A SOCIO-TECHNICAL ASSESSMENT FRAMEWORK FOR INTEGRATED WATER RESOURCES MANAGEMENT (IWRM) IN LAKE URMIA BASIN, IRAN

A Thesis

by

MUKHTAR HASHEMI

Submitted for the degree of Doctor of Philosophy (PhD)

at Newcastle University

January 2012

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ABSTRACT

The main aim of this interdisciplinary research is to develop a socio-technical and institutional framework for implementing the Integrated Water Resources Management (IWRM) paradigm by analysing how water resources can be managed in response to anthropogenic drivers (e.g. population/economic growth) and environmental pressures (e.g. climate change) within an evolving institutional set-up. Implementation of the Framework has focussed on Iran, and Lake Urmia basin as a case study, which involved a significant element of action research based upon stakeholder participation.

Lack of implementation of concepts such as IWRM has been attributed to the gap between technical outcomes and policy decisions. To achieve an integrated synthesis for this interdisciplinary study, the integrated methodological framework has used four analytical components based on the IWRM concept: (1) Driver-Pressure-State-Impact Response (DPSIR); (2) Institutional Analysis and Development (IAD); (3) Integrated Socio-technical Assessment (ISTA) using modelling and Multi criteria Decision-Making (MCDA) tools; and (4) Ethics to assess water allocation decision outcomes in multitier Multi-Stakeholder Platforms (MSPs).

Results from the case study show that the non-structural responses (legislations, new administrations etc.) adopted since 2003 have not guaranteed the implementation of sustainable water allocation outcomes in river basins including Lake Urmia basin. Water allocation has become highly political and caused polarisation in opinions and multiple perspectives among stakeholders underlined by diverging discourses on climate change, water and land development and irrigation water use efficiency. The participatory water allocation decision reached for Lake Urmia Basin, which included an allocation to sustain the hydrological and ecological functions of the Lake, has been re-evaluated by analysing historical climatic and hydrologic data. The outcome suggests that water availability in the basin is less than that adopted by the stakeholders based on trend analysis within the existing discourse. Therefore, the thesis demonstrates a mechanism for adaptive water allocation and demand management under an uncertain future climate which is represented through rainfall scenarios generated using a stochastic rainfall model. It is concluded that the participatory process has enhanced the efficacy of the water governance system, but the effectiveness of water allocation will be compromised unless an adaptive water allocation approach is implemented, and basin-wide water use efficiency measures are taken.

It is recommended that modern day water and land governance has to take into account the ethical and cultural aspects of the community to form an alliance for sustainable resource use; thus, an Ethical legal framework for community-based land and water governance has been proposed. The overall integrated methodological approach provides an innovative analytical framework to understand the discursive deliberations in a complex Social-Ecological system heightened by (1) scientific uncertainty over climate variability and change; and (2) dynamic institutional transformation and evolution.

DEDICATION

In memory of my beloved father who has been the inspiration for all my work

To Three Women in my Life

My mother Frisha who is the angle in my life

My sister Saadat who I feel that our soul is inseparable

My wife Leila who is the love of my life

And

To my adorable trio Ammar…..Mona ….and ….Ahmad Hadi

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I would like also, to express my appreciation to my colleagues at the Conservation of Iranian Wetlands Project (CIWP) for providing the platform to carry out my work and for their unlimited support especially Dr Ali Nazaridoust, Mr Solaymani, Mr Saber Masoumi, Mr Ali Arvahi, Ms Sara Koochaki, Mr Osqoee, Mr Arabpour, Dr Mike Moser, Professor Eeloc van Beek, Mr Lotfi and Mr Saeid Ferdosi.

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My sincere thanks go to all the stakeholders for their dedication and professionalism especially Water and Agriculture Working Group members.

Finally, I thank my family and all my friends who morally, spiritually and financially supported me throughout my work and it is not possible to acknowledge all of them on this page.

NOMENCLATURE

AHP	Analytical Hierarchy Process
AJO	Agricultural Jihad Organisation
AMP	Asiatic Model of Production
BAU	Business as Usual
CIWP	Conservation of Iranian Wetlands Project
COP	Conference of the Parties
DoE	Department of Environment
DPSIR	Drivers (Driving forces)-Pressures-States-Impacts-Responses
DSS	Decision Support System
EA	East Azerbaijan
EAAJO	East Azerbaijan Agricultural Jihad Organisation
EAEPO	East Azerbaijan Environmental Protection Organisation
EARWC	East Azerbaijan Regional Water Company
FAO	Food and Agriculture Organisation
FWD	Fair Water Distribution (Act)
FYDP	Five-Year Development Plan
GCM	general circulation model
GDP	Growth Domestic Product
GEF	Global Environmental Facility
GHGs	greenhouse gases
GIS	geographical information system
GWP	Global Water Partnership
HTO	Heritage and Tourism Organisation
IAD	Institutional Analysis and Development
IDA	Institutional Decomposition and Analysis
IPCC	Intergovernmental Panel on Climate Change
ISTA	Integrated Socio-technical Assessment

IWRM	Integrated Water Resource Management
IWRMC	Iran Water Resources Management Company
JWF	Japan Water Forum
KAJO	Kurdistan Agricultural Jihad Organisation
KEPO	Kurdistan Environmental Protection Organisation
KRWC	Kurdistan Regional Water Company
LUB	Lake Urmia basin
MCDA	Multi-Criteria Decision-making Analysis
MENA	Middle East and North Africa
MJS	Ministry of *Jihad-e- Sazandegi* (Construction Jihad)
MoAJ	Ministry of Agricultural Jihad
MoE	Ministry of Energy
MoM	Minute of Meeting
MP	Member of Parliament
MSP	Multi-stakeholder Platform
NGO	Non-Governmental Organisation
NRWMO	Natural Resources and Watershed Management Organisation
RWC	Regional Water Company
SES	Social-Ecological System
SYDP	Seven-Year Development Plan
ToR	Terms of Reference
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WA	West Azerbaijan
WAC	Water Allocation Code (2008)
WAD	Water Allocation Directive (2003)
WAM	water allocation model
WAP	Water Allocation Permit

WBM	water balance model
WAAJO	West Azerbaijan Environmental Protection Organisation
WAEPO	West Azerbaijan Environmental Protection Organisation
WANA	West Asia and North Africa
WARWC	West Azerbaijan Regional Water Company
WPAC	Water Policy and Allocation Commission
WAWG	Water and Agriculture Working Group
WJF	World Justice Forum
WRS	Water Resources System
WRWW	Water Resources and Water and Wastewater

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Chapter I. Water Resources Management: *Issues of Concern*

1.1 An overview

With increasing human population coupled with expanding economic activities and improved living standards, the world's freshwater resources are under increasing pressure. The competition and often conflict [1]over the limited freshwater resources leads to mismanagement of the precious resource (e.g. Tamas, 2003). In addition, water pollution is inherently connected with human activities as a water resource often acts as a medium for transporting domestic, agricultural and industrial waste, thus degrading its potential as a resource.

The above problems are aggravated by shortcomings in the management of water. Fractional (*sectoral*) approaches to water resources management have dominated and still prevail, especially in the developing world; as a result, fragmented and uncoordinated development and management of the resource is a real practice. The overall problem is caused by inadequate legal legislation (governance) and institutional set-ups as well as increased demand for the finite amount of the water resources. Hence, the need for a new integrated and holistic approach to water management has been widely recognised to achieve sustainability of the water resources system (e.g. GWP, 2000).

The concept of Integrated Water Resources Management (IWRM), Figure1.1, was envisaged by the International Water Resources Association nearly 4 decades ago (Braga 2001), and IWRM now constitutes an emerging global norm (Swatuk, 2005).

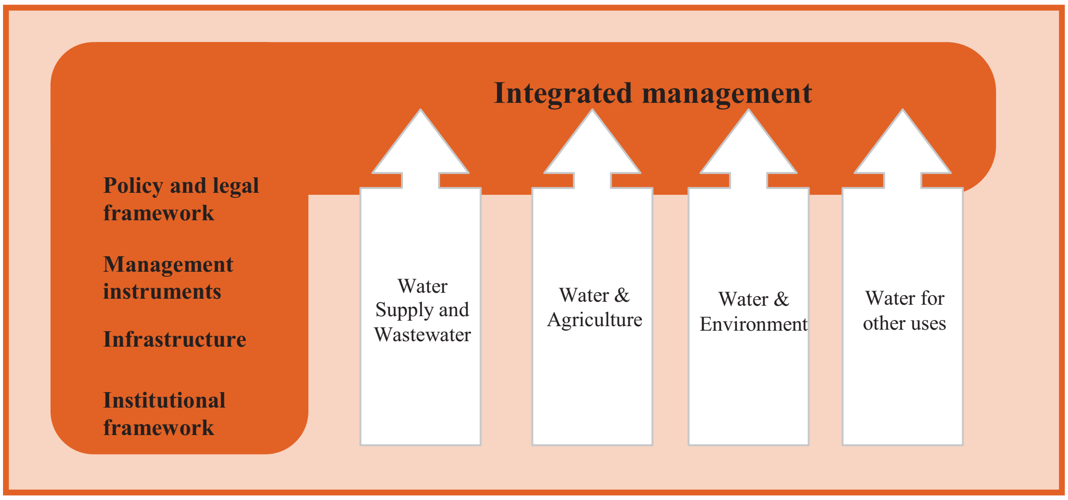


Figure 1.1: IWRM approach (After GWP, 2000).

[1] Conflicts can be inter and intra state tensions and disputes and do not imply waging wars. A list of water conflicts can be found in this website http://www.worldwater.org/conflict/list/.

IWRM came to prominence in 2000 by the effort of the Global Water Partnership (GWP) which defines IWRM as:

a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystem"(GWP, 2000; p.22)

On this basis, the IWRM paradigm is a holistic, river-basin oriented approach[2] with the following aims: (i) water-use efficiencies, (ii) equity of access, (iii) balance of competing uses, (iv) environmental sustainability, and (v) participation of all stakeholders. The definition also suggests that IWRM is a process, which *"is not a goal in itself. It is a means to an end, or rather it is a process of balancing and making trade-offs between different goals in an informed way*"(Jønch-Clausenand Fugl, 2001).

The institutional implementation of the IWRM paradigm within the trianglular model of sustainability (Khan, 1995) has three components (Figure 1.2):

- Enabling environment: good governance, adequate policies etc;
- Management instruments: water allocation modelling, economic tools etc
- Institutional roles: capacity building, level of actions etc.

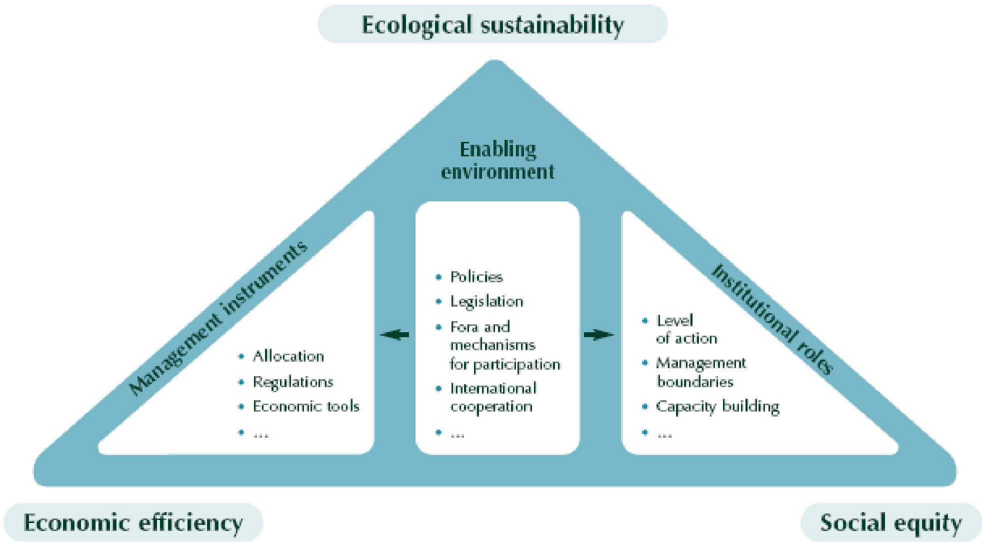


Figure 1.2: Sustainability triangle and IWRM implementation approach (GWP, 2000).

Iran, which has a semi-arid/arid climate and is part of West Asia and North Africa (WANA) region (Figure 1.3), experiences many challenges in moving towards sustainable water resources management. Sustainable water resources system are "*those designed and*

[2] This is not in the definition but implied in its application

managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental and hydrological integrity" (ASCE, 1998). A survey of 54 water managers conducted by the author during 2007-8 reveals that there is a need for a holistic and integrated approach to water management (Table 1.1). The managers were asked to list the five most important issues in the water sector (Source: Appendices A1). Table1.1 presents a summary of the broad definition of issues of concern in Iran's water sector. Based on the many challenges indicated, there has been a move towards adopting the IWRM paradigm in Iran.

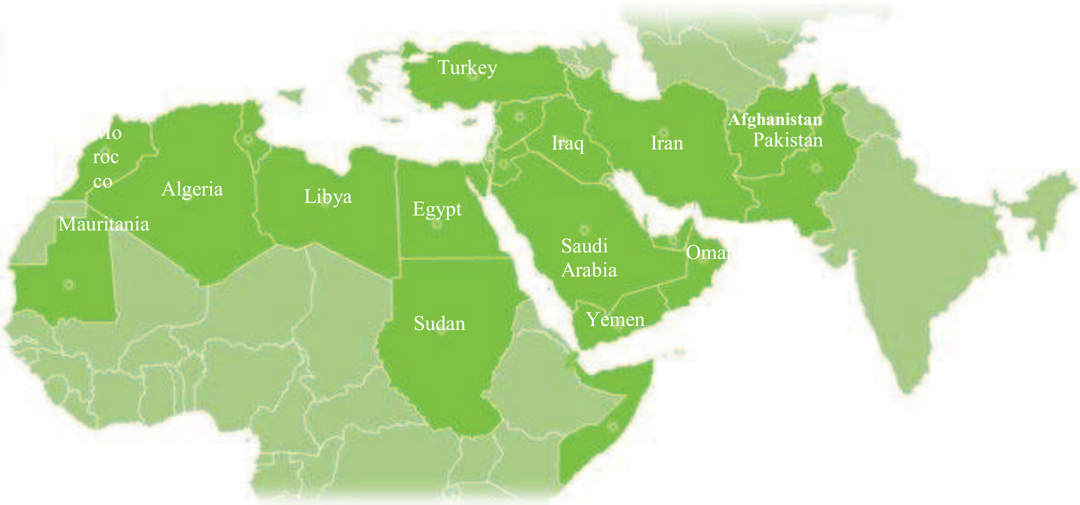


Figure 1.3: Iran within WANA region in dark blue (Source: www.wanaforum.org).

In the following sections of this chapter, the rationale, aim, objectives and scope of the research are outlined.

1.2 Rationale of the research: *Research gaps and questions*

In recent years, there has been a great deal of interest in how to implement IWRM and in why it has not been implemented since its introduction some 40 years ago. Van der Zaag (2005) argues that IWRM is not just a buzzword but is a relevant, yet elusive and fuzzy concept. Wide-scale implementation has been limited. Many scholars and researchers (e.g Brown, 2005; Amjad, 2003) have concluded that there is a need for institutional change and reform underpinned by capacity building interventions targeted at enabling a learning culture that values integration and a participatory approach. Therefore, the question remains as to what intervention pathway is required to achieve the IWRM concept.

Physical Environmental

- ✓ the temporal and spatial variation of water availability; water scarcity; limited resources
- ✓ problems of droughts and floods and the impact of climatic variations on water resources
- ✓ inter-basin water transfer schemes
- ✓ excessive and unbalanced agricultural use and consumption of surface and groundwater resources including irrigation supply
- ✓ domination of traditional farming with low water use efficiency;
- ✓ depletion /over-exploitation of groundwater resources
- ✓ impact of pollution on freshwater resources/source pollution and river water quality issues
- ✓ pollution of water resources and water quality issues; degradation of lakes and wetlands and natural habitats
- ✓ lack of precise information on the quality-quantity of the existing water resources; lack of accurate hydrological data; incomparability of information and data at different levels of management; lack of adequate information and data for managerial decision making in many basins;

Socio-economic

- ✓ population growth; accelerated urban population growth and lack of urban planning
- ✓ urbanisation, industrialisation and economic growth
- ✓ illegal use of wells and abstraction from groundwater resources
- ✓ inadequate social awareness about role of water for life and the environment;
- ✓ lack of public concern and knowledge about limited water resources
- ✓ lack of valuation of water as an economic good: in another word: no economic perspective on the value of water
- ✓ regional (development) challenges and political influence; lack of consideration for sustainable development
- ✓ limited financial resources for water projects
- ✓ Gender issues: lack of representation of women at planning stage of water resources development
- ✓ Health related problems

Institutional

- ✓ Lack of conflict resolution management for trans-boundary waters and provincial water allocation
- ✓ lack of administrative integration
- ✓ Insufficient , inadequate and ambiguous laws, legislations and guidelines; lack of compliance with water laws; weakness of legal guarantees to implement law;
- ✓ lack of implementation mechanisms in water resources planning;
- ✓ provincial management instead of river basin management
- ✓ duplication of decision centres
- ✓ lack of system approach in water resources management
- ✓ inadequate /unclear inter-provincial water allocation practices; no clear allocation strategy for inter-provincial water shares
- ✓ lack of community capacity building; lack of stakeholder participation in decision making
- ✓ lack of consideration to demand management
- ✓ Weakness of non-structural approaches (consumption management, demand management…)
- ✓ Introduction of short term policies without consideration for technical principles in water uses by politicians
- ✓ No river basin authority
- ✓ Sectoral approach

Based on analysis of 54 questionnaires collected during 2007-8 (Source: Appendix A1)

Table 1.1: Issues map for Iran's water sector.

A report by the fourth World Water Forum (WWF, 2006)[3], entitled: *Implementing Integrated Water Resources Management*: *the Inclusion of IWRM in National Plans*, reviews the progress made by countries in some 6 regional categories. According to two different statistical surveys by the Japan Water Forum (JWF) and the GWP, up to 28% have made good progress but some 28% are in their initial stages of implementing IWRM. They make some key recommendations for future work on IWRM, which are centred on five themes: (1) institutional and legal framework, (2)stakeholder participation, (3)socio-economic, (4)capacity-building and (5)environmental sustainability. More recently, UN-Water (2008) completed a survey showing an improvement of IWRM planning process at national level but much more efforts are required to implement the plans at local levels and in Asia generally, the institutional reforms are advanced but there are problems with institutional cooperation and coordination. The fifth World Water Forum, which was held in Istanbul in 2009, confirmed the importance of the institutional and cultural dimensions of water resources management (WWDR, 2009).

Read-in to this, the neglect of the institutional dimension in water resources management has created a huge barrier to implementing IWRM. Water resources management requires a radical reorientation and an effective dialogue between decision makers, stakeholders and engineers/academics (Falkenmark et al, 2004). However, the challenge is how this radical reorientation can be made operational on the ground, and how to design and use institutional reforms, potential interactions with other incentives/disincentives at the operational level and the effect they may ultimately demonstrate in practice. Institutional transformations are not a common occurrence (Cowie and Borrett, 2005), so the question is: what are the prerequisites for institutional change? And what constitutes change?

Biswas (2004), in reassessing the IWRM paradigm, concludes that there is a need for "*an objective, impartial and non-dogmatic assessment of the applicability of IWRM*". Can a single paradigm be applicable to every climatic conditions, every cultural, economic and social settings? "*…can it be applicable……to Islamic customs*?"(Biswas, 2004). Is there a need for an evolving paradigm to make the concept implementable? How can we have local solutions using a global concept? Iran has a strong Islamic tradition as a Constitutional democratic Islamic Republic. For example, what is the institutional role of Islamic principles in implementing IWRM based on sustainability criteria? How can sustainable policies emerge

[3] This report came out at the start of the PhD project providing an insight into research gaps in implementing the IWRM paradigm.

from the moral and ethical values of Islam, bearing in mind that institutional, ethical and cultural aspects have been recognised as important elements of IWRM (e.g. WWDR, 2009).

Strengthening institutional aspects by having and implementing adequate policies, laws, regulations and administrations are vital for the implementation of an integrated approach to water management. This is known as good governance. The World Bank (2007) asserts that Middle East and North African (MENA) countries have appreciated the importance of good governance in implementing sustainable water management policies in the region, which includes Iran.

Multiple stakeholder participation (social learning process) is crucial to the evolution of sustainable river basin management, and an integral part of the IWRM paradigm. Social learning theory developed by Bandura (1977) postulates that people can learn from each other's experiences via observation, imitation and modelling or coding the information, which guides the actions. Therefore, the question is how to facilitate multi-stakeholder processes and social learning. This leads to questions about governance and democracy, which have become important global issues as we work towards making sustainable development a reality. Research is required on linking technical analytical methods and participation (social learning) approaches, (Pahl-Wostl, 2002). For IWRM to be effective, a tripartite alliance between policy maker, stakeholder and engineer (scientist) is required (Schulz et al, 2004). Simonovic and Bender (1996) conclude that participation is essential because stakeholders have the knowledge and experience necessary to formulate effective alternatives.

IWRM is a wide-ranging concept. The scope of the PhD programme has therefore focussed on developing a socio-technical framework for implementing the IWRM paradigm in general, and in Iran specifically, by considering the water allocation decision-making using:

a) a sustainability framework for analysing drivers and pressures associated with water management and management options which provides a pathway towards implementing the IWRM paradigm
b) an institutional analysis framework that can be linked to (a)
c) a case study approach to facilitate participatory decision-making; and
d) exploring the ethical and cultural spheres to foster good governance

The PhD programme will address the above questions and hence will contribute to the advancement of IWRM theory and practice.

1.3 Main Aim

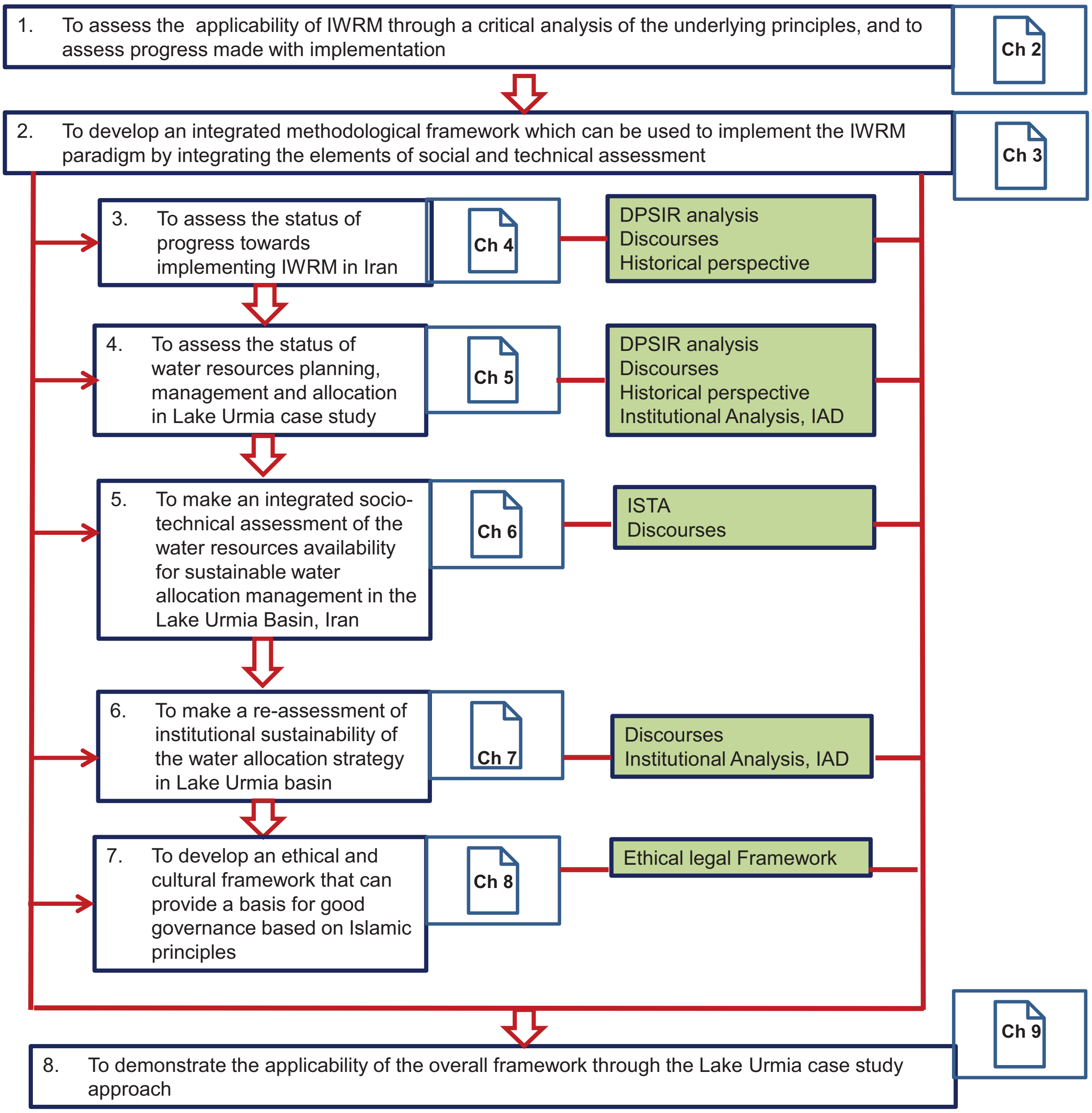
The main aim of this project is to develop an integrated Socio-technical Framework for implementing the Integrated Water Resources Management (IWRM) paradigm in a case study approach by analysing how water resources can be managed and adaptively administered in response to anthropogenic drivers (e.g. population/economic growth) and environmental pressures (e.g. climate change) within the current institutional set-up, and to demonstrate the application of the Framework using a case study approach that is based upon stakeholder participation (Lake Urmia basin, Iran).

1.4 Objectives

1. To assess the applicability of IWRM through a critical analysis of the underlying principles, and to assess progress made with implementation (Chapter II).
2. To develop an integrated methodological framework which can be used to implement the IWRM paradigm by integrating the elements of social and technical assessment (Chapter III).
3. To assess the status of progress towards implementing IWRM in Iran (Chapter IV).
4. To assess the status of water resources planning, management and allocation in the Lake Urmia Basin (Chapter V).
5. To make an integrated socio-technical assessment of the water resources availability for sustainable water allocation management in the Lake Urmia Basin, Iran (Chapter VI).
6. To make a re-assessment of the institutional sustainability of the water allocation strategy in Lake Urmia basin. (Chapter VII).
7. To develop an ethical and cultural framework that can provide a basis for good governance based on Islamic principles (Chapter VIII).
8. To demonstrate the applicability of the overall framework through the Lake Urmia case study approach (Chapters VI - VIII).

1.5 The structure of the thesis:

The structure and the scope of the thesis are given in Figure 1.4 which shows relevant chapters and methodologies associated with the objectives.



Acronyms:

Ch	Chapter
DPSIR	Drivers-Pressures-States-Impacts-Responses
IAD	Institutional analysis and Development
ISTA	Integrated Socio-technical Assessment
IWRM	Integrated Water Resources Management

Figure 1.4: The scope and objectives of the thesis with relevant methodological tools used in each Chapter denoted by 'Ch'.

ChapterII. Sustainable Water Resources Management in the 21st Century: *Concepts, Theories, Issues and Methodologies*

2.1 Introduction

In Chapter I, the challenges facing the water resources sector worldwide, and in Iran in particular, have been outlined. The survey (Table1.1, p.4) showed that lack of institutional capacity development in Iran is perceived as one of the main obstacles on the road to sustainable water resources management; and this is probably the case in many other countries. Despite acknowledging the need for an integrated management approach, the implementation of concepts such as IWRM has been slow or non-existent. Therefore, Chapter II attempts to assess the progress made and applicability of IWRM through a critical review of the underlying governing principles and related concepts such as ethics of decision-making and water institutions. The main aim of IWRM is to achieve sustainability. Thus, IWRM is reviewed through the lens of sustainability of different aspects of the water resources system (WRS).

IWRM has become a dominant paradigm and actively promoted by national governments and international agencies as the basis for sustainable water resources management (e.g. Falkenmark and Rockström, 2006; Molle et al, 2008; Merrey, 2008). The Global Water Partnership (GWP) has been a driving force behind the internationalisation of the concept. However, there has been a lack of implementation of IWRM worldwide despite its adoption by national governments around the globe (Biswas, 2004; Merrey, 2008). According to the Johannesburg Summit in 2002, governments had to have an IWRM plan by 2005. In 2003, Iran was the first country in the Middle East region to adopt the principles of IWRM through a landmark legal provision and normative plan called '*Long Term Development Strategies for Iran's Water Resources*' (IWRMC, 2004). In addition to legislative measures, several IWRM research studies have been initiated and are on-going. Thus, IWRM concept which was conceptualised in the latter half of the 20th century is a dominant paradigm but is still relevant in contemporary water resources management despite much criticism about its practical applications by e.g. Merrey, 2008; Biswas, 2004 and van der Zaag, 2005.

Chapter II is divided into three main parts: first, the governing principles of sustainable water resources management will be described; then IWRM is reassessed by considering its (a) conceptual limitations and (b) applicability. The discussion and conclusions constitute the final part of this chapter.

2.2 Governing principles: *definitions, concepts and issues*

2.2.1 IWRM

A critical landmark in the history of the development of IWRM was the UN Water Conference in Mar Del Plata in 1977 which set the general principles for international and national agencies (Amezaga, 2005), and these principles were updated in 1992 in Dublin. The Dublin principles[1] contributed to the Agenda 21 recommendations (see Chapter 18 of UNCED (1992) on freshwater resources) and were adopted at the UN conference on Environment and Development (UNCED) in Rio de Janeiro, 1992. They provide the basis for an integrated approach to water management.

From its definition (Chapter I: p.2), IWRM considers all the three interacting components of a WRS (Figure2.1; Loucks and van Beek, 2005):

i. Physical (infrastructure and technology) and natural environment;
ii. Institutional and political (policies, laws, regulations and administrations); and
iii. Socio-economic.

Neglecting a particular aspect of the system poses great challenges to the sustainable management of this precious resource. Hence, the water resource system is not only about the natural system and the infrastructure and technology, but it is inter-related with institutional and socio-economic and institutional subsystems as well.GWP (2000) acknowledges that there is no unique definition of IWRM. Moreover, GWP (2000) has further elaborated on the meaning of 'management' and 'integration'; management encompasses both development and management and integration is defined as:

the art and science of blending the right proportions of regular interaction and interdependent groups of items into a whole. The concept of integrated water resources management in contrast to traditional fragmented management is concerned with the management of water demand as with its supply (GWP, 2000; p.23)

[1]The 4 Dublin Principles form the basis of modern water management: (1) Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment; (2) Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels; (3) Women play a central part in the provision, management, and safeguarding of water; (4) Water has an economic value in all its competing uses, and should be recognised as an economic good.

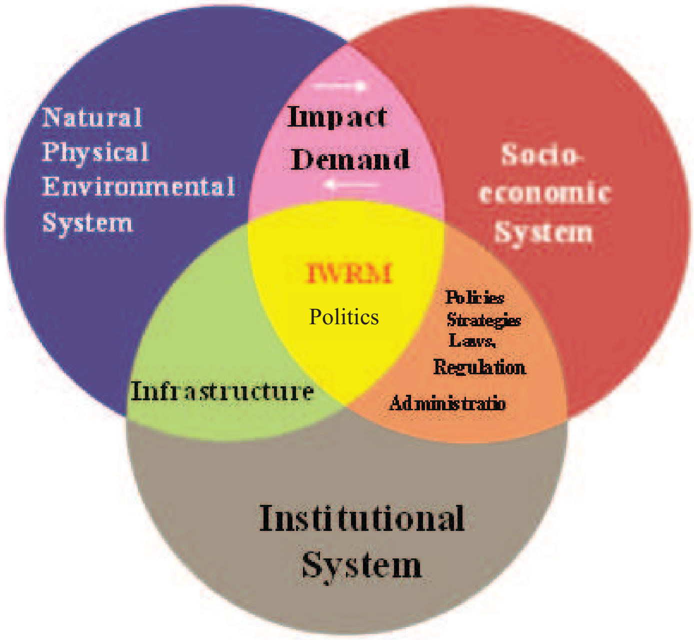


Figure 2.1: The components of WRS (Adapted from Loucks and van Beek, 2005).

The essence of integration is challenging and the process of integration has been beset with both technical and conceptual problems. Collaboration, cooperation and coordination are terms used to describe partially the meaning of 'integration' within the context of an integrated management decision-making process. However, Morrison et al (2004) suggest that integration means all of the named terms and more. A seven dimensional diagnostic framework has been envisaged including strategic, structural, procedural, facilitative, functional and methodological integrations (Morrison et al, 2004). An integration of water resources may have four characteristics or dimensions as shown in Table 2.1.

In the context of IWRM, the word 'paradigm' refers to the idea that IWRM is a balancing process that facilitates trade-offs among competing goals and not a goal in itself (Jønch-Clausen and Fugl, 2001). This is very important. IWRM plans are not traditional, project-oriented '*Water Master Plans*' but they are strategic 'dynamic' plans based on long term visions that continuously will be reassessed and evaluated over time (Figure 2.2).

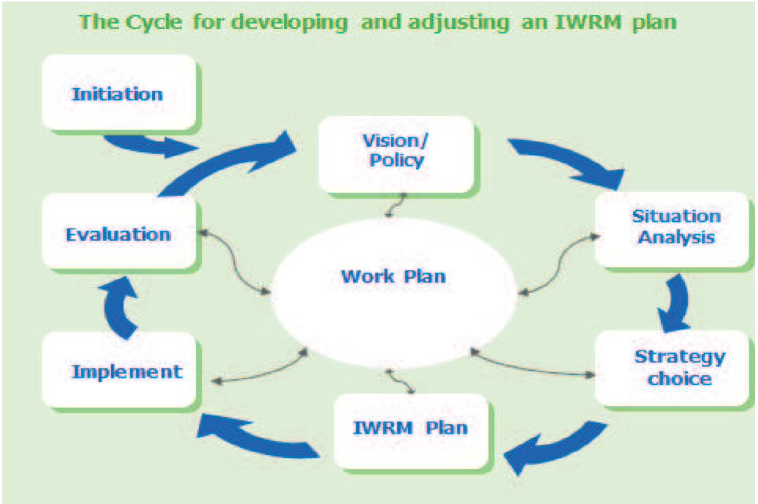


Figure 2.2: The Cycle for IWRM plans (Source CAP-NET, 2005).

Four dimensions of integration *(Morrison et al, 2004))*	***Five criteria for sustainability (sustainable development*** *(Gasparatos et al, 2008)*	Interpretations in terms of IWRM
1- A multi-jurisdictional spatial organization	1- Integration of social, economic, environmental and institutional issues and their interactions and interdependencies;	1-Fulfilling Sustainability criteria using sustainability assessment frameworks
2-Participatory coordination of different stakeholders, civil societies and actors	2- Creating a participatory environment; empowerment policies;	2- Stakeholder participation mechanisms such as stakeholder platforms; councils, forums associations etc. Balance of power among stakeholders Facilitating bottom up decisions
3-Collaborative decision-making from the participatory approach	3- Predictions of future trends and the impact of policies and development plans on sustainability; 4- dealing with uncertainties by taking conservative and precautionary measures	3-Using a systems analysis approach (policies, scenarios, management options (measures) and strategies) and integrated assessment tools
4- Agreement based on rationality	5- To foster ecocentric ethics and equity (intergenerational and intergenerational);	4- Supporting the socio-economic welfare of people i.e. eradicating poverty; empowering women; sustaining the environment

Table 2.1: Integration and sustainability in terms of IWRM.

2.2.2 Sustainable Development: ecological and environmental sustainability

The concept of sustainability came into the domain of academia In the 1970s (Rogers et al, 2006,p.42). However, Sustainable Development came into prominence after the publication of the 1987 World Commission on Environment and Development (WCED) report[2] which defines sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED, 1987: 43).

[2]Also known as the Brundtland Report named after the former Norwegian Prime Minister, Gro Harlem Brundtland.

The word “needs” is used twice in the above sentence and some critics have argued that the anthropocentric nature of the Brundtland report is a paradox and accused the author of taking a political stance in her approach by putting human needs at the centre of Sustainable Development (Barr, 2008). Braga (2001) points out that the explanation of the meaning of the term given by WCED (1987) is rather ambiguous and argues that the sustainability of natural systems is a measure of how they come into equilibrium during naturally occurring changes. However, humans have used these natural resources as if they are in ‘*infinite supply*’ which is a linear approach or “*the one- way society*” approach (Braga, 2001). As given in Chapter I, ASCE (1998) proposes another definition of Sustainable Development within the context of river basin approach that not only encompasses the “*needs*’’ or the demands of the current generation but gives an equal if not higher importance to the need for demand management. Demand management is an integral strategy within river basin approach. It is argued that the ASCE definition needs to be improved to include the political dimension or the institutional sustainability of WRSs.

In recent decades, there have been many contributions to the Sustainable Development debate (e.g. Barr, 2008; Khan, 1995; Hediger, 2000; Pearce 1988; Pearce et al, 1989 among others), notably Khan’s (1995) triangular model of sustainable development (social, economic and environmental sustainability) and Giddings et al’s (2002) nested sustainability model based on trade-offs among social, ecological and economic objectives. Gasparatos et al’s (2008) review on the Sustainable Development debate came up with a consensus on five criteria for sustainability which forms the basis of a holistic sustainability assessment as given in Table 2.1.ASCE (1998) outlines a number of methods to measure sustainability criteria in terms of net welfare of the system with reference to three development objectives: efficiency, survivability and sustainability including:

1. *weighted criteria indices* which consists of a list of criteria which are subsequently divided into sub-criteria which capture different aspects of the WRS; each are given equal weights and “*the sum of numerical values given in each sub-criterion is a sustainability index* “ (ibid, 51);
2. statistical indices which are defined as “*separate or weighted combination of reliability, resilience and vulnerability (RRV) of various economic, environmental ecological and social criteria that contribute to sustainability* ” (ibid, 51);

3. reversibility criteria which uses entropy as a sustainability criterion; and
4. robustness criteria by using the economic concept for evaluating alternative water resources development plans.

Among these methods, RRV analysis has been widely used to assess the performance of WRSs under the impact of climatic variability and change (e.g. Walsh and Kilsby, 2007; Jain and Bhunya, 2008; Kjeldsen and Rosbjerk;2004).

Worldwide acceptance of Sustainable Development made it necessary to develop sustainability assessment frameworks. Guio-Torres (2006) and Waheed et al (2009) have reviewed various approaches. Waheed et al (2009) categorises the sustainability assessment frameworks into 6 categories (ibid; p.448):

- Objective-based (e.g., strategic environmental assessment (SEA)
- Impact-based (e.g., Environmental Impact Assessment (EIA), Sustainability Impact Assessment(SIA), TBL Assessment)
- Influence-based (e.g., Transport Canada Framework)
- Process-based or stakeholder-based (e.g., USDOE "Ten Steps to Sustainability")
- Material flow accounting and Life cycle assessment
- Linkages-based (e.g., pressure-state-response (PSR), Driving forces-Pressures-States-Impacts-Responses (DPSIR)

The main conclusion drawn from the review and comparison of the assessment tools is that none of the approaches can fulfil the criteria for holism. The complex nature of natural physical, socio-political, economics and institutional issues with ethical dimensions present the problem in a way that cannot individually tackle the sustainability assessment task (Hashemi and O'Connell, 2011b). They are complementary to each other and a variety of tools might be considered, depending on the context of the assessment. Another obvious point is that these shortcomings are not disadvantageous to the point of nullifying the various approaches, but it is advised that stakeholders should know about these limitations and assumptions so to make informed decisions.

Despite their limitations, linkage based frameworks such as DPSIR have been successfully implemented in many sectors (Waheed et al, 2009). There is room for improving the conceptual and analytical dimensions of these frameworks. For example, Turner et al (1998) call for incorporation of ethics into the DPSIR framework. We will discuss this topic further in Chapter III.

2.2.3 Sustainability and environmental ethics

Ethics can be defined as a set of beliefs, values and perceptions which have cultural and religious dimensions and are a vital element in policy and decision-making situations. Ethical principles are frequently ignored in conventional water management (Sohail and Cavil, 2006). However, the ethical dimension of decision-making should be acknowledged since it empowers a certain group of people to make robust decisions affecting others.

Lord Selborne (2000) states that the ethics of freshwater use have five elements: (1) human dignity (rights); (2) stakeholder participation, (3) equity; (4) sustainability; and (5) good governance. The latter is part of an enabling environment to implement the IWRM paradigm. These ethical elements are implicit within the concepts of IWRM and Sustainable Development.

Environmental ethics is defined as "*a systematic account of the moral relations between human beings and their natural world* (Des Jardins, 2001 p. 11). Des Jardins (2001) provides a comprehensive review of different environmental ethics based on their philosophical foundations. Throughout the history of mankind till today, the anthropocentric ethics have dominated with severe environmental consequences resulting in environmental degradation and resource depletion as humans are considered to be the central fact in the universe (Proops and Wilkinson, 2000). The biocentric ethics considers animal rights but fails to recognize ecosystems as a unit. Therefore, a sound environmental ethic has to be ecocentric giving full environmental protections but recognises human society as an integral part of the ecosystem.

Armstrong (2009) outlines a 'water ethic' in line with Leopold's (1949) 'Land Ethic'. The proposed water ethic principles is based on the "*rights of the nature*" (Armstrong, 2009) which emphasises the ecological dimension of water management: "*ethical water management is thus not just about the allocation of water resources to human beings, but to all species, and to all landscape components*" (ibid, p.146).

2.2.4 Socio-political (institutional) dimension of sustainability

Institutions are considered to be the mould of social life, consisting of interacting systems of laws (rules) with inbuilt monitoring and enforcing mechanisms (Campbell, 2004). The mechanisms are enabled by actors to make decisions regarding water resources management (Cowie and Borrett, 2005). Institutions, therefore, are the means of stability in society by channelling and regulating conflicts. Therefore, water resources decision-makers need to consider their social responsibilities in achieving sustainable societies (ASCE, 1998).

There is no unique definition for the term ‘institution’ (Ostrom 1999, 2005). A confusing prospect for non-institutional experts is the varying ways in which institutions are analysed based on the conceptual definition of an institution. In an institutional analysis process, we must clearly state what is meant by a water institution. Classical institutionalists such as Ostrom (1999, 2005) take the view that institutions are the rules that organisations (administrative institutions) or actors adhere to but Saleth and Dinar (2004) and Bandaragoda (2000) have taken a broader view to consider institutions in terms of three main components: policy, law and administration. This is a pragmatic view since water administrations cannot exist without the other two and vice versa. Therefore, in any institutional analysis of sustainability, the term ‘institution’ has to be clearly defined based on the applied analytical framework.

From comprehensive literature reviews (by e.g. Amezaga, 2005; Hashemi et al, 2007a,b; Ivey et al, 2006; Cowie and Borrett, 2005), a water resources institution can be a mixture of six broad categories:

1. Vision statements, policies and guidelines and strategies
2. Laws (which can be formal and informal), rules, regulations and conventions operational plans and procedures
3. Administrative structures (organisations), their bylaws and core values
4. Political structures and processes (accountability mechanisms)
5. Economic and financial arrangements e.g. incentive mechanisms
6. Norms, traditions, practices and customs

Governance is a term which is widely used in the literature. It is defined by UNESCAP[3] (undated) as “*the process of decision-making and the process by which decisions are implemented (or not implemented)”.* A further consideration is the need to understand that a governmental system is part of a larger governance system and is characterised by its sectoral, functional and hierarchical differentiations; these are the sources of governance complexity (Blau and Meyer, 1956). Sectoral and functional differentiations are the result of government specialization in a discrete policy area and usually cause duplication of efforts and fragmentation of responsibility. This is not necessarily disadvantageous (Imperial, 1999).

[3]The United Nations Economic and Social Commission for Asia and the Pacific(UNESCAP)

In a world in which water scarcity is a fact of life, water sector institutions need to be re-oriented to cater for the needs of changing supply-demand and quantity-quality relationships in the emerging realities (Saleth & Dinar, 2004).ASCE (1998) postulates that "*any process involving change will require that we change our institutions – the rules under we function*". As noted by many researchers, water resources institutions are in a continuous flux and we need to analyse institutional mechanisms that allow the change to occur (ASCE, 1998). But the study of institutional change is in the domain of social and political sciences and hence there is a need to link institutional analysis to any sustainability assessment of WRS.

One of the vital characteristics of IWRM is its "*strong institutional orientation*" (Imperial, 2009). Therefore, IWRM concept is consistent with the notion of institutional (decision-making) levels (see e.g. ASCE, 1998) i.e. IWRM can interface with three levels of institutional interventions: (1) operational (local/basin) level which deals with biophysical, environmental, hydrological, ecological and socio-technical aspects of the WRS; (2) organisational level which deals with administrative aspects of the WRS; and (3) policy level which deals with policy and legal aspects.

Decisions at a higher level determine the rule sets or institutional arrangements at the lower level. However, the actions in the operational level will directly affect the distribution of water and land resources and usage in the physical world. By monitoring and assessing the distribution of outcomes at the operational level, a process of feedback to higher levels is established. Therefore, the processes at each level are not mutually exclusive.

Searle (2005) makes an outstanding contribution to the institution debate as he advises those who are involved with the theory of institutions that they should see an institution from the first person point of view since the institutional ontology is subjective. Searle (2005) believes that you can see the institution through the lens of the participant and no external functionalist can understand the situation. You have to be an insider rather than an outsider looking into institutional problems. An inner knowledge of institutional matters will foster (a) good relationships and partnerships (long term socio-political commitments to sustainability concept); (b) socio-political support (financial sustainability); and(c) achievable stakeholder participation.

Institutional analysis is a key theme in this thesis which will be discussed in the next sub-section.

2.2.5 Policy/decision-making processes

IWRM uses systems analysis approach (Figure 2.1; Box 2.1) to achieve holistic sustainability(e.g. Loucks and van Beek, 2005).A water policy (see Box 2.1 for definition) is usually based on water uses. There are different policies for agricultural, domestic, urban, industrial, energy and environmental uses of water. Now, on an international platform, water policy comes within broader policies on sustainable development, Millennium Development Goals, (MDGs) and human development.

- Policy: a political (governmental) statement outlining the vision,goals and objectives of IWRM plans
- Scenario: a futuristic outlook of development such as assumptions under which development occurs; these are exogenous to the water system such as population growth or climate change that cannot be controlled or determined by the water resources system
- Management option: a measure or an action taken to improve the performance of the water system, these measures can be legal, institutional, technical, social, economics, ecological.
- Strategy: a collection of management options to be considered under different anthropogenic and natural climatic scenarios.

Box 2.1: The components of systems analysis approach and their basic definitions (Source: Hashemi and O'Connell, 2011b).

The most crucial stage for an issue to become policy is to gain agenda status. Framing an issue depends in part upon whether the claims persuade others that "*X is a social problem or that Y offers the solutions*" (Best, 1995). Issues labelled as social or public problems get the attention of legislative bodies and hence will gain agenda status. Issues that are not perceived as a problem by society will not become a policy. Therefore, it must be remembered that policies are made by politicians in response to perceived social problems and for the advancement of their own political interests and careers.

A policy has two goals: the interests of individual wellbeing and the interests of the society as a whole. However, these two goals are not the same (Pearce, 2000). In a politically correct world, decision-making based on self-interest (the first goal) is unacceptable, and so citizens' preferences are accepted. Pearce (2000) asserts that this kind of contrast between the preferences is exaggerated and unhelpful. Socially motivated preferences are elicited by political means whereas self-interests are well served by the economic medium. However, political decision-making is open to the influence of lobby groups and political self-interest.

The policy-making process should ideally be participatory since policy decisions are based on societal values as a whole (Stave, 2002). Thus, on this basis, all stakeholders should be given a voice and be heard without prejudice and advantage (Hampton, 2004) and should be involved in discussing the trade-offs. However, the challenge is that there is no clear way to assign and determine the qualitative values (i.e. weights) attributing the relative importance of different management options in a Multi-Criteria Decision-making Analysis (MCDA) approach to decision making (discussed in Chapter III).

It is argued that participation provides legitimacy for a given policy (Hendriks, 2005). Furthermore, people's evaluation of policies may change as their perception changes about issues they value. Therefore, in recent years, far-reaching public policy changes have occurred in many countries so that some scholars consider them as shifts in policy paradigms (Menahem, 1998). A policy paradigm comprises of a system with two components (ideas and standards) that defines policy goals.

In a dynamic world (climate, technological and resource availability changes), policy-makers have to consciously change their assumptions. Financial resources can be an important factor. For example, technological changes affect water sector organisations and in response, they have to adapt to these changes in order to survive in a competitive financial environment e.g. monetary or market forces (see e.g. Archibugi et al, 1999). So, policy-makers tend to use technological assessment tools such as modelling systems to legitimise policy decisions which have a great deal of uncertainties. We have to understand that the interplay between public policy and legitimacy is a vital component in a policy analysis (Hashemi et al, 2007a) and to remember that the primary role of the modelling systems is to educate the policy-makers about the nature of the problem and provide evidence for a sound decision using the available data and technologies and not to legitimize policy (Sharifi, 2003). In Chapter III, more insight is given on institutional and policy analysis tools. In the next sub-section we will further discuss the role of technology on the sustainability of WRSs.

2.2.6 Sustainability and the application of modelling systems:

Sparked by the availability of digital computers, a flurry of watershed modelling activity started around the late 1950s. Comprehensive digital modelling was initiated thorough the Stanford Watershed Model, (Crawford and Linsley, 1966)[4]. In parallel to the development of watershed modelling, the wider field of water resources planning and management saw the evolution of a range of WRS simulation and optimisation methods which dates back to1950s (Keiner, 2004; Jain & Singh, 2003). The 'Harvard Water Program' (HWP, 1955-1965) was the driving force behind the agenda for water resources modelling in the USA and worldwide (e.g. Maass et al, 1962; Loucks et al, 1985; Dzurik, 2003). HWP's contribution to water resources planning and management was three fold (Reuss, 1989): (1) using computer simulation to design water resource systems; (2) developing synthetic or operational hydrology as a means for designing water resource systems and (3) the development of multi-objective economic analysis and planning. The HWP's 'blueprint' remains a relevant vision to date (Reuss, 2003).

Due to the sheer number of simulation and optimisation models, it is almost impossible to make an inventory of the models. Many researchers have reviewed different types of models including Biswas (1974), Loucks et al (1981), OTA (1982), Basson et al (1994), Watkins and McKinney (1995), Wurbs (1997, 2005), Boughton and Droop (2003), McKinney (2004) and Labadie (2004).

Based on a comprehensive review, Hashemi and O'Connell (2011a) conclude that water resources models have contributed greatly to the advancement of the planning and management of water resources and have been recognised as an integral part of the decision-making process. Water resources models are used to simulate future demands and assess the impact of water resources development plans on the available resource in terms of quantity and quality. They can be generally classified as (a) reservoir/river systems or river basin (water balance/allocation) models; (b)emergency (Flood/spill) models; (c) water Quality models; (d) environmental models; and (e) integrated modelling systems (i.e. a combination of socio-economic, hydrologic, ecologic and hydraulic models) which emerged in the 1990s.

The start of the 1990s brought further technological advancements and the proliferation of Personal Computers (PCs) and better MS Windows (Microsoft Corporation) environments with even better graphical capabilities. The main characteristics of the status of modelling system in the 1990s can be summarised in Box 2.2.The increasingly important role of information technology in the development and application

[4]In this section we concentrate on the role of water resources modelling systems in sustainable management of the resource see Hashemi and O'Connell (2011a) for a comprehensive review on the development of watershed and hydrological modelling including physically based distributed models.

of watershed and water resources system models was encompassed very well by the new integrating and cross-disciplinary concept of hydroinformatics formulated by Abbott (1991) which embraces hydraulics, hydrology, environmental engineering, socioeconomic and political (institutional) sciences, and uses information and communication technologies to provide evidence for decision-makers.

Box 2.2: The main characteristics of the status of water resources modelling in the 1990s.

1. Emergence of a number of comprehensive, distributed, and physically based models such as Mike-SHE (Refsgaard & Storm, 1995) and SHETRAN (Ewen et al, 2000) which could be applied to address a wide range of environmental and water resources problems.
2. Linking hydrologic models with water quality/ecosystem models
3. Models gained greater acceptance as tools for water resources planning, development, design, operation, and management.
4. Major advances in the field of digital imagery and data acquisition techniques (e.g. remote sensing, radar and satellite technology) with applications in e.g. real-time flood forecasting, weather forecasting, forecasting of seasonal and/or short-term snowmelt, mapping of groundwater potential to support the conjunctive use of surface water and groundwater; Environmental Impact Assessment (EIA) of large-scale water resource projects etc.
5. Use of Digital Elevation Models (DEMs) (e.g. Sugumaran et al ,2000) and Digital Terrain Models (DTM) and other digital maps of vegetation, soils and geology etc in hydrologic modelling systems
6. Application of new hydroinformatics data mining tools such as artificial neural networks (ANNs) in river basin/hydrologic modelling
7. Improvement of the technology of model calibration and use of optimisation techniques and multi-criteria analysis techniques for multiple objective evaluations
8. Emergence of the first generations of integrated systems such as NELUP, WaterWare, IQQM, RIBASIM, WEAP etc

There are many examples of integrated modelling systems such as MODSIM (Labadie et al, 1984), IRIS (Salewicz et al, 1991**),** NELUP(O'Callaghan, 1995), WaterWare(Jamieson and Fedra, 1996),IQQM (Simons et al, 1996), AQUATOOL (Andreu et al, 1996), WEAP (Raskin et al, 2001), MIKE SHE river basin integrated modeling tool (Graham & Butt, 2005), Mike Basin (DHI, 2003, Ammentorp, 2001) and RIBASIM (WL| Delft Hydraulics, 2005). These exhibit some (i.e. not all) of the five desirable features:

- GIS/graphical user interface and geo-database management system
- scenario analysis with multi-criteria analysis or statistical techniques for strategy evaluation (expert systems)
- socio-economic assessment tools/indicators
- institutional assessment tools (e.g. water pricing)

In 2000, IWRM took the centre stage in both national and international policy spheres worldwide. Due to the interdependent nature of the interplay among various WRS components, there is an implicit quest for integrated assessment tools. The IWRM concept which requires the integration of physical, chemical, biological, environmental, ecological and socio-economic components has helped for the conceptualisation of integrated modelling approaches.

There is a strategic trend towards implementing integrated assessment tools at multi resolution, multidisciplinary levels. Major projects around the globe spend a large amount of resources on developing modelling systems with the aim of attaining IWRM goals to achieve sustainability criteria. Examples include the SAHRA (Semi-Arid Hydrology and Riparian Area) initiative (Liu et al, 2008); the Nile Basin Initiative (NBI) covering 10 African counties, the Colorado River DSS (CRDSS) and EU's NOSTRUM-DSS which aims to support the EU's policy on stronger stakeholder participation, pro-poor emphasis and gender sensitivity. Other examples include WaterStrategyMan (Todini et al, 2006) MULINO, (Giupponi et al., 2004) and DANUBIA (Ludwig et al, 2003).

2.2.7 Sustainability and uncertainty in sustainable decision outcomes

There are three categories of uncertainties: (i) inherent; (ii) knowledge (e.g. scientific, data); and (iii) decision-making uncertainties (Langsdale, 2008; Loucks and van Beek, 2005).

Inherent uncertainty is due to the complexity, dynamic and unpredictable nature of ecological and water resource systems processes. One of the lessons that have to be learned is that most decision-makers perceive uncertainty to be of the second category (knowledge uncertainty) and hence scrutinise scientific outputs ignoring the inherent uncertainty. Thus, Langsdale (2008) calls for two important actions: (1) the acknowledgment of the inherent uncertainties in the decision/policy-making process and (2) clear communication of uncertainty elements in the outputs to the stakeholders.

Knowledge uncertainty relates to available data or the inadequacies of the assumptions made or gaps in the structure of methodological approach. There are four knowledge management domains (Steyaert & Jiggins, 2007): (1) the known: these are manageable and there is no uncertainty or risks attached to them; (2) the complicated but unknown: they are normally very important; e.g. climate change, population growth pressures, physical processes affecting evaporation rates, the impact of geometry of pore size in preferential flow etc.; (3) the complex, unknowable but partly predictable: most model outputs fall into this category; and the chaotic: all natural processes fall into this category.

'Uncertainty due to lack of data' is now a cliché in the water resources management. The enhancement of data management technology and modelling will not improve the knowledge uncertainty on its own unless collection and data measurements techniques are improved too. They are a complement to the data collection process and not a substitute to it and scientific observations are needed for better understanding of the system problems (Silberstein, 2006). In the case of hydrological data for example, Sutcliffe (2004) calls for improving measurement techniques. Therefore, there should be a shift from purely technological to a combined technological and data collection techniques approach.

Shackley and Wynne (1996) also note that knowledge uncertainties can diminish the authority of scientific judgements in policy and decision-making process. The scientific ambiguity serves both policymakers and scientists: it can be used as an alibi in accounting for a lack of policy effectiveness. However this should not affect the importance of scientific knowledge in decision-making, as uncertainty is a by-product of analysing complex issues (Armitage, 2004). Furthermore, the process will benefit from better dialogue between natural and social scientists, water users, environmental regulators and the public at large (Ioris, et al, 2008).

Decision uncertainty is shaped by incoherent goals and objectives and influenced by the ethical context of decision-making e.g. customs, culture and belief (Loucks & van Beek, 2005). Loucks and van Beek (2005) assert that, in many cultures and legal systems, doing nothing is more acceptable than failing after an action. Loucks et al (1985) make an intelligent observation about the incremental nature of political decisions. Based on this, they suggest that the model solutions should also be incremental as political communities are not happy admitting that they were wrong but they might be happy with making small changes within a learning process. Therefore, the uncertainty should not be a scapegoat for inaction (Cosgrove et al, 2008).

Scientific arguments are often the basis for public policy debates and the importance of science in sound public policy-making cannot be ignored (Montz, 2008). There is a strong link between science and the policy-making process (e.g. Montz, 2008; Freehafer, 2008). Scientific uncertainties normally polarise policy-making decisions and indeed provide a hindrance for change or reform. But uncertainty is part of the decision-making process i.e. it is fact of life (see e.g. Refsgaard et al, 2007). It is not possible to isolate, remove or eliminate uncertainty entirely by further research. However, research can improve the uncertainty of know-how and knowledge.

2.3 Reassessment of IWRM paradigm

Many scholars have called for reassessment of the IWRM concept (e.g. Biswas, 2004; Falkenmark et al, 2004; and Llamas and Martinez-Santos, 2005; Falkenmark and Rockström, 2006; Merrey, 2008). Nevertheless, the conceptualization of the IWRM paradigm came about at a time when water resources around the world were poorly managed. Therefore, most scholars (whom criticise IWRM) also value the importance of the concept as a countermeasure to balance conventional water management practices which manifest unsustainable development.

In this section, we discuss the problems with the 'integration' aspect of the IWRM paradigm and reassess the validity of the concept, bearing in mind its dismal lack of implementation success. In the next sub-sections, issues and constraints of implementing IWRM are discussed.

2.3.1 Conceptual constraints

Problems with scope of IWRM. According to Molle (2006), the river basin concept "*has been associated with various strands of thinking and sometimes co-opted or mobilised by a particular group to strengthen the legitimacy of their agenda*". IWRM is a political process seeking to entrench democracy through participation and good governance. Hence, it should be possible to envisage political boundaries that influence the hydrologic boundaries and incorporate an enlarged political map by identifying actors and organisations that affect WRS. Therefore, a politicised IWRM is envisaged by moving away from a watershed to a "*problemshed*" perspective (Mollinga , 2008). Merrey (2008) states the need for "*identifying empirically what are the boundaries of a problem and not imposing a hydrological boundary*". This means that the scope of IWRM should be enlarged and goes beyond hydrological boundaries (i.e. river basins). WWDR (2009) calls for dealing with the 'water box' dilemma' by looking for solution outside the 'water box' with a political decision-making process involving political, civil society and business and economic actors.

The call for politicising IWRM by enlarging the boundary of the watershed (i.e. considering 'problemsheds') is well founded as IWRM is essentially a political process (e.g. Allan, 2003a). But, it is argued that there is a misconception on the philosophical nature of IWRM. As stated earlier, IWRM provides interfaces for three decision-making levels (policy, organisational and operational levels) which go beyond watershed boundaries. The reason why IWRM has been very elusive in terms of being implemented is that it is not a framework; instead it is a romanticised (idealistic) concept. What is required is a framework that can translate the IWRM concept into implementable strategies and management decisions. It is argued that river basin approach is still valid because it represents the operational level within nested decision levels (boundaries) i.e. for our analysis; we need to consider the ‘resource unit’ which is affected by our decisions.

According to Merrey (2008), the wide ranging scope of IWRM “*normative package*” objectives is leading to “*indecisions and paralysis”*. It is simply not possible to achieve all the objectives of IWRM at the same time. For example, the complexity of the nature of implementing IWRM is clear as Biswas (2004) lists some 36 issues that should be ‘integrated’. Therefore, objectives need to be prioritised. However, Merrey (2008) does not call to abandon IWRM altogether but asserts that the IWRM normative form should be discarded as an unchallenged “*religious text*” or a blueprint.

It is argued that IWRM is a high level set of water management principles and so it is vague on how to prioritise its wide ranging objectives but a practical implication of IWRM by ‘being a process and not a goal in itself’ is that objectives can be prioritised by having short term objectives within a long term vision i.e. the long term sustainability of water resources systems can be achieved by gradual implementation of IWRM plans. Therefore, there is a need to develop ‘good practice’ guidelines on how IWRM is implemented.

Need for paradigm shift. Researchers such as Pahl-Wostl, (2007), Lankford et al (2007)and Rivers-Moore and Jewitt (2007) among others, call for incorporation of the idea of adaptive management within a “*social learning*” process. The idea of adaptive management originates from the understanding of ecosystems as being adaptive or “*self-organising*” to changes in the system (Holling, 1978). It has been introduced to resources management for quite some time (Pahl-Wostl , 2007; Jewitt, 2002). The overall approach is to combine ‘‘soft’’ subjective perceptions (values, ideology, belief systems) based on perspectives or mental models of stakeholders and ‘‘hard’’ factual knowledge from data analysis in a participatory group model building process (Pahl-Wostl, 2007). Stakeholders will learn from each other and make decisions based on their evolving understandings and perspectives. People can have multiple non-mutually exclusive value-laden perspectives at the same time (Spranger, 1928). Different human perspective models are shown in Table 2.2. In my opinion, the human face of IWRM can be improved by consideration of perspectives in an implementation framework. We will return to the theme of perspectives in Chapter III.

Name of perspectives model	**Perspectives' values and their attributes**					
Spranger 's (1928) Human Perspective	**Theoretical** general legality, value of objectivity	**Economic** utilitarian ethics the value of utility	**Aesthetic** inner form and the value of proper form and harmony	**Political** desire or will to gain political status (power)	**Social** ethics of helpful love and loyalty and social ties	**Religious** holiness in God
TOPEA Model plus economic (Hall et al. 2003; Hall and Davis; 2007 and Hall, 2008) based on **Courtney's (2001) TOPEA model**	**Technical** A functional, rational and ordered orientation	**Economic** Efficiency	**Aesthetic** The beauty and harmony of a solution design	**Personal** Prestige, power	**Organizational** organisational self-interest	**Ethical** Integrity, way criticism is dealt with

Table 2.2: Different perspectives models and their main attributes.

2.3.2 Neglecting parts of the water cycle: omissions in IWRM approach

One of the main criticisms of IWRM is that it focuses more on the "Blue Water" part of the water cycle. Falkenmark (1997) introduced the concept of Blue and Green Water to separately account for (a) renewable surface runoff and groundwater resources (Blue Water); (b) and soil moisture and water consumed by plants through evapotranspiration (Green Water); and (c) return flow or wastewater (Grey Water). Falkenmark et al (2004) points to "*three omissions*" in IWRM approach: i.e. water sources which are not fully considered in IWRM plans including Green Water, Grey Water and environmental services (ecological functions) of water.

Need for Evergreen Revolution. From 1960's, irrigated areas in the world has increased exponentially based on extensive use of Blue Water. Expansion of irrigation agriculture which is termed as the first "*Green Revolution*" brought economic prosperity to many countries and enhanced food security lifting the threat of hunger from many parts of Asia (Falkenmark and Rockström, 2006).The Green Revolution has placed a great pressure on the WRS worldwide. Overexploitation of groundwater resources in many parts of the world had reached a crisis level (Calder, 2004 and 2005; Falkenmark &Rockström, 2006, Falkenmark et al, 2004). Surface water developments have been marred with financial difficulty and environmental degradation and political controversies. But according to Llamas and Martinez-Santos (2005), despite the problems posed by the Green Revolution, its impact on irrigation policy changes has been minimal and less attention has been drawn to irrigational expansions because of the socio-economic gains.

Expanding Blue Water consumptions (that is mainly irrigation) are not a sustainable option in the future. Thus, to deal with this problem, IWRM plans in many developing countries including Iran have concentrated on Blue Water.

Food security and removal of world hunger cannot be addressed without considering the full water cycle including Green Water. A new "*Evergreen Revolution*" is required to enhance our understanding of the relationship of land and water and the Green Water part of the water cycle i.e. evapotranspiration or total evaporation (Falkenmark et al, 2004; Falkenmark and Rockström; 2006; Calder, 2005). However, there are many technical and social challenges to initiating the Evergreen Revolution. As, rightly pointed out by Jewitt (2006) "*good conceptual understanding is prerequisite for integrating Blue and Green Water Flows for water resources management"*.

On the social side, the Evergreen Revolution is a difficult proposition to lead and control and depends on decision-making at both micro (e.g. farmers) and macro (e.g. market forces) levels. Abderrahman (2000) reports a successful case study from Saudi Arabia in which Islamic principles were used in water demand management in which support for wheat cultivation was reduced to about 25% of the previous level to minimize irrigation water use. Hence, cultural aspects of the society need to be considered in any policy shifts.

At the policy (political) level, Calder (2005) argues that many land and water polices failed because of the "*mismatch between the public and scientific perceptions of the biophysical impacts of changing land-use, with policies more often based on 'land and water myths' than modern science*" (Calder, 2005; p.309). Duda (2003) makes a valid point that "*the land linkage must also be included because land-use decisions often represent water-use decisions*". Calder (2005) proposes an Integrated Water and Land Resources Management (IWLRM) paradigm as there is an explicit inter-linkage between land and water management (Amezaga, 2005). Therefore, it is desirable for IWRM to conceptually implicate land use management in water resources planning.

In technical (hydrological) terms, lumping evaporation and transpiration as one parameter (evapotranspiration) is problematic (Jewitt, 2006). To understand the transpiration part of the Green Water, physical processes such as the rate of plant water uptake in different climates have to be studied so the potential of rain-fed or dryland agriculture (Green Water) can be evaluated in any policy shifts. Modelling techniques will have an important role to play here. It has to adjust to the new paradigm's set of added parameters and take an adaptive and innovative modelling strategy. Therefore, the Evergreen Revolution entails (a) recognition of land-water nexus and (b) improvement of technological solutions to improve productivity and reduce water consumptions in different water uses including irrigation agriculture; and consideration for ethical and cultural aspects of land and water governance.

Considering Grey Water. IWRM has been criticised for neglecting the role of Grey Water i.e. return flow from households and industrial wastewater, return water from irrigated land, recycled water from treatment plants in water balance calculations (Falkenmark et al, 2004; Falkenmark and Rockström; 2006). Traditionally, IWRM has been associated with Blue Water allocation which represents the majority of renewable resources. In Iran for example, out of total renewable water resources of 159 BCM, 29 MCM are return flows (Siadat, 1999) which represent 18.2% of the total amount. Grey Water can enhance water availability in water scarcity conditions (e.g. Halalsheh et al, 2008).

Using Grey Water is not straight forward to calculate or to use. For example, a religious Islamic ruling or 'fatwa' was used in Saudi Arabia as part of demand management strategy to enhance the acceptability of using treated (recycled) wastewater for non-drinking purposes such asgreen area irrigation in cities (e.g.Abderrahman, 2000). The untreated Grey Water has been used for agriculture in some countries such as Pakistan but objections on health ground are made to the use of untreated Grey Water. Accounting for Grey Water is also problematic as return flows from irrigation sites are not usually monitored or calculated. There is a degree of evaporation and some of the Grey Water will enter the Blue Water cycle by recharging groundwater and entering water bodies such as wetlands and rivers. Therefore, Grey Water is somehow covered by Blue Water. Therefore, water resources planners find it less attractive to account for Grey Water due to uncertainty about estimating it and the prevailing cultural barriers. In addition, recycling or re-use of Grey Water not only involves technology, it is energy dependent as well[5]. Energy is a limiting factor in the use of recycled wastewater. It is anticipated that energy policy in the Middle East will have a profound impact on water sector (see e.g. Siddiqi and Diaz

[5] Water desalination from seas and brackish water cannot be considered as Grey Water or wastewater; it is an alternative source of water for semi-arid and arid countries which have access to sea. Again, they are extensively energy-dependent.

Anadon, 2011). The World Bank (2007) has highlighted the influence of non-water policies such as energy policy on the water resources of the region including Iran.

Streamlining with ecohydrological approach. The good governance principles of IWRM seeks to achieve ecological sustainability of the WRS i.e. integrating water and land use governance based on environmental and ecological principles (GWP, 2000). However, much of the work has concentrated on river quality and environmental water flows[6] but this is not sufficient. GWP (2000) acknowledges that more multidisciplinary research is required to value ecological functions of water as "*valuation of ecosystem costs and benefits has not been on the practical water management agenda so far*" (ibid, p.58). Therefore, paradigms such as ecohydrology might be a useful to enhance the ecological credential of IWRM. Zalewski (undated: 1) defines ecohydrology as a"*transdisciplinary*[7] *and applied science*" which "*uses the understandings of relationships between hydrological and biological processes at the catchment scale to achieve water quality improvement, biodiversity enhancement and sustainable development*".

Application of this concept entails three steps (Gouder de Beauregard et al, 2002): (1) a comprehensive ecological study of the catchment (climate, soil science, vegetation, human occupation), (2) implementation of a water quality catchment modelling system to assess the fluxes of pollutants where the outputs of the model will contribute to a land use management policy and long term management strategies; and (3) Implementation of technologies to restore the ecosystem. In the Lake Urmia case study, we will further consider the ecohydrological approach to water allocation decision in Chapter VI.

2.3.3 Putting more food on the planet: Land-water-food nexus

The debate over water and food security shows a degree of confusion as there are no unique definitions for the above terms and all depends on what 'threats' we are looking for. One might think of water and food security as the measure of the access and availability of water and food to the population. But it is more than that because the term 'security' has different connotations depending on the context of the problems. This term implies that we need a defensive measure in response to conditions of water scarcity. Therefore, water

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[6]This global trend is perhaps influenced by the Water Framework Directive (WFD) of the European Union (EU); about the river quality in European river basins highlighting a North-South divide i.e.this perhaps indicates the difference between well-developed industrialised North and the less developed industrializing South; (see. e.g. Allan, 2005 about the development of water paradigms).

[7] See e.g. Max-Neef (2005) as there are philosophical arguments with regards to the meanings of different concepts attached to 'disciplinarity ' e,g transdisciplinary , interdisciplinary' and 'multidisciplinary'. In Chapter III, we will explore this further to describe the methodological design.

scarcity is one of the main attributes of water security. According to Grey and Sadoff (2007), water security involves "*harnessing the productive potential of water and limiting its destructive impact*".

National food security has become a distinct agricultural policy in many countries which is based on increasing food production through irrigation agriculture (i.e. more Blue Water consumption) and better crops (i.e. enhanced technology). This policy is supported by UN and international agencies which aim to increase food and social security (alleviate hunger and eradicate poverty). The impact of this policy on water resource systems is to allocate more water for irrigation. Therefore, the present world water crisis is essentially a food crisis (Green, 2003). Hence, water security will increasingly become an important issue in the future. This is because physical water scarcity is partially induced by human behaviour[8]as well as being affected by natural phenomena like droughts. John Parker (2011) writing in the Economist on how to feed "*9 Billion-people*" acknowledges the impact of water shortages and Climate change but asks for producing more crop for less water by using better technology to achieve food security. He finishes on an optimistic note by saying that despite the challenges, "*countries from Brazil to Vietnam have shown that, given the right technology, sensible policies and a bit of luck, they can transform themselves from basket cases to bread baskets*". Parker (2011) implies that policymakers have no choice but to deal with growing problem of food security but this can only happen through technologically-oriented measures or Evergreen Revolution as stated earlier. Thus, to deal with water security we need to consider water-land-food nexus[9] (Source: Appendix A, Table A.1.6).

Despite their obvious interdependencies, it is not easy to link water and food policy. An innovative concept to link food 'trade' and water was coined by Allan (1997): Virtual Water 'trading.' Allan defines Virtual Water as the water embedded in the production of commodities including agricultural products e.g. 1000 litres of water needed to produce a kilo of grain is considered to be Virtual Water. Therefore, 'trading' food commodities can be considered as 'trading' Virtual Water (Zeiton et al, 2010). Despite some controversy and criticism about the economic and linguistic credibility of the term (e.g. Merrett, 2003), Virtual Water can address blind water policy assumption gaps in water scarce countries.

[8] There are some empirical evidences that climate change is induced by human lifestyle because of greenhouse gas emissions.
[9] This issue of water-land-food nexus was strongly featured at the Amman Workshop in Jordan held by WANA Forum in February 2011 (see Appendix A1, Table A1.6.)

Virtual Water 'trading' in fact is a reality and many countries depend on imports of agricultural produce. Iran, as an example of a semi-arid country in the Middle East, imported 6 million tons of wheat from 15 countries in 2008 and was expected to import 7.5 million tons in 2009 as shown in Figure 2.3. The question is why this is not considered in agricultural policy and regional developments plans. Therefore, this issue needs greater debate in the political and academic arena.

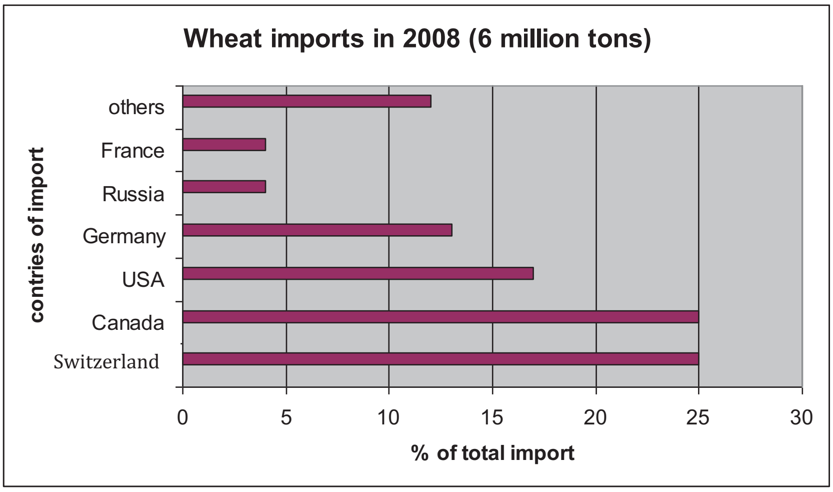


Figure 2.3: Iran's wheat imports in 2008 (Source: Iran Economics, 2009).

One issue to be considered is that many policymakers are uneasy about using the terminology because of the political sensitivity. For example, in an interview with Memari (2006), advisor to Deputy Minister for Water Resources, Ministry of Energy (MoE), Iran, he dismissed the idea of Virtual Water because it encourages more reliance on food imports and "*derails the production cycle*" i.e. it will damage the agricultural sector as one of the most important productive economic sectors[10]. This clearly demonstrates the political nature of decision-making about water resources system which has been noticed by many researchers (e.g. Allan, 2003a and Merrey, 2008).

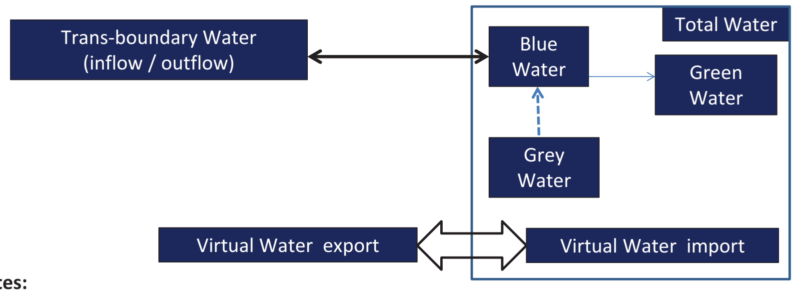
As Virtual Water 'trade' is not really 'virtual' and happens in reality, it can be considered as one of policy tools which is both exogenous and endogenous to the 'water box'as schematically presented in Figure 2.4. Virtual Water 'trading' may

- influence Blue Water by shifting priority from water for food to water for drinking or industry
- shift attention to Green Water by emphasising on rain-fed agriculture

[10] The author experienced similar resentment in WANA workshop on water scarcity in Amman Jordan attended by a former advisor to the Late King of Jordan, February 2011 (Appendix A1).

- reduce Grey Water by shifting the attention from Blue Water use for irrigation agriculture which produces a large sum of return flow as well as reducing industrial wastewater
- reduce trans-boundary conflicts by affecting water resources developments in trans-boundary waters

Further research is required to assess the long term and short term implications of Virtual Water 'trade' by not only considering water security at global level but also to consider its impact on regional, local and basin level water security. For example, Virtual Water 'trading policy' might leads to spatially shifting water resources problems. The rich Middle East countries are 'trading' Virtual Water by purchasing farmlands in Tanzania, Kenya, Indonesia, Malaysia, Pakistan and so forth to grow food (e.g. Breisinger et al, 2010). They import up to 85% of their domestic foodstuff. Therefore, one thing that is missing is the real impact of the Virtual Water concept in water resources planning and management; thus it is argued that this may be brought into IWRM plans.



Notes:
- **The water box shows total water available within a political boundary**
- **Blue Water = runoff + subsurface flow + Groundwater**
- **Grey Water = Recycled water+ Wastewater+ Return flow**
- **Dotted arrow indicates that Grey water is not fully available as a resource**
- **Trans-boundary Water is both exogenous and endogenous to the water box – it has a lot of bearing on Blue Water through water development and dam building policy**
- **Virtual Water has a bearing on the whole water box and is both exogenous and endogenous to the Water Box**
- **Virtual Water influence Blue Water by shifting priority from water for food to water for drinking or industry**
- **Virtual Water shifts attention to Green Water by emphasising on rainfed agriculture.**
- **Virtual Water can reduce Grey Water by shifting the attention from Blue Water use (irrigation agriculture) which produces a large sum of return flow as well as reducing industrial wastewater**

Figure 2.4: Virtual Water as exogenous and endogenous to the water box which represents total water in a system within political boundaries.

2.3.4 The role of cultural and ethical aspects:

As stated before, a central question in policy appraisal is how to take environmental ethics into account in the decision-making process. Moral (value-laden, ethical, religious) considerations have been the backbone of environmental agenda (Healy and Shaw, 1994).

Also, WWDR, (2009) has acknowledged the role of actors (politicians, civil society and business actors) in decision-making; ethics and cultural attributes of the actors play a major role in the process. In this sub-section, we consider three aspects: (1) the sustainability of land and water resources system by looking at community-based governance approach; (2) the universality of IWRM; and (3) the legitimacy issue.

Community-based governance systems. The decline and the overexploitation of common resources such as water resources, fisheries and forests due to population and urbanisation growth have prompted Hardin (1968) to posit his theory on the "*Tragedy of the Commons*". Hardin's notion of the "*Tragedy*" prompted Ostrom (2005) to assess the role of local communities in managing 'common pool resources' including water for irrigation. Scholars such as Ostrom (1990, 2005) and Imperial (1999) among others have shown empirical evidences that local community have the ability to manage common pool resources. To be effective, policies should be relevant to the communities they serve otherwise it will not be implemented. Armitage (2004) recalls the failure of a top-down approach in policy-making to control population growth and environmental degradation in West Africa which was based on national and international policy discourses on resource mobilisation mechanisms. The policy has caused the marginalization of local communities (disadvantaged resource users) least able to protect their interests and rights. Similarly, Kidane-Mariam (2003) notes that the top-down policies adopted by Ethiopia and Ghana had little impact on actual population growth and environmental degradation because of the lack of implementation strategies at local, regional and national levels. Therefore, any successful policy should take into account local knowledge systems on the use of resources (Armitage, 2004).

Local Knowledge (expert) systems stem from practical experiences and cultural and ideological heritage. Based on the above assumption, crafting community-based land and water (natural resources) management is increasingly popular (Fortmann et al, 2001). The reason is that top-down centralised interventions such as the introduction of environmental regulations, protected areas, IWRM and so forth have not completely stopped the over utilisation of these resources. Therefore, community-based participatory governance systems based on local values and belief systems are encouraged. There is a need for research that how community based governance principles can be bridged with modern day governance systems. This theme will be further explored in Chapter VIII.

*Universality of IWRM.*Biswas' (2004) questions the universal applicability of the IWRM paradigm and asks whether it is applicable under different cultures and religions. This question epitomises the IWRM dilemma: as Merrey (2008) noticed, IWRM has been promoted by its global advocates like a universal religious text. The universality question is a wrong one in my opinion. The question should be how can we localise IWRM and adapt it to diverse social-ecological systems rather than apply it like a prescriptive dogmatic doctrine.

This notion of universality hides the fact that local communities (the society) and its core values and ethics have been rather overlooked in the IWRM equation. IWRM concept is ambiguous about its foremost principle of participation which is termed "*appropriate level of participation"* (GWP, 2000; p.17). For example how the principle of economic cost recovery matters to communities which have no access the water due to lack of hydraulic infrastructure? Without hydraulic infrastructure and well developed institutional set up for distribution and allocation of water resources, it is very difficult to implement cost recovery principles; thus developing countries (the South) perhaps continue with their "*hydraulic mission*" (Allan, 2005) i.e. go ahead with development plans to build hydraulic infrastructure (e.g. Allan, 2003b, Merrey, 2008).

Water resources governance is influenced by the ideological component of the decision-makers (e.g. Denzau and North, 2000). Cultural and ethical aspects (including religious beliefs) can have a bearing on water management policies and have an impact on the way people perceive water-related issues such as the impact climate change, wasteful use of water etc. On the issue of climate change, Daniels and Endfield (2009) argue that the actions taken by the decision makers are influenced by their perception of the 'danger' of climate change. Hence, the cultural context of the climate change issue should not be ignored:

..what people make of climate change, and what they do about it, are complex cultural matters, with a matrix of narratives, specific meanings emerging in and from particular times and places; they draw attention to a continuing, if troubled, and fractious, history of human –environment relations (Daniels and Endfield , 2009; p. 222)

Therefore, lately, there has been a move towards acknowledging ideology as an influential aspect of policymaking and decision-making processes and moving away from 'rational choice approach' to common pool resources management.

Legitimacy. Most religions have the same value-laden perspectives with regard to water as the precious resource. Therefore, there is an assumption that religious ethics can assist the implementation of IWRM plans in two ways: increasing environmental awareness and improve the legitimacy of the decision-making process. Bearing in mind that policymaking is about "*a struggle over ideas*" and values, high moral grounds are used to justify political decision-making especially in the WANA region. There have been some attempts to streamline IWRM with religious beliefs[11] such as Faruqui et al (2001) whom worked on Islamic principles of water management. They have concluded that Islamic beliefs are compatible with IWRM and Sustainable Development. Beaumont (2005) believes that it certainly includes all the concepts for a sustainable management of water. In the case of Christianity for instance, Jenkins (2008) asserts that the mainstream environmental ethical discourse *overlooks "practical domains"* of Christian community which could be used *"to help reintroduce to public debate these major arenas too often left to the invisible hand and other unquestioned logics of salvation*".

In Iran, for instance, legitimacy is based on the Islamic model which can has two dimensions: the first refers to citizens' (public) support for a policy (the cultural context) and the second refers to the fulfilment of the religious criterion of public interest or '*musalaha*' as it is called in Islamic principles or '*Sharia*'. Hashemi et al (2007a) have illustrated how Islamic environmental ethics is comparable to ecological ethics. However, the Muslim world such as most of WANA region like a large part of the world, historically suffers from anthropogenic ethics in water management, despite the very explicit 'green' credential of a religious perspective on the environment. The question is why such entrenched beliefs are ignored? The answer may lie in the cultural dimension of the set of beliefs. For example, ideas such as 'basic human needs' (which is both social and religious) and 'life necessities' which is both economic and natural can override strongly-held beliefs about stewardship for nature (which is religious and ethical). This prioritisation of human basic need and its right and integrity forms part of the "meta-belief" that has to be considered. It is not enough just to dismiss the 'needs' concept, as it was not ignored by the WECD's report (1987) on Sustainable Development. Therefore, there is a need to show how common good values and ethics can be used to implement sustainable water resource management within the context of societal livelihoods.

[11] I have reviewed Islam since our case study area is Iran and WANA region which have predominately Islamic culture.

2.3.5 Institutional capacity development: dealing with participation issue

Institutional capacity development is a corner stone of IWRM. Therefore, in this part we deal with one main aspect which is stakeholder participation. Capacity building, development or enhancement is a term widely used since the 1980s (e.g. Attari and Salehzadeh, 2009) and the term capacity relates to the Sustainable Development concept. Alaerts and Kaspersma (2009) provide a review on the definition of capacity and they define it as:

the capability of a society or a community to ***identify*** *and* ***understand*** *its development issues, to* ***act*** *to address these, and to* ***learn*** *from experience and accumulate knowledge for the future" (ibid, p.7).*

Institutional capacity development can take four main forms which are not mutually exclusive (Hashemi and O'Connell, 2009):

(1) Human resources development e.g. training and education requirements, changes in ethics and perceptions, culture, morals and motivation etc. The concept of human development is defined by HDR[12] (2006) as "*first and foremost about allowing people to lead a life that they value and enabling them to realise their potential as human beings*". To achieve this goal, a visionary framework is set out in the Millennium Development Goals (MDGs). The objectives are to reduce "*extreme poverty, extending gender equality, and advancing opportunities for health and education*". So this internationally agreed set of time bound goals centres around human wellbeing.

(2) Knowledge capacity development e.g. research, stakeholder participation.

(3) Organisational capacity development which entails both financial and institutional sustainability of water management ; it includes infrastructure as well as administrative change or reform.

(4) Enabling environment capacity development which includes good governance; adequate policies and laws; enforcement and conflict resolution mechanisms.

According to IWRM concept, stakeholder participation ensures the implementation of IWRM plans within river basin context since this will increase their acceptability and ownership. There are vital roles that they can play as shown in Table 2.3 (Cap-Net, 2008). There are different levels of stakeholder involvement and decision-making powers as

[12] Human Development Report (UNDP)

shown in Figure 2.5 (Delli Perscoli, 2003) which indicates the level of decision-making powers associated with the level of involvement.

Management objectives	Roles of Stakeholders
Basin planning	Problem identification, priority setting, situation analysis, approval.
Water Allocation	Advisory, monitoring and reporting, decision making.
Pollution control	Monitoring, reporting, permitting

Table 2.3: Stakeholder roles with reference to river basin management objectives (Source: Cap-Net, 2008).

Worldwide, a mixture of participatory mechanisms has been used such as river basin councils, water user associations (WUAs), and local water and agriculture committees. The main aim of stakeholder participation has been conflict resolution. Albeit being a useful platform for dialogue, participation is bigger than conflict resolution.

With increasing complexity and the involvement different sectors and interests, decision-making has become more difficult and hence a participation platform is seen as "*decision-making body (voluntary or statuary) comprising of different stakeholders*" (Warner, 2007) which are called Multi-stakeholder Platforms (MSPs). Warner (2007) stresses that dialogue has been increasingly recommended in common pool resources such as water management based on multifaceted systems approach integrating the interaction and relations between (1) quality and quantity' (2) surface and groundwater' (3) water and land use, (4) water and stakeholders and (5) water institutions (ibid, p.2).

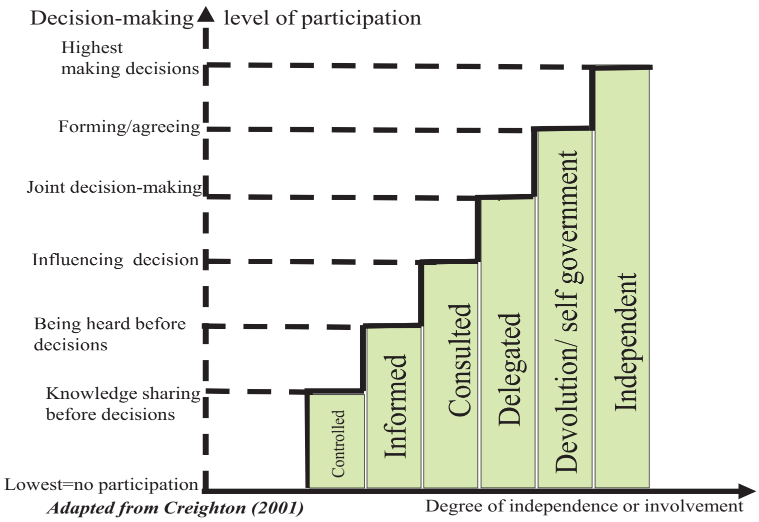


Figure 2.5: The level of participation with reference to the degree of decision-making powers (based on Delli Perscoli, 2003)

However, this holistic approach requires an unprecedented level of institutional cooperation and coordination; as well as posing a great challenge to model complex social and ecological systems settings. Furthermore, modelling integrated socio-technical aspects are going to be very difficult.

Mitchell (2007) believes that MSPs are compatible with IWRM if institutional design recognises two levels of sub-basin and basin-wide MSPs working and communicating in parallel to each other (ibid, 61). Otherwise, IWRM's strong river basin orientation can cause tensions. Participatory governance requires a special attention to the enabling environment in terms of capacity development and empowerment and the removal of legal obstacles in the way of participation. New laws might be required to facilitate the participatory approach. Participation has been linked to good governance and democracy by enhancing accountability and transparency of the decision-making and remains one of the most important issues in the water and land resources management.

2.4 Discussion and conclusions: towards a socio-technical approach

Need for a paradigm shift. Based on previous sections, water resources management is multi-dimensional (human, society and environment), multilevel (national, regional and local), multi-sectoral (energy, food, drinking etc.) and multi-disciplinary (hydrology, ecology, law etc). Implementing sustainable land and water resources management poses five main challenges:

1. How to integrate the complex and overlapping dimensions of WRS?
2. How to deal with the dynamism of the system?
3. How to measure sustainability?
4. How to deal with various levels of decision-making (institutional levels) and ethics and values held by decision-makers?
5. How to create mechanism for participatory consensus?

To deal with the above challenges, many scholars have called for a paradigm shift towards:

- Consideration of full water cycle in IWRM i.e. Green Water and Grey Water concepts should be considered in IWRM plans (e.g. Falkenmark et al (2004), Falkenmark and Rockström (2006)
- Virtual Water 'trading' (e.g. Zeiton et al 2010) can offer real alternative policy instruments to deal with water security (and scarcity)

- Inter-linkage with land use management *(e.g.* Calder, 2004, 2005; Amezaga, 2005)
- Adaptive management (e.g. Pahl-Wostl, 2007; 2009, Merrey, 2008)
- A more politicised IWRM (e.g. Allan, 2003a; Merrey, 2008)
- Mapping institutional elements beyond hydrological boundaries such as influential actors in the decision-making process (e.g. Merrey, 2008)
- Social learning processes and multi-stakeholder platforms (MSPs) for effective engagement and participation of actors in the IWRM process (e.g. Warner, 2007)
- Greater emphasis on culture and ethics (e.g. Daniels and Endfield, 2009)

There are many 'scattered' research efforts at both national and international levels. As stated, there are more than 26 UN organisations that deal with water related research which necessitates a call for an integrated international strategy for research into IWRM that can cater for the required paradigm shift and the change of boundaries of research inquiries.

Need for a methodological framework. IWRM normative package has very little to offer on implementation. Therefore, a methodological framework is needed to evaluate the implementation of IWRM. It can be concluded that the main obstacle to implementing IWRM is institutional inadequacy (e.g. WWF, 2006; WWDR, 2009). Consequently, the neglect of the institutional dimension has created a huge drawback in implementing the IWRM paradigm worldwide. Institutional matters were still the most important issue in the 2009 Istanbul World Water Forum (WWDR, 2009). Lack of implementation has been attributed to the gap between policy decisions and technical outcomes. Therefore, there has been a move from technical to socio-technical approach.

Scientific and conceptual inquiries are required to have a greater understanding of the physical process of the hydrological cycle as well as the points of interactions with ecological, social, economic and institutional dimensions of WRSs. Technological advancements have not solved many of the uncertainties in our knowledge systems (e.g. assumptions and conceptual models). We need to understand better the inherent uncertainties to better manage decision-making uncertainties.

Researchers as facilitators. In Iran and worldwide, numerous researchers are involved in a variety of IWRM research themes but their efforts are dispersed and there is lack of communications between different research groups as well as between policy makers and the research communities. A dialogue between the research communities and stakeholders is essential to create a platform for a wider dialogue among policy makers, the scientific community and the public at large. Researchers can become facilitators in difficult public policy debates and create a foundation for participatory decision-making processes (Hashemi and O'Connell, 2011b).

To achieve the objectives of the PhD research, a new integrated socio-technical methodological approach has been developed in Chapter III based on combining multiple theoretical and analytical components into a single methodological framework to attain a linkage between technical science and policymaking. By using this unique analytical approach in which technical and non-technical assessment tools are linked, an Integrated Socio-technical Assessment Framework can be attained which is described in Chapter III.

Chapter III. Integrated Socio-technical Framework: Methodologies and Analytical Components

3.1 Introduction:

Objective 2 of the PhD research (Section 1.4, p.8) aims to develop an Integrated Socio-technical Framework by linking the elements of social and technical assessments approaches to implement IWRM. With reference to governing principles described in Chapter II, five main ingredients are considered with the methodological approach:

1. The underlying conceptual approach is provided by concepts such as IWRM, Sustainable Development and Ethics.
2. The analytical components are used to deal with technical and socio-political (institutional) aspects of water resources system (WRS) sustainability.
3. Integrated Socio-technical Assessment tools are applied to provide evidences using reliable data about the WRS.
4. Role of Ethics and community belief systems are considered to (a) frame the mental models or perspectives of actors in decision-making process and (b) to provide evaluation criteria for analysis of the decision outcomes.
5. Multitier Multi-stakeholder Platforms (MSPs) are crafted for participatory decision-making.

In Chapter II, it was shown that despite conceptual constraints IWRM is still relevant for ever increasing challenges in the water sector (van der Zaag, 2005; Merrey, 2008). From the literature review, it is apparent that lack of implementation has been attributed to the fact that IWRM is a concept and not a framework. Therefore, it is postulated that there is a need to develop an integrated methodological framework for IWRM since the normative form of the concept is not implementable.

To design the methodological framework, two survey questionnaires were used with the following objectives:

1. To sketch an issues map for Iran's water sector based on perceptions of water managers, consultants and policymakers (as described in Chapter I).
2. To assess the progress made in Iran with respect to the introduction and implementation of IWRM (i.e. whether IWRM is relevant to Iran); it is

noted that IWRM has been formally adopted in 2003 and this need to be further evaluated in Chapter IV).

3. To provide guidance on choosing a suitable analytical components for the proposed Integrated Socio-technical Framework.

For achieving the objectives 1 and 2, a questionnaire was design based on European Commission (2006). Some of the results are given in Table 1.1, Chapter I. A total of 54 acceptable questionnaires were collected while rejecting incomplete ones.

Based on the literature review in Chapter II, it seems that that linkage based approaches such as Drivers-Pressures-States-Impacts-Responses (DPSIR) have been successfully implemented in many sectors since it can study environmental change and capture the relationship between the physical environment and the human system (e.g.Waheed et al, 2009). Therefore, DPSIR approach is used to evaluate changes in all the components of the water resources system (WRS)

The second questionnaire was based on Saleth and Dinar's (2004) with an exception that a section was added on how IWRM can be implemented within the water sector. The questionnaire was translated in close consultation with Dr Jalal Attari my consulting supervisor in Iran. It is a 20 page questionnaire on the performance of water sector based on Institutional Decomposition and Analysis (IDA) approach in which water institution is decomposed as: water policy; water law and water administration. The inter-linkages between different components were statistically measured. This survey produced 24 completed questionnaires from both national and provincial stakeholders providing an overall picture of water sector and acted as a validation for the choice of Institutional Analysis and Development (IAD) approach (Ostrom, 2005) as a suitable component for the proposed Framework. Saleth and Dinar's IDA approach cannot capture the role of actors in participatory decision-making. Therefore, IAD (Ostrom, 2005) was chosen for the proposed Integrated Socio-technical Framework.

In Section 3.2, first, the development of the Integrated Socio-technical Framework is described including research design and the overall description of the Framework. Secondly, the components of the Framework are outlined in Sections 3.3 to 3.6. Thirdly, data collection methods are described in Section3.7. Fourthly, the application of the Framework in the thesis is described in Section 3.8 followed by an overview of the thesis in Section 3.9.

3.2 Research design and development of the Integrated Socio-technical Framework

3.2.1 Multi-strategy research design

Innovative approach. According to Max-Neef (2005), water is one of the main "*problematiques*" i.e. "*problems of global and long term impact";* thus no single discipline can adequately deal with such multifaceted problem. Water resources planning, allocation and management can be considered as an interdisciplinary endeavour (see Max-Neef, 2005). In the past, many multidisciplinary teams have failed to produce integrative synthesis because the members " *carry out their analyses separately, as seen from the perspective of their individual disciplines, the final result being a series of reports pasted together, without any integrating synthesis" (ibid, p.6.)* Max Neef (2005) asserts that integrative inter-disciplinary approach cannot be achieved by amassing different brains; educational capacity development is needed to build a shared vision. Hence, it is argued that interdisciplinarity needs to be embraced to synchronise research in the interface of both social and physical sciences. An interface is defined as the points of interaction, interplay and linkage between technical and social (institutional) analytical components.

In social sciences, combining qualitative and quantitative research approaches are increasing popular within the same project (Robson, 2011). Robson labels this type of method as "*multi-strategy design research*" because it is not only about collecting different types of data but it also uses "*more than one research strategy" (ibid, p.161)*. However, as cited by Robson (2011) multi-strategy research has been rejected on the ground that the quantitative and quantitative paradigms are distinctly different and are not compatible with each other. The "*incompatibility thesis*" have been refuted by Howe (1988) arguing that the multi-strategy research approach is beneficial and qualitative and quantitative methods are "*inseparable*" (Robson, 2011, p.162). The author has been convinced by Howe's argument. Although, Robson (2011) describes quantitative and qualitative debate within the realm of social sciences data, this research has leapt forward a step further by using quantitative data from the physical sciences as well as the mixed strategy social research. Nevertheless, the description of multi-strategy (mixed design) research is valid to describe the interdisciplinary methodological approach taken in this thesis.

Turner (2000) highlights some of lessons learned from interdisciplinary research to synthesise and communicate policy relevant findings including (ibid, p.459):

- To deal with natural science/social science divide there is a need to "*translate across disciplines the different terminologies and methodological approaches*".
- To deal with information failure, data needs assessments for both natural and social sciences are required before the start of the research "*in order to identify data inconsistencies, limitations or real gaps*".
- *"Naive expectations across the disciplinary divide"* are understandable but we need to appreciate that the mismatches "*reflects the difference between functioning of ecological, institutional and societal systems*".

Striving to be an interdisciplinary PhD work, a "*Sequential transformative design"*(Robson, 2011, p. 165) strategy has been used to develop the Framework. The application of the *sequential transformative design* is to translate the normative form of IWRM concept into polices and strategies by assessing the outcomes of interactions of stakeholders in the participatory decision-making process using social and technical analytical components (Figure 3.1).

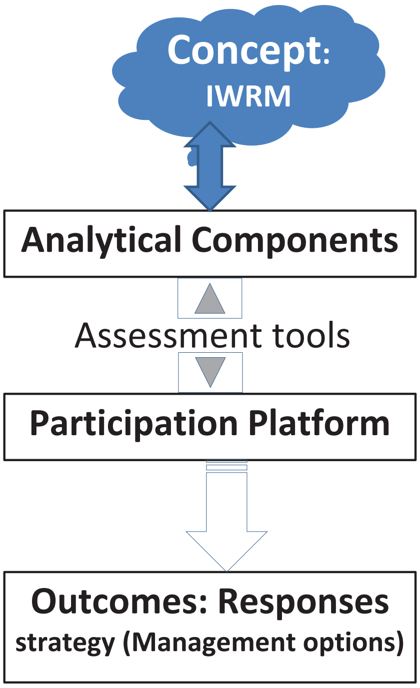


Figure 3.1: Sequential transformative design: conceptual research approach for translating or transforming the IWRM concept into implementable management options using the theoretical Integrated Socio-Technical Assessment Framework.

This research is guided by a theoretical perspective which manifests the Integrated Socio-technical Framework. The Framework represents a major innovation in this thesis by complementarily combining socio-technical, ethical and socio-political (institutional) analytical and assessment components to assess the sustainability of the WRS.

Meaning of Framework. Before explaining the new Framework, we need (1) to understand the meaning of the 'framework' and differentiate it from theory and model (see e.g. Clement, 2008); and (2) to appreciate the implications (and advantages) of combining different analytical components to form the single Integrated Socio-Technical Framework.

As explained by Clement (2008) "*A framework identifies structures and links the relevant variables or elements that affect the issue in concern, but does not make any predictions*" (ibid, p. 33). By comparison, a theory "*makes specific assumptions on the linkages between variables and outcomes*" and a model provides outcomes based on assumptions made in the theory and available data (inputs).

Some might criticise this approach of combining different analytical components into a single framework to be "*an internally contradictory and messy approach, with a limited explanatory capacity*" (Clement, 2008, p.40). However, we need to appreciate that these components are non-mutually exclusive and there are interfaces between them; hence they can be conceptually linked to each other as can be seen in the following sections in which the components of the Framework are described.

Definitions of stakeholders, actors and participants. Stakeholders are defined as any individuals or organisations that influence or are influenced by decisions made about water resources system. Actors are individuals or organisations which are involved in making decisions on water resources planning, allocation and consumption. Participants are actors that are either directly involved in policy/decision-making and consultation processes through the formation of a participation mechanism such as Multi-stakeholder Platforms (MSPs) or participate in the process of social research i.e. surveys, interviews and questionnaires

Flexible research design. Two approaches to flexible research design have been considered (Robson, 2011):

1. The case study approach which is a well-established research strategy "*where the focus is on the case*" and usually involves "*multiple methods of data collection*". Our case is the water resources system in Lake Urmia but we also look into wider characteristics of WRS in Iran since decisions about the WRS are centralised.

2. An ethnographic study approach which focuses on the cultural, ethical and social structure of stakeholders and communities within the WRS. It enriches the case study approach by having a better understanding of discourses and narratives that shape stakeholders perspectives. The author has had multiple positions in addition to being a researcher and has built up a close relationship with many of the stakeholders in the field. The author has acted as
    a. ***a facilitator and actor*** in Multi-Stakeholder Platforms such as workshops, seminars, stakeholder and working group meetings**;**
    b. ***an advisor*** to national and international agencies working on the Lake Urmia case study;
    c. ***a researcher*** as a PhD candidate at the School of Civil Engineering and Geosciences, Newcastle University which is partially funded by the Ministry of Energy, Iran (the main stakeholder); and
    d. ***an actor in producing policy briefs*** for west Asia and North Africa (WANA) region through the initiative of WANA Forum based on the research results.
3. Therefore, the case study entailed a large element of 'real world (applied) research comprising linking valuation research and participatory action research (Robson, 2011, p.189). The purpose of action research is "*to influence or change some aspect of whatever is the focus of the research*" (ibid, p.188). In the context of this PhD work, the real world research is concerned with (a) involvement, improvement and broadened understanding of the water allocation decision-making process; (b) evaluating the outcome of the decisions using analytical components; and(c) studying change where there is concern for actions.

Scientific attitude and ethics of research. Robson (2011) stresses that real world enquiry requires a scientific attitude with three ingredients (ibid, p.14): (1) a systematic approach is taken to develop a sound methodology with ability to observe, evaluate and scrutinise the issues of concern; (b) enquiries are carried out in a sceptical manner; and (3) the research ethics are maintained. According to Robson (2011), a scientific ethical attitude to research adheres to a code of conduct which "*ensures that the interests and concerns of those taking part in, or possibly affected by, the research are safeguarded*". In this research, the University's *Code of Conduct* has been maintained in dealing with other individuals and organisations. Permissions have been taken for the material used in the thesis and in no way have I misled or disadvantaged anybody to obtain information. In fact, I have been warmly received to engage in almost all of the meetings with formal invitations. I have had gain stakeholders' trust and respect through ethical conduct inside and outside the field.

I have had an influential role as an independent facilitator during water allocation negotiations and this was accepted by all the stakeholders involved with little reservations. I have been transparent in all my dealings as a facilitator about my discursive position to foster a win-win IWRM discourse which is the subject of my thesis.

Robson (2011) notes that close engagement with stakeholders stimulate some researchers to cross the boundary and change the role "*to that of advocate*". Acknowledging this difficult task, on the one hand, I have preserved the independence of this research from any influences from the stakeholders. On the other hand, my PhD research programme and statement of interest have been acknowledged and well known to stakeholders while co-facilitating workshops, working groups, seminars; conducting interviews or collecting questionnaires and other qualitative and quantitative data.

Discursive position of analysis. IWRM encompasses both the principles of Sustainable Development and ethical decision-making concepts and provide the context to deal with issues of integration and sustainability aspects of WRS by using systems analysis approach as described in Chapter II. IWRM will be carried through the thesis by providing the objectives (social, economic, environmental) which feed into the analytical components of the proposed Integrated Socio-technical Framework.

3.2.2 Describing the Framework

The Integrated Socio-technical Framework which combines **FOUR** core analytical components (Figure 3.2) is a non-predictive representation of structures and links between different variables and components that influence the water resources planning and allocation system in Iran and the Lake Urmia case study. There is a continuous iterative time-based loop in the overall framework:

1. First, the Drivers-Pressures-States-Impacts-Responses (DPSIR) component which is a causal framework is used to provide an understanding of the changes that occurred to the various components of the water resources system by *"describing the interactions between society and the*

environment" (EEA, 2011). Based on a systems analysis approach, the socio-economic, political and climatic Drivers exert Pressures on the WRS which leads to changes in the social, economic and environmental States of the WRS. After a strategic assessment of the changes (States), the Impacts of policies on water resources systems are assessed and the evolution of previous Responses in time t-1 are described. In this thesis, DPSIR is used to make a strategic multilevel evaluation of the IWRM concept in Iran and the Lake Urmia basin (LUB), thus providing a structured overview of water resources management in contemporary Iran, (Chapter IV) and LUB (Chapter V) for the period of 1909-2008. The IWRM concept provides objectives which feed in at both the Drivers and Responses levels.

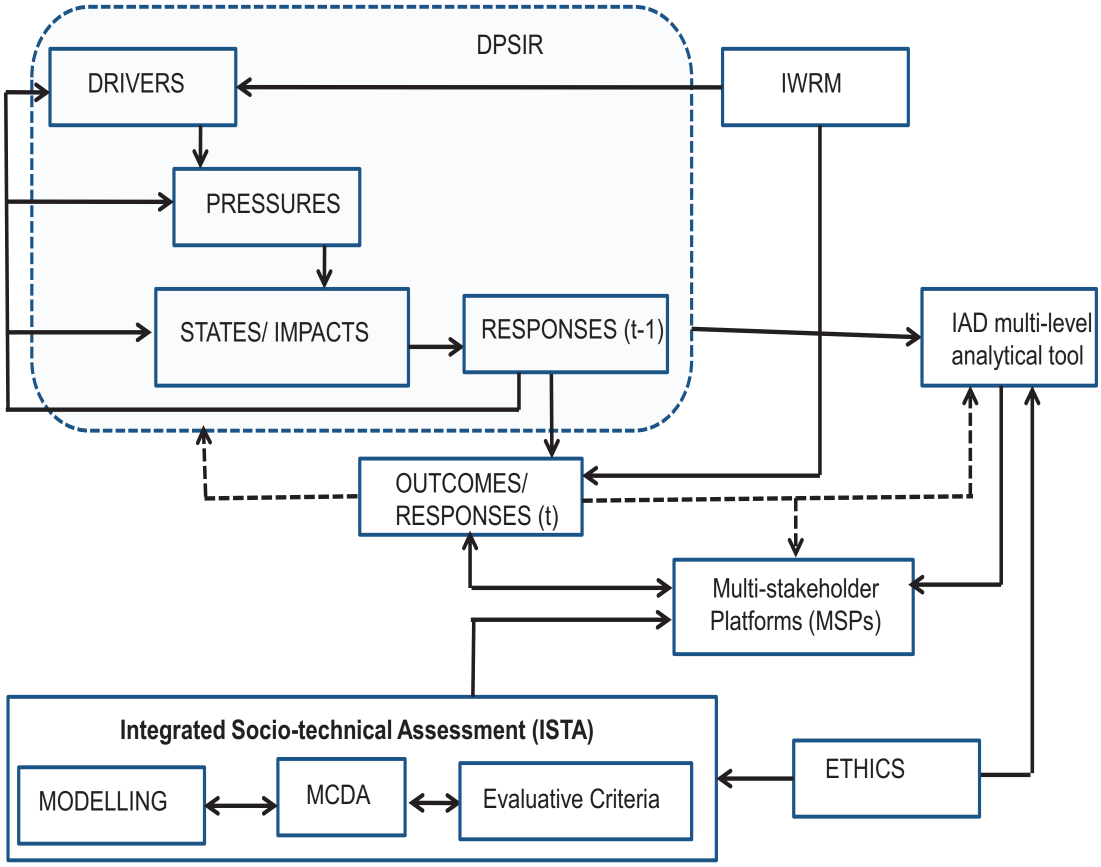
2. The Institutional Analysis and Development (IAD) component is used to make an ex post analysis of Responses:
    a. First, ex post analysis of Responses in time t-1is carried out which represents a Business as Usual (BAU) scenario. In Chapter V, the water allocation process during 1909-2008 has been analysed in the context of the case study.
    b. Secondly, in Chapter VI, (a) DPSIR Analysis is extended for period 2008-2010 to describe the new Drivers and Responses based on IWRM and (b) water allocation is made using Integrated Socio-technical Assessment (ISTA) component (describe in bullet number 3). Then, in Chapter VII, IAD is used to evaluate the new Responses (i.e.in time t) which have been made by actors (stakeholders) to deal with the Pressures on the water environment to propose revised Responses (e.g. institutional design or reform or an adaptive allocation strategy that factors in an environmental allocation).
3. As mentioned, Integrated Socio-technical Assessment (ISTA) component (Chapter VI) describes how actors in MSPs use information or data to make their decisions based on a scientific integrated assessment approach using modelling and Multi-Criteria Decision Analysis (MCDA) to reach a decision on water allocation. The overall ISTA is used to evaluate the Responses made by the actors e.g. water allocated to the lake (Chapter VI) and propose revised (preferred) Responses as part of the PhD work (Chapter VII). It also

evaluates the quality of the evidence (data and information) used in the decision-making process (Chapter VI and VI). ISTA comprises of three elements:

   a. MCDA used by actors and represents
      i. the simple water allocation model (WAM) using an Excel Spreadsheet (Chapter VI);
      ii. the Analytical Hierarchy Process (AHP) procedure used to allocate water shares (Chapter VI)
   b. Modelling
      i. by stakeholders using Vensim Dynamic simulation (Chapter VI) and
      ii. as part of the thesis using water balance modelling, stochastic modelling and risk based analysis (Chapter VI)
   c. Evaluative Criteria for measuring institutional sustainability which are based on Good Governance principles and the Ethics component of the Framework (Chapters, V, VI and VII)

4. The Ethics component:
   a. represents perspectives (or mental models) of actors which have been shaped by values and cultural aspects of the community; and have a bearing on the decision-making by influencing the exogenous factors affecting the IAD component and providing a basis for Evaluative Criteria used to reach outcomes (Chapters V, VI, VII)
   b. is further developed based on community values (predominantly Islamic) to propose revised Responses to enhance the water and land resources governance system (Chapter VIII).

In Sections 3.3 -3.6, the components of the Framework will be described.



Acrynoms:

t	time;
DPSIR	Drivers-Pressures- States-Impacts-Responses;
IAD	Institutional Analysis and Development;
IWRM	Integrated Water Resources Management

Figure 3.2: The Integrated Socio-technical Framework.

3.3 DPSIR component

The definitions of the D-P-S-I-R elements are given in Box 3.1 (e.g. EEA, 1998, 1999; Turner et al, 1998). DPSIR is linkage-based sustainability assessment approach (e.g. Guio-Torres, 2006; Waheed et al, 2009) which provides a strategic evaluation of the status of the water resources system by describing the causal relationship between various interacting subsystems. As stated in Chapter II, linkage-based sustainability assessment approach have been widely used in general and in particular since it was adopted by many international and regional organisations such as the European Environment Agency (EEA) for "*structuring integrated research program and assessment*" (Svarstad et al, 2008) i.e. as a method for the State of the Environment (SoE) reporting. Turner et al (1998) demonstrated its usefulness in assessing the marine and coastal environments by considering the feedbacks between the human system and the coastal and marine system using a function based valuation methodology. Many researchers have used DPSIR as a framework for sustainability indicators in many environmental assessments (e.g. Walmsley, 2002; Agyemang et al, 2007; Borja et al, 2006).

Box 3.1: DPSIR: definitions (based on e.g. EEA, 1998, 1999; Turner et al 1998)

D, the Drivers: root causes on a macro level described through scenarios representing alternative futures (e.g. climate change and variability, socio-economic etc.)

P, The Pressures (threats) variables: immediate causes (e.g. water demands, water pollutions)

S, The States: describing physical and measurable characteristics and social livelihood systems (e.g. water availability)

I, The Impacts: monitor the long term impacts of change defined as changes in states resulting from pressures (e.g. environmental degradation)

R, The Responses: are problem-solving policies, actions or investments; an appropriate mix of *Structural Options* e.g. new reservoirs/pipelines etc. and *Non-Structural Options* e.g. legislation, institutional reform, demand management etc.

EEA (1999) acknowledges that DPSIR (Figure 3.3) is a simplification of a complex and dynamic system but nevertheless, it deals with dynamism by focusing on the "*links*" between DPSIR elements; e.g. EEA (1999) states that:

the relationship between the Impacts on humans or eco-systems and the 'S' depends on the carrying capacities and thresholds for these systems. Whether society 'Responds' to impacts depends on how these impacts are perceived and evaluated; and the results of 'R' on the 'D' depends on the effectiveness of the Response (ibid, p.7)

Therefore, DPSIR is increasingly used since it can easily capture the relationship between human and non-human impacts on the environments. In addition, the DPSIR appraoch has been successfully implemented in developing integrated modelling systems or decision support systems (DSSs) such as the WaterStrategyMan (WSM) DSS (ProGea, 2004), MULINO DSS (Giupponi et al, 2004).

EEA (2003) asserts that DPSIR, while providing "*good way of structuring thoughts on indicators, has its limitations in terms of interpretation*". However, we have to appreciate that the DPSIR approach is based on discursive biases and it is not a tool for producing impartial evidence as argued by Svarstad et al (2008). The reason is that the application of DPSIR will bring out discursive positions based on the discourse implied in the application. As stated previously, in this research, the IWRM discourse is used based on a win-win discursive position which has some implications for how the DPSIR elements are interpreted.

The main criticism centres on the causality aspects of DPSIR and the linearity and simplicity of the cause-effect relationship of its components (e.g. Kohsaka, 2010; Rounsevell et al, 2010). However, Rounsevell et al (2010) asserts that the notion of linearity is confused with "*sequential thinkin*g". They conclude that DPSIR takes into account the non -liner behaviour of Social-Ecological Systems (SESs) and the complex interdependences of the variables by allowing for positive and negative feedback Responses which is explicit in the schema.

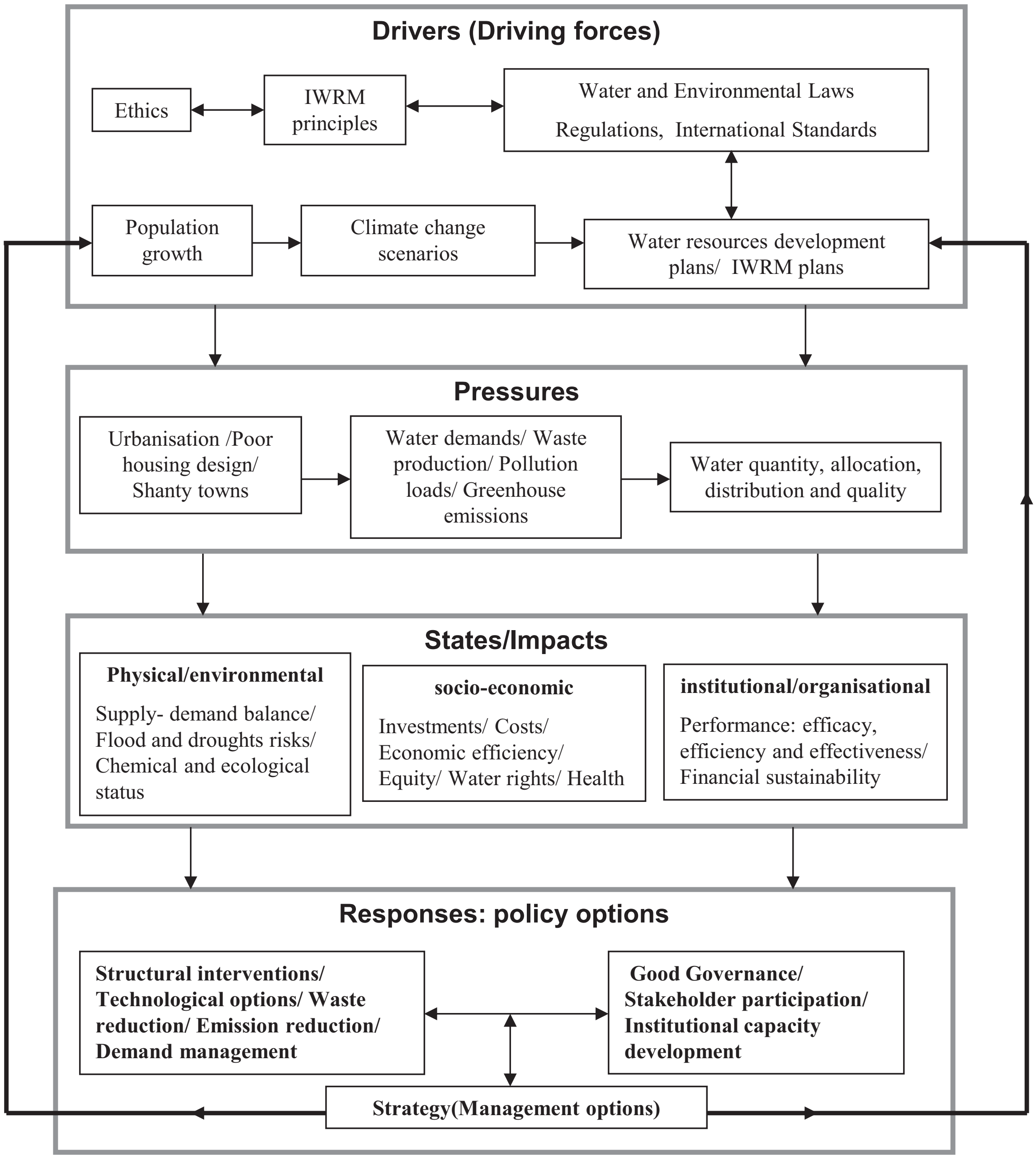


Figure 3.3: The DPSIR component with reference to the water resources system.

DPSIR and its modified versions have been widely adopted in many policy relevant environmental assessments because of its communication power (Niemeijer and de Groot, 2008). The DPSIR approach provides applicable management options for policy and decision-makers by bridging socio-economic and natural sciences (Karageorgis et al, 2005).

In this research, DPSIR analysis has been enhanced by combining it with institutional analysis and development (IAD) component within the socio-political and ethical context of policy and decision-making process interactions. Turner et al (1998) have acknowledged that the DPSIR analytical approach "*should also be extended to cover ethical analysis of inter temporal and inter species choice*" i.e. analysis should consider "*community, social norms and collective preferences*" (ibid, p.271). Also, the DPSIR component is linked to technical assessment tools such as modelling systems for evaluating States (e.g. water availability), Impacts and Responses and is a powerful tool to study the development and evolution of policies and institutions (i.e. institutional change) in conjunction with the IAD component. Therefore, it is a robust and rigorous approach to assess the socio-technical attributes of Social-Ecological Systems (SESs).

3.4 IAD component

3.4.1 An overview

Definition of institution. Ostrom (1999, 2005) broadly defines institutions as the principles that humans use to organise all form of repetitive and structured interactions including those within communities, private associations and governments at all scales (ibid, p.3). More specifically institutions are rule sets that direct/constrain actions at multiple levels. Each level comprises of situations where choices are made and actions are taken in an action arena influenced by a set of exogenous external variables: (1) biophysical conditions; (2) community attributes; and (3) rules in use (see next sections).

Levels of decision-making. The IAD approach is based on rational choice theory[1] and has been described in detail by Ostrom (1999, 2005, 2007; 2010 and 2011). It proposes four levels of analysis as shown in Figure 3.4 (Ostrom, 1999): meta-constitutional, constitutional, collective choice and operational levels; at each level, rules are prescribed, invoked, monitored, applied and enforced which affect how rules are made at the next

[1] Ostrom's Institutional Rational Choice conceives public policies as institutional arrangements or rules so policy changes result from action by rational actors in an action arena (see Schlager and Blomquist, 1996) but this thesis moves away from rational choice theory as will be described later.

level[2]. The operational level deals with rules that govern how decisions on water and land resources management are taken in terms of provision, production, distribution, appropriation, assignment and consumption of the resource. Frequently only three levels are used.

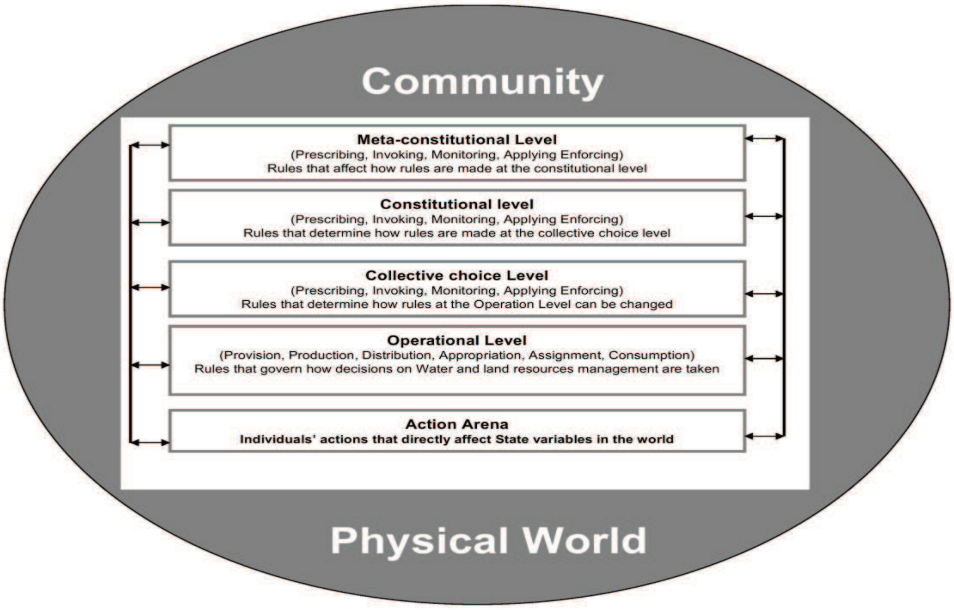


Figure 3.4: Institutional (decision-making) levels in IAD component, adapted from Ostrom (1999).

The IAD approach is a powerful analytical tool to capture institutional (decision-making) levels which do not necessarily correspond to administrative levels. For example, local communities can establish their own rules which can operate at collective choice or even the constitutional levels (see e.g. Clement, 2008). Therefore, it is not a rigid framework and can be used in a variety of situations depending on the actors and action situations. As noted by Clement (2009) among others, IAD has been extensively developed for common pool resources and is one of the most tested and distinguished approaches. It has also been applied to an extent to water resources problems e.g. Imperial (2009); Smajgl et al (2009); Ostrom (2010); Larson (2006), Maru and LaFlamme (2008). In this research, the IAD approach has been used primarily to assess the extent of central government's (national level) recognition of local level basin governance i.e. water allocation decisions by Lake Urmia basin stakeholders.

[2] In most case studies, three levels are taken excluding meta-constitutional level of analysis.

3.4.2 Conceptual unit of institutional analysis

Focal level of institutional analysis. The aim of the IAD approach is to analyse situations of human interaction (Ostrom, 2010). Therefore, the focal point of analysis is the concept of an action situation affected by exogenous factors within an action arena as shown in Figure 3.5.

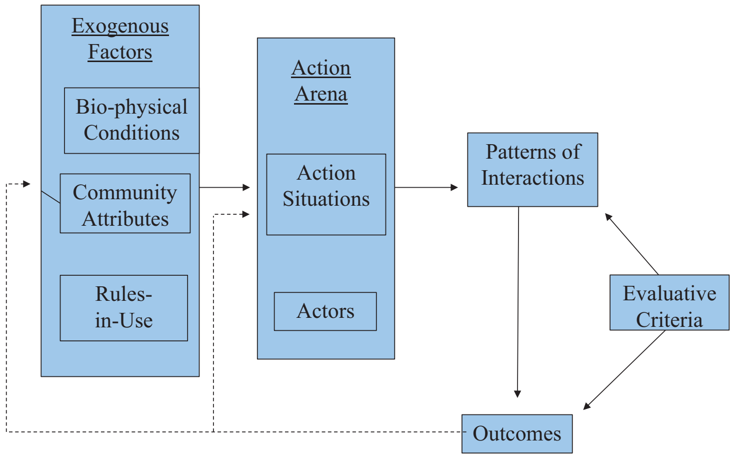


Figure 3.5: Action situation and action arena as focal level of institutional analysis (Ostrom, 2005; p15).

Ostrom (2005, 2011) describes the IAD approach as a cluster of variables or holons defined as "*nested subsystems of whole units in complex adaptive systems"* (Ostrom, 2005). The water resources system can be analysed by '*unpacking*'the cluster of variables (holons) depending on action situations. The action arena[3] is a conceptual unit of institutional analysis. This can be as small as a household and as large as a continent. The key to the IAD approach is identification of an action situation to focus the analysis on(Ostrom, 2011). Examples of action situations for the land and water resources system in the Lake Urmia basin is given in Table 3.1.

Decision-making analysis levels	Example of action situations
Operational	provincial water allocation, sectoral water allocation decisions, land use decisions (irrigation area); water charges; developmental plans
Collective choice	The design of rules governing water allocation; design and implementation of water resources polices and WR development projects
Constitutional choice level	The selection of actors in collective choice level who will implement and enforce water allocation policies with their ToR; definition of water rights; rules governing collective choice decisions

Table 3.1: Examples of water resources system action situations in Iran and Lake Urmia case study

[3]Ostrom (2011) acknowledges that many have confused the difference between action arena and action situation and so the term 'action arena' has been removed in her latest paper.

The internal structure of an action situation can be described and analysed using ***seven*** sets of variables (Figure 3.6): the set of **actors (participants)**(1) are assigned to the **positions**(2) which is assigned to sets of allowable **actions**(3) and functions to achieve the **potential outcomes**(4) as a result of the degree of **control**(5) exhibited by the actor and based on the available **information(6)** about actions, outcomes and their linkages (i.e. evidence) and the **Costs and benefits**(7) assigned to actions and outcomes (used as an incentive measure)**.**

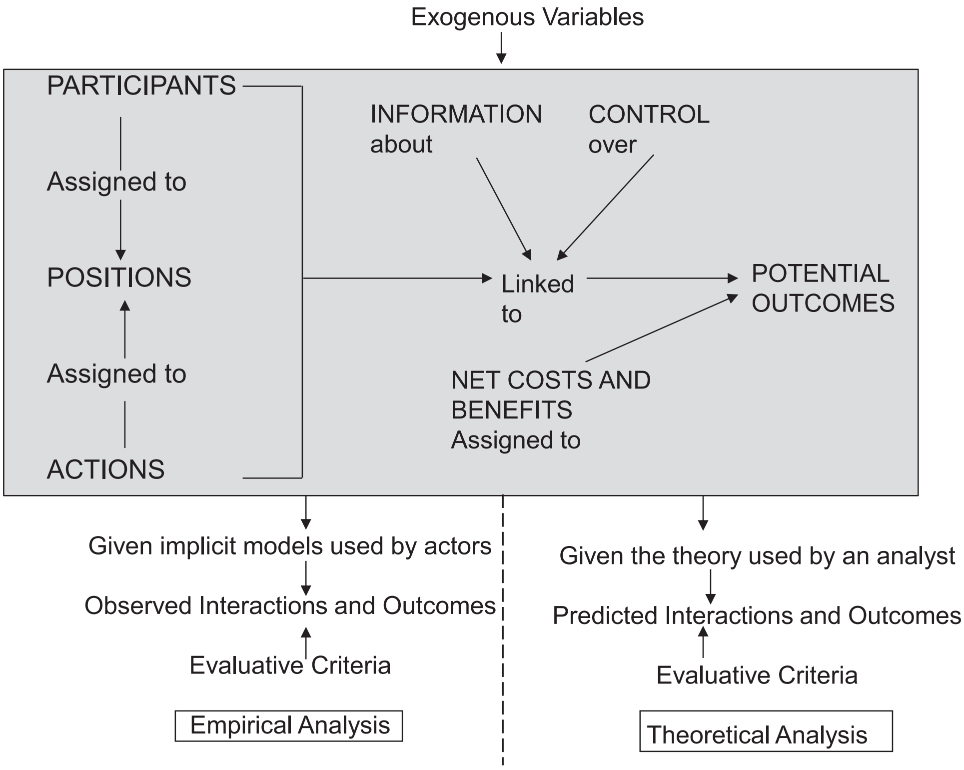


Figure 3.6: The internal structure of an action situation (Source: Ostrom, 2005).

The actors (participants or stakeholders) in an action situation can be an individual, a group of individuals such as a community or an organisation (institution). There are four characteristics of the actors that have to be considered by the analyst (Ostrom, 2011):

- The belief and value systems they use to evaluate the outcomes ;
- the resources at their disposal to make the decisions
- the level of information they possess and their ability to process the information
- the way they are going to choose a strategy (a selection of management options) based on their "*mental heuristics* (Clement, 2008)"

3.4.3 Biophysical and material conditions

Ostrom (2005) explains the attributes of the biophysical variables in terms of how the attributes of the biophysical world affect what actions are physically possible and what effect a set of rules in use[4]will have on the ***resource use*** based on available types of goods (resources) (ibid, p.22). V. Ostrom and E. Ostrom (1977) identify four types of goods: Toll, private, public and common pool. Ostrom (2005) uses two criteria to assess the biophysical conditions which are: subtractability of use and difficulty to exclude other users. This typology of resource use is based on common pool resources (CPR) literature and was influenced by Hardin's notion of "*Tragedy of the Commons*" (1968). CPRs are both less difficult to exclude others and have a high subtractability of use[5] (Schagler, 2007).

Based on the current legislations, the land and water property regime in Iran does not fit the classification made by V. Ostrom and E. Ostrom. Ostrom considers natural resources systems in the broadest sense to be CPRs. However, in Iran the State (government) owns certain types of CPR which are named as public state property goods. Iranian legislation implicitly acknowledges private ownership of groundwater from private wells but tries to restrict their use or even charge a price for their use. Therefore, the property regime in not well defined in the water legislations in Iran. But, in general, water is considered as a common property.

3.4.4 Community attributes: role of belief systems

Actors or participants can be individuals or representative of organisations which display a degree of aggregate behaviour i.e. they follow organisations' strategy and interest. A community is an array of actors e.g. users, decision-makers, researchers, stakeholders etc. Due to heterogeneity of the social fabric of the community, there is going to be a varying degree of common understanding about the action situation. In this analysis, the attributes of the community are articulated by analysing the mental models (perspectives) of the actors which represent the community in question. There are some examples which can be considered:

- level of trust between different provinces and national and regional levels

[4]Ostrom distinguishes between rules in use which can be formal or informal and rules in form which have not been enforced despite being formal rules.

[5] For limited water resources, subtractability means that if someone uses a unit of resource it will not be available for others (e.g. Schagler, 2007); for instance, if an upstream user is withdrawing water from a river stream, then the water is not available for downstream users.

- level of homogeneity in the preferences and priorities of the regions in terms of water resources planning and allocation compared to the national priorities
- the allocation of basic assets among the regions
- the dominant economic models in the regions
- the influence of the political system on the decision-making

3.4.5 Linking rules in use to action situations

Ostrom (2005) has based her 'rules' concept on Black's (1962) understanding of the word 'rule' to denote the meaning of rule in terms of (ibid, p.17):

- regulations which are effectively legislations made by constitutional and judicial lawmakers;
- strategies i.e. instruction rules adopted by participants as plan of actions
- norms which are ethical codes of practice; and
- principles which describes a law used in everyday language.

Rules can be formal or informal. Informal rules are rules practiced with regard to an action situation and include customary rules as well unauthorised rules in use such as informal and unauthorised abstraction rules for water resources. In this analysis, we concentrate on legislative and policy (normative) rules.

In the IAD approach, rules are linked to the action situations (Ostrom, 2005, 2011). As described earlier, an action situation has seven components and so it is reasonable for these components to be governed by seven types of rules as shown in Figure 3.7 (Ostrom and Crawford, 2005):

1. Boundary rules control who can leave or enter the positions;
2. Position rules denote a set of positions and how many actors hold each one;
3. Choice rules regulate which actions are bestowed upon an actor in a position;
4. Information rules refer to how information is communicated across or among actors and what can be shared or kept from the actors;
5. Scope rules affect the outcomes;
6. Aggregation rules specify how a decision-making process is made e.g. whether a decision is based on consensus or majority rule etc.
7. Payoff rules regulates how benefits and costs are distributed in the community of actors

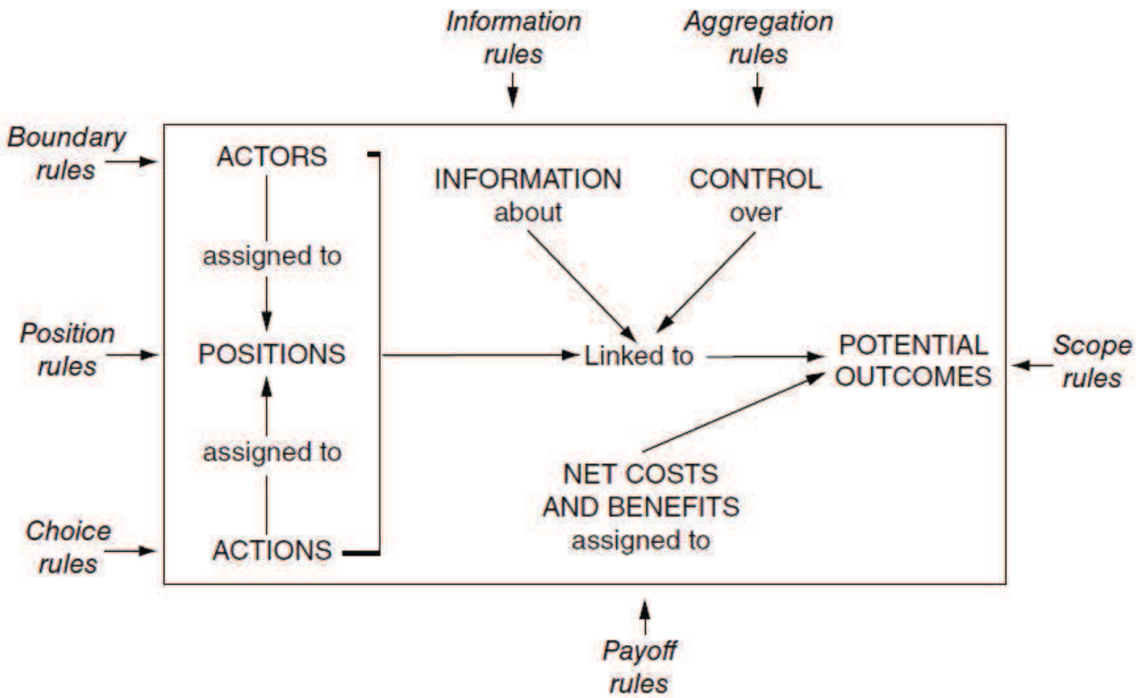


Figure 3.7: Conceptualisation of rules linked to components of an action situation. (Source: Ostrom, 2005, 2011).

3.5 Integrated Socio-Technical Assessment for sustainable water allocation

The ISTA component has three main parts:

1. Modelling and MCDA elements are used by the stakeholders in making water allocation decisions which will be described in Chapter VI.
2. Water balance and stochastic rainfall modelling and risk-based assessment tools are used to assess the decisions made in (1). The ISTA component complements IAD analysis: Larson (2006) criticises the IAD approach for being evaluations (ex-post) rather than assessments (ex-ante). Nevertheless, the ISTA component can provide risk-based ex-ante assessment for future climate and water abstractions scenarios using stochastic modelling for proposal on revised Responses i.e. adaptive water allocation governance.
3. Evaluative Criteria used to assess the institutional sustainability of the water allocation process and stakeholder participation arrangements in Chapters V (pre- participatory water allocation) and VII (Post-participatory water allocation).

The methodological approaches of part (1) will be briefly described in this section However; more elaboration about (1) and a full description of (2) are given in Chapter VI, Section 6.4. This is because parts (1) and (2) are based on the stakeholder consultation and participation process and without introducing and describing the contextual setting of the case study, it is inappropriate to describe the methodology. Part (3) is described in this section.

3.5.1 Modelling and Multi-criteria Decision Analysis (MCDA) for water resources allocation

A generalised schema of the participatory water allocation process cycle is shown in Figure 3.8.

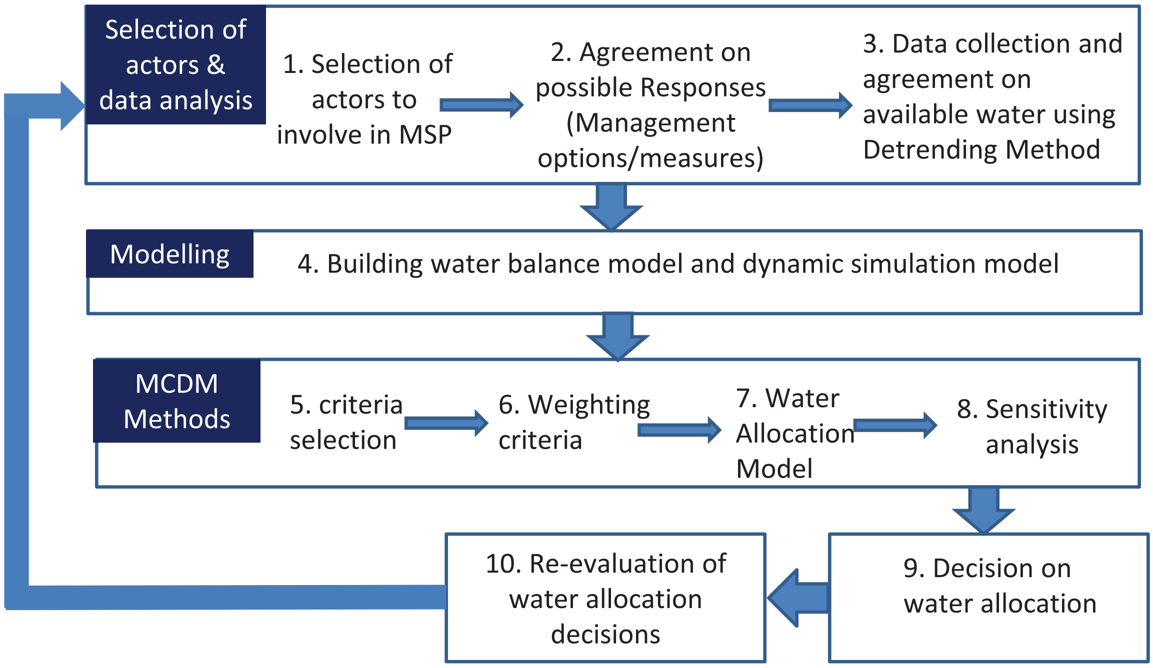


Figure 3.8: Water allocation cycle based on the ISTA component.

Water allocation in Iran is based on a legal requirement pertaining to the use of modelling and assessment tools. It can be seen that the ISTA component of the Framework has a profound role in the decision-making process but the role of MCDA and modelling is limited to stages 4-8 as shown in the cycle. Usually, the actual decision is made by actors at a higher level in the multitier MSPs (see e.g. Buchholz et al, 2009).

Expectations from MCDA. MCDA methods have been used in many resource sectors including water and environment (e.g. Hajkowicz and Higgins, 2008), forestry and land management (e.g. Ananda and Herath, 2009) energy (e.g. Pohekar and Ramachandran, 2004) and so forth. Figueira et al (2005) edited a book in which 70 MCDA software packages have been reviewed by Weistroffer et al (2005). Drawing from an extensive reviews by many researchers (e.g. Hayashi, 2000; Pohekar and Ramachandran, 2004; Roy, 2005; Hajkowicz and Higgins, 2008; Ananda and Herath, 2009), it can be seen that MCDA methods have a great deal of theoretical limitations and conceptual constraints in sustainability assessments. However, Munda (2005) believes that the MCDA approach can deal adequately with "*sustainability conflicts at both micro and macro levels of analysis*".

Problems of participation. Sustainable Development (and of course IWRM), call for far greater public participation in policy issues. The scientific community are no longer dealing with only decision-makers but they have a far reaching responsibility towards the society (Munda, 2005). This dominant paradigm of participation puts a formidable challenge to the scientists involved in the MCDA process as they are ethically accountable to critically scrutinise inputs by the actors (Munda, 2005). Therefore, the power relationship between different actors in the multi-criteria participation process is crucial. There are powerful actors who might try to influence the decision-making process. Thus, participatory MCDA is not just a scientific endeavour but it is also a social learning process (see Chapter II). Therefore, knowledge of actors and their values and judgements are necessary to ensure the scientific credibility of the process. Munda (2005) concludes that other social research methods such as institutional analysis can be used to map "*social actors*" to avoid pitfalls in decision-making. We also have to acknowledge that focus groups and MSPs are not fully representative of all the stakeholders. Nevertheless, they provide a platform to make "better'' and more accountable and transparent decisions fostering democratic reconstruction of the society.

Since the 1960s, the subject of Multi-criteria Decision Analysis (MCDA) has been producing a phenomenal number of theories and applications (Roy, 2005) but there are no clear guidelines of how to choose a particular method. Therefore, some practitioners may use methods based on their expertise and judgments. However, "*Both analysts and stakeholders need to be informed about the underlying assumptions of the tools used* (Gasparatos, et al, 2008)".To choose a method, we need to understand the factors influencing the outcomes of an MCDA application. Munda (2005) provides some "*good practice*" guideline on factors affecting the result of MCDA exercise; these are (1) quality of the information available; (2) information about why indicators are chosen by the actors and whose interests are taken into account i.e. transparency; (3) direction of each indicator (i.e. positive or negative influence); (4) weights of the indicators which reflect their importance; and (5) ranking method used.

In the case study, MCDA has been used; the methodological approach for MCDA method chosen by the actors will be outlined in Chapter VI, Section 6.3. ExpertChoice software (Saaty, 2005) which is based on the analytical hierarchy process (AHP) procedure has been used as part of the MCDA.

3.5.2 Modelling

With increasing pressure on limited water resources due to population growth and greater demand, there is a need for modelling approach to simulate future demand and assess the impact of water resources development plans on the available resource in terms of quantity and quality. Modelling systems have been recognised to help with the decision-making process and their use is now an integral part of planning and management of water resources. From an extensive literature review in Chapter II, it can be concluded that modelling systems are indispensible tools in modern water resources planning and management. As described in Chapter II, there is no doubt that the modelling approach has contributed greatly to the advancement of the planning and management of water resources. The main aim of a modelling system is to provide information or 'evidence' for a sound decision using the available data and technologies.

Generally, there are two kinds of modelling approach: simulation and optimisation which are often used conjunctively as described in Chapter II. Wurbs (1997) listed a number of generalized water resources simulation models in seven categories: watershed, river hydraulics, river and reservoir water quality, reservoir/river system operation groundwater, water distribution system hydraulics and demand forecasting models. Increasingly, sophisticated hydrological models became integrated into the water resources field. Many multi-reservoir modelling systems have been reviewed by Labadie (2004).

In Iran, there is an explicit requirement to use system dynamic simulation modelling in the water allocation process as shown in Figure 3.8. Vensim is a "*visual modelling tool that allows you to conceptualise, document, simulate, analyse, and optimize models of dynamic systems …..*" and "*provides a simple and flexible way of building simulation models from causal loop or stock and flow diagrams* (Ventana Systems, 2007). Thus, the modelling component consists of

- VENSIM system dynamic software (Ventana Systems, 2007)
- a water balance model of Lake Urmia in Excel Spreadsheet
- the Expert Choice software which is AHP/MCDA software as water allocation model (Saaty, 2005).

The methodology will be fully described in Chapter VI, Section 6.3.

3.5.3 Evaluative Criteria: institutional sustainability

General criteria. Evaluative criteria are used to assess the performance of the water resources planning and allocation governance and hence it is a vital part of the ISTA component. The choice of these criteria depends on the requirement of the analyst and hence they are flexible. Ostrom (2005) provides a set of general criteria including

- economic efficiency,
- equity,
- adaptability,
- resilience and robustness,
- accountability,
- conformance to general morality, and
- the need for trade-offs. Ostrom (2005 p.67) asserts that trade-offs are "*often necessary in using performance criteria as a basis for selecting from alternative institutional arrangements*"

The base assumption is that any change in institutional arrangements will influence these criteria i.e. a new or revised institutional arrangements can increase (or decrease) these criteria (Clement, 2008).

Design Principles. Ostrom (2005) describes in detail eight design principles and asserts that they are not blueprints (ibid, p.257) but they characterise "*long-enduring institutions for governing sustainable resources*" and are a measure of their robustness and ability to "*adapt and learn so as to be robust to the many social, economic and ecological disturbances that occur over time*". Cox et al (2009) analysed over 100 studies and confirmed the validity of the design principles and have made some adjustments which have been adopted by Ostrom (2011). A brief description of the design principles are as follows (Cox et al, 2009; Ostrom (2005, 2011):

1. *Clearly Defined and Locally Understood Boundaries:*
    a. User boundaries separating legitimate users from non-users
    b. Resource boundaries separating specific resources from larger SESs
2. *Proportional Equivalence between Benefits and Costs*:
    a. *Congruence with Local Conditions*: Appropriation and provision rules are congruent with local social and environmental conditions

   b. *Appropriation and Provision*: Appropriation rules are congruent with provision rules; the distribution of costs is proportional to the distribution of benefits.
3. Collective Choice arrangements (or decision level rules): local people should be able to participate in modifying the rules
4. *Monitoring* is done by accountable and independent monitors at two level*:*
   a. the allocations and provisions levels of users and
   b. the biophysical condition of the resource.
5. *Graduated Sanctions*: unauthorised uses (i.e. those who break the rules) are likely to face graduated sanctions.
6. *Conflict Resolution Mechanisms*: conflicts have to be timely resolved at local arena using affordable methods.
7. *Minimal Recognition of Rights*: the government should lift restrictions on local users to make their own rules.
8. *Nested Enterprises*: planning, allocations, provisions, monitoring, enforcements, conflict resolutions are organised by multi-layered nested enterprises.

3.6 Ethics component: framing the issues in the decision-making process

As stated in Chapter II, there has been a call to embrace Ethics in water resources management and therefore, this is an integral part of the Integrated Socio-Technical Framework. In this research, the Ethics component has three functions:

- Ethics is part of the community attributes and constitute the actors' belief systems which factor in cultural, ideological and religious values. The mental models are shaped into perspectives based on perception of actors about the reality and the exogenous factors such as discourses and narratives behind the discourses. The cultural context of ethics relates to the environment in which decision-making takes place.
- Ethical principles can be used as a basis for Evaluative Criteria in the ISTA component (as described earlier).
- In a case study approach, the role of predominantly Islamic Ethics is considered to revive the concept of traditional community-based land and water governance in the West Asia and North Africa (WANA) region and

the way to present revised Responses for Lake the Urmia Case study. A new Ethical framework developed in Chapter VIII provides a proposal for good governance of land and water resources.

In the following sub-sections, the remaining functional elements of the Ethics component are described.

3.6.1 Perceptions vs. perspectives

Perceptions have been studied as part of psychology in terms of cognitive and attitudinal aspects. Perception is the conviction of actors about reality and truth. For example, our perception of climate change risk has three main components:

1. emotional (feelings): e.g. our fears about future uncertainty over climate change
2. attitudes (action and behaviour): e.g. our attitudes towards climate change adaptation measures; and
3. cognitive (intellectual and mental): e.g. our belief about what is happening in reality.

Perspectives are an informal representation of actors' emotions, attitudes and cognitive understanding about the truth i.e. the mental models of actors showing some sort of belief that might be "primitive" (Oppenheimer, 2006). Oppenheimer states that belief is *"the mental state or function of cognising reality…* [Quoting from James, 1890] *a sort of feeling more allied to the emotions than to anything else. The true opposites of belief, psychologically considered, are doubt and inquiry, not disbelief*

Oppenheimer (2006) notes that previous "primitive beliefs" are transformed into advanced and developed beliefs because of our inquiry and subsequent understanding that "*become dominant in human functioning, rather than to completely replace previous primitive beliefs*''. Mankind exhibits residual perceptions and can have deep rooted beliefs affected by value and cultural dimensions.

In this research, perspectives are mental models of actors involved in the decision-making process; they have an important role and can have inputs into both analytical and conceptual components of the Integrated Socio-technical Framework by measuring cultural and ethical influences on policy-making decisions. Therefore, perspectives are considered as part of evidence or input information within the Framework.

3.6.2 Add-on (optional) application of Ethics component: bridging the gap between tradition and modern day land and water governance system

As part of Objective 6 of the research outlined in Chapter I, Chapter VIII aims to assess the role of the Islamic belief system in attaining good governance for the land and water resources system by developing an Ethical legal framework.

As demonstrated, the role of belief systems in decision-making is very important. Religion is considered to be part of a meta-belief (e.g. Hall, 2008). Most religions have the same value-laden perspectives with regard to water and land. Researchers such as Faruqi et al (2001) and Jenkins (2008) have attempted to use religious environmental ethics as a basis for IWRM and Sustainable Development. In Chapter II, lack of good governance was highlighted as one of the major stumbling blocks in implementing the IWRM paradigm. Therefore, the assumption is that participation at community level can provide a basis for good governance: community participation ensures sustainable use of the resources and an ethical and cultural component for the legal framework will provide the required sustainability perspective. This off course depends on how the the community places a value on allocating water to the environment, particularly if water is scarce due to Pressures. In this thesis we will not make an analysis of the proposed Ethical legal framework. Therefore, this hypothesis must be tested in future research.

Environmental degradation as a result of unsustainable water use in the farming and agriculture sector and, in a wider context, the depletion of land and water resources have led many to re-consider policy options in Response to the Pressures driven by socio-political and climatic Drivers. The rationale for the optional Ethical legal framework is based on four assumptions: (1) stopping over-exploitation of natural resources cannot be achieved without the involvement of local communities and consideration for their cultural and belief systems; (2) there is an explicit relationship and strong inter-linkage between land and water management bearing in mind water governance traditionally has been subordinate of land rights (Wilkinson, 1990); (3) traditional practices, knowledge systems and institutions can offer an interface and platform for establishing a community based approach to natural resources management for sustainable use and (4) Islamic ethics and legal theory can provide a coherent set of principles for community-based natural resources governance in the WANA region.

It has to be emphasised that this dissertation is not debating or promoting any religious theological discourse i.e. it is not a theological thesis, but like any other ethical discourses, the potential of Islamic environmental ethics is demonstrated in contemporary land and water management.

Chapter VIII is an attempt to bridge the gap between tradition and modern day governance of land and water resources. It uses the concept of *Hima* to develop an Ethical legal framework. *Hima* is defined as a Community-based Natural Resources[6] Management, (CBNRM) system based on community ethics which are predominately Islamic. The applicability of the Ethical legal framework in the context of the Iranian case study will not be assessed but is taken as a proposal for further research. The Work has also contributed to formulate a policy brief on *Hima* governance system for WANA Forum which was founded in 2009 for an initial period of 5 years with the aim of becoming a platform for new regional thinking based on shared values and common good (Figure 3.9). The Forum maintains that it is apolitical, non-partisan and an independent platform for dialogue. The dialogue centres on the formation of a regional perspective on water and land resources governance; a policy brief contribution has also been provided on super-national (inter-State) governance mechanisms for cooperation to deal with water scarcity in the region (WANA,2011). The proposed legal framework is used as a basis for a Global *Hima* Initiative which is at proposal stage. The platform to carry forward the work is provided by WANA Forum and some other partners.

[6] Natural resources imply both land and water resources.

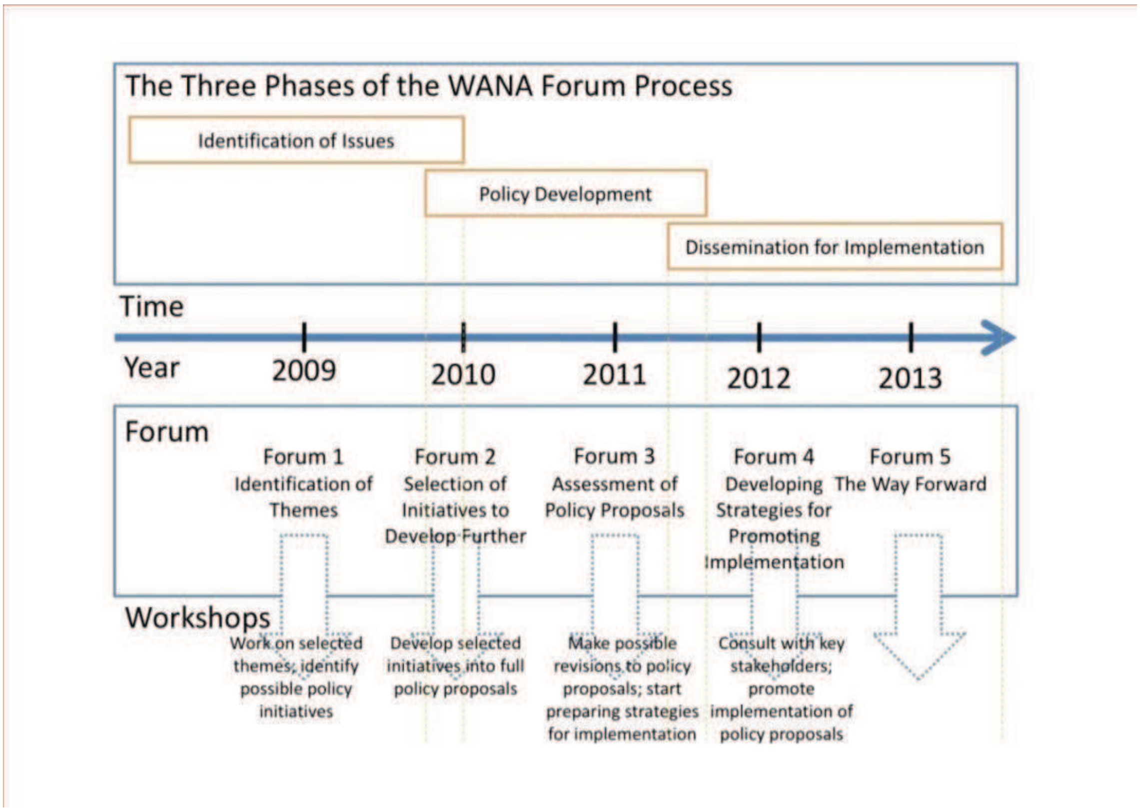


Figure 3.9: Timeline of the WANA Forum Process (Source: www.wanaforum.org)

3.7 Data collection methods

3.7.1 The methods

The term 'data' is used with different contexts in the social and physical sciences and hence we must appreciate the controversy of using the term 'data' in defining data in the context of the thesis. In physical sciences, data is considered to be quantitative (numerical) which can be raw (i.e. direct measurements), experimental (i.e. outputs of an experiment), simulated (i.e. outputs of models) or processed (i.e. analysed). Aerial photographs, satellite images and maps are also considered as spatial data in remote sensing and geographical information system (GIS) and modelling applications. The word information and data is sometime used in a confused manner. However, information is considered to be a higher level of data abstraction. For example data about rainfall trend will inform us about climatic veracity. Once the information is verified by our mental patterns it becomes knowledge which is the highest level of abstraction.

In social sciences, there is a controversy about what kind of data is used depending on philosophical and ideological schools. As described earlier, social sciences use two types of research methods: quantitative and qualitative (e.g. Robson, 2011); thus broadly speaking, we can have quantitative and qualitative data. We have to appreciate that the quantitative data in social sciences is used in a different context compared to the physical sciences. In social sciences, quantitative data is the basis for scientific facts according to quantitative research paradigm which is closely related to positivism. So, quantitative data is used to understand a social phenomenon using statistical tools to establish causal relationship between variables under study; thus social quantitative data is defined as statistical quantitative data in this research.

To implement the multidisciplinary objectives outlined in Chapter I which has elements of both social and physical sciences, the context for data collection encompasses a broader definition to be able to understand the physical subsystem of the water resources system as well as the policymaking processes within the institutional and socio-economic subsystems (referring to Figure 2.1, Chapter II). Thus, multiple methods are required to collect data based on both social and physical sciences to accommodate the data needs of the thesis. The thesis uses elements of qualitative and quantitative data within the realm of real world research (e.g. Robson, 2011) and quantitative data as well as information or knowledge in the context of physical sciences. Therefore, some element of social quantitative data is used in addition to predominately physical data which represent the baseline data.

Various data collection techniques have been used including (Robson, 2011):

1. Quantitative data comprises of
    a. quantitative physical data which is defined as baseline data from various sources including:
        i. Internet-based databases including national and international agencies online databases such as FAO, the World Bank, World Water Council, UNDP, different Iranian Ministries including Energy, Environment, State and Agriculture and so forth;
        ii. Data from desktop study using electronic journals and databases provided by Newcastle University Library
        iii. Secondary data is defined as data which is collected and compiled by different research; consulting and departmental organisations. For Lake Urmia case study, secondary data consists of more than 6000 pages of project reports which

have been reviewed by the author to produce a synthesis report for the Water and Agriculture Working Group (WAWG). The document was adopted by the stakeholders as the basis for decision-making. It is referenced as Hashemi (2008) in the thesis.

iv. Lake Urmia case study baseline data was mainly obtained through a participation process. There was a mismatch between national databases of Ministry of Energy (MoE) and Ministry of Agricultural Jihad (MoAJ) and their provincial representatives (Regional Water Companies, RWC, and Agricultural Jihad Organisations, AJOs). In general, there was a level of mistrust. This has created some confusion and frustration for both sides. Also, there is a low level of information exchange between provinces and between different departments within a province. No field measurements or reconstructions of the data were made. Stakeholders provided baseline data during Working Group meetings. This has ensured data ownership and acceptance and reduced some uncertainty. However, there have been some question marks on the quality of the data; therefore it went through a verification process during the meetings. The baseline data is referenced as MoE (2010b).

b. Statistical quantitative data based on survey questionnaires.

2. Qualitative surveys using non-probability purposive sampling[7] (ibid, 275): many interviews and 78 fully completed questionnaires were obtained using:

   a. Formal (structured) and informal (unstructured) interviews of water sector experts during 2008-2011 during meetings with stakeholders; a large number of meetings have been held which involved discussion about the case study. Notes were taken during these meeting with the prior knowledge of the participants.

[7] Robson (2011, p. 275) states that "*the principle of selection in purposive sampling is the researchers judgment as to typicality or interest*". The reason this approach was chosen is that the author had unprecedented access to key stakeholders and so, data collected from these stakeholders is very authentic and relevant to participatory decision-making.

   b. Forums: one forum was arranged with agricultural experts in 2008.
   c. Capacity development training workshops: Three events were organised by the author; these were held for governmental departments.
   d. Policy proposal workshops: the author has gained a better understanding of water scarcity issues on a regional scale by sharing preliminary results with experts and policymakers in the WANA Forum network. The author attended several workshops held by the WANA Forum in Amman, Jordan (twice) and Istanbul, Turkey.
3. Secondary data analysis including
   a. Content analysis of documents: Media (newspapers) and internet resources about major governmental organisations have been monitored to understand the underlining perspectives held by policy-makers and decision-makers. References are provided when directly used in the thesis.
4. Observation methods: the author has been an observer in many meetings:
   a. Working Group meetings: some 50 hours of video and audio tapes were recorded with prior knowledge to observe the participants (actors and stakeholders) in the decision-making process providing perspectives, narratives, and discourses associated with the action situation; and
   b. Informative missions during field work: meetings with experts and managers of the key national (Tehran-based) and provincial departmental ministries and organisations. Evidence from this category has been assigned to the respected organisation e.g. Ministry of Energy; thus the persons who provided the evidence are not mentioned by name as this is not culturally seen appropriate to personalise public issues . As an advisor and facilitator, the persons gave the evidence to the author to position themselves in the negotiations and hence they intended to be used and quoted.
   c. Consultation workshops organised as stakeholder meetings
   d. Drought Risk Management workshop involving almost all the major 60 stakeholders from national and provincial organisations.

Details of the data collection sources and fieldwork are given in Appendix A1.

3.7.2 Non-English language References, names and terms in Chapter VIII

Many original works by early, medieval[8] and late Islamic scholars (7th to 19th century) on various Islamic sciences have been used in Chapter VIII; however, either recent reprints or new references by contemporary writers have been used based on these original works in three languages: Arabic, English and Persian. Preference has been given to works either translated or written in English. The references which are not in English have been indicated in the references sections. No particular guideline has been used in translating Arabic or Persian names for the references that did not appear in English at all. The simplest form of translation has been used based only on the primary English alphabets. Islamic terminologies are shown in *italic*. Some of the terms have entered the English dictionary and are widely used. The translations of some of the foreign language works are the author's own work. The prefix 'Al' in Arabic is commonly used for names e.g. Al-Karaji (1966). In the References Section, this prefix has been ignored in listing the references; thus Al-Karaji is listed under letter 'k' authors.

3.8 Application of the Framework: modifying DPSIR-IAD components

3.8.1 Introduction

The adopted research design moves away from multidisciplinarity to interdisciplinarity by working in the interface of physical and social sciences. The Framework uses the DPSIR component as a platform for socio-technical analysis. The Outcomes of the DPSIR strategic assessment i.e. the Responses are then analysed using the IAD and ISTA components.

IAD component is the engine or the 'motherboard' which provides the linkages or points of interaction for different components of the Framework including the individual D-P-S-I-R components. IAD provides the focal level for the analysis. To elaborate further, the original conceptualisation of the IAD focal level analysis developed by Ostrom (2005) is modified to become a focal level of integrated socio-technical analysis. Using Ostrom's terminology, we need to "*unpack*" the IAD within the Framework i.e. how different components are linked to provide a robust assessment and evaluation of water allocation

[8] The term medieval might have a negative connotation; with regards to Islamic science and philosophy; the medieval period was a golden age for Islamic thinking.

decision outcomes. We will return to this theme later. First, the IAD component itself has to be modified to incorporate power issues.

3.8.2 Politicising IWRM through politicising IAD

Both IWRM and IAD approaches had been criticised for inadequate handling of power issues[9] and political interests within the institutional design or "*Crafting of institutions*" (Clement, 2009). Our point of entry is the notion of politicising the IAD approach which is postulated by Clement (2009). As part of a PhD research project based at Newcastle University, she added discourses (and narratives) and socio-political context to the list of the exogenous factors in Figure 3.5.

The rational choice theory does not recognise the role of ideas (values, beliefs) in the policy analysis and instead focuses on "*the behaviour of intendedly rational individuals motivated by material self-interest*" (Sabatier, 1999; p.8). Power-centred approaches (such as political ecology and decentralisation studies) will provide some useful insight into the question of power within an institutional and social contexture. But as Clement (2009) noted, power-centred approaches have lacked a rigorous conceptual framework and hence it is argued that institutional analysis or IAD should be used as the core institutional analytical tool in the Integrated Socio-technical Framework but reconciled with the discourses and narratives (or stories) behind the discourses that shape actors' beliefs and mental models. Therefore, a power-based discourse analysis will be used within a political and economic context at three levels: local/basin, provincial (regional) and national levels

In addition to the contextual use of discourses in the institutional analysis, societal values and culture are taken into consideration by incorporating the Ethics component to provide perspectives or mental models of actors shaped by the discourses. Ethics, which form parts of the community attributes, are usually overlooked in the analysis. We will explore this theme further in Chapter VIII.

3.8.3 Incorporating socio-political variables

Discourses, narratives (stories) and arguments (i.e. linguistic parameters) have been central to policy analysis and they emphasise the need for participatory decision-making involving all the three main domains: citizens (or civil society), analysts (e.g. researchers) and decision-makers (actors). Discourses, narratives and arguments play an important role

[9] The 'Integration' (I) and the 'Management' (M) including water allocation aspects of IWRM are essentially part of a political process. Therefore, attributes of politics has to be considered in the implementation approach.

in public policy debates on environmental and natural resources issues (Hajer and Versteeg, 2005; Clement, 2008; Roe, 1994).

In terms of IWRM, a water policy can be defined as a well-developed political perspective with three elements: (i) a political statement of vision; (ii) goals and objectives which will govern (iii) the implementation plans. This definition is adopted bearing in mind various definitions have been put forward for public policy. Fischer (2003) noted that defining public policy is not as straightforward as expected. According to Fischer (2003), since Laswell founded the field of policy science in the 1950s, there has been a shift from "technocratic orientation" towards recognising ideas and beliefs in policy analysis in the 1980s onwards[10]. Fisher asserts that the technocratic form "*geared more to managerial practices than to the facilitation of democratic government* (ibid, p.4)". This brand of science was based on Positivist Empiricism which separated facts and values. In the process, decision-making is based on rationality. This empirical approach has neglected the socio-political variables. Fischer notes that there has been appreciation of the importance of the social context including normative story-telling (narratives) about policy problems (ibid, p.12).

Discourse is defined as "*an ensemble of ideas, concepts and categories through which meaning is given to social and physical phenomena, and which is produced and reproduced through an identifiable set of practices* (Hajer and Versteeg, 2005).

Discourse is defined according to two schools:[11]Foucaultian[12] and Habermasian[13]. The latter refers to the communicative rationality of the discourse with a goal "*to supply communication model of action*" (Fischer, 2003). According to Fischer, Foucault focuses on the functionality of discourse within historical context i.e. how people has been shaped by discourses rather than how people construct the reality through discourses (ibid, p. 37). In the analysis, we consider discourses in the Foucaultian sense (Chapters IV-VII).

There are two essential elements to the discursive policy approach: language and power. The knowledge embedded in discourses is "*transformed into discursive formations*

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[10] This is a reference to the point that is made by e.g. Fischer (2003) that self-interest models cannot explain major social and political changes or understand religious and ideological worldviews held by political leaders; in fact it is established from a body of research work that social and demographic characteristics and ideological orientations provided a better explanation. (ibid, p.26)

[11] The philosophical arguments about the two schools are beyond this dissertation; what we are interested in is the way discourse is defined.

[12] After French philosopher Paul-Michel Foucault (1926-1984) which discussed discourses within the context of power structures and hence its link to critical theorists.

[13] After the German philosopher and sociologist Jürgen Habermas (1929-)

(that is) disciplines such as science, law and so forth" (ibid, p. 38). As Hajer and Versteeg (2005) stated, discourse analysis can be regarded to be part of the social constructionists' tradition in the social sciences (ibid, p.176) which asserts that multiple "*socially constructed*" realities can exist and we can gain knowledge about the real world through inductive methods. Clement (2008) asserts that discourse analysis is not in contradiction with institutional analysis (see Section 3.4):

Indeed it is in accordance with sociological institutionalism arguments that discover conferring power to institutions by reinforcing or undermining their credibility. In return, institutions influence discourses as the latter depend on the institutional practices in which they are embedded (ibid; p.38)

Narratives behind discourses. Policy narratives are stories, scenarios and arguments on which policies are based (e.g. Roe, 1994). Stories commonly used in describing and analysing policy issues are a force in themselves and must be considered explicitly in assessing policy issues. In this approach, our use of "narratives" is limited as will be explained later.

Narrative Policy Analysis (NPA) has come about because of the limited capacity of conventional methods to deal with highly complex and polarised issues as well as financial and time constraints. Roe (1994), who proposed the NPA approach, notes that policies resist change or modification even in the presence of "*contradicting empirical data*". This is because they continue to override and stabilise the assumptions for decision making in the face of high uncertainty (which is different from risk or ignorance), complexity (which is about issues' internal intricacy or their interdependence with other policy issues) and polarization (i.e. concentration of groups around extremes in the issue). There is a lack of knowledge about what really matters in terms of complexity and polarization. In other words, many policy issues have become so **uncertain**, **complex** and **polarised** that their empirical, political, legal and administrative merits are unknown and not agreed upon. Therefore, the only thing left is to examine and analyse different stories which policy makers and their critics use to articulate arguments and make sense of the three elements of a policy issue.

The NPA procedure proposed by Roe (1994), which is a dynamic and powerful tool in assessing very complex and uncertain situations, can help us to understand loops in the narratives or stories told by the participants e.g. it will help us to unblock the deadlock over the controversial reallocation of water resources. The procedure is outlined in Figure 3.10.

In this research, Roe's (1994) concept is only used to provide a structured approach to establish the problems or "*Problem Statements*" (PSs) and their causal relationship and thus demonstrating how uncertain or how complex the issues are (Chapter VII) and to see how an alternative narrative policy is formed (i.e. steps 1-2 of Figure 3.10):

- The dominant narratives behind discourses are obtained
- Alternatives policy narratives or counter-stories are established.

This will enable us to understand better how arguments are articulated within a participatory decision-making process.

3.8.4 Integrating synthesis

Unlike multidisciplinary research, the thesis aims to achieve interdisciplinarity by producing an "*integrating synthesis*" (Max-Neef, 2005) of the assessments. Therefore, we have to overcome language barriers between physical and social sciences. It is not desirable to omit well-established terminologies used by different component but it is reasonable that they can be conceptualised as to be complementary to each other. For example, socio-political context which is considered as part of the exogenous factors in the modified IAD component is extended to be the basis of DPSIR analysis using discourse analysis tool to broaden our understanding of the water resources governance in Iran and Lake Urmia case study. Hence we need to redefine the focal (conceptual) point of analysis which is larger in scope to visualise how different components of the Framework interface with each other. Therefore, the original conceptual focal point for institutional analysis is broadened as described in the next sub-section.

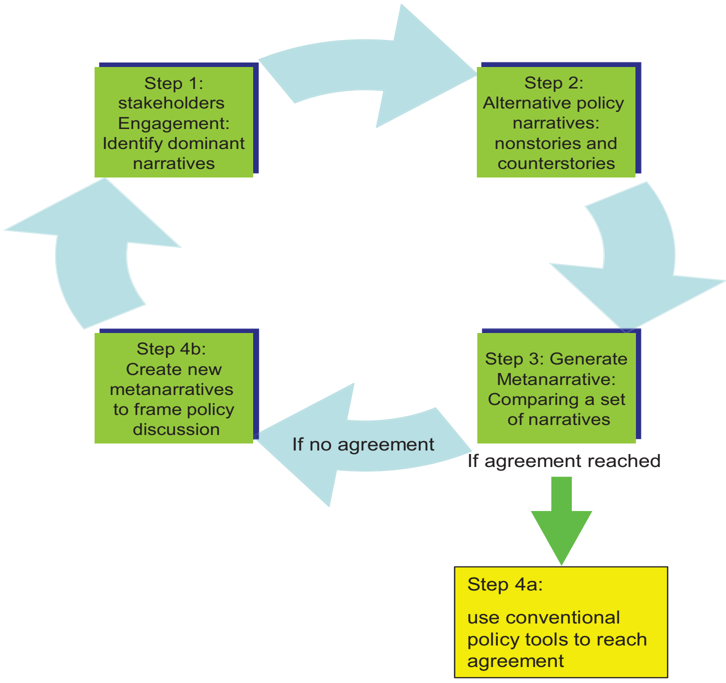


Figure 3.10: Narrative Policy Analysis (NPA) procedure (Adapted from Roe, 1994).

3.8.5 Contextual setting: a conceptual unit of analysis

The integrated synthesis of the assessments is presented within a contextual setting which is our conceptual unit of analysis describing the attributes of the water resources system that are relatively unchanged including:

- The geopolitical characteristics of the action arena
- Actors (as described earlier)
- Community attributes (as described earlier)
- Socio-economic conditions
- Biophysical, and materials conditions as an element of the IAD component (Figure 3.5) are enhanced to include not only institutional attributes but also ecological, hydrological and hydraulic attributes of the water resources system which will be discussed in the next sub-section.

In this study, three action arenas were considered.

- In Chapter IV, a geographic setting (i.e. Iran) was considered to describe the national water resources planning and management process.

- In Chapter V, a multi-tier action arena is considered: national level and provincial level organisations (actors) involved in the water allocation process. This represents the business as usual (BAU) process i.e. the sectoral water management and allocation action situation.
- In Chapter VI and VII, Lake Urmia basin is the geographic action arena but a new institutional set up has been designed to facilitate stakeholder participation. Multitier Multi-stakeholder Platforms (MSPs) have been in place. The platforms were designed through stakeholder consultation; although the author attended most of the workshops, but was not directly involved in the institutional design.

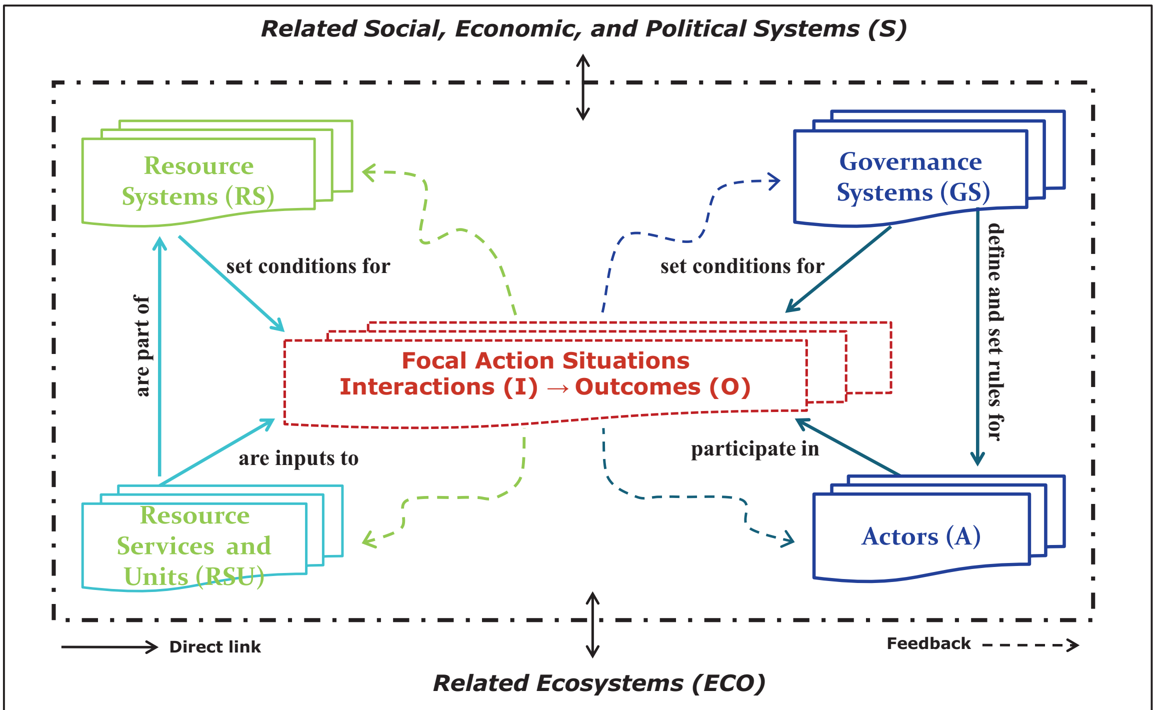
There are three types of MSP models (Verhallen et al, 2007): (1) a scientific rational model comprised of experts using socio-technical assessment tools to come with the "*one best way solution*" using distributive negotiations and lobbying techniques; (2) A communicative social learning model guided by values in an open access adaptive process using integrative negotiations and skilled discussions and arguments; and (3) a mixed-mode model comprised of invited major stakeholders who are guided by both values and scientific facts to present a consensus on a coherent set of better solutions using an integrated methodological approach. The crafted multi-tier MSP used in the case study is mainly based on a modified scientific rational model by choosing experts from invited or selected national and local actors.

3.8.6 Overcoming language barrier: re-defining biophysical conditions

As stated before, the linguistic barriers have to be appreciated in combining technical and social components. Perhaps one of the obstacles in using IAD in water resources assessment is the problem in understanding the socio-political language used in the IAD literature. Ostrom (2007) has omitted the use of the term 'action situation' in her attempt to elaborate the role of ecological variables in an action situation by describing how Interaction-Outcomes pathway is affected in Social-Ecological Systems (SESs). In her latest writings, Ostrom (2011) has recognised that action situations are affected not only by institutional (social science) variables such as rules in use but by an array of socio-technical variables relating to the ecological system that have not been unpacked.

Using a taxonomical approach, Ostrom and her colleagues are developing the SES framework i.e. it is evolving. Ostrom (2011) describes the SES framework with reference to Figure 3.11 as follows:

...one can think of Actors interacting in Action Situations generating Interactions and Outcomes [i.e. Responses]that are affected by and affect a Resource System, Resource Units, Governance System, which then affect and are affected by Social, Economic, and Political Settings and Related Ecosystems (ibid, p.22)



Revised SES Framework with Multiple First-Tier Components (Source Ostrom, 2011)

Figure 3.11: Action situations embedded in broader Social-Ecological Systems (SESs) (*Source*: Ostrom, 2011).

Basurto and Ostrom (2009) and Ostrom (2009, 2011) have identified several variables in the four holons within the action situation: Resource System, Resource Units, Resource Governance and Actors as shown in Figure. 3.11 which represents the "*highest tier of variables*" (which exists in all the SESs) which "*can be unpacked multiple times when one is trying to analyse specific questions related to SESs in the field"* (Ostrom, 2007). The second tier variables are given in Figure 3.12.

Social, Economic, and Political Settings (S)
S1- Economic development. S2- Demographic trends. S3- Political stability.
S4- Government resource policies. S5- Market incentives. S6- Media organization.

Resource Systems (RS)

RS1- Sector (e.g., water, forests, pasture, fish)
RS2- Clarity of system boundaries
RS3- Size of resource system
RS4- Human-constructed facilities
RS5- Productivity of system
RS6- Equilibrium properties
RS7- Predictability of system dynamics
RS8- Storage characteristics
RS9- Location

Governance Systems (GS)

GS1- Government organizations
GS2- Nongovernment organizations
GS3- Network structure
GS4- Property-rights systems
GS5- Operational rules
GS6- Collective-choice rules
GS7- Constitutional rules
GS8- Monitoring and sanctioning rules

Resource Services and Units (RSU)

RU1- Resource unit mobility
RU2- Growth or replacement rate
RU3- Interaction among resource units
RU4- Economic value
RU5- Number of units
RU6- Distinctive characteristics
RU7- Spatial and temporal distribution

Actors (A)

A1- Number of actors
A2- Socioeconomic attributes of actors
A3- History of use
A4- Location
A5- Leadership/entrepreneurship
A6- Norms (trust-reciprocity)/social capital
A7- Knowledge of SES/mental models
A8- Importance of resource (dependence)
A9- Technology used

Action Situations: Interactions (I) → Outcomes (O)

I1- Harvesting levels
I2- Information sharing
I3- Deliberation processes
I4- Conflicts
I5- Investment activities
I6- Lobbying activities
I7- Self-organizing activities
I8- Networking activities
I9- Monitoring activities

O1- Social performance measures (e.g., efficiency, equity, accountability, sustainability)
O2- Ecological performance measures (e.g., overharvested, resilience, biodiversity, sustainability)
O3- Externalities to other SESs

Related Ecosystems (ECO)
ECO1- Climate patterns. ECO2- Pollution patterns. ECO3- Flows into and out of focal SES.

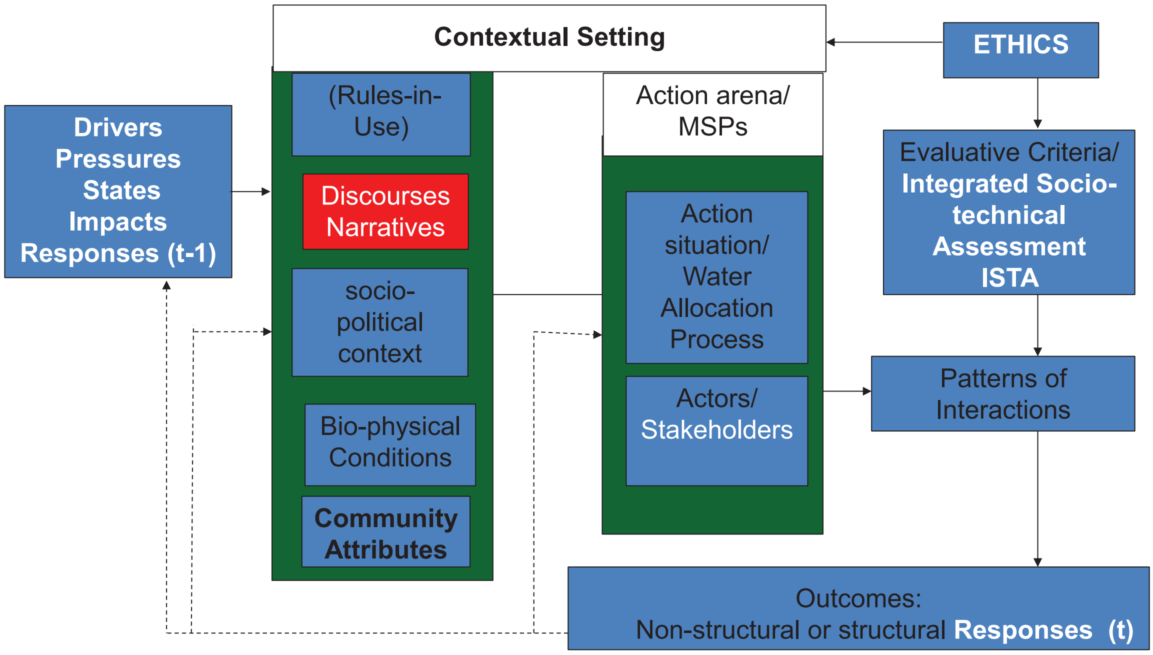
Second-Tier Variables of a SES (Source: Ostrom , 2011)

Figure 3.12: Second-tier variables of a SES (Source, Ostrom, 2011).

Therefore, it is argued that it is reasonable to include the ecological, hydrological and socio-economic attributes together with the biophysical and materials conditions described earlier. Also, it is argued that Ostrom’s description of biophysical conditions can be enhanced by the contribution made by the DPSIR analysis. For example, referring back to the issue of subtractability of use, Hardin (1968) noticed that the main aspect of common pool resources strategy is overpopulation which is one of the main socio-economic **Pressures** caused by population growth which in turn is one of the main **Drivers** (the D of the DPSIR component) of a resource system. It can be seen that the rate of subtractability of use depends on Drivers such as population growth. Therefore, DPSIR sustainability analysis complements IAD by describing Drivers and Pressures affecting the Interactions-Outcomes pathway in water allocation action situation in the SES.

3.8.7 Interfacing the components of the Framework

The interface between the four analytical components of the Framework is shown in Figure 3.13. This is achieved by considering the *Interaction-Outcome pathway* in the action situation. With reference to Figure 3.13:



***Source:* Modified from Kiser and Ostrom, 1982; Ostrom, Gardner, and Walker 1994; Ostrom, 2005; Clement, 2009;**

Figure 3.13: Conceptual unit of analysis: the interfaces and points of interaction between the four components of the Integrated Socio-technical Framework.

- the DPSIR analysis (Chapters IV and V) complements the IAD analysis by better mapping the ecological, hydrological and environmental elements in the analysis and feeds into the IAD component. This will provide an enhanced understanding of the water resources system and the decision-making process operating in multitier MSPs. It provides Responses in time t-1 (R_{t-1}) which represent the evolutions of rules in use and administrative institutions. Therefore, the R_{t-1}component is a measure of institutional change. Additionally, the D-P-S-I elements represent a multi-level assessment of changes in biophysical conditions and socio-political and economic attributes of the action situation for a particular action arena in the IAD approach. Some of Responses in time t-1 represents rules in use. In this research, since we are assessing water allocation and planning governance, then we are only concerned with operational level decision-making level.

The rules in use will be assessed according to design principles and rule typology analysis as described.

- IAD makes an ex-post analysis of water allocation decisions and earlier rules in use i.e. Responses at time (t-1) by using results from the ISTA (Chapter VI) as the basis for analysing, designing and integrating institutional reforms as part of proposed Responses (Chapter VII)
- ISTA component provides two types of analysis of the Interactions-Outcomes pathway: (1) analysis based on MCDA and system dynamic modelling to allocate water using the water allocation model; and (2) Evaluative Criteria which is a theoretical analysis based on good governance principles i.e. it provides (a) the evidence (i.e. information) for the decision-making and (b) the Evaluative Criteria for institutional sustainability of the Outcomes or Responses (i.e. costs and benefits associated with the Outcomes).
- The Ethics component feeds into the IAD, capturing mental models of the actors as well as providing Evaluative Criteria which sets a benchmark for institutional sustainability in the ISTA component.

3.9 A guided tour of the thesis

The scope of the research and its aim and objectives is outlined in Chapter I. The aim of the PhD thesis is to develop an Integrated Socio-technical Framework for IWRM by linking social and physical sciences using a case study approach.

Chapter II is a critical state of the art review on the theories, concepts, and methodologies of sustainable water resources management in the 21st century. Different aspects of sustainability are reviewed followed by a reassessment of the governing principles of water resources management.

Chapter III presents an Integrated Socio-technical Framework to achieve the objectives of the research. The Framework has four core analytical components which represent the innovation of the PhD work:

- Drivers-Pressures-Impacts-States-Responses (DPSIR) sustainability assessment component
- Institutional Analysis and Development (IAD) component
- Integrated Socio-Technical Assessment (ISTA) component

- Ethics Component

Chapter IV provide a historic analysis of the evolution of water resources management in Iran, viewed within the DPSIR analytical component. The DPSIR analysis outlines the Drivers which create Pressures on the water resource system during the modern history of Iran (1906-2003). DPSIR analysis is used to assess the progress made with respect to the introduction and implementation of IWRM plan in Iran. The impact of water resources policies and plans and the States of the Social-Ecological systems are assessed. DPSIR analysis provides a wider national outlook which has a strong bearing on the Lake Urmia basin case study.

With reference to Chapter IV, Chapter V focuses on the Lake Urmia case study to deal with water allocation conflicts in the basin. In the first part, a detailed DPSIR analysis is done to understand the physical, biological, ecological, socio-economic and institutional attributes of the Lake Urmia water resources system. Within DPSIR, historical analysis of institutional reforms (Responses) is made for the period 1909-2008. Then, the IAD component is applied to make an ex-post analysis of rules in use (earlier Responses) to deal with the Drivers and Pressures on the water resources system as described earlier in Chapter IV and the first part of Chapter V. Both IAD and DPSIR analysis are enriched by using the power-based approaches. Narratives behind discourses and discourse analysis are used as tools to understand the power relationship within the socio-political context of the water allocation process for the period mentioned. Throughout the thesis, discourses which shape the perspectives of actors are analysed to have a better understanding of the socio-political and cultural context of water resources management in the Lake Urmia basin.

Chapter VI is comprised of two parts: the first part describes a stakeholder participation process in which actors have used the ISTA component of the Framework to make water allocation decisions at basin level. The Ethics component provides a benchmark to the ISTA component by providing Evaluative Criteria for sustainability. It also has a bearing on the mental models and perspectives of the actors involved in the decision-making process.

System dynamic modelling and Multi-criteria Decision Analysis (MCDA) are used to allocate water to provinces within the basin on multitier Multi-Stakeholder Platforms (MSPs). Further modelling techniques are applied to evaluate the technical sustainability of the water allocation decisions using water balance modelling, stochastic rainfall modelling and risk based analysis in part two of Chapter VI.

The outcome of the ISTA analysis in Chapter VI forms the basis of an institutional analysis using the IAD component in Chapter VII to propose revised Responses based on an adaptive water resources allocation strategy. The ISTA component is also used to analyse the performance of the water resources system under different futuristic climatic water allocation scenarios.

In Chapter VIII, the principles of community based natural resources (CBNR) governance in the WANA region are developed based on predominately Islamic culture and ethics to foster sustainable resource use and livelihood management within the context of conservation and environmental protection. An Ethical legal framework for CBNR governance is proposed. The implication of the use of the proposed Ethical legal for the Lake Urmia case study is outlined.

Finally, after revisiting the Objectives of the thesis, lessons learned, the applicability of the PhD work, conclusions and recommendations for further work are described in Chapter IX.

Chapter IV. Towards Sustainable land and Water Management in Iran: DPSIR Assessment

4.1 Introduction

The concept of IWRM is not new to Iran. As stated previously, since the mid-1990s, the IWRM concept has been deliberated in public policy debates in Iran, and in 1999, the first inter-sectoral Directive was introduced. In 2003, IWRM was formally adopted. Therefore, the objectives of this chapter are (a) to describe the progress made in Iran in implementing the IWRM paradigm and (b) to define the boundary of issues and conflicts with reference to water allocation in Iranian river basins.

Therefore, Chapter IV is structured as follows: first, it describes the methodological approach to achieve the mentioned objectives (Section 4.2); then it presents the contextual setting (Section 4.3) followed by the DPSIR assessment at national level within the socio-political context is described in Section 4.4. Finally, the discussion and conclusions are given in Sections 4.5 and 4.6 respectively.

4.2 Methodological approach

4.2.1 Data collection

With reference to section 3.7 (Chapter III) and Appendix A1, data used in Chapter IV include:

- quantitative baseline data (i.e. hydrologic, hydraulic, climatic and socio-economic data):
  - online databases and printed surveys of international organisations such as FAO Statistical Yearbook, the World Bank, various United Nations agencies etc.
  - a survey of official online databases and printed surveys of different ministries such as Ministry of Energy (MoE), Ministry of Agricultural Jihad (MoAJ), Iran Statistical Centre (ISC) and provincial state organizations etc.
  - secondary data analysis such as research reports and journal publications on Iran (online and printed format)
- qualitative data including questionnaire survey, formal interviews, observational data from stakeholder meetings or workshops.

4.2.1 The analytical approach

With reference to Section 3.8 in Chapter III, the data has been analysed in the following steps:

1. With reference to Section 3.8, the contextual setting is described in Section 4.3
2. In Section 4.4, DPSIR component is used as the core analytical approach to capture the hydrological, ecological, socio-economic, political and institutional factors which influenced the development of water resources governance in Iran. The DPSIR analysis is enhanced by the historical analysis of the development of the Responses (and subsequently Drivers) in the form of evolution of rules in use (mainly legislations) within a socio-political context i.e. discourse analysis is used to highlight dominant discourses which are relevant to water resources planning in Iran.
3. To reflect the water resources system's dynamism, DPSIR analysis focuses on the links between DPSIR elements; thus, it does not take a rigid taxonomical approach. The analytical results are presented illustrating the inter-linkages among the DPSIR elements. By showing the interplay and the dynamic nature of the DPSIR elements, the integrating synthesis is achieved.

4.3 Contextual setting:

4.3.1 Action arena, action situation and major actors

The action situation is water resources planning for the period of 1909-2007.

Iran is divided into 30 provinces (Figure 4.1) which are administered by governors (appointed by the central government). Water resources planning and management (i.e. action situation) is the sole responsibility of MoE which uses the 1982 Fair Water Distribution (FWD) Act to manage water resources. The administrative structure of MoE has three levels of decision-making. (1) Policy level is administered by the Deputy Minister for Water Resources and Water and Wastewater (WRWW). Deputy Minister has 6 deputies responsible for 6 Directorates including the Office of Macro Planning for WRWW which has a Water Resources Group responsible for river basin planning. (2) The implementation of polices are administered by Iran Water Resources Management Company (IWRMC); which has an Water Planning Bureau which has a technical Committee dealing with water allocation applications. (3) At the operational level, Regional Water Companies (RWCs) are the executive arm of the IWRMC.

However, the MoAJ is also a major player in the planning process as 92% of the water is used for agriculture and is responsible for managing the agricultural water sector and irrigation and drainage networks. The role of Department of Environment (DoE) has become more important since the introduction of the 1974 Environmental Protection Act and, recently, the 1998 Environmental Impact Assessment (EIA) Act which requires EIA for all major projects. The Strategic Planning Directorate at the office of the President (formally known as Planning and Management Organisation) is responsible for 5 Year Development Plans (FYDP) which set the developmental goals and fiscal (material conditions) needs of the FYDPs. Non-governmental organisations (NGOs) and local communities have no input into the top-down policy-making and planning process. However, the Members of Parliament (MPs) have been lobbying on behalf of their constituents (especially farmers) during the passage of FYDP in the parliament. In Chapter V, I will return to the theme of actors with greater detail.

4.3.2 Community attributes

Iran is a multi-ethnic and religious society (Figure 4.2). There are 49 languages in Iran (Moqimi, 2006; p.21). However, Persian (Farsi) is the official language of the country (Article 15 of the Constitution). Bilingualism has posed serious ethno-political and cultural problems (Khadivi and Kalantari, 2010). The majority religion is Shiite Islam which is the official religion and the Constitution is based on Shiite doctrine but recognising the civil rights of Sunnis and other religions (Articles 12, 13 and 14). The Constitution states all citizens are equal irrespective of their ethnic background.

Sunnis are mainly in the border regions and are the majority among Kurds, Baluch and Turkmen. There is a small minority of Christians (mainly Armenian) and Jews. Also, a small community of Iran's ancient religion (Zoroastrian) has survived. It is worth mentioning that there are ethnic and religious tensions and conflicts but they constitute a smaller factor than socio-economic and political aspects. Full implementation of the Constitution is lagging in many areas such as environmental protection (Article 50) and privatisation and economic efficiency (Article 44) and so forth.

Based on the questionnaire survey (Appendix A1) the main community attributes are: (1) inter-basin water transfers plans have caused tensions between various RWCs and Governor's Offices demanding more water allocations quota for their province;

(2)incomparability of information and data at different levels of management i.e. lack of trust and exchange of data between different national and inter-provincial organisations; (3) inadequate social awareness about role of water for life and the environment; and (4)political influence and imbalance of power among actors.

4.3.3 Biophysical and materials conditions: socio-economic, political, ecological, hydrological and hydraulic attributes

Iran's population was estimated to be nearly 75 million people in 2010; the 2006 census put the population at nearly 71 million people (SCI, 2010). Population growth has accompanied urbanisation as more than 68% of the population lives in cities (World Bank/WDI, 2010); there are some seven mega-cities in Iran with a population over 1 million people (Ardakanian, 2005: P. 98).

Figure 4.1: Geopolitical map of Iran.

Iran has 0.36% of the world's freshwater resources whereas about 1% of the world's population lives in Iran (IWRMC, 2005).Annual precipitation is characterised by both temporal and spatial variations ranging between 50 mm in central Kavir Desert to 2275 mm in Caspian Sea river basins, and with an overall annual average of about228 mm (FAO, 2009)[1]. Iran has total renewable water resources of 130 BCM (Table4.1). Iran's hot summer

[1] There are different figures for average annual rainfall e.g. Almasvandi (2010) states it 247 mm based on 1969-2009 dataset

climate means that almost 66% of the precipitation is evaporated before reaching the land. The amount of return flow is 29 BCM (Siadat, 1999).

92 % of the 93.3 BCM water use is consumed by the agricultural sector (Figure 4.3). Environmental water requirements are only met through unregulated and overflow waters (IWRMC, 2005). Groundwater is the main source of agricultural water use which is estimated at about 70% considering illegal and informal abstractions.

The 1982 FWD Act states that water is a common pool property and belongs to the state. However, much of groundwater is owned and controlled by private well owners. The 1982 Act controls the use of groundwater resources by issuing Water Allocation Permits. There are illegal and informal abstractions in addition to the quotas in both surface and groundwater resources. Much of the surface water is used through traditional water rights (abstraction from rivers which is about 50% of the total). Regulated water from dams is considered to be a State owned public property.

Resources	**billion (10^9) cubic meters (BCM)**
Precipitation	400
Evapotranspiration	270
Renewable Surface water	92
Renewable Groundwater	38
Overlap between surface water and groundwater	18.1 (Source,FAO, 2009)
Total renewable resources	**130**
Return flow	29

Table 4.1: Iran's water balance (Source: MRC (2007) based on 2006 statistics).

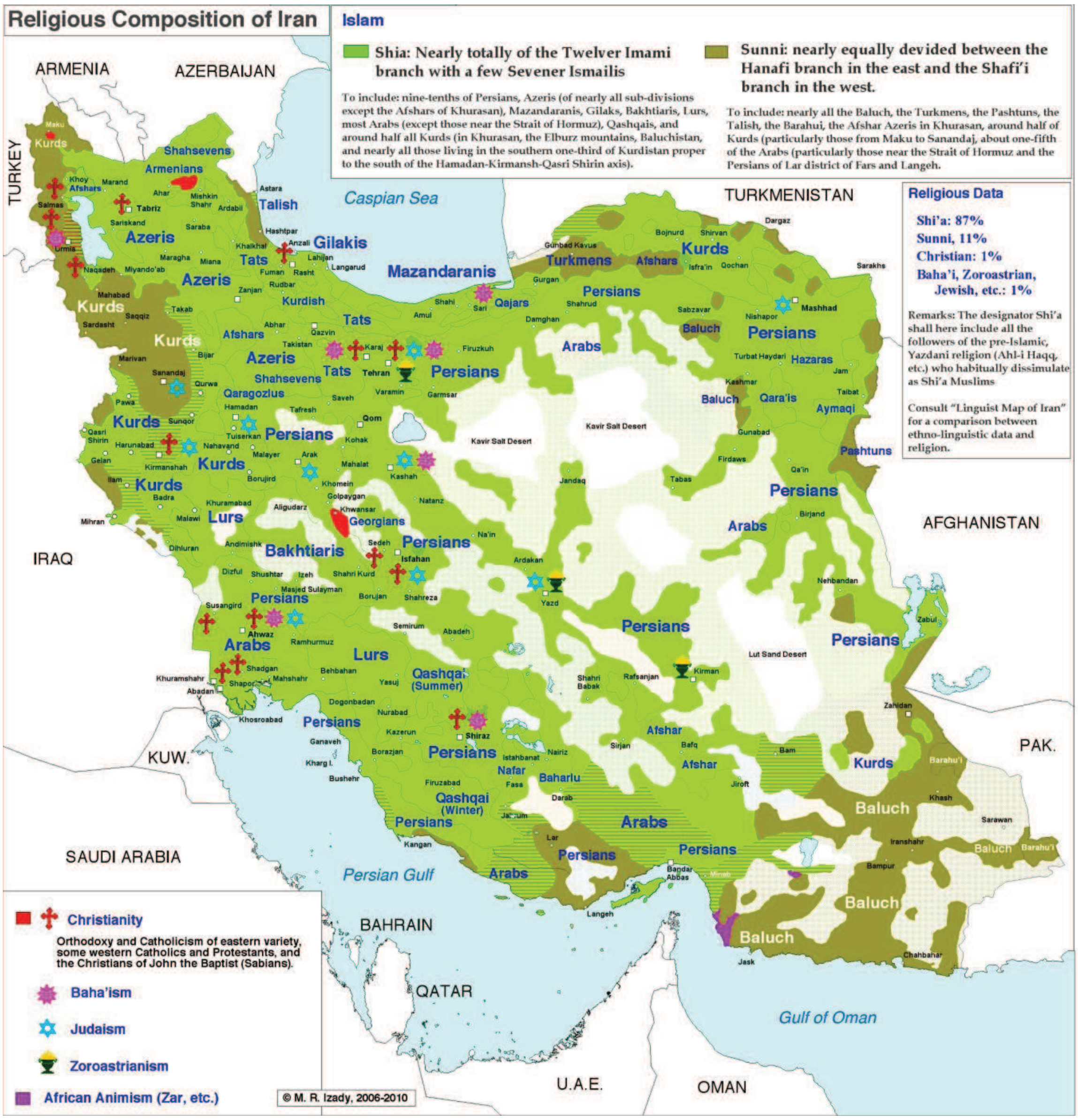


Figure 4.2: Iran's ethno-religious distribution (Public domain map).

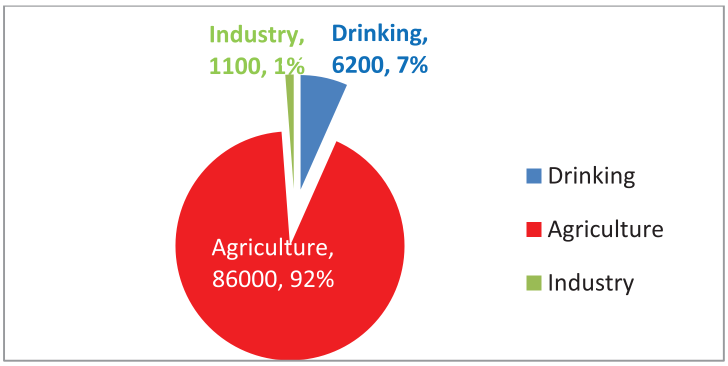


Figure 4.3: Annual sectoral water use in 2007 all in MCM (Source: FAO, 2009).

The sanitation sector is underdeveloped as only 25% of the urban population and only1% in rural areas have access to full sanitation services (Mahmoudi, 2006; Hashemi et al, 2007b). Many cities are without treatment plants due to lack of infrastructure, technology and financial constraints and; otherwise some 98% have access to safe drinking water (Hashemi and O'Connell, 2009)

Nearly a half of Iran's total land area is covered by deserts, wastelands, mountain ranges and rangelands (Chapin Metz, 1987).Table4.2 provides major land uses together with agricultural and rural demographic information. Out of more than 23 million in rural areas, about 16.5 million people are involved in agriculture. However, there are some 6.5 million people who are only economically active in rural areas but who live in urban areas. This shows a great deal of migration to the cities. Iran is ranked 5th in the world in terms of irrigated land area and there are major irrigation schemes in operation including Lake Urmia, Caspian Sea, Persian Gulf and Central basins.

Land use	1000 ha
Irrigated land	8,856
Arable land	16,869
Permanent crop	1,680
Pastures	29,524
Land area	162,855
Agriculture and Rural Demography	**million people**
Total agricultural Population	16.583
Economically active people in agriculture	6.526
Rural population	23.191

Table 4.2: Iran's land use and agricultural and rural demography in 2007 (Source: FAO, 2009).

4.4 A national outlook for the water resources sector in Iran

4.4.1 Introduction

The application of the DPSIR component within the socio-political context to analyse the evolution of the water sector in Iran is shown in Figure 4.4. The analysis is for the period 1909-2007.

Iran's water resources system has been affected by major driving forces including: population growth, urbanisation, climatic variability and change, land use and agricultural self-sufficiency and modernisation policies as well as short term developmental plans. These drivers have placed a remarkable pressure on the water resources system.

The demand for water has increased due to rapid population growth and some sectors have experienced water shortage. Iran is approaching water stress conditions. The climatic variability of arid-semi arid Iran has necessitated the implementation of many development projects and irrigation networks to provide food security and self-sufficiency as well as an adaptation policy to droughts. The rapid economic growth and developments have brought better living standards (Zekavat, 1997) but they have caused environmental degradation and loss of biodiversity in many rivers and wetlands (Bahrainy, 2003).In this section, the results of the assessment are presented and analysed.

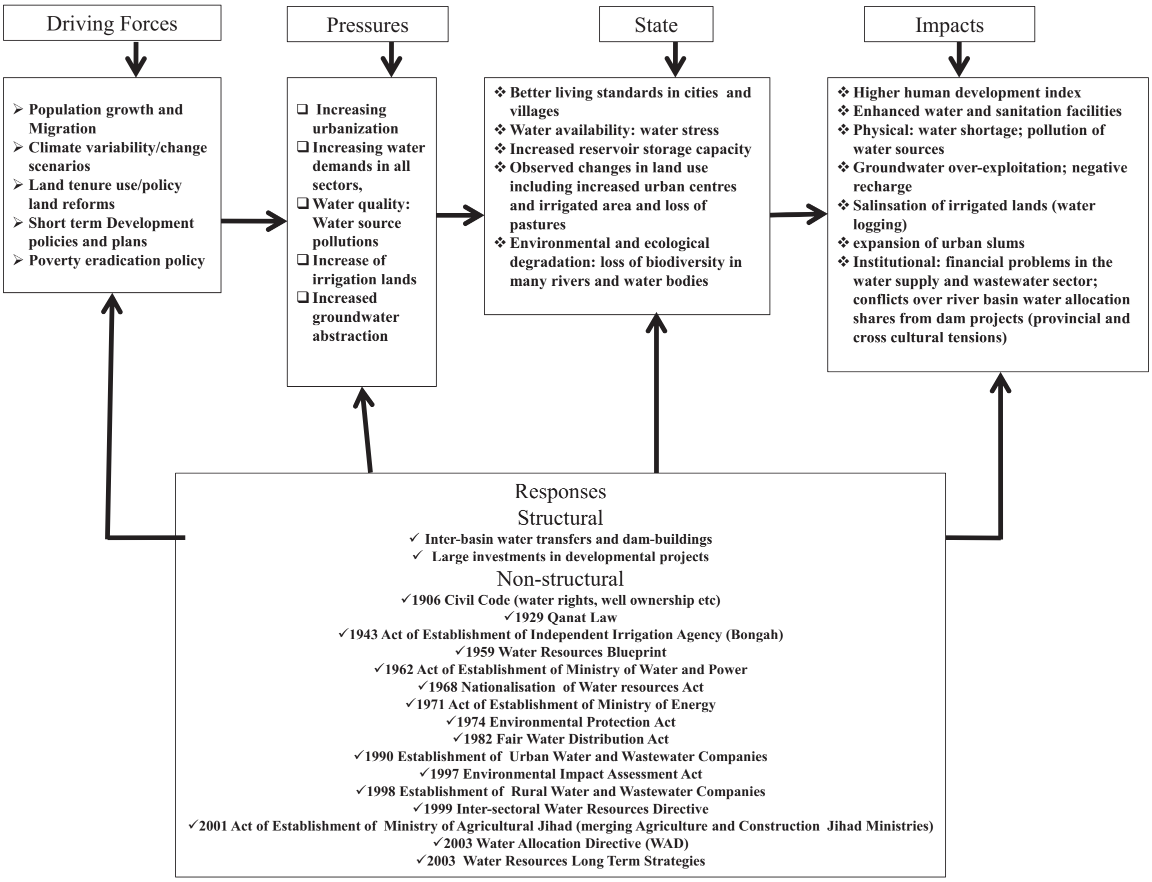


Figure 4.4: Results of the DPSIR assessment at national level, 1909-2007.

4.4.2. Driving forces (Drivers)

Population growth and migration. The first nationwide population census was carried out in 1956 (Bharier, 1968). Prior to this date, only estimated population values were available. Gilbar (1979) states that Iran was regarded as the most populated country in the MENA region in the mid-19th century and according to Lambton (1998) the population was estimated to be 9 million people in 1900[2].

There has been an almost three-fold increase in population since 1956. Much of the population lives in urban centres and there are 7 mega-cities. Thus, there are 2main characteristics of the increase in population: (1) a faster rate of growth in urban areas, and

[2]Bharier (1968) estimates population to be 9.9 million.

(2) immigration from rural to urban areas in search of employment which resulted in enlargement of existing cities and the creation of new ones.

The introduction of a Family Planning Program (i.e. birth control policy) during 1966-1979 (see e.g. Abbasi-Shavazi, 2002) did not have a lasting impact on the rate of population growth showing an increasing trend (Figure 4.5). The Program was suspended after the 1979 Islamic Revolution but it was started in late 1980s and proven to be one of the effective factors affecting the downward trend in population growth rate. There has been a mismatch between the total population growth and rate of urban population growth. Table 4.3 shows a huge increase in urban population due to migration. Between 1990 and 2008, the annual growth rate of urban population is 2.6% which is much greater than the average annual population growth rate of 1.6% for the same period; whereas rural areas had a negative growth rate of -0.3% (World Bank/WDI, 2010). Earlier projections of the population of Iran reaching 100 million by 2025 has been revised to 80.2 million (Table4.3).

Year	**Population**	**Notes**
1900	9,000,000*	* estimated (Lambton, 1998)
1956	18,954,704	Nationwide census (NC)
1966	25,788,722	NC
1976	33,708,744	NC
1986	49,445,010	NC
1991	55,837,163	
1996	60,055,488	NC
2006	70,495,782	NC
2010	74,733,230**	** estimated (SCI, 2010)
2025	80,200,000	*** revised projection (SCI, 2007)
2050	100,200,000	*** projected (SCI, 2007)
	Urban areas (source World bank/WDI, 2010)	
Year	**Population (millions)**	**% of total population**
1990	30.6	56
2008	49.3	68

Table 4.3: Iran’s population (Source: SCI (2010) unless stated).

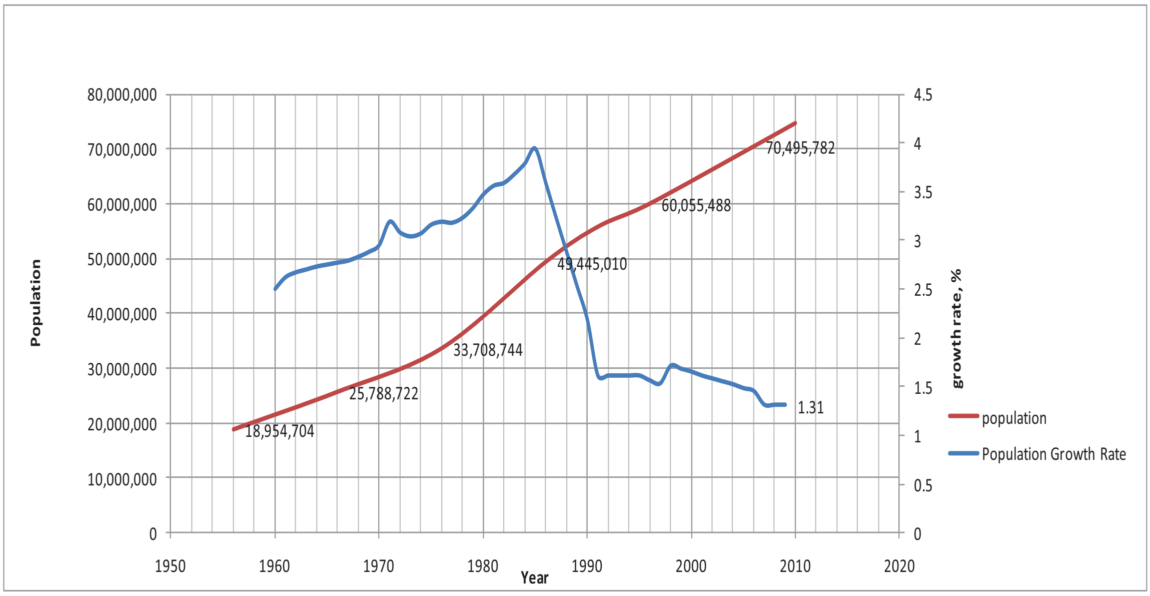


Figure 4.5: Population growth for the period1956-2010(SCI, 2010) and population growth rate (1960-2009) (World Bank /WDI, 2010).

Climate variability/change. As a semi-arid and arid country, Iran is characterised by high climatic variably; thus historically experienced low spells of rainfall or meteorological droughts which have affected natural runoff i.e. caused hydrological droughts. Droughts usually have longer terms impacts including (1) socioeconomic (immigration, poverty famine) and (2) agricultural (i.e. shortage of foods) impacts[3].

By the late 1990s, a new discourse emerged based on the climate change discourse. The experts of the Water Planning Bureau at IWRMC have started to doubt the sustainability of the development plans and supply-oriented Water Master Plans[4]. Climate change discourse centred on the downward trends of the precipitation based on linear regression approach in the 15 years since 1995(Figure 4.6) as can be noticed in Figure 4.6, the linear regression variance is not statistically significant at all. The time series used (1969-2009) is too short to provide conclusive evidence in a meaningful trend analysis. But most water managers started to belief that climate change is already happening due to successive droughts and increasing trends in flood events in the last 50 years (MoE, 2010a)[5]. However, no conclusive evidence has been presented despite some attempts to study climate change.

[3]For example there was "*recurrence of famine in Tehran in 1860, 1870, 1872, and 1896*" due to food shortages and related to mismanagement of the economy and climatic factors (EttehadiehNezam-Mafi, 1993)
[4]We will introduce this later under the Pressures sub-section.
[5] Recently, the perception held by many ordinary people is that we have less rainfall and certainly less snowfalls compared to the 1960s (from author's experience).

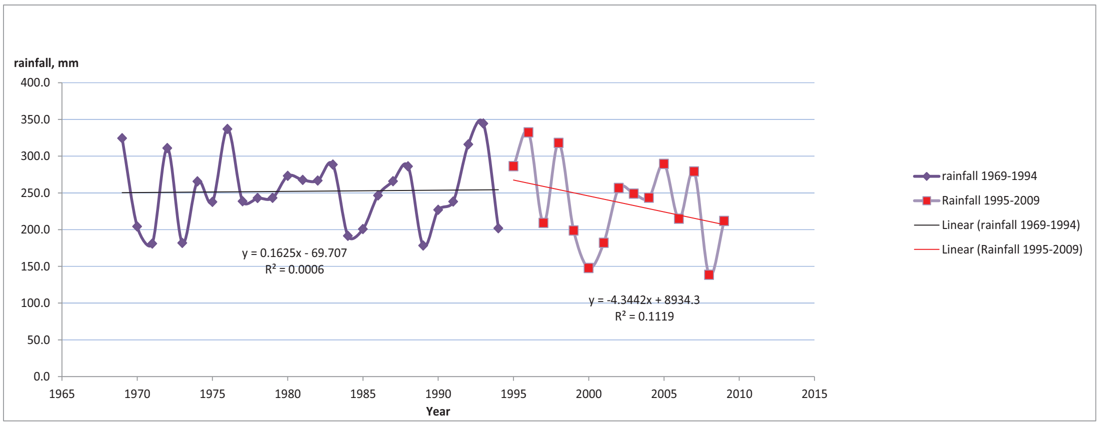


Figure 4.6: Trends in precipitations and climatic variability during 1969-2009 based on MoE (2010a) discourse on climate change.

In the 1990s, research on climate change and droughts started; for example as cited by DoE (2003), Khalili et al (1990) completed a pioneering work to understand the impact of climate change on water resources in Iran. In June 1992, Iran joined the United Nations Framework Convention on Climate Change (UNFCCC) at the Earth Summit and ratified the Convention in 1996. The 4th FYDP (1999-2004) did not explicitly link climate change to water resources but it recognised that Iran should be part of the Kyoto Protocol of the 3rd Conference of the Parties (COP) meeting of the UNFCCC which was attended by Iran in 1997. The drive to join the Kyoto Protocol prompted the national project on climate change at DoE producing the *Initial National Communication to UNFCCC*[6] in 2003 (DoE, 2003). The report was an example of inter-sectoral cooperation between various ministries in the era of the reformist government of President Khatami and was an achievement of the first woman Vice President, Dr Massouma Ebtekar, Head of the DoE.

DoE (2003) outlines the status of the environment, greenhouse gases (GHGs) inventory, mitigation policies, vulnerability and adaptation assessments and proposed strategies to address the issue of climate change. Results from a Runoff Assessment Model (RAM) applied to all the river basins obtained by Fahmi[7] (1999) are also cited in the report indicating that a rise in temperature (as a result of emissions of GHGs) will have an impact on runoff regimes; for example, the snowmelt season will be brought forward due to the

[6] This project was led by Dr Taqi Ebtekar the first Director of DoE after the 1979 Revolution and the father of Mrs Ebtekar, Head of DoE.

[7] Dr Hedayat Fahmi was Head of Research Committee at the Office of Planning at IWRM at the time and now has moved to MoE, the Office of Macro Planning as Manger of Water Resources Group. He represented Iran on climate change issues.

rise in temperature; the flood regime will change in many watersheds (higher flood index) and there will be a shift in rainfall and snowfall seasons as well (DoE, 2003).

The study used 6 (3 emission and 3 climate sensitivity) scenarios using selective combinations of two global circulation models (HadCM2 and ECHAM4). The temperature and precipitation changes were predicted using MAGICC [8] software for different combinations of scenarios, climate sensitivities and CO_2 rate of emissions up to 2100. However, the climate change modelling was primitive as acknowledged by the writers whom asserted that more precise scenarios should have been used as well as recommending the use of regional/local general circulation models (GCMs) and more spatially improved GCMs. Nevertheless, the DoE report (DoE, 2003) enhanced the acceptability of the climate change discourse within policymaking circles but it provides rather inconclusive and confusing remarks about temperature and precipitation changes and asks for better and more detailed analysis.

DoE (2003) provides an assessment of vulnerabilities and adaptation measures for the main economic sectors such as agriculture which represents more than a fifth of the GDP. For example, DoE (2003) shows the vulnerability of the agricultural sector to climatic variability and the question of food security (self-sufficiency policy) by stating the loss of 3.6 million tons of wheat production of during the 1998-99 droughts.

Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (IPCC, 1997) has acknowledged "the *importance of adaptation in the climate change question*"; however, there are differences within most countries to how to adapt to climate change (Smithers and Smit, 1997). Therefore, DoE (2003) asks for an adaptive management strategy to deal with this pressing Driver. To deal with climate change, a range of management options should be taken; for example deficit irrigation[9] has been shown to increase water use efficiency (e.g. Mushtaq and Moghaddasi (2011). Climate change adaptation policy requires an adaptive governance system which recognises "*institutional flexibility and diversity which is the ability to create local institutions that can respond to location-specific needs rather than needing to fit cleanly within nationally or regionally defined frameworks*"; in addition building infrastructures should accommodate

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[8] For more information See website http://www.cgd.ucar.edu/cas/wigley/magicc/ which states that "*MAGICC consists of a suite of coupled gas-cycle, climate and ice-melt models integrated into a single software package*."

[9] Based on a literature review, Mushtaq and Moghaddasi(2011) define deficit irrigation as a practice of deliberate under-irrigation of a crop or deliberate stressing of crops to influence yield and profit

"*uncertainty, variability, and change, while avoiding path dependencies*" (Moench, 2010; p.977).

Land tenure/use policy. Despite climatic aridity, most Iranians policymakers in the last 100 years perceive that Iran can accommodate more agricultural developments and can achieve food self-sufficiency given the right technological means i.e. water is not seen as a limiting factor. Therefore, irrigation policy has been instrumental as a major Driver.

Data from Table 4.6 show a net loss of nearly 16.5 million ha of pastures to other land covers in Iran between 1995 and 2007. Irrigated area has increased by 21% between 1996 and 2007. A substantial increase in the permanent crop cover has occurred: from 1.13 million ha to 1.68 million ha; an increase of 48%.

Year/	Arable area (x 10**3 ha)	Permanent crop (x 10**3 ha)	Pastures (x 10**3 ha)	Irrigated area (x 10**3 ha)
1987	15,400	1,130		
1992	16,969	1,318		
1995	17,388	1,320	45,500	
1996				7,308
1997	16,502	1,330		
2000	14,924	1,360	46,600	
2001				7,868
2002	16,029	1,415		
2005				8,574
2006				8,715
2007	16,029	1,680	29,524	8,856
Percentage change	10% increase	48% increase	35% decrease	21% increase

Table 4.4: Land use change in Iran, 1987-2007 (Source: FAO, 2009).

One of the major drivers of land use change has been the1962-71 Land Reform which was part of Pahlavi's White Revolution (Pahlavi, 1998). Hasan Arsenjani (1922-1969), the architect of the Land Reform, was a "*brilliant and erratic*" leading Iranian politician who was a regular visitor to the Shah in the 1950s (Cottam, 1999)[10]. He masterminded the populist reform but was mistrusted by the Shah and was dismissed in 1963 and was sent to Italy to serve as Iranian ambassador. By the end of 1978 some 3.5 million acres were distributed to the peasants to channel support for the monarchy.

[10]An authentic translation is available in Farsi which has been referenced here. The English edition was published in 1979 by University of Pittsburgh Press.

However, this has politicised the peasantry and hence is regarded as one of the main reasons for the 1979 Revolution. It seems that the *Shah* thought that the development plans were vehicles for implementing the 1966 Cultural Policy outlined by Behnam (1973) and a stride towards modern Iran.

Scholars have asserted that the Land Reform were marked with failure due to poverty, water shortages as a consequence of lack of necessary infrastructure (Walton, 1980) and inappropriate water governance(Farman-Farmaian& Farman-Farmaian, 2002)[11]. The Land Reform dismantled the feudal land management system and degraded the agricultural sector and caused the migration of rural communities to urban centres; hence it caused economic imbalance (Engineer[12], 1980).

Post Revolution Land Reform in 1979-80 was led by a radical movement within the new Islamic Republic headed by Reza Esfahani, Deputy Agriculture Minister for Land Affairs. He tried to redistribute the agricultural land with the aim of empowering the '*oppressed*'. Esfahani's zealous efforts resulted in a Program bearing his name: the Reza Esfahani1980 Land Reform. McLachlan (1988) provides a scholarly analysis of this Program describing it as "*little short of a disaster* (ibid, p.221)". The post Revolution agrarian reform had the following characteristics : (1) geographically sporadic as it mostly affected Kurdish populated regions i.e. Kermanshah, Kurdistan and West Azerbaijan;(2) large land owner institutions were created such as Bonyad-e- Mostaz'afan (The Foundation of the Oppressed) owning some 100,000 ha of land and major dairy industries; in total some 850,000 ha were distributed among those so called 'oppressed' people on temporary *Farming Contracts* (Eslahi et al, 2002); (3) the Ministry of Agriculture (MoA)did not have the sole responsibility for the Program because the Ministry of Jihad-e- Sazandegi (MJS)which was linked to the Guards (*Pasdaran*) of Islamic Revolution Militia was in charge of rural regeneration and were effectively in control; (4) the Program was halted and the Council of Guardians produced a legal verdict that the new Land Reform is illegitimate as it transgresses ownership rights and limits the size of private ownership (Eslahi et al,

[11]The book '*Blood and Oil: Memoirs of a Persian Prince*, was published in English by Random House, New York in 1997. The authors belong to one of the most influential political families in Iran until the 1979 Revolution.

[12]Ali Ashghar Engineer, is an Indian reformist-writer and activist focusing on collectivism advocating communal harmony and a culture of peace and non-violence (Source: Wikipedia website: http://en.wikipedia.org/wiki/Asghar_Ali_Engineer)

2002) and (5) the majority of land confiscated was given back to the owners and many rulings of the Courts of The Islamic Revolutions were overturned[13].

The MJS and MoAJ were not on good terms. The MJS was established in 1983 and lead by Bejan Namdar Zanganeh who later became Minister of Energy (1988-1997). In 2001, MoA and MJS were amalgamated to form the MoAJ. Traditionally, the MoAJ ministers are appointed from former MJS members. They also provided many ministerial ranks to other sectors including petrochemical and energy.

The agricultural modernisation policy and land use policy on irrigation have placed a great deal of pressure on groundwater resources. Groundwater development plans started in 1945 with the introduction of deep wells to replace traditional *qanats* and new technologies in irrigation. This is a legacy of sectoral land use and water governance system. We will come back to the theme of Pressures from groundwater developments in the next section.

Short term development planning. One of the main discourses centres on the belief that we need to harness more surface water development plans as a measure (i) to adapt to the droughts conditions[14]; (ii) to produce clean hydropower energy and (iii) to achieve food security. However, despite concerns for climate change and the emergence of a new discourse, the water resources development plans are underway unabated as an adaption policy for climate change too. It has been shown that infrastructure buffers the impacts of climatic variability on the economic outputs (Halsnaes and Traerup, 2009).

Based on the questionnaire survey (Appendix A1), many participants felt that building more dams fosters superficial expectations about alleviation of climate change risks; creates new water rights for farmers in downstream and has generated a great deal of tensions among provinces sharing a rivers basin.

The idea of short term development planning is not new. For example, colonial development planning was enacted at the time of Chamberlain in 1895 (Abbott, 1971) with the purpose of solving unemployment in the UK by having limited development spending in the colonial territories. Later, the 1929 Colonial Development Act and the 1940 Colonial Development & Welfare Act were introduced, and in 1947, the Colonial (Commonwealth) Development Corporation was established (Cowen, 1984).

[13] The author has witnessed that many noble families such as Ardalan, Sanandaji, Kamangar in Kurdistan and Kermanshah provinces have regained their lands.

[14]This is perhaps a case in semi-arid/arid regions e.g. E. Strobl and R.O. Strobl (2011) states that adaption to drought is the main reason for building dams in Africa

Iran was not inspired by the British or the Russian 'Communist' neighbours' (formerly USSR) on the idea of short term development planning. Instead, the emergence of the World Bank in the 1950s as an important agency has been very influential in surface water development planning (dams and irrigation networks) in Iran.

In 1946 the Planning Committee was active and with the aid of the *Overseas Consultants Inc.* (McLachlan, 1986), the first Seven Year Development Plan (SYDP) was enacted in 1948. At the time of Imperial Iran, 2 SYDPs and 3 Five Year Development Plans (FYDPs) were completed during which major dams were built and these has been reviewed by Beaumont (1974). Massive dam building and water supply and irrigation networks were built as a result of these plans. After enacting five Plans i.e. 3 FYDPs and 2 SYDP, the proposed fourth FYDP (i.e. the 6th Plan) did not see the light of day as the monarchy was overthrown by the new Islamic Revolution in 1979 (Figures 4.7 and 4.8).

The plans lacked both long term vision and strategy. The First Five Year Development Plan (i.e. the 3rd Plan) concentrated on planning to irrigate the Khuzestan lowlands and build hydropower plants (Beaumont, 1974)and so 5000 million Iranian Riyals (IRR) were allocated for the projects. The actual dam construction started in the Second Development Plan as 4 major dams were built. There was a policy shift in both the Third and the Fourth Development Plans to concentrate on existing irrigation networks and water supply schemes for the growing urban populations respectively (Beaumont, 1974). The Fifth Plan concentrated on consolidating the existing water structure, and13 major dams, 17 major diversion dams and 17 large irrigation schemes were built as a result.

Iraq invaded Iran soon after the 1979 Revolution (22 Sep 1980). The longest conventional war in the 20th century continued until August 1988 which brought much devastation to both countries. During this period, no FYDPs were employed (MoE, 2003). Agricultural developments were hindered by the war and ideological wrangling about land ownership and a multiplicity of institutional responsibilities in the management of the land resources. The imposed war was partially responsible for this mismanagement. After the imposed war, the past legacy of development planning continued. The post-war reconstruction was led by Zanganeh from the MJS who headed the MoE from 1988 and brought with him MJS's zeal for hard work.

A massive reconstruction programme started with the 1stpost-RevolutionFYDP (1989-1993) which was characterised by the sheer number of development projects which were very difficult to manage due to the lack of a holistic approach and any sort of integrated approach to river basin management. Hence, the percentage of completed water resources and irrigation networks was small compared with the 3rd and 4th FYDPs.

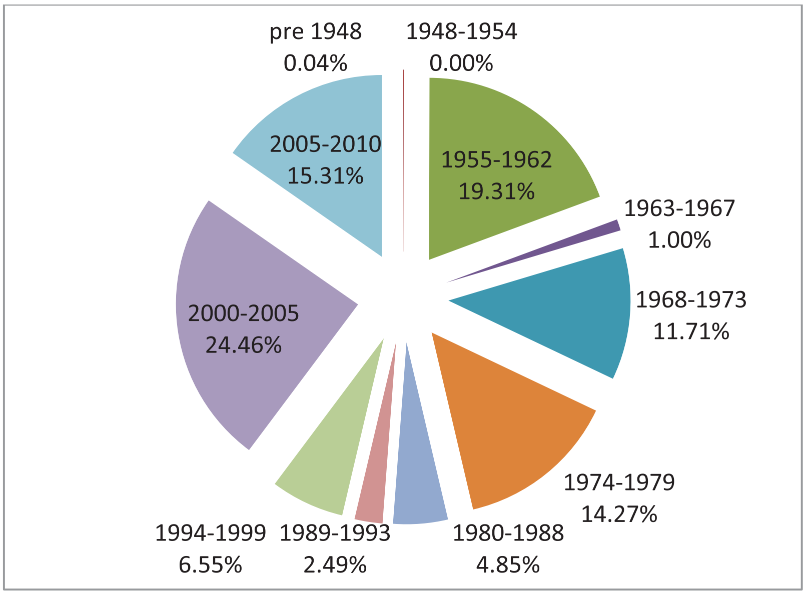

Figure 4.7: Percentages of water resources development in each period corresponding to FYDPs.

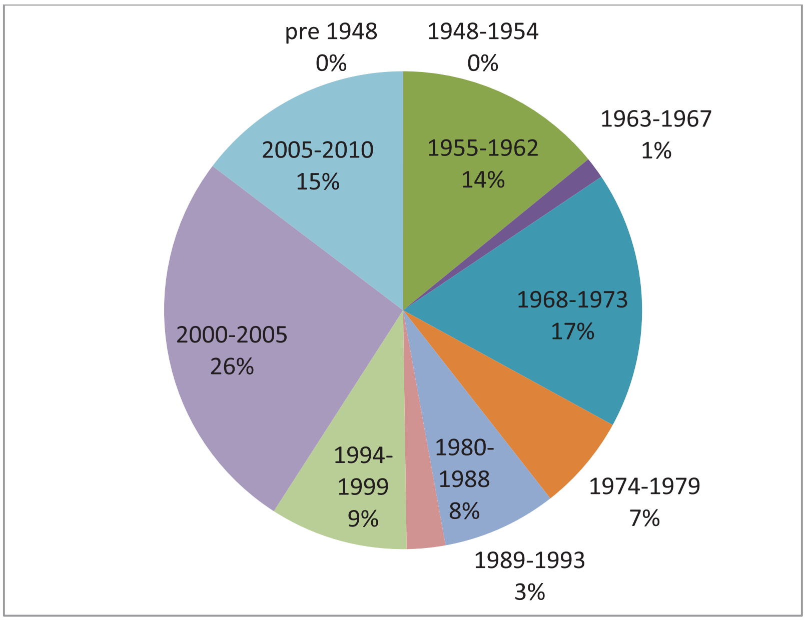

Figure 4.8: Irrigated land development downstream of dams in each period corresponding to FYDPs.

The overall policy was shaped by President Ali Akbar Rafsanjani (1989-97) which believed in liberalisation of the market. Rafsanjani's market economy lacked political reforms and openness; hence his plans were not popular with the public.

In 1997, the Reformist Movement led by Muhamad Khatami (1997-2005) won a landslide victory which was repeated in 2001.A dawn of reform had started. He promoted the *'Dialogue between Civilisations*' and started a programme of social and political reforms. The 3rdFYDPsaw the culmination of earlier projects: nearly 24.5% of completed dam projects (Figure 4.7) and 26% of total irrigation networks (Figure 4.8) were completed during this time This pace had slowed down in the 4th FYDP which saw the completion of 72 dams with a total regulated volume of 4.7 BCM and the development of 320, 033 ha of irrigated networks. Owing to these developmental drives, Iran is now ranked 5th in the world in the dam building industry.

The development plans were also affected by economic growth or decline in the respective periods and the rather erratic fluctuation of economic indicators such as rate of growth and rate of inflation (Figure4.9). The financial sustainability of the projects has been affected by the economic factors and hence it is very difficult to assess their economic impact or performance.

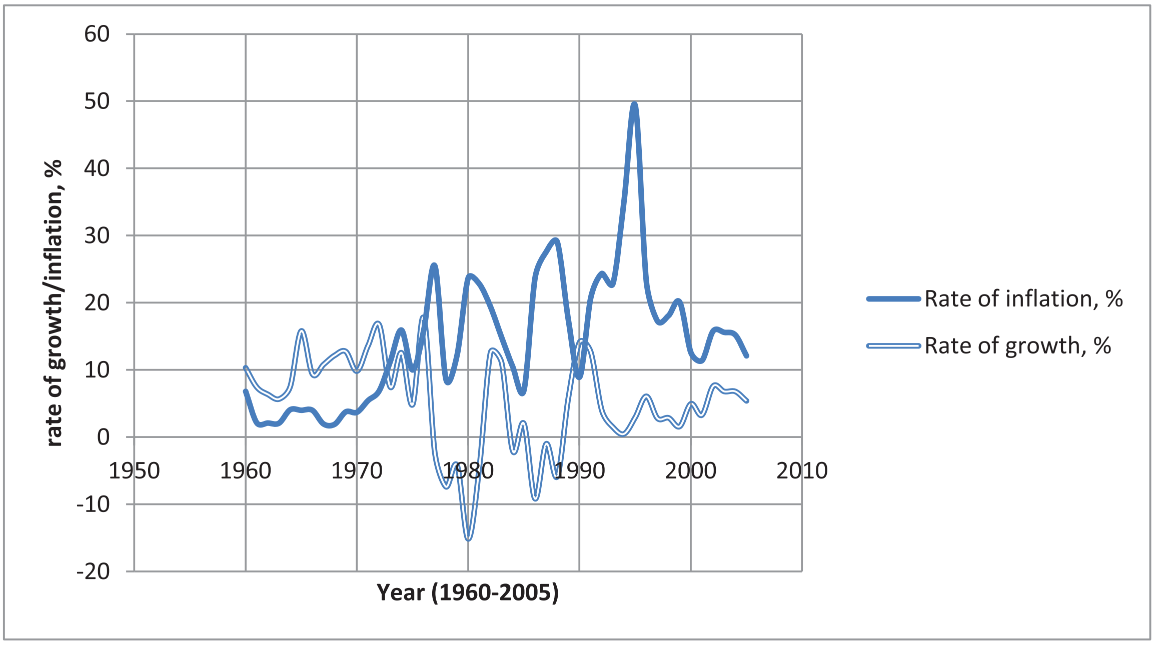

Figure 4.9: 1960-2005 fluctuations in inflation and growth rates (Source: MRC, 2008) .

Poverty eradication policy has been an official aim of successive Iranian governments in modern times**.** Since the 1906 Constitutional Revolution in the early 20th century, social reform and poverty eradication have been on the political agenda and part of demands for social justice as an attribute of the community's Islamic ethical principle.

According to the World Bank (2001), Iran has made considerable progress with poverty eradication; the percentage of people below the poverty line [15]has fallen significantly from 47% in 1978 to 15.5%" in 1995 which has further fallen to 6.21% in 2002 (MPO/UN, 2004) . However, here are different ways of measuring the poverty line. Hence, there are different statistics; for example, based on the 2002 data, some of the researchers put the number of people below poverty line at about 20% of the population (e.g. Mehrgan and Nessabian, 2010). This means that poverty is an important issue to the policy-makers. The government policy in the 3rd FYDP was to reduce it to 7%, and this goal has been reached as mentioned.

Land Reform and water and agricultural development plans have been seen as a means to achieve economic prosperity. Poverty is a multi-dimensional phenomenon and hence cannot be eradicated with only economic plans. Access to education, health service, drinking water and sanitation, political empowerment and employment are among the key factors that affect the degree of poverty.

4.4.2. Pressures

Increased water demand. Population growth as a high level Driver has induced other Drivers such as land use policy, short term development plans, energy policy on hydropower and irrigation politics which have led to increasing pressure on the water resources by increasing demands in all the sectors.

Jamab (1998; 2007) state that

- the demand for water has increased from 83 BCM in 1995 to 93.3 BCM in 2004;
- the agricultural water withdrawal increased from 76 (91.2% of total withdrawals) to 86 BCM (92.18% of total withdrawals);and
- there has been a 21% increase in the irrigated land area during this period.

Total annual water use based on 2007 survey is given in Table 4.5.

[15]Poverty line is defined as income of US $2 per day. There are criticisms about this simplistic monetary indicator but it is widely used as a target indicator and very practical to measure.

Freshwater				No conventional water source				Total water use
Surface water	Groundwater	Total	% of total water use	Desalination	% of total water use	Reused treated wastewater	Reused agricultural drainage water	
40, 000	53, 100	93,100	99.8	200	0.2	-	-	93,300

Table 4.5: Total annual water use (all in MCM) (Sources: FAO, 2009; Jamab, 2007; MoE, 2010a)

There is scattered and inaccessible information on water demands before 1975. To make strategic assessments, comprehensive *Water Master Plans* were initially commissioned in 1969 by Plan and Budget Organisation for making projections on water demands and potential water resource development capacity in Iranian basins. Later the initiative was adopted by MoE and produced the first *Water Master Plan* in 1975 and since then the *Plans* have been updated by *Jamab Consulting Company* in 1991 (based on 1983 baseline date); 1996 (based on 1993 baseline data), and 1998 (based on 1994 data). Jamab (1998) was a first attempt to foster basin-wide water resources planning and development process in LUB. However, the demand-driven *Water Master Plans* do not recognise systems analysis approach or IWRM and is mainly based on assessment of the technical aspects of river basin planning. Also, Management and Planning Organisation commissioned Jamab (2007) to produce an adapting Master Plan for Arid/semi-arid Climate of Iran which lacks holistic planning approach.

Groundwater over-exploitation. Officially, 59.9 % of the 2004 water demand of 93.3 BCM is met from groundwater resources (FAO, 2009). More than 120,000 illegal wells are in operation, which accounts for an excess withdrawal of 5 BCM/year i.e. an additional 5.4% is utilised (Almasvandi, 2010). Almasvandi[16] (2010) states that more than 70% of water demands utilise groundwater resources (mainly private wells). The phenomenal increase in the utilisation rate is due to the introduction of deep wells after 1945(Figure4.10); before that date, groundwater utilisation was through *qanats* and springs (Vali-Khodjeni, 1995). This level of utilisation has depleted groundwater resources and there has been a drop in the water table of between 12 and 67 m as depicted in Table 4.6 (Motagh et al 2008). Motagh et al (2008) assert that there is a great deal of land subsistence due to falling water tables of varying degrees in Iran's main plains (Table 4.7). The

[16] Managing Director of IWRMC at the time; illegal or informal abstraction information is not given but this rare information was provided during a keynote speech at a conference which was picked up by Iran News Agency, IRNA

numbers of groundwater structures (wells, *qanats* and springs) have increased (Figure 4.10), but the discharge per structure has lowered by up to 50% which indicates depletion of groundwater resources (Figure 4.11).

Year	**Wells**				**Springs**				**Alluvial qanats**		**Total discharge, BCM**		
	Alluvial		**Hardrock**		**Alluvial**		**Hardrock**				**Alluvial**	**Hardrock**	**Total**
	No.	Q	No.	Q	No.	Q	No.	Q	No.	Q			
1994	365,711	40.5	unknown	0.2	5,290	1.1	37,300	12.75	31,521	9.4	51	12.95	**63.95**
2001	435,729	42.9	1064	1064	4,067	0.92	43,588	12.8	32,163	7.9	51.7	13.3	**65.0**
	No		Q, BCM		No		Q, BCM		No	Q	Q, BCM		
2007	624,833		48.9		124,443		22.9		37,197	7.4			**79.2**

Table 4.6: Groundwater exploitation, 1994-2001 (Main source: Jamab, 2007).

Region	**Period**	**Decrease in water table (m)**	**Rate of land subsistence cm/year**
Tehran area (Varamin Plain)	Since 1990s	~13	19-23
Rafsanjan Plain (central Iran)	1971-2001	~15	~50
Valleys of Mashhad and Kashmar	In the last 4 decades	15-64	~27-30
Zarand-Kerman Plain	Since 1990s	~27	~ 25
Yazd	Since 1970s	~12	~9.4

Table 4.7: Groundwater over-exploitation in parts of the Iranian plains (Source: Motagh et al 2008 from InSAR-derived subsidence maps).

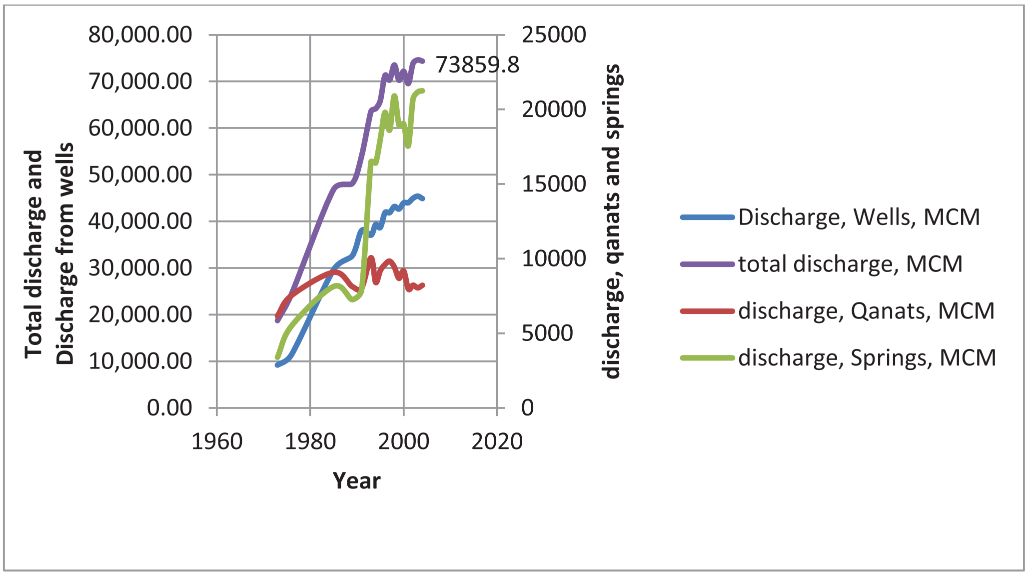

Figure 4.10:Shows discharges from different groundwater resources (1973-2004): (a) Left axis shows total groundwater discharges and abstraction from wells; (b) right axis illustrates natural spring and *qanats* flows and abstractions.

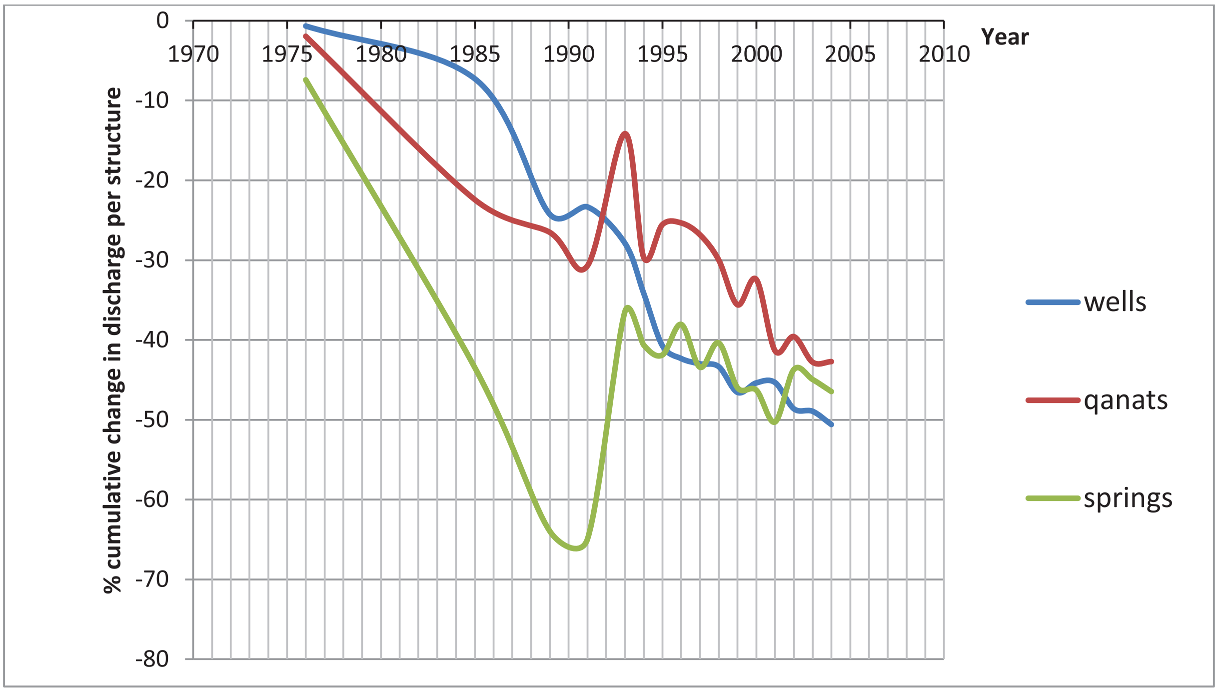

Figure 4.11: Annual rate of cumulative change of discharge per structure (1973-2005).

Pressures from pollutions. The land use policy was based on self-sufficiency and food security has exerted pressure on the environment. The excessive water demand in agriculture has posed a serious problem with land quality. There are over 1,000,000 ha of irrigated lands which are water-logged (source: FAO, 2009). As a result of water-logging, 30% of irrigated lands have been affected by salinisation (Siadat, 1999); which have led to low irrigation efficiencies. Nearly 20% of the renewable resources are coming back into the system as return flows with much lower qualities. Sewage and untreated urban and industrial effluents enters rivers and streams and hence groundwater and surface water resources pollution and degradation put huge Pressures on the water resources system.

Environmental services. The economic prosperity and overall higher living standards has placed huge pressure on the environment sector. Water allocation for the environment is not given any priority. This places a huge pressure on inland waters such as rivers as well as wetlands. Irrigation water efficiency is seen as the key to reducing the percentage of water use in agricultural sector for environmental purposed. But IWRMC (2005) predicts that water demands in 2021 will increase to 123,000 MCM; an increase of 30,000 MCM. The net increase in agricultural water use will be from 86,000 to 106,000 MCM. Hence, the reduction of agricultural water use in % terms is rather misleading. In real terms, the saved water might not return to the environment. In fact, IWRMC (2005) predict that it is expected to officially allocate5% of the total renewable resources to the environment (Figure4.12). This clearly shows that the future demands are not sustainable and there is a need for IWRM type of Responses i.e. more emphasis on demand management rather than build and supply perspective to deal with the environmental requirements of the water resources system.

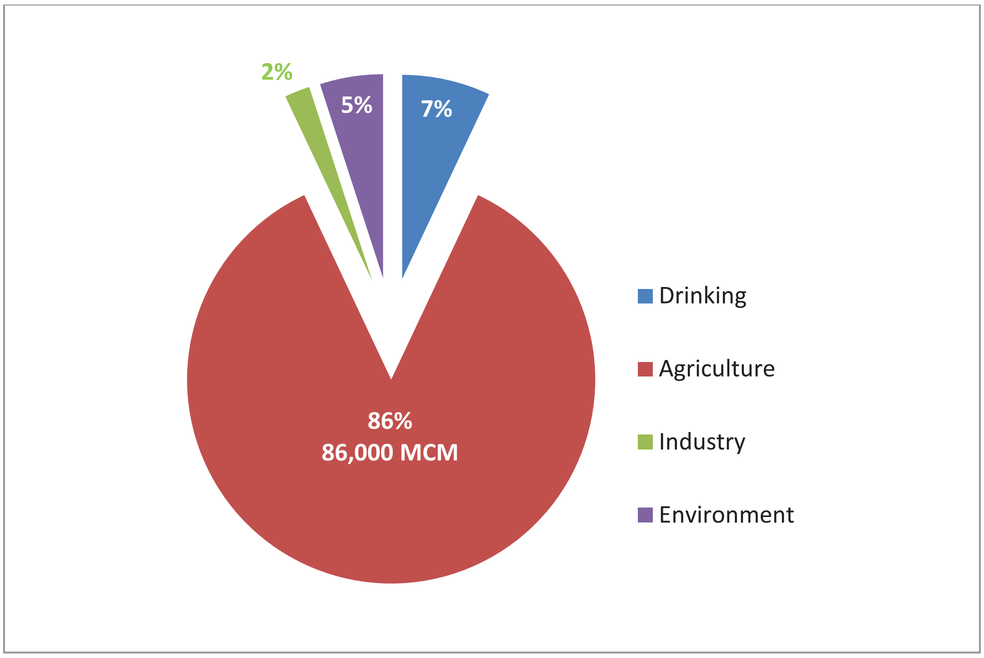

Figure4.12: Predicted future water demands in 2021(IWRMC, 2005)

4.4.3. States/Impacts

Better living standards but poverty looms. Iran has moved up 10 places in the Human Development Index HDI[17] ranking during the last 20 years and is now ranked 70th in the world (HDR, 2010). Despite stagnation in the income and a fall in the GDP, Iran has experienced good health and education indicators as reported by HDR (2010). Since 1990, water supply and sanitation have improved in rural and urban areas (IWRMC, 2005), and now more than 98% and 87% have access to safe drinking water in urban and rural areas, respectively. Low cost interventions have helped the non-income part of HDI to improve, but the income complement has not improved as such and so the poverty eradication policy has not been as successful due to inflationary and other factors; as mentioned before, some researchers suggest that up to20% of the population are living below the poverty line.

The status of environmental services. Valuing Ecosystem Services is not an easy task since much of environmental damage is traded off against economic benefits and

[17] HDI is a multi-dimensional index which reflects the wellbeing of the society and aggregate income and non-income based indicators.

reflected in the economic indicators such as GDP (World Bank, 2004). In 2000, the UN started the Millennium Ecosystem Assessment (MA)[18] to "assess *the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being*." (MA, 2005). The Word Bank (2005) produced a report on Iran which was a valuable attempt at highlighting the cost of environmental damage.

It is noted that industrial, hospital and municipal wastes are directly discharged into many rivers. Increased irrigation activities have caused groundwater and surface water resources pollution and degradation. World Bank (2005) notes that many watersheds lack proper land use or watershed management and so there are a great deal of soil erosion and sedimentation of dams. World Bank (2005) asserts that deforestation and poor land use management can contribute to increasing flood events. The number of floods has already increased from 192 events in 1950s to 1,341events in 1990s (World Bank, 2005)[19]. World Bank (2005) has estimated that the total environmental cost due to the degradation of water and land services represents 2.82 and 1.7 % of the GDP respectively. Land resources costs are due to cropland salinisation, rangeland degradation, wetland loss, and floods. For example in 1975, 16 of the 90 million ha of rangeland were considered to be in a poor state compared with 43.4 million ha in 2003.

Water stress. Water scarcity (shortage) in Iran (and the MENA region) is multi-dimensional. A World Bank Report (2007) highlights three factors influencing levels of scarcity including

a. Lack of physical resource.
b. Lack of organisational capacity and
c. Governance deficiencies (transparency and decision-making)

Physical resource scarcity. Water shortage in Iran is both a spatial and temporal phenomenon. Iran is approaching water stress level[20] (i.e.1700 m^3/capita): per capita renewable water resources are~1900 m^3/capita (MoE, 2010a). In 1956, annual renewable water availability was 7000 m^3/capita. By 2001, this figure had reached 2000 m^3/capita. It is expected to reach 1300 m^3/capita in year 2021(IWRMC, 2005; MoE, 2010a).

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[18] MA is used and not MEA as one might expect.
[19] As stated by MoE (2010a) in earlier parts as parts of the climate change discourse.
[20] Falkenmark's water stress index (resource per population per year) is a measure of scarcity of a country; based on a threshold of 1700 m^3/inhabitant/year as the requirement for sustaining the needs of population in all the sectors (see e.g. Falkenmark, Lundqvist and Widstrand, 1989)

Self-sufficiency policy on cereal production such as wheat has been adopted since the Pahlavi era but it became a real objective of the Islamic Republic and this policy has had a tremendous impact on the state of water resources as noted by Faramarzi et al (2009). Wheat self-sufficiency was achieved in 2005. But three years later, as shown in Figure 2.2 (Chapter II, Section 2.3.4), Iran needed to import wheat during the 2008 season to compensate for the shortage in production.

However, official strategy on Virtual Water 'trade'[21] (e.g. Zeitoun et al ,2010) has been opposed by policymakers despite empirical evidence (e.g. Memari[22], 2006; Chapter II). The perception is that any official Virtual Water strategy will encourage import trades which will be governed by globalisation forces such as international trade patterns. Memari (2006) draws a geo-cultural mental model (North- South and West -East divide) that Iranians who come from water scarce regions i.e. mainly East, Central and southern parts of Iran) are very sensitive to water scarcity and are "*interested in utilising and harnessing water [resources] .....They are interested in holding water in reservoirs rather than allowing it to flow [naturally] away [outside the region]*"[23]. Accordingly, Northern and Western Iran have not such sensitivities since they have plenty of water. Based on this analogy, since major policymaking centres in Iran lie in the arid regions (Central region e.g. Tehran, Semnan; Eastern region e.g. Khurasan; and Southern region e.g. Yazd and Esfahan),the cultural perceptions and discourses of these regions dominate public policy decisions i.e. they favour dam building.

Lack of organisational capacity. The perception of water sector performance by Iranian water managers is given in Figure4.13. (Source: survey questionnaires, Appendix A1). More than 82% of the participants believe that the water sector performance is average, below average or unsatisfactory.

[21] The issue of Virtual Water trading is dealt with in Chapter II.
[22] Advisor to Deputy Minister for Water Resources, He is a poet and a speech writer for ministerial ranks in MoE. As a cultural figure, he has a web of influence within the ranks and orders at the MoE. He is fluent in English, French and Arabic. His first degree was in Irrigation in 1953. Then he obtained an MSc degree in 1974.
[23] Many experts and policymakers consider natural flowing water and low efficiency water use to be 'wasted water'; this perspective is based on pure engineering utilitarian culture.

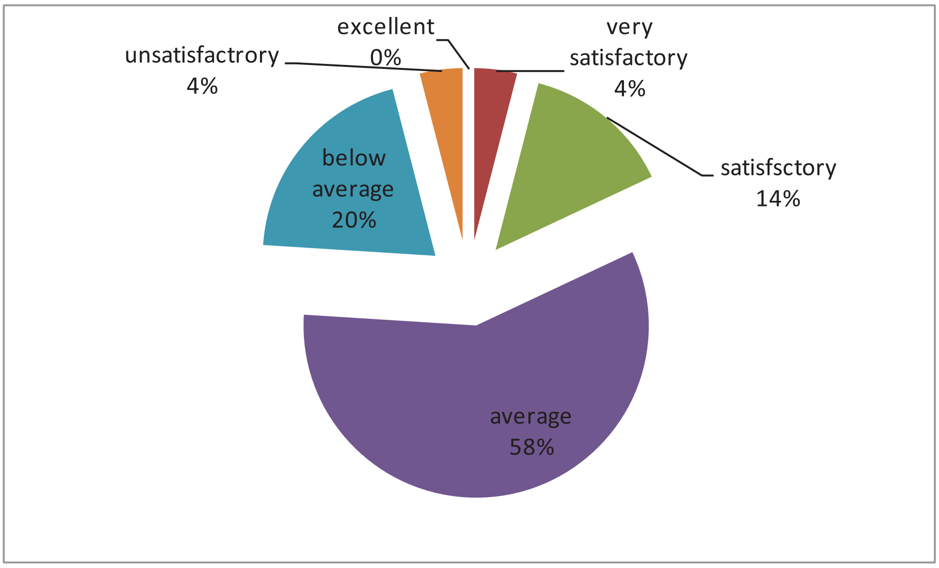

Figure 4.13: Perceptions of participants about overall water resources management performance (Source: Survey Questionnaires, Appendix A1)

The organisational capacity to manage water resources is limited since most of the efforts and investments have been placed on developing surface water whereas most of the consumption in the agricultural sector is from groundwater resources which are predominately privately -owned and managed by farmers (Figure 4.14). Memari (2006) suggests that there is a need for a new comprehensive water law[24], an integrated water policy and planning and water rights regime to overcome the organisational deficiency. The real question is whether IWRM can be implemented in Iran considering the state of the water resources system? The process of IWRM was initiated in the late 1990s and a few scattered projects were undertaken in various river basins. 26% of the participants had no idea about how IWRM plan is moving forward in Iran (Figure 4.15) (Survey Questionnaires, Appendix A1). 40% accepted the current management approach as integrated. Therefore, only 34% (a minority) asked for a change of approach. Bearing in mind that 83% the participants were from provincial departments, this shows that the IWRM policy has not filtered down the organisational channel. Furthermore, 50% of participants indicated that the very little consultation process took place for these new polices on IWRM which was formulated through smaller circles of experts and academics at national level; additionally there is no clear national strategy to implement IWRM

[24]Comprehensive Water Law Project was initiated in 1999 and lingered on with no consensus until it was dropped because of differences between MoE and MoAJ. The author was involved in reviewing the 9th version during 2007-8 and worked with the projects as an independent researcher.

(Figure 4.16). Therefore, institutional capacity development is needed to harmonise national and local level policy implementation strategies. IWRM should not be seen as a blueprint enforced by top-down approach as it was perceived by many participants because they were not involved in the process or at least 50 % of them.

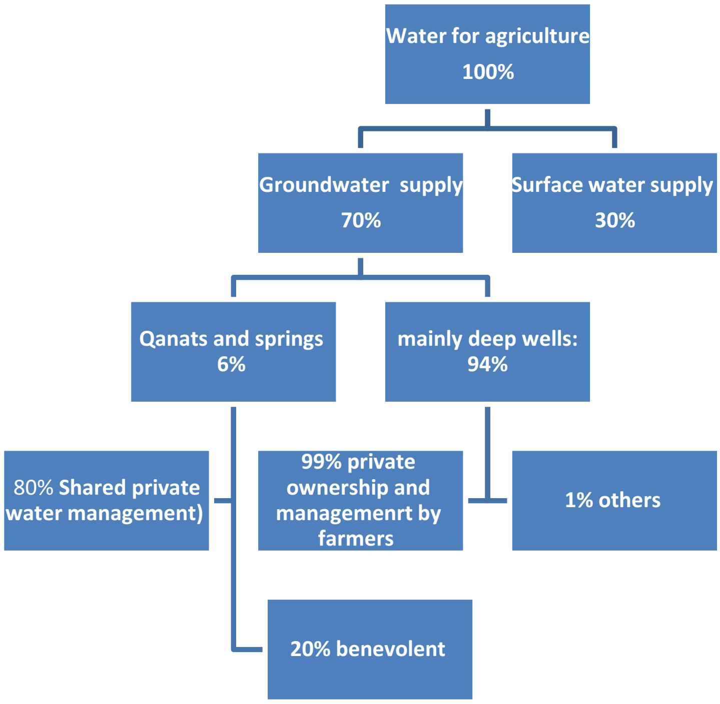

Figure 4.14: Schema showing agricultural water ownership and management (Memari, 2006; interview)

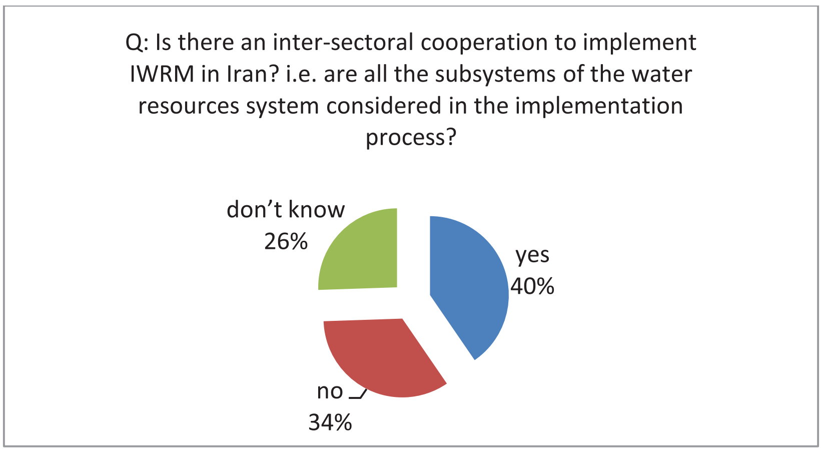

Figure 4.15: Perception of inter-sectoral co-ordination to implementing IWRM in Iran (Source: Survey questionnaires, Appendix A1)

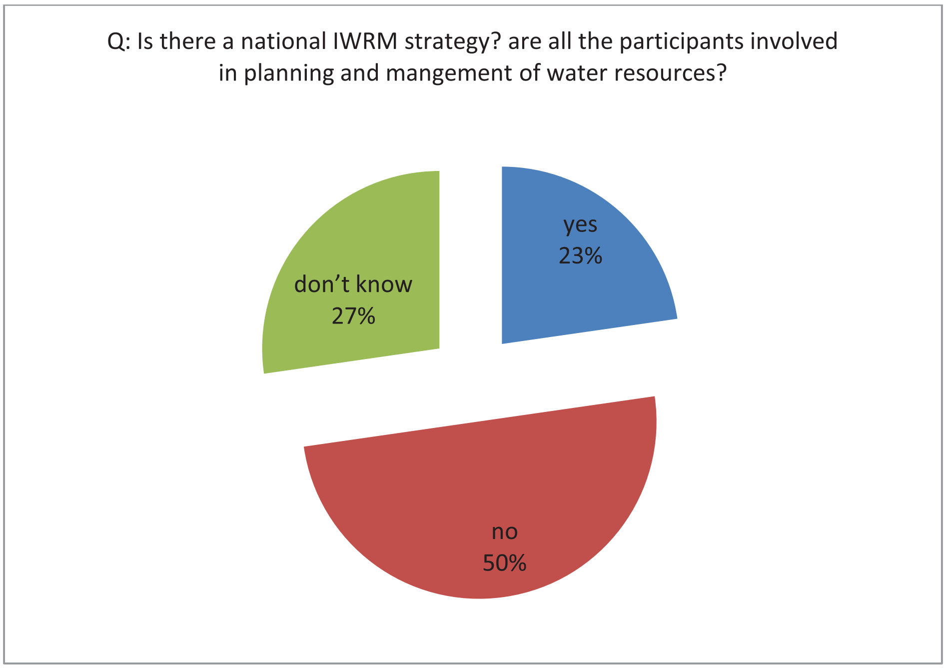

Figure 4.16: Perception of level of participatory approach in IWRM planning in Iran (Source: Survey questionnaires, Appendix A1)

Governance deficiencies. Earthtrends (2003) has narrated governance indices based on criteria set by the Freedom House [25]"*that advocates for American-style leadership in international affairs*" and have understandably given Iran a very low rating in terms of freedom 6 out of 7 for 2 criteria political rights (PR) and civil liberties (CL) where 7 is the worst case. The methodology is based on a list of questions that measure different aspects of CL and evaluated by a group of "*in-house and consultant regional experts and scholars*" (Freedom House, 2010). These are highly biased and subjective indices based on a list of questions that is and cannot be a good measure of good governance in Iran. However, they partially reflect contemporary governance issues. Worldwide Governance Indicators (WGI) developed by the World Bank/WGI (2010) are based on perception data and measure six categories of good governance since 1996 as tabulated in Table 4.8 which shows a mixture of improved and worsening indicators; it shows that Iran has improved in Control of Corruption and Rule of Law indicators.

[25] Based in New York, Freedom House is an advocacy organization close to the US government; it was established in 1941 to fight the Nazis and later was involved in anti-communist propaganda.

Indicators	1996	Rank	2009	Rank
Voice and Accountability	-1.3492238	11	-1.486247382	8
Political Stability and Absence of Violence	-0.63080443	24	1.518201658	8
Government Effectiveness	-0.64752027	29	-0.742798693	26
Regulatory Quality	-1.64474609	6	-1.737524811	3
Rule of Law (RL)	-1.17095084	13	-0.900895771	20
Control of Corruption (CC).	-1.0686678	13	-0.829989113	22
Notes:				
Ranks are based on 1-99 where 1 is the worst				
Indicators value between -2.5- 2.5 where 2.5 is highest (best)				

Table 4.8: Change in good governance indicators for Iran from 1996 to 2009 (World Bank/WGI, 2010)

Participants show a large degree of dissatisfaction with water sector governance and there are calls for the introduction of new laws and capacity development. Areas such as accountability, government effectiveness, regulatory quality and rule of law have been highlighted. 89% of the participants emphasised the need to strengthen the current governance set up and for new ‘enforceable’ legislative measures as indicated in Figure 4.17 (Source: survey questionnaire; Appendix A1).

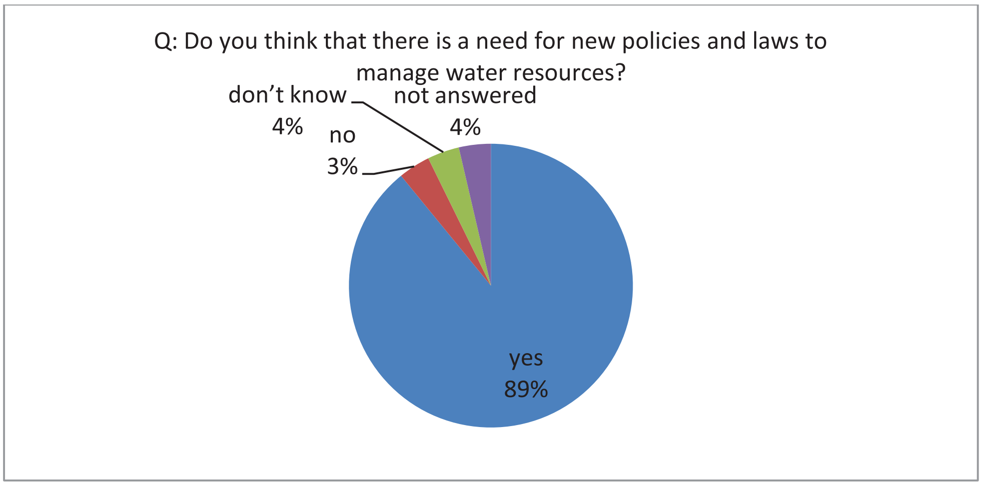

Figure 4.17: Perception of the need for institutional reforms (Source: Survey questionnaires, Appendix A1)

Water storage capacity has increased from 14.6 BCM in 1979 to 30.4 BCM in 2010; a total of 588 dams are in operation (see Table4.9). However, the volume of reservoir storage behind the dams has been fluctuating and sometimes they are less than 50% full. Climatic variability and the resulting droughts or dry spells have resulted in these dams operating under their capacity. Also, another feature is that many dams lack primary irrigations networks beside secondary and tertiary networks. Due to the arid climate, a considerable amount of water is evaporated from the reservoirs which amount to 1.22 BCM/year (FAO, 2009). There are massive water transfer projects such as Sirvan-Garmasiri project which entails 400 km of tunnelling and a large number of diversion and storage dams. The whole system has high vulnerability to both system failure and climatic variability and change (Hashemi, 2008a).

Development Plan periods	*No. of dams*	*Regulated volume, MCM*	*Irrigated land, ha*
Pahlavi Era			
Pre-development planning	24	12	190
1st SYDP: 1948-1954	1	0	0
2nd SYDP: 1955-1962	5	5915	307,240
3rd FYDP:1963-1967	4	307	31,800
4th FYDP: 1968-1973	7	3587	379,371
5th FYDP: 1974-1979*	4	4370	140,872
Subtotal Pahlavi era	**45**	**14,191**	**859,483**
Dawn of Islamic Republic in 1979			
Iran-Iraq war: 1980-1988	113	1486	168,162
1st FYDP: 1989-1993	75	762	56,833
2nd FYDP: 1994-1999	157	2007	203,289
3rd FYDP: 2000-2004	126	7492	571,436
4th FYDP: 2005-2010	72	4690	320,033
Subtotal after 1979	**543**	**16,437**	**1,319,753**
Total	**588**	**30,628**	**2,179,236**

* 2 dams completed in 1979 which were ready just after the revolution so 1979 is added to this era.

Table 4.9: Water resources development (dams and irrigated area) 1948-2010 representing the Pressures by the short term development plans (Source: IWRMC, 2009/2011).

4.4.4. Responses:

In this section, past Responses are analysed to understand the institutional evolution of water resources planning and management providing an overview of the institutional performance.

Responses under uncertainty. As discussed earlier, 9 ‘Development Plans’ have been implemented since 1948. In the process, the water industry has become a subject of national pride by fulfilling the ambitions of the political domain through engineering progress. But, as a result of these developmental drives, many challenges appeared in the water resources sector including: entering a water stress phase; depletion of groundwater resources; pollution of surface waters; an increased gap between demand and supply leading to the rise of social conflicts according to MoE (2010a).

From ancient history of Iran, the need for irrigation was based on an economic perspective for more revenue to the state coffers from agricultural produce (see e.g. Ravandi, 1975). This has been accompanied by the need for developing water distribution systems such as *qanat* groundwater system and canals for irrigation. The historical legacy is mixed with the new discourse on climate change. So, the need for more development is not only to deal with economic security but it is about water and food security. The perception is that the vulnerability to climate change can be offset by harnessing the renewable surface water resources. The complex hydraulic systems need an integrated management approach and hence, there is a great interest in the 'M' component of the IWRM concept based on risk assessments.

In the next part of this section, I present the historical development of ***Non-structural Response*** i.e. the evolution of rules in use and changes in perspectives among major actors in water sector[26].

Monarchy era 1909-1979. During the early monarchy era, the 1906 Civic Code established private water and land rights. The first water law was the 1929 Qanat Law. In 1943, the Independent Irrigation Agency '*Bongah*' was established to allow for a central planning and management of water and land resources. New dams and irrigation networks were established and hence the state officially tried to control surface water provisions. More importantly, traditional groundwater management systems such as *qanats* were neglected and drilling for private and public deep wells started in the mid-1940s.

The 1959 Water Resources Blueprint paved the way for the development plans. During the 2nd SYDP, in 1962, the *Bongah* became part of the Ministry of Water and Power (MoWP). Regional and provincial water authorities were established during this period to oversee the modernisation efforts.

In order to implement the plans, Muhammad Reza Shah's 'White Revolution' and Land Reform accompanied important water sector legislation such as the creation of Ministry of Water and Power (1962) and the1968 Nationalisation of Water Resources Act (Beaumont, 1974) which was the basis of the 1982 Fair Water Distribution Act which has remained as

[26] The historical evolutions of Ministry of Energy and water legislations were described by Memari (2006) in his interview. Later the transcript was corroborated with official publicly accessible information.

the most important water law in Iran. MoWP expanded and changed its name to Ministry of Energy (MoE) in 1971.

The first conservation law was the Game Law which was enacted in 1956 to establish the Game Council. This law was proven to be difficult to implement due to the socio-political climate of the time (Firouz et al, 1970). In 1967, the Game and Fish Council was established with broader responsibilities including creating protected areas and national parks. In 1971, the Game and Fish Council was upgraded to a ministry within the office of the Prime Minister, namely the Department of Environment (DoE). Eskandar Firouz[27],one of the leading charismatic environmentalists, became DoE’s first director.

Firouz was a major actor in the 1972 Stockholm Conference on Human Environment and was elected as one of the 26 vice-presidents of the Conference (Gowdy Wygant, 2004) and later became the vice president of the IUCN. He was instrumental in enacting the 1974 Environmental Protection Act which has remained an important legislation to date.

Earlier in 1971, Firouz organised a Convention on wetlands held in the Caspian seaside resort of Ramsar. 18 countries signed the Convention which was named the Ramsar Convention on Wetlands and was adopted officially in 1975. In line with Shah's grandeur vision, Firouz initiated one of the most expensive *Pardisan*[28] Ecoparks (1973-1978).

Despite the dominance of the oil economy and the decline of agriculture, landmark policies and laws were introduced in the 1970s: in 1974 the Environmental Protection Act was adopted. The Department of the Environment became more significant during this period. In addition, Iran signed international conventions and protocols such as 1948 International Union for Conservation of Nature and Natural Resources in 1974. Firouz was able to establish a more institutionally powerful DoE by the late 1970s.

Post Revolution, 1979- 2008.This period can be divided into 5 main phases as follows:

1979-80: Political instability. The new Constitution was enacted despite chaotic socio-political, security and economic conditions. Articles 44, 45 and 50 of the Constitution deal with privatisations, water rights and the environment, respectively. The latter is credited to Taqi Ebtekar who became Director of DoE towards the end of 1979.

[27] Prince Firouz (b.1926-) is a grandson of former Iranian *Shahensha* 'King of Kings’ of the previous Qajar Dynasty, an alumni of Yale University and is known as the father of Iran's Environmentalism.
[28] Farsi word for Paradise

1980-1988: The Imposed War. During the period 1980 - 1988, some 27 thematic water laws were passed (Memari, 2006). Notably, an important piece of legislation was adopted in 1982: the Fair Water Distribution Act. This Act was an attempt to officially control groundwater resources as 99% of groundwater is controlled by private land owners either by shared customary rights in the case of *qanats* or privately owned wells. The owners were offered 'Water Allocation Permits' or 'Licences'.

1989-1997: Reconstruction period. Since the late 1980s, the trend was to break up regional water authorities into provincial water authorities and now there are 33 companies in the 30 provinces[29]. This was to create a provincial base for the reconstruction drive guided by the FYDPs. Another important land mark was the Bill for the Establishment of Water and Wastewater Companies for urban areas (1990) and rural areas (1998). The aim is to completely "privatise" all the companies (owned by the state); at present, they operate privately under the auspices of the Mother State Companies: Iran Water Resources Company (IWRMC) and Iran National Water and Wastewater Company (INWWC). These companies are not economically viable and make cumulative losses and are financed by the central treasury. The economic value of water is not appreciated. Water is traded at a small fraction of its full cost.

By 1997, Iran had signed over 24 major international conventions related to the environment, and Water Master Plans for all the rivers basins were completed (Jamab, 1998) which was an important water resources study.

1998-2008: Reform period. Legal reforms were initiated in the late 1990s and the Environmental Impact Assessment (EIA) Act was enacted in 1998. Large projects are required to have proper EIA studies. The institutional and political fragmentation of the agricultural sector was evident from the post Revolution Land Reform series of events as described earlier. For example, MJS exercised more power in the rural areas and did not cooperate with MoA; many of their works overlapped. Thus, from 1987 onwards, there was a call to merge MSJ with MoAJ to create a new Ministry of Agricultural Jihad (MoAJ). Finally, The Bill to create MoAJ was enacted in 2001.

MoE has officially adopted the IWRM concept in 2003 (IWRMC, 2004) with emphasis on a holistic, integrated approach to water management which were inspired by a new understanding of the Constitution dealing with the environment. Furthermore, Article

[29] The 31st province was created at the start of 2011; Alborz province which was part of Greater Tehran, taking Karaj as its capital.

17 of the fourth 5 Year (2004-2009) Development Plan (FYDP) asserts the principles of IWRM and sustainable development based on a river basin approach (MPO, 2005). It refers to water as playing a 'central' role in development of the country and appreciates the economic and environmental value of water. Thus, there is a movement in the right direction by having better polices and acknowledging the link between water resources management and sustainability. The green credential of the 4th FYDP was enhanced by Article 67 which explicitly asks for drafting and implementing an ecological management plan for Lake Urmia and other wetlands.

Table 4.10 shows some important legislation which paved the way for the introduction of IWRM in Iran. The introduction of the 2003 Water Allocation Directive provides a detailed procedure for river basin planning and sustainable water allocation decisions. The directive asserts that the water allocation policy is based on dynamic simulation of water resources availability at river basin level.

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Legislations	***Year***	Articles
Approved Polices of the Expediency Council	2000	6
Principles of the Water Resources Management	2000	28
3rd 5 Year Socio-economic Development Plan (1999-2003): Section 3	1999	6
IWRMC Mother Holding's Articles of Association (Public Company)	2003	33
Water Allocation Directive	2003	
Long Term Strategies for the Development of Iran's Water Resources (IWRM Plan)	2003	18
Law of Promotion of Investment in Water Projects in Iran	2003	15
4th 5 Year Socio-economic Development Plan (FYDP) (2004-2009):	2004	23

Table 4.10: The reform of the water sector through legislations (1999-2004).

4.5 Discussion

Iran has made tremendous progress in terms of living standards and, since 1948, with the exception of the Imposed War (1980-88), has embarked on massive reconstruction and modernisation development projects in the water resources and agriculture sectors. Iran holds the fifth position in dam building and size of irrigated area in the world. The anthropogenic and demographic dynamics have been Drivers for change and relative prosperity. Contemporary Iran has been moulded into a highly urbanised consumer society; the rural regeneration has occurred but with less population and less importance.

Incomes from oil provide 75% of the budget. This rentier economy (i.e. based on selling oil) has shown erratic fluctuations as economic and inflation growth rates have been unpredictable, showing the influence of oil price instability on the economy. As coined by McLachlan (1988), Iran can be described as "*the neglected garden*" since agriculture has been neglected and Iran moved from an agro-economy to an oil economy. The irony is that the promotion of agriculture and agro-society has been part of the psychic and mentality of Iranian policy makers: that 'Iran can attain food self-sufficiency' has been entrenched even in the 1979 Constitution[30].

The DPSIR analysis at the national level has shown that, as a result of the historical economic growth Drivers, there are great pressures on the water resources both in terms of quality and quantity. Environmental degradations have accompanied better economic living standards. Informal and unauthorised abstraction for agricultural use has become an important common practice and account for nearly 11% of the total water use (nearly 10 BCM) of groundwater and about 50% of the surface waters. The use of water cannot be easily policed. Also, despite building many dams, the associated irrigation and drainage networks have lagged behind and many dams lack even primary irrigation networks and are thus rendered useless.

Lack of consideration for environmental concerns has been noticed. The 1974 Environmental Protection Act has not been updated and clearly, this cannot satisfy the environmental sector. A major shift occurred in the late 1980s and 1990s where the question of sustainability was highlighted, but the war-torn Iran embarked on more developments, and since 1989, has implemented four more FYDPs.

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[30] Article 3, Clause 13 states "*the attainment of* ***self-sufficiency in*** *scientific, technological, industrial,* ***agricultural****, and military* ***domains****, and other similar spheres*".

Fast institutional changes have occurred in the water sector. Since 1943, the state has been trying to control water resources planning and allocation. The institutional changes have been dramatic and progressive but have failed to completely tackle private water rights and enforce water laws. The institutional changes have been the result of an ad-hoc approach. The evolving nature of water sector institutions shows that institutional equilibrium has not been reached. As previously stated, 89% of the senior water managers expressed the view that there is a need for institutional reform.

Emergence of climate change discourse. Since the 1990s, Iranian policymakers have been aware of climatic change as a major driver and so embarked on a policy of executing basin-wide planning exercises. Water allocation has been a source of conflicts between different provinces. So, MoE has been trying to implement the 2003 Water Allocation Directive (WAD) which is based basin-wide planning. The idea has not been welcomed at provincial level. We will come back to this issue in Chapter V (Lake Urmia case study). Since 2003, WAD has been promoted by MoE's Water Policy and Allocation Commission (WPAC). MoE has embarked on an institutional capacity building programme to train water companies on the river basin planning.

4.6 Concluding Remarks

Paradigm shift. Senior managers and experts in the Office of Macro Planning at MoE have come to the conclusion that dam-building as a Response to the Drivers in years gone by, has created unsustainable Pressures on the resources, as has happened in many other countries; hence the need for revised Responses based on IWRM principles and there should be a reassessment of development plans (Appendix A1, Tables A1.1-A.1.4). However, these decisions are solely political and the socio-political Pressure such as lobbying MPs, provincial Governors and farmers have created a two tier discourse within MoE: a regional development discourse is favoured by Regional Water Companies and IWRMC and the IWRM discourse is strongly advocated by some sections of MoE. Therefore, the non-structural Responses (legislations, new administrations and rules etc.) have not guaranteed the implementation of sustainable polices adopted since 1999 due to disparity in priorities among major actors; political influences, lack of institutional capacity development and so forth.

Water allocation planning and allocation are mainly political and hence, there should be both lateral and vertical capacity buildings. MPs and provincial governors hold a great deal of influence in terms of provincial development objectives which are based on political boundaries and not the river basin approach. Therefore, MoE has recognised that water resources planning and allocation is one of the major challenging issues. Internal conflicts and different perspectives within MoE at governance level have caused the '*Business as Usual*' (BAU) to continue in terms of water planning and allocation. Also, the implementation of the 2003 WAD has been hampered by the 'build (dams) and provide' lobby which has been (and remains) a strong thread of thinking among policymakers within MoE. Lack of information about abstraction from rivers and streams and data uncertainty and lack of cooperation between provincial water companies have led to a lull in the progress of enforcing the 2003 WAD.

Emergence ofcentralised groundwater resources governance. There has been some success with regards to control of groundwater resources. The 1982 Act required well owners to register their wells to provide them with Permits. However, this controlling measure has been marred with over subscription of permits which has caused a great deal of problems.

Groundwater resources are literally managed by farmers and well owners (Memari, 2006). MoE's policy has been to bring some order to surface water management through the enactment of 1982 Act. MoE overlooked groundwater and concentrated on controlling surface water by investing in dam-building and irrigation network projects. 90% of the investments has gone towards the projects (MoAJ, 2008); but in the process they have created more water rights, much tension among upstream and downstream stakeholders and lost some control to socio-political forces. In Lake Urmia for example, 27% more abstractions are taken from the rivers informally (MoE, 2010b). In fact, there is no formal water allocation for dams in Lake Urmia basin with more than 60 dam-building projects (Appendix A1; Table A1.4). MoE has failed to implement IWRM in its first phase of introduction (1999-2008). Institutional reforms are not sufficient unless there are water use efficiency strategies as well as capacity development. Build and supply approach will lead to disaster.

MoAJ has become a giant ministry with a wide-ranging mandate (from farming to building small dams). It is like a dinosaur that cannot locate its prey. The MJS cloud is still hanging over it and perhaps it has not reached an institutional equilibrium.

There is a consensus that there is a need for a better institutional design to cater for complex governance systems which exists within multilevel smaller nested agricultural enterprises. A community-based participatory water resources management approach has been advocated by most of the participants in Lake Urmia basin (LUB) based on the social research conducted as described in Appendix A1.

In chapter V, LUB has been taken as a case study to make an integrated assessment of water allocation decisions at basin level since water allocation is central to the implementation of IWRM. LUB is a suitable case study for the following reasons (not an exhaustive list):

- Lake Urmia is one of the 6 main river basins of greatest importance in Iran (Figure 4.18). The Lake itself is considered to be one of the "*most important and valuable ecosystems in Iran"* (WRI, 2005) and had been declared as a National Park, Ramsar Site (since 1971) and UNESCO[31] Biosphere Reserve (since 1976). In addition, the Lake is surrounded by equally internationally important freshwater satellite wetlands including Ramsar sites. Although, the basin is only 3% of the total area of Iran, it contains more than 7% of the total available freshwater resources. Therefore, it is of vital importance within the water resources management and planning strategies.
- In the last 10 years, there have been more than three major national and international projects with the aim of implementing IWRM. Article 67 of the 4th FYDP (2005-2010) specifies to implement a participatory project to formulate an ecosystem management plan based on IWRM paradigm for Lake Urmia basin; therefore, there was a window of opportunity for the author to get involved in the formulation and implementation of the IWRM plan.
- It provides a classic case study for common pool resources management in which water allocation among different interests is central in the implementation plan. The Lake itself is a salt lake similar to the Aral Sea in the neighbouring countries of Middle Asia which has almost dried up (98%).
- The basin is situated within three provinces and so it can be considered as a trans-boundary water allocation case study with cross-cultural conflicts.

[31]United Nations Educational, Scientific and Cultural Organization

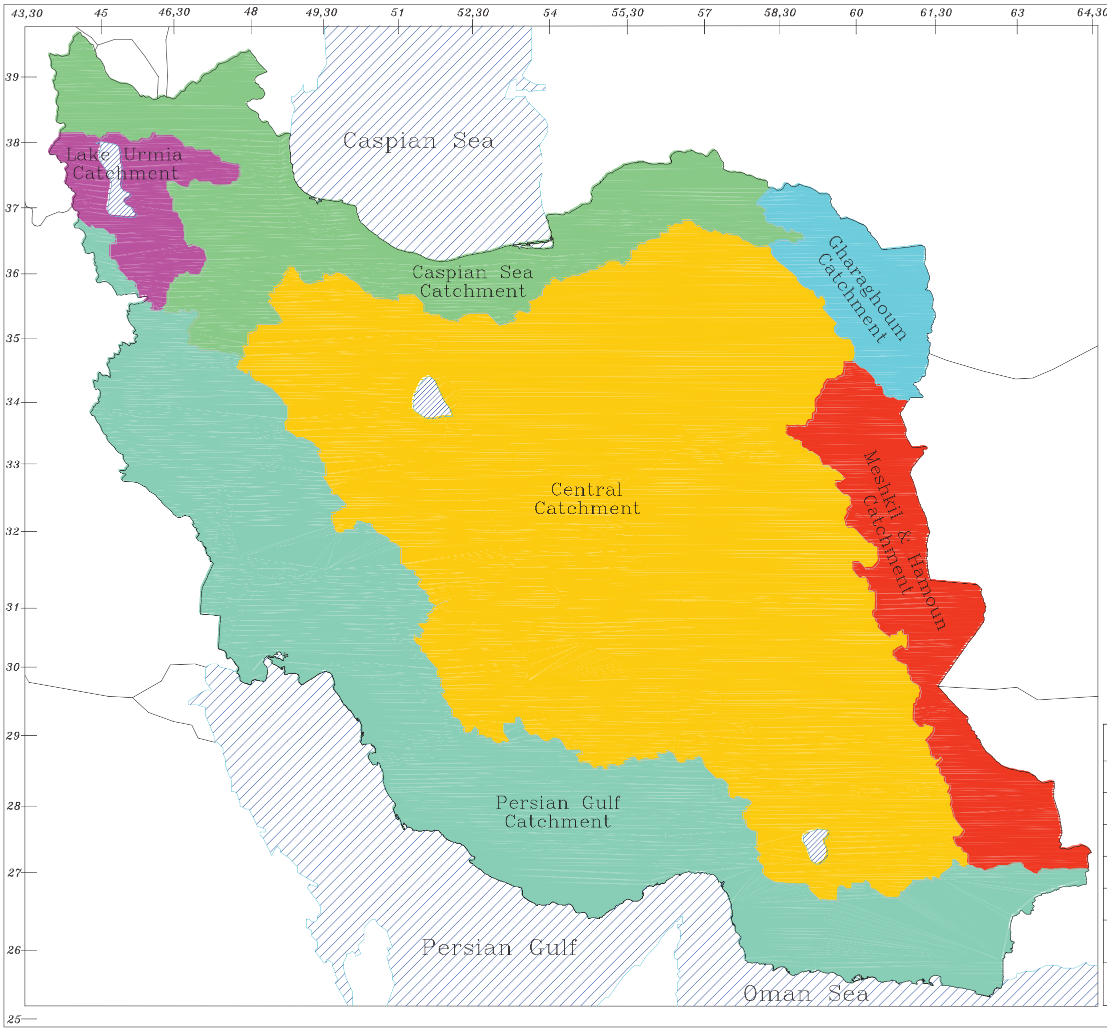

Figure 4.18: Major river basins in Iran (Courtesy of WRI, 2005).

Chapter V. Towards Sustainable Water Allocation Decisions in Lake Urmia Basin (LUB):

5.1 Introduction: a historical context towards IWRM in Lake Urmia Basin

Start of IWRM initiatives. Lake Urmia basin has been an interest to the Iranian policy/decision-makers since it has nearly 7% of Iran's water resources. A massive programme of dam-building and irrigation networks have started in late 1960s. However, a growing attention has been on Lake Urmia that has shrunk with falling water levels since 1995. So, Lake Urmia has been registered on the political agenda since 2000. In late 1990s onwards, several multidisciplinary joint projects were initiated with international partners including:

- 1994-2002: a joint Dutch-Iranian and the World Bank venture which was part of the Environmental Component of the IIP (EC-IIP) to evaluate and design land and water resources development programme of 4 sub-basins in LUB (1994-2002) (Yekom, 2002); and
- 1998-2005: the IWRM for Lake Urmia project (WRI, 2005).

Emergence of a socio-economic Driver. The 4th FYDP (2005-10) explicitly asks for drafting and implementing an ecological management plan for Lake Urmia indicating the main boundary and position rules:

Ecological management plan in sensitive ecosystems, especially in Orumiye[1] Lake will be prepared and implemented. Executive By-law of this Article will be prepared by the Environment Protection Organization[2] in cooperation with the Management and PlanningOrganisations, and Ministries of Energy and Agriculture Jihad, and shall receive approval of the Council of Ministers. (MPO, 2005 p.106)

[1]The spelling for Urmia used by MPO (2005) is kept.
[2] This is DoE; MPO (2005) uses this term in translations

Evolvement of Participation mechanisms. In line with the above ruling, in February 2005, DoE on behalf of the government signed an agreement with the UNDP/GEF to conduct a 7 year project named as *Conservation of Iranian Wetlands Project*, CIWP (Figure5.1). The IWRM project proved to be a "*strong catalyst for the approval, design and execution of this GEF project*" (WRI, 2005).

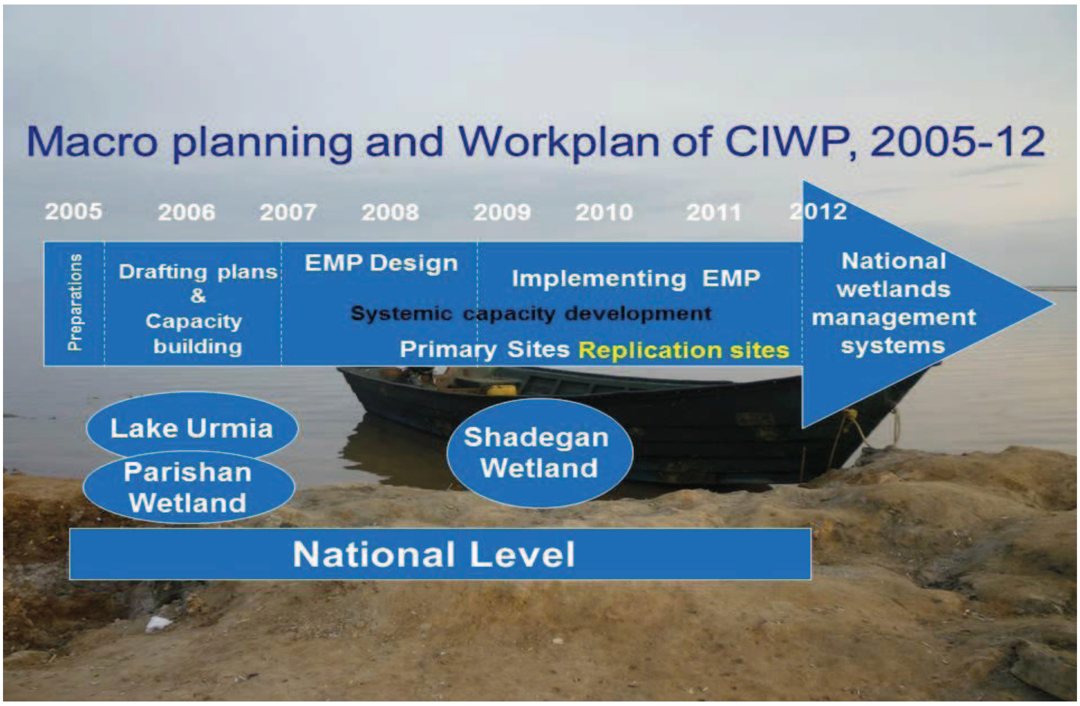

Figure 5.1: Timeline of CIWP's workplan (Source: CIWP, 2010; Photo by author).

Both IWRM for LUB Project and CIWP are a continuation of the EC-IIP (Yekom, 2002) which proposed an ecosystem management plan and an implementation action plan. This was the first attempt to make Lake Urmia the central theme of the studies as previous studies mainly concentrated on water and agricultural developmental potentials.

Window of opportunity. In 2006 (start of the PhD work), the author was introduced to the CIWP[3]. The CIWP had a slow start as it coincided with the inauguration of a new President; it almost collapsed and the project's team were released from their duties during 2006-2007. In early 2007, the CIWP was given a new mandate and has been led by a new National Manager, Dr Ali Nazaridoust[4] who has just ended his PhD thesis on the subject of

[3] This was facilitated by a distinguished scholar, Dr Jalal Attari, former graduate from Imperial College, University of London and Project Manager of the IWRM for LUB Project and deputy Chancellor of Water Research Institute (WRI), MoE, who accepted to become the author's PhD consulting supervisor in Iran as part of Newcastle University regulations for combined PhD degrees.
[4] At that time, Nazaridoust was also an environmental expert at MoE.

ecological water requirement of Lake Urmia. In 2007, the author was invited to attend various workshops and seminars (Appendix A1) as an observer and independent researcher. In 2007, CIWP initiated a consultation exercise to allow for the interaction of stakeholders from the three provinces under a new management. The CIWP invited the author to most of the stakeholder meetings. LUB was established as the new action arena.

Formations of Multi-stakeholder Platforms. In 2008, after several stakeholder consultations, an important step towards implementing IWRM in LUB was taken as a Memorandum of Understanding (MoU) was signed by all the stakeholders; adopting an Ecosystem Management Plan (EMP)[5]. In Chapter IV, we have witnessed that Iran has moved towards river basin planning and management within the legal context of the 2003 Water Allocation Directive (WAD). At national level, there is a consensus that the status quo is not sustainable; hence there has been a call for implementing IWRM. The 2003 WAD requires water allocation to be made based on river basin level rather than the geopolitical boundaries i.e. provinces. But as noticed, a top-down approach of management still prevails.

The objectives of this chapter are:

- To make a DPSIR analysis to assess the progress made with respect to implementing IWRM in LUB for the pre 2008 (MoU) period
- To employ IAD to make an institutional analysis to analyse the sustainability of water allocation governance for the same period by analysing the efficacy of water allocation rules in use mainly legislations at three levels of decision-making.

In the next section, the methodological approach to achieve the above objectives is described.

5.2 Methodology: data collection and analysis

Data collection. With reference to Chapter III and Appendix A1, the same data collection methods are used as described in Chapter IV, Section 4.2.1. The baseline data and information in this chapter is based on a synthesis of a considerable amount of secondary data which was obtained during the stakeholder meetings (workshops, working groups, seminars etc.) and provided by the stakeholders, carried out by Hashemi (2008).

[5] The ceremony was held in Urmia city on the 20th of October.

We will return to this theme in Chapter VI. Any data or information used is accordingly referenced in the text.

Analytical approach. With reference to Section 3.8 in Chapter III, the Integrated Socio-technical Framework is applied as follows:

- Similar to Section 4.3 (Chapter IV), the contextual setting is described in Section 5.3.
- Having projected a national outlook of the WRS in Iran in Chapter IV, the DPSIR component is used to map different aspects of the WRS at Lake Urmia basin level by repeating steps 1-3 used in Section 4.2.2. This captures the changes occurred to the WRS of LUB during 1909-2008. It also provides the development of the water resources allocation governance system at different decision levels (Section 5.4).
- In Section 5.5, the efficacy of the major legislations on water resources allocations assessed by for a transitional period from the start of IWRM initiative to the signing of the MoU i.e. 2003- 2008 Using the IAD component. This represents the analysis of water allocation for '*Business As Usual*' scenario. The efficacy of these Responses is measured by the level of their implementation
- The combined DPSIR-IAD assessments at national level will have a direct bearing on the provincial action situation; hence, Chapter IV is a prerequisite reference for this chapter; thus the results and arguments presented in Chapter IV will not be repeated in Chapter V. However, Chapter V attempts to highlight the relevant specific characteristics of the Social-Ecological Systems at local level (i.e. at Lake Urmia basin level).

Finally, discussions and conclusions are given in Sections 5.6 and 5.7 respectively.

5.3 Contextual setting

5.3.1 Pre MoU Action arena and action situation

The action arena is Lake Urmia Basin (LUB) which is located in NW of Iran between 44°-07′ and 47°-53′ eastern longitude and 35°-40′ to 38°-30′ northern latitude has an area totalling 51,876km^2 is situated in the west of Iran covering 3 provinces: West Azerbaijan (WA), East Azerbaijan (EA) and Kurdistan Provinces. Around 500 km^2 of the basin is located in Turkey (Figure 5.2). LUB covers the northern slopes of Mount Zagros and the eastern slopes of the mountain ranges between Iran and Turkey with arid-semi arid climatic conditions. It can be classified as an endorheic (closed) drainage catchment and Lake Urmia (LU) acts as a sink.LU has a surface area of about 5,100 km^2 and is surrounded by equally internationally important freshwater wetlands including Ramsar sites mainly in the southern part. The area around Lake Urmia is a National Park or a protected area and considered as an "*ecological zone*" (Yekom, 2002). The action situation which is provincial water allocation is described in Section 5.5.

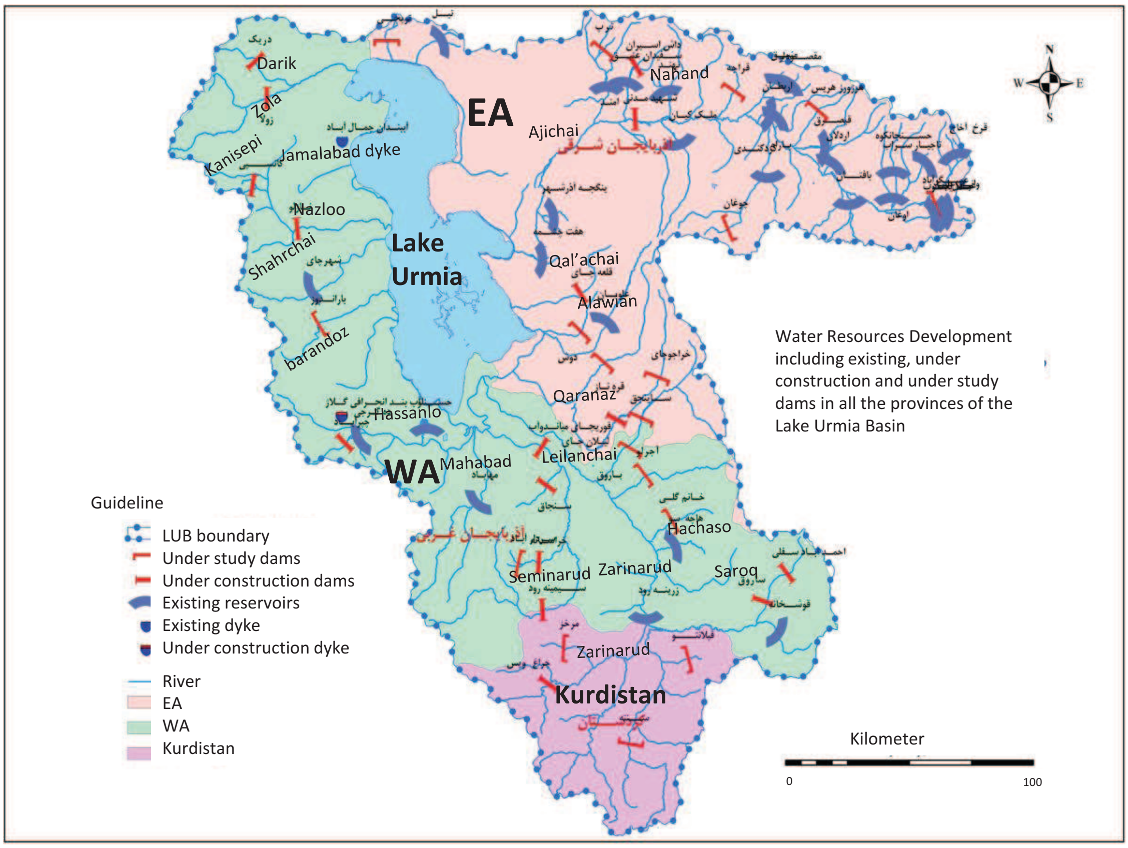

Figure 5.2: Map of Lake Urmia basin showing the political boundaries of the provinces situated within LUB and water resources hydraulic infrastructure.

5.3.2 Actors

Key actors are given in Figure5.3. MoE is responsible for water allocation as recognised by the 1982 Fair Water Distribution (FWD) Act. MoE is bestowed with decision-making powers for the water resources planning process which ends up in water allocation policy. The 2003 WAD provides specific action plan for the allocation process.

Several other national and provincial political institutions have played a major role in water allocation process. These include, MoAJ, DoE, the *Majlis* (MPs), Presidential Office and provincial governors. Based on the qualitative data i.e. questionnaires and interviews and stakeholder meeting (Appendix A1, Tables A1.1- A1.4), the political leverage on the MoE is fourfold: (1) the *Majlis* has powers to approve developmental priorities and budgets and controls water price which is set every year by an Act of Parliament; (2) provincial politicians together with local MPs have been a source for lobbying for greater water resources development and greater allocation; (3) MoAJ has pursued a demand driven policy and have been actively building small water supply dams[6]and hence in effect bestowed with water allocation powers; (4) Presidential By-laws for development of provincial water resources and irrigation projects have placed a pressure to give more allocation. Council of Ministers and its subcommittee, the Supreme Water Council[7] has watered down the MoE's decision- making powers.

At provincial level, MoE is represented by the regional water companies (RWCs). Water allocation is made at the national level but provincial conflicts are sorted out atthe provincial Water and Agricultural Commission which is a subcommittee under the Provincial Economic and Production Working Group of the Planning Bureau at the Governor's Office. The Commission can make recommendations to be approved in the Provincial Planning Council

At local level, farmers are by large the main actors and they are not involved in the formal water allocation process. Provincial agricultural Jihad organisations (AJOs) represent their interests and conflicts can be resolved in the Water and Agriculture Commission. District organisations of the governmental departments are the first point of contact of water users. Initial individual applications have to be first approved by the district (i.e. county level) departmental organisations.

Independent consulting engineering firms such as Mahab Ghods (a subsidiary of MoE), Jamab, Yekom and Pandam Consulting Engineers and over 50 public research institutes such as MoE's Water Research Institute (WRI) have been involved in collecting baseline data and information and analytical results on all aspects of water resources planning and future water demands as well as management of the resources in Lake Urmia basin. But water allocation process has not been the focus of their studies. Jamab (1998) presents the Water Master Plan for the basin but it does not include inter-provincial or provincial water allocation strategy.

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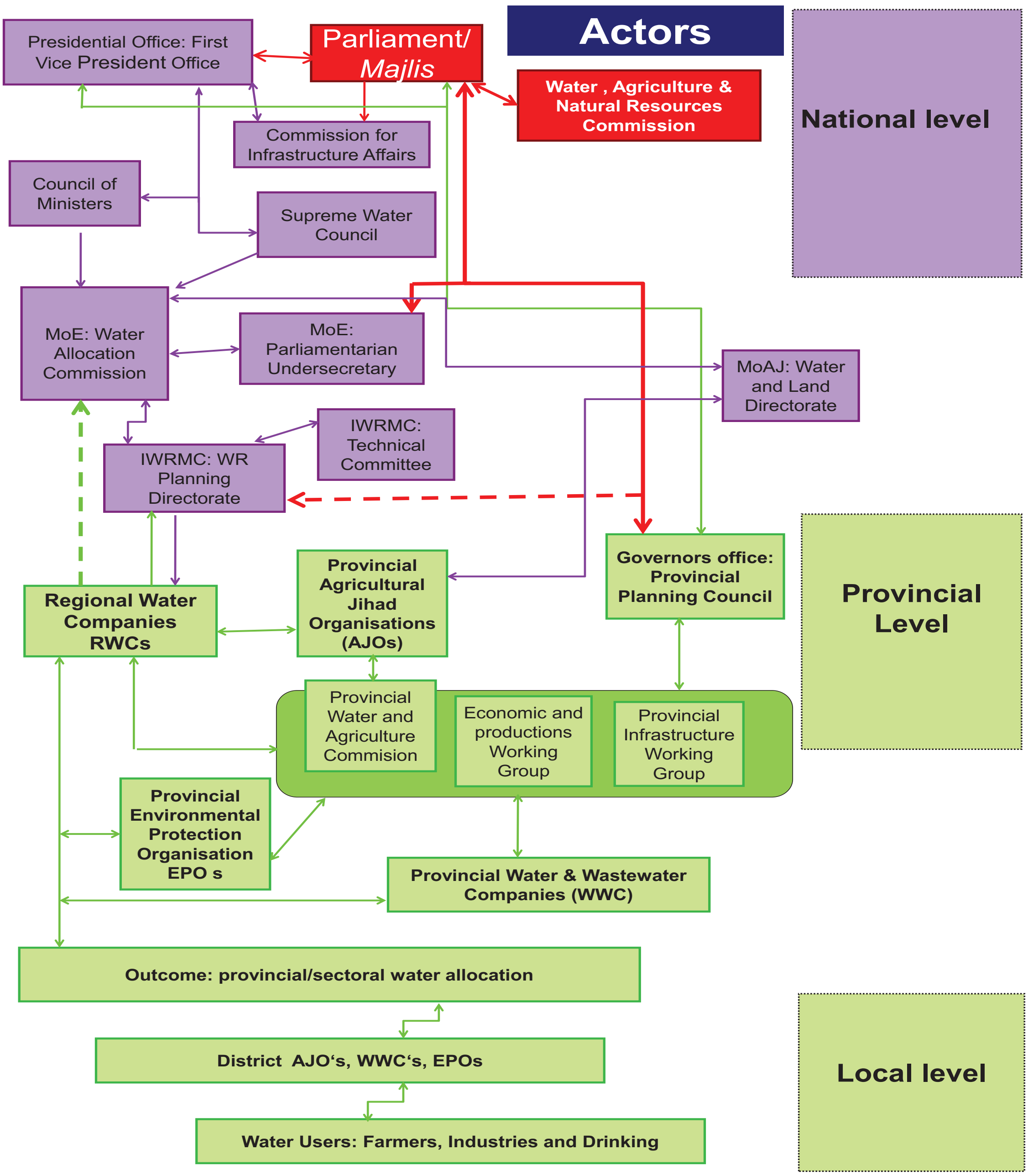
[6] Small dams have a capacity of less than 5 MCM.

[7]Sometimes it is called High Water Council; it has no policy/decision-making powers according to Memari (2006) and hence it is seen as ineffective extra administrative layer by some stakeholders.

5.3.3 Biophysical and material conditions: socio-economic, political, ecological, hydrological and hydraulic attributes

Average annual rainfall is 329.6 mm based on 1969-2010 period (Figure5.4). Much of the precipitation (20.3 BCM) is evaporated and about 6.9 MCM is captured in surface runoff which is the potential surface water for the whole basin according to Jamab, (1998) and MoE, (2010b).



Note: This figure only shows the spatial distribution and not the level of influence and importance of actors

Figure 5.3: Major actors

There is about 2 BCM of potential groundwater resources and are mainly in the eastern part of the basin. Groundwater abstractions are mainly through privately owned wells. There are unauthorised wells operating but the legal wells have Water Allocation Permits[8].

Season	Fall	Winter	Spring	Summer	year
Precipitation	26.5	32.3	38.4	2.8	100

Table 5.1: Seasonal distribution of the precipitation in the Lake Urmia basin (%) (WRI, 2005).

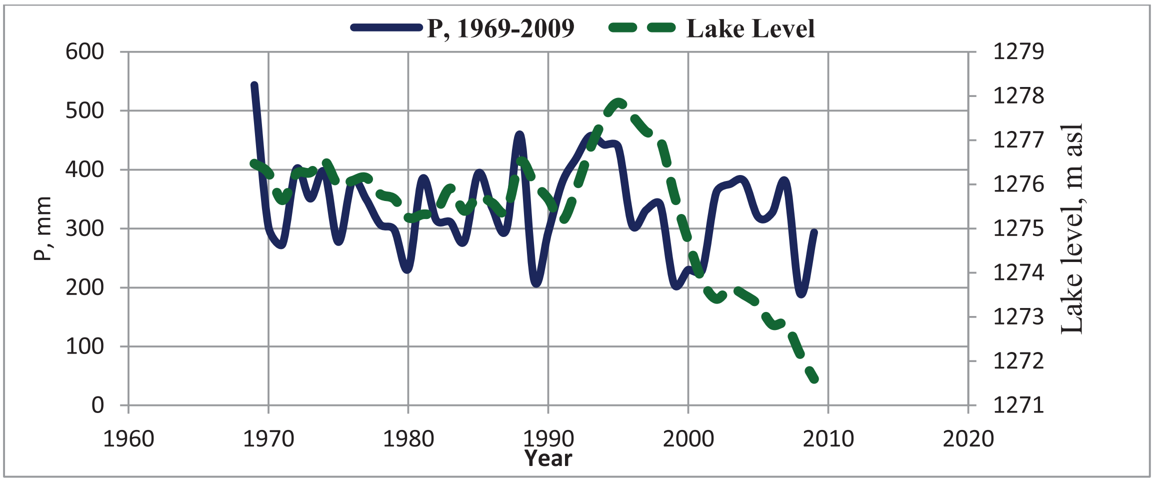


Figure 5.4: Average precipitation in LUB and corresponding annual average lake levels, 1969-2009 (Source MoE, 2010b).

There are 17 permanent rivers, 12 seasonal rivers and 39 flood routes which terminate at LU (Hashemi, 2008) as shown in Figure 5.1.In the last decade, lake levels have dropped (Figure 5.3) and the lake area has reduced by nearly 46% to 2700 km^2 (Jabbari, 2011).LU is very sensitive to the surface inflows as only receives a small amount of groundwater discharge (up to 210 MCM). Much of water inflow into the lake is from southern rivers. The rivers' runoff flows vary in time and space due to temporal and seasonal variation in precipitation as given in Table 5.1. The hydraulic system consists of 37 dams including 6 major storage dams with 1680 MCM capacity in WA and EA. Kurdistan has no existing dam in operation.

Evaporation from Lake Urmia is the most difficult hydrological parameter to quantify: only point estimations can be made. WRI (2005) suggests establishing 4 new evapometric stations to better the estimation. WRI (2005) makes a good attempt to quantify

[8] No official data is accessible; we will return to this theme later.

this parameter and provides a creditable value. It uses satellite images to validate the results by considering a wet year (1993-4) and a dry year (1999-2000). The long term average evaporation from Lake Urmia is estimated to be around 1180mm. MoE (2010) provides a higher estimate of 1272 mm/year for 1967-2007. Average annual temperature for the basin is around 9.4 °C.

Yekom (2002) have identified 12 land use categories from the 1990 satellite images and based on 1994 "Comprehensive studies for agricultural development" and FAO classifications, land forms were identified. The land use is shown in Figure5.5. Irrigation farming constitutes more than 7% of the total area; based on information given by actors (Appendix A1, Table A1.4), there are total of 463,000 ha of irrigated lands in all the provinces (see Box 5.1).

The dominant economic model is mainly agricultural with a degree of industrial (mainly in EA) and tourism (WA) (Table5.2).

Province	% Provincial RDP Output		Dominant
	Agriculture	Industry	Economic model
EA	11.4	33	Industrial
Kurdistan	18.2	12.3	Agricultural
WA	18.9	18.8	Agro- industrial
Source: calculations by author based on SCI (2007) National Accounts			

Table 5.2: Proportion of provincial Regional Domestic Product (RDP)[9] outputs for economic sectors showing dominant economic models for each province.

5.3.4 Community attributes

LUB is both multi-ethnic and multi-religion. Turks and Kurds are the main ethnic groups. They belong mainly to Shiite and Sunni Islam. But there are Armenian and Assyrian Christians as well. Total population of the basin is estimated to be 5.9 million people in 2010 mainly living in urban centres.

Referring to in Chapter IV and qualitative data (questionnaires survey, interviews and stakeholder meetings) described in Appendix A1, community attributes which apply to provincial and national actors can be described as follows:

- a low level of common understanding about water resources planning and allocation i.e. the presence of different perspectives among the stakeholders

[9] RDP is the regional version of the GDP; this economic indicator is based on provincial boundary.

- low level of homogeneity in the preferences and priorities among national stakeholders and the same is true among the provinces of the basin in terms of water resources planning and allocation (later described as shown in Box5.1)
- lack of trust between different provinces and national and provincial levels e.g. lack of flow of information among stakeholders
- there are disparity or inequality of basic assets among the provinces (e.g. disparity in RDP or distribution water resources and so forth)
- the economic paradigms of the provinces are different (Table 5.2)
- local political influence has an important bearing on the dynamics decision-making by the actors

This has created an environment of tension and high level of mistrust with conflicting priorities due to heterogeneity of the social fabric of the community.

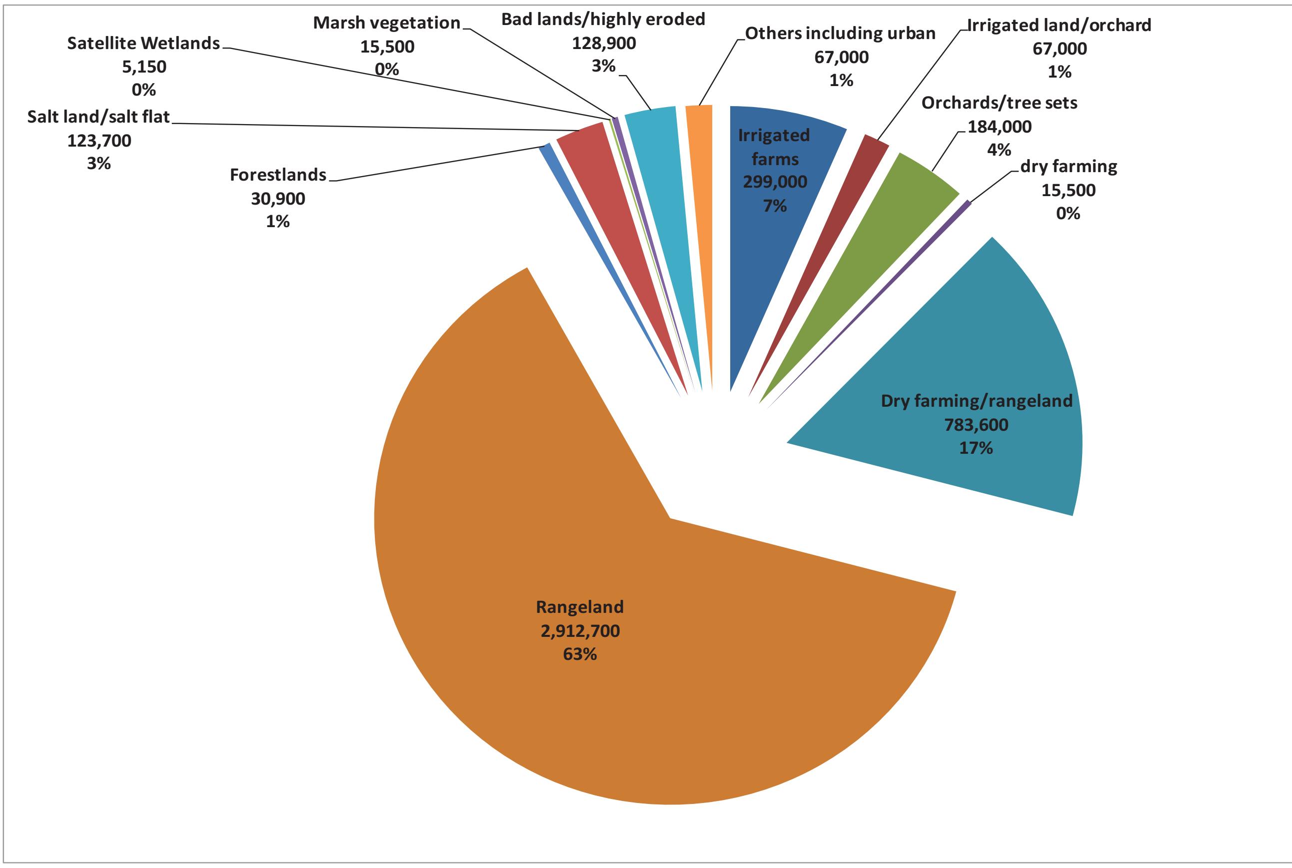


Figure 5.5: Land use in LUB (Source: Yekom, 2002).

5.4 DPSIR assessment for Lake Urmia basin

5.4.1 Introduction

The DPSIR assessment results are given in Figure 5.6 and each of the components are described in the following sub-sections. Given the centralised management of water resources allocation, the DPSIR analysis in this section complements the DPSIR results in Chapter IV.

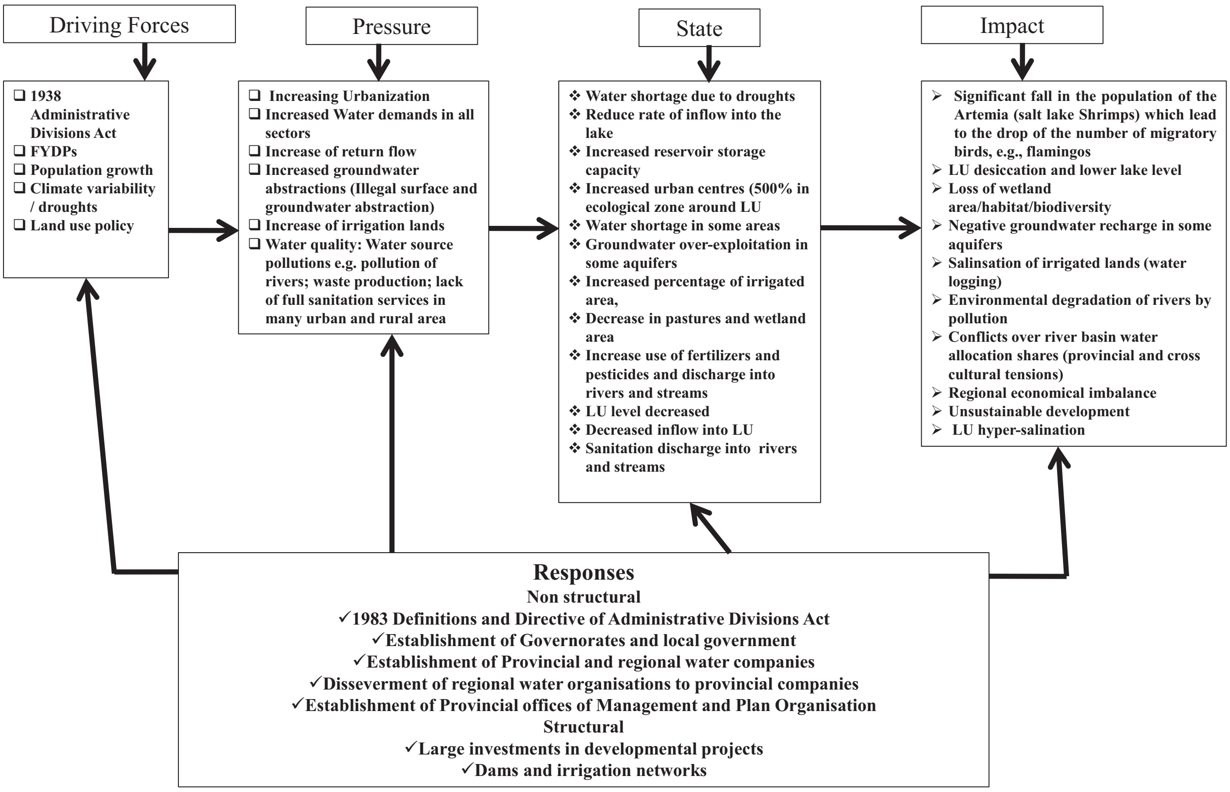


Figure 5.6: DPSIR analysis at LUB level.

5.4.2. Drivers (Driving forces)

I938 Administrative Divisions (AD)Act was a turning point in establishing a form of local government in modern Iran replacing the princedom divisions governed by the 1909 AD Act. These administrative divisions have been changing due to modified legislations namely the 1960 and 1983 AD Acts. The old princedom divisions were changed to provinces or '*ustans*'. Administrative divisions are driven by political objectives and depend on (i) demographic trends (population based), (ii) ease of communications and transport and (iii) economic considerations. By gaining town or city status, the urban institutions will gain much greater financial and political influence as the town of the city will be included in formal development and fiscal planning. So, urbanism[10] is a major driving force in local politics.

Cottom (1999) believes that nationalism did not have a strong base among the Azeri and Kurdish minorities of Iran but the ethnic and cultural identities remain very strong especially among the Kurds. Thus, both Azerbaijan and Kurdistan have a turbulent historical past. In the aftermath of World War II, local dissidences from central rule were registered with the inauguration of the short lived Republic of Azerbaijan and the Kurdish Mahabad *Republic* which were crushed by the Imperial Army of the Shah in 1949. Despite having comparatively small publicity, the 1945-8 Azerbaijan crisis was an important event in modern world history: as Hess (1974) noted, it was the start of the 'Cold War' between USSR and USA.

Internal boundary changes show a degree of political instability (Ahmadipour and Mansorian, 2006). The political instability is perhaps due to complex ethno-religious distribution which makes the idea of integrated Iran postulated by Reza Shah Pahlavi (1887-1944) a very difficult aim to achieve. The cost of this integration has been multi-dimensional including environmental degradation and unsustainable water resources developments. Much of developmental projects have not performed well due to the disparity created by the administrative divisions due to imbalance of power distribution (Farzanegan, 2001). As a result, different economic paradigms have evolved (Table 5.2) EA is more industrialised compared with WA and Kurdistan. The latter is less developed compared with both EA and WA.

Population growth has been phenomenal since 1976 (Table 5.3). Yekom (2002) has made a detailed analysis of the demographic trends in LUB. They suggest that rural communities are in decline despite vast agricultural developments. However, in areas such as *Mahabad* sub basin, rural communities have increased (WRI, 2005)[11] and so this sort of generalisation is misleading to an extent. Also, the definition of ' city' or 'town has changed with the passage of time (see e.g., Fanni, 2006). The AD Act now requires a city to have a municipality. But previously, a city was considered to have a population of 5000 people. In recent times, it seems that MPs and Presidential Candidates have used AD Act for their convenience and has been included in manifestos of MPs.

[10] Urban way of life provides access to a wider socioeconomic and political sphere- traditionally; rural areas are associated with peasantry and non-political community.
[11] This module of the project was carried out by Pandam Consulting Engineers under the heading water for environment; thus Pandam prefers to be cited as (Pandam, 2005).

Year	Population			Cumulative increase %
	Rural	Urban	Total	
1976	1,440,731	1,223,338	2,664,069	0.0
1986	1,565,892	1,565,892	3,131,784	17.6
1996	1,607,845	2,750,724	4,358,569	63.6
2002*	-	-	4,800,000	80.2
2010**	-	-	5,900,000	121.5

Notes
*estimated
** provided by provincial stakeholders in 2010
Source Yekom (2002)

Table 5.3: Population trends in LUB.

Climate variability/droughts. Much of the discussion in Chapter IV about climate variability and change is applicable here but at provincial level, greater reference is given to droughts. Partly, this is because droughts attract central treasury funds as part of the '*Emergency and Crisis Management*' package. The official position of MoE is based on attribution analysis made for year 2000 which was a severe drought year (this will be described in chapter VI) which suggests that in year 2000, 67% of the Lake's decline is due to droughts, 27% to recent developments (i.e. abstractions) and 5% as a direct impact of dams (Namjo[12], 2009; MoE, 2010b). As shown in Figure 5.7, the rainfall series for 1969-1994 exhibits an upward trend whereas downward trends are observed for 1995-2010. Therefore, trend analysis might be inappropriate approach to formulate an understanding of the hydrologic and climatic regime of Lake Urmia basin which shows a large degree of variability. We will return to this theme in Chapter VI.

Despite this concern and MoE's strong environmental inclinations since late 1990s, water resources planning have been sectoral in approach and pro-development. The change of attitude (i.e. considering climate change in planning matters) by MoE is marred by the question of the uncertainty about data (mainly hydrological data) resulting in the polarisation of opinions on both sides of the argument (see e.g. Roe, 1994). There is a discrepancy between MoE and IWRMC's database mainly due to a disagreement between MoE and IWRMC about the feasibility of some of the proposed development plans as well as some of the small dam projects are funded through provincial budgets and may not be listed on the MoE database. It is interesting to note that none of the dams have Water Allocation Permits.

[12]Majid Namjo is the current Minister for Energy.

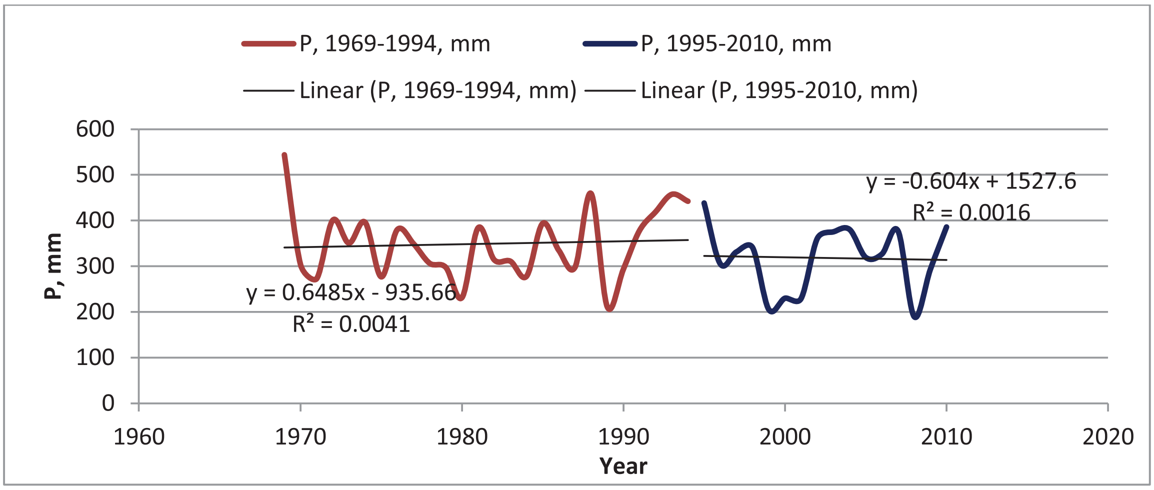


Figure 5.7: Precipitation trends for 1969-1994 and 1995-2010 periods based on MoE discourse on climate change (Source MoE, 2010b)

MoE is trying to use the climate change discourse (see Chapter IV) to resist additional provincial water resources development applications as demonstrated by Namjo[13] (2009) who wrote to the Governor of EA that the current demands for more dam building are not tenable mainly due to the climate change. However, RWCs have taken a provincial perspective and implicitly have been on the side of MPs and governors to "*get a better deal*[14]" for the provinces (Source: Questionnaire survey, Appendix A1). The differences between MoE and RWCs priorities have been detrimental in terms of implementing effective water resources planning and allocation. So, despite introducing Responses such as the 2003 Water Allocation Directive (WAD) (as described in Chapter IV), no integrated planning and allocation has been made[15].

FYDPs. In 1970, the first major dam came into operation in LUB i.e. Mahabad dam which is situated in a city that bears the name of the *Kurdish Republic* led by Qazi Muhammad. 40 years later, there are 37 dams in operation in WA and EA (Figure 5.8). Kurdistan and WA has been less fortunate in the "*hydraulic mission*"[16] as they were embroiled in the Kurdish autonomy movement after the demise of *Shah*. The political instability was further heightened by the Imposed War[17] (1980-88). On the other hand, EA was able to capitalise on low exchange rates and went on a development spree according to

[13] He is Deputy Minister of Energy for WRWW.
[14] I.e. to get more water allocation for the province.
[15] Responses such as legislation will be analysed in Section 5.5.
[16] This terms used by Allan (2005) to describe a demand driven water management paradigm involving building hydraulic infrastructure as described in Chapter II and will be discussed further in Chapter VII.
[17] Iraq-Iran war is known as the 1st Gulf War. It is commonly agreed that Iraq started the war and so in Iran is known as the Imposed War (1980-88).

some Kurdish politicians (Table A1.4, 2010). This perspective is very strong in Kurdistan and WA. However, WA has now taken over EA in terms of its development drive but have an extensive program to catch up. 12 dams are under construction with 1235 MCM regulated capacity (IWRMC, 2011). FYDPs drive the infrastructure building programme and hence remain the most important legal framework with respect to water resources planning and development.

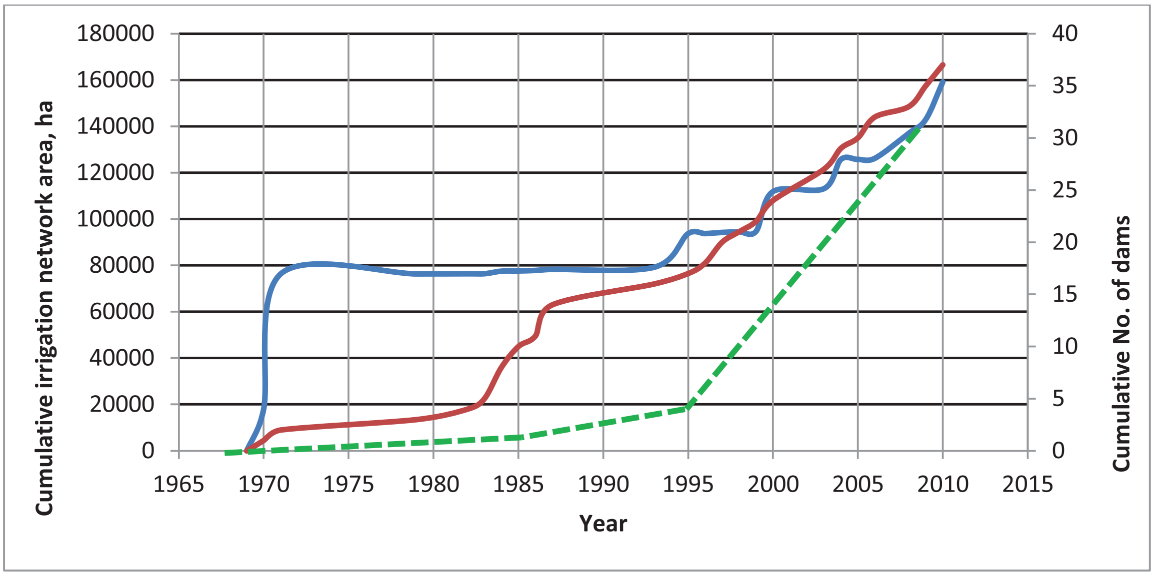


Figure 5.8: Number of existing dams (red line) and new modern irrigation network area (blue line) for the period 1969-2010:showing a rapid growth in the number of dams but irrigation networks has lagged behind; the graph is misleading to suggest that over one 1 nearly 80,000 ha of land was developed; this perhaps shows the capacity for Mahabad dam which came to operation in 1970; therefore the green line (drawn by the author) is postulated to show a realistic representation of irrigation development: the expansion began after the Imposed War specially after the 2nd FYDP.

Pro development arguments have won since water sector performance is judged by the level of achieving FYDPs i.e. how many dams have been completed. In addition, there is a tremendous political lobbying by provincial governors and MPs to provide economic incentives to their constituents.

Land use policy. The politics of irrigation and "*hydraulic mission*" (Allan, 2005) have dominated the policy sphere in LUB but with not much physical success (see Figure 5.8). Water resources planning have emphasised securing more water for agriculture but irrigation and drainage network constructions have lagged behind dam-building. There are many dams without even primary networks. The land use policy on the other hand, has resulted in loss of wetland area, increase in reservoir (dam) area and loss of rangelands.

5.4.3. Pressures

Urbanisation explosion. The rate of urbanisations has been fast and Tabriz is considered to be the 4th mega city[18] in Iran. A 500% increase in urban land use in the sensitive ecological zone around LU for the period 1990-2000 (Yekom, 2000) is a clear pressure indicator. Inter-provincial conflicts have risen as a result of the increased urbanisation and population growth. For example, Tabriz mega city (capital of EA) has a population of over 1.2 million people. Tabriz's water supply is secured for WA's Zarinarud dam which receives much of its water from Kurdistan. However, Tabriz is suffering from water shortage and hence a second water transfer line is underway from WA (Sorkhab, 2010). But this has been opposed by the WA Governor. The project has been delayed because foreign finance has not been found and there has been resistance from WA to the proposed plans.

WA sells water to EA despite lack of formal water trading rules. The present agreement to deliver water to Tabriz can be regarded as water trading between provinces. In informal interview meetings with both EA and WA stakeholders, the idea was not paradoxically popular (Appendix A1, Table A1.5).The implication is that they have to buy from Kurdistan. Nevertheless, participants from Kurdistan thought that there is a clear need to establish water trading rules or legislation to ensure equitable use of the resource and reduce the provincial conflicts.

Increased demand. Hashemi (2008) reviewed much of the recent secondary data on water demands (e.g. Yekom, 2002, 2005; WRI, 2005 and Jamab, 2007) but there is lack of adequate information about water demands. However, they all agree that most of water demands come from the agricultural sector i.e. 94% compared to 5.6% for drinking and 0.4% for industry. Water use efficiency in irrigation is very low (less than 30%) (Table 5.4).

Agricultural water use is virtually uncontrolled: 87% come from groundwater resources owned by mainly private well owners and most of surface water is abstracted by traditional water rights. However, drinking supply is a cause of heightening future conflicts as in the Tabriz case.

[18] Mega city means a population of more than 1 million people

Water demand, MCM				Return Flows, MCM,								Urban waste
Agriculture	Drinking	Industry	Total	Agriculture		Drinking		Industry		Total		(Tons)
				SW	GW	SW	GW	SW	GW	SW	GW	
4022	313.117	44.057	4379	957	451.5	36.4	116.18	16.85	10.25	1010.5	677.68	986,799
note:												
GW: Groundwater, SW: Surface water												

Table 5.4: Water demand based on Year 2001 and return flows (Jamab, 2007).

As stated, MoE (2010b) has found that 27% of abstractions are due to new mainly agricultural development based on trend method analysis. Unfortunately, there is no clear statistical data of consumptions to be able to draw an accurate trend. Nevertheless, the increases in demands have been noticed in all the sectors. Most of the major national studies (Yekom, 2002, WRI, 2005, Jamab, 2007) have estimated water demands for the basin with different methodological approach and periods.

To deal with increased demands, MoE is using the climate change discourse based on several main narratives:

1. risks due to climate change and drastic climatic variability in the basin;
2. agricultural water demand has to be re-assessed in the re-allocation process;
3. "water for environment" should be emphasised; for example, Lake Urmia have not featured in Water Master Plans; and
4. resources are limited: i.e. we cannot allocate water based on average conditions or normal conditions because of the climatic variability and change

However, policymakers have not been able to formulate real solutions to the problem underlined in the above discourse. Irrigation efficiency has been postulated as a way to save more water for the environment but in practice, farmers tend to use extra water to irrigate more land; and in fact the land policy has favoured this option. It is interesting to note that lower irrigation efficiency has meant that the return flow has been 'beneficial' as inflows into LU. Without the return flows, LU would be in serious problems.

Localised groundwater overexploitation and pollution. Groundwater resources supply 45% of the total demand; of which 87% is used for agriculture (WRI, 2005). Most of the aquifers are in normal conditions have a prospect of further development by about 150 MCM according to WRI (2005). However, several northern and eastern aquifers suffer from continuous lowering and negative recharge as shown in Table 5.5. Nearly more than 65% of the abstractions return to the system with much less quality and hence put pressures on the WRS.

Aquifer area	Province	Average annual groundwater lowering (m)	Unit Hydrograph duration (year)	General condition of water table
Salmas	WA	-1	7	Continuous lowering
Ajabshir	EA	-0.4	13	Continuous lowering
Tabriz	EA	-0.1	12	Negative recharge
Azarshahr	EA	-0.1	10	Negative recharge
Bilverdi-Duzozan	EA	-0.4	5	Continuous lowering
Sufian-Shabestar	EA	0.45	8	Continuous lowering
Tessuj	EA	1.4	7	Continuous lowering

Table 5.5: Major aquifers with negative groundwater recharge and continuous water table lowering (Source: WRI, 2005).

Return flow and wastewater from settlements (urban and rural) agricultural, drainage and industrial sites (Table 5.4) are increasingly an important component of water resources management in LUB. They form a large portion of the basin's water cycle. There is consensus that in future, these return flows constitute a large segment of the renewable water resources with an increasing role; hence, there is a need to include this factor in the strategic planning and integrated management of the water resources.

A third of the agricultural water demand and more than 2/3 of the water supply, sanitation, industrial and mining sectors return to the system and in many cases cause environmental degradation of the water resources (Jamab, 2007).

WRI (2005) notes that the amount of water required for sustainable management of the satellite wetlands (e.g. about 15 MCM for Mahabad sub basin) is negligible and can be obtained from return flow without impairing agricultural developments and irrigations schemes. However, this is not true for the survival of the Lake. In the case of the Lake, abstracted water reduces inflow into the Lake and hence has a direct impact of the sustainability of its biodiversity and environment.

Land use change in the urban, industrial and farming sectors have been a source of pressure on water resources system. For example, some of the pressures to the satellite wetlands are (WRI, 2005 based on Pandam, 2005): (1) conversion of the wetland habitat into cultivated land, (2) increased pollution from agricultural fertilisers and pesticides causing eutrophication and degradation of the water quality, (3), disturbance of wetland wildlife and (4) overgrazing in the basin. For example the trends in land use changes in the ecological zone during 1990-2000 (Yekom, 2002) are shown in Table 5.6.

Land use/land cover	Area (ha) 1990	Area (ha) 2000	Area changed (ha) 1990-2000	% change 1990-2000
Irrigated land	116870	128220	11350	9.7
Orchard and tree sets	46060	47420	1360	3
Mixed agriculture/orchards	14730	23140	8410	57.1
Mixed range/dry farming	37760	38420	660	1.7
Rangeland[1]	233170	123290	-109880	-47.1
Salt land/salt flat[2]	115320	231540	116220	100.8
reservoirs/fishponds and artificial wetlands[3]	2470	8880	6410	359.5
Lake Urmia	523940	483300	-40640	-7.8
Others	2890	15200	12060	426
Total	1093210	1099410		

Notes:

[1] The trend of changes was not determined due to the lack of information

[2] The area of rangeland and salt lands and their corresponding changes during 1990-2000 are for the northeast of the Ecological Zone

[3] Wetlands in the Mahabad and Gadar chai sub basins which were completely desiccated out equal to 2085 ha

Table5.6: Land use/land covers change of the Ecological Zone, 1990-2000 (Yekom, 2002).

5.4.4. States/Impacts:

Lake Urmia (LU)'s physical and biochemical indicators. Lake Urmia is situated at the extreme downstream of all the river watersheds in the basin. Therefore, the lake itself is a good indicator for both the State of the ecosystem and the Impact of the water resources planning and abstraction. Since mid-1990s, two major droughts were experienced (1999-2001 and 2007). LU's water level drops started in 1995 which coincided with the introduction of 2 dams. The droughts have heightened the water shortage problem and some fear that LU will slowly be desiccated. Another Aral Sea is looming in Iran's most celebrated and historic lake. The State of the LUB ecosystem and the Impact on the water resources system is shown in Figure 5.9 which simplifies a complex set of dynamic and complex interactions within the ecological, geological and hydrological dimensions of the system.

Williams (2002) highlights five major human induced factors affecting (usually with an adverse impact) salt lakes as follows (Table 5.7): (1) surface inflow diversions which will affect both the physical (volume, water level) and chemical (salinity) characteristics of the salt lakes - permanent salt lakes are more inclined to be affected by surface inflow diversions as well as catchment activities; (2) catchment activities such as (a) secondary (or anthropogenic) salinisation caused by leaching of salt deposits in the catchment of the salt lakes; (b) soil erosion, (c) groundwater pumping and (d) urban development; (3) salt-mining mostly affects dry lakes; (4) pollution especially from wastewater and agriculture and (5) anthropogenically-induced climatic and atmospheric changes as climate models predict that the aridity of arid regions will increase. This means that the temporary salt lakes will be drier for longer periods and permanent lakes will become smaller and saltier (Williams, 2002). Based on these five factors, LU is compared to Aral Sea, which is a permanent salt lake on the brink of extinction (Table 5.7). LU has a striking similarity with the Aral Sea as most of the water use is in the agriculture sector.

Increase storage capacity. Permanent lakes, such as Aral Sea and Lake Urmia, have been affected by the diversion of surface water (by dams) mainly for agriculture. In the last 10 years, surface water diversion has affected the salt concentration and water balance of the Lake. For a decade, inflow into LU has been in the order of a tenth of the average long-term inflow. The precipitation in the basin has been on a downward trend. The salinity has increased, which has caused the demise of the only organism in the Lake; namely Artimea. Many birds, such as pelicans and flamingo, have lost their habitat and so the Lake is on its death-bed, if the current situation persists.

The physiochemical characteristics of the Lake Urmia Lake are vital indicators to assess the environmental, ecological status of the Lake. With regard to quality of the lake water, past works have looked into 4 parameters:

1. Sedimentation in the Lake via inflowing rivers
2. The Electric Conductivity (EC)
3. The Total Dissolved Solid (TDS) rate
4. The dissolved salt (NaCl) (since this is an important factor for Artima's reproduction-the only living organism in the Lake together with some green and blue alga)

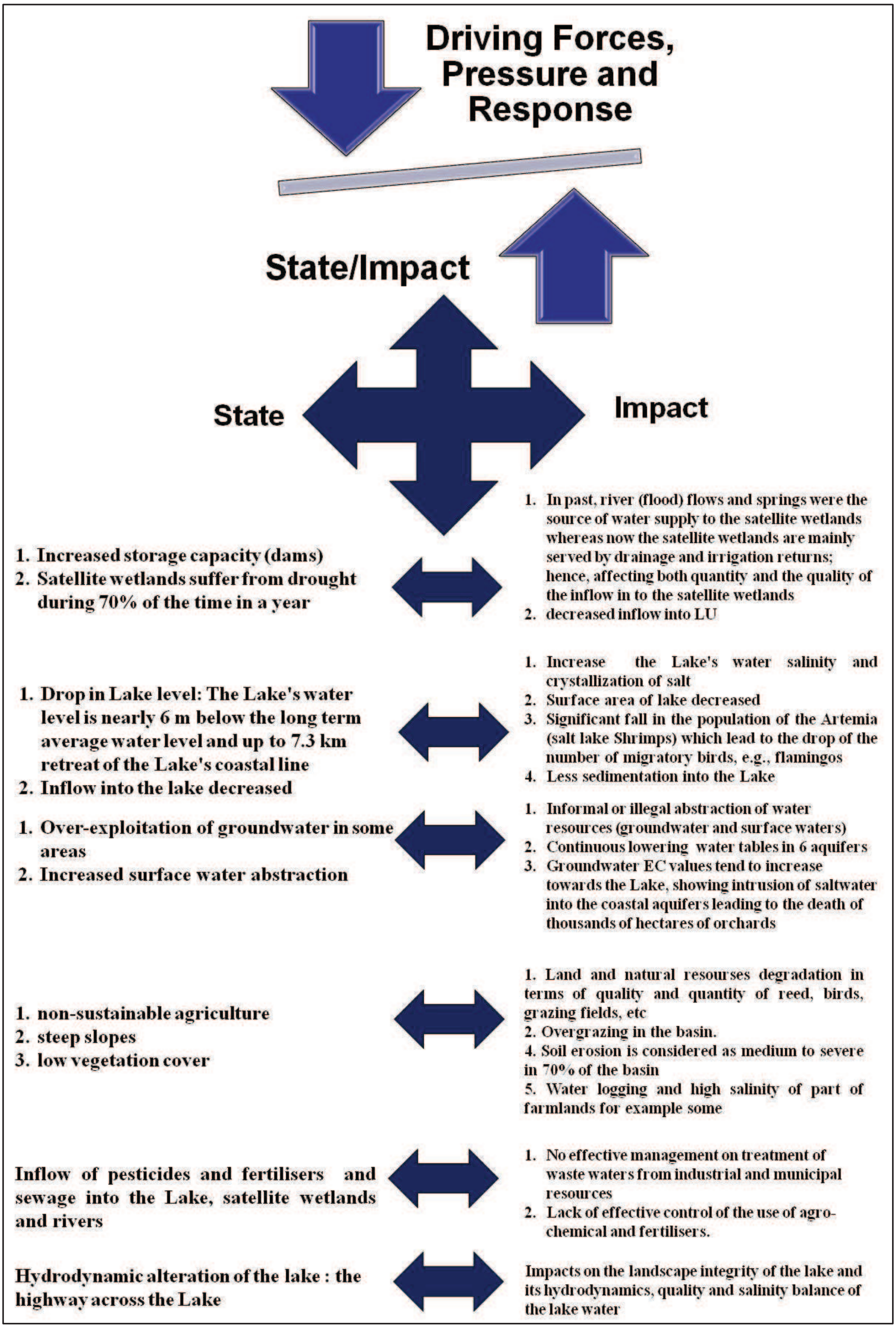


Figure 5.9: The dynamics of the States/Impacts inter-linkage for LUB.

Factors	Surface water Diversion			Catchment activities				mining	Pollution	Biological disturbances	Climatic	
Lake (types)^	Volume	Lake level	Salinity g/l	Salinisation	Soil erosion	GW	UD				Local Climate moderation	Utra-Violet
Urmia (P)	32→14 BCM	-6 m*	204→326	√	√	-ve	+ve 500% in sensitive area between 1990-2000	Not at this stage- coastal retreat so certain pressure on mining	Wastewater Solid waste	Loss of Artemia and wetland birds	-ve****, in the highlands, precipitation is affected by the surface area of the Lake	?
Aral Sea ** (P)	-	-20 m***	10→>50	√	√	-ve	Loss of communities	?	wastewater	27 fish species extinct	No longer; dust wind	?

Notes:
^ types of salt lakes, P= permanent; -ve= decrease; +ve= increase; √ adverse impact; GW= groundwater, UD= Urban Development; ?= unknown
* in the last 10 years, ** based on Williams (2002), *** at the end of 2002, Based on Yekon (2006)

Table 5.7: Human Impacts on Lake Urmia compared to Aral Sea.

The last 3 parameters are basically measures of Lake's salinity. The origin of the salinity is well discussed by WRI (1995) which has been reflected in all the studies including Yekom (2002, 2005,). According to researchers, LU has a history of 500 thousand years and the present Lake is 35-40 thousand years old. The ultra-saturated condition had prevailed since 8-9 thousand years ago. There are two issues with important consequences: (1) LU has a natural depth (cavity) without any exits for sediments and dissolved particles. Therefore, after evaporation, all the solids are left behind; and (2) the sediment loads mix with salt particles to form 90 m deep muddy layers at the bottom of the Lake. Hence, it is concluded that the main source of salinity is from surface water inflows into the lake.

Various consulting engineers and IWRMC reports indicate that the amount of annual sediment inflow into the Lake is estimated as 5.3 million tonnes of which 40% is conveyed by Aji Chai River, EA. The completion of many dam building projects is going to affect the level of sedimentation into the Lake and will reduce sharply the amount of sediments entering the Lake [off course it will reduce the amount of inflow as well]. EC is the most common indictor used to establish the salinity of a water body. Due to a large drop in the Lake's water level, EC of the Lake has risen sharply. EC depends on internal ionic movements of the dissolved salt but it is a function of surrounding temperature as well since temperature will affect molecular movements. The Average EC in the past 36 years (1967-2004) has been estimated as 382,740 μm/ cm by Yekom (2005).

In the index period of 1966-2002, the average TDS has been 267 g/l according to WRI (2005) study at the average water level. A value of 222.6 g/l is given for an index period of 1993-2004 by the Yekom (2005). The maximum TDS of 362g/l was recorded in February 2002. A recent TDS of 338 g/l was recorded in January 2008. This is above the tolerance level of Artemia production. According to some reports as sited by Yekom (2002) and Nazaridoust (2006), the Artemia cysts are unable to hatch when the NaCl (salt) concentration is above 250g/l. Therefore; the ecological requirement (discussed in Chapter VI) for salt level is 240 g/l.

The annual rate of salt inflow into the lake is estimated to be 2.2 million tons (WRI, 2005 and Yekom, 2005); some 54% (1.2 million tons) is from Aji Chie River. It is estimated that 4.8 billion tons of salts are dissolved in the Lake. This is 2800 times more than the annual inflow of salts via surface flows. There is a direct linear relationship between the TDS value and the EC (Nazaridoust, 2006). With reduction in Lake's water level, there is a corresponding increase in EC value of the Lake which is an indication of the salinity of the Lake's water content.

Water quality dose not consist only of salinity related parameters as discussed above. Additional water pollution indicators need to be considered in any assessment of the quality of the Lake. Therefore, these indicators are important and paramount in the application of IWRM and attainment of environmental sustainability criteria in the management of the lake. At present, it is unfortunate that there is no baseline data on pollution indicators which is a major information gaps with regard to water quality of LU.

5.4.5. Responses

In Section 4.4.4 in Chapter IV, the main Responses and policy options were discussed and are not repeated here. Therefore, this section is complimentary to the discussion in the named section.

Emergence of new governance system. The modern state required new administrative divisions to move away from Princedoms (*Ayalat*) and small States (*Welayat*) systems. So the Constitutional Revolution (1905-9) started the process. Figure 5.10 shows the evolution of a new governance system with reference to LUB. However, as shown in Figure 5.10, the development of water administration has lagged behind the political administrations. This shows that the new governance system did not include water planning and allocation management.

Formal water planning administration came into existence in 1943 with the establishment of the Independent Irrigation Agency (the *Bongah*). This was an attempt to manage the water resources planning process. With reference to Figure 5.10 it can be deduced that

- There has been a mismatch between the establishment of political administrational and water administration.
- Water resources planning have gone through 4 phases. The administrative evolution has been driven by 1959 Water Resources Blueprint which envisaged a programme of water (dams) and land (irrigation) development. The Development Council and Plan and Budget Organisation were responsible for these plans initially and so the *Bongah* was established to oversee the developments. Hence, administrative changes were born based on political considerations outside the water resources domain.

Year	1900-9	1910-19	1920-9	1930-9	1940-9	1950-9	1960-9	1970-9	1980-9	1990-9	2000-9
Provincial AD development	1906 Constitutional Law		1921 End of QaJar Dynasty and start of Modern State	**1937 Administrative Law,** EA and WA Provinces established, Kurdistan part of Western State	abdication of Reza Shah in 1941, 1945-1948 Azerbaijan Crisis and no local government	1958 Kurdistan province established and separated from Kermanshah jurisdiction	**1960 amended AD Law**	1979 Islamic Revolutions and end of Pahlavi Dynasty	**1983 AD Definitions and Regulations Act**, 1980-88 Iran-Iraq War	greater urbanisation rate	888 citied in 2001 compared with 338 cities in 1976 (Fanni, 2006)
	Phase I: no national and provincial water resources planning and allocation				**Phase II: Towards co-ordinated water resources Planning and allocation**			**Phase III: consolidation period**		**Phase IV: Towards IWRM**	
Water resource planning and provincial water administration development	Traditional water management , no coordinated water planning, 1929 Qantas Law				1943 Independent Irrigation Agency: first formal water resources planning, 1948 1st SYDP	1956 Khuzestan Water and Land Plan ; 1959 Water Resources Blueprint	Milestone: 1963 Water and Power Ministry; Regional Water and Power Organisations	1972 Western Development Company in Kurdistan, 1974 Ministry of Energy , EA and Ardabil Regional Water company, WA Regional Water company	1980 Western Regional Company in Kermanshah replaced Western Development Company in Kurdistan 1982 Fair Water Distribution Act, comprehensive water planning and management law, 1989 1st FYDP	milestone: 1990 Water and Wastewater Companies	2005, Regional water companies were dissolved to create provincial companies, 2006 Kurdistan Regional Water Company, EA Regional Company was established (Ardabil became separate)

Figure 5.10: The timeline for the development of provincial administrative divisions and respective water administrations with reference to water resources planning and allocation.

- The drastic disparity and mismatch is illustrated by the development of water management institutions in LUB. East and West Azerbaijan provinces were established in 1937 whereas Kurdistan province was established in 1958. Both Azerbaijan had some sort of regional water company since 1960s but Kurdistan

Regional Water Company (KRWC) was established in 2006. Therefore, in past, Kurdistan has not been considered to be a major player in LUB. This current tension between Kurdistan and WA water allocations to Kurdistan from existing Zarinarud dam has a historical dimension. Despite supplying more than 85% of the dam's water, Kurdistan has a small share of the allocation.

- It can be said that both Azerbaijanis and Kurdistan share a turbulent history and so has been influenced by non-water policies. For example, in 1980, Western Development Company which was based in Kurdistan was moved to Kermanshah under the name of Western Regional Water Company (WRWC) "*due to political situations and a Decree by the Supreme Revolutionary Council*"[19].
- After the revolution, administrative changes continued to be motivated by the old Pahlavi vision of modernisation and development until late 1990s when the concepts such as IWRM and sustainable development were adopted in national policy and legislations. However, opinions and perspectives within MoE have been without consensus. The political drive for decentralisation and privatisations has not been reflected in water administrative change.
- In 2004, some of the remaining regional water companies were broken into provincial companies. WRWC was dismantled to form 5 provincial companies including Kurdistan Regional Water Company (KRWC). So, a dual policy has been pursed: IWRM and the concept of river basin as a unit at national level in conjunction with provincial water management at regional level. This related to power relationship between governors and the regional water companies: on the one hand, regional companies such as WRWC were not accountable to provincial officials i.e. they had a larger jurisdiction than the political boundary of a province and felt more powerful. On the other hand, provincial representatives of regional companies did not have the ranking status as director general enjoyed by other governmental departments; thus in the case of WRWC, Kurdistan's local representative as well as Hamadan, Ilam and Lorestan wanted to gain more power and independence from Kermanshah-based WRWC. Kurdistan has felt that there has been a degree of discriminations in terms of water resources planning and allocation due to their downgraded status. Hence, the discourse is that the new KWRC is in a better place to take care of the province's interest. According to this

[19] This is mentioned in the website of KRWC.

notion, home-grown (local) mangers are more accountable and act more responsibly. This discourse has been encouraged by political manifestos which promised local rule and managers in the provinces e.g. this issue was part of the 2009 Presidential Manifesto[20].

The non-structural response in the water sector has been partially based on the needs to carry out the structural response programme but the geopolitical factors have played a major role in shaping the institutional set up. Administrative divisions are unavoidable due to population growth and economic realities but they should take a holistic approach by considering environmental, transportation, tourism, agriculture, energy and water demands, commerce and security aspects within the macroeconomic planning and development strategy (Farzanegan, 2001).

The structural Response has been based on agrarian policy of food security and more irrigated area (described in Chapter IV). As noted earlier, most of the large dams have been built or under construction. The dam building in LUB has been marred with financial difficulties and hence the progress made by some projects is under par. Agricultural development plans for the provinces are based on increasing more irrigated land (Box 5.1). EA is leading the provinces and in the last 7 years an average of 9300 ha has been developed each year. WA is planning to develop a further 202,000 ha and this requires nearly 4000 MCM of surface water. Kurdistan is lagging behind and has no dams in operation and no irrigation and drainage network in place. It seeks to develop a further 60,000 ha. IWRMC (2011) recognised that by year 2016, irrigation networks will be around 324,000 ha after the completion of the 12 dams.

Box 5.1: Regional agriculture development plans

- Kurdistan: currently have 19,000 ha irrigated area; **future plans**: orchards: 20,000ha, irrigated lands: 40,000 ha
- WA: currently have 189,200ha irrigated area; **future plans**: orchards: 40,000ha, irrigated lands: 162,600 ha
- EA: currently have 265,000 ha irrigated area; future plans: an increase of 3.5% (9300 ha per year) in the last 7 years.

Source: Appendix A1, Table A1.4

There are many important questions to be considered: (1) are there adequate water resources for these expansion plans? (2) Are these plans within the framework of agricultural sustainability and IWRM? (3) What criteria have been used in these plans? (4) What are the impact of climate changes and other anthropogenic drivers? (5) Can LU and

[20] Section 2.8 of the 9th Government Plans available on http://www2.irna.ir/occasion/dolat9/index.htm

the satellite wetlands survive after implementing these plans? Lake Urmia has entered a very critical stage; its demise is a distinct possibility as graphically shown in Figures 5.11 and 5.12; the lake has shrunk to half of its size. None of the stakeholders could have a clear answer to the above questions which indicates that the plans did not consider the IWRM and sustainability approaches. Thus, the sustainability of these plans is doubtful. Therefore, revised Responses are required to deal with the imbalance created by the "*hydraulic mission*" in LUB.

Figure 5.11: Farming at the Coast of the LU; up to 7 km coastal retreat is shown (25 May 2009, Mahabad-Urmia Motorway; photo by Mukhtar Hashemi).

New rules. Referring to Section4.4.4, there are two main legislations in water planning, management and allocation including

- The 1982 FWD Act which aims to empower MoE to become 'the guardian' of both groundwater and surface waters and
- The2003 WAD which has given responsibility to Water Policy and Allocation Commission (WPAC) at MoE to make allocation decisions based on simulation and modelling of the water resources at basin or sub-basin level. It requires legally using system dynamic modelling and this in itself is an innovation. We will return to this theme in Chapter VI.

Before year 2003, water allocation was based on proposal applications by regional companies indirectly to the commission via the Planning and Development Deputy Office, IWRMC. Hence the 2003 WAD aims to reverse the provincial perspective to water needs (or demands) and to have a river basin approach.

In reality many decisions have been made about dam buildings in the WPAC without upholding the 2003 WAD. Some have ignored the commission altogether by building dams without any allocation decisions. Therefore, much customary rules in use have prevailed and RWCs have not been able to implement the formal rules. There are three important elements: (1) unauthorised abstractions of both groundwater and surface waters have been rife; (2) according to the WPAC "*no dams in LUB have formal Water Allocation Permits (WAPs)*" (Appendix A1, Table A1.4) and (3) groundwater overdraft has continued and RWCs have not been able to cap the consumption of legal permit holders. The institutional set up has failed to sustainably manage water resources in LUB; e.g. MoE has been unable to manage water resources during the LU crisis and the sharp drop in its levels (Figure 5.11 and Figure 5.12).

Figure 5.12: Lake Urmia coastal retreat (Photo by Mukhtar Hashemi).

Concluding remarks. The DPSIR analysis in Section 5.4 shows that despite introducing the 2003 WAD, MoE has failed to implement a sustainable water allocation strategy in LUB. In the next section, an institutional analysis is made to better understand the process of water allocation in the period from 2003 till the period leading up to the MoU agreement in 2008 in the path towards IWRM.

5.5 Institutional analysis: The efficacy of the Responses on water allocation decisions for the period 2003-2008

5.5.1. Introduction

With reference to Figure 3.13 (Chapter III, p.82), the focal level of water allocation decision analysis is at multitier action arena and action situations; Figure 5.13 shows the focal point of analysis used to make an assessment that why water allocation institutions failed to implement the IWRM paradigm after its introduction.

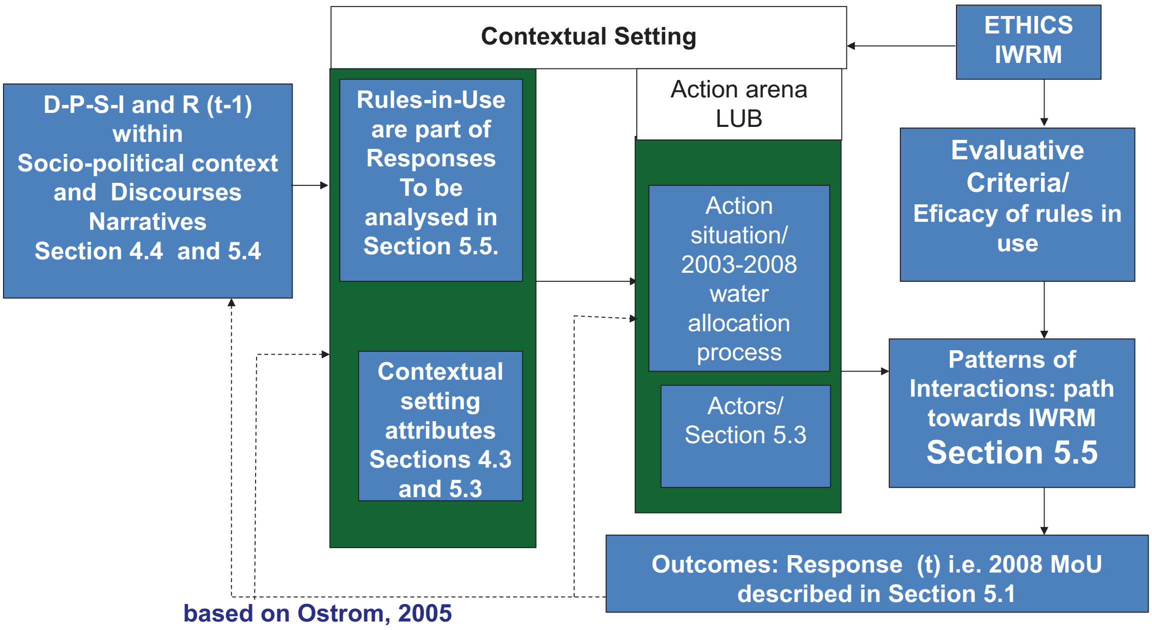


Figure 5.13: Conceptual focal point of analysis.

Earlier parts of Chapters IV and V (as indicated on Figure 5.13) providea detailed account of the characteristics of the national and provincial attributes using combined DPSIR-IAD approach. In this analysis, we concentrate on the rules in useusing IAD analytical approach. First, the rules in use in described in Section 5.5.2 and then their vertical integration in multi-level decision-making are outlined.(Section 5.5.3) Water allocation interactions in pre 2008 period is evaluated (Section 5.5.4) followed by an assessment of the efficacy of the rules in use at constitutional, collective choice and operational decision-making levels in Section 5.5.5.

5.5.2 Rules in use

The main rules in use are given in Figure 5.14. Before **1943,** there was no specific water allocation law**.** Customary water rights existed and users freely used water resources. In 1909, The Civic Code introduced laws governing property rights which included well and *qanat* (groundwater rights) ownership. The first water law came in 1929, the Qanat Law which again was an attempt to control the use of *qanats*. The Civic Code was updated in 1989 and is still in force.

In 1943, the *Bill for the establishment of the Irrigation Bongah* was established to control the use of surface water resources and to bring in some sort of order to a disorganised water sector. However, water allocation was based on property (land) rights with no implicit reference to centralised allocation process. The dominant perspective had strong economic and institutional (political) dimensions. The FYDPs were a driving force towards both economic reconstruction and institutional (organisational) change. Laws were brought in as a result of this economic and political perspective.

In **1968, *The Nationalisation of Water Act*** was a first major step to have a central control over water allocation. This allowed water charging for distribution of water (drinking and industrial as well as irrigation). The water charges were nominal. Provincial water companies were established in mid 1960s but they did not have a control over water allocation**.** However, informal rules were prevalent and water allocation was based on riparian rights. Major dams were built and this meant that agricultural corporations were formed to sell water for irrigation. Water allocation for newly built irrigation networks and agro-businesses in the 1970s was enforced centrally. But, this represented a small percentage of water abstraction.

Formal Water allocation rule was specified by the ***1982 FWD Act.*** Since 1983, there has been an attempt to control water allocation by the central authorities. Accordingly, MoE is responsible for water allocation to each sector and province. Intra-sectoral allocation will be made by each sectoral institution; for example agricultural water quota will be given to MoAJ to allocate for its sector. However, all water abstraction permits should be obtained from MoE. The 1982 Act specifies priories for water allocation in the following ranking order: drinking, industrial, agriculture and environment. In 1990, the Bill for creating water and wastewater companies was passed and gave these companies the power to obtain water quota and then distribute to the households and industrial customers. The *Majlis* produces a ***Water Charging Bill*** every year and controls highly subsidized water prices. In 1998, the Bill for establishing rural water and wastewater companies were passed but lacked any real financial investments to make inroads in the rural area. However, this attempted to control water allocation in rural area by tagging a subsidised price to water supply in rural areas. In this period, MoE gradually fastened its control over water allocation but the main problem remained to be groundwater resources which were mostly owned by private well owners. The wells are provided with Water Allocation Permits. However, there are considerable number of unauthorised wells in addition to informal or unauthorised abstractions from unregulated rivers and streams as well. Information about unauthorised wells is not public and RWCs sometimes hide this information from MoE (Appendix A1, Table A1.5)

In 2000, the ***Bill for establishment of MoAJ*** created some confusion about the role of MoAJ in agricultural water allocation. Article 11 asks for an inter-sectoral cooperation and agreement between MoE and MoAJ for agricultural water demand, supply, utilisation and distribution. In the meantime, MoAJ and AJOs had built small supply dams and petitioned MoE and RWCs for the required water under the legal umbrella of the ***Agricultural Water, Water Supply, Reservoirs and Irrigation Network Directive***. MoAJ was supposed to create water user associations (WUA) in which the users, RWCs and AJOs have a stake of 25%, 24% and 23% respectively. This rule has not been materialised. Instead, RWCs established a limited number of WUAs which were 100% owned by the RWCs.

2003 Water Allocation Directive. Article 11 of the MoAJ Bill, was very vague and had produced tensions between MoAJ and MoE and their provincial subsidiaries. The 2003 Directive have moved from economic perspective to an environmental and physical resources perspective. The 2003 Directive is based on river basin planning and allocation. IWRM became the national policy and so, water allocation was supposed to follow the IWRM principles. It requires the use of modelling tools to simulate the whole basin in order to come up with water allocation strategy. However, the Directive fails to recognize the provincial and inter-provincial water allocation conflicts and hence, the application of the Directive has been limited so far.

Informal rules. In parallel to the formal set of formal rules, informal rules operate in the form of

- a communal set of traditional water rights including groundwater resources from private wells as well as traditional river stream rights ;
- unplanned water abstractions[21] and
- unauthorised abstractions

[21] For example due to sectoral and provincial planning, some of the water abstractions are not within formal planning framework

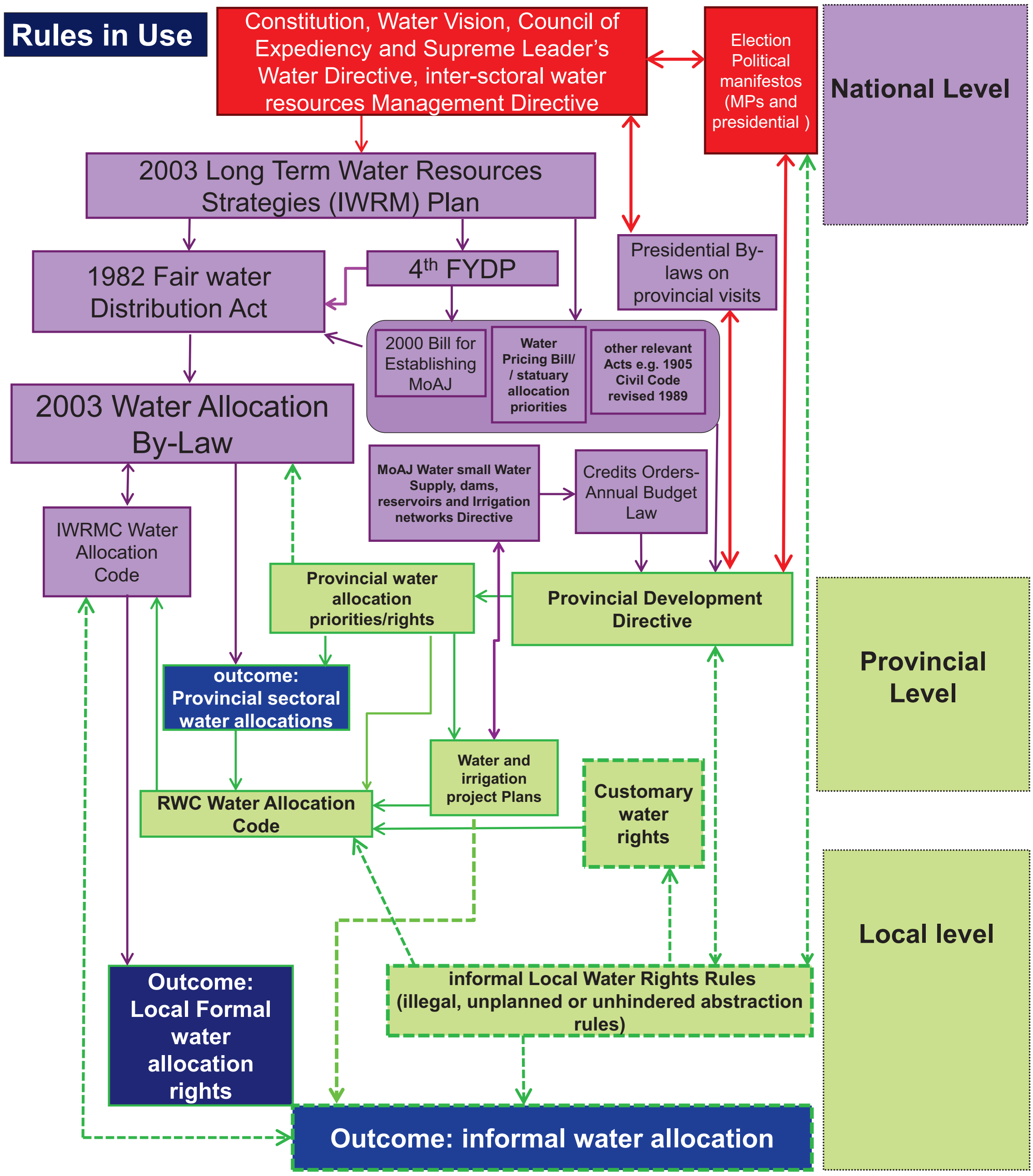
Informal rules are important in two ways: firstly, as there are no effective provincial and inter-provincial water allocation rules, informal rules are widely applied in the basin; and secondly, the formal rules have been used to legalise informal or unauthorised abstractions by issuing permits creating water rights for the users. Hence, any new water allocation process involves highly sensitive issue of re-allocating the existing water abstractions by the water users. This is a classic example of upstream and downstream conflict.

5.5.3. The vertical integration of action situation and rules in use

Based on IAD component described in Chapter III, the interactions of rules in use and action situations at multiple decision and analysis levels are shown in Figure 5.15. We have to remember that the water allocation process is entwined with broader sets of rules which are related to wider action situations such as planning process, utilisation of water resources and so forth.

Water allocation decision outcomes which occur at the operational level action situation not only monitored and sanctioned by collective choice rules but will be affected by the attributes of the community and the biophysical world. Furthermore, the collective choice rules are monitored and sanctioned by the Constitutional level rules. Water users such as farmers have created informal rules which are based on customary laws, informal water rights and sometimes unauthorised abstraction rules. These rules are not recognised but decision-makers are aware of them. However, in most occasions, they are unable to change these rules.

The "*nesting of rules*" (as termed by Ostrom, 2005) in LUB is complicated by the fact that water allocation outcomes which is an operational decision is made at national, provincial and local levels and hence poses a serious challenge and is a source of conflict.



Note:
dotted lines indicate informal rules in use

Figure 5.14: Rules in use.

The evolution time of constitutional rules such as 1982 FWD Act are longer and they cannot easily be modified. The collective choice rules are easier to redefine and modify. In the case of FYDPs, this is a five year plan and sometimes By-laws are added to it during its implementation. Operational rules are also slow to modify and sometimes the explanatory and procedural Codes are produced much later. For example the Water

Allocation Code (WAC) was enacted in 2008 which is beyond the scope of this part of the analysis (see Chapter VI). It took five years to issue the 2008 Code for the 2003 WAD.

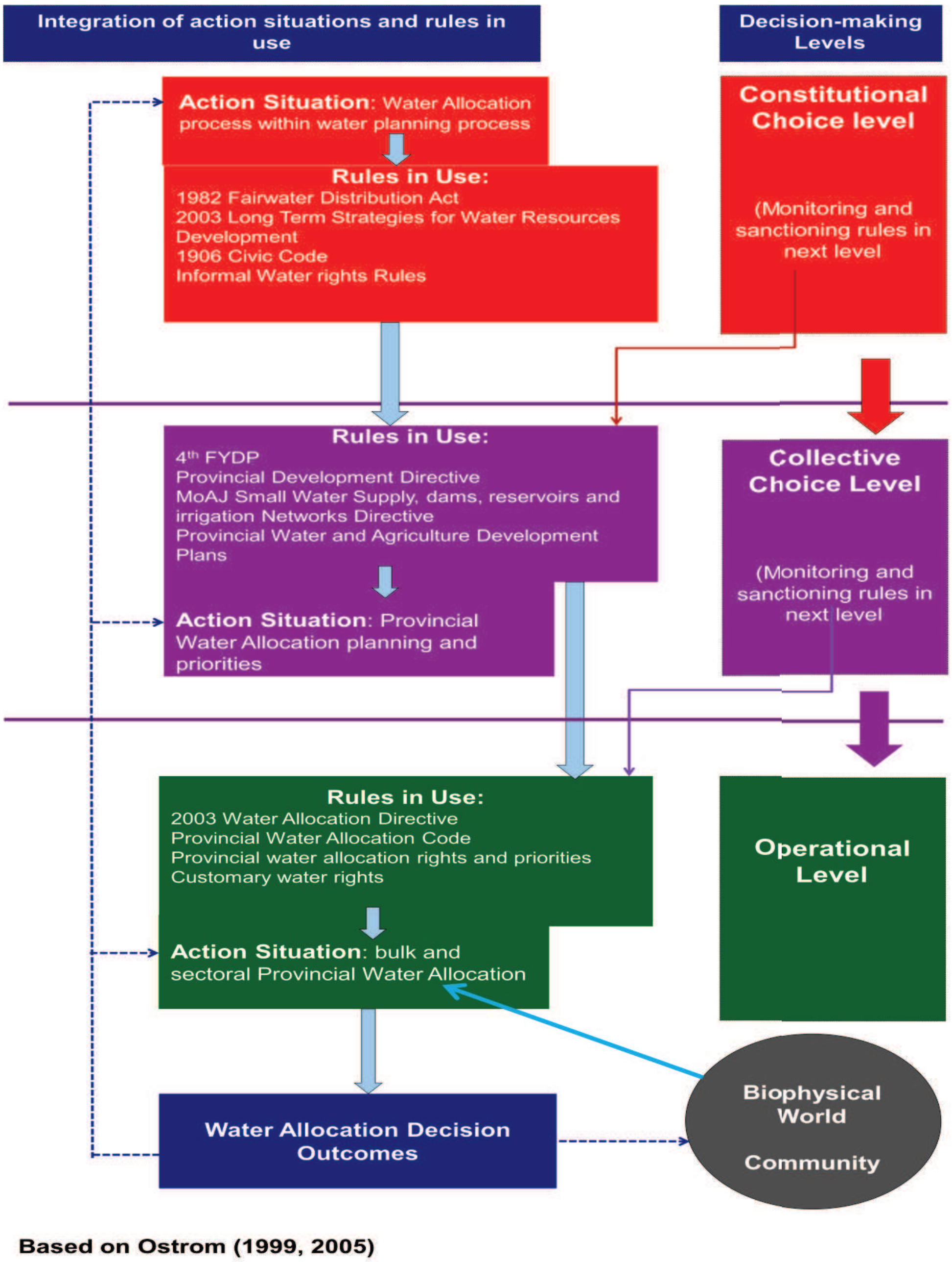


Figure 5.15: Vertical integration of rules in use: level of analysis and outcomes (Ostrom, 1999, p.60; 2005, p.59).

5.5.4. Interactions: Water allocation practice in LUB pre MoU period

Water allocation before 2003. Legal entities such as individuals and private companies (industrial, agricultural and drinking) had to make applications to the district (county) representatives of RWCs. Using water allocation priority policy, the application was approved given that the necessary documents and technical reports were submitted. Ownership and property documents were the most important documents. This allocation would have been in line with the quota given to each province. In this analysis, we will not concentrate on individual water allocation; instead, provincial bulk surface water allocation process is discussed.

Groundwater resources in LUB are mainly controlled by private landowners of wells and *qanats* and hence, the 1982 FWD Act was an attempt to control groundwater resources. Initially, private individuals and companies were offered a Water Allocation Permit (WAP) without any strict criteria to encourage owners to register their share. The wells did not have volumetric devices to monitor the implementations of the WAPs which are oversubscribed. According to the participants (Appendix A1), there are many non-permit owners which use groundwater resources. Basically, there is no policing mechanism towards implementation of groundwater allocations.

Provincial' bulk' shares were determined according to water resources planning and allocation proposals which were prepared separately by different economic sectors in the province. RWCs made application to the Water Planning Bureau of the IWRMC. After appraisal of the proposal by the technical committee it was sent to the WPAC for final approval. Some of stakeholders (participants) were highly critical of the decisions made by WPAC which according to them was biased and highly political (Appendix A1, Tables A1.1- A1.3). However, due to inter-provincial conflicts, not much decision was made by the Commission. But this did not stop provinces to ask for water allocation through their water and agriculture plans. Some of these projects were provincial projects with provincial *Credit Orders* and so did not need MoE's approval. Some of these projects later become national projects and were entitled to national *Credit Orders*.

EA was more successful than the other two to attract Credit Orders for their national and provincial projects with Kurdistan being least fortunate. Kurdistan did not have an independent RWC and was part of the Western Regional Water Company based in the neighbouring province of Kermanshah. According to some participants (Appendix A1, Table A1.5), a high level of mistrust between WAPC and RWCs was created. IWRMC's Water Planning Bureau also felt unease about the role of WPAC and the manner it dealt with the backlogs of proposals which were with no decisions. Some of the stakeholders felt that these projects "*should be closed and finished*" or "*if water allocation was not possible, WPAC should formally reject them*" (Source: ibid). These tensions between two MoE subsidiary organisations have not hindered the will of the provinces to ask for more and many proposals were sent. Water for environment was only met through unregulated river flows. There was no formal consideration for environmental water allocation.

Local provincial water allocation was controlled by Water Allocation Departments of the RWCs. First, provincial water resources plan was approved according to the guidelines and the codes based on the rules in use and then allocation was made according to the plan. Any conflicts of interest between different sectors were resolved in the provincial Water and Agriculture Commissions

This period is characterised by lack of inter-provincial co-ordination in water planning in LUB and each province tried to attract more projects with varying success to have more bargaining power at a later date. Informal water abstractions (pumping from rivers and streams, unauthorised wells etc.) were exercised in LUB. According to some participants from Kurdistan, WA had exercised less control over the informal abstractions. Local MPs and provincial governors (and district governors) were considered to be the most influential players in "*supporting the informal abstraction due to socio-economic considerations*" (Source: ibid).

Water allocation for period 2003-2008. The pre 2003 procedure has continued despite the new requirement for a basin wide IWRM assessment made by the 2003 Directive. IWRMC's Planning directorate has approved many provincial projects to be approved by the WPAC. The Commission has reluctantly approved dam building planning projects but did not issue any Water Allocation Permits. Many provincial projects have easily obtained *Credit Order*s without the need for MoE approval so provinces have built the infrastructure. Effectively, water allocation was not considered in these plans.

MoAJ 2003 Directive on small projects was a main driver for building small water supply and irrigation networks under the management of AJOs. The ***Annual Budget Law*** had financed such small projects and so there was a clear source of funding for these projects which had an informal water allocation arrangement. Participants have stated MoE's unease about this sort of planning which was an added burden on the RWCs (Source: ibid). MoAJ felt that building large dams are not suitable for agriculture and hence, these projects were "value for money" and less damaging to the environment (Appendix A1, Table A1.3). On the other hand, MoE felt that a comprehensive basin wide water resources planning is needed as mentioned in the 2003 WAD (Source: ibid). The political wrangling between MoE and MoAJ continued while provincial RWCs and AJOs were on good terms to attract more development funds for their respective provinces.

To conclude, the outcomes of this analysis can be summarised as follows:

- Emergence of new rules on water allocation and
- The inability of MoE to fully implement the rules e.g. 1982 FWD Act and 2003 WAD based on IWRM after six years of experience and deliberations

In the next sub-section, we will analyse the main rules in use affecting the Interaction-Outcome pathway: (a) based on taxonomical framework for rules; and (b) design principles which are described in Chapter III.

5.5.5. Need for revised Responses:

Need for comprehensive water law. The 1982 FWD Act (Table 5.8) was an important piece of legislation with water resources allocation rules. Prior to this water allocation rules were scattered and incomplete. However, the Act has several shortcomings. In this section, the Act is analysed based on Ostrom's (2005) classification of rules as followings:

1. *Boundary and position rules*: Article 21 (Chapter IV) explicitly states that MoE is 'solely'[22] responsible for water allocation decisions as the main position rule. Water rights were exclusively given to the State but the law implicitly acknowledges private water entitlements '*haqabe*'[23] and water users '*abbaran*'[24]. *Haqaba* is defined as a 'consumption right' which has to be rational[25]. The Act tries to avoid the word of private water entitlements. But, it mentions that these rights are only transferable with the transfer of lands. Chapter II extends the boundary rule to encompass groundwater entitlements and provide a deadline for owners to register and gain WAPs based on 'rational consumption'. However, Article 21 does not specify how to apply for water entitlements and hence the 2003 WAD was to provide procedural instruction for water allocation. There are numerous Bylaws, Directives and Codes and *Nota Bene* to help the implementation of the Act.
2. *Choice and scope rules*: there are numerous choice and scope rules with regard to issuance of Water Allocation Permits (WAPs) including consumers should control

[22] The Farsi words indicates an exclusive right for MoE
[23] The Farsi word is combination of words 'right' and 'water' to form right to water and could mean access as well as ownership
[24] The Farsi term is 'water takers'
[25] The Farsi term for rational, could mean reasonable and wise consumption as well. The author has chosen the word rational which is based on reasons and wise mode of actions.

demand and stop excessive use as well as their responsibility for not polluting the sources. Choice rules deal with actual water allocation rules and the Act has no provision for the environment. But, the Act mentioned several situations where it can issue WAPs such as if there is un-used public water; or water from treatment plants etc. Much of the choice rules are about issuing Permits to the users and less about the criteria of water allocation. The scope rule (water allocation outcome) is vaguely defined as ‘rational (reasonable) right’ of use has no upper limit and hence it cannot be enforced.

3. *Payoff rules* are included in Chapter VII with 10 clauses which deal with ‘damage caused to water system structures and unauthorised abstraction or violation of other water consumers with up to 3 months imprisonment. Pricing water is discussed in Chapter V but the Act does not recognise full water costs and the water charges are to be approved by the Supreme Economic Council. The over usage is not permitted but no limits have been set and the penalty is not clear.

Chapters	***Articles***	**Bylaws, Directives and Codes**
I. Ownership and water rights	2	4
II. Groundwater	15	9
III. Surface waters	3	3
IV. Duties and responsibilities	12	7
including water allocation clause	2	4
V. Water Charges	8	1
VI. Protection and maintenance of		
Public water structures	10	2
VII. Penalties		
Total	52	30

Table 5.8: the contents of the 1982 Fairwater Distribution Act

4. *Information rules* which refer to the regulations about communication between MoE and the applicants are ambiguous and based on voluntary exchange of information. In case of pollution for example, the users have to report this to the DoE. The Act specifies that agricultural water consumptions will be decided on information provided by MoAJ or groundwater abstractions rate is based on ‘provided information on water resources etc. In another clause it refers to the right of MoE to conduct water resources studies and collect information.

5. *Aggregation Rules* to the decision making process. The 1982 Act does not have a clear aggregation rule on how for example data information are coordinated that lead to consensual perspective on data validity. As there is lack of trust among actors, the situation has worsened. There are no rules for concurrence of other actors (e.g. MoAJ) to MoE decisions.

Based on the above assessment, it is argued that in order to implement IWRM, the main water law has to be streamlined with other legislations. It is not enough just to introduce new rules while the main legislations are in use and there is a far greater precedence for its application than newly 'untested' rules which are ambiguous.

2003 WAD: need for procedural guidelines. As mentioned before, WPAC was frustrated for the lack of cooperation of RWCs and IWRMC to implement the 2003 WAD. There was a degree of resistance to change and off course; there were conflicts between WPAC and Water Planning Bureau of IWRMC on procedural matters. The 2003 WAD for example, did not have any procedural and operational guidelines and hence it was not favoured by water managers.

IWRMC believed that WPAC should be concerned with policy and governance issues (Appendix A1, Tables A1.1- A1.3). However, national actors (MoE, Majlis etc.) had shared a dominant perspective that water allocation decisions (an operational level rule) should be made at national level and not the basin level based on national interests discourse (e.g. MRC, 1995; Memari, 2006). This is in contradiction with IWRM which fosters decisions at "*lowest local level possible"* (GWP, 2000). RWCs continued to use 1982 FWD Act as the main law and they were not obliged to use 2003 WAD. WPAC was frustrated by not receiving support from RWCs.

Using the ***design principles*** (Ostrom, 2005, p.259), an analysis is made based on stakeholder perceptions in addition to the outcomes of water allocation process in the LUB.

Principle 1: clearly defined boundaries. Unlike post 1999 legislations and policy documents, the 1982 Act does not specify river basins as a unit for water resources planning and management. In the post 1999, a new set of rules were created at constitutional and collective choice levels (such as the 2003 WAD, 2003 Long Term Strategies and so forth) which made the1982 Act an out-dated piece of legislation but still in force. This means that RWCs would legally follow the 1982 Act approach. The interface between province and river basins are not clear. All the provinces in LUB have Trans-boundary river basins and hence this unclear boundary rule makes the decisions more difficult. So each province did not have any water allocation quota and so the projects were either stopped or went ahead irrespective of water allocation.

Principle 2: proportional equivalence between costs and benefits. The cost of new rules did not feature in the assessment of benefits and costs to the community in question. This was due to (1) lack of information and (2) lack of time and funds to have an IWRM study of LUB. Provincial stakeholders could not recognise the cost or benefits of the government polices to their communities. There is a question of fairness and equity and many felt that the system is unfair and unjust especially from Kurdistan and WA points of view (Source: ibid).

***Principle 3: collective choice arrangements*.** Ostrom (2005) asserts that many who are affected by the constitutional and collective choice level rules should be able to participate in modifying the rules. However, water users were not involved through any consultations. These rules were made and modified through a consultation including only MoE and RWCs.

Principle 4: monitoring. Generally, stakeholders have acknowledged that there are low enforcement and executive powers to enforce the rules at the operational level (Source: questionnaire survey, Appendix A1). There is no basin wide monitoring program and the provinces zealously guard their ‘local interests’ rather than swaying towards national interest discourse put forward by MoE.

Principle 5: graduated sanctioning. The sanctions and penalties for non-compliance are not specified in the 2003 WAD. They are mainly normative type of rules and hence, the enforcement is not easy.

Principle 6: conflicts resolutions. Taking up the river basin approach by MoE heightened conflicts between provinces as they were trying to gain more benefits from this new approach. The provincial communities generally felt that it is a one way traffic and they are not listened too if a conflict arises from WPAC decision. Hence, a conflict resolution mechanism has to be incorporated to bridge the gap between provincial stakeholders and the WPAC.

***Principle 7: minimal recognition of rights to organise*:** Referring to Ostrom’s notions of the right of users to devise their own institution and their long term tenure rights, the new rules lack such rights. In fact, the whole aim of the 1982 Act and the 2003 WAD is to define a rigid and rigorous water allocation rules and the users have the right to consume only. There is no provision for local level management or participation. The decisions are made by the experts appointed by MoE. In the case of conflicts, courts can give a legal ruling and normally very few people win against the state in the courts. However, in practice, the balance of power has been towards the users as MoE was not able to fully implement the mentioned legislations due to socio-political pressures.

Principle 8: nested enterprises. In explaining the advantage of smaller nested enterprises in larger organisation, Ostrom (2005) advocate the robustness of polycentric systems. This will blend local knowledge with scientific information and allow for more efficient governance systems. Most of the stakeholders are working within the nested systems of both government and the water sector. The stakeholders felt that there is a need for streamlining rules within the complex multilevel sectoral governance systems (Source: ibid). The 2003 WAD is not going to encourage the formation of polycentric systems of governance for water allocation.

The design principles analysis shows that water allocation system in LUB was not robust and the informal local rules of water allocation have dominated the operational action arena. Due to the decision uncertainties, the provincial water and agriculture development plans remained a major Driving force in the face of pro IWRM rules and policies at national level.

5.6 Discussions: *Business as Usual (BAU) is not sustainable*

Local Drivers. Geopolitical factors and administrative divisions have played a major part in water resource planning and some regional disparity is seen in the country as well as provincial inequality at the LUB level. The Administrative Divisions Acts have been influential on the scope and scale of the developments and have caused political and ethno religious tensions. Administrative changes have taken place without consideration of the impact on the water resources system. The reform of AD Act is required to cater for the eco-hydrological and environmental dimensions of water resource planning and allocation.

Environmental aspects have not been a top priority in LUB. The environmental catastrophe of LU had a political repercussion and LU gained an agenda status on national level (see Chapter II on policymaking aspects). Although, provincial concerns about LU have been registered but the "*hydraulic mission*" and call for more developments have been unabated.

The DPSIR analysis has shown that most of the pressure comes from the agricultural sector in terms of increased agricultural demand driven by land use policy and politics of irrigation. The developmental discourse is dominant and has had far reaching consequence on environmental degradations in terms of poorer water quality of rivers and loss of wetland area as well as a huge drop in Lake Urmia's water level. Informal (and unauthorised) abstraction has become an important norm with virtually no monitoring system. Thus, a better institutional design is needed to cater for complex governance systems which exist within multilevel smaller nested farming enterprises.

The institutional analysis has shown that the formal rules (1982 Act, 2003 WAD) have not been implemented in LUB due to several important factors including:

- Lack of cooperation between RWC and MoE on the one hand and MoE and IWRMC on the other hand i.e. internal conflicts within water resources organisations.
- Lack of mechanism to bridge the gap between recent laws and established water allocation practices (pre 2003 era).
- Lack of capacity building to institutionalise the new rules in RWCs.
- Lack of inter-provincial cooperation in terms of water planning.
- The impact of non-water legislations such as FYDPs and provincial. Development Directives on water resources planning i.e. FYDP is project driven plan and is different from IWRM Plans.

5.7 Concluding remarks: *a new Response based on IWRM*

"Officially, participation is encouraged but in practice stones are thrown in the way"
A quote by an NGO participant

It can be concluded that the integrated DPSIR-IAD analysis has shown that the present institutional set up has failed because it could not deal properly with an increased water demand from agricultural sector. There is a need for re-orientation of LUB water sector institutions so that it can deal with the pressures exerted on the system. However, any institutional design should consider the informal rules in use which have been long practiced in LUB and so a participatory water allocation process is recommended. We will return to this theme in Chapter VII.

Emergence of new water management paradigm. As described in Section 5.1, the 4th FYDP (Article 67) initiated a move towards implementing an integrated ecosystem management plan for Lake Urmia. The Ecosystem Management Plan (EMP) was agreed by the stakeholders through the MoU on Lake Urmia management. Due to the Lake's predicament, there was a national outcry to save the lake and to implement the EMP. It can be claimed that Iran is moving towards a new water management paradigm. We will return to this theme in Chapter VII.

Earlier, in November 2007, a new institutional design was undertaken by creating several working groups on water resources and agricultural management, biodiversity and public awareness issues. New boundary and position rules were created in terms of water allocation decisions. Initially, water and agriculture were separated but they were put together because of the inter-linkage between the two issues, the groups were merged. The first meeting of the new Water and Agriculture Working Group (WAWG) meeting was conducted in November 2007 as two separate meetings in Urmia city. A stakeholder participation platform was created. Position rules about the membership of the WAWG were drafted by the CWIP team. Membership was restricted to representatives of the main provincial (RWCs, AJOs, EPOs) and national (WPAC, IWRMC) stakeholders. Kurdistan stakeholders were not involved in this stage. CWIP was aware of the need of the participation of Kurdistan Province in the WAWG. However, Kurdistan Governor's office was not aware of the importance of the issue and KRWC was slow to react to the invitation. Meanwhile, the preparation was underway to draft the EMP through a consultation process comprising of several workshops attended by the provincial stakeholders, national and international consultants including the author. On the 20th of October 2008, the MoU was signed. Later, in November 2008, the report by Hashemi (2008) and the final draft of the EMP were presented to the stakeholders to be approved and start the water allocation process which will be described in the next chapter.

In March 2009, the author officially became the IWRM National Consultant for CIWP to facilitate the agreement on water allocation through the formation of the WAWG. Terms of Reference (ToR) for the above position rule is given in Appendix A2.

Next in Chapter VI, the new participatory approach to water allocation based on a new institutional design will be discussed and the technical merits of water allocations decisions are assessed using the Integrated Socio-technical Assessment (ISTA) component. A reassessment of the institutional set up is made in Chapter VII.

Chapter VI. Integrated Socio-technical Assessment (ISTA) for Sustainable Water Allocation in Lake Urmia Basin

Campaign for LU water rights
(Design: unknown, source: internet)

6.1 Introduction

As described in Chapter V, Lake Urmia (LU) has been experiencing a fall in its level without recovering ever since the1999-2001 drought and has been shrinking at an alarming rate; at the end of 2010, the lake level was more than 4 m below its annual long term average. Policymakers and, in particular, the Ministry of Energy (MoE) have been searching for a window f opportunity to make a reassessment of the development plans. But faced with immense socio-political and climatic challenges (Drivers), MoE was unable to implement its national flagship polices on IWRM and river basin planning. LU's predicament ironically has been helpful in the quest for sustainable water allocation. The 2008 Memorandum of Understanding (MoU) between all the stakeholders endorses an IWRM-based Ecosystem Management Plan (EMP) in which Lake Urmia is a central theme in the water planning and allocation process.

Based on the MoU, multitier Multi-Stakeholder Platforms (MSPs) were established by the government to implement the Ecosystem Management Plan (EMP) by agreeing on a water allocation strategy for all the provinces, while also allocating water to Lake Urmia. The MSP comprised of the Water and Agriculture Working Group (WAWG), the membership of which was drawn from the major stakeholder organizations and selected NGOs. The first part of this chapter (part (1)) describes the stakeholder interaction process, consisting of a mix of meetings and technical assessments) that led to the water allocations required by the EMP. Therefore, Chapter VI has three main objectives:

1. To describe the new contextual setting for decision-making at Lake Urmia basin level; this is described in Section 6.3. The new institutional design in the form of multitier Multi-Stakeholder Platforms (MSPs) and associated actors is described.
2. To extend the DPSIR analysis in Chapter V to cover the period 2008-2010;this is described in Section 6.4 to include major IWRM-based Responses (R); The D-P-S-I elements have been dealt with in Chapters IV and V.
3. By using the ISTA component of the Integrated Socio-technical Framework comprising of two main elements, the analysis was carried out by
    a. the actors to make water allocation decisions which is outlined in Section 6.5 (part (1); and
    b. the author to assess the sustainability of the water allocation decisions using water balance, stochastic rainfall and water allocation modelling as shown in Figure 6.1 (part (2):Sections 6.6 – 6.9).
4. Conclusions are presented in Section 6.10

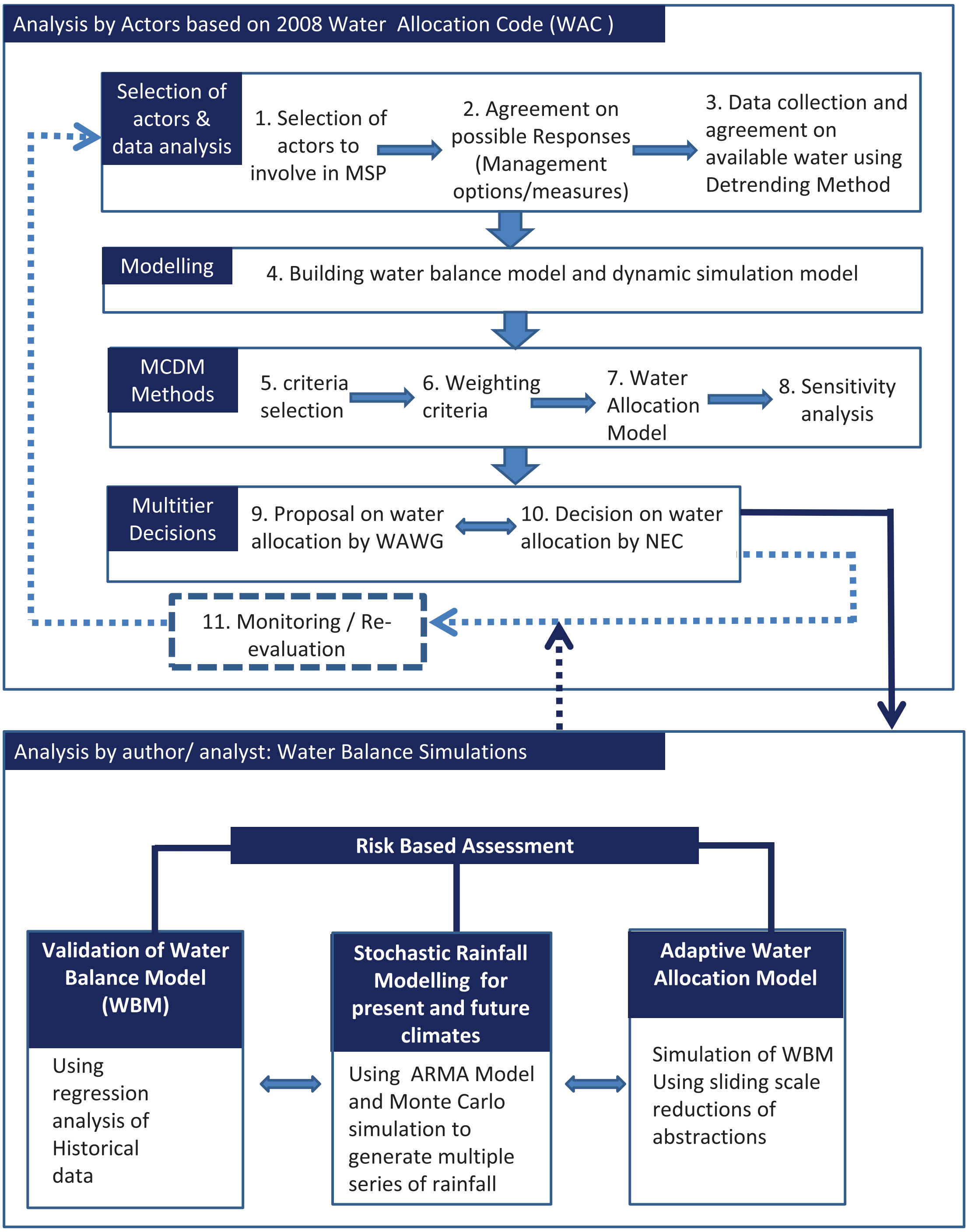
In the next section, the methodological approach employed to achieve the above objectives is outlined.

6.2 Methodological Approach

6.2.1. Unpacking the ISTA component

With reference to Figure 6.1, the ISTA component comprises of two main assessments:

1. The analysis in part (1) is based on the 2008 Water Allocation Code (WAC) which specifies procedures for water allocation. This consist of 11 steps as fully shown in Figure 6.1 with 4 main phases:
    a. selection of actors and data analysis (steps 1-3);
    b. water resources simulation using system dynamic and water balance modelling;
    c. use of Multi-Criteria Decision Analysis (MCDA) tools to express stakeholder preferences; and
    d. decision-making based on the trade-offs in the MCDA process.



Notes:

Dotted lines/boxes indicate feedback

ARMA	Autoregressive moving average
MCDA	Multii-criteria Decision Analysis
NEC	National Executive Council for the management of Lake Urmia basin
WBM	Water Balance Model
WAWG	Water and Agriculture Working Group

Figure 6.1: Data analysis, modelling and MCDA, with reference to the ISTA component of the Integrated Socio-technical Framework.

2. Risk based assessment to evaluate the sustainability of water allocation decisions in part (2). Part (2) will be fully explained in Section 6.6.

It must be recognised that the steps described in Figure 6.1 were not carried out in a strict order which reflects a real world action arena. For example, data analysis continued until the last meeting of the stakeholders and beyond; the MCDA process started before the completion of simulation model construction. Therefore, the dynamism of the process is reflected in this part of the chapter. The process is outlined as follows:

1. Step 3: Data collection is described next in Section 6.2.3.
2. Step 1: Contextual setting is described in Section 6.3.
3. Step 2: The strategy (i.e. management options) which is represented by Responses is outlined in Section 6.4
4. Steps 3 and 5, which involve choosing baseline data as a basis for water allocation criteria are described in Section 6.5.1
5. Step 6: the weighting of criteria for water allocation using the Analytical Hierarchy Process (AHP) MCDA approach is outlined in Section 6.5.2.
6. Steps 4, 7,8, and 9: technical support for water allocation using water balance modelling and system dynamic simulation (Section 6.5.3)
7. Step 10: finalising the water allocation decision by the National Executive Council (NEC) is outlined in Section 6.5.4.
8. Step 11: no reassessment of the allocations was made by the actors; however, assessments in part (2) are a contribution towards re-evaluating the water allocation outcome decisions.

6.2.2 Data collection

Data collection methods are given in Chapter III. Data collection was the most contentious part of a complex process and agreement on data continued well after the provisional decision on allocations was made. In this chapter, the main data used is baseline data which was the basis of the water allocation criteria. Baseline data collection went through two main stages: secondary data analysis which was carried out by the author on behalf of the stakeholders to provide an independent synthesis of the available water resources i.e. no new data was produced. This will be described later.

The baseline data needed for the MCDA included:

- socio-economic data (population, Regional Domestic Product (RDP),etc.)
- water resources data (e.g. potential natural surface runoff; water demands and supply; water abstractions; inflow into the lake etc.) and
- climatic data (e.g. precipitation, evaporation etc.); all the data were provided by the stakeholders and agreed during the water allocation

process. The data was also scrutinised during the participatory decision-making.

Groundwater resources were not considered in the allocation process for two reasons: (1) groundwater discharge to Lake Urmia is about 190 MCM/year which represents a small percentage of total inflow into the lake; and (2) it is extremely controversial since there is an overlap between groundwater and surface water and groundwater is not directly managed by the MoE as abstraction rights are mostly held by private tenants. This is a major gap that has to be dealt with in the future and we will come to this theme in Chapters VII and IX.

Synthesis report based on secondary data. At the start of the participatory process, it was evident that there was no baseline databank which was endorsed by all the actors. There was a clear ownership problem. Thus, a critical review of secondary data was commissioned by the actors; the author was chosen to appraise the available data and produce the synthesis report which is an independent review of major studies made on the Lake Urmia basin. Hashemi (2008) evaluated the status of the water resources in the basin and the water budget of the Lake itself based on the studies/projects carried out by national and international agencies and organisations. Through this synthesis, the knowledge and data uncertainty were dealt with. This synthesis report was used as the main reference for making strategic decisions in the basin by all the stakeholders and the members of various *Working Groups* formed as a result of consultation exercises during the early stages of the project.

The independent review by Hashemi (2008) was presented to the stakeholders in the last consultation workshop in 2008. Hashemi (2008) tried to address three main issues. First, during the consultation period, there was no consensus about even basic data e.g. average annual rainfall for the basin; thus, facts and figures needed to be synthesised in a coherent manner. Secondly, water for ecosystems (satellite wetlands and LU) is not specified in the Fair Water Distribution Act (1982) and so water rights for the ecosystem including LU and other satellite wetlands needed to be specified. Past works since the1960s[1] neither focus on LU nor contain any water balance modelling of the lake. They were either (a) *Feasibility Studies* carried out in the 1960s- 1980s as parts of agricultural, irrigation, dam building or highway development projects including valuable information about water resources and water quality, or (b) demand driven *Comprehensive Water Master Plans (*described in Chapter IV) which do not recognise

[1]They are mainly consultancy reports commissioned by ministries and governmental institutions but they are not necessarily 'owned'by them.

IWRM and are mainly based on assessment of the technical aspects of river basin planning. A brief summary of Hashemi's (2008) synthesis is provided here.

In the late 1990s, multi-disciplinary projects based on the river basin paradigm started as summarised in Table 6.1. Yekom (2002) was the first project to highlight the environmental issues in the basin; there, certain management action plans were proposed to deal with institutional, hydrological and ecological requirements in the basin.

Reference	Description	ISTA tools
Yakom (2002)	1995-2002: EC-IIP project conducted baseline studies of the natural, human and institutional environment of the Lake Urmia basin, as well as making a large number of recommendations for future research, monitoring and sustainable management of the Basin	Socio-technical assessment but no modelling was used
WRI (2005)	2002-2005: It consists of four modules: IWRM (with integrated modelling system); water for food, water for ecosystems and Cross cutting module (capacity building).	RIBASIM, HYMOS and GIS software
Nazaridoust (2006)	2002-2006: PhD thesis entitled "A Methodological Framework, Guidelines and DSS Model to Calculate the Minimal Ecosystem Water Requirements for Lake Urmia"	Ecohydrological approach Regression modelling
Yekom (2005)	2003-2005: 9 volumes of reports by Yekom Consulting Engineers: The Environmental Impact Assessment and study (quality and quantity) of the Development Projects in the LUB. Commissioned by WARWC	Used the work done by Nazaridoust (2006); water balance modelling; droughts assessment
On-going projects	**Timeline Reference Description**	**Modelling used**
MoE (2010b)	2005-2012: Conservation of Iranian Wetlands Project (CIWP) to prepare and implement an ecosystem management plan for LUB. This PhD's work is based on this project.	Vensim dynamic simulation; AHP and Expert choice (Multi-criteria software)
MoE(2011)	2008-2012:MoE's Updating the Water Master Plan project (IWRM approach) carried out by Mahab Ghodss Consulting Engineers. Draft report has been produced in 2011	A DSS to be developed

Table 6.1: Past and on-going multi-disciplinary research studies in LUB.

There is a lot of overlapping and repetitive reporting which makes the analysis rather tedious. The data comes from the most reliable sources since these reports were commissioned by ministries and related organisations and the consultancy firms had good connections to produce these reports and carry out these major studies. Despite all these, there are major information gaps, and much work was needed to organise a databank for the basin.

Yekom (2005) contains a rather detailed analysis of the hydrological data. Using results from Nazaridoust (2006), the study comes up with the concept of a minimum ecological water requirement of Lake Urmia, providing a first insight into one of the elusive pieces of data needed for the water allocation process. We will return to this theme later. Hashemi (2008) highlighted this data in the synthesis report as most of the actors were not aware of Lake Urmia's water requirement.

Major research gaps identified in the Yekom (2002) study were followed upby the other multidisciplinary projects as shown in Table 6.2. One great advantage of the multidisciplinary projects has been that a lot of information gaps have been covered: new hydrological, climatic and institutional data have been collected and recorded. It makes the Lake Urmia basin one of the best-studied catchments in Iran. There is a historic link between the projects which can be considered complimentary to each other; they also show continuity in the research agenda in the basin which is both unique and advantageous. The Conservation of Iranian Wetlands Project (CIWP) can be considered to be the continuation and culmination of the international projects as the main aim of these projects was to achieve sustainability and ecological balance in the whole basin.

No.	Recommendation made by Yekom (2002)	Works corresponding to the recommendations
1	Water resources developments in the basin combined with the drought period have had a remarkable effect on water level and lake surface area. A detailed study of the water budget in the basin is therefore needed.	Yekom (2005) Volume 2: Water Budget of the Lake; WRI 2005: water resources planning modelling including the water balance of the lake Nazaridoust (2006): ecological water requirement of the lake
2	A detailed study on microclimatic changes and the effect of the Lake in climatic moderation is recommended.	Yekom (2005) Volume 5: The Impact of Microclimatic (local Climate) changes on the Surface Area of the Lake and vice versa: effect of the Lake on temperature and humidity Volume 4: Impacts of Droughts on the Condition of the Lake: drought analysis with respect to water inflow into the lake and Lake's water level.
3	Hydrometric stations should be installed at the outfall of tributaries near the Lake, to provide an accurate estimate of the inflows to the Lake.	Yekom (2005) Volume 1: Calculation of Inflow into the Lake; WRI (2005): water balance of the Lake
4	Extensive agriculture is undertaken in the coastal areas around the Lake. The amount and quality of withdrawal water and the return flow to the Lake should be monitored.	Yekom (2005) Volume 1: Calculation of Inflow into the Lake
5	Installation of a water quality-monitoring network (surface and groundwater) near the Lake is essential for future monitoring.	Yekom (2005) Volume 1: Calculation of Inflow into the Lake (Water Quality section).
6	An assessment of saltwater intrusion into coastal aquifers should be made and appropriate measures, such as artificial recharge undertaken.	WRI (2005) Module 1 Basic Studies Report, section 4 Groundwater Resources
7	Since the condition of the Lake is too critical from hydrological point of view and consequently from biological point of view, it is strongly recommended to make a comprehensive study of long term consequences of water resources projects throughout the Lake Urmia Basin.	Yekom (2005) Volume 7: The Impact of Water Resources Developments in the Basin on the Lake WRI: RIBASIM Modelling approach

Table 6.2: Follow up of major research gaps which were identified by Yekom (2002), WRI (2005) and Yekom (2005).

Qualitative and observational data. Most of the meetings were documented by audio and video recordings with the knowledge of the participants in addition to minutes of the meetings (MoM) which the author took the lead in recording. These types of data are used to provide the socio-political context for the ISTA component. Full details are given in Appendix A1.

6.3 Contextual setting

The attributes of the Social- Ecological system of Lake Urmia basin has been described in Section 5.3 (Chapter V); thus, we only consider here the action arena and the actors involved in the participatory decision-making.

The ***Action arena*** is the same as in Chapter V with a difference that new multitier Multi-Stakeholder Platforms (MSPs) has been established for the management of LUB including the National Executive Council (NEC), the Regional Council (RC) and Water and Agriculture Working Group (WAWG) as shown in Figure 6.2.

The MSPs paved the way for a participatory decision-making process at the basin level. WAWG is an advisory platform helping the Regional Council (RC) to facilitate agreements on proposals to be approved by the policy-making NEC. This institutional design did not work in practice as RC was dormant, and so the Working Group (i.e. WAWG) decisions were presented to the NEC via CIWP acting on behalf of Department of Environment (DoE).

Actors. The actors for each of the Working Group, Regional Council and National Executive Council (NEC) are given in Figure 6.2 and Figure 6.3. In this Chapter, the focus is on the Working Group actors whom have been involved in the water allocation process (steps 1-9) as given in Figure 6.1. The participants have been appointed as representatives of major governmental departments primarily representing wider respective provincial and national interests, but they were mandated to make a socio-technical judgement on water allocation in Lake Urmia .

From the outset, provincial representatives formed a united front in the discussion i.e. coalitions were formed based on political borders e.g. Kurdistan representatives formed a coalition of governmental departments, becoming an actor with one voice. Deputy Governorates for Development and Planning were behind ‘gluing’ the antagonistic provincial organisations to safeguard provincial interests. Kurdistan’s dominant perspective has been that they have lost because of being upstream to trans-boundary watersheds. Hence, the Kurdistan Regional Water Company (KRWC) played an active role in the negotiations based on scientific and political arguments. WA and EA were more relaxed since their shares of the surface water consumption are about 90% of the total abstraction.

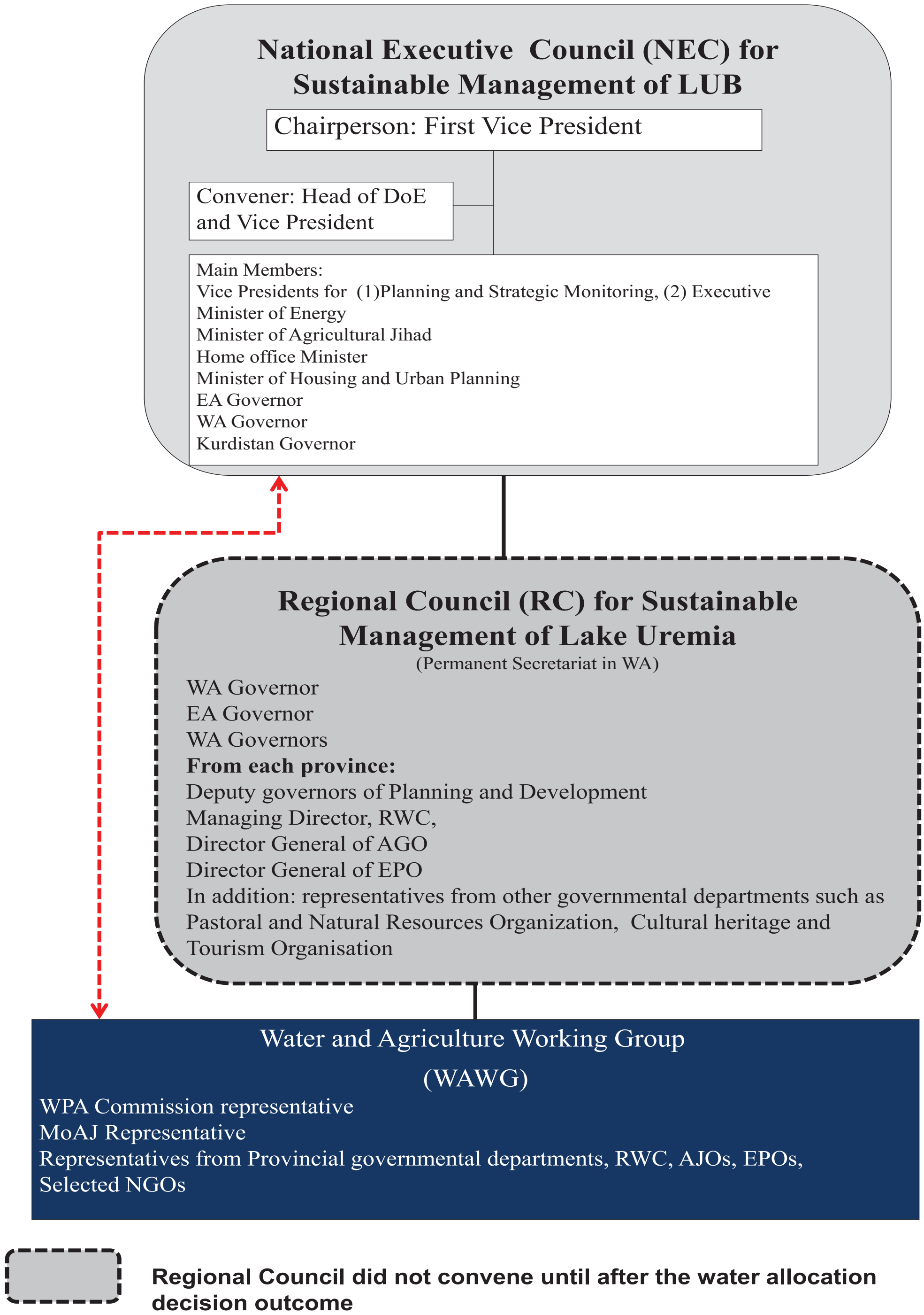


Figure 6.2: Action arena: multitier MSPs in LUB.

The RC Secretariat was unofficially established by the West Azerbaijan Environmental Protection Organisation (WAEPO) in October 2009 as a floating unit; the extra tasks have been bestowed upon employees of the WAEPO with limited resources. The RC became irrelevant as the time went by. In 2010, the RC Secretariat was officially appointed by the WA governor but no budget or resources have been allocated to it as yet (Jabbari, 2011).

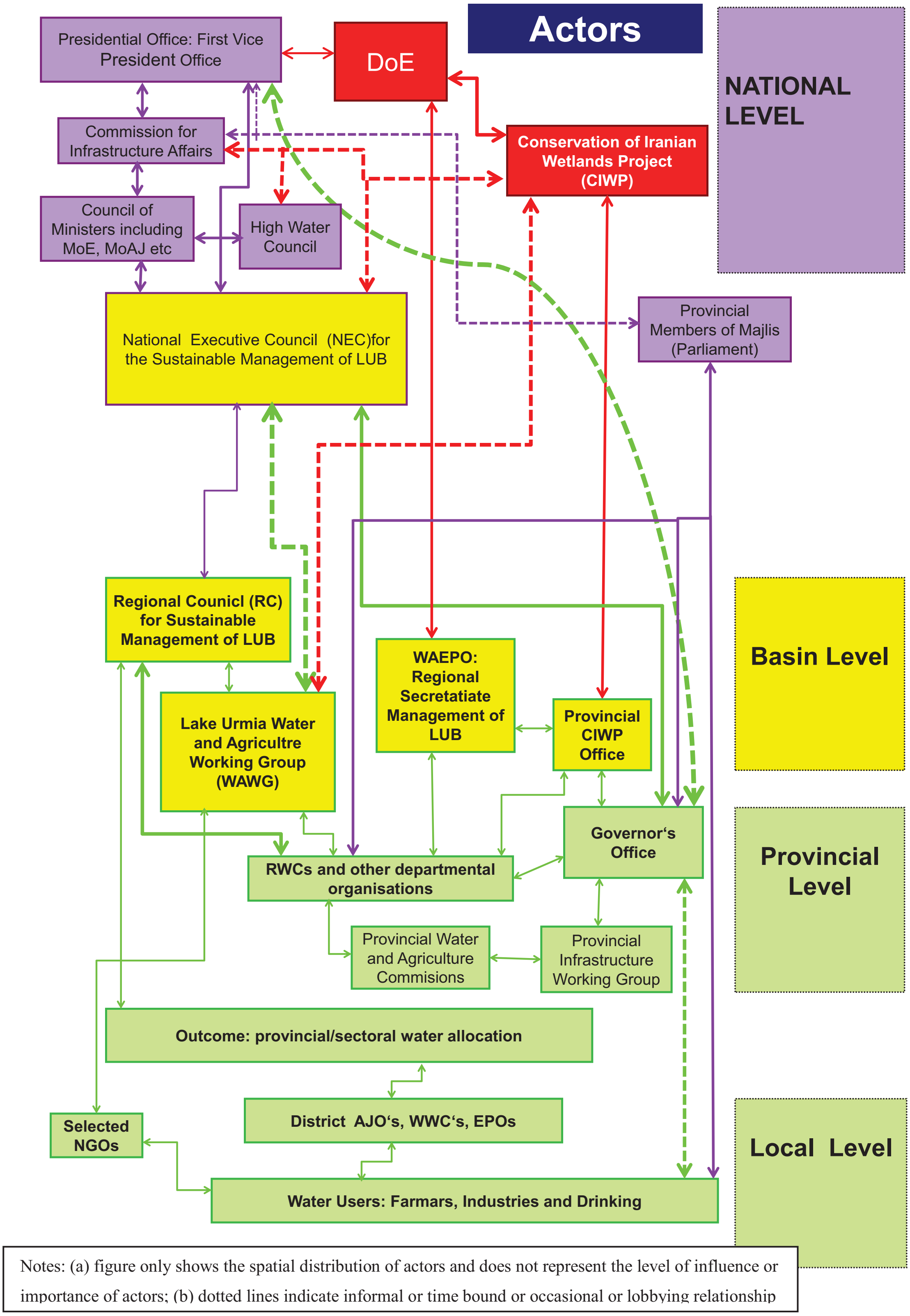


Figure 6.3: Main actors in the action arena, showing the levels they operated at and the linkages between them.

With the exception of selected NGOs, no local civil society actors were involved in the negotiations. We will discuss this important theme in Chapter VII. CIWP offices in WA and EA had a very limited role. There was no CIWP office in Kurdistan; thus the author has been representing CIWP in Kurdistan. This informal position rule was sanctioned by CIWP and was endorsed by Kurdistan stakeholders who tried to put across their arguments and narratives. On many occasions, the author was invited to attend Kurdistan Water and Agriculture Commission meetings.

Table 6.3 summarises the roles and positions of the main national and provincial actors in the water allocation process. CIWP tried to maintain its role as a facilitator, but, due to negotiation deadlocks, it became an important game-changer which was respected by the provincial stakeholders. The author was given a mandate by the CIWP to facilitate the proceedings as described in Appendix A2. The agendas of the WAWG meetings were initially drafted by the author as the national consultant for the CIWP, and then they were reviewed and sanctioned by the CIWP team.

Actors	*Role and position*
National	
CIWP: Conservation of Iranian Wetlands Project	Played an important role as facilitator in the water allocation process from consultation stage to implementation
Energy Group, Office of the 1st Vice President	Responsible for preparing budgets and financial package for implementation of the agreement on the allocations; a major player in getting the final agreement
DoE: Department of Environment, Office of Head of DoE, Vice President	Represented by CIWP which carried out its work under the auspices of DoE
MoE: Ministry of Energy represented by Water Policy and Allocation Commission (WPAC)	WPAC set the rules for analysis by the actors to make a decision according to the 2008 Water Allocation Code
IWRMC: Iran Water Resources Management Company	Represented by various departments including the Water Planning Office and the newly established Office of River Basins; they participated in the process mainly to support the process and to clarify some operational ambiguities about water resources planning and allocation
MoAJ Ministry of Agricultural Jihad	MoAJ participated through the Office of Water and Land to confirm baseline data on potential irrigation areas for each province
Provincial : each province was represented by four main stakeholders;	
Provincial Governor's Office	Represented by the Office of Planning and Office of Development; Except for Kurdistan, the other two provinces did not have an active role in the WAWG meetings
RWCs: Regional Water Companies	They led the negotiations for most of the time
AJOs: Agricultural Jihad Organisations	They also actively participated in the negotiations
EPOs: Environmental Protection Organisations	The EPOs were not active in the later stages since the LU's minimum ecological water requirement was approved by law
NGOs	A few NGOs participated but had a very limited role

Note: For the provincial organizations, the acronyms used were K for Kurdistan, EA for East Azerbaijan and WA for West Azerbaijan; thus, the West Azerbaijan Agricultural Jihad Organisations is denoted as WAAJO

Table 6.3: Permanent actors in the WAWG meetings.

The relationship between CIWP and national actors was not so comfortable i.e. there was a difference in perspective. Nevertheless, CIWP had the support of the Vice-President's office which was crucial for its saliency in the process. The Water Policy and Allocation Commission (WPAC) and Iran Water Resources Management Company (IWRMC) represented MoE as a national stakeholder. IWRMC was represented by three departments: the Baseline Data Bureau, the Water Planning Bureau and the Office of River Basins. The Office of River Basins was newly established to coordinate river basin activities but did not have an established 'institutional charter' or '*Code of Conduct'* as it has been evolving from the new policy on river basin management. Therefore, the Water Planning Bureau continued to take responsibility for water allocation and planning at provincial level and there has been no basin level planning as yet. Also, no unified position was held by the IWRMC departments and so there was no uniformity in their perspectives. There was also a degree of rivalry and mistrust among these departments. However, they acted positively in the negotiations and left the provinces to take the lead in the negotiations.

The Water Policy and Allocation Commission (WPAC) had a bigger stake and has traditionally been the game-changer. The allocation was made according to the procedures drawn up by the Commission: the 2008 WAC as will be described in the next section.

NEC is a mini- Council of Ministers comprising of several ministries (including Energy, Agricultural Jihad, Home and Housing and Urbanisation) and the three provincial governors.

6.4 DPSIR assessment

6.4.1 Drivers

The main Driver has been ***the2008 EMP*** which was the outcome of numerous seminars and workshops and provides a vision and a goal with four main objectives; priority actions for each of the objectives were also set. Objective 2 of the EMP is on sustainable management of water resources and land use (Box 6.1).The methodological approach was to prepare a sustainable water allocation target in LUB. The 25year vision states that:

Lake Urmia will have adequate water to sustain an attractive landscape and rich biodiversity where people and local communities can make wise use of its resources, and will enhance cooperation between the involved provincial organizations (DoE, 2008)

Based on the above vision, the 2008 EMP specifies a strategy comprising of five action priorities (management options) to deal with the pressures outlined in the DPSIR assessment (Chapter V). The strategy was agreed during the 2008 Tabriz IWRM Workshop (see next section, Figure 6.6) by the stakeholders as shown in Box 6.1; the prime priority was to agree on a water allocation plan for the basin. Priority 1 of the strategy deals with preparing a water allocation plan based on IWRM with consideration for socio-economic and environmental conditions. Based on the consultation process, a simple water allocation model was agreed as a starting point for the water allocation process based on a MCDM approach. Provisionally, several criteria were chosen as shown in Table 6.4. The provisional allocation criteria were: total area, population, regional domestic product (RDP), existing withdrawals and average supply (surface runoff).

Box 6.1: EMP clauses relevant to water allocation

Objective 2: Sustainable management of water resources and land use
Aim (goal) (long term e.g. 25 year vision): is to save the lake
Purpose (Priority Issues): water supply to the lake & wetlands
Target:
Long Term: inflows to maintain water supply to the Lake and satellite wetlands: water level at 1274 m amsl
Short Term: increase river flow (inflows) by 3% each year
Suggested Indicator by the author: a measurable indicator is needed to verify whether the target has been met–in this case an indicator could be measurements of river flows (and inflow into the LU)
Priority actions (Management Options) for water Supply to Lake Urmia and satellite wetlands
Priority 1: Prepare an agreed plan for allocating the water resources of the basin to the three provinces and the Lake, taking into account required environmental flows for the rivers and satellite wetlands

Priority 2: Prepare provincial Master Development Plans for water and land resources based on an ecosystem approach and taking into account the available water for each province resulting from action 1.

Priority 3: Determine an agreed range of Lake water level fluctuation - how to deal with dry years

Priority 4: Investigate feasibility for water diversion from neighbouring catchments and evaluate environmental impacts
Priority 5: Investigate feasibility of measures to reduce excess evaporation from the Lake (i.e. segregation of the very shallow parts of the Lake in dry years), and evaluate environmental impacts

	Socio-economic data					Present inflows to the lake	Average supply	Allocation	To Lake (check) [1]
	Total area	Population	RDP	Irrigation area	Existing withdraw.				
W-Azerbaijan.									
E-Azerbaijan.									
Kurdistan									
Total							7.0	**4.0**	3.0
	ha	Mil.	BRial	ha	BCM	BCM	BCM	BCM	BCM

[1)] This allocation should be checked to ensure adequate water is supplied to the satellite wetlands.
RDP is regional Domestic product in billion Riyals; BCM: billion meter cubed (10^9 m^3); The figures shown in table were approximations only
Source: IWRM Workshop Tabriz, Nov 2008

Table 6.4: Provisional template for water allocation baseline data and criteria agreed by stakeholders (DoE, 2008); based on secondary data analysis, Hashemi (2008) reported that there is about 7 BCM potential surface water in the basin; the minimum lake requirement is 3 BCM.

6.4.2 Response 1:Ecohydrological approach to determine minimum ecological water requirement for Lake Urmia

The concept of a minimum ecological water requirement for Lake Urmia came about due to MoE's quest to understand the lake's water needs. There has been no formal water allocation for Lake Urmia as historically it received direct precipitation over the lake and the surplus water (unregulated) from river tributaries. The concept was investigated by Yekom (2005) based on Nazaridoust's (2006) PhD thesis which employed a risk analysis and regression modelling approach based on the water balance of Lake Urmia by considering ecological and hydrological (water quality and quantity) indicators.

Lake Urmia has a small biota with a simple food chain; Artemia, which is the only primary consumer, feed on green algae and provide nutrition for flamingos (Abbaspour and Nazaridoust, 2007). Therefore, Artemia plays an important role in the food chain and can be a good ecological indicator. Artemia is sensitive to the level of salinity and, in particular, sodium chloride and hence, salinity was chosen as the water quality indicator. Then, the water quality was related to a water quantity indicator, lake level and the relationship between lake level and change in salinity shown in Figure 6.4 was described by the following equation:

$$Elv_{(Eco)} = (1.657E\text{-}10) \times NaCl_{(Eco)}^{2} - (1.012E\text{-}4) \times NaCl_{(Eco)} + (1288.83) \qquad (6.1)$$

where $Elv_{(Eco)}$is the ecological elevation or lake level and $NaCl_{(Eco)}$ is the optimal salt concentration i.e. 240 g/l.

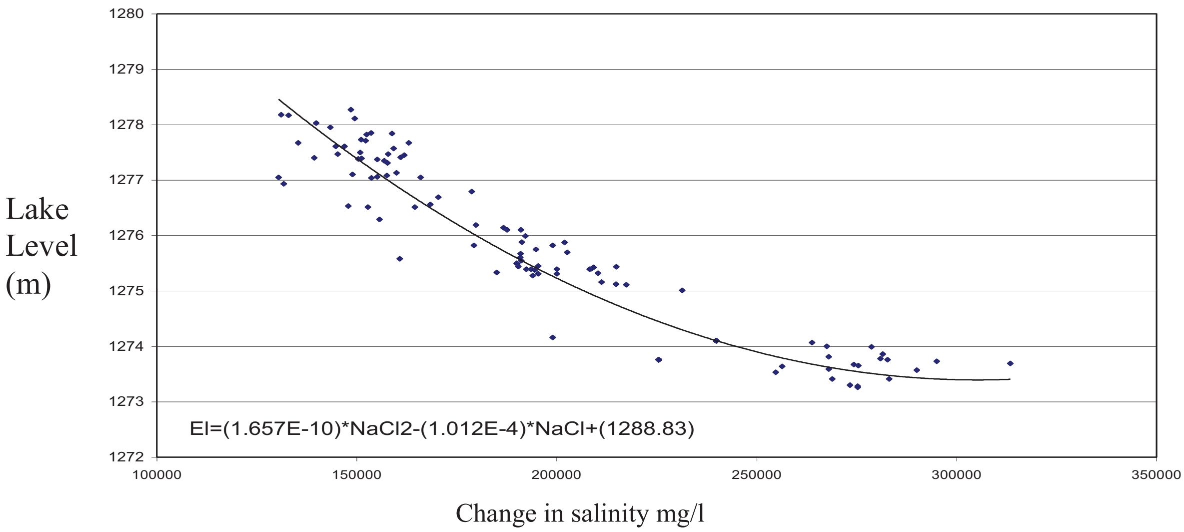


Figure 6.4: The relationship between Lake level and salinity (quantity and quality indicators; Abbaspour and Nazaridoust, 2007).

Based on an extensive literature review, Abbaspour and Nazaridoust (2007) concluded that the optimal salinity for normal reproduction of Artemia is 240 g/l. Hence, using equation 6.1, the ecological lake level was estimated to be 1274.1 m asl. Using a volume -surface area -lake level (VAL) relationship, the ecological surface area (A_{Eco}) was calculated as 4652.2 km^2 using the following equation

$$A_{(Eco)} = 479923 - \frac{6.05501 \times 10^8}{Elv_{(Eco)}} \quad (\text{km}^2) \qquad (6.2)$$

In order to find the water requirement to maintain the ecological lake level, Abbaspour and Nazaridoust (2007) simulated the water balance of the lake for the historical period 1966-2004 using the following water balance model(WBM):

$$\Delta S = I + A(P_L - E) \qquad (6.3)$$

where ΔS is monthly change in storage, P_L is monthly rainfall over the lake in mm, I is the monthly inflow into the lake in MCM, E is monthly evaporation in mm and A is area in km^2.

Constant values for E (960 mm/year) and P_L (296 mm/year) were assumed to simulate the water balance and to calculate the minimum ecological water requirement needed to sustain the ecological and hydrological (quantity and quality) functioning of the lake; this was estimated as 3086 MCM or approximately 3100 MCM/year. Yekom (2005) states that considering ecological lake level as a benchmark serves two important functions: (1) the salt marshlands in the southern part of the lake will be filled with water (Figure 6.5) and (2) the important islands will be surrounded with water which provide sanctuary for endangered red deer species on these islands; otherwise, they would be threatened by hunters as shown in Figure 6.6.

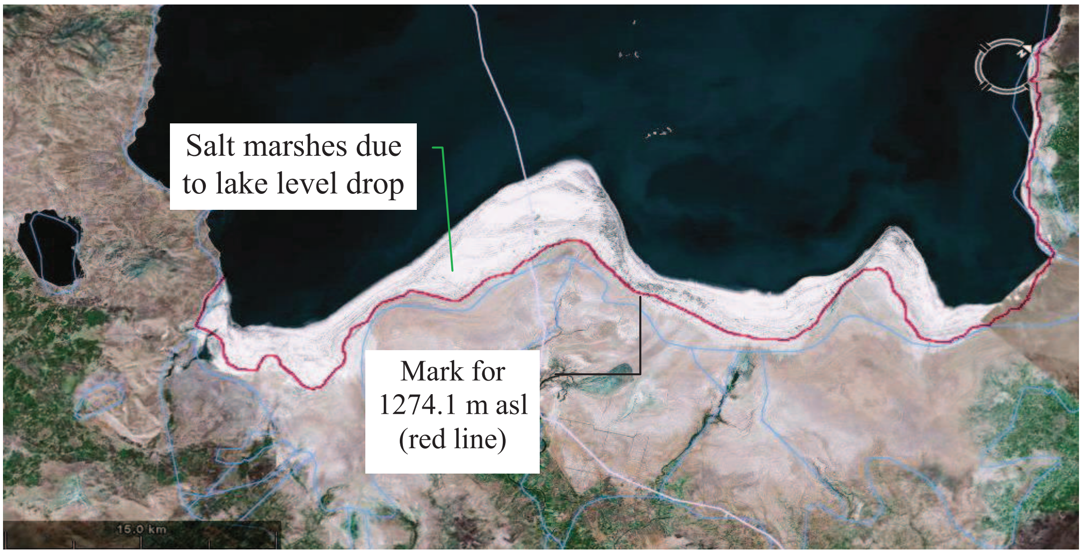


Figure 6.5: Satellite image showing how, at elevation 1274.1,m, the southern salt marshes will be filled with water.

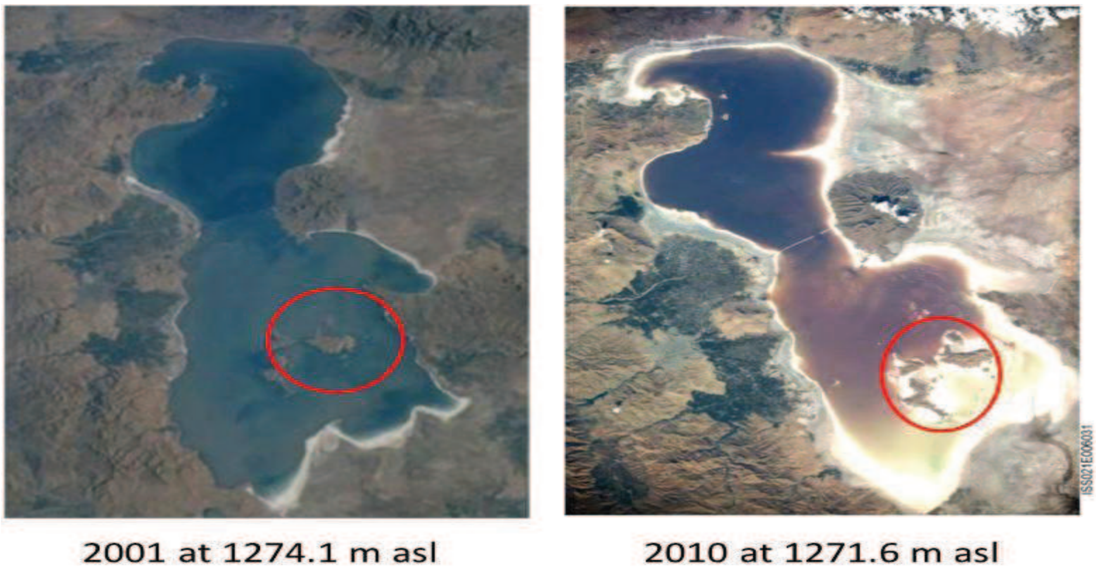


Figure 6.6: Satellite Images showing that the Eslami Islands are surrounded with water at elevation 1274.1 masl (Yekom, 2005)

6.4.3 Response 2: 2008 Water Allocation Code (WAC)

Water allocation has been a source of conflict in all the Iranian basins and so MoE's dominant perspective has been that a water resources modelling system can help the process. In 2008, a new Water Allocation Code (WAC) was enacted containing a comprehensive procedure for water allocation in the river basins based on an evidence-based approach that specifies that "*evidences should be documented*". But the WAC does not endorse participatory decision-making. The water allocation process in the

Working Group is governed by both the 2008 WAC and the Ecosystem Management Plan (EMP). The 2008 WAC procedures were described earlier in Section 6.2.

6.4.4 Response 3: establishment of MSPs

Guided by the 2008 Water Allocation Code (WAC) and the 2008 EMP, Water and Agriculture Working Group (WAWG) meetings were convened to reach a decision on water allocation as shown in Figure 6.7.

With reference to the procedure (1-9 steps) outlined in Figure 6.1, Figure 6.7 shows the main achievements in each of the meetings which will be described in the next section. The meetings took place during a period from November 2007 to July 2010. The water allocation decision was finalised at a higher MSP i.e. National Executive Council (NEC) which will be described in Section 6.5.4.

Figure 6.7: Water allocation process progression in the WAWG meetings (Photo courtesy of WARWC).

6.4.5 Response4: formal Lake Urmia water rights

As shown in Figure 6.8, the concept of a minimum water requirement for Lake Urmia gained a legal status in 2010 through a By-law issued by the Council of Ministers.

- 2005	**Yekom (2005) produced a report based on a PhD thesis by Nazaridoust (2006)**
- 2007	**the concept was used in the consultation workshops**
- 2008	**Hashemi (2008) highlighted Yekom's finding which was to be presented at the final consulting workshop to be included in the EMP**
	An MoU including the EMP was signed and endorsed by stakeholders,thus accepting the concept
- 2009	**the concept was approved by the High Water Council's technical committee through the work of CIWP**
- 2010	**Council of Ministers approved the minimum ecological water requirement as a By-law.**

Figure 6.8: The timeline of development of the concept of minimum ecological water requirement for Lake Urmia as 3100 MCM/year.

With reference to Figure 6.8, two important steps became the entry point to the participatory decision-making process. First, the 1st WAWG meeting (Figure 6.7) was convened before the formal adoption of the 2008 EMP, as CIWP was aware that more preparation was needed for the adoption of the EMP. The participants highlighted two important challenges: agreements on (1) baseline data and (2) the water requirement of the Lake. Hashemi (2008) prepared the synthesis report in response to a request from the first meeting. The report highlighted the findings on the minimum ecological requirement of the Lake. The intention was that the report would be endorsed by the stakeholders. The stakeholders initially endorsed a simple water allocation model (WAM) based on MCDA approach, which in principle recognised LU's water rights. With reservations, they accepted the idea of a minimum ecological water requirement of 3100 MCM per year to be used as a constraint in the water allocation model (WAM).

Parallel to the CIWP work at basin level, the MoE and the DoE established a 'Joint Committee' to look into the water requirement of the lake but could not come up with a decision. CIWP had to be neutral during the MoE and DoE synergy. After attending the 13th MoE/DoE Joint Committee meeting in 2009, it was apparent that the Water Policy and Allocation Commission (WPAC) would not accept the figure of 3100 MCM. The meetings produced great tensions between MoE and DoE; DoE dismissed the disagreement on the data among the MoE 'group' and asked for the delivery of the water to LU as required by law. So CIWP had to detach itself from DoE patronage by asserting that it was an independent national project under the umbrella of DoE, and thus mended the relationship with the powerful WPAC.

Secondly, CIWP realised that, without formal water rights for the Lake, it was very difficult to initiate the basin water allocation process, and there was a need to have a legal basis for the decisions made by the Working Group. In 2009, DoE and CIWP put the idea of a minimum water requirement to the test at the High[2] Water Council (HWC) which made a recommendation to the Council of Ministers. The Council of Ministers approved the minimum requirement agreed in 2010 (Figure 6.8). This proved to be very effective in galvanising the participatory water allocation process which is described in the next section.

To support the WAWG, CIWP had to act independently from DoE and use the institutional mechanisms to continue and push forward the process. The political support came from the Office of the First Vice President and its Energy Commission Group and the Infrastructure Committee of the Presidential Office. The latter has the power to approve budgets and hence had financial leverage as well.

6.5 Participatory Water Allocation Decisions

6.5.1 Choosing baseline data as a basis for water allocation criteria

Dealing with uncertainty. It was commonly acknowledged that the available data were not very accurate; thus there was (and is) a degree of uncertainty about the validity of the hydrological and climatic data. Knowledge (data; scientific such as climate change) uncertainty was one of the important issues which was mentioned in almost all the meetings and workshops. There was a need to deal with knowledge uncertainty so that it would not become a reason for inaction or lack of action or decision-making. Thus, the ownership of the information was of paramount importance. Hence, the provincial stakeholders were involved in providing data that they accepted and owned and then in compiling a database agreed by all stakeholders based on consensus. For example, it took a considerable time to arrive at figures such as the amount of potential surface water in each province. The important issue is that the risks and uncertainties should be communicated to the stakeholders (Hashemi and O'Connell, 2011a). Therefore, the data used in this process have been provided and owned by stakeholders and considered to be the best data available.

Rule for facilitating dialogue. CIWP was aware that filling data/information gaps by adding interpretations and elaborations was not a practice envisaged as a facilitator of the WAWG meetings because any elaboration or interpretation would

[2] In some English texts, the word 'Supreme Water Council' is also used.

require an extensive dialogue with the provinces; they might disagree with the interpretation or the elaboration, leading to conflicts.

In addition, a new information rule had to be established: one of the challenges was to divide the Lake Urmia basin into three pseudo sub-basins in line with provincial geopolitical boundaries to obtain baseline data on (1) water resources availability and supply; (2) agricultural production and water use and (3) socioeconomic data. The problem is that information on (2) and (3) is based on district administrative divisions and information on (1) is based on river catchments, of which some are trans-boundary catchments.

Choosing water allocation criteria and constraints. Based on the vision outlined in the 2008 EMP, a MCDA approach was recommended. There were some guidelines in choosing the possible criteria and constraints: they should be simple and measurable and be based on consensus i.e. everyone should accept them in the consultation process. Based on long deliberations in the WAWG meetings, participants discussed a large number of possible criteria to be used which are summarised in Figure 6.9.

Water resources availability and supply. Agreement on hydrologic baseline data proved to be very difficult. The reports provided by the provinces were the basic facts on the ground and were not considered to be reliable by the WPAC. Before the 2nd Working Group meeting in May 2009 in Urmia City, a request was sent that all the provinces should send their reports on water and agriculture sectors and the information needed for water allocation i.e. to complete Table 6.4. However, despite having sent a single format to all the three provinces, they did not exactly follow it in presenting their reports. They did not hand in any documentations-just oral presentations. This was inconsistent with the aim of the WAWG. Also, the provinces were selective in how to present the data. MoE's perception was that "*they may use statistics to suit their case*"[3]. "*…part of the reason I think is the fact that they either did not have the information, or they did not want to report it*"[4]. Provincial stakeholders were very careful about their statements and hence there was a perception by WPAC that provinces hid some information or would like to engineer some data and statistics. This perception was supported by the fact that the provinces failed to produce socio-economic data as well. This was outside MoE's sphere and the governorates were responsible for these data.

The WPAC was pressing for documentation of the data as a basis for the process and was dismissive about the data presented in the meeting. CIWP realised that WPAC

[3] This statement is from a mission report to the CIWP
[4]personal communication of a CIWP colleague

has its own hydrological database but it had not been corroborated with the provincial database. On the other hand, provincial stakeholders were conservative in their approach as all official documents had to be approved by the provincial authorities and the participants did not have that authority.

The provincial actors disliked the "*excessive and aggressive pressure put by WPAC*". The sentiment was that "*It seems that WPAC has a veto power*" (Appendix A1, Table A1.4). CIWP tried to tilt the power balance and reassure the actors that the process would not be dominated by WPAC. However, the 2008 WAC specifies that "*evidences should be documented*" and so WPAC was 'hard to please' about the sources of the data, especially the hydrological data. The 'documentation rule' has created provincial cooperation and alliances. Any discrepancy would have discredited the legitimacy of the evidence. Therefore, actors were cornered into thinking segmentally and not in terms of the wider LUB. However, the process was advantageous as the hydrologic data was rigorously evaluated.

A distinct outcome of this rigid requirement of WPAC was that three blocks were formed in the WAWG to represent the interests of the three provinces. Now we had three coalitions advocating the interests of their province in the negotiations. Such formations have been described by Sabatier and Jenkins-Smith (1999) as *Advocacy Coalitions* (this will be described in Chapter VII). As a result, a sectoral integration has resulted in the provinces. In Kurdistan, for example, the Kurdistan Province Water and Agriculture Commission became a meeting place for the Kurdistan WAWG block; they started to make joint decisions and put forward a united front in the WAWG. This form of solidarity was perhaps stronger in Kurdistan because of the discourse that Kurdistan lags behind WA and EA in implementing the development plans (dams and irrigation networks) because of the past political turmoil.

Water Allocation Model Criteria/Constraints

A. Criteria are factors used in the water allocation model (WAM); their direction is either **positive (+ve)** i.e. a province with a higher value will get more water or **negative (-ve)** i.e. a province with a higher value will get less water

Criteria and constraints / units	Direction, Definition and Purpose
Potential available surface water) / MCM/year	**(+ve);** defined as the amount of water that the province 'generates' itself; the idea behind including this criterion is that a province has the first right to use its own water
Potential area for irrigation/ 1000 ha	**(+ve);** defined as potential area within LU only that physically and economically can be irrigated; the areas should be spatially defined (where) and be supported by a kind of pre-feasibility study
Regional Domestic Product per capita (RDP/cap) / Million Riyals per capita	**(-ve);** defined as RDP in year 2008 according to official national statistics divided by official national population statistics; included to express the urgency of a province to support its people to develop themselves; only the RDP and population within the LU basin should be taken into account; this may require a kind of proportional allocation of basic data (e.g. at district level)
Population/ no in millions	**(+ve);** obtained from official national population statistics. only the population within the LU basin should be taken into account as above; included to express the requirement of a province to support its population's need for water (drinking, industrial and agricultural water)
Per capita investment in water/ MRial (price level 2009)	**(-ve); defined as** replacement value of existing infrastructure for irrigation development (only reservoirs, intake structures, first and second level irrigation canals) in 2009 price level divided by population (see under population); included to express the invested capital in the water sector; the idea behind this criterion is that provinces will less development should be given more chance to develop; only investment for agricultural use to be taken into account
Consumption per capita/ m^3 per capita	**(-ve);** total water intake per year of a province (for drinking, industrial and agricultural use) for an 'average' year, divided by population; included to express the present level of use of water and by that the level of development of the water system to support the people in their socio-economic activities

B. Constraints are the 'hard' criteria that have to be taken into account in the allocation between the provinces. The ultimate allocation should meet these constraints. There was no consensus on how these has to be calculated but they were considered for later modification of the WAM

Constraints / MCM	**Implementation in the water allocation model**
Existing withdrawals	Present withdrawals under average (meteorological and hydrological conditions) included to make sure that the present users will be able to continue their activities
Upstream rights	This was considered as a high level policy constraint. The determination if this constraint is met will have to be done by applying a river basin allocation model (WEAP, RIBASIM, etc.)
Environmental flow rivers/ MCM	This constraint applies to all individual rivers in the province and cannot be aggregated. included to ensure a minimum ecological functioning of the rivers; in principle this should include the required flow characteristics (minimum flow, flood levels, maximum flow, etc.) at certain points at a river and at/during certain time periods; for practical purposes, this criterion should limit to a maximum of 2 flow characteristics; ;the determination if the allocation complies with these constraints can only be done by applying a dynamic water allocation model (e.g. WEAP, RIBASIM or the VENSIM application
Water supply to satellite wetlands	included to ensure that there will be sufficient supply of water to the wetlands

Figure 6.9: Water allocation criteria and constraints (Appendix A, Table A1.4).

Detrending Method to estimate potential surface water (natural runoff). The 2008 WAC specifies the use of the Detrending Method (Box 6.2) to calculate the annual average surface runoff which was estimated to be about 6927 MCM. The method was applied by the MoE to runoff series from 27 stations in the provinces by removing the trend from the inflow and then adding the amount given by the trend line to get natural runoff. The use of the method has been illustrated here by applying it to the aggregate annual basin runoff time series (Figure 6.10). Initially, a value of 7400 was obtained from the MoE analysis, but the final agreement was on 6927 MCM. This shows that the value was not based entirely on independent assessment but was partly a result of political manoeuvring. Also, this figure was almost the same as the synthesis report's value (Hashemi, 2008). The Detrending Method was used primarily to estimate the huge level of abstractions in recent years but there is a doubt about the soundness of the approach and many of the actors were not happy about using it, but it was dictated by the 2008 Water Allocation Code (WAC).Also, Mahab (2011) criticized the method and applied a reduction factor to "*minimise the deficiency of the Detrending Method*", providing a different result for both the natural runoff and the level of abstractions as given in Table 6.5.

Box 6.2: Procedure for Detrending Method (Source: MoE 2008 WAC).

1. choose statistical period for stationary data: in this case 58 years was chosen from 1949-50 water year to 2007-8 was chosen; in most cases no data matched the period.
2. choose hydrometric stations to estimate potential water available for each watershed
3. In Excel, Runoff, R, is plotted against time in years, t for a period n
4. A linear Trend Line is drawn in the form of:
   $R_t = A*t + B$ where A and B are the coefficients of linear regression.
5. Then the A coefficient is used to obtain Natural Runoff, RN_t, using the formula:
   $RN_t = R_t + [- (A* t)]$ where t= 1, n
6. The upstream abstraction, UA, is calculated from
   $UA = RN_t - R_t$ where t= n i.e. the final year of the period
7. Finally, Detrended RN_t time series is obtained from

Detrended $RN_t = RN_t$ - UA where t= 1, n

8. Potential average surface runoff generated for a given catchment is calculated using

Average annual surface water = $\sum$Detrended RN_t / n (for t= 1, n)

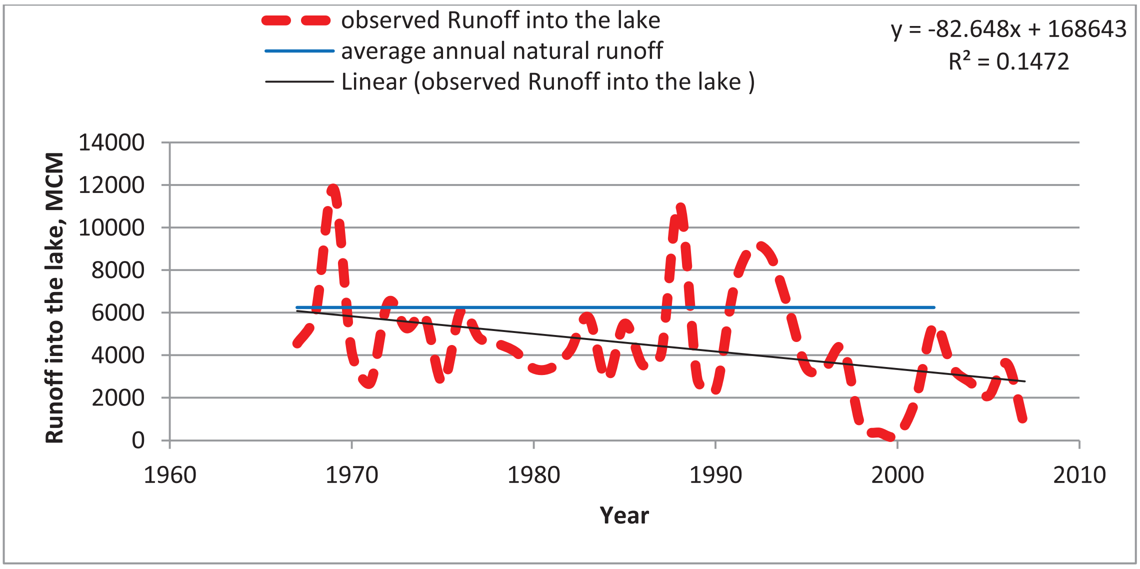


Figure 6.10: This is an illustration of how detrending is done: in this figure, an example historical series of annual average runoff into Lake Urmia for the period 1969-2009 is shown with a trend line in black; the blue line shows the average value of 6255 MCM obtained by the Detrending Method for this time series.

Sector	*Consumptions MCM*	*Province*	*Natural runoff MCM*
Agriculture	2243	Kurdistan	1580
Drinking	117	WA	3525
Industry	59	EA	1287
Total	**2419**		**6392**

Table 6.5: Estimation of natural runoff and levels of abstraction by Mahab (2011)

The main problem with this method is that it does not take into account natural variability of hydrological time series and so the basis for using it is considered to be flawed. Therefore, there is a need to look into this issue and it will be explored later in section 6.7.

The bickering between the RWCs and WPAC about this important information was embarrassing for the MoE group. Agricultural Jihad Organisations (AJOs) were asking that the MoE group should come out with figures for the hydrological data and water resources abstractions. WPAC tried to sort the information outside the WAWG: they arranged bilateral meetings with RWCs as well as a MoE/DoE Joint Working Group (JWG). Some of the participants seemed to think that there was a shift of attention from WAWG to the DoE/MoE JWG and were waiting for instruction from the Commission to initiate the allocation process. The poor wording of the Minutes of the 13th JWG Meeting indicated that the process was done within "*separate negotiated meeting with the RWCs*"[5]. This '*behind the closed door'* approach is based on old sectoral procedures: RWCs felt that this is their comfort zone. WPAC has effectively (may not intentionally) tried to detach RWCs from their commitment to the WAWG based on sectoral loyalty of the MoE group (coalition). Eventually, a few bilateral meetings were arranged to put the 'MoE house' in order and they finally agreed on the hydrological and water resources data to be used in the water allocation process. The rest of the data was provided by national and provincial participants**.** All of the information is given in Figure 6.11

[5] Source is the Minute of the 13th meeting held in MoE in August 2009.

	CRITERIA									CONSTRAINTS			
	Economic				Social		Allocation			Social		Environm.	
	Potential irrigation area	RDP/cap	Potential water availability	Per capita invest-ement in water	Population	Consumption per capita	Allocation (gw+sw)	To Lake		Existing withdrawals	Upstream rights	Environmental flow rivers	Water supply to satellite wetlands
W-Azerbaijan.	600	19	3.98	6.0	2.8	1256				1.91			
E-Azerbaijan.	647	28	1.36	6.0	2.9	523				0.78			
Kurdistan	289	19	1.58	2.0	0.2	1330				0.22			
Total/average	1536	NA	6.92	NA	5.9	NA	3.82	3.10		2.91			
	1000 ha	MRial/ cap	BCM	MRial/ cap	Mil.	m^3/ cap	BCM	BCM		BCM	BCM	BCM	BCM
	+	-	+	-	+	-							

Notes: + means more water if criteria is high
- means more water if criteria is low
the missing information in the table is provided in next phase of the process

individual rivers and wetlands

Figure 6.11: Template of baseline data for MCDA used in WBM in Microsoft Excel.

Despite many efforts to document the data, the water allocation process was undertaken under the shadow of uncertainty. There was still a disagreement on the potential irrigated land area in each province and so it was decided that MoAJ should present the data on behalf of the provinces. The data was presented in the 6th (final) meeting by the MoAJ.

6.5.2: Weighting water allocation criteria using AHP MCDA approach

As stated in Chapter III, there are numerous MCDA methods that can be used in water allocation problems. WPAC recommended the Analytical Hierarchy Process (AHP: Box 6.3) which has been widely used in natural resources management and has been very popular despite its shortcomings (e.g.Ananda and Herath, 2009).

Wattage and Mardle (2005) have used AHP to investigate stakeholder preferences towards conservation versus development for a wetland in Sri Lanka. They have acknowledged that AHP "*requires significantly less time and expertise requirements from respondents*". A similar approach is taken by Heck et al (2011) in the design of a marine protected area (MPA) using a Multi-stakeholder Platform. They found that AHP is useful towards contributing a local vision for MPA planning by showing local preferences and opinions. Steiguer et al (2003) have considered the AHP to be "*a method and planning framework with potential for implementation of Integrated Watershed Management*" by providing "*numerical weights to criteria where subjective judgments of either quantitative or qualitative alternatives constitute an important part of the decision process*".

> **Box 6.3: Analytical Hierarchy Process (AHP)**
> (Excerpts from Ananda and Herath, 2009; Appendix A; p. 2554).
> The theoretical foundations of AHP were developed by Saaty (1977, 1980). AHP aggregates the separate criteria into an integrated criterion (Bouma et al., 2000). When applying the AHP, the preferences of the decision elements are compared in a pairwