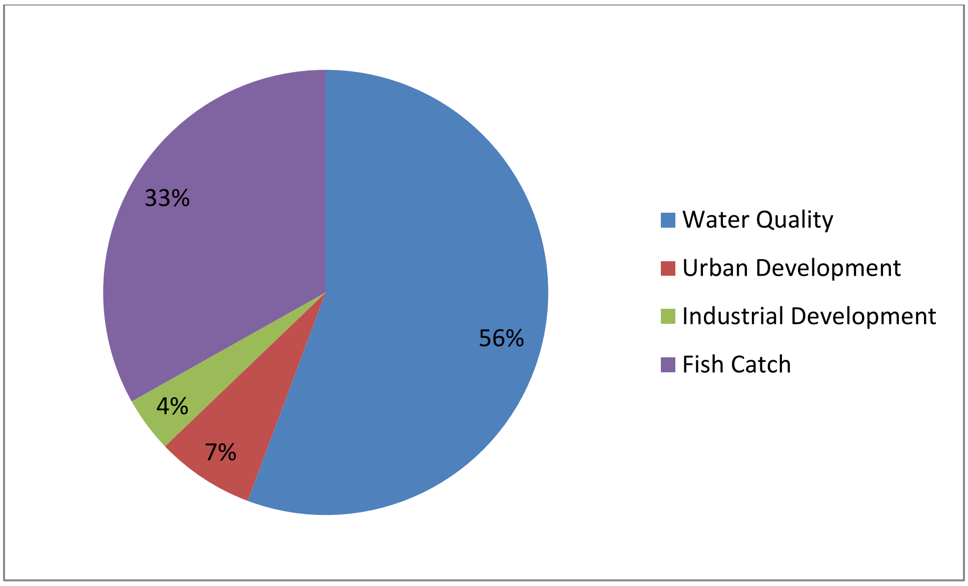


Figure 5-29 EDAM MOE Normalised Principle Eigenvectors

5.4.7.6 Analysing MOE Results with Respect to SDDM

Outputs of GOA SDAM are spatially overlaid on the SDDM using the SDAM GIS spatial functions. The objective is to examine the consensus between GOA and the SD components.

Overlaying the SDDM diagram on the MOE diagram shows that the Ministry of Environment's decision-making process is inclined towards upgrading the environmental aspect (see Figure 5-30). MOE overall preferences match with the environment component of the SDDM. Figure 5-31 shows the area of intersection between the Ministry of Environment preferences and the environment objective illustrating the degree of consensus between the environment dimension and MOE in the decision orientation.

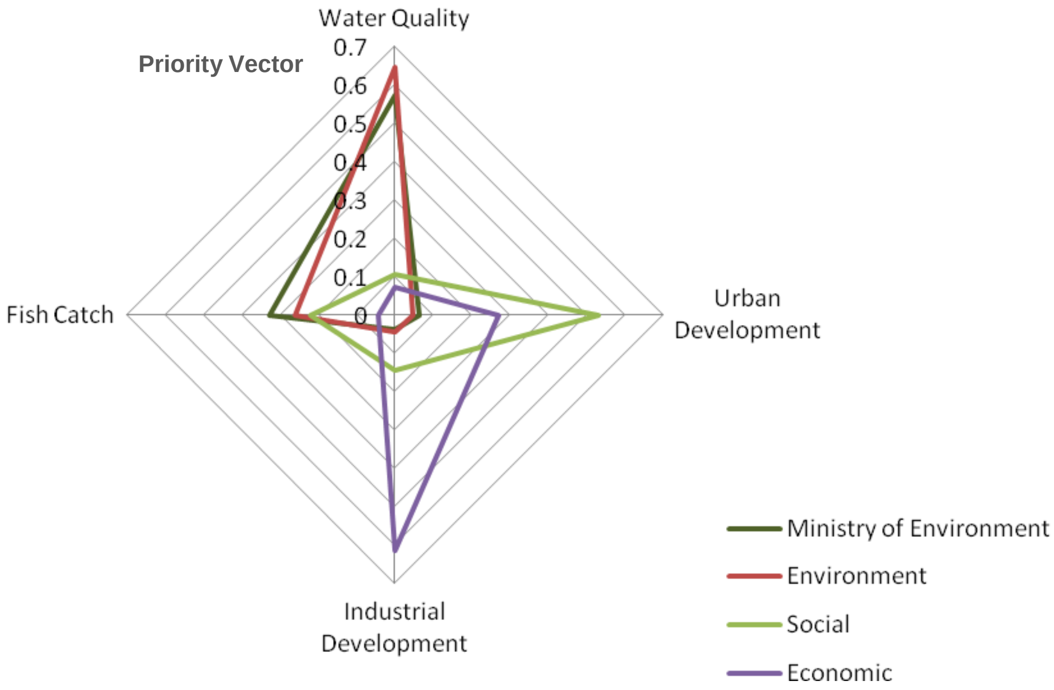


Figure 5-30 Relation between SDDM and MOE

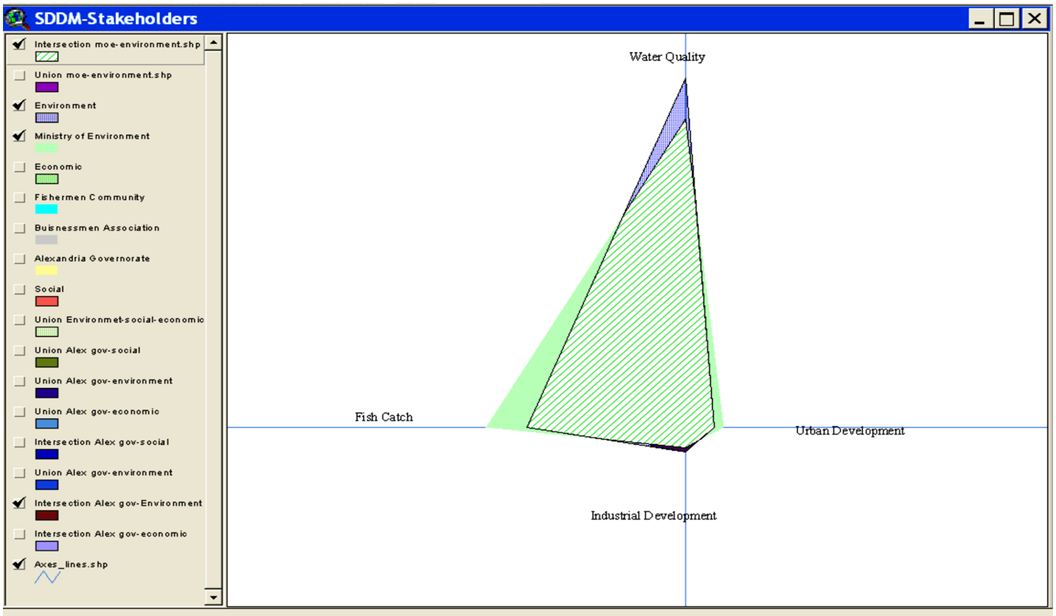


Figure 5-31 Intersection Between MOE and Environment

Figure 5-32 and Figure 5-33 show the intersections between the MOE preferences and the economic and social dimensions of the SDDM, while Figure 5-34 illustrates percentages of MOE consensus in relation to SDDM.

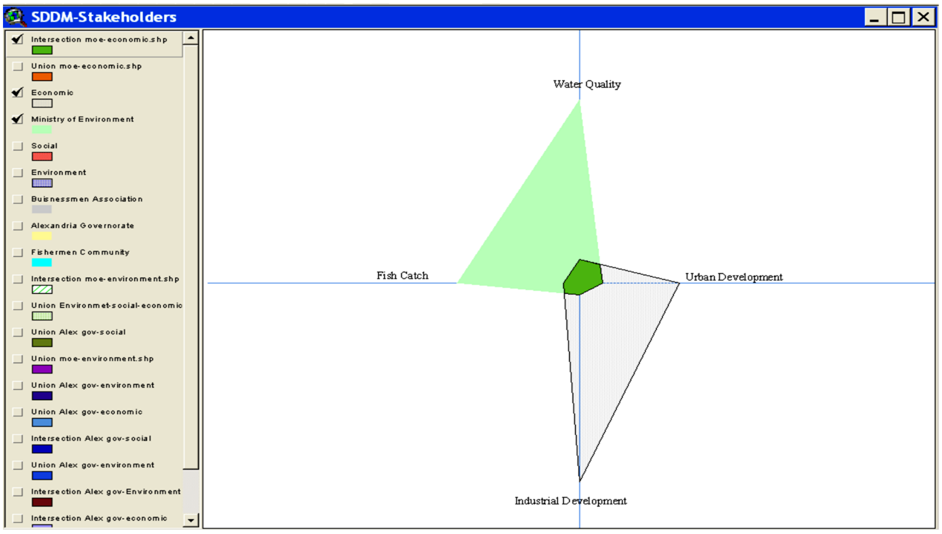


Figure 5-32 Intersection Between MOE and Economic

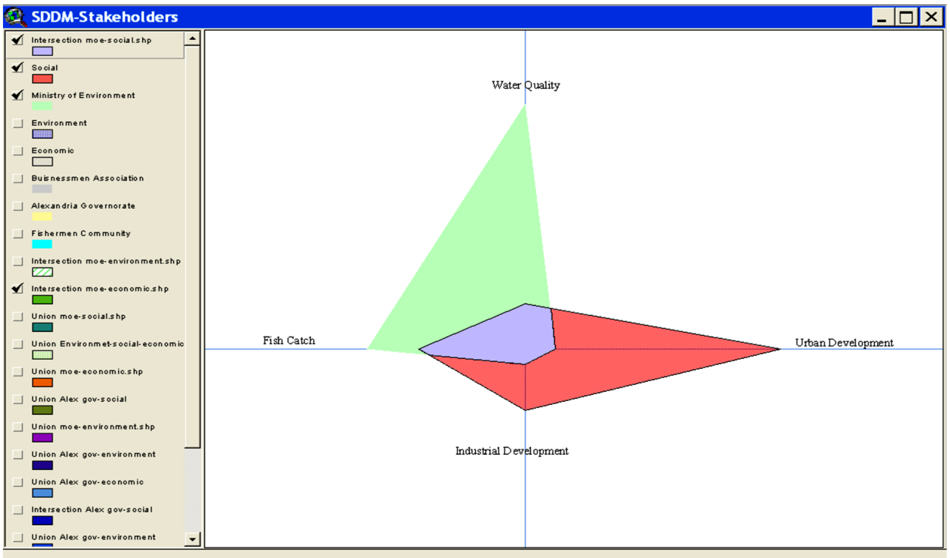


Figure 5-33 Intersection Between MOE and Social

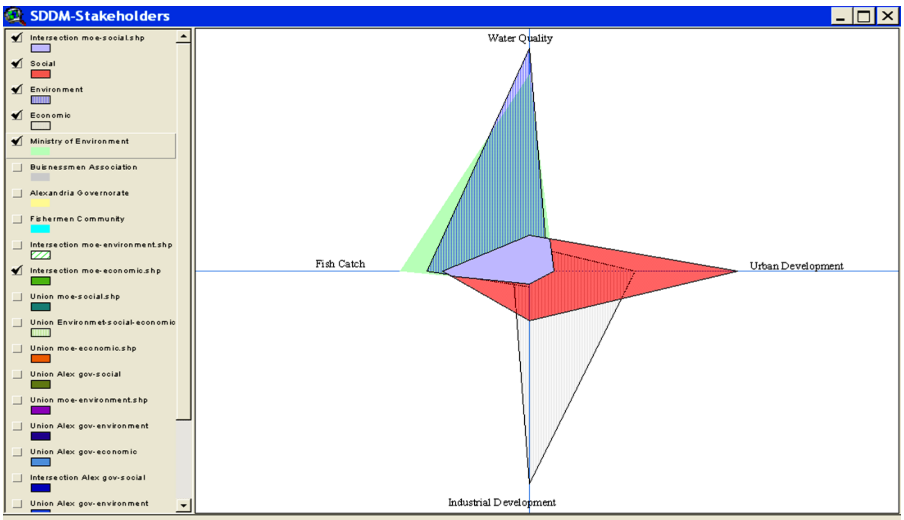


Figure 5-34 MOE areas of consensus with SDDM

5.4.7.7 Calculating Consensus between MOE SDAM and SDDM using SDAM

Table 5-36 shows the overall preferences in relation to the identified alternatives compared to the MOE's overall judgment. The percentage of consensus between the MOE and the environment objective is equal to 81.64% which represents a high level of consistency with this sustainable development pillar, with the social objective trailing by a large margin at 12.61%, and very little consensus with the economic dimension, at only 3.67%.

Table 5-36 comparative preferences between SDDM and MOE

	Area of Consensus	Total Area	Percentage
MOE-Environment	0.1014	0.1242	81.64%
MOE-Economic	0.008	0.2182	3.67%
MOE-Social	0.0238	0.1888	12.61%

Figure 5-35 below shows the percentages of consensus between the preferences of the Ministry of Environment (MOE) and the SDDM components.

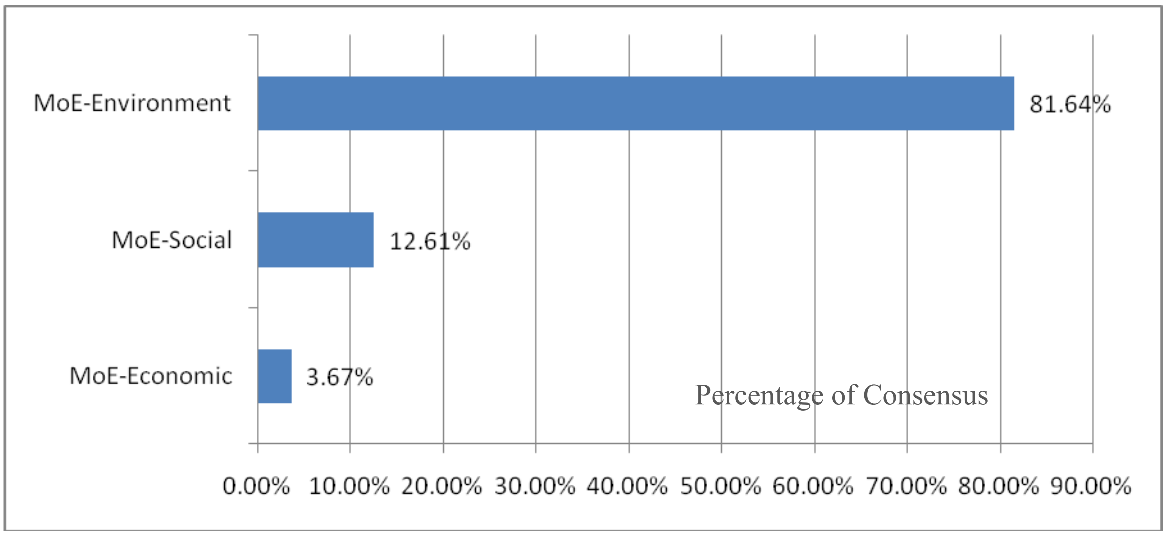


Figure 5-35 Percentages of MOE Consensus in respect to SDDM

5.4.8 Analysis of Fishermen Community (FC) Preferences

5.4.8.1 Development of FC Pairwise Comparison Table

Data from FC questionnaires are organised and entered into the SDAM module. A FC SDAM matrix is created based on the identified comparative values (see Table 5-37).

Table 5-37 Relative Preferences with respect to Fishermen Community

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality		Strong	Extreme	Extreme
Urban Development			Moderate to Strong	Extreme
Industrial Development				Extreme
Fish Catch				

Analysis of the preferences of fishermen illustrates that the main objective is to increase the fish catch production. The fishermen attribute extreme importance to the fish catch giving this objective the highest priority by far compared to other alternatives.

5.4.8.2 Development of FC AHP Matrix

Based on FC's inputs, SDAM developed the FC's preferences matrix (see Table 5-38).

Table 5-38 SDAM FC AHP Matrix

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality	1	**5**	**9**	**1/9**
Urban Development	1/5	1	**4**	**1/9**
Industrial Development	1/9	1/4	1	**1/9**
Fish Catch	9	9	9	1
SUM (col)	10 1/3	15 1/4	23	1 1/3

5.4.8.3 Calculation of SDAM FC Normalised Matrix

Table 5-39 shows the calculated normalised Eigenvalues for FC priorities based on the developed AHP SDAM matrix.

Table 5-39SDAM FC Normalised Matrix

normalized matrix

$$\begin{array}{r} \text{Water Quality} \\ \text{Urban Development} \\ \text{Industrial Development} \\ \text{Fish Catch} \end{array} \begin{pmatrix} 0.097 & 0.328 & 0.391 & 0.083 \\ 0.019 & 0.066 & 0.174 & 0.083 \\ 0.011 & 0.016 & 0.043 & 0.083 \\ 0.873 & 0.59 & 0.391 & 0.75 \end{pmatrix} \qquad \begin{pmatrix} 22\% \\ 9\% \\ 4\% \\ 65\% \end{pmatrix}$$

5.4.8.4 *Calculation of FC Consistency Ratio (CR)*

Examining FC's inconsistency reveals that their judgments are highly inconsistent with a Consistency Ratio of 37% (see Table 5-40).

Table 5-40 FC Inconsistency Ratio

Lambda	1.2888	1.2189	1.5243	0.9717	5.004	principal Eigenvalue
n	4			CI	0.335	
				CR	37.2%	Consistency

5.4.8.5 *Analysing FC overall Results*

Results show that FC's main priority is the fish catch, as it is their main source of income (65%). Water quality is their second preference (22%) because of its positive impact on fish reproduction and overall catch, and also on the health of the local community. Urban development is their third priority (9%), since development of the area could have positive impacts on their local economy while industrial development is their last alternative with only 4% (see Figure 5-36).

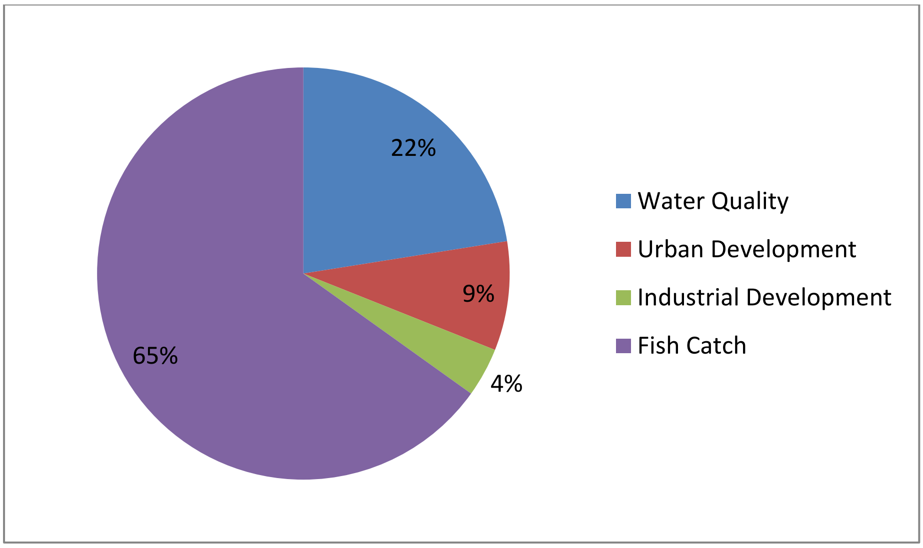


Figure 5-36 FC's Priorities

5.4.8.6 Analysing FC Results with Respect to SDDM

Overlaying the SDDM diagram over the fishermen community diagram (see Figure 5-37) shows that the fishermen's preferences do not match any particular pattern of the SDDM. Fish catch is considered a cross-cutting issue between environment, social and economic. It is environmental in terms of preserving the existing species and protecting the ecosystem.

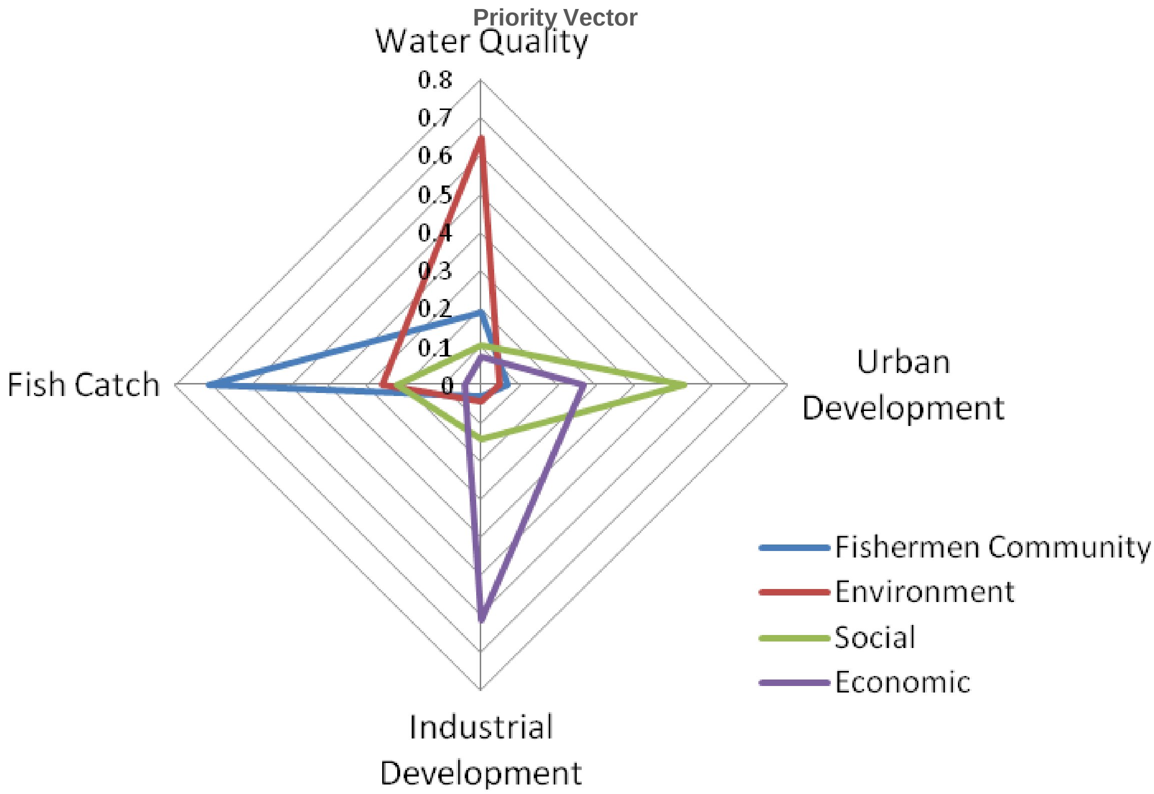


Figure 5-37 Relation Between SDDM and Fishermen Community

5.4.8.7 Calculating Consensus between FC SDAM and SDDM using SDAM

Figure 5-38, Figure 5-39 and Figure 5-40 show the areas of intersection between the FC and the sustainable development components.

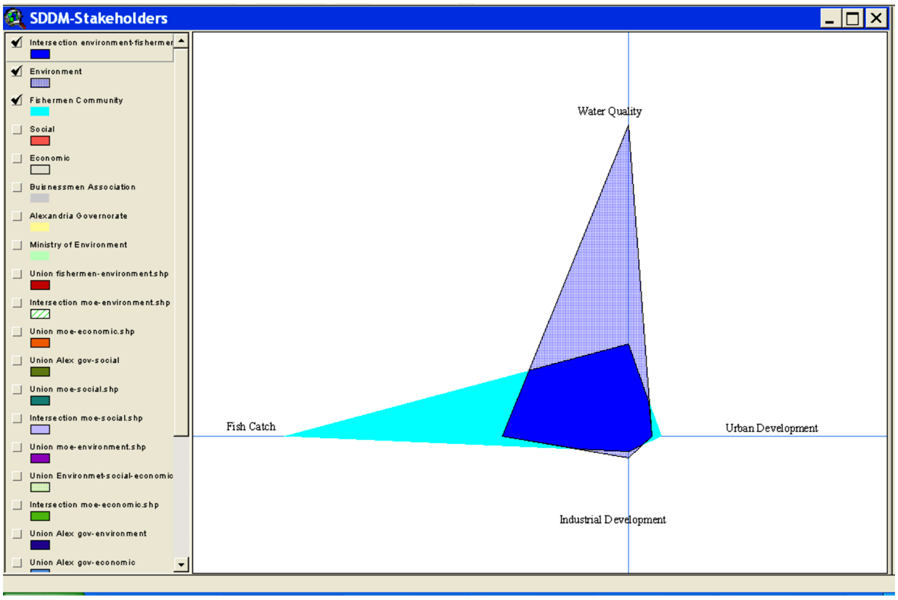


Figure 5-38 Intersection between Fishermen and Environment

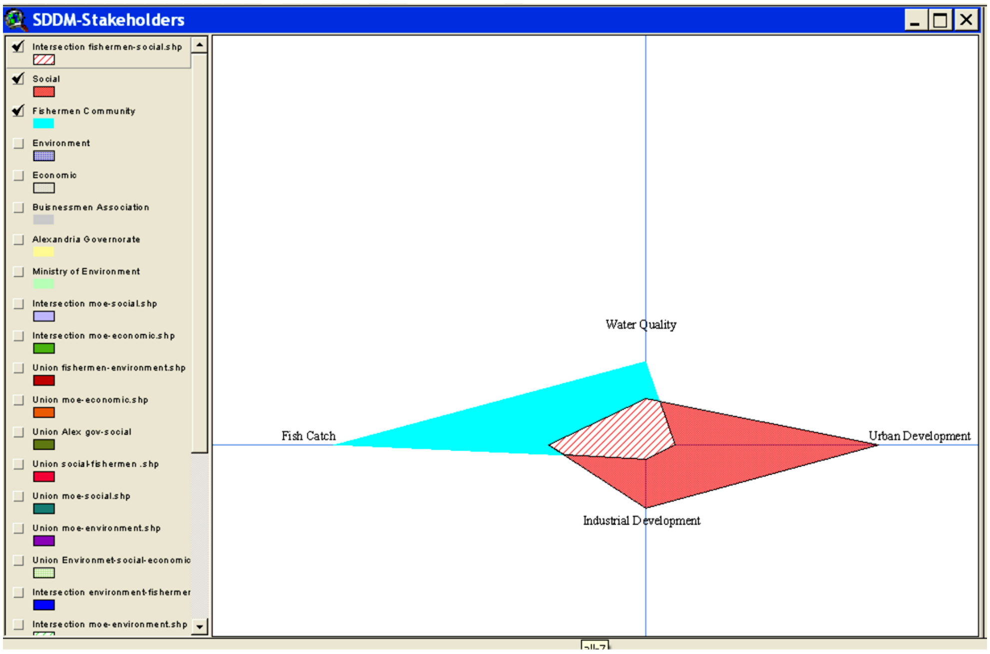


Figure 5-39 Intersection between Fishermen and Social

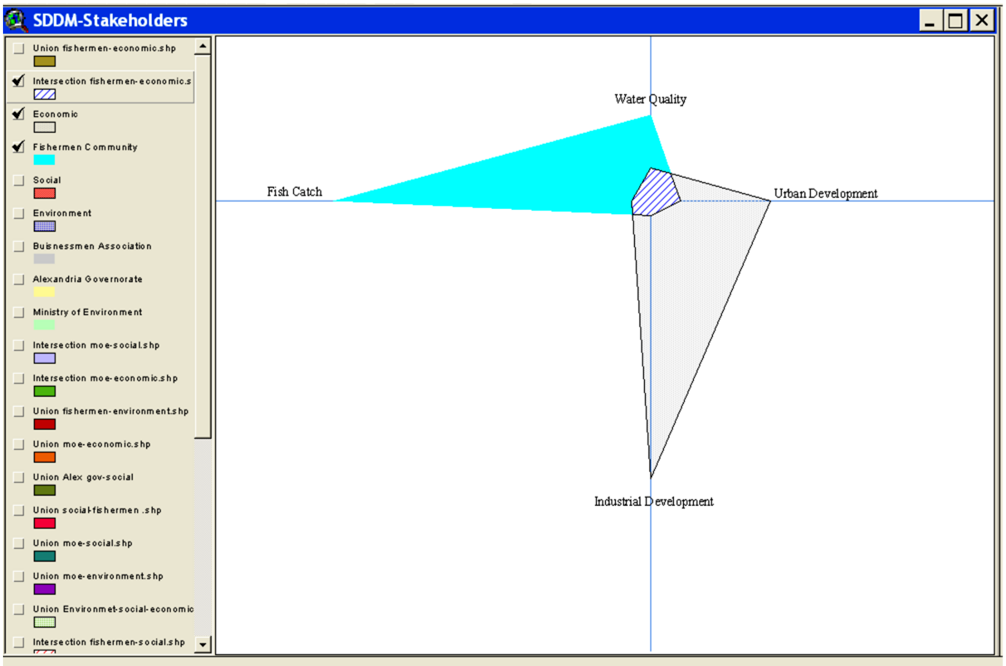


Figure 5-40 Intersection between Fishermen and Economy

Figure 5-41 shows fishermen's overall judgment and different components of the SDDM.

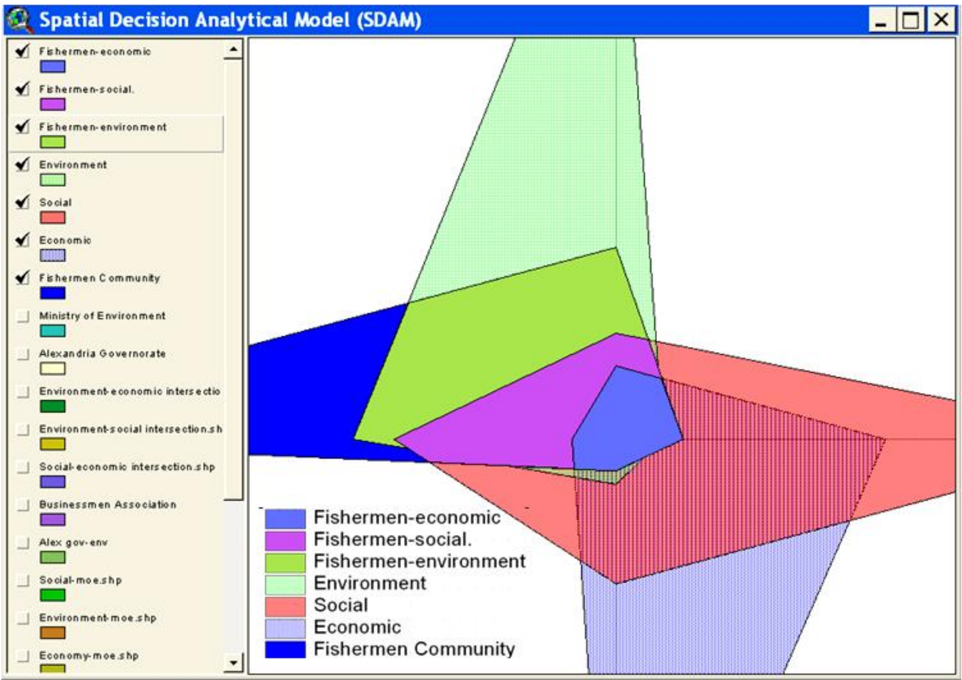


Figure 5-41 Intersections between SDDM and Fishermen

SDAM calculates the areas of intersection between the preferences of the fishermen community and the three pillars of sustainable development represented in the SDDM (see Table 5-41).

Table 5-41 Comparative preferences between SDDM and Fishermen

	Area of Consensus	Total Area	Percentage
Fishermen-Economic	0.0076	0.18624	4.08%
Fishermen-Social	0.0232	0.157	14.78%
Fishermen-Environment	0.0491	0.1441	34.07%

Analysis shows that there is 34.07% consensus between the environmental dimension and the fishermen judgment. Fish catch has a social dimension in terms of the impact of a reduced catch on the local community, specifically the fishermen and their families. Results show that there is 14.78% consensus between fishermen and SDDM social dimension. The economic dimension is also connected with the fish catch as it contributes to the local economy.

The low percentage of 4.08% consensus with economic dimension is due to the reduction in volume and value of the fish catch (see Figure 5-42).

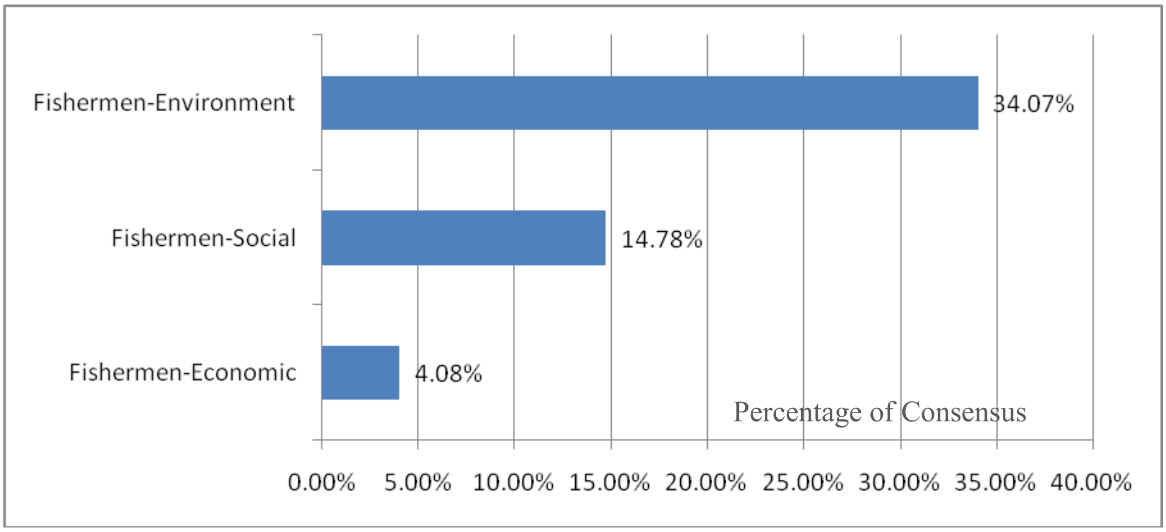


Figure 5-42 Percentages of Fishermen Consensuses in relation to SDDM

5.4.9 *Analysis of Alexandria Businessmen Association (ABA) Preferences*

5.4.9.1 *Development of ABA Pairwise Comparison Table*

The Businessmen's Association as described in institutional analysis are a group of industries and businesses around the area of Lake Maryout. Data from ABA questionnaires are organised and entered into the SDAM module. ABA SDAM matrix is created based on the identified comparative values (see Table 5-42).

Table 5-42 Relative Preferences with respect to Businessmen Association

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality		Very Strong	Extreme	Strong
Urban Development			Very Strong	Very Strong
Industrial Development				Extreme
Fish Catch				

Analysing their preferences shows that industrial development is of extreme priority compared to all other alternatives. ABA judgments attach very strong importance to urban development, and lesser importance to both water quality and fish catch. This is due to their need for urban expansion in order to expand their businesses.

5.4.9.2 *Development of ABA AHP Matrix*

Table 5-43 ABA AHP Matrix

	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality	1	**1/7**	**1/9**	**5**
Urban Development	7	1	**1/7**	**7**
Industrial Development	9	7	1	**9**
Fish Catch	1/5	1/7	1/9	1
SUM (col)	17 1/5	8 2/7	1 3/8	22

5.4.9.3 Development of SDAM FC Normalised Matrix

Normalised Eigenvalues are calculated for ABA inputs according to ABA's pairwise comparison. Table 5-44 shows the normalised principle Eigenvectors for ABA preferences with respect to the identified alternatives.

Table 5-44 SDAM ABA Normalised Matrix

$$\begin{array}{r} \\ \text{Water Quality} \\ \text{Urban Development} \\ \text{Industrial Development} \\ \text{Fish Catch} \end{array} \begin{array}{c} \text{normalized matrix} \\ \begin{pmatrix} 0.058 & 0.017 & 0.081 & 0.227 \\ 0.407 & 0.121 & 0.105 & 0.318 \\ 0.523 & 0.845 & 0.733 & 0.409 \\ 0.012 & 0.017 & 0.081 & 0.045 \end{pmatrix} \end{array} \quad \begin{pmatrix} 10\% \\ 24\% \\ 63\% \\ 4\% \end{pmatrix}$$

5.4.9.4 Calculation of ABA Consistency Ratio (CR)

The inconsistency ratio is equal to 35.3%, which is above the acceptable limit, showing a high degree of inconsistency in the judgments of ABA (see Table 5-45).

The inconsistency is mainly due to the industrial development-urban development comparative judgment that was assigned very strong and has to be adjusted to strong. The urban development-water quality ratio needs to be adjusted to be moderate/strong. Fish catch-water quality ratio needs to be adjusted from strong to moderate.

Table 5-45 ABA Consistency Ratio

Lambda	1.3696	1.19948	0.97107	1.41336	4.954	principal Eigenvalue
n	4			CI	0.318	
				CR	35.3%	Consistency

5.4.9.5 Analysing ABA overall Results

The pairwise comparison results for ABA showed industrial development had the highest priority (63%), followed by urban development (24%), and then water quality (10%), and lastly fish catch (4%) (see Figure 5-43).

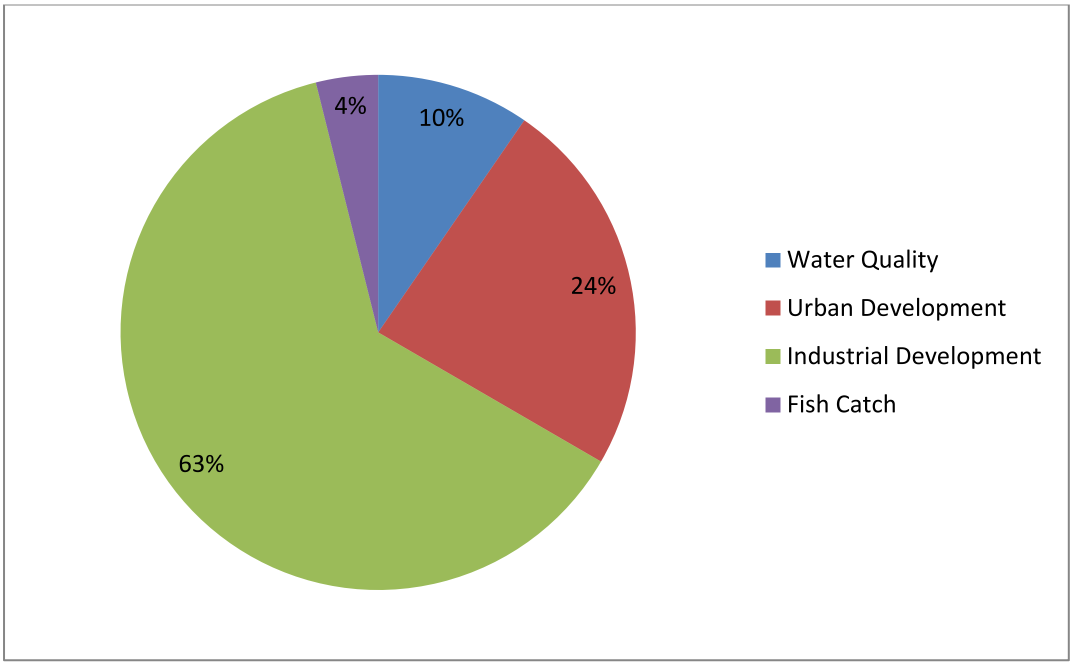


Figure 5-43 ABA Priorities

5.4.9.6 Analysing ABA Results with Respect to SDDM

Overlaying the SDDM diagram over the ABA diagram shows that the Alexandria Businessmen Association's preferences match the economic objective of the SDDM (see Figure 5-44).

Both ABA and economy objectives look at the monetary value of the resource regardless of its impact on other sectors while sustainable development is located in the area between the three pillars.

In order to change this pattern, businesses and industries must adopt Corporate Social and Environmental Responsibility (CSER) approaches so as to shift the decision orientation towards the social and environmental dimensions.

Figure 5-45, Figure 5-46, and Figure 5-47 show the areas of intersection between ABA priorities and environment, social and economic SDDM components.

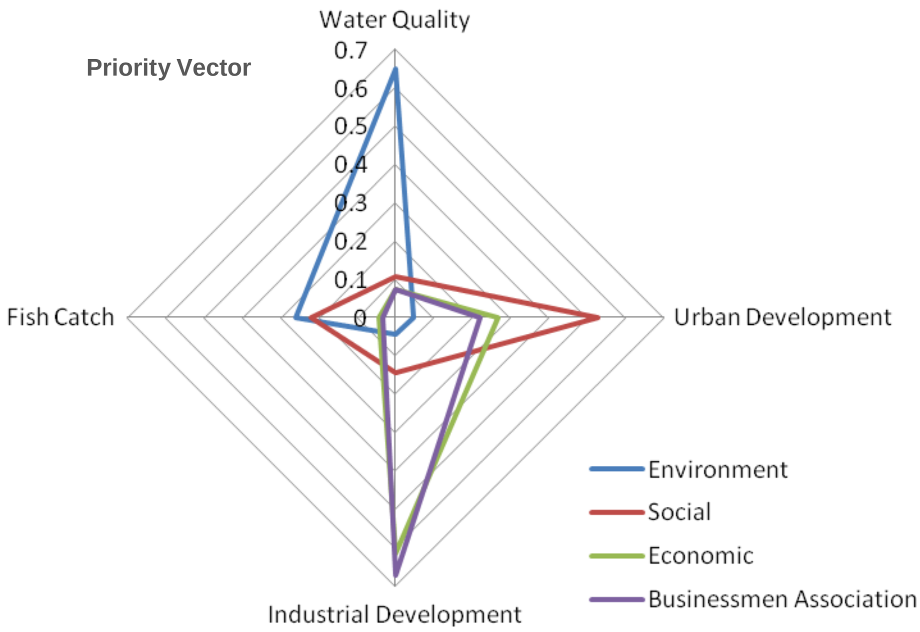


Figure 5-44 Relation Between SDDM and ABA

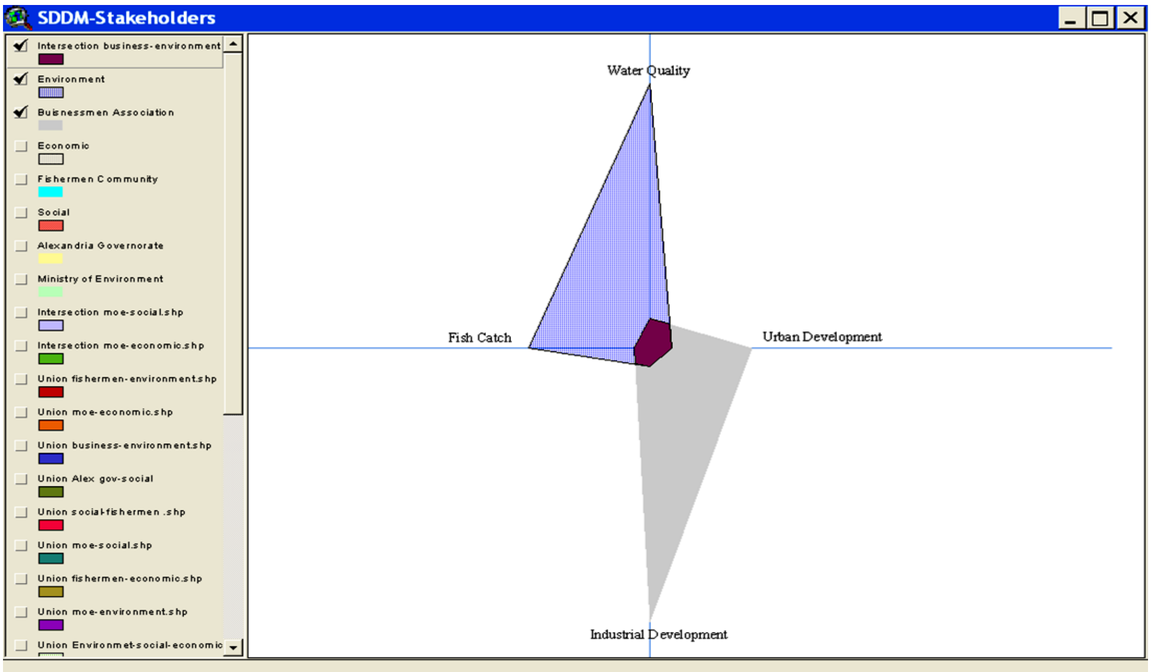


Figure 5-45 Intersection between ABA and Environment

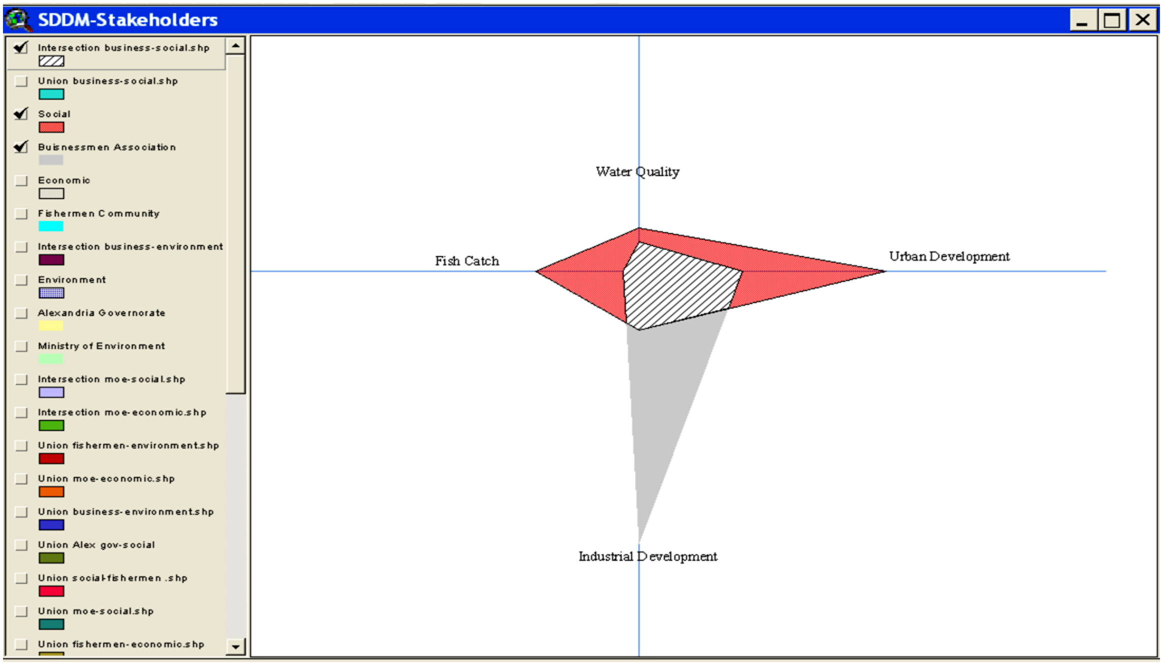


Figure 5-46 Intersection between ABA and Social

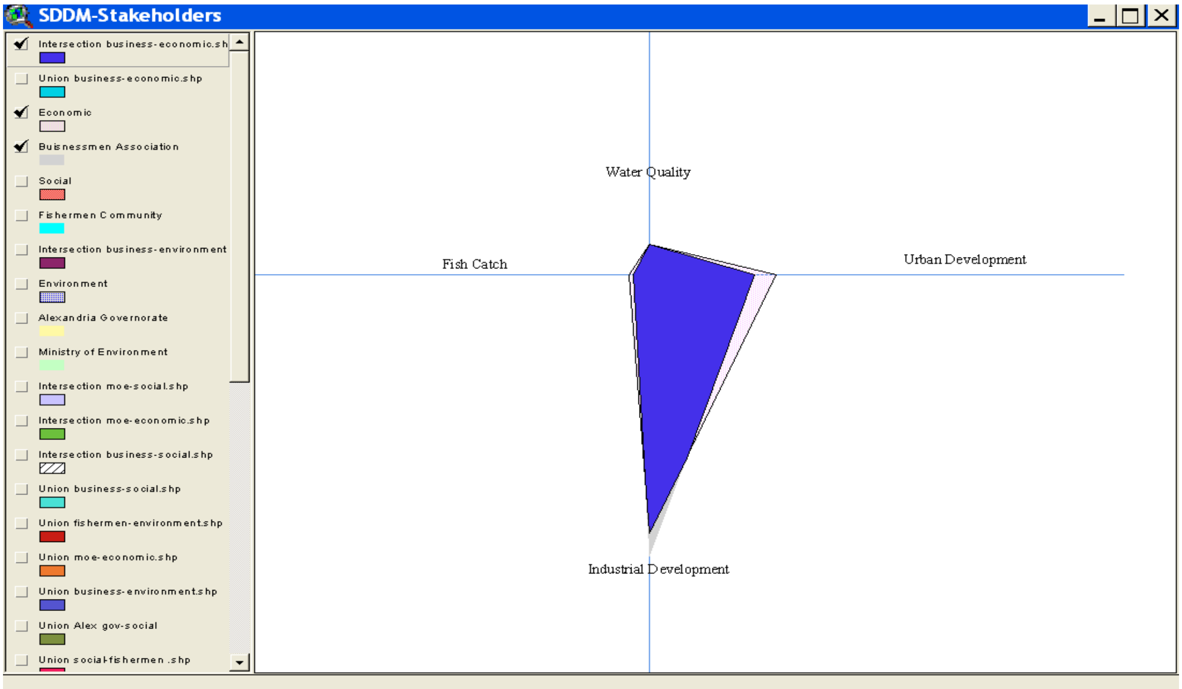


Figure 5-47 Intersection between ABA and Economy

5.4.9.7 Calculating Consensus between SDAM and SDDM using SDAM

Outputs of ABA SDAM are spatially overlaid on the SDDM using the SDAM GIS spatial functions. The objective is to examine the consensus between ABA priority diagram and the SDAM components.

Figure 5-48 shows the area of intersection between ABA preferences and SDDM objectives, illustrating a high degree of consensus in the decision orientation of the ABA with the economic dimension.

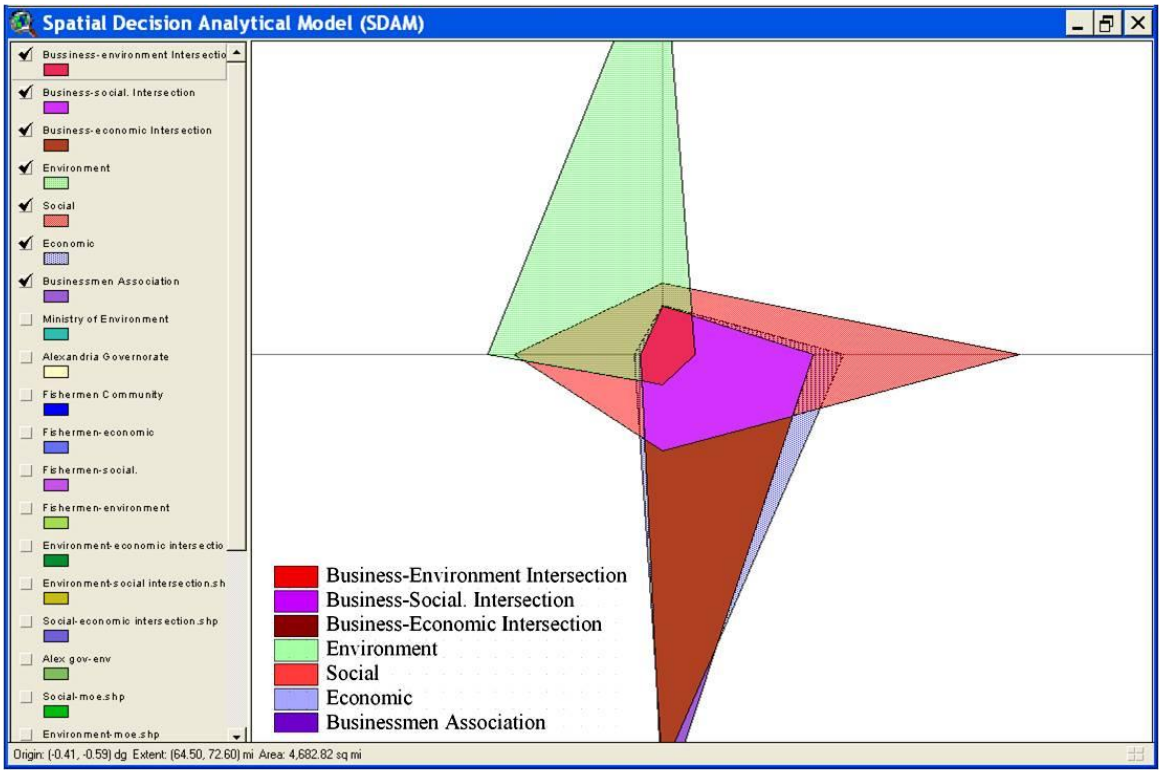


Figure 5-48 Intersections between SDDM and ABA

Calculating the areas of intersection between the SDDM and the ABA's preferences demonstrate that economic sector of SDDM occupies 84.58% of the total intersection area while social represents 24.64% and environment intersects with only 3.33% of the total area (see Table 5-46).

Table 5-46 Comparative preferences between SDDM and ABA

	Area of Consensus	Total Area	Percentage
Business-Environment	0.0065	0.1953	3.33%
Business-Social	0.0373	0.15141	24.64%
Business-Economic	0.0927	0.1096	84.58%

Figure 5-49 shows the percentages of ABA Consensus with respect to the components of SDDM.

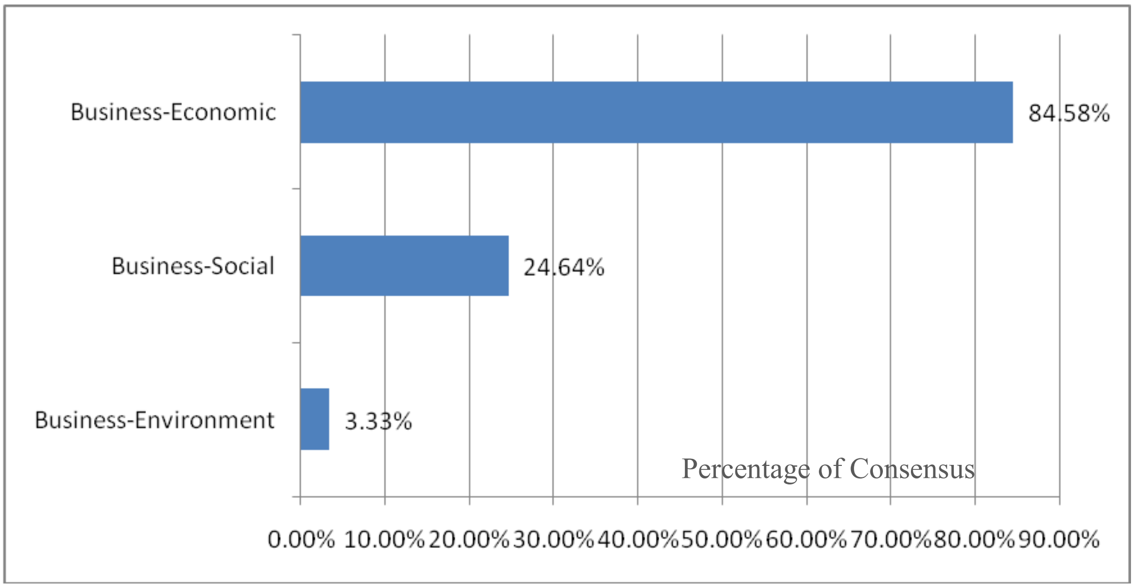


Figure 5-49 Percentages of ABA Consensus in respect to SDDM

5.4.10 Analysing Stakeholder Consensus

The objective of analysing consensus among stakeholders is to examine the area where all stakeholders have agreed in respect to the identified objective.

The results need to be compared with the influence decision-making model where differentiated weights are assigned to the stakeholders based on the stakeholder analysis. This step is essential to investigate the degree to which power is impacting the overall decision-making process.

Identifying the area of consensus is essential in both cases to determine whether the influence diagram for the case study area contributes to consensus or to conflict between stakeholders.

Table 5-47 shows the overall judgments of all stakeholders. Figure 5-50 compares different stakeholder judgments with regard to the identified objectives.

Table 5-47 Summary of Stakeholders' overall judgements

	Water Quality	Urban Development	Industrial Development	Fish Catch
Alexandria Governorate	0.12	0.577	0.236	0.066
Ministry of Environment	0.571	0.063	0.037	0.329
Fishermen Community	0.191	0.067	0.032	0.711
Businessmen Association	0.072	0.223	0.672	0.033

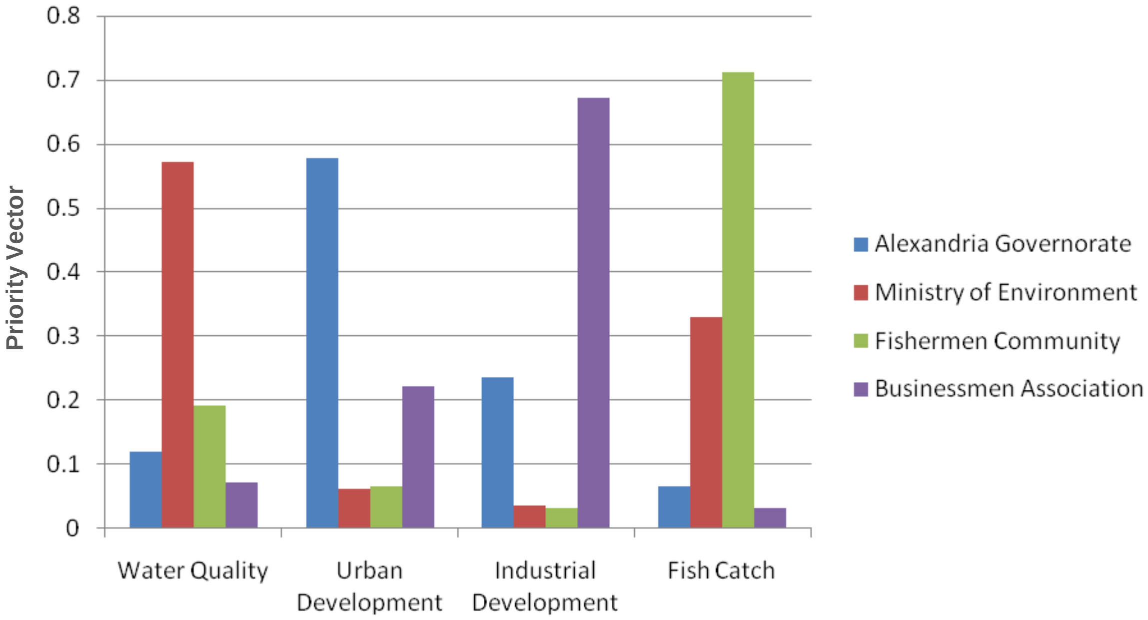


Figure 5-50 Stakeholder priorities with respect to Alternatives

5.4.11 Synthesising Stakeholder Priorities

Inputs of all stakeholder priorities are synthesised using SDAM to provide the overall priorities of all inputs. SDAM assigns the weight of each objective to the highest priority alternative. Other alternatives receive weights under each objective in relation to their priority relative to the best alternative under each objective. The priorities for all the alternatives are normalised to add up to 1.0 (see Table 5-48).

Table 5-48 Stakeholder Synthesised Priorities

Objective	Fish Catch	Water Quality	Industrial Development	Urban Development	Total
Synthesised Values	0.273	0.248	0.238	0.241	1.00

Presenting the stakeholder overall analysis of the synthesised results for stakeholders shows that there is a great diversity in stakeholder objectives with respect to the overall goal of managing Lake Maryout (see Figure 5-51).

Stakeholder decisions follow more consistent patterns when mapped against the SDDM showing environmental, social or economic interest. As illustrated earlier, fish catch is located in a different direction as it is a cross-cutting theme between the three pillars.

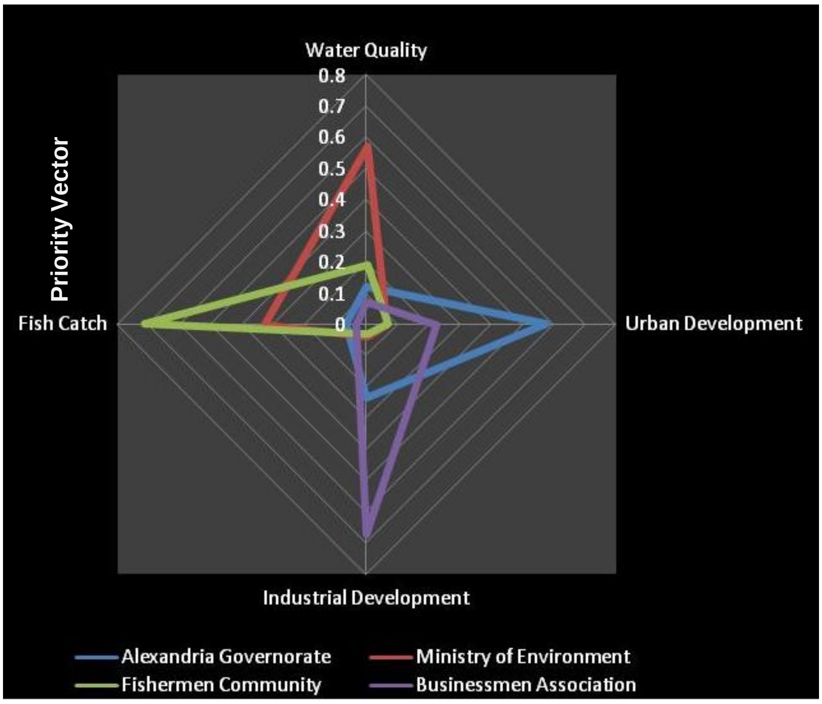


Figure 5-51 Stakeholders Priorities Diagram

The overall synthesis of priorities of the identified stakeholders show that fish catch comes as top priority followed by water quality, urban development, and lastly industrial development (see Figure 5-52). This synthesised judgment is a function of the original assumption that all stakeholders are equally weighted.

Performance Analysis of the synthesised results illustrates that fish catch has the highest priority for both fishermen (3 extreme values) and MOE (2 extreme values) and a low priority for ABA and GOA. These extreme values in comparison to other alternatives reflect the urgent need of these resources to the fishermen community and the importance of keeping the ecological balance by the Ministry of Environment.

In an ideal case, this would have been reflected on policies in the study area. Analysis of the state of the environment shows that fish catch has deteriorated over time. This is mainly due to unequal stakeholder power, which has led to filling and dumping of wastes, which has led to the deterioration of fish catch. The same applies to water quality. While it may consider a second synthesised priority, it has actually deteriorated in absence of any collaborative planning process.

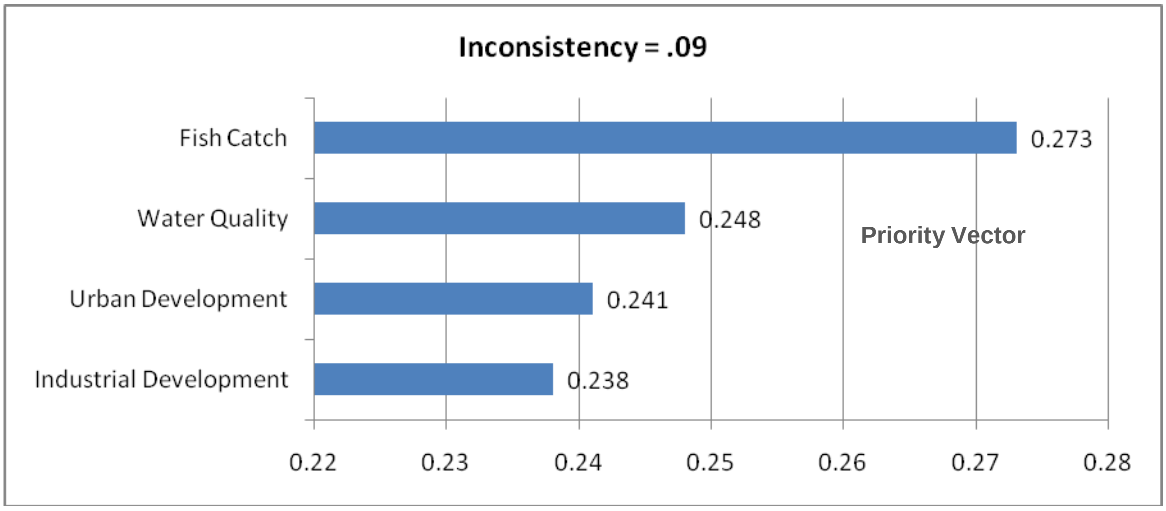


Figure 5-52 Synthesis of Stakeholders with respect to Management of Lake Maryout

5.5 Assessment of Stakeholder Consensus

Outputs of SDDM and SADM are analysed to identify the areas of consensus among stakeholders, and between stakeholders and SD components.

5.5.1 Development of Consensus Scale (CS)

Table 5-49 shows the constructed Consensus Scale (CS) that corresponds to the final percentage of consensus to the total net areas of compared decisions. CS matches the AHP categories in terms of the number and description of main categories.

The main function of CS is to transform numerical percentages into a descriptive ranking. This allows better understanding of results by stakeholders, decision-makers and resource planners and managers.

Table 5-49 Consensus Scale (CS)

Percentage of Consensus	Consensus Rank (CR)
0 – 20	No or Poor Consensus
20 – 40	Moderate Consensus
40 – 60	Strong Consensus
60 – 80	Very strong Consensus
80 – 100	Extreme Consensus

5.5.2 *Assessment of Stakeholder Consensus in SDDM*

There are serious debates during conferences, forums, reports, books, journals, seminars and conventions about the rationalization of a sustainable type of development. The concerns question if sustainable development, particularly in developing countries, can create the harmony between environment and development and also among stakeholders to create a conservation development action.

According to Lafferty (2004, p.1), "governments are never established in a theoretical vacuum, but reflect the exigencies of their time and place, as well as the conflicting interests and power bases of their major actors".

According to this viewpoint, sustainable development is defined by the major stakeholders in a particular timeframe. However, stakeholders tend to conflict as a result of the intrinsic differences of those who define it. Bradshaw (2007) states that development implies change, therefore it is constantly synonymous with conflict.

Table 5-50 presents the results of the SADM based on the inputs of SDDM. It shows the consensus between the different components of SD. It presents the Consensus Rank (CR) between the three SDDM components.

Table 5-50 comparative preferences between SDDM components

SDDM Components	Percentage	Consensus Rank
Social-Environment	12.80%	Poor Consensus
Economic-Environment	3.54%	Poor Consensus
Social-Economic	28.10%	Moderate Consensus

According to the developed Consensus Scale, results from SDDM, based on expert judgments of inter-relations of different priorities with respect to sustainable development components, there is poor consensus between economic and environment component (3.54%).

As revealed by SDDM results, economic component is led by the industrial development while the social component is led by the water quality.

SDDM results show that there is poor consensus between the environment component and social component which is led by urban development. Analysis shows that there is moderate consensus (28.10%) between social and economic components.

The SDDM results reflect the rationale of the complexity of the decision-making process regarding the overall management process of the case study with respect to the identified alternatives and their subsequent impacts on the study area.

Validating these outputs with the analysis of the case study reveals that this relatively strong consensus between social and economic components. This is a direct result of strong socio-economic inter-relations between urban expansion and industrial development as they both contribute to social and economic upgrading of the study area.

Table 5-51 shows the consensus between different stakeholders and the three pillars of sustainable development. It shows how each stakeholder is in harmony with environmental, social or economic component of sustainable development.

Table 5-51 comparative preferences between SDDM and Stakeholders

	Percentage	Consensus Rank
Governorate of Alexandria (GOA)		
GOA-Environment	5.94%	Poor Consensus
GOA-Social	57.84%	Strong Consensus
GOA-Economy	32.75%	Moderate Consensus
Ministry of Environment (MOE)		
MOE-Environment	81.64%	Extreme Consensus
MOE-Social	12.61%	Poor Consensus
MOE-Economy	3.67%	Poor Consensus
Fishermen Community (FC)		
Fishermen-Environment	34.07%	Moderate Consensus
Fishermen-Social	14.78%	No or Poor Consensus
Fishermen-Economy	4.08%	No or Poor Consensus
Alexandria Businessmen Association (ABA)		
ABA-Environment	3.33%	No or Poor Consensus
ABA-Social	24.64%	Moderate Consensus
ABA-Economic	84.58%	Extreme Consensus

The above table summarises the results of calculated percentages of consensus between stakeholders and the SDDM components.

Results show the extreme consensus observed between MOE and environment component and between ABA and economic component. Both organisations have a clear mandate and objectives about the direction of alternatives they want to achieve. GOA has a strong consensus with the social component.

Main component of GOA's duty is to look after the social aspects of the people in its region. However, conflicting priorities and mixed objectives have resulted in not having a clear vision of what decisions should be made to achieve its target objectives.

5.5.3 Assessment of Stakeholder Consensus in SADM

SADM spatial module locates all areas of stakeholder judgments. SADM overlays each stakeholder priority diagram against another.

GIS combines two areas to identify the area of judgment. GIS clip function extracts the area of intersection between the two polygons (see Figure 5-53). Percentages of consensus between stakeholders are calculated as per the equations below in Table 5-52.

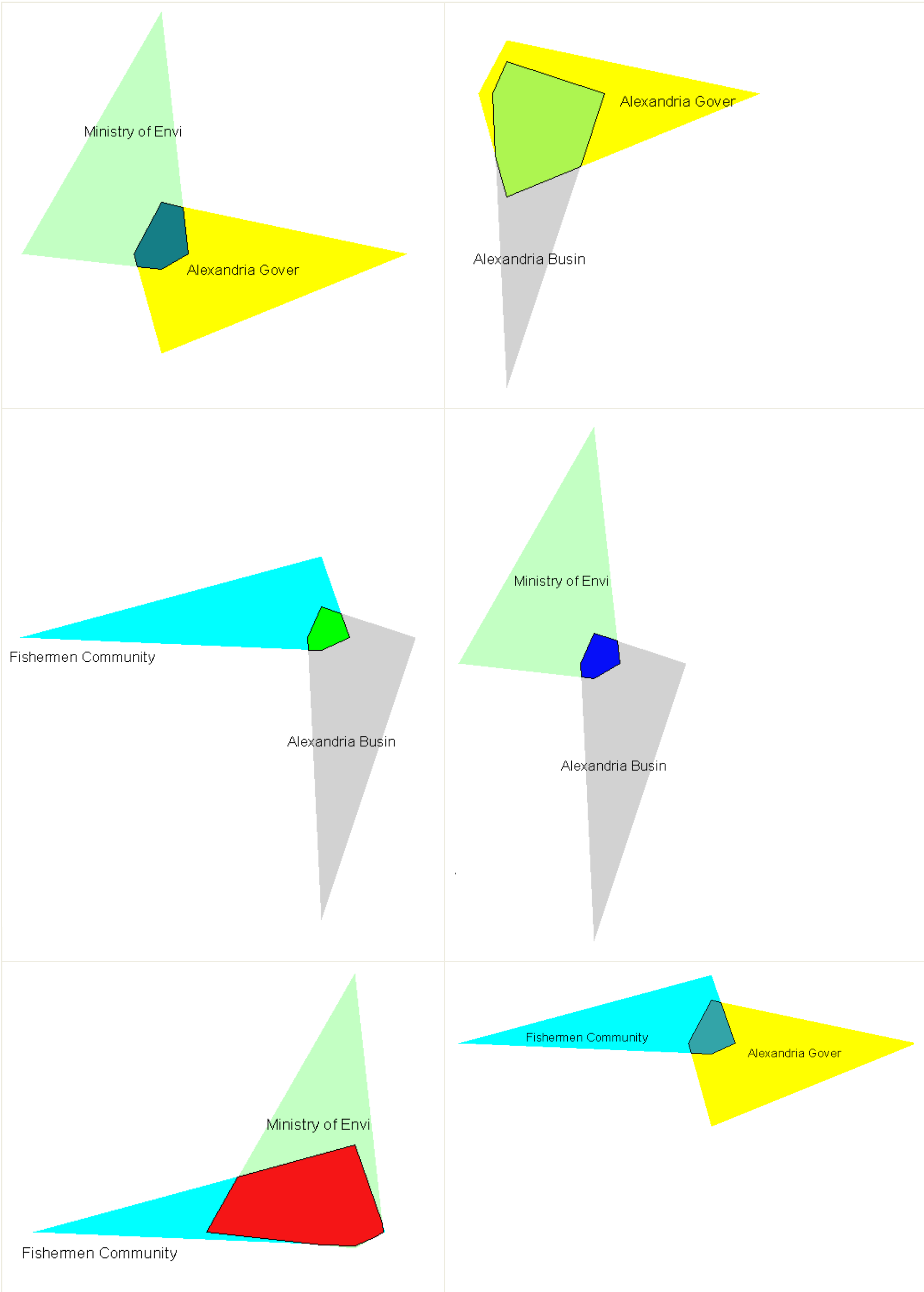


Figure 5-53 Locating Areas of Consensus in SDAM

Table 5-52 Calculation of Stakeholder area of Consensus

Calculation of Stakeholders' Consensus
Total Areas of Judgments =Area of Stakeholder n1 + Area of Stakeholder n2
Area of Consensus = Area of Intersection between Stakeholder n1 and n2
Net Area = Total Area of Judgment – Area of Intersection
Net percentage of Consensus = (Area of Consensus/Net Area) * 100

Results show that the Ministry of Environment and fishermen community have the highest consensus among all stakeholders (39.23%).

Table 5-53 shows the high consensus in the overall objectives is the case between the Governorate of Alexandria and the Alexandria Businessmen Association (33.83%).

This highlights to planners and managers of the area that there are two major conflicting stakeholder groups in the study area.

The two groups are: MOE-FC group and GOA-ABA group (see Figure 5-54). The groups can be categorised as environmental-social stakeholder group and social-economic stakeholder group.

Table 5-53 Calculation of Stakeholder Areas of Consensus

Stakeholder Intersection	Total Areas of Judgments	Area of Consensus	Net Area	Net percentage of Consensus
Fishermen Community-Businessmen Association	0.18194	0.0069	0.1751	3.92%
Ministry of Environment-Businessmen Association	0.2143	0.0072	0.2071	3.49%
Alexandria Governorate-Fishermen Community	0.20119	0.0124	0.1888	6.55%
Alexandria Governorate-Ministry of Environment	0.23355	0.0137	0.2199	6.23%
Alexandria Governorate-Businessmen Association	0.20965	0.0530	0.1567	33.83%
Ministry of Environment-Fishermen Community	0.20584	0.0580	0.1478	39.23%

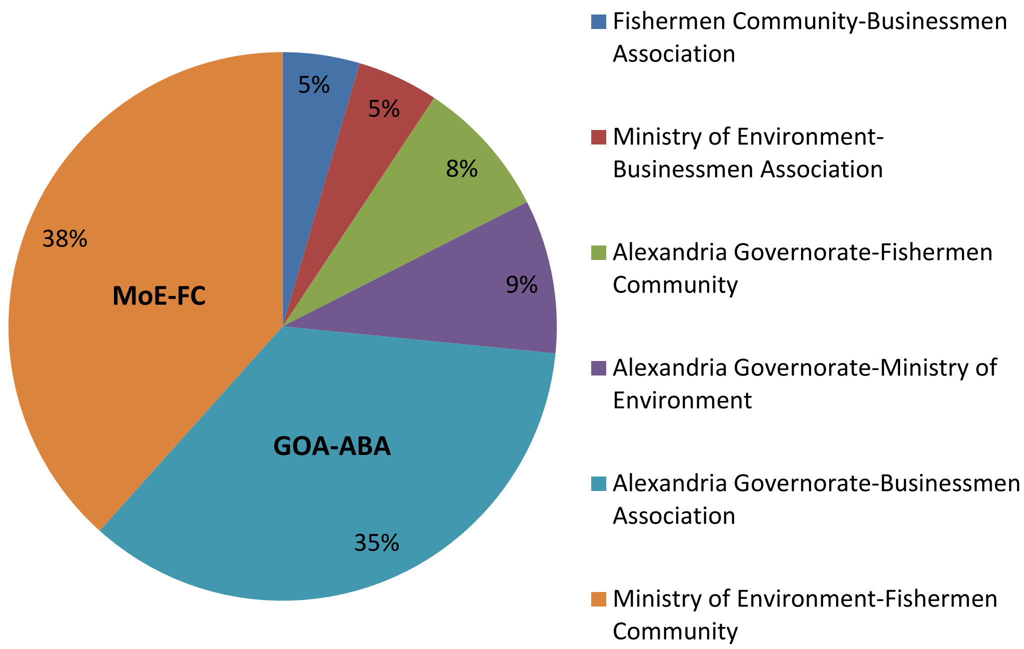


Figure 5-54 Percentages of Stakeholder Consensus

Table 5-54 shows the final results for stakeholder consensus. It shows the degree of synthesised consensus between different stakeholders with respect to the identified alternatives. Results show that consensus is ranked between “moderate” and “poor”.

Table 5-54 Final Stakeholder Consensus Results

Stakeholder Intersection	Net percentage of Consensus	Consensus Rank
Fishermen Community-Businessmen Association	3.92%	Poor Consensus
Ministry of Environment-Businessmen Association	3.49%	Poor Consensus
Alexandria Governorate-Fishermen Community	6.55%	Poor Consensus
Alexandria Governorate-Ministry of Environment	6.23%	Poor Consensus
Alexandria Governorate-Businessmen Association	33.83%	Moderate Consensus
Ministry of Environment-Fishermen Community	39.23%	Moderate Consensus

Table 5-55 shows the final identified consensus between stakeholders. According to the identified scale, the consensus between all stakeholders is ranked as “Poor”.

This low ranking reflects the diversity in objectives between stakeholders. Analysis of the case study showed that there is a lack of co-operation between stakeholders and few attempts to reach a collaborative decision on measures to mitigate the lake’s current condition. This results in the current deterioration of the lake’s environmental, social and economic conditions.

Table 5-55 Final Overall Area of Consensus

	percentage of Consensus	Consensus Rank
Area of Consensus among all stakeholders	2.34%	Poor Consensus

5.5.4 Impact of Applying the Influence Ratio on Decision-Making

Data is extracted from Stakeholder Influence Expert Questionnaires. The questionnaires were distributed to the same group of experts that assisted in the SDDM through e-mail or regular mail. The filled questionnaires were discussed in an expert panel meeting.

The influence ratio is calculated from a set of questions to rate each stakeholder’s degree of power over the management of the study area.

Table 5-56 presents the numerical scale for the influence values. The scale was developed in AHP comparative ratio in order to be consistent with the overall analysis.

Table 5-56 Influence Scale

Comparative Influence	Numerical Rating
Extreme Influence	9
Very strong to Extreme	8
Very Strong	7
Strong to Very Strong	6
Strong	5
Moderate to Strong	4
Moderate	3
Equal to Moderate	2
Equal Influence	1

AHP relative influence matrix is constructed based on the identified influence values (see Table 5-57). This relative importance is ultimately affecting all sub-objectives in the decision tree.

Table 5-57 Relative Importance of Stakeholders

Stakeholder	Ministry of Environment	Fishermen Community	Businessmen Association
Alexandria Governorate	Moderate to Strong	Strong to Very Strong	Equal to Moderate
Ministry of Environment		Equal to Moderate	Equal to Moderate
Fishermen Community			Moderate to Strong

Structured AHP tree is developed using comparative influence in the criteria level (see Figure 5-55).

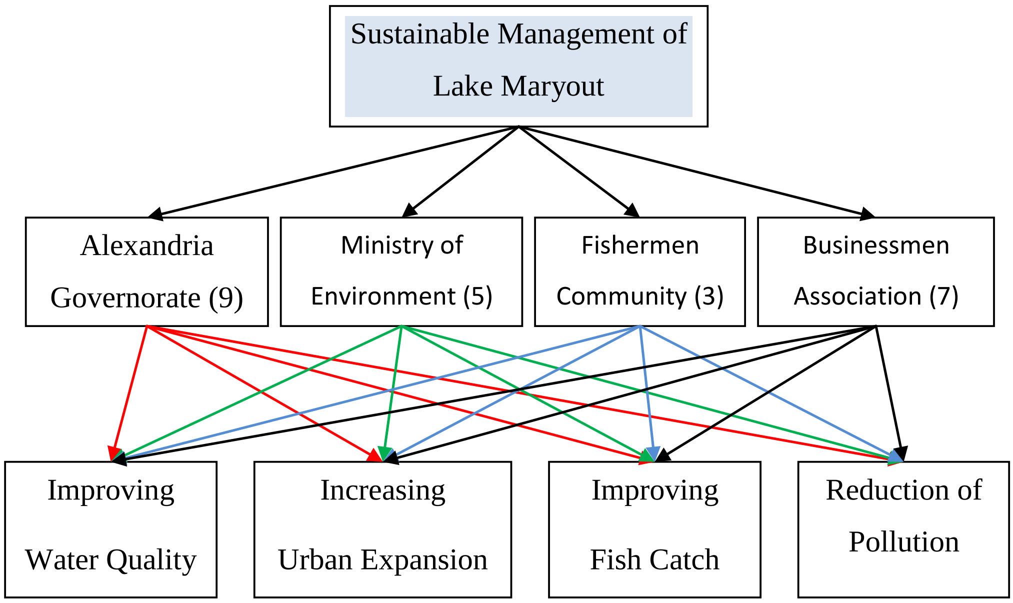


Figure 5-55 Structured AHP using influence in the criteria level

Assigning influence value to the key stakeholders has resulted in the comparative stakeholder values in the decision matrix (see Figure 5-56).

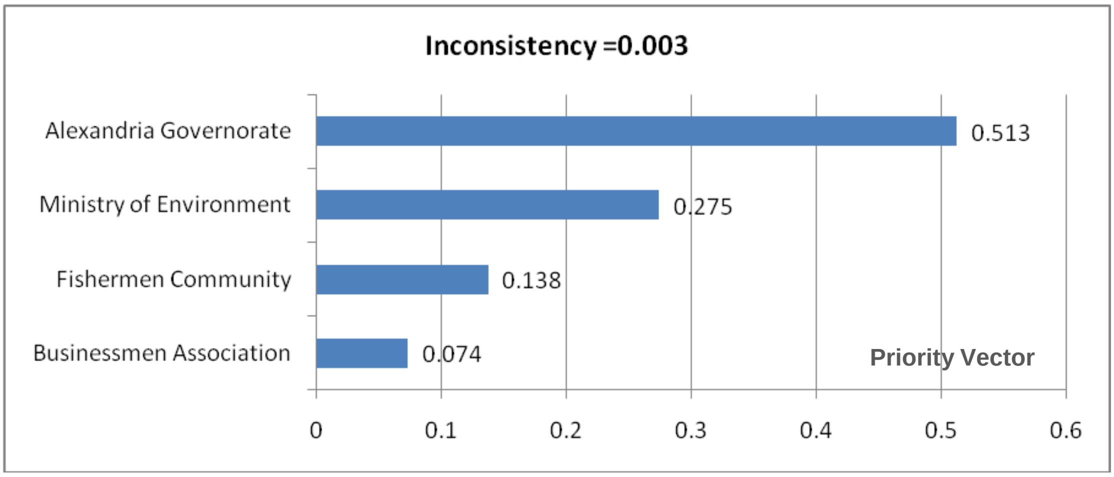


Figure 5-56 Synthesis with respect to Influenced Stakeholders

Table 5-58 shows the equal participation and influenced participation SDAM output values. It highlights the changes of the synthesised values for the stakeholder alternatives. The comparative influences of stakeholders have led to a change in the overall synthesis of the group-decision. As shown in Figure 5-57, fish catch was the highest synthesised priority for equally-weighted stakeholders; whereas urban development is the highest when applying the influence values (see Figure 5-58). Industrial development ranks second in the influence diagram while it ranks lowest in the equal weighted stakeholder analysis.

Table 5-58 Comparison between equal and influenced participation

Objective	Fish Catch	Water Quality	Industrial Development	Urban Development
Influenced participation	0.137	0.179	0.303	0.381
Equal Participation	0.273	0.248	0.238	0.241

Performance Sensitivity analysis for the Influenced Values, as shown in Figure 5-59, shows how alternatives are prioritised relative to other alternatives, and with respect to each stakeholder.

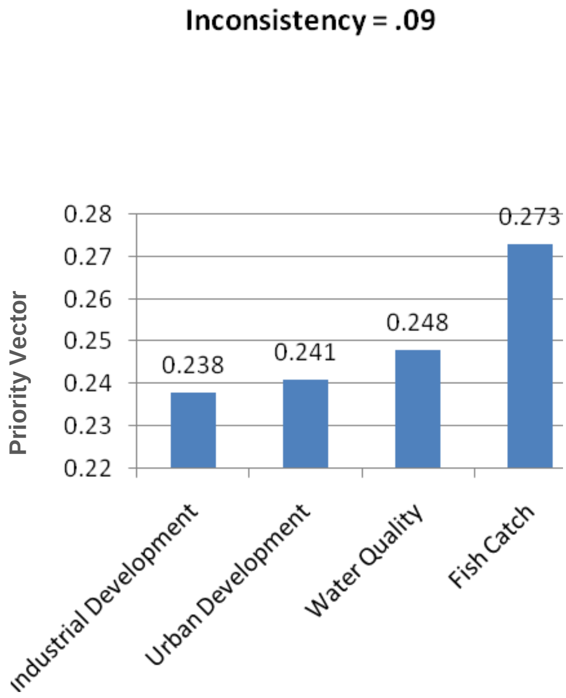


Figure 5-57 Equal weighted Priorities

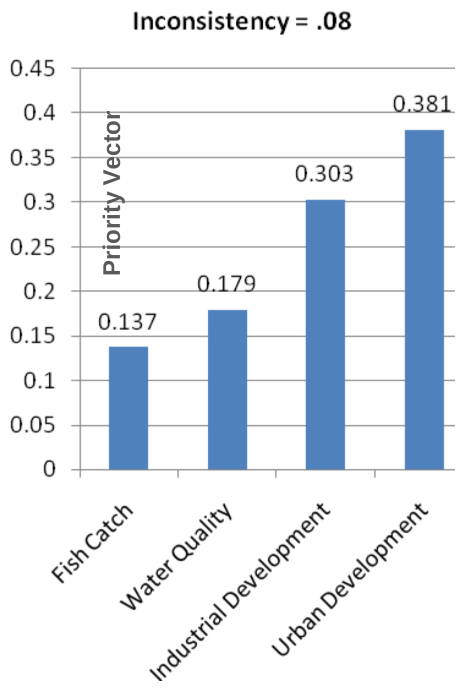


Figure 5-58 Influenced weighted Priorities

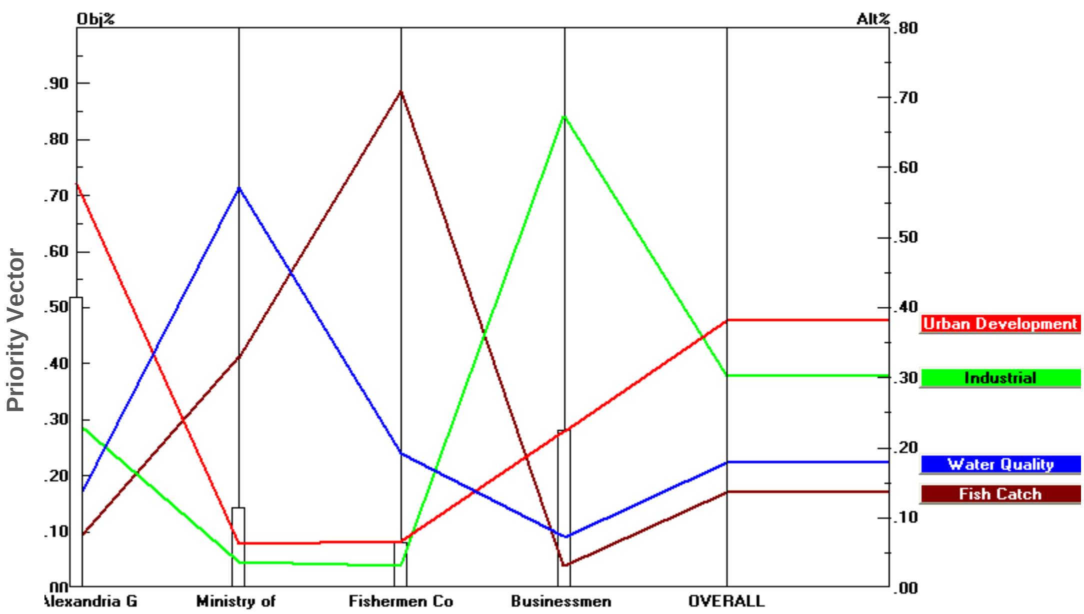


Figure 5-59 Performance Sensitivity for Influenced Participation

Figure 5-60 shows the shift in priorities of the synthesised decision after applying the influence values. The influence values only affect the synthesised results, not the individual stakeholder judgments, nor the areas of consensus between different stakeholders. The final area of consensus between stakeholders remains unchanged.

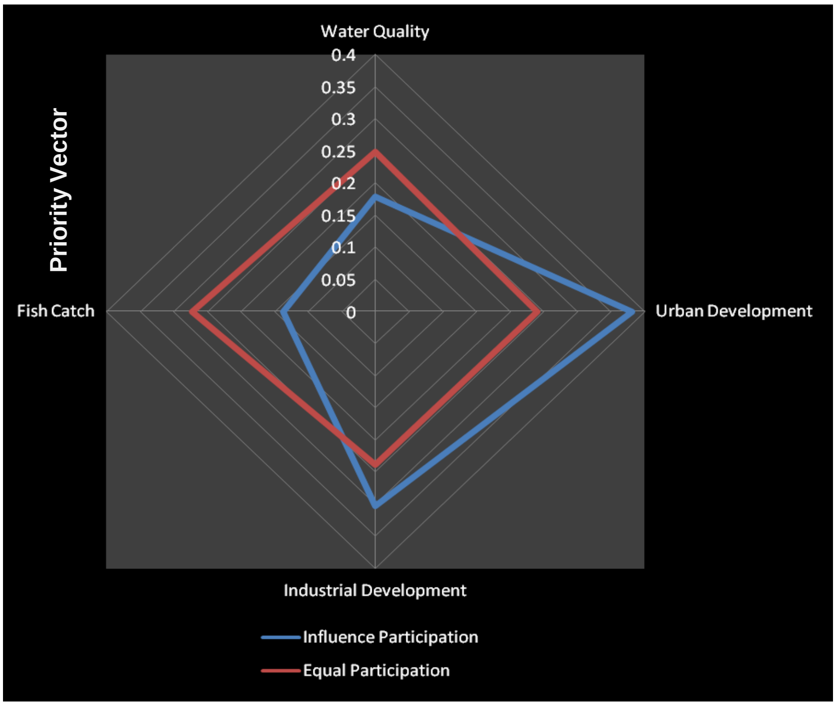


Figure 5-60 Synthesised Decision Shift as a Result Of Influence

5.6 Summary of Results

EDAM analyses three main areas:

- the identified primary stakeholder alternatives with respect to the sustainable development environment, social and economic components;
- the stakeholder preferences with respect to the identified alternatives; and
- the consensus or conflict between stakeholders with respect to these preferences.

Results from SDDM show that the four identified stakeholder alternatives are conflicting with respect to the sustainable development pillars. Environment component is conflicting with both social and economic components.

According to the consensus scale, economic-social components are ranked as "moderate consensus" (see Table 5-59).

Table 5-59 SDDM Consensus Rank

SDDM Components	Consensus Rank
Social-Environment	Poor Consensus
Economic-Environment	Poor Consensus
Social-Economic	Moderate Consensus

Analysing the above results show that environment mostly depends on enhancing the water quality while social component focuses on increasing fish production. Economy of the area is mainly a function of both industrial and urban development activities (see Figure 5-61).

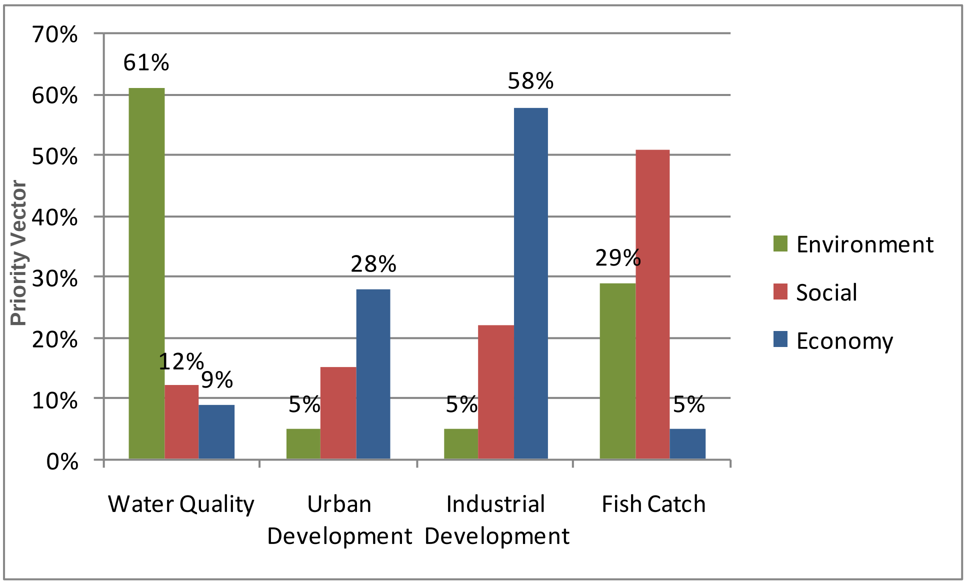


Figure 5-61 Summary of SDDM Results

According to expert opinions regarding the three components of sustainable development and to the SDDM Pairwise comparison synthesised priorities result, a sustainable development decision consists of urban development as a first priority followed by water quality, industrial development and finally fish catch.

SDDM results prove that GOA priorities and actions are focused on the social aspect while MOE is more oriented towards the environmental aspect. FC has cross cutting priorities and do not follow exact pattern as they have environmental, social and economic interests in the resource. ABA shows clear economic objective in exploiting the Lake Maryout area.

Results from SADM show that consensus rank between stakeholders ranges from poor to moderate consensus. It also shows that there are two main conflicting groups: Governorate of Alexandria-Alexandria Businessmen Association versus Ministry of Environment-fishermen community group.

Synthesising stakeholder equal weighted priorities using SADM shows that fish catch has the utmost priority followed by water quality, urban development and finally industrial development.

Analysing stakeholder relative influence shows that the Governorate of Alexandria is the most powerful among stakeholders followed by Ministry of Environment, Fishermen Community and lastly Alexandria Businessmen Association.

Applying influence ratio on the SADM shows shift in the priorities towards urban development as prime priority followed by industrial development, water quality and finally fish catch.

Validating results of stakeholder priorities against the spatial analysis change detection at the study area shows similarity of patterns of activities on the ground and stakeholder identified priorities. Clustering the overall activities on the ground according to the identified four alternatives also shows similarity with the influence weighted synthesised results of the SDAM.

Using SADM to locate the areas of agreements within the four identified priorities, the overall consensus rank between primary stakeholders is identified according to the scale as “Poor”. Feedback from stakeholders regarding these results shows that MOE, FC and ABA agree with their SDAM identified synthesised priorities, while GOA respondents view their preferences different than the outcomes of the SDAM. GOA believes that the water quality is its second priority while this was not the case either in pairwise comparisons or in the implementation of GOA’s policy and activities on the ground which provides evidence of its role in degrading the quality of water.

Reaction of stakeholders regarding equal weighted synthesised priorities for the management of Lake Maryout shows that MOE-FC agrees with the resultant synthesised preferences to be the basis for a collaborative action plan. Only 36% of the replies from

GOA agree with the results, while ABA sample totally does not agree with the presented priorities.

Reaction of stakeholders regarding influence weighted synthesised priorities show that GOA-ABA group mostly agrees with the results while analysed samples from MOE-FC feedback express non-agreement with the results that take influence ratio into consideration. EDAM results show the stakeholder map in terms of what alternatives they have, what priorities each stakeholder has, and why they chose these priorities. Results do not intend to referee any stakeholder but rather to analyse the preferences and reactions to develop an understanding.

It explains how environmental, economic and social aspects contribute to stakeholder decision-making concerning an environmentally sensitive area. Results also show the direction of stakeholder preferences with respect to the three pillars of sustainable development.

Results illustrate how the differentiated influence stakeholder conflicting priorities impact the environmental quality of the study area. EDAM results show that applying the differentiated influence ratio in the SDAM results in a new set of synthesised order of priorities. Validating these influence weighted preferences shows that actions and changes on the ground are consistent with these results. This reflects that stakeholder powers have succeeded in implementing their preferences agenda.

EDAM outputs highlight the degree of consensus between different stakeholders and the overall degree of consensus with respect to the identified alternatives.

Feedback from stakeholders towards the presented ranks of consensus shows that they mostly are either not aware of the existence of conflict or they do not acknowledge it. GOA and ABA do not agree with their AHP pairwise comparison results. They perceive their order of priorities differently and more environmentally sound by pushing water quality as a second priority.

Feedback regarding synthesised decision regarding the overall action plan for Lake Maryout shows clearly two different conflicting groups. GOA-ABA only agrees with the influence weighted synthesised preferences while MOE-FC agrees with equal weighted synthesised preferences.

This conflict shows that both groups can only reach a higher degree of consensus if one group acknowledges the power of the other group or the more influenced group agrees with a management plan that stands at equal distance between all stakeholder preferences.

CHAPTER 6

VALIDATION OF RESULTS

Chapter 6. Validation of Results

6.1 Introduction

According to Saaty (2007), the results of stakeholder preferences pairwise comparisons should be validated against their real-world actions. Data from real world actions are collected through the spatial investigations that were conducted in chapter four. Results from change detection are analysed to measure the percentages of change on the ground for the four identified alternatives. These changes are compared to stakeholder decisions to compare if these decisions were actually implemented on the ground through real actions.

The application of the Analytic Hierarchy Process (AHP) methodology needs a degree of knowledge and understanding about the real-world situation where the methodology is applied and about the issues being examined. In AHP based models, the validation process is conducted through finding examples with measures in a scale that is already known.

Saaty (2007) pointed out that there are two ways to validate AHP results. One is to regard the objectives as influences to get the outcome, and the alternatives of the model regarded as this outcome which can be compared to some data reflecting the situations on the ground from the real world. In this case AHP is used as an analytical tool. The other validation method is to use the AHP as a decision-making tool to determine the best option to use to reach a desired situation.

In this research, AHP is used as an analytical decision tool and therefore, the first validation method is used. The stakeholders are used in the criteria/objective level that steer the decision-making process while the available alternatives are the outcomes of these decisions. According to Saaty (2007), the results of stakeholder pairwise comparisons should be validated against their real-world actions.

There are two levels of validation for the EDAM results in addition to the model sensitivity analysis that was conducted during the model implementation.

The first is conducted through comparing the outputs of the EDAM methodology against the change detection results to evaluate if the actions on the ground are, to some extent, consistent with the decision analysis resultant from the developed methodology.

The second level is to present the results to decision-makers to understand how these results may assist them in better management of the stakeholders in the area under investigation. Decision-makers and managers of the environmentally sensitive areas should have the knowledge about the severity of the conflict and the nature of the problem in terms of being environmentally, socially or economically rooted. The research explores if the methodology would assist in shaping the interventions and the policy formulation in the area under investigation.

6.1.1 Validating results with respect to GOA

Verifying stakeholder preferences against the SDDM components show that there is strong consensus (57.84%) between Governorate of Alexandria (GOA) and the social component of the SDDM, moderate consensus (32.75%) with the economy and poor consensus with the environment objective.

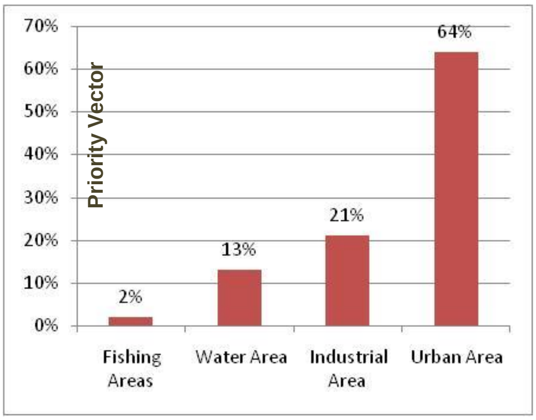
Analysing SDAM results with respect to GOA decision judgments and preferences show that there is moderate consensus (33.83%) with Alexandria Businessmen Association (ABA) while GOA has poor consensus with both the MOE (6.23%) and the fishermen community, 6.23% and 6.55% respectively.

Validation of this result with respect to the actual decision-making process as shown by stakeholder analysis reveals that GOA's mandate and objectives are of a social and economic nature. GOA managers envisage environmental protection as the responsibility of the Ministry of Environment (MOE) represented by its local branch in Alexandria. Upgrading the quality of life for Alexandrians, finding new jobs, and encouraging businesses by attracting capital investment, industrial developments and tourism are the main objectives. These targets are clearly reflected in the GOA's judgments towards the presented alternatives.

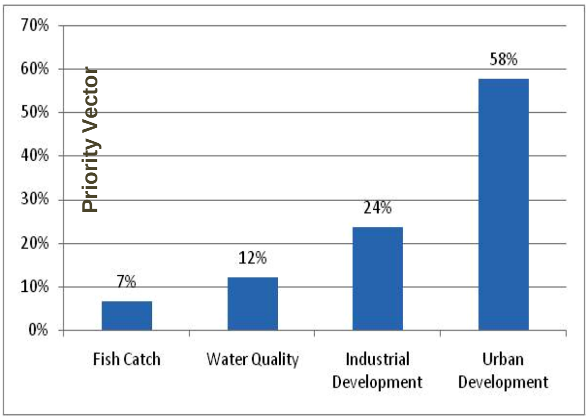
Validations of the consensus ratio with stakeholder analysis show that GOA and ABA are partners in implementing the Alexandria 2025 plan, which includes extensive urban and industrial expansion. GOA is pledging more land-filled areas for urban and industrial developments.

GOA is in direct conflict with the MOE and environmental NGOs that share its objectives. Several lawsuits have been filed against the GOA to stop land-filling. Fishermen and the Fishing Authority are using their representatives in the local council to pressure the GOA into taking positive action to stop discharge of pollutants and drying of the lake.

Validating output data from the SADM against the change detection analysis of the area of study on the ground as presented in chapter four show a high degree of similarity. Both results show that GOA considers urban development as the highest priority followed by industrial expansion. Increasing the water areas and fishing areas present its lowest priorities respectively (see Figure 6-1).



GOA Results from the Spatial Analysis



GOA Results from SADM

Figure 6-1 Comparison Between Spatial Analysis and SADM Results in respect to GOA

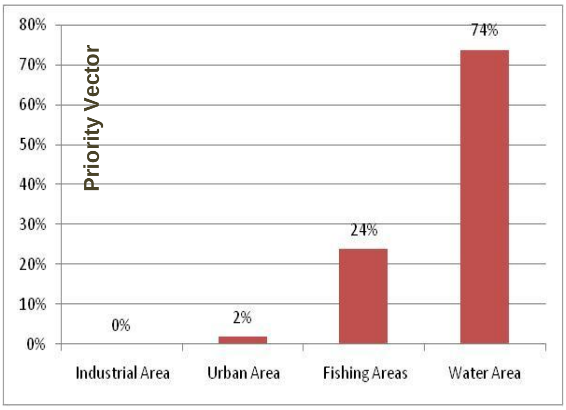
6.1.2 Validating results with respect to MOE

Analysis shows that there is extreme consensus (81.64%) between the Ministry of Environment (MOE) and the environment component of the SDDM, and poor consensus with both the social (12.61%) and economy (3.67%) components. Comparing these results with the case study shows that MOE objectives and mandate focus only towards protecting the natural environment. The overall majority of MOE activities are directly targeted to upgrading the water quality and preserving the ecosystem.

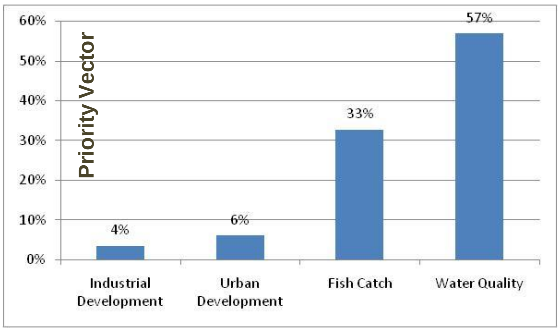
Results from the SDAM with respect to MOE show that the Ministry has moderate consensus (39.23%) with the fishermen community (FC), while it has poor consensus with both GOA (6.23%) and ABA (3.49%).

Stakeholder analysis shows that MOE and FC have joined forces to stop several projects that GOA and ABA had started to implement, such as the new industrial area at the northern end of the lake, and filling the 1000-Feddan basin for urban expansion.

MOE and FC have not reached a strong consensus because of different ways of visualising and prioritising common objectives. MOE perceive fish production as one of the main indicators of enhanced water quality but not as an objective. MOE objects to efforts to introduce new species to enhance fish production. MOE looks at conserving the indigenous species. It sees that increasing fish levels might disturb the natural ecosystem balance of the lake. FC sees fish production as an ultimate objective and water quality as a means to achieve this objective. The two groups share the same objectives but do not co-operate to prioritise and synchronise their activities. MOE-FC Consensus can be only ranked as 'moderate'.



MOE Results from Spatial Analysis



MOE Results from SADM

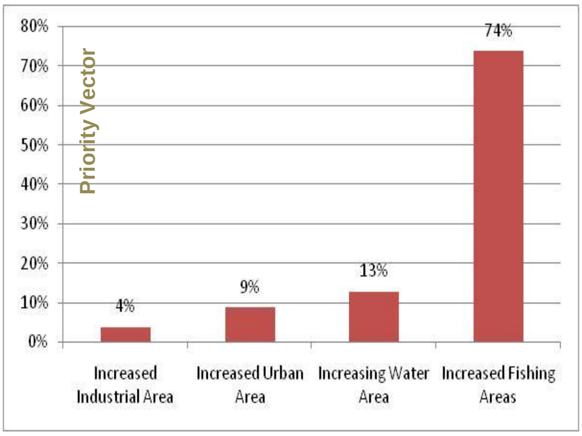
Figure 6-2 Comparison Between Spatial Analysis and SADM Results in respect to MOE

Validating output data from the SADM against the results of the analysis of change detection as presented in chapter four shows a degree of consistency of results. Both results show that MOE considers water quality as its highest priority followed by increasing the fish catch. Increasing urban and industrial areas present the lowest priorities respectively (see Figure 6-2).

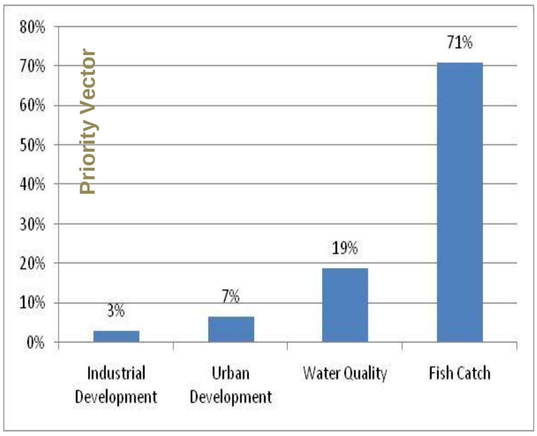
6.1.3 Validating results with respect to FC

Results from SDDM show that the fishermen community share moderate consensus with the environment component (34.07%). They have poor consensus with social (14.78%) and economy (4.08%). Validating the consistency of these results with the analysis presented in chapter five, show that the limited consensus with social and economic components reflects the economic nature of these dimensions that involve activities which have negative impacts on fish production. There is also a high degree of opposition to industrial development activities among fishermen. They consider the industry sector very harmful to fish production and community health. This is their synthesised collective decision despite that it may drive the economy of the area under investigation.

Validating results from the SADM module against the change detection results as presented in chapter four show consistent degree of similarity between stakeholders identified priorities and the identified changes on the ground. Both results show that the fishermen community considers fish catch as the highest priority followed by the increase of water areas which ultimately increases fish production. Expanding urban areas represent their third priority. This result is consistent with the spatial analysis results that show some degree of expansion of the fishermen's residential areas. Both results show that increasing the industrial areas is the lowest priority (see Figure 6-3).



FC Results from Spatial Analysis



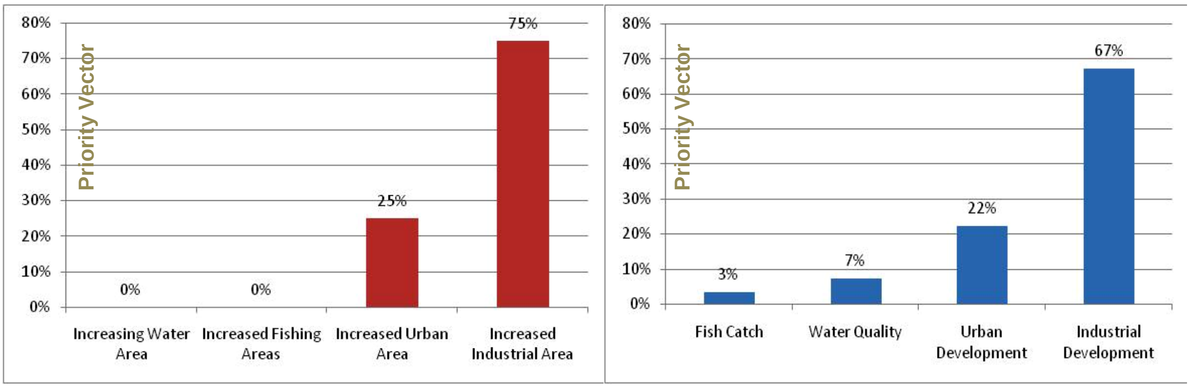
FC Results from SADM

Figure 6-3 Comparison Between Spatial Analysis and SADM Results in respect to FC

6.1.4 Validating results with respect to ABA

Validation of SDAM's result with respect to ABA shows that ABA preferences are of economic and to a certain extent social in nature. Results presented show that there is 84.58% consistency between ABA priorities and economic component. This degree of consistency is the highest among all stakeholders. Analysis presented in chapter four explains that there is a driving force of increased demand for new industries, as well as continuous need for expansion of current industries.

Validating the results of SDAM with results obtained from change detection show a considerable degree of consistency between the SDAM module results and the actual changes on the study area. Both results show that increasing industrial activities in the investigated area represents the highest priority of the ABA cartel which is backed up by the Ministry of Petroleum, and the Ministry of Investment in association with the GOA (see Figure 6-4).



ABA Results from Spatial Analysis ABA Results from SADM

Figure 6-4 Comparison Between Spatial Analysis and SADM Results in respect to ABA

6.1.5 Validating synthesised results of SDAM

Results of synthesised SDAM overall priorities as presented in section 5.4.11 shows that, in case of hypothetical equal weighted stakeholders, fish catch comes as highest priority followed by water quality, urban development and lastly industrial development. When applying the influence ratio as presented in section 5.5.4, urban development comes as first priority followed by industrial development. Water quality and fish catch present the least priority respectively (see Figure 6-5).

In order to analyse the overall Consensus between stakeholders, results of SDAM can be split into two main categories: poor and moderate consensus. In the first category are stakeholders that have conflicting objectives leading to very poor consensus, such as MOE and ABA with a consensus of only 3.49%.

This percentage is the smallest among all stakeholder combinations. FC and ABA ranked second in terms of conflicting objectives with a consensus percentage of 3.92%. In the same category GOA-MOE consensus percentage is equal to 6.23%. Consensus between GOA and FC is 6.55%.

GOA and ABA share a consensus rate of 33.83% which is considered as per the consensus scale as “moderate consensus”, while the highest consensus rate of all stakeholders is between MOE and FC at 39.23%.

Comparing these results with the influence diagram shows that GOA and ABA share the second highest degree of consensus, and have the highest influence rate leading to a major shift in the decision-making process affecting management of Lake Maryout.

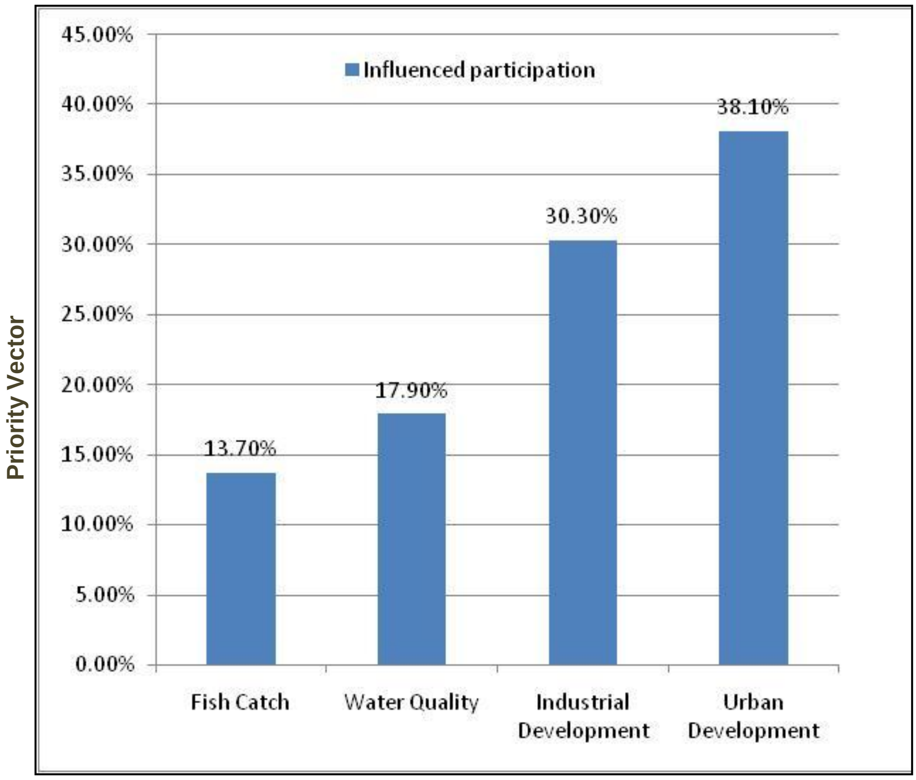


Figure 6-5 Synthesised Influenced SADM Results

Validating the influenced synthesised SDAM with the outcomes of the change detection and spatial analysis shows that changes on the ground are consistent with the results of SDAM (see Figure 6-6).

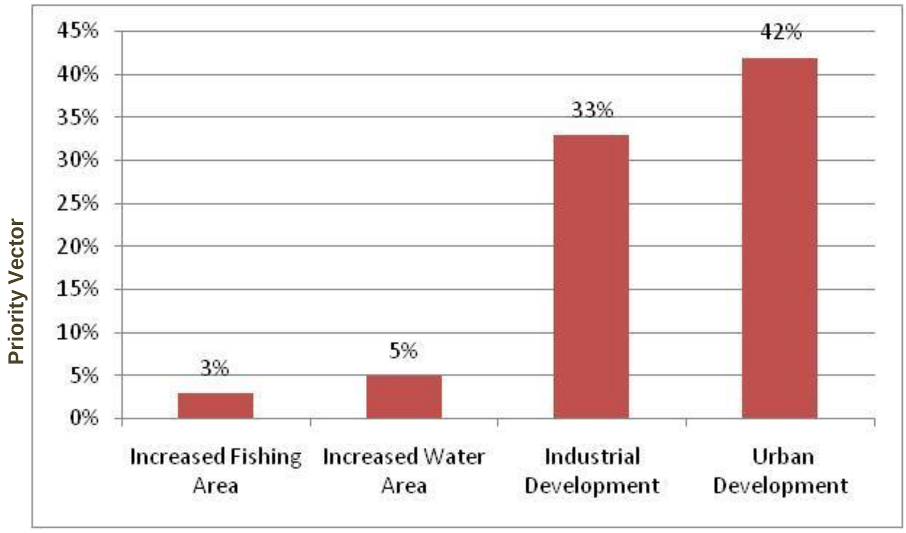


Figure 6-6 Results of Changes on the Ground From Change Detection

Urban development has the highest percentage of change as it was increased by 42% followed by industrial expansion which has 33% of change. The results reflect that the extent of influence of both GOA and ABA is high to a degree that they can implement their objectives on the ground despite that they are conflicting with other primary stakeholders.

In general, on-going activities and management strategies tend towards more land-filling for urban expansion and more industrial development in and around the lake boundaries. Results from the influence diagram show that urban expansion has the highest priority followed by industrial development, which is consistent with the analysis of the case study, DPSIR framework of Lake Maryout, and with the spatial analysis of the implemented activities on the ground.

6.2 Stakeholder Reaction to the Findings

EDAM results are sent to stakeholders. The objectives of this step are to assess if these results reflect stakeholder priorities, if the synthesised decision is plausible, and if these results can be used as a base for the development of the management of the resource.

A questionnaire was developed (Appendix D) and distributed to the key stakeholders. The questionnaire assesses three outputs of the EDAM: the synthesised decision for each stakeholder, the consensus rank between stakeholder and other stakeholder groups, and if the overall synthesised decision could be an acceptable base for the planning of Lake Maryout.

6.2.1 *Feedback regarding stakeholder priorities*

AHP SADM results are interpreted as a reflection of stakeholder preferences towards the favourable directions of management and planning of Lake Maryout. Results of stakeholder priorities as per the pairwise comparisons outputs from SADM are shown in Figure 6-7.

Stakeholders were asked to manually prioritise their alternatives so that they can be compared to the AHP results.

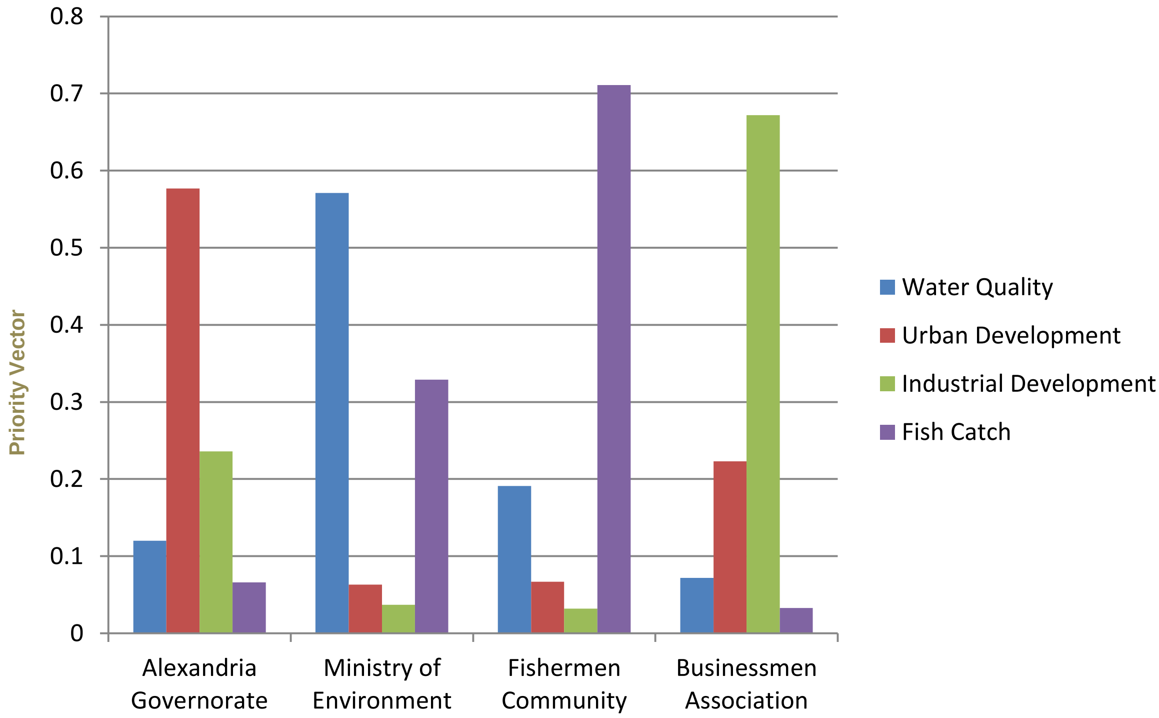


Figure 6-7 Stakeholder Priorities

Results from the GOA sample feedback questionnaires show that GOA has presented different priorities than AHP pairwise comparison results. It agrees that urban development has the highest priority.

Following in importance they presented water quality as its second preference in the planning and management actions in Lake Maryout. It also presented fish production as the third alternative and the last preference is the industrial development (see Table 6-1).

According to the feedback questionnaires, both Ministry of Environment and fishermen community have identified the same preferences as AHP results.

Respondents from ABA agreed with the identified preferences by SADM AHP pairwise comparison results.

Table 6-1 Stakeholder Preferences Feedback

Stakeholder	Results	Stakeholders' Priorities			
Alexandria Governorate	SADM	Urban Development	Industrial Development	Water Quality	Fish Catch
	GOA	Urban Development	Water Quality	Fish Catch	Industrial Development
Ministry of Environment	SADM	Water Quality	Fish Catch	Urban Development	Industrial Development
	MOE	Water Quality	Fish Catch	Urban Development	Industrial Development
Fishermen Community	SADM	Fish Catch	Water Quality	Urban Development	Industrial Development
	FC	Fish Catch	Water Quality	Urban Development	Industrial Development
Businessmen Association	SADM	Industrial Development	Urban Development	Water Quality	Fish Catch
	ABA	Industrial Development	Urban Development	Water Quality	Fish Catch

6.2.2 Feedback regarding consensus rank

Results from EDAM showed that there is poor consensus between fishermen community and both Alexandria Businessmen Association and Governorate of Alexandria. This also applies to the priorities of Ministry of Environment and both ABA and GOA. Table 6-2 shows the summary of the consensus ranks between stakeholders and stakeholder feedback.

Table 6-2 Summary of stakeholder feedback regarding Stakeholder Consensus Ranks

	Relation	Consensus Rank	No. of Replies	Agree	Do Not Agree	% Agreed	Stakeholder Comments
GOA	GOA-MOE	Poor Consensus	25	2	23	8.0%	Strong Consensus
	GOA-FC	Poor Consensus		5	20	20.0%	Strong Consensus
	GOA-ABA	Moderate Consensus		21	4	84.0%	Agree
MOE	MOE-GOA	Poor Consensus	20	5	15	25.0%	Moderate Consensus
	MOE-FC	Moderate Consensus		7	13	35.0%	Strong Consensus
	MOE-ABA	Poor Consensus		20	0	100.0%	Agree
FC	FC-GOA	Poor Consensus	28	27	1	96.4%	Agree
	FC-MOE	Moderate Consensus		25	3	89.3%	Agree
	FC-ABA	Poor Consensus		24	4	85.7%	Agree
ABA	ABA-GOA	Moderate Consensus	24	0	24	0.0%	Strong Consensus
	ABA-MOE	Poor Consensus		5	19	20.8%	Moderate Consensus
	ABA-FC	Poor Consensus		7	17	29.2%	Moderate Consensus
Total			291	148	143	50.9%	

6.2.3 *Feedback regarding stakeholder synthesised decision*

6.2.3.1 *Equal weighted synthesised priorities*

The synthesised equal weighted stakeholder preferences resulted from SDAM represent hypothetically the basis of agreeable management plan for Lake Maryout that takes into consideration all stakeholder preferences.

Stakeholders are asked in the feedback questionnaire if these synthesised priorities shown in Figure 6-8 can form an acceptable base for future planning.

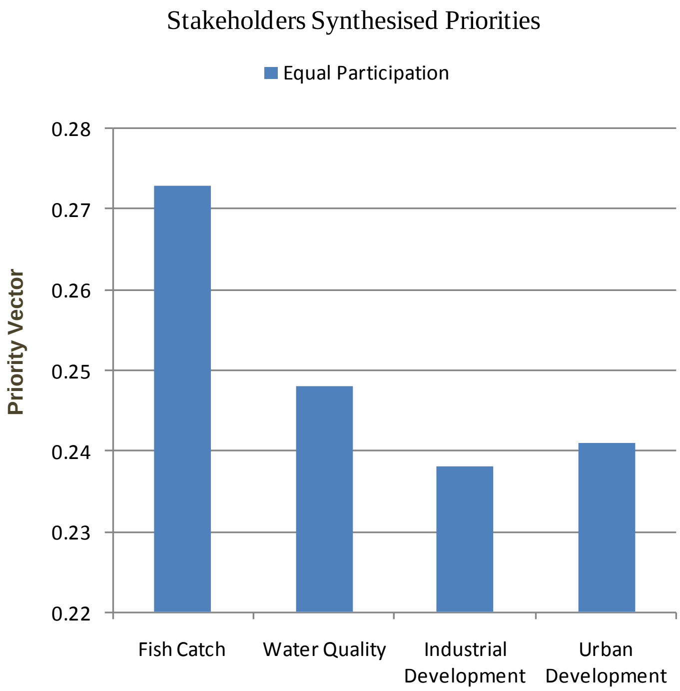


Figure 6-8 Identified SDAM Synthesised Stakeholder Priorities

GOA sample shows that only 36% of replies agree with the synthesised priorities. MOE and FC samples show high percentage of agreement with the synthesised priorities while ABA sample shows total disagreement (see Table 6-3).

Table 6-3 Stakeholder Feedback regarding Equal weighted Synthesised Priorities

	No. of Replies	Agree	Do not Agree	Percentage Agreed
Alexandria Governorate	25	9	16	36.0%
Ministry of Environment	20	18	2	90.0%
Fishermen Community	28	27	1	96.4%
Businessmen Association	24	0	24	0.0%
	97	54	43	55.7%

6.2.3.2 Influence weighted Synthesised Priorities

Influence weighted SDAM pairwise comparison results are included in the feedback questionnaires to assess the reaction of stakeholders regarding applying the influence ratio. Results from SDAM and SADM showed similarity between influenced synthesised decision and action on the ground. Feedback from GOA and ABA show a considerable degree of agreement with the synthesised priorities while both MOE and FC mostly do not agree with the resulted sequence of priorities. Table 6-4 shows the number of replies and the percentages of agreement to each stakeholder sample.

Table 6-4 Stakeholder Feedback regarding Influence weighted Synthesised Priorities

	No. of Replies	Agree	Do not Agree	Percentage Agreed
Alexandria Governorate	25	22	3	88.0%
Ministry of Environment	20	2	18	10.0%
Fishermen Community	28	4	24	14.3%
Businessmen Association	24	19	5	79.2%
Total	97	47	50	48.5%

6.3 Chapter Conclusion

AHP methodology can be validated using against real-world actions. Data from Lake Maryout change detection analysis are collected through the spatial investigations that were conducted in chapter 4.

Stakeholders' preferences from the SADM results were compared against the percentages of stakeholders' actions with respect to the identified alternatives. Results show that the results are consistent when applying the influence ratio.

Results were presented to stakeholders to get their feedback regarding their preferences. Results from feedback show that the higher the influence the higher the percentage of agreement of the influenced synthesised priorities.

CHAPTER 7. DISCUSSION

Chapter 7. Discussion

7.1 Introduction

This chapter discusses the main findings of the research. The research sought to answer the main research question of the study: How does the degree and direction of conflicting stakeholder preferences impact the state of the environment in an environmentally sensitive area?

This chapter tries to provide critical analysis of the developed methodology. It reviews how the EDAM methodology is applied on the case study of Lake Maryout in light of its current policy, planning and legal frameworks. The chapter discusses the Methodology's strengths, weaknesses and constraints encountered and its limitations.

The phenomenon investigated is related to conflicting stakeholder preferences over natural resources in a sensitive area. These types of conflicts tend to lead to decision paralysis on the part of the management authority and ultimately to environmental deterioration.

The analyses of the legal, policy, planning and institutional dimension of the case study shed light on the link between various types of conflicts and their impacts on the environmental quality of the environmentally sensitive area.

Unsustainable management of the resources in the lake area, accompanied by exponential population growth and increased levels of economic and social activity, has led to significant changes in land-use patterns in Lake Maryout.

Stakeholder priorities and decisions are evaluated, analysed, categorised, measured and spatially represented through proper analysis of stakeholder perceptions.

In order to answer the above research question, the research results have to answer three main sub questions as follows:

1. What are the contributions of environmental, economic and social aspects to stakeholder decision-making concerning an environmentally sensitive area?
2. Why does differentiated conflicting stakeholder priorities influence and impact the environmental quality of a sensitive area?
3. How is consensus between the conflicting perceptions of differentiated-power stakeholders measured and ranked?

To this end, an explanation is provided as to how and why environmental decision-making processes need to be analysed, measured and categorised. The benefits of measuring the degree of consensus among various stakeholders of a sensitive environmental area are discussed, as are the implications of the methodology for environmental decision analysis research.

The research does not strive to explain a single, dichotomous variable: if the stakeholders can reach agreement or not. Rather, it stresses the belief that mapping stakeholder preferences with respect to their identified preferences could assist in understanding the structure of stakeholder conflict, and thus assist in the management and planning of the study area. The research examines the plausibility of developing a model to analyse stakeholder preferences, identify the areas of consensus and rank it based on the degree of conflict among various stakeholders.

The discussion in this chapter tries to highlight the findings to develop an understanding of the outcomes.

Results from different modules are discussed and analysed in connection with the findings from other chapters. The final results, presenting the different stakeholder preferences and the interactions between these preferences in terms of the degree of consensus are investigated within the wider context of stakeholders, institutional and policy analysis.

The chapter tries to conceptualise the findings in a meaningful way that helps to improve policy- and plan-making, and thus assist in the environmental management of Lake Maryout.

This research investigated the plausibility of developing a methodology to assist decision-makers in assessing and measuring the degree of stakeholder consensus or conflict in environmentally sensitive areas. To achieve this goal, the research developed an Environmental Decision Analytical Model (EDAM). EDAM is a decision-support analytical tool, based on Multi-Criteria Decision Making (MCDM). EDAM consists of three sub-modules that constitute the building blocks of the research.

The sub-modules are namely; the Sustainable Development Decision Module (SDDM), the Stakeholder’s Decision Analytical Module (SDAM), and the Spatial Analytical

Decision Module (SADM). (see Table 7-1) shows the EDAM sub-modules in relation to the research questions.

Table 7-1 EDAM Sub-modules and Responding Research Questions

Module	Research Question
EDAM	How does the magnitude and direction of conflicting stakeholder preferences impact the state of the environment in an environmentally sensitive area?
EDAM Sub-modules	
SDDM	What are the contributions of environmental, economic and social aspects to stakeholder decision-making?
SDAM	How is consensus between the conflicting preferences of differentiated-power stakeholders represented, measured, and ranked?
SADM	Why does differentiated conflicting stakeholder priorities influence and impact the environmental quality of a sensitive area?

Each of the sub-modules works to analyse an element of the study to answer the research question. SDAM uses sustainable development pillars and IEA methodology as basis for understanding the drivers and evaluating the decisions. It tries to answer the question of how the environmental, economic and social variables are contributing to stakeholder decision-making concerning an environmentally sensitive area. SADM uses Analytic Hierarchy Process (AHP) to analyse each stakeholder's strategy towards management of the study area and then compare all strategies and analyse the areas of conflict.

The main purpose for using the AHP is to improve the understanding of how stakeholders trade-off non-quantifiable preferences that may exhibit merely subtle differences.

AHP is a measure of relative stakeholder preference of one alternative against another alternative. AHP is a flexible, structured methodology that allows an individual or a group of individuals to identify a particular problem and develop an explanation based on the individual's or the group's own perspective of the problem (Saaty, 1980a).

SADM uses AHP methodology to answer the question: What is the magnitude and direction of consensus among conflicting stakeholders?

SDAM uses the outputs of the previous two sub-modules as inputs in the module. It utilises Geographic Information System and spatial analysis to spatially represent the decisions and hence to locate the area of consensus. SDAM explores the impact of differentiated level of stakeholder influence on the overall synthesised decision-making process. Therefore, SDAM tries to respond to the question: How is consensus between the conflicting perceptions of differentiated-power stakeholders measured and ranked?

By answering the three research sub questions, the research tried to develop an understanding of how to assess and measure the impact of differentiated influence and conflicting stakeholder priorities on the degradation of an environmentally sensitive area, which represents the main research question.

To achieve the research objectives, various elements of the research question need to be analysed. These elements include identifying stakeholder priorities, measuring the degree of influence for each stakeholder, assessing the degree of degradation in the area of study, and measuring and ranking the degree of consensus. Each of these elements needs to be evaluated to understand under which theoretical context it could be investigated.

The Environmental Decision Analytical Model (EDAM) tries to develop an understanding of how environmental conflict emerges, what contributes to this conflict, what the severity of the disagreement is and what the directions of resolution are.

The main objective of the research is to develop a new methodology able to assess measure and rank the degree of consensus among stakeholders. The methodology as described in chapter 3, is applied on simplified application of analytical hierarchical structure as an example to identify the main variables underpinning Lake Maryout's stakeholders' conflicting priorities. This is achieved by comparing stakeholder preferences against the sustainable development components in SDDM. The module overlays each stakeholder preference on SD components and examines the overall direction of these preferences. Consequently, it calculates the consensus rank with each SD pillar.

Specific objectives include the development of a spatial analytical module capable of mapping preferences and priorities among stakeholders with respect to their identified preferences to assist highlighting the rationale behind these positions. SDAM is designated to receive the preferences from the two other sub-modules and spatially represent the individual and synthesised preferences. This provides a user-friendly visualising tool for decision- makers, managers and planners to view the preferences map of stakeholders in the area under investigation.

The second specific objective is to develop a methodology to assess, measure, and rank the degree of consensus among all participating stakeholders. This is achieved through analysing all stakeholder preferences in SDAM, exports the outputs to SDAM, and calculates the areas of consensus. EDAM ranks the degree of consensus according to the developed consensus scale.

Mendoza and Prabhu (2003) regard MCDA as a conveniently structured method to facilitate collaborative planning and the decision-making environment. The research provides the foundation for future research concerning the applicability of MCDA through Analytic Hierarchy Process (AHP) to understand the stakeholder environmental decision-making processes.

Future research can build on EDAM by adding more layers to better analyse the impacts of each decision, such as adding a financial implication module, environmental valuation of identified preferences or calculating the cost of environmental degradation for each strategic decision.

The research develops a model capable of analysing the stakeholder decision-making process that is shaping the changes on the ground. Therefore, stakeholder preferences have to be evaluated and compared to their actual practices. The research reviews the historical foundation and the genesis of the concept of public, community and stakeholder participation to develop an understanding of the forces that shape the environmental decision-making process, and the role and influence of the public in that process.

The research distinguishes between different types of stakeholder theories. Accordingly, normative, analytical, instrumental, organization-centric or stakeholder-centric theories are investigated. Stakeholder conflict definitions and resolution techniques are evaluated to explore if the developed EDAM model is contributing to create an understanding of the root causes of environmental conflicts.

The research tries to utilise and merge several disciplines and techniques. EDAM uses spatial analysis through Geographic Information System (GIS) and remote sensing, Multi-Criteria Decision Analysis (MCDA) by using Analytic Hierarchy Process (AHP) and DPSIR framework to construct a model capable of measuring and scaling the degree of consensus among conflicting stakeholders.

EDAM provides decision-makers with an information sheet that illustrates the areas where decision-makers must improve the inter-relation between environment-social-economic elements in order to have balanced policy options.

It highlights the degree of consensus or conflict among the stakeholders exploiting the area of study. Decision-makers can propose a series of intervention measures to build consensus among stakeholders.

7.2 Critical Analysis of the Developed Methodology

The problem investigated in this research is associated with conflicting stakeholder preferences over natural resources in an environmentally sensitive area. Analysing the case study of Lake Maryout shows that stakeholders' conflict tend to cause decision paralysis and policy failure which leads to continuous environmental, social and economic deterioration. The methodology has to identify the magnitude and direction of the stakeholders' conflict that are contributing to the current management failure.

Therefore, the selected research methodology has to meet certain criteria to be able to analyse the stakeholders' conflict and develop an understanding of the current environmental degradation within the framework of existing policies and institutional setup.

7.2.1 Characteristics of the Environmental Decision Analytical Model (EDAM)

A summary of the main characteristics of the Environmental Decision Analytical Model (EDAM) is provided as follows:

- Emphasis has been placed in this thesis on the importance of the developed model (EDAM) to be comprehensive and flexible in order to assess stakeholder conflict in any relevant environmentally sensitive area subject to stakeholder conflict.

- Mixed methodology of both qualitative and quantitative is used to examine the relationship between stakeholders' conflict and environmental degradation. The underpinning data are collected through expert and stakeholder questionnaires, interviews, public hearings, field survey and remotely sensed data.

- SDDM assists decision-makers to compare stakeholder position against the three pillars of sustainable development (environment, social and economic). SDDM provides understanding of how the situation on the ground is contributing to sustainable development.

- SDAM assists decision-makers to analyse stakeholder preferences against one another. It helps decision-makers understand the positions of each stakeholder with respect to their identified alternatives and highlights the rationale behind taking these positions.

- SADM is an analytical tool that assists decision-makers spatially visualise, locate the analysed stakeholder preferences, and calculate the areas of consensus.

- EDAM is conducted through three main phases: situation analysis, decision analysis and a validation process.

- The developed model was tested using the outcomes of the analysis of the case study area of Lake Maryout, Egypt.

- The model was validated using the case study and results from spatial analysis change detection are used to validate the consistency of results from the developed decision model.

- Results were sent to decision-makers to assess their feedback and reactions regarding the outcomes.

The overall goal for EDAM and all sub-modules is sustainable management of the area of study. EDAM aims to develop a decision support methodology to assist decision-makers in assessing and measuring the degree of stakeholder conflict in environmentally sensitive The EDAM has its strengths and weaknesses. The strengths are as follows:

7.2.1.1 Ability to analyse multi-criteria decisions on a real-life case study

The selected methodology is able to analyse multi-criteria decisions. The developed methodology therefore, includes the development of a MCDM model and validated through the use of Lake Maryout as a case study. The strength of using case study research method is its ability to study, in-depth, a “case” within its “real-life” context (Yin, 2004).

MCDA models are functional tool for decision analysis because it is an appropriate structured method to facilitate collaborative planning and decision-making. Multi-Criteria Analysis methodology is generally most appropriate not to develop answers for environmental problems but rather to set the conditions for a transparent and informative decision process (Hajkowicz, 2008).

The EDAM methodology uses MCDA for analysing stakeholders' conflicting complex problem of Lake Maryout where environmental, social and economic aspects need to be considered. Applying MCDA on a case study provides an analytical tool for identifying policy failure or lack of management plans.

EDAM is able to use the case study to collect the required data to test the model, to examine if the methodology develops an understanding of the root causes of the conflict, and to verify the research results by comparing the outputs against the situation on the ground.

The multiple objectives criteria that are identified either through Stakeholders' Alternatives Questionnaires or Sustainable Development Experts' Questionnaires were analysed through the developed methodology. The methodology was flexible enough to incorporate different types of multiple criteria. SDDM used sustainable development pillars in the multiple objectives level while SDAM used case study alternatives such as water quality, fish catch, urban development and industrial development in the model's multiple objectives level. The strength of EDAM therefore, is its ability to analyse multi-criteria and can be applied in many different situations.

7.2.1.2 Ability to apply Analytic Hierarchy Process (AHP)

The decisions that have been taken by Lake Maryout's stakeholders need to be analysed to understand the factors that have contributed to these decisions, why these decisions were taken and how differentiated stakeholder power may have affected these decisions. The analysis is conducted retroactively, since the preferences of stakeholders have already been assessed through the questionnaires, and the methodology is used to analyse these positions to develop an understanding of why these judgments were made.

EDAM uses AHP method which is an appropriate tool for complex social issues in which intangible and tangible factors cannot be separated (Lee, 2008). AHP assists analysts to organize the critical aspects of a problem into a hierarchy problem tree (Bevilacqua et al., 2004). In the last two decades, and because of its practical nature, AHP has led to many diverse applications in analysing complex and elusive decision problems (Leung et al., 1998).

The research uses AHP to analyse each stakeholder policy, preferences or decisions through using pairwise comparison between two alternatives.

Participation of decision-makers is a central part of multi- criteria analysis where several criteria have to be taken into account simultaneously in a complex situation. AHP is designed to help decision-makers integrate the different options, which reflect the opinions of the stakeholders or actors involved (Bottero et al., 2011).

Numerous methods have been used to examine the societal preferences in environmental attributes (Ananda and Herath, 2003). The conventional theory of economic policy generally applies the paradigm of rational decision-making (Hafkamp and Peter Nijkamp, 1986). The majority of models designed for policy analysis assume rational behaviour of recognisable, individual decision-makers or of a collective decision agency. These models deal with a set of axioms for rational decision-makers subject to complex situations. These policy analysis models are mostly normative in nature (Harsanyi, 1979).

Conventional economic evaluation for environmental quality often depends on contingent valuation to elicit judgments cast as replacement values in dollar terms. Contingent valuation involves posing a hypothetical situation, then asking survey participants how much they would be willing to pay to improve the environmental quality or to prevent environmental degradation. These replacement values are used as inputs into cost-benefit analysis (McDaniels, 1996).

Contingent valuation and the willingness to pay method is not applicable for this research because of its relative inflexibility, and because it uses the dollar value as the only value to measure the preferences of stakeholders. The research investigates the preferences of each stakeholder from environmental, social or economic perspectives.

Considering the objective of the research and the qualitative nature of the identified alternatives and the complexity of the variables contributing to stakeholder decisions, Multi-Criteria Decision Making (MCDM) methods are an appropriate framework for evaluation. MCDM has the capability to take into account conflicting, multidimensional, incommensurable and uncertain effects of stakeholder decisions (Carbone et al., 2000, Munda, 2000, Omann, 2000).

Normative, utility-based approaches could be applied in cases of structured and simple judgment conventional situations. However, it is hard to apply it in complex multi-group, multi-level, and multi-attribute decisions in light of conflicting behaviour of actors or stakeholder groups (lsard and Smith, 1983).

There are several techniques that can analyse preferences. The Choice Experiment (CE) is used in investigation of individual preference (Carlsson et al., 2007; Alfens, 2004; Burton and Pearse, 2002 and Burton et al., 2001). The theoretical foundations of CE depend on two main theories: 1) Lancaster's Theory of Value (Lancaster, 1985), which suggests that utilities can be broken down into distinguishable utilities for their characteristics or attributes, and 2) Random Utility Theory, which explains the main judgments made between pairs of offerings (Kallas et al., 2011).

AHP is more applicable to this research than CE because it allows for determining preference scores at individual levels while the CE does not.

Multiple Objective Criteria Decision Analysis (MCDA) considers the presence of conflict among stakeholder goals, while institutional and procedural aspects of planning can be included through collaborative decision strategies (Rietveld, 1981, Spronk, 1981).

Multiple objective decision analysis generally uses "satisficer" principle as an alternative to an assumed optimizing behaviour based on a compromise between different and mostly conflicting objectives (Simon, 1958).

AHP is a consistent tool that enables the structure of logical decision-making processes and identifies the significance of a set of criteria and sub-criteria (Rajiv Bhatt et al., 2010). The research investigates multiple environmental, economic and social alternatives. AHP method is very appropriate for complex social issues in which intangible and tangible factors cannot be separated (Lee, 2008).

AHP is a mathematical method for analysing complex decisions with multiple criteria. It is a general theory of ratio scale measurement based on mathematical and psychological foundations (Kangas, 1993). The AHP is used in this research because of its applicability to deal with various stakeholders with different preferences to develop a synthesised judgment. Saaty (1980) believes that it is also useful when numerous interests are involved and a number of people participate in the judgment process.

The developed methodology uses AHP because of its support to other decision-making methodologies. As explained in the chapter 3, the research uses combined qualitative and quantitative methodology.

AHP allows stakeholders or decision-makers to minimise extensive drawbacks in the decision-making process, such as lack of focus, planning, involvement or possession, which eventually are costly distractions that can prevent the decision-maker from making the right choice.

7.2.1.3 Ability to analyse multi stakeholders preferences

One of the main objectives of this research is to develop a module capable of mapping preferences and priorities among stakeholders with respect to their identified alternatives and to analyse the rationale behind these positions. The research methodology therefore uses AHP to analyse and evaluate the stakeholders' preferences with respect to identified alternatives for the management of the case study area. Stakeholders' Decision-Making involves identifying priorities. AHP is usually used where there is no "right" answer to complex problem (Saaty, 2008). It is applied when there are conflicting values and vested interests. Chapter 2 highlighted many methods that are able to identify stakeholders' priorities. However, because of the nature of the addressed problem of stakeholder priorities conflict, the research requires a research analytical method that can address and assess social preferences. Cost-benefit analysis is able to analyse economic-related preferences while there are other methods that have been used to examine the societal preferences in environmental attributes (Ananda and Herath, 2003).

Analysing stakeholders' preferences is a complex and difficult procedure. Stakeholders' Decision-Making includes various types of trade-offs among intangibles (Saaty, 2008). To achieve this goal, SADM analyses each stakeholder's comparative preferences towards the management of the study area. The stakeholders' conflict analysis characterized by multiple objectives, socioeconomic, and political judgments. Primary stakeholders are identified in chapter four and selected for analysis. The model is able to use stakeholders at the criteria/objectives hierarchical level and proposes the identified policy options at the alternative level. This highlights the ability of the methodology that explores the various options taking into consideration all stakeholders' preferences. The methodology is able to identify the hypothetical overall management decision or strategy that meets the requirements of stakeholders within their identified alternatives.

Accordingly, the output of the methodology is not an unambiguous solution but rather an analytical roadmap to assist decision-makers to better manage the sensitive area accordingly.

7.2.1.4 Ability for assisting in natural resources management

Management of natural resource has become an arena for stakeholders' participation in environmental decision making. Increasingly, affected groups demand a voice, both in policy making and management decisions (Schmoldt et al., 2001). Because of its capabilities and flexibility, various institutions and governments regularly use AHP for making key policy decisions (Elkarni and Mustafa, 1993).

It is very challenging to make rational decisions within the social and economic cross cutting environmental issues. In light of these fundamental complexities, decision support tools are essential to assist decision makers take structured decisions with respect to natural resource management. Decision making in land management includes selection among conflicting alternatives. Regularly, such selections are often challenging due to the complexity of the decision process (Schmoldt, 2001).

The principles and the philosophy of the AHP method provide analytical framework to develop an understanding of the complex relationships inherent in the research topic. The developed methodology helps assessing the human-induced influence on natural resources at each decision level of the same order of magnitude, thus enabling accurate comparisons. The first AHP stakeholders' participation applications were conducted in nature conservation planning (Kangas, 1994). AHP method has also been applied in forest policy analysis at the province level (Kajala, 1996).

The developed methodology tries to analyse factors that explain the stakeholders' decision-making mechanisms and how it contributes to the degradation of the natural resource. One of the main strengths of EDAM methodology is its applicability as a useful tool for natural resource decision making. The AHP as the main foundation for the EDAM has several capabilities include: assist in group decision making, problem structuring, consensus building, works with both qualitative and quantitative information, conflict resolution, decision support tool, and preferences structuring. EDAM provides a road map to manage Lake Maryout taking into consideration the ecological problems such as water quality and fish reproduction. In order to manage the natural resource the methodology is able to consider the economic issues such as industrial activities as well as social activities such as urban expansion.

7.2.1.5 Ability to be used for stakeholder conflict management

The conflicts in land use incorporate political, economic and environmental dimensions which can only be understood entirely by investigating the historical context within which the problems arose and intensified (Whitlow, 1985).

Conflict management is the most common issue in the area of natural resource management (Schmoldt, 2001). Saaty and Alexander (1989) show the ability of the AHP for resolving conflicts. They described several case studies where different conflicts were simulated using the AHP in order to develop an understanding of conflicts. The AHP was used as an effective tool to analyse the different elements of conflicts (Ibid).

EDAM methodology used pairwise comparisons to map different stakeholders' preferences. Preferences are overlaid using the methodology's spatial tool (SDAM) in order to calculate the areas of conflict or consensus.

7.2.1.6 Ability to be integrated with other tools such as GIS

Schmoldt (2001) critically assesses the use of Geographic Information System as an effective complementary tool for AHP. He explains that GIS can offer an analytical domain within which the AHP can easily be integrated to analyse natural resources and to enable the analysis of environmental systems to be more site-specific.

Itami et al. (1999), describes a decision support system that is able to combine GIS with the AHP. Integration of AHP with spatial analysis includes the work of Jankowski (1995), Jankowski et al. (1997), and Eastman et al. (1998).

EDAM provides flexible analytical features that can take advantage of GIS spatial capabilities to serve as an advantageous connection to bridge information gaps using stakeholders' and expert opinions.

EDAM uses the sub-module Spatial Decision Analytical Module (SDAM) as a GIS tool that allows analysis of the outputs of the AHP process to be integrated in a spatial domain. The main function of the SDAM is to perform spatial analysis for the input stakeholder judgments to spatially represent the analysed decisions and locate the areas of consensus.

7.2.1.7 *Ability to integrate mixed qualitative and quantitative data*

The AHP fundamentally uses mixed qualitative and quantitative data. When quantitative data are available, more particularly when the decision elements are clear, pair-wise comparisons can become very precise (Schmoldt, 2001). According to Kulak and Kahraman (2005), humans are unsuccessful in making quantitative predictions, whereas they are relatively efficient in qualitative forecasting.

The developed methodology uses MCDA, represented by the AHP process to analyse Lake Maryout stakeholder preferences. The analysis is supported by qualitative data from the stakeholders, and expert questionnaires and interviews to develop an understanding of the underpinning causes of stakeholder positions. The research used DPSIR framework to investigate the different variables that are contributing to these decisions and to examine the effectiveness of the available policies and legislation in the area of study.

Qualitative analysis of stakeholders' preferences can provide insight of the perception of each stakeholder towards the identified set of priorities. Quantitative data is collected through Stakeholders' pairwise comparison questionnaires, stakeholders provide a list of their preferences, policy actions or alternatives towards proposed management plan. They can provide verbal justification for their choices.

Qualitative methods have the ability to depict stakeholder order of preferences. However, the qualitative method cannot depict the comparative preferences between each of the two alternatives. Using questionnaires and interviews could help in identifying priorities and justifications for selecting these preferences, but cannot provide answers of how relative power affects stakeholder preferences.

AHP therefore, can be used to help capture both subjective and objective evaluation measures. It has the capability of providing a valuable tool for examining the consistency of the evaluation measures and alternatives suggested by Lake Maryout stakeholders in order to reduce the biases in the decision-making process.

7.2.2 *Weaknesses of the developed methodology*

The main weakness is that the methodology is costly and time intensive. It requires teams to meet with stakeholders, distribute questionnaires, conduct interviews and explain the methodology. The methodology entails the distribution of 5 questionnaires which might be exhaustive to the identified sample.

The methodology also requires a group of experts that are familiar with the case study and the concepts of multi-criteria analysis. This combination of disciplines requires specific expertise.

EDAM methodology entails conducting change detection of the selected case study. Acquiring recent and historic images is very costly. The research was able to conduct it because it relied on the already existing EU project of ALAMIM which allowed the use of satellite images.

The developed methodology requires assessment of the environmental, social and economic quality of the area under investigation. This assessment should be regularly updated. This type of quantitative data is mostly very dynamic particularly in environmentally sensitive areas.

The methodology conducts institutional and policy analysis of the case study. It provides road map for how to enhance the current policy and legislations. However, adjusting existing policies is usually a very optimistic task to achieve.

7.3 Constraints and Limitations

The research developed an Environmental Decision Analytical Model (EDAM) to assist decision-makers in assessing and measuring the degree of stakeholder conflict in environmentally sensitive areas. AHP pairwise comparisons data inputs are based on questionnaires that were distributed to different experts and stakeholders. The values represent their judgments, which are, as in the case of all AHP applications, subjective. However, any approach to simulate a complex human decision-making process will generally depend on subjective judgments.

This research uses the output Eigenvalues obtained from classical Saaty matrices, which may produce some degree of errors to the AHP pairwise consistency ratio. Some of these errors could be adjusted using some modified robust priority evaluation methods (Lipovetsky and Conklin, 2002). The challenge for any AHP is the aggregation technique over different levels of the hierarchy and the methods of calculating inconsistency ratios and rank reversal phenomenon (Hurley, 2002). Some high inconsistency values may occur in the case of conflicting stakeholder preferences. Stakeholders might have confused interconnected perceptions to the available alternatives, which could be reflected in a high inconsistency ratio.

The absence of a rigorous statistical theory in AHP is also seen as one of the disadvantages of the method (Alho et al., 1996). AHP does not provide analysis of the uncertainty inherent in the data.

Selection of alternatives has a major effect on the results. Alternatives should be carefully identified. Alternatives should not be limited to those imposed by the affected stakeholders, but should rather represent the whole spectrum of stakeholder and planning objectives. In the case of Lake Maryout, the selected alternatives were based on the limited availability of options because of existing reality, policy conflict and lack of management plan. The research used a limited number of stakeholders' identified alternatives to assess their priorities. However, in order to use the model for planning, expert opinion should be considered to develop a comprehensive set of management options.

The Identifying Influence ratio is a subjective judgment, based on values originating from managers' perceptions (Donaldson and Preston, 1995). These values should be carefully weighted in light of thorough stakeholder analysis. Factors that could affect other secondary stakeholders, sometimes known as externalities, are usually functions of the degree of influence.

The research used IUCN model for assessing the degree of influence. Depending on the case study, several other influence criteria can be applied to assess the stakeholders' degree of influence.

The research aimed at developing a new methodology able to provide a management roadmap that could be considered by Lake Maryout's decision makers and stakeholders' groups. In order to examine this assumption, the research presented the outputs to decision-makers. Analysis of the feedback as presented in chapter 6 showed that not all stakeholder groups accept the results. However, and according to the change of political landscape after the Egyptian revolution in January 2011, the developed road map and the methodology were requested by both the Governorate of Alexandria and The Ministry of Environment. Both authorities expressed their willingness to consider the priorities presented by stakeholders' groups in the new management plan. GOA requested formally to apply the methodology in another sensitive area to the west of Alexandria. This could be explained by the change from centralised authoritative institutions which used to control the decision-making process, as explained in chapters 2 and 3, to more democratic participatory decision-making process. This development could limit the application of the research methodology to certain political and societal domain where public participation is at the centre of the decision-making process.

7.4 Findings within the Case Study's Policy, Planning and Legal Frameworks

The case study area of Lake Maryout represents an example of failure in the management of natural resources. Chapter 4 provides an illustration of stakeholders' conflicting priorities coupled with conflicting policies and legislation. It shows the lack of capable institutions able to develop a comprehensive communicative planning. Absence of proper legal framework plays a role in exacerbating the deterioration of its environmental quality. The analyses of the legal, policy, planning and institutional aspects shed light on the link between various types of conflicts and the environmental quality of the environmentally sensitive area.

The national environmental policy in Egypt expresses the sensitive political, economic, and societal balances that exist within the context of policy perspectives. However, it is perceived as an economic obligation because of its emphasis on the budget constraints that pushed the system's orientation in the direction of resolving immediate problems rather than looking at long-term needs. Achieving sustainable development entails a close collaboration and cooperation between environmentalists and the decision-makers (Wahaab, 2003).

Results show that unsustainable management of the resources in the lake area, accompanied by exponential population growth and increased levels of economic and social activity, has led to significant changes in land-use patterns in Lake Maryout.

7.4.1 Findings from the Sustainable Development Decision Model (SDDM)

SDDM is used to analyse the sustainable development pillars' contribution to the identified preferences in order to examine stakeholder preferences with respect to the environmental, social or economic dimensions. Understanding the nature of each stakeholder's priorities provides a mapping for their order of priorities. This could help decision-makers and planners to develop a balanced sustainable management strategy for the sensitive natural resource. The foremost activity of the public planners is to assist (or participate in) processes of deliberation (Fischler, 2000).

The research suggests that the outcomes of stakeholder preferences mapping could assist in the participatory deliberation process for developing communicative planning for the area. Stakeholder conflict over competing and conflicting interests and objectives regarding natural resource decision-making continues to hinder sustainability efforts (Rockloff and Lockie, 2004).

The concept of sustainability has been extremely popular in public policies (Brown and Worldwatch Institute, 1981). Currently, most initiatives must be sustainable and are predominantly evaluated on that criterion. However, there are no available specific methods that could be used specifically for building sustainable strategies (Philippe, 2011). Evaluation of sustainable development with respect to urban areas is very important to future development (Li, 2009). Global and national organizations and institutions have tried to investigate the relationships between various sustainability pillars in order to understand the nature of these relationships, particularly causalities between sustainability pillars to reach sustainability targets (Mirshojaeian Hosseini and Kaneko, 2011).

The Analytic Hierarchy Process (AHP) is very appropriate evaluation technique for the assessment of urban sustainable development (Fang, 2009). AHP models are suitable for evaluating sustainable development aspects in urban areas (Hai-yang and Fang, 2009).

In SDDM, experts conducted pairwise comparison of the selected stakeholder preferences to identify the preference of each alternative to the environment, economic or social objective. AHP pairwise comparison synthesises all preferences to identify the percentage of each alternative to SD component. SDAM overlays stakeholders' judgments with respect to the identified preferences against an identified sustainable development synthesised diagram reflecting the three pillars of sustainable development (environment, social and economic). It provides an example of how different components of sustainable development are interacting in the area of study. The synthesised SD diagram is used to compare stakeholder preferences to the SD components.

Sustainable development, with respect to the sustainable use of natural resources, has to consider social aspects to prevent the emergence of conflict (Switzer, 2002). AHP method is used for analysing complex social issues in which intangible and tangible factors cannot be separated (Lee, 2008). A recent study of the causality between pillars of sustainable development concluded that the relationships among pillars of sustainable development are not global facts but rather depend on the situation and these interactions need to be analysed locally (Mirshojaeian Hosseini and Kaneko, 2011).

Therefore, SDDM module looks at the entire SD components to better map the areas of potential consensus or conflict. Given the expert SD pairwise comparison, results from SDDM show that each component of sustainable development has its respective objectives in relation to identified preferences. According to the results, the social-economic percentage of consensus is equal to 28.10%, and is ranked as moderate consensus according to the consensus scale. However, it is the higher percentage of consensus among other components. SDDM does not rank or measure the nature of any of the identified preferences as environmental, social or economic, but rather identifies the percentage of SD pillar aspects within each specific alternative.

Stakeholder and institutional analysis in chapter four show that major economic activities such as industrial development and tourism have an interchangeable impact on the social level with respect to residents and fishermen around Lake Maryout.

According to the analysis of the case study, the high dependency of social aspect such as unemployment, income and economic activities on the economy of the area, has led to the relatively moderate consensus of these two components.

Results show poor consensus between the social and environment component. Results show only 12.80% consensus between the social-environment components. Water quality is affecting both health and fish production, which consequently affects income.

Results shows that the economic and environment share poor consensus of only 3.54%. Analysis of the case study in chapter four shows that there is strong conflict between the two components. Economy, which relies mostly on industrial activities and urban expansion, is highly contradicting with the environmental quality of Lake Maryout.

The synthesised SD preferences showed that urban development mostly contributed 37% to the sustainable management of Lake Maryout. Water quality represents 24% in terms of preferences. Industrial development has the third priority with 23%, while increasing the fish production in the lake is the last preference contributing 16%. Therefore, the synthesised SDDM is important to understand how each sector is contributing to the SD plan.

Analysis of SDDM shows that MOE has primarily environmental oriented preferences, which are consistent with its mandate and the assigned relevant legislations (81.64% consensus with environment component). ABA has clear economic oriented preferences that meet its objectives (84.58% consensus with economy component). FC preferences are divided by environmental, social and economic dimensions (34.07%, 14.78%, and 4.08% respectively). This is justified by the need of the fishermen community to the three dimensions. The GOA however, has strong consensus with the social component (57.84%), moderate with economy (32.75%) and poor with environment (5.94%).

Therefore, the research recommends that the GOA may have to assign more weight to the environment component, a recommendation that could be translated into actions through proper policies. An adjustment in the current legislation to avoid conflicts with other agencies is required.

These results highlight the areas that need intervention. The GOA as part of its institutional mandate has to protect the environmental quality of the Governorate. It has developed a special environment unit. However, it does not monitor or implement environmental regulations. This unit has a continuous conflict with the MOE while they should have the same goals.

The analysis provides a road map for managers and decision-makers. It assists in delineating the directions of each stakeholder's objectives in relation to the sustainability of the Lake. This mapping offers a clearer view of the existing orientation of the problems and an understanding of the directions and priorities for intervention.

7.4.2 Findings from the Stakeholder Decision Analytical Model (SDAM)

Results from SDAM are analysed in light of the DPSIR framework, stakeholders, institutional, legislative and policy analysis conducted in previous chapters.

Chapter 4 shows that the responsibilities for environmental protection in Egypt are scattered among a number of Ministries and Governorates (EEAA, 2009). Coastal Zone Management in Egypt is described in the environment law 4/1994. As amended by Law 9/2009, article 39 defines the coastal zones. Article 48 (p.37) define Integrated Coastal Zone Management as "a process by which all concerned authorities participate in coordinating their work in order to preserve the environment of the coastal areas." The calculated degree of consensus show that contradictions and conflicts in laws and regulations have led to policy failure in applying the coordination stated in these articles.

Results from SDAM show that the highest recorded consensus is between MOE and FC. The comparatively high consensus between MOE and FC is calculated at 39.23%, which ranked according to the CS as moderate consensus.

Institutional, policy and legislative analysis show that there is high degree of complementarity for the powers assigned to both MOE and Fishing Authority.

According to Law 4/94, MOE, represented by the Egyptian Environmental Affairs Agency (EEAA) is charged with overall monitoring and regulatory coordination. Presidential Decree (PD) 45/1983 assigns MOE to sign and monitor the Protocol for the Protection of the Mediterranean Sea from land based pollution sources. Monitor of water quality and industrial wastes constitute the main conflict between MOE and ABA. Results show that consensus between the two is ranked as poor with a low percentage of 3.49%, the lowest recorded among all stakeholders.

Law no. 124 of 1983 assigns the Fishing Authority as the main body responsible for the protection of water resources, and it regulates the conservation of marine animals and fish farming. The Fishing Authority is authorized by the same law to provide licences to fish farms.

According to Law no. 124 of 1983, the General Authority for Fish Resources Development should establish the Lake Maryout Development Committee. This committee has the mandate to plan and monitor any activities or violations in and around the Lake. Due to its limited power, its role has been limited to regulate fish catch, and protect the interests of the fishermen community (EEAA, 2009). Therefore, the MOE has assisted the FC in monitoring and reporting any violation. However, there is no evidence of implementation and enforcement of laws. The division of tasks between MOE and FC and the complementarity in laws and legislations make consensus between the two stakeholders more evident.

SDAM analysis shows that the Alexandria Governorate (GOA)-Business Association (ABA) ranked second in terms of consensus with a percentage of 33.83% (Moderate Consensus).

DPSIR framework analysis shows that population growth represents a major driving force to urban filling. GOA has a consistent strategy for urban expansion, driven by the increasing demand for new residential areas for the growing population. The industry sector takes advantage of this policy by using the filling of lands for industrial sites.

According to the local administration law, the governorate manages its property within the governorate boundary. This applies to the lake and surrounding lands since the governorate is the legal owner. However, law 124 of 1983 states that the land surrounding the lake is under the authority of the General Authority for Reconstruction and Agricultural Development (GARD). This contradictory legislation creates more conflict between various agencies.

Despite Egypt's long history of environmental legislations, it suffers from the weak enforcement of these regulations. Egypt has developed plenty of environmental plans; however, it lags in the use and application of these plans (Wahaab, 2003) .

Results show poor consensus between GOA and MOE with a percentage of only 6.23%. The law of local management system amending law no. 43 of the year 1979, amended by law no. 50 of the year 1981 states that the governorate's public local council, within the State's general policy, monitors the different facilities and works within the jurisdiction of the governorate according to the article. Law no. 43/79 conflicts with the main rules governing MOE's mandate, operation and functions. The MOE mandate is derived from law no. 4 of 1994, updated by law no.9 of 2009 and complemented by the executive regulations, issued in the Prime Minister's Decree Number 338 of 1995. This law assigns the monitoring to the Ministry of Environment, Ministry of Irrigation and Ministry of Health. Law no. 4 of 1994, amended by law no. 9 of 2009 and its executive regulation prevents some encroachment cases on the lake such as back filling, improves water quality, monitors industrial drainage, and increases fish production. These tasks are already scattered between many other agencies.

This conflicting responsibility does not create complementarity of objectives, but rather a power struggle between who has the authority to monitor and implement the laws.

According to SDAM, FC has poor consensus with both GOA and ABA. The FC's main mandate is planning, coordination and regulation of activities related to fish production (capture and culture).

According to law 124 of 1983, the land surrounding the lake is under the authority of the General Authority for Reconstruction and Agricultural Development (GARD), which is the main agency within the FC. The same law prohibits backfilling or draining any part of a lake, and imprisons and charges fines to anybody who does this. According to interviews with ABA, GOA and FC it was found that this is the main reason of conflict between FC and both GOA and ABA.

SADM builds on the outcomes of SDDM and SDAM to spatially calculate the areas of preferences. It compares them with the spatially-located areas of consensus and locates the areas of consensus among all stakeholders.

Analysis of the outcomes provides an understanding of how the conflicting priorities affect the way these institutions may co-operate and hence to develop a consensus on a unified management plan.

7.4.3 Effect of differentiated stakeholder powers

Mapping stakeholder influence on decision-making is crucial to examining the degree to which the differentiated power wielded by stakeholders influences the group decision-making processes. The impact of stakeholder power should be taken into consideration in any attempts to resolve stakeholder conflict as well as in the communicative planning process.

According to Habermas (1984), and the critical theorists, planning is conducted in the "face of power". Building on Habermas , Innes (1995) has proclaimed the ascendancy of a "new (communicative action) paradigm" for planning (Stein and Harper, 2003). The work of Foucault has been the base for many planning theorists. The issue of power and ethics are essential to both planning practitioners and theorists (Healey, 2003a).

The acknowledgment of the 'power of agency' was the centre of the work on 'implementation' in local planning and development procedures in both the USA and UK in the late 1970s and early 1980s. Since then, it has turned out to be a significant perception in the social sciences for investigating the relations between structuring forces and human agency (Healey, 2003b).

An organization's actions toward the natural environment constitutes a competitive dimension with clear strategic interest (González-Benito, 2008). Numerous organizations willingly undertake initiatives, programmes, and practical "proactive" or "committed" environmental behaviours to reduce their negative impact on the environment (Berry and Rondinelli, 1998; Hunt and Auster, 1990).

Stakeholder influence mapping is a significant method to study the relative importance of different stakeholder groups and their degree of power over decision-making (Mayers, and Vermeulen, 2005). The expression of power is more beneficial for legitimate conflict resolution, consensus building, and planning (Stein and Harper, 2003).

Following the WWF Stakeholder Influence Analysis cross-cutting tool, the research has identified the differentiated relative powers. The degrees of power were fed into the decision tree to examine how these powers would influence the overall synthesised preferences. The results were compared to the outcomes of spatial analysis and remote sensing change detection to examine how these powers actually influence the situation on the ground.

Results from the effects of influence are used to develop an understanding of what influence stakeholders have over decision-making processes, and how this factor can shift the direction of lake management, resulting in changes to the overall priorities as compared to the synthesised equal-weighted stakeholders' decisions.

The significance of these results is that it shows how synthesised preferences can be shifted by the impact of differentiated powers. This can allow decision-makers to understand the need of empowering specific affected groups in order to balance this influence, which might ultimately affect the overall changes on the ground.

Results of equal weighted preferences show that if stakeholders have the same influence the synthesised priorities would have ranked the fish catch as the first priority followed by water quality, urban development and finally industrial development.

Applying the influence ratio on the AHP pairwise comparison resulted in a different rank of preferences. Influence weighted preferences results show urban development has the highest priority followed by industrial development, water quality while fish catch has the least preference.

Comparing the results of the synthesised influence preferences with the spatial analysis change detection results presented in chapter 4 show consistencies with the actual actions on the ground. The results on the ground reflect how current policies are impacting the environmental quality of Lake Maryout. To reverse this situation, a revision of current conflicting policies is required in light of their negative impacts on the institutional mandate of the main stakeholders.

7.4.4 Analysis of Stakeholder Overall Preferences and Their Feedback Regarding Results

AHP is used to compare decision elements with each other and weights assigned in order to identify the priorities in the decision process (Zahedi, 1986). SDAM has analysed the pairwise comparison of each stakeholder to define the preferences for each stakeholder. SDAM has also produced synthesised preferences considering all stakeholder judgments.

EDAM based on the AHP approach provides excellent insight about how the different pillars of sustainable development are interacting with respect to the available alternative actions. Real-life case studies can help planners become aware to the threats of distorted communication and can provide opportunities of additional consensual modes of decision-making (Forester, 1989; Healey, 1996).

EDAM results were sent to stakeholders to assess their feedback and reactions regarding the outcomes. Feedback questionnaires were distributed to primary stakeholders.
A sample of 115 questionnaires was sent to primary stakeholders. The total response rate was 84.3%.

Analysis of stakeholder feedback, existing laws, regulations and applied policies show that MOE and FC have consistent clear objectives that are reflected in balanced priorities to choosing the preferences in management of Lake Maryout. Laws and regulations that were assigned to MOE and FC, particularly the Fishing Authority, support both stakeholders to achieve their mandate.

Analysing feedback from each group reveals that 92% of the GOA respondents do not agree with their synthesised pairwise comparison results. They clarified in their feedback questionnaires that they view water quality as their second priority, fish catch as the third priority while industrial development is the least preferable among the identified alternatives.

Change detection and field visits show otherwise. Filling for urban and industrial activities are underway. Pollution levels have not decreased and this negatively affects fish production.

Change detection analysis presented in chapter four shows that in a period of five years (2002—2007) urban filling represents 62% of the total changes. GOA contributed to 64% of these filling activities while ABA has contributed 25% through expanding its premises for non-industrial activities. The positive change in water areas represents only 5% of the changes. Industrial activity changes over the original area of Lake Maryout represent 40%. The GOA contributed 21% and ABA 75% of the recorded changes in industrial activities.

The GOA has conflicting priorities with other primary stakeholders and internal conflicts in its mandate and legislation. As indicated in this chapter, the authority of Lake Maryout and surrounding areas is divided between the GOA and other agencies. Monitoring of environmental quality and reporting of violations is divided between the GOA and MOE. GOA therefore, has the authority to fill parts of the lake and the authority to report on any filling by other agencies or individuals. It has the authority to assist ABA to grant permits for more industries within the lake area and the mandate to enhance the water quality.

Environmental protection in Egypt, and particularly towards wetlands are spread among several Ministries and Governorates (EEAA, 2009).

Egypt's policy agenda has primarily problematic areas concerning industrial planning, dumping of wastes and urban encroachment (Hafez, 1996). These are the same areas, which mostly contribute to the degradation of Lake Maryout. The degradation problem is exacerbated by existing stakeholder conflict.

Therefore, EDAM allows for better understanding of the orientation of stakeholder preferences and how these preferences interact with SD components in order to assist in adopting particular strategies to very complex issues of sustainable management of environmentally sensitive areas, where the complexity of ecological, social and economic variables makes decision-making difficult.

7.5 Using EDAM Results to Improve Environmental Management of Lake Maryout

EDAM provides decision-makers and planners with an information sheet that summarises the results of all sub-modules. The information sheet highlights the areas that either need attention by suggesting adjustments to the current policies or proposing new ones, design consensus-building exercise, deliberation process, empower particular stakeholders, or need mitigation actions on the ground.

The research does not intend to provide a comprehensive list of required actions for each identified area that requires intervention. It rather highlights the main areas that EDAM has identified, and thus provides practical examples of policy intervention.

7.5.1 Improving environment-social-economic balance

SDDM results show two sustainable development components of the identified alternatives that need intervention: environment-social and environment-economic.

Principles of sustainable development in Egypt are integrated in the National Urban Development Strategy, up to the year 2017. Components of the strategy are also scattered in various urban and regional strategies and policies (European Commission, 2005).

The Ministry of Environment has to promote the integration of environmental considerations into other policy sectors (Hafez, 1996). Egypt has to take the necessary steps to prepare a new comprehensive national sustainable development strategy to ensure national and sectorial strategic planning to ensure that sustainable development is at the core of Ministry policies and strategies. It has become increasingly recognized that research and policy need to consider the interactions of social, environmental and economic factors (Huby et al., 2007).

There is an essential need to develop a master plan for Lake Maryout, depending on the future vision for sustainable socio-economic development (Ragué and El-Refaie, 2009).

In Lake Maryout, environment-social component is characterised by the interaction between water quality, health condition and income. Improvement of water quality will lead to the improvement of health conditions of residents of the Lake Maryout area. It will also attract more investments to the area, which will generate more jobs for the local community. According to Abdrabo (2006), investments in Lake Maryout is concentrated in areas where water quality is acceptable. The new residential area of Alex West has been developed in Wadi Maryout which considers one of the best water quality areas.

Water quality can be improved through reduction of industrial, domestic and agricultural pollution loads, reduction of vegetation cover, and restoring water areas that were deducted by land filling.

Environment-economic component is characterised by the link between water quality, fish production and the tourism industry. Improved water quality will improve the quantity and quality of fish catch. It will also help in attracting new investments and eco-tourism and fishing activities to the area, which will reflect positively on the local economy.

7.5.2 Improving the environment aspect of the GOA

According to the results, GOA's activities are more of a social and economic nature. GOA's consensus rank with the environment component is categorised as "poor" with very low consensus percentage of 5.94%.

MOE has to improve the ability of integrating environmental considerations into overall policy development and into its sectorial policies. Hafez (1996) argues that Ministry of Environment has to conduct not only Environmental Impact Assessment but also Social Impact Assessment. At the institutional level, enhancing the environment component of GOA's work can be achieved through empowering the already established environmental management unit. The unit is not functioning as it has a complete conflict with other programmes and projects within the governorate, particularly urban construction and industrial support units (ALAMIM, 2008a).

At the technical level, the environment unit should be empowered with the required expertise to enable the unit to achieve its objectives. The unit should have a clear description of the implementation arrangements of laws and legislation, including roles and responsibilities for monitoring of violations. Empowerment of the management unit could provide decision-makers with the required data on the state of the environment in the lake (Hassouna, 2007)

At the policy level, GOA should develop the required governorate's environmental policy. The environment should be mainstreamed with government activities. It also should develop its environmental information dissemination strategy. This needs a complete coordination with MOE and other relevant agencies.

According to Egypt's law of the local government system (1975), the governor heads all the governorate's units. He also heads the local council, which plays an important role in the coordination of activities and policy-making. He also represents the president in his governorate. This assigns the governor and hence the governorate with the main responsibility for "political and food security" (Hafez, 1996). At this higher policy level, the governorate should be mandated not only with monitoring but also with environmental protection within its boundaries through the implementation of environmental violations. Nominating a deputy Governor for Environment will ensure that environmental protection is taking a high priority within the decision-making process of the governorate.

7.5.3 Improving the social and economic Aspect of MOE

As explained in the institutional assessment in chapter four, the main procedures governing MOE's mandate and operation are derived from Law Number 4 of 1994, updated by Law 9 of 2009 and supplemented by the executive regulations issued in the Prime Minister's Decree number 338 of 1995 (EEAA and CAPMAS, 2011).

The MOE, through its regional offices focuses on monitoring environmental quality, and reports on the state of the environment in different governorates.

According to the EEAA (2011), MOE acts as the coordinating body of the government for environmental activities, formulating general environmental policies, drafting environmental legislation, and issuing rules, regulations and standards. In addition to these tasks, it also coordinates the implementation of plans and programmes for encouraging economic activities in the field of pollution prevention. This part of MOE's mandate has not been adequately functioning in Lake Maryout.

In order to integrate the socio-economic aspect within the Ministry's activities, MOE has to develop coordinated programmes with relevant authorities that can enhance the environmental condition of the lake, while other primary and secondary stakeholders can have socio-economic benefits. MOE needs to improve the ability of mobilising the necessary financial resources for environmental improvement programmes.

International cooperation could be useful to assist MOE improve its current policies. The European Neighbourhood Policy (ENP) was developed in 2004, with the objective of "avoiding the emergence of new dividing lines between the enlarged EU and the neighbouring countries" (European Commission, 2010). The European Commission through ENP assists countries to develop strategies and to prioritise convergence of their environmental policies and legislations with those of the EU under the ENP Action Plans. The ENP programmes objective aims at increasing the importance of the environment sector on the agenda of ENP countries in order to improve the social and economic return through analysing the benefits for each country (Ecologic Institute, 2011).

Making use of EU partnership will strengthen the environmental dimension of public policy and will promote sustainable development policies and actions. These programmes could include eco-tourism or encourage investment in the use of water reeds to produce local products. After applying Environmental Impact Assessment to any activity, such pilot projects could help in the integration of strategies for nature conservation, preservation of natural resources, and increase environmental education and public awareness in Lake Maryout.

7.5.4 Improving the social and economic awareness of the Fishing Community

Results show that the fishing community consensus with respect to social and economic components is poor. Accordingly, there is a need to improve the socio-economic conditions of the fishermen community. Decision-makers and planners have to develop sustainable economic strategies through improved fisheries management and fishing industry engagement of the local community.

The socio-economic situation of the affected community reflects its social exclusion and high poverty levels; this includes two linked aspects, which are lack of access to basic services, low income, and the housing situation (Verhagen and Abu-Zeid, 2011).

Degradation of water quality and fish production is negatively affecting people’s livelihoods. The fishermen community relies on both fish production (their main source of income) and vegetation for feeding livestock, cooking, and as thatching for living quarters to support their living (EEAA, 2009).

Fish catch contributes to the fishermen community’s local economy. However, the connection between 140 industries around the lake and the FC is limited to providing jobs to members of the family and a few small fish production activities.

The relationship between the fishing community and existing industries formulates ‘bridging’ of the social capital, which can substantially affect community lives. The local and national NGOs can provide credit in the form of loans. Over 500 fishermen can benefit from loan scheme, which can be used for productive fish industries (Verhagen and Abu-Zeid, 2011). Interaction of the fishing community with international organizations can provide training programmes and introduction of new technologies to improve fishing methods.

Awareness campaigns should take place to improve the fishermen community's knowledge to the value of having an environmentally sound industry, as well as upgrading their fishing methods and fish industry.

7.5.5 Improving the environment aspect of ABA

SDDM results show poor consensus with the environment component. This is also evident from the analysis of the case study and the analysis of the ABA's actions on the ground in chapter four.

The research suggests increasing the technical capacities of industrial activities within and around the lake in order to develop environmental management systems to comply with the Environment Law 4/94.

Local authorities represented by GOA are mandated by Law 93/1962 to regulate the discharge of wastewater into public sewer networks. Presidential Decree (PD) 1948/1965 establishes a permanent committee by the Ministry of Defence for protecting the sea from pollution while Presidential Decree 45/1983 assigns MOE to monitor the Protocol for the Protection of the Mediterranean Sea from land based pollution sources. Contrary to previous legislations, Law 196/53 (amended by law no. 33 of 1954) allows the discharge of public commercial and industrial wastewater into the sewage system.

This conflict I policy has led to policy failure. Authorities are not able to implement any specific regulation because of the existence of a law, Ministerial Decree or Presidential Decree permitting the same action.

Improving the legislative system and the existence of a unified nation-wide strategy for pollution reduction will help in minimising some of the existing symptoms of industrial pollution.

The Egyptian Pollution Abatement Project (EPAP) that was carried out from 1997 to 2003 is a good example of how Egyptian industries are helped to alleviate their environmental problems. The World Bank provided grants and soft loans to interested companies, which showed willingness to implement environmental projects (EEAA, 2003). Sustainability of these types of projects help industry to upgrade their environmental performance, institutional support to improve the enforcement of the environmental regulations (Askar, 2010). Steps should be taken to promote the adoption of cleaner and environmentally sound technologies in Egyptian industry.

7.6 Improving Lake Maryout Stakeholder Consensus

Four alternatives were selected to test the degree and existence of conflict among Lake Maryout stakeholders. The categories used to rank the degree of conflict range from "no or poor consensus" to "extreme consensus".

Final EDAM results show that the consensus rank between identified primary stakeholders with respect to the identified alternatives is "Poor". EDAM provides decision-makers with an information sheet for overall stakeholder mapping. It highlights the areas that need intervention in order to build consensus towards the development of a management plan for Lake Maryout.

Analysis of the EDAM outcomes identifies three areas that cause the stakeholder conflicts of Lake Maryout:

1- Conflict of existing policies
2- Conflict because of differentiated stakeholder priorities
3- Conflict because of differentiated stakeholder influence

Ignoring stakeholders and the local people's priorities and not including them in the planning, management, and decision-making have been found to be the main source of conflicts (Lewis, 1996). Reducing the root causes of stakeholder conflict could significantly improve consensus and pave the way towards a participatory communicative planning for Lake Maryout.

The fundamental fact challenging all societies is that scarcity of valued things prevails, leading to differences over their allocation (Easton, 1965).

Guba and Lincoln (1989) state that consensus on all issues `is rarely if ever possible'. There is a reasonable chance that the articulation of differences and opposition between stakeholders will result in impasses, making conflicts more visible (Abma, 2000).

Kelso (cited in Germain and Floyd 1999, p.396) suggests the basis of environmental conflict, while "land resources are limited, human desires are limitless". Kelso contends that land-use conflicts arise because stakeholders and their real and perceived priorities are transient, whereas land is fixed in space and content. These differences in perceived priorities could be seen as opportunities for developing dialogue among stakeholders.

Lake Maryout Stakeholder Management Information Sheet

Table 7-2 Lake Maryout Stakeholder Management Information Sheet

1-Stakeholder Preferences With Respect to Sustainable Development Pillars			
SD Pillar	Environment	Social	Economic
Environment		Poor	Poor
Social			Moderate
Economic			

2-Stakeholder Consensus with Respect to SD Pillars			
	Environment	Social	Economic
GOA	Poor	Strong	Moderate
MOE	Extreme	Poor	Poor
FC	Moderate	Poor	Poor
ABA	Poor	Moderate	Extreme

3-Stakeholder Synthesised Priorities				
Stakeholder	Stakeholders Identified Alternatives			
GOA	Urban Development	Industrial Development	Water Quality	Fish Catch
MOE	Water Quality	Fish Catch	Urban Development	Industrial Development
FC	Fish Catch	Water Quality	Urban Development	Industrial Development
ABA	Industrial Development	Urban Development	Water Quality	Fish Catch

4-Stakeholder Consensus Ranks				
	GOA	MOE	FC	ABA
GOA		Poor	Poor	Moderate
MOE			Moderate	Poor
FC				Poor
ABA				

5-Overall Stakeholder Consensus With Respect to Identified Preferences	
	Consensus Rank
Consensus among all stakeholders	Poor Consensus

6-Stakeholder Influence With Respect to Lake Maryout				
Stakeholder	GOA	MOE	FC	ABA
Influence Value	Extreme	Strong	Moderate	Very Strong

7-Stakeholder Equal Weighted and Influenced Synthesised Preferences				
	Preference 1	Preference 2	Preference 3	Preference 4
Influenced participation	Urban Development	Industrial Development	Water Quality	Fish Catch
Equal Participation	Fish Catch	Water Quality	Urban Development	Industrial Development

7.6.1 Resolving conflict of existing policies and legislations

Policy and legislative analysis conducted in chapter four show a considerable degree of conflict among the existing laws and regulations concerning the monitoring and management of wetlands in Egypt. These contradicting laws, Presidential Decrees, Ministerial Decrees and governmental decisions have led to complete paralysis in the implementation of these regulations.

Resolving water quality legislation is essential to enforce the implementation of laws against water pollution. Two main laws govern Egypt's legislation regarding water quality. The first Law is 48/1982 for protection of the Nile River and waterways from pollution, which regulates the discharge of wastewater into the Nile and other waterways.

The second is Law 4/1994 on Environmental Protection, which constitutes the main legislative body in the field of environment to formulate the general policy and prepare the necessary plans for the protection and promotion of the environment (EEAA, 2009). Despite that the EEAA is responsible for the environment countrywide, Law 4/1994 retained most of the monitoring authority for inland waters with the Ministry of Water Resources and Irrigation (MWRI) and the Ministry of Interior (EEAA, 2009).

Law 93/1962 assigns responsibility to the Ministry of Housing and Public Utilities to monitor and regulate the discharge of wastewater into public sewer networks. Ministerial Decree 134/1968 implements Law 38/1967 of the Ministry of Local Development to monitor any dumping of wastes.

According to 48/1982, The Ministry of Health should perform monitoring and regular analysis for treated liquid waste samples, taken from the facilities that obtained licenses for discharging into water canals.

According to Presidential Decree number 465/1983, monitoring of all water bodies in Egypt is placed under the jurisdiction of the General Authority for Fish Resources; the main member of the fishermen community.

Law of local management system amending law no. 43 of the year 1979, amended by law no. 50 of the year 1981 gave the governorate's public local council, within the State's general policy, the authority to monitor the different facilities and works within the jurisdiction of the governorate.

Accordingly, monitoring of water quality and pollution has been assigned to the Ministry of Environment, Ministry of Irrigation, Ministry of Housing and Public Utilities, Ministry of Local Development, General Authority for Fish Resources, Ministry of Health and Ministry of Interior.

To improve the effectiveness of these conflicting legislations, the research suggests dividing the monitoring, supervision and implementation of laws among three main authorities.

First, MOE has to have the legal status stated in Law no. 4/94 for the overall monitoring of environmental quality including water, air and land pollution. EEAA (2009) suggests that MOE should be the sole entity responsible for any environmental monitoring activities.

Second, GOA has to have the overall responsibility for the supervision of any violation in Lake Maryout area with accordance to Law no. 43/1979. Abdrabo (2006) stresses the importance of assigning supervisory power to local government to report of any environmental violation.

Third, the Ministry of Interior has to be the legal authority to implement the laws in case of any reported violations. According to Hafez (1996), implementation of laws and regulation within each governorate is the responsibility of local police forces which operates under the overall leadership of the Ministry of Interior.

7.6.2 Improving Stakeholder Consensus

The EDAM overall stakeholder consensus rank is a function of the bilateral consensus among stakeholders. Consensus between stakeholders is consequently a function of the comparative weight assigned to each priority and to the final synthesised stakeholder order of priorities.

Enhancing the degree of consensus among primary stakeholders would positively improve the integrated consensus. EDAM results show that consensus rank between GOA-MOE, GOA-FC, MOE-ABA and ABA-FC is “Poor”.

7.6.2.1 Improving GOA-MOE Consensus

Conflict between GOA and MOE is categorised as poor with a percentage of 6.23%. The main area of conflict, as indicated in chapter four, is the on-going land filling for urban and industrial expansion. Results show that urban development represents GOA's first priority (56%) while it represents MOE's third priority with a low consensus of 7%.

Legislative conflicts as stated in section 8.7.1 contribute to the conflict, and prevent both stakeholders from working in a collaborative way. Both authorities claim the responsibility of monitoring and reporting on violations.

Improving the environment component of GOA and social component of MOE as described in section 8.6.2 will help in improving the degree of consensus between the two stakeholders.

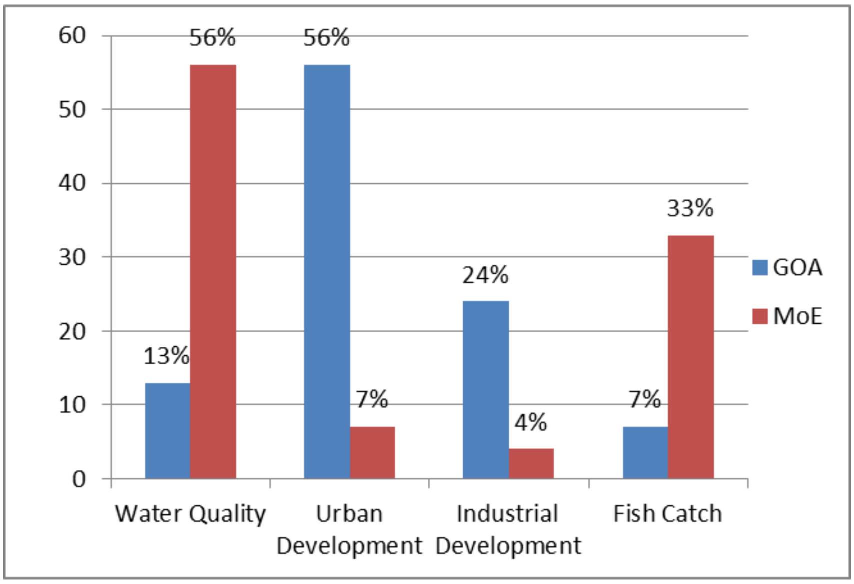


Figure 7-1 GOA-MOE Preferences

Water quality is MOE's first priority with a percentage of 56%. According to results, water quality represents GOA's third priority with only 13% (see Figure 7-1).

The GOA's feedback regarding their synthesised priorities shows that they view water quality as a second priority. This could be a good base to develop programmes and actions to enhance the water quality between GOA and MOE.

Consensus between the two stakeholders could be enhanced through the following:

- Policy reform and clear division of responsibilities, which will contribute to more collaboration and reduce the competitive nature of the two stakeholders.
- GOA to ask EEAA to carry out Environmental Impact Assessment (EIA) studies for all projects, and prohibition of any activities that may negatively impact the environment (EEAA, 2009).

- Co-operation towards the reduction of land-based source of pollution. This can be achieved through agreeing and setting of pilot pollution reduction measures (EEAA, 2009). These measures can be monitored by MOE and supervised by GOA.
- A joint programme for lake dredging could significantly improve the water quality.

7.6.2.2 Improving GOA-FC Consensus

Results show that the consensus rank between GOA-FC is poor with a percentage of 6.55%. Results of SDAM show that fish catch and urban filling represent the main areas of conflicts. Figure 7-2 shows the GOA-FC comparative priorities.

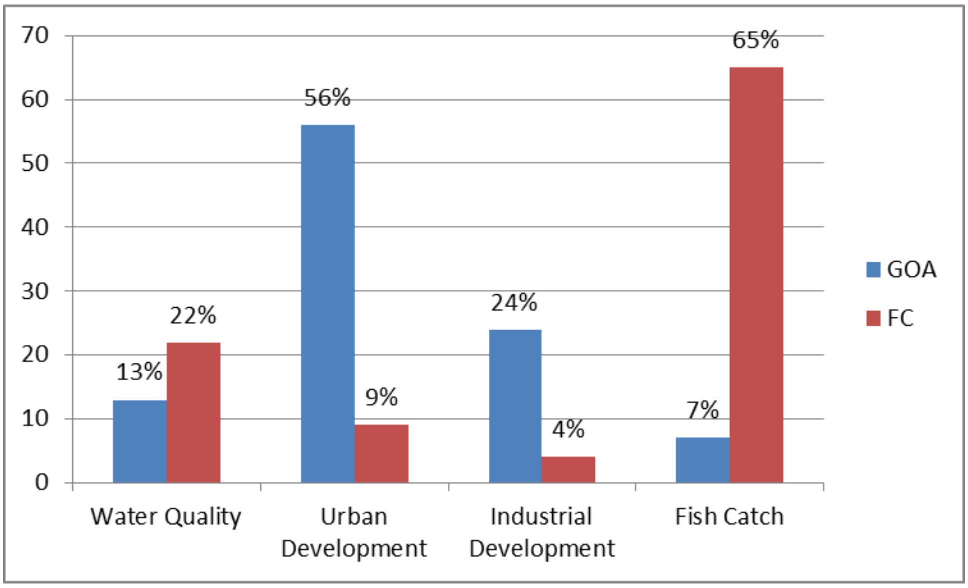


Figure 7-2 GOA-FC Preferences

Improving GOA-FC consensus can be achieved through the following:

- GOA has to improve the housing condition of the fishermen community.
- GOA has to build healthcare facilities within the FC's village.
- After conducting the required EIA, GOA needs to give priority to family members of fishermen to work in newly developed projects.
- GOA has to exert more effort to upgrade water quality. This can be done through the allocation of the required budget to water treatment plants for domestic and agriculture wastewater.

- To develop social inclusion initiatives with emphasis on poverty reduction, equity and participatory approaches to create improved planning and management (Ragué and El-Refaie, 2009).

7.6.2.3 Improving MOE-ABA Consensus

Conflict between MOE and ABA is categorised as poor with a percentage of 3.49%. This is the lowest recorded rank among all stakeholders.

The main area of conflict, as indicated in chapter four, is industrial pollution, which is affecting the water quality. Results show that industrial development represents the primary priority of ABA with a percentage of 63%, while water quality represents 10%. Industrial development is the least priority of MOE with a low percentage of consensus equal to 4% as shown in Figure 7-3.

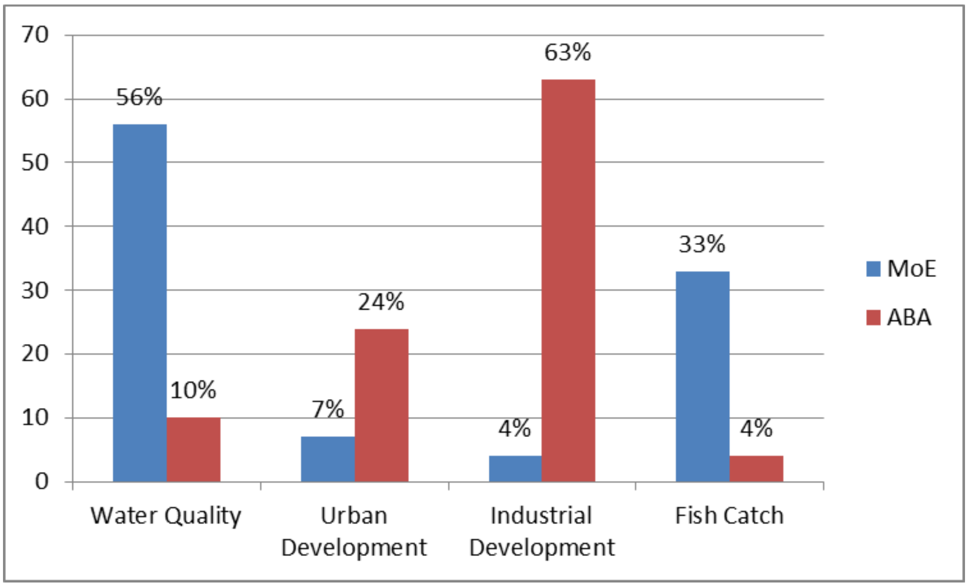


Figure 7-3 MOE-ABA Preferences

Improving MOE-ABA consensus can be achieved through the following:

- MOE has to assist in the implementation of the Pollution Abatement Project that aims at providing grants and soft loans to interested industries to alleviate their environmental problems.
- ABA has to develop EIA to any new developed project.
- ABA has to assist in the proposed efforts for enhancing water quality, such as dredging and aeration.

- ABA-GOA should co-operate in the reduction of COD/BOD levels through the diversion of nutrients from the lake, reduction of water reeds, and improving water circulation (EEAA, 2009).
- ABA has to develop a new vision for Lake Maryout industrial development based on clean production and in line with the corporate social responsibility (Ragué and El-Refaie, 2009).

7.6.2.4 Improving FC-ABA Consensus

Conflict between FC and ABA is categorised as poor with a percentage of 3.92%. Stakeholder analysis in chapter four reveals that the main area of conflict is industrial pollution, which negatively affects fish production. Results show that fish production represents the utmost priority of FC with a percentage of 65%, the highest identified pairwise preference among all stakeholders (see Figure 7-4).

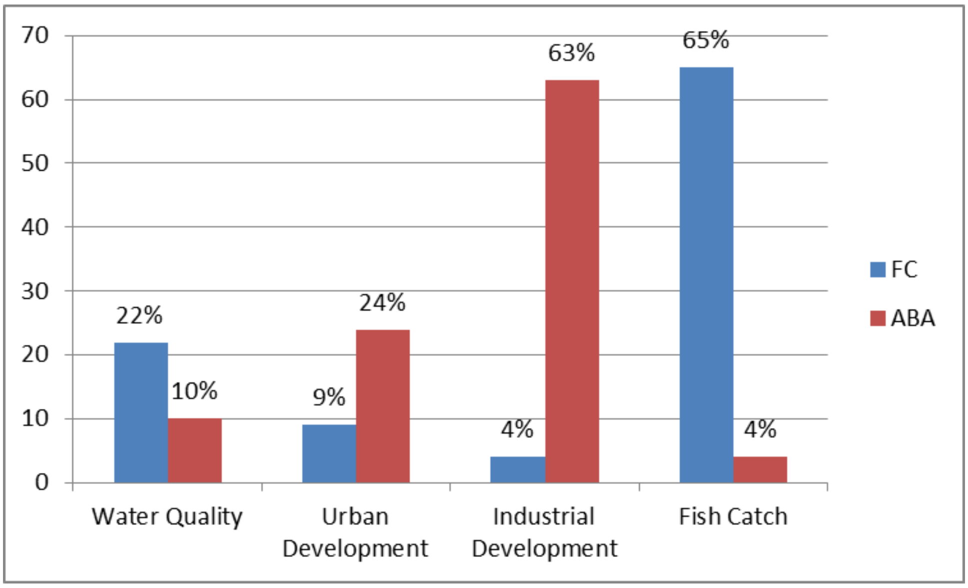


Figure 7-4 FC-ABA Preferences

Improving FC-ABA consensus can be achieved through the following:

- ABA has to take steps towards integrating its Corporate Social Responsibility (CSR) commitment into strategy processes. CSR has to be implemented in the form of activities, resources, and organizational change (Schmitt and Wolff, 2006).
- FC could be represented in ABA Board of Trustees (BOT). Despite FC's small contribution to the economy, they are major stakeholder in Lake Maryout. Their representation will enhance the communication between both stakeholders.

- ABA has to assist FC to upgrade their current fish production industry, fish farms and storage facilities.

7.6.2.5 Balancing Stakeholder Influence

Participation in coastal zone management considers the dominant coastal decision-making paradigm. However, it is critically important to evaluate the nature of the participation processes to deliver the aspiration of inclusivity (Stephen, 2007).

This research examines conflicting stakeholder priorities over Lake Maryout. It therefore investigates the impact of stakeholder influence in the overall management of the lake. Stakeholder participation only is insufficient to ensure that 'right' decisions are taken; instead, it is recommended that any decision should be considered sensibly through a process of deliberation (Fishkin, 1991).

Several studies have attempted to recognize both contextual and organizational conditions that might prompt some key players to be compelled to protect their natural environment while others disregard it (Aragón-Correa, 1998; Arora, 1996; González-Benito, 2008).

Particular stakeholders are more powerful or influential than others. They could be influential concerning only specific issues, while others may have less influence and power. They may exercise their differentiated influence or "power" on the arena they are exploiting, which may ultimately result in the shift in the decision-making process. (Ginter, 1989).

Stakeholder and institutional analysis show that Lake Maryout's stakeholders have a differentiated comparative power and influence in the decision-making process. From the synthesised preferences presented in chapter five, it is apparent that GOA has the highest influence, followed by ABA, MOE and finally the FC. According to Smith (1993), within the environmental conflict resolution model, stakeholder commitment is directly proportional to the degree of participant bargaining power.

As explained in section 7.4.3, these differentiated powers have led to the implementation of the powerful stakeholder strategies on the ground.

SDAM results show that the synthesised stakeholder decision has been entirely changed when applying the influence ratio. Therefore, in order to have a balanced stakeholder influence, an empowerment strategy for MOE and FC should take place.

Sustainable management of Lake Maryout cannot be achieved without participation from all stakeholders that are committed, despite their differences, to integrating environmental sustainability within their organizations and throughout the community. Differences are not only in their priorities but also with regard to their powers. In order to ensure that any management plan is broadly accepted, and thereby sustained, priority differences need to be recognised, and power differences have to be minimised.

Review of current policies and legislation to give more responsibilities to MOE to apply Law4/94 is essential to balance the current power struggle over the monitoring, reporting and implementation of legislative regulations. The law ensures that all activities and projects have to submit EIA studies for approval by MOE.

Policy analysis of the case study shows that there is a need to enforce the implementation of Law no. 124 of 1983, which gives the General Authority for Fish Resources the authority to establish the Lake Maryout Development Committee. This committee will empower the FC to plan and monitor any activities or violations in and around Lake Maryout.

To further empower the fishermen community, as indicated in chapter 7, membership of FC in ABA's BOT is important for enhancing cooperation with the existing industries. The FC has to work towards more representation of fishermen in Local Council.

7.7 Presenting the Results to Decision-Makers

The main contribution of the research is to provide a roadmap for decision-makers to identify the main weaknesses and areas of conflict that need immediate intervention in order to enhance consensus among stakeholders.

The analysis of the case study and the outcomes of the EDAM highlighted the following points that need the attention of decision-makers:

1- Conflicting stakeholder priorities with respect to sustainable development pillars
2- Conflicting stakeholder priorities resulting in poor consensus
3- Conflicting legislation and policies
4- Lack of implementation of laws
5- Lack of mechanism for participation
6- Weak institutional structure
7- Imbalance of stakeholder power

8- Limited institutional capacity
9- Lack of political support to mitigate the current degradation
10- Lack of integrated communicative planning for Lake Maryout

Enhancing consensus between stakeholders is not an easy task. It requires not only a set of measures but also the political will to take these measures.

Communicative theorists assign a rational role to planning theory. Communicative planning for Lake Maryout is essential to engage a wide spectrum of affected stakeholders in a transparent socially oriented participatory endeavour. In order to have successful communicative planning for the area, a full understanding of each stakeholder's priorities and powers is required.

Developing collaborative planning will help in enhancing the collaboration between conflicting stakeholders. According to Healey (2004) as cited in (Gaffikin, Morrissey et al. 2005, p.4), "collaborative planning seems not to be an end in itself but a path to co-existence in shared spaces". Mendoza and Prabhu (2000) regard MCDA as a conveniently structured method to facilitate collaborative planning and the decision-making environment. Several tools and applications use MCDM, particularly MCDA to assist decision-makers. One of the most popular MCDM techniques is the Analytic Hierarchy Process (AHP) (Saaty, 1980). In a survey of the use of AHP, Mendoza and Martins (2006) identified more than 59 applications in natural resource management since the 1970s until 2005. The widespread use of AHP applications in natural resources management reflects the increasing dependency of decision-makers on the application of information systems and computer modelling.

Since adoption of the concept of Integrated Coastal Zone Management (ICZM) it has received increased consideration for the development of tools for planning and management. The increased attention has led to many advances in the development of practical management tools for ICZM (Burbridge, 1999). The use of computer modelling, GIS, and remote sensing spatial analysis will provide decision-makers with updated information and analysis of the area under investigation (Van der Weide and De Vrees, 1999; Gustavson et al., 2000).

Decision-makers have to be aware of the impacts of the available alternatives with respect to the sustainable development pillars. They have to understand how differentiated influence conflicting stakeholder priorities can affect the environmental quality of Lake Maryout, and thus balance these influences with empowerment programmes.

Presenting the results to decision-makers and stakeholders could assist in the consensus-building process within the principles of discourse ethics.

The Lake Maryout information sheet represents a summary that encompasses the results in verbal ranking expressions to enable decision-makers to take the necessary measures to mitigate the situation on the ground.

Successful management of stakeholder conflict can only be achieved once the areas of conflicts are identified and overcome. While management of Lake Maryout remains inadequate and ineffective, the degradation of natural resources continues.

CHAPTER 8. CONCLUSION

Chapter 8 Conclusions

8.1 Conclusions

The aim of this research is to develop a new methodology to assist decision-makers in assessing and measuring the degree of stakeholder conflict in environmentally sensitive areas.

The case study area of Lake Maryout, Egypt, was used as a model of failure in the management of natural resources. Lake Maryout provided a good example that conflict among different stakeholders coupled with contradiction in the current policies and legislation play a role in exacerbating the deterioration of its environmental quality.

The research identified the magnitude and direction of consensus among Lake Maryout's conflicting stakeholders. The analysis highlighted the link between various types of conflicts and the environmental quality of the environmentally sensitive area.

The research emphasised Lake Maryout's conflicting strategic and short-term objectives in the quest for sustainable development. Lake Maryout's currently implemented policies are characterised by short-sighted socio-economic tactics and conflicting legislation. Despite government institutions' recognition of the long term remunerations of sustainable development, they wish to mollify the constituency's short-term demand (Hafez, 1996).

Environmental decision-making is a multifaceted process due to the complexity of the systems considered and the competing interests of multiple stakeholders (Ascough Ii et al., 2008). Analysing stakeholder alternatives and priorities is an important tool to understand the environmental decision-making process.

This research focuses on identifying the links between the decision-making process, policy, planning and legal frameworks, environmental degradation, and stakeholder conflict in environmentally sensitive areas.

The management of conflicting stakeholders has emerged as an important tool for strategic management (Lim et al., 2005). Organization theorists have argued the primary role of the stakeholder in planning and management. Mapping of stakeholder conflicting preferences in an environmentally sensitive area provides a useful platform for better management of natural resources.

The compatibility between MCDA, particularly AHP method, natural resources management and decision-making, strongly highlights the AHP's potential as a decision support tool (Schmoldt, 2001). MCDA is considered a widely accepted framework for supporting multi-stakeholder environmental decisions (Teng and Tzeng, 1994; Maguire and Boiney, 1994; Bellehumeur et al., 1997; Regan et al., 2006; Gutrich et al., 2005). Analytic Hierarchical Process (AHP) is the most commonly used multi-criteria process for analysing a predetermined number of alternatives (Saaty, 1980).
The research uses EDAM as a decision support tool for stakeholder management. Decision support includes analysis of decision actions to provide some measure of assurance that all relevant issues and information have been properly addressed in decision-making (Schmoldt, 2001).

The research uses AHP to provide a foundation on which environmental decisions could be analysed, compared and evaluated in order to understand the root causes leading to the existing state of the environment in any environmentally sensitive area.

The research examined the impact of differentiated conflicting stakeholder priorities influence on the environmental quality of a sensitive area. The results showed that considering the power of stakeholders would change the synthesised priorities to shift towards the powerful stakeholders' agendas.

The research developed a model able to measure and ranks the consensus between the conflicting perceptions of differentiated-power stakeholders.

The thesis identified a gap in the decision support mechanism in stakeholder analysis, particularly in environmental conflict contexts. An environmental decision analytical model was developed, tested, and validated in this thesis to identify contributions of environmental, economic and social aspects to stakeholder decision-making process.

The research adopted both a qualitative and quantitative mixed methodology. The underpinning data was collected through expert and stakeholder questionnaires, interviews, public hearings, field survey and remotely sensed data.

The research methodology applies MCDA, using Analytic Hierarchy Process (AHP), with the support of Geographic Information System (GIS), and DPSIR analytical framework.

The research has shed light on the dynamics of environmental conflicts, illustrating the formation and direction of disagreements between various stakeholders. Results showed that areas of consensus between various conflicting stakeholders could be identified, measured and located within a uniform scale.

Results provided insight of how different sustainable development pillars interact with respect to the available alternative actions. Research results showed changes in synthesised stakeholder preferences when applying comparative differentiated power. Results indicated that environmental conflicts were exacerbated by the differentiated degree of stakeholder influence ratio.

The analysis of Lake Maryout's environmental policies and legislations highlighted two main concerns. First, Sustainable development is difficult when the available alternatives are conflicting; and secondly, the current Egyptian environmental policies create more environmental conflict than protection of the environment.

The research suggests that identifying the root causes and the particular areas of stakeholder conflict can assist decision-makers to take the necessary measures to minimise the possible consequences in order to improve the environmental quality of the natural resource.

The research provides a tool to measure and rank consensus between the conflicting perceptions of differentiated-power stakeholders. It helps to improve the decision-making process to assist in the management of environmentally sensitive areas.

Results of this study provide a roadmap to improve policy-making and planning towards better environmental management of Lake Maryout. The research study therefore draws the following conclusions:

8.1.1 Relationship between Sustainable Development and stakeholder decision-making

The study of sustainable development relies on an understanding of the connections between the physical, social and economic environments.

Chapter four has presented the negative impacts of human induced activities in the area of Lake Maryout. Chapter five calculated the accelerated rate of change of Lake Maryout by filling for urban and industrial expansion. The developed methodology used AHP pairwise comparison to investigate the consistency of available alternatives with respect to SD pillars. It has also investigated the consistency between stakeholder preferences and SD pillars. The research highlighted the existing conflict in legislation and policies.

The Egyptian environmental policy embodies the sensitive political, economic, and societal compromises that exist within the framework of policy perspectives. Nevertheless, it is mostly perceived as an economic necessity. This perception pushed the orientation of decision-makers and stakeholders towards solving immediate problems and ignoring sustainable long-term needs (Hafez, 1996). The research therefore, investigated the environmental, social and economic orientations to understand the direction of stakeholders with respect to SD pillars. The research emphasised the irreconcilable stakeholder short-term priorities in Lake Maryout.

Urban sustainable development prospective reflects the support for urban development by society, economy, and environment. The analytic hierarchy process (AHP) is very suitable for evaluation of urban sustainable development (Hai-yang and Fang, 2009). Evaluation for sustainable development is very important to the future development of urban management (Zhao and Jia, 2003; Leung et al., 1998).

EDAM based on the AHP approach provides excellent insight about how different pillars of sustainable development are interacting with respect to the available alternative actions. Research results of Lake Maryout case study show that environment-social and environment-economic components are conflicting with respect to stakeholder preferences. This shows that the emergence of the conflict could be initially embedded in the available alternatives. Results show that stakeholder conflicts over natural resources are not mainly triggered by environmental factors. There are strong social and economic elements that can contribute to conflict. For example, the conflicts in land use incorporate political, economic and environmental dimensions, which can only be understood by investigating the historical context within which the problems arose and intensified (Whitlow, 1985).

Stakeholder conflict in natural resource decision-making over competing and conflicting interests and objectives continues to hinder sustainability efforts (Rockloff and Lockie, 2004). Many attempts have failed to mitigate the negative impacts of pollution in Lake Maryout due to stakeholder conflicting objectives (Ragué and El-Refaie, 2009).

This was mainly due to focusing on the mitigation processes without building consensus and agreement to apply these measures.

Sustainable use of natural resources should consider sustainable development aspects, to prevent emergence of conflict (Switzer, 2002). Identifying the environmental, social and economic areas of conflict with respect to the available mitigation measures is essential to develop a balanced sustainable mitigation plan that meets the expectations of stakeholder priorities.

8.1.2 The impact of differentiated influence on stakeholder conflicting priorities

Research results show changes in the synthesised stakeholder preferences when applying the differentiated powers to the EDAM model. This allows decision-makers to understand the need to empower specific affected groups in order to balance this influence. Smith (1993) points out that in the environmental conflict resolution model, stakeholder commitment is directly proportional to the degree of participant bargaining power. Comparing the results of the physical changes in Lake Maryout shows that stakeholder power is proportional to these changes.

This complexity of multiple stakeholder conflicting objectives raises the need for decision-makers to understand the impacts of their decisions on other stakeholder groups (Westmacott, 2001). The impacts of any taken decision could be evaluated differently based on the objectives of the competing stakeholders (Jennings and Moore, 2000).

Bounded rationality accepts the relative constraints to the coordination of knowledge and actions to take full advantage of given ends. Therefore, rationality does not look for best possible strategies, but a ‘‘satisficing’’ or ‘‘bounded’’ exploration for solutions given these constraints (Simon, 1957).

The research builds on Herbert Simon’s argument, that it is important when managing stakeholder conflict not to try to find the best possible strategy but rather to explore what is the most acceptable satisfying solution.

According to Ginter (1989), some of the stakeholders are powerful or influential; others could be influential concerning only specific issues, while other stakeholders may have less influence and power. These institutions or social groups may exercise their differentiated influence or "power" on the arena they are exploiting which may ultimately result in shift in the decision-making process.

Feedback regarding EDAM results shows that influential stakeholders tend to agree on the strategy that only meets their objectives. Presenting a synthesised order of preferences, that take into consideration all stakeholder priorities, was not acceptable to the powerful stakeholders. However, when applying the influence ratio they found the preferences acceptable.

The work of Jürgen Habermas and Michel Foucault inquires about the effectiveness of empowering civil society on the decision-making process and on the relationship between consensus building and conflict.

Foucault (1980) argues that power has both positive and productive dimensions and could be accepted because it develops things such as pleasure, knowledge, and discourse that offer positive advantages to both individuals and society. Habermas used communicative rationality concept to provide the implications of a non-coercively unifying, consensus-building power of a discourse in which the stakeholders or participants can overcome their subjectivity in favour of a rationally motivated agreement (Habermas, 1987).

The research suggests that the first step towards building the consensus is to assess stakeholder power, and hence to empower the less marginalised groups of affected stakeholders. The next step is to use the power of discourse to build agreement towards the management of the natural resource.

8.1.3 The impact of conflicting policy and legislation

Analysis of the case study shows that conflict of existing legislation and policies are contributing to the failure in the management of Lake Maryout.

Without implementation of laws and legislation and environmental protection, people cannot have meaningful development that can improve the quality of their lives.

Bureaucratic reaction to policy formulation is critical to the outcome of development efforts.

Many countries have applied synoptic approach of scientific management and systematic analysis to decision-making (Lindblom and Cohen, 1979). This approach assumes that authoritative and rational planning will resolve development problems.

The Egyptian environmental policy dilemma revolves around the question of how to survive and interact without compromising its development (Hafez, 1996).

Egypt's environmental policy should be reformulated to consider sensitive economic, political, social and administrative conflicts.

The discussion of Lake Maryout's related environmental legislation highlights two main concerns:

- Sustainable development is difficult to achieve, even though it is recognised; and
- Current Egyptian environmental policies create more environmental conflict than protection of the environment.

Hafez (1996) points out that the Egyptian environmental policy system is dysfunctional. Governmental strategies are authoritative in their narrow limited objectives and do not pay attention to societal needs.

Results from stakeholder feedback show that institutional policies are distracted by bureaucratic structure and are incapable of transforming policy into action. This was evident from the GOA's inconsistent feedback, which perceives its actions as environmentally sound. The current environmental law provides the MOE with power to inspect, but the real problem is the lack of implementation.

Analysis shows that the lack of effective institutions and enforcement of laws has a major consequence of weakening the capacity of society to manage environmental resources.

The apparent failure of environmental policy can be related to a combination of factors as follows:

- The lack of capacity and expertise to formulate, implement and evaluate these policies. The overload of legislation stifles the implementation of policies.
- The lack of government commitment to the environmental policy.
- The existence of conflicting policies.

Although it is less difficult to analyse the problems than to find solutions, it is rather important to understand how the problems occur to draw lessons gained from Lake Maryout, as a case study of policy failure and stakeholder conflict to enhance the prospects of an effective environmental management plan.

Understanding stakeholder priorities and objectives will enable decision-makers to make informed decisions.

There is a need for a framework to internalise environmental considerations in national policy. The policy should focus on causes of the problems and not the effects.

Land-use conflicts are a major concern for planners, as they need to understand the different aspects of these conflicts so that they can take structured decisions and better manage the conflict (Von der Dunk et al., 2011).

Results from the EDAM show that the most affected groups, such as the fishermen in this study, tend to apply the highest comparative weight to their source of survival. Environmental management therefore, is not the main priority in marginalised stakeholder groups; achieving vital survival demands is their foremost priority.

Real-life case studies can alert planners to the threats of distorted communication and can provide opportunities of additional consensual modes of decision-making (Forester, 1989; Healey, 1996).

The management of sensitive areas must take into consideration the prevention measures rather than the control. Prevention measures include better stakeholder management through the identification and recognition of their priorities and alternatives.

Susskind, McKearnan and Thomas-Larmer (1999) point out that consensus building "involves a good-faith effort to meet the interests of all stakeholders". The power of affected non-influential stakeholder groups should not be underestimated. They may not be able to make changes on the ground; however, they are capable of preventing any positive or negative measures without having a consensus between different actors.

Results from Lake Maryout EDAM, stakeholder and institutional analysis, interviews and questionnaires show that imbalance development, lack of communicative planning, conflicting legislations generate environmental, social, economic consequences, polarisation and stakeholder conflict.

By identifying potential consequences, decision-makers can take immediate measures to minimise the possible conflicts that are likely to occur to improve not only the quality of life but to eliminate the threat these challenges bring to life itself.

8.2 Recommendations for Future Research

The EDAM model can assist not only in environmental management but also within the disciplines of sociology, psychology and behaviourism. EDAM can be used as a tool to provide a clearer understanding of human behaviour under certain environmental, economic and social conditions.

EDAM can shed light on some of the decisions taken in terms of measuring the degree of consensus and the inter-relation between personal judgment and institutional objectives. Future research can use EDAM to measure the degree of biases within each decision. Further research can be conducted to assess the impact of any proposed policy on a specific area.

Merging spatial analysis, particularly geographic information systems (GIS), with MCDA, provides spatial decision analysis that can enable decision-makers to develop site-specific strategies that address the priorities of stakeholders and local communities.

Communicative planning approach has to establish dialogue between stakeholders from different social groups (Healey, 1997). The developed model can facilitate group decisions in communicative planning to engage a wide spectrum of affected groups. Future application can make use of the currently available electronic hand-held devices for entering judgments in an AHP group decision-making sessions. This will facilitate collecting judgements at the site and presenting the synthesised decisions to get their immediate reactions.

The research uses a two dimensional x-y grid to measure and calculate the output of the AHP eigen priority vectors and convert them to GIS shape files vector layers to allow for Spatial analyses. Future research can build on this approach and develop a three dimensional models using the Influence ratio as a third dimension. Influence Ratio should not necessarily be consistent at the entire decision surface. Value of Influence ratio can be identified with relation to the specified alternatives. The values in this case can be assigned to the decision area in a raster domain. This will ultimately create a surface of each decision and ultimately creates a three dimensional decision object. The Intersected objects can be analysed using the 3D modelling to calculate volumes of intersections. The volume of the intersection can be measured to identify the “Volume of Consensus”. This will allow the identification of the volume of conflict with respect to each alternative and hence to allow for better identification and interpretation of the conflict taking into consideration a third dimension of Influence.

The methodology provides a tool for assist decision makers to evaluate, prioritise and rank the variables that contribute to stakeholders'' preferences in order to understand the direction and magnitude of the environment-socio-economic problem. Future researchers can develop complementary models to be integrated with EDAM. Furthermore, as the methodology develops a roadmap to assist decision-makers, it will be of value if the future models include environmental valuation sub models. This will provide planners and managers of environmentally sensitive areas with the economic implication for any suggested policy. This will provide monetary value for each stakeholder identified strategy.

Future research can examine the element of time in relation to existing policy and measure the degree of stakeholders' acceptance to this specific policy over time. EDAM can identify the element contributing to the identified shift and compare it to temporal changes on the ground.

The development of the EDAM web based version can be used as a monitoring tool of stakeholder priorities and perceptions concerning their identified alternatives.

The implementation of web-based tool represents an opportunity to leapfrog the costly phase of classical data collection through sending questionnaires and conducting interviews. The web based tool will act as a platform where stakeholders meet, share, compare and explore alternatives and policy options. It will engage stakeholders in a constructive and open dialogue on the environment, overcoming geographic and other traditional barriers.

Stakeholders can select from a list of potential alternatives then enter their comparative preferences with respect to the selected alternatives. Results can be posted on the web site to provide a transparent participatory process to both stakeholders and decision-makers.

The EDAM on-line system will use powerful social media to challenge rigidity of thought and empower the public to participate in the environmental decision-making process, and as such, participate in a communicative planning process.

APPENDICES

Appendix A Stakeholders Alternatives Questionnaire

Name:

Address:

Institution:

Institution mandate:

Position:

The objective of this questionnaire is to assess Lake Maryout's stakeholders' priorities towards any proposed development of a management plan for the area.

The results are used for academic research. However, it will be presented to decision-makers to assess if these priorities could be considered a road map for future planning and management.

Kindly Identify your four priorities that you think should be considered during the planning and management of Lake Maryout.

Priority	**Reason**	**Additional comment**
1-		
2-		
3-		
4-		

Appendix B Stakeholders' Influence Expert Questionnaire

Name of expert:

Institution:

Field of Expertise:

Assessing the influence and importance of each stakeholder (Adapted from WWF 2005)

Rank the following Stakeholders according to their relative importance:

0= not important 9= extremely important

Stakeholder	Degree of Influence 0-9	Reason
Governorate of Alexandria		
Ministry of Environment		
Fishermen Community		
Alexandria Businessmen association		

Key questions to be considered while filling the questionnaire:

• Who is directly responsible for decisions on issues important to Lake Maryout?

• Who holds positions of responsibility in interested organizations?

• Who is influential in the Lake Maryout area (both thematic and geographic areas)?

• Who will be affected by the degradation of Lake Maryout?

• Who will promote/support the management of Lake Maryout, provided that they are involved?

• Who will obstruct/hinder the management if they are not involved?

• Who has been involved in the area (thematic or geographic) in the past?

• Who has not been involved up to now but should have been?

	Significant Influence	Some Influence	Little Influence	No Influence
Significant Importance				
Some Importance				
Little Importance				
No Importance				

Appendix C Sustainable Development Expert Questionnaire

Expert Name:

Address:

Institution:

Position:

Please fill in the below according to your area of expertise:

Making Numerical Judgments:

The main function of the Questionnaire is to analyse expert judgements against the three pillars of Sustainable Development to identify the overall goal with respect to the main objectives, which are Environment, Economic and Social integration to achieve sustainable development of Lake Maryout.

The Numerical Comparison table is designated to understand the comparative importance to the identified indicators with relation to the three pillars of sustainable development. Numerical judgments are made in the below table.

Two indicators are compared with respect to your priority using a numerical scale. The numerical value is inserted to indicate which judgment is preferred and the strength of that preference.

The numerical equivalents of the judgments are displayed here as numbers from 1 to 9 as per the below table.

Comparative Importance Preference	Numerical Rating
Extreme	9
Very strong to Extreme	8
Very Strong	7
Strong to Very Strong	6
Strong	5
Moderate to Strong	4
Moderate	3
Equal to Moderate	2
Equal	1

The Questionnaire is using comparative preference; you have to enter the value that reflects your relative importance between the two alternatives with respect to one pillar of sustainable development as per the table above.

Four main priorities are compared namely;

Water Quality: How comparatively importance the increase of water quality

Urban Development: How comparatively important the increase of urban area

Industrial Development: How comparatively important to increase the area allocated for industries and factories

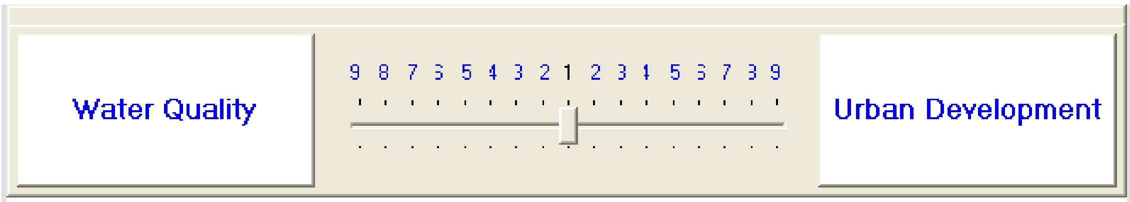
Fish Catch: How comparatively important the increase of Fish catch to your Institution

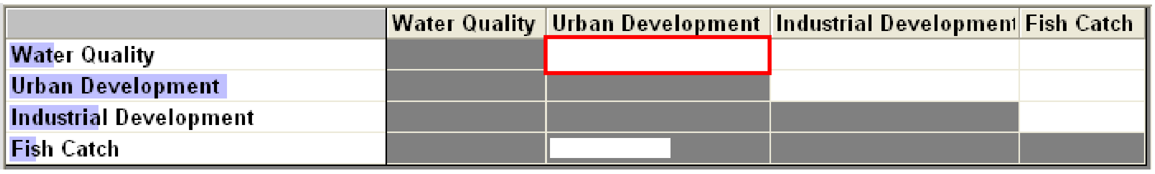
The questionnaire is repeated for the three pillars. Kindly circle each pillar while inserting the values.

Environment

Water Quality- Urban development

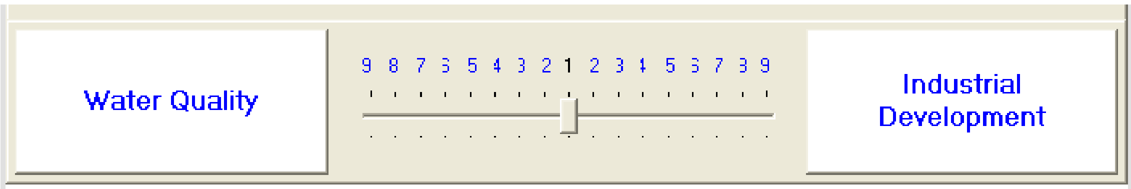
1- Please enter your preference between Water Quality- Urban development
2- Please enter your comparative preference between in numeric value from 1-9 in the respective space

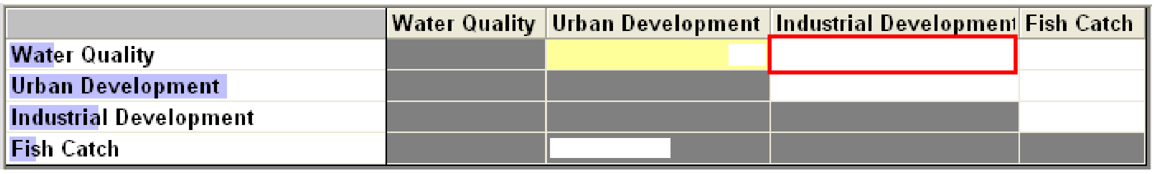




Water Quality- Industrial development

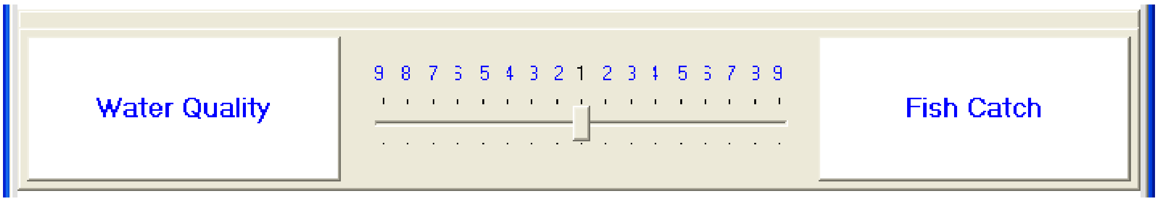
1- Please enter your preference between Water Quality- Industrial development
2- Please enter your comparative preference between in numeric value from 1-9 in the respective space

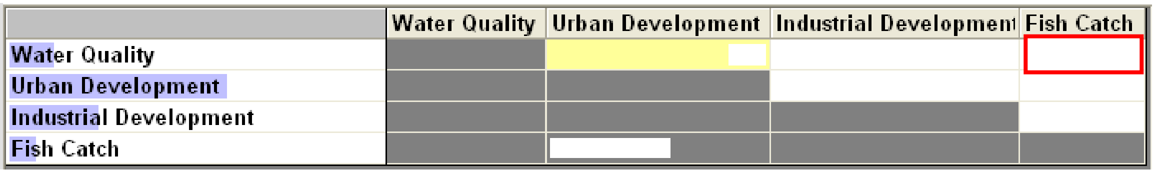




Water Quality- Fish Catch

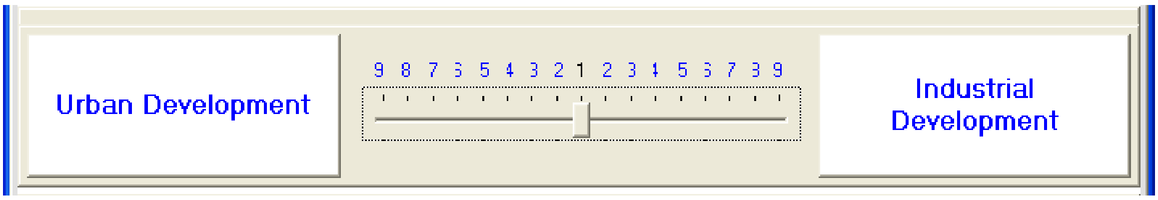
1- Please enter your preference between Water Quality- Fish Catch
2- Please enter your comparative preference between in numeric value from 1-9 in the respective space

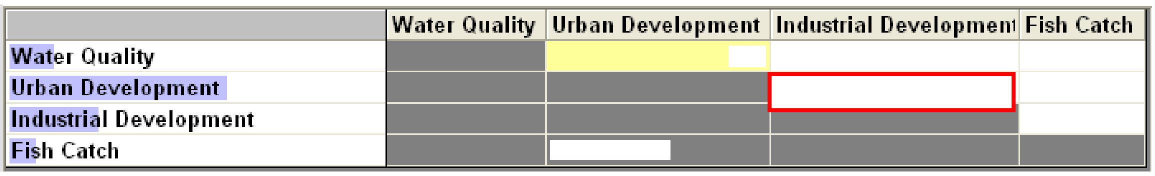




Urban Development-Industrial Development

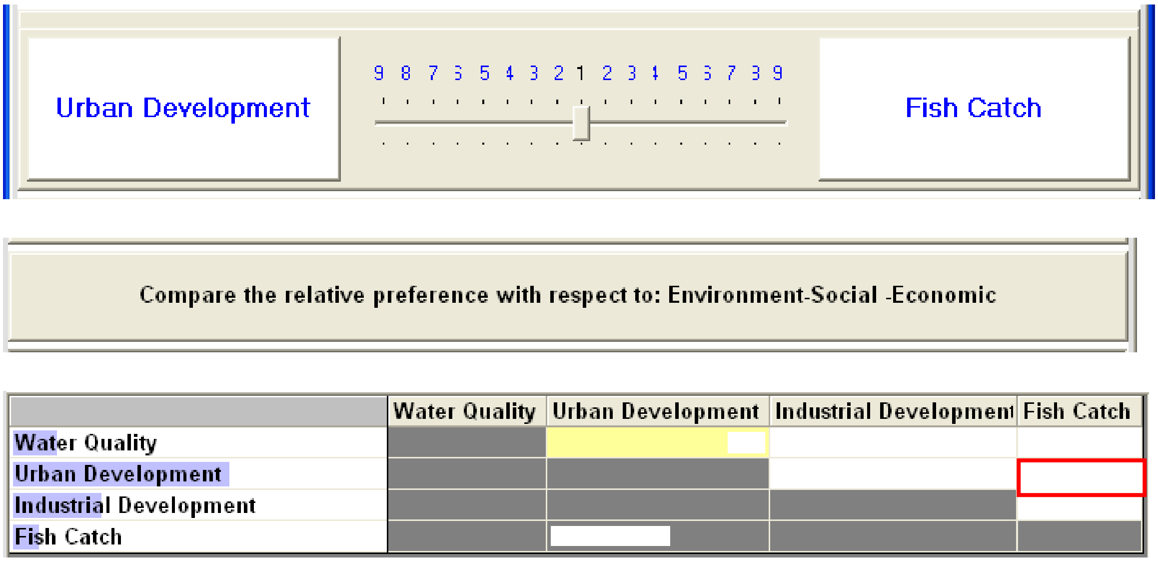
1- Please enter your preference between Urban Development-Industrial Development
2- Please enter your comparative preference between in numeric value from 1-9 in the respective space





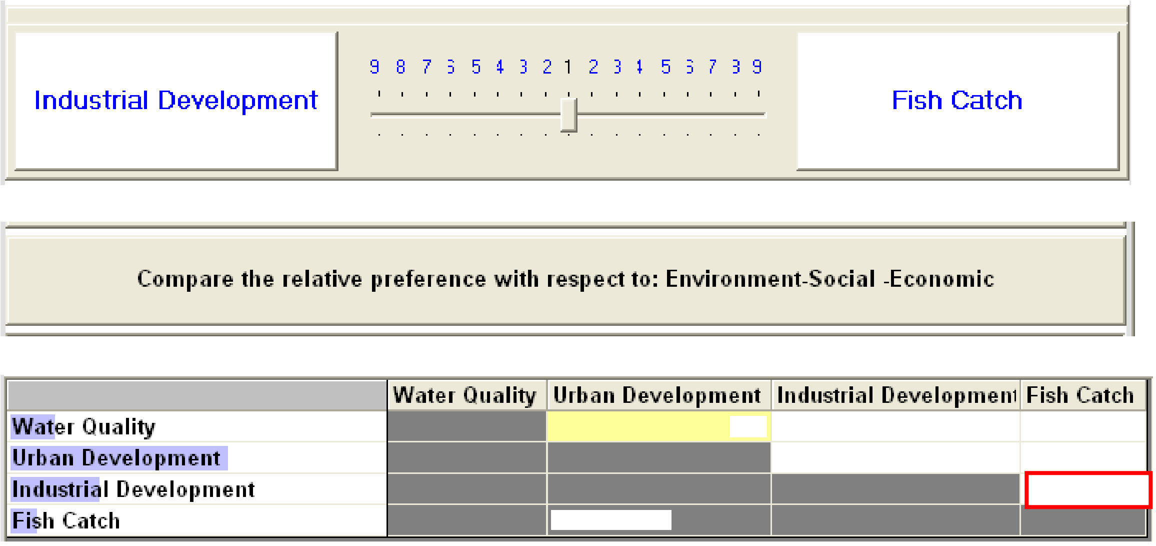
Urban Development-Fish Catch

1- Please enter your preference between Urban Development-Fish Catch
2- Please enter your comparative preference between in numeric value from 1-9 in the respective space



Industrial Development - Fish Catch

1- Please enter your preference between Industrial Development and Fish Catch
2- Please enter your comparative preference between in numeric value from 1-9 in the respective space



Appendix D Stakeholders Pairwise Comparison Questionnaire

Name:

Address:

Institution:

Institution mandate:

Position:

Please fill in the below according to your area of expertise:

Making Numerical Judgments:

The Numerical Comparison table is designated to understand your comparative importance to the identified indicators. Numerical judgments are made in the below table. Two indicators are compared with respect to your priority using a numerical scale. The numerical value is inserted to indicate which judgment is preferred and the strength of that preference. The numerical equivalents of the judgments are displayed here as numbers from 1 to 9 as per the below table.

Comparative Importance Preference	Numerical Rating
Extreme	9
Very strong to Extreme	8
Very Strong	7
Strong to Very Strong	6
Strong	5
Moderate to Strong	4
Moderate	3
Equal to Moderate	2
Equal	1

The Questionnaire is using comparative preference; you have to enter the value that reflects your relative importance between the two alternatives as per the table above.

Four main priorities are compared namely;

Water Quality: How comparatively importance the increase of water quality

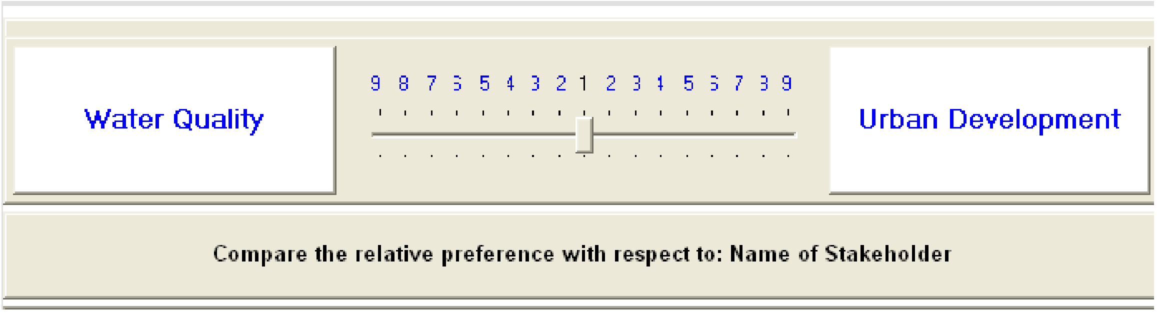
Urban Development: How comparatively important the increase of urban area

Industrial Development: How comparatively important to increase the industrial activities around Lake Maryout.

Fish Catch: How comparatively important the increase of fish production to your Institution

Water Quality- Urban development

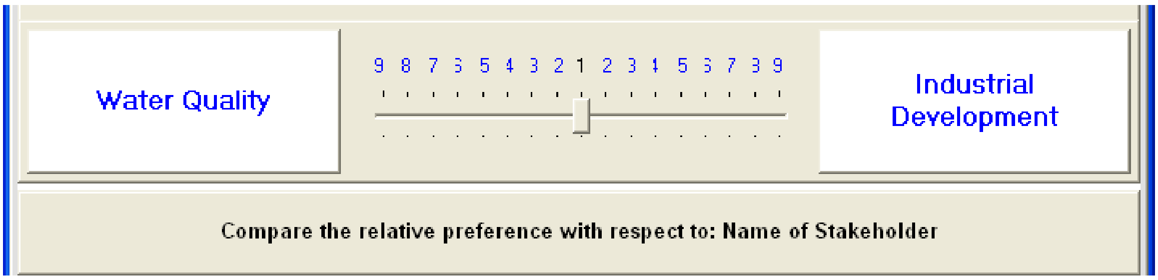
3- Please enter your preference between Water Quality- Urban development
4- Please enter your comparative preference between in numeric value from 1-9 in the respective space



	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality				
Urban Development				
Industrial Development				
Fish Catch				

Water Quality- Industrial development

3- Please enter your preference between Water Quality- Industrial development
4- Please enter your comparative preference between in numeric value from 1-9 in the respective space

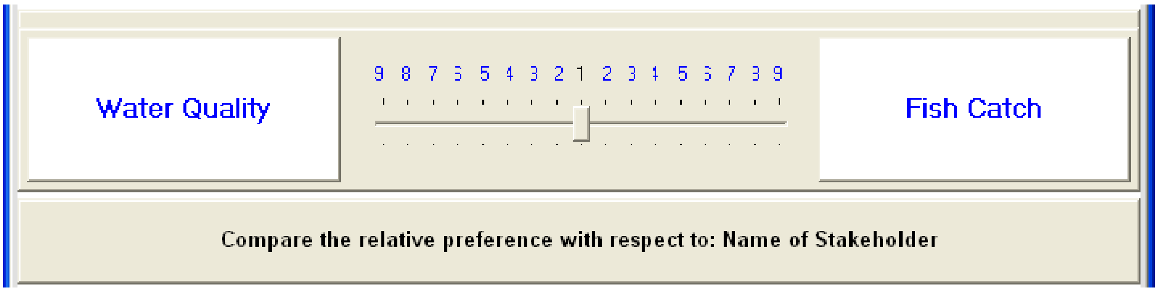


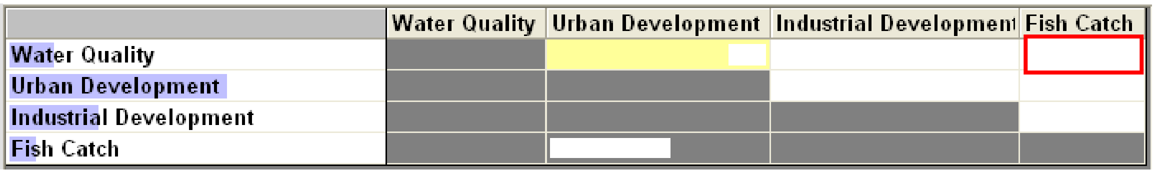
	Water Quality	Urban Development	Industrial Development	Fish Catch
Water Quality				
Urban Development				
Industrial Development				
Fish Catch				

Water Quality- Fish Catch

3- Please enter your preference between Water Quality- Fish Catch

4- Please enter your comparative preference between in numeric value from 1-9 in the respective space

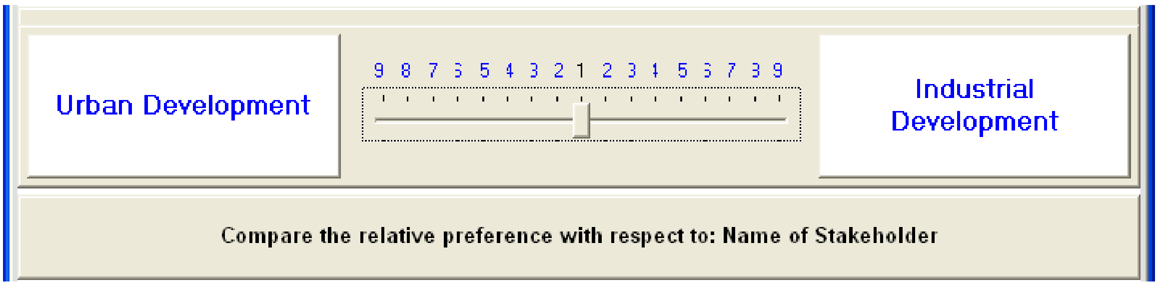


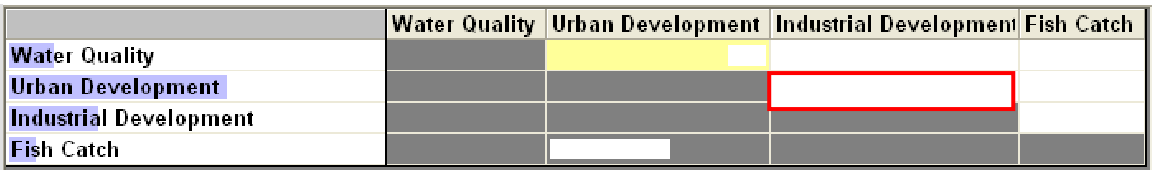


Urban Development-Industrial Development

3- Please enter your preference between Urban Development-Industrial Development

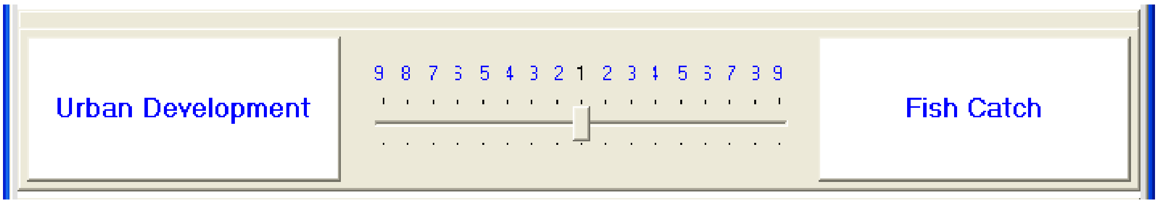
4- Please enter your comparative preference between in numeric value from 1-9 in the respective space

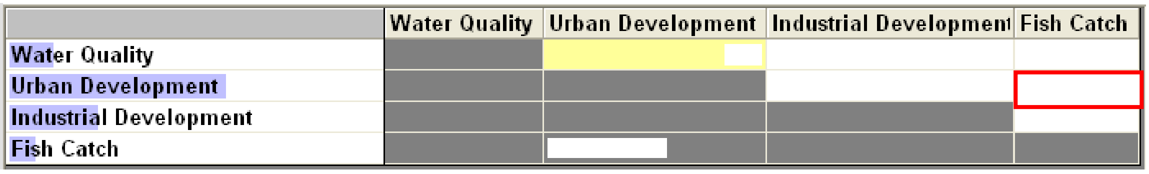




Urban Development-Fish Catch

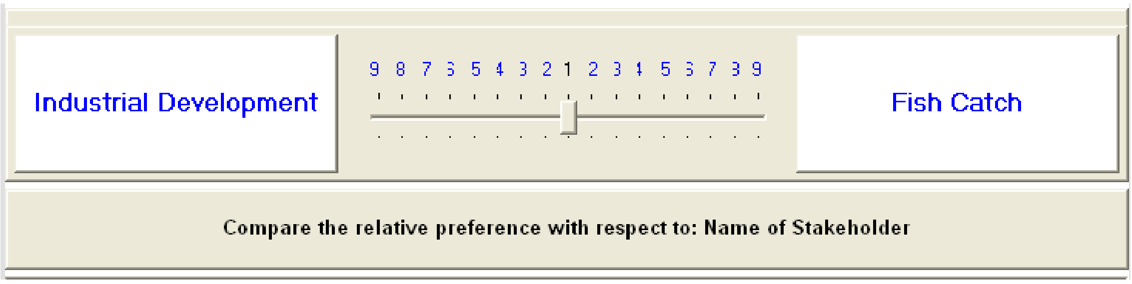
3- Please enter your preference between Urban Development-Fish Catch
4- Please enter your comparative preference between in numeric value from 1-9 in the respective space

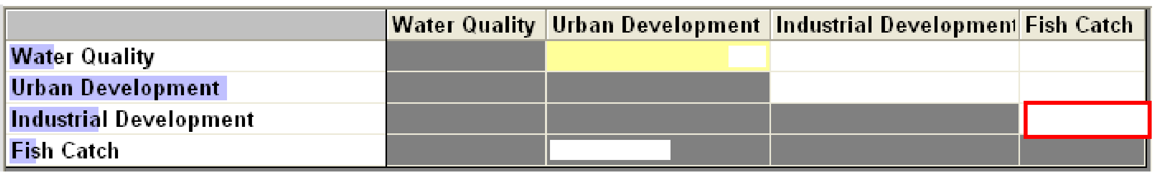




Industrial Development - Fish Catch

3- Please enter your preference between Industrial Development and Fish Catch
4- Please enter your comparative preference between in numeric value from 1-9 in the respective space





Appendix E Stakeholders Feedback Questionnaire

Name:

Address:

Institution:

Institution mandate:

Position:

The objective of this questionnaire is to assess your opinion regarding the proposed management plan for Lake Maryout.

The presented results are the outcomes of an academic research aims to develop a decision support methodology. The new methodology could assist decision-makers to develop a road map for future planning and management.

Kindly comment on your answer explaining the reasons for making these choices.

Table 1 below shows the outcome of calculating the degree of consensus between your Institution and other primary stakeholders in Lake Maryout.

Table 1 Stakeholder Consensus Ranks

	GOA	MOE	FC	ABA
GOA		Poor	Poor	Moderate
MOE			Moderate	Poor
FC				Poor
ABA				

Do you agree with the above ranking?

Yes I agree ☐ No I do not agree ☐

Reasons:

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Table 2 below shows the calculated synthesised priority of your institutions. The calculation of these priorities is based on the questionnaire that was distributed in early 2011 to all primary stakeholders. The stakeholders' preferences were entered a decision model to calculate your integrated synthesised preferences.

Do you agree with the below ranking?

Table 2 Stakeholder Synthesized Priorities				
Stakeholder	Stakeholders Identified Alternatives			
	Preference 1	Preference 2	Preference 3	Preference 4
GOA	Urban Development	Industrial Development	Water Quality	Fish Catch
MOE	Water Quality	Fish Catch	Urban Development	Industrial Development
FC	Fish Catch	Water Quality	Urban Development	Industrial Development
ABA	Industrial Development	Urban Development	Water Quality	Fish Catch

Do you agree with the above ranking?

Yes I agree ☐ No I do not agree ☐

Reasons:

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Table 3 below shows the calculated synthesised priorities based on the questionnaire that was distributed in early 2011 to all primary stakeholders.

The stakeholders' preferences were entered a decision model to calculate an overall integrated synthesised preferences.

The model output has two options. Please indicate which order of priority might be used as a good road map for action towards the development of a management plan for Lake Maryout

Table 3 Stakeholders' Synthesised Preferences

	Preference 1	Preference 2	Preference 3	Preference 4
Option 1	Urban Development	Industrial Development	Water Quality	Fish Catch
Option 2	Fish Catch	Water Quality	Urban Development	Industrial Development

Do you agree with the above ranking?

I agree with option No. ( )

Reasons:

……………………………………………………………………………………………

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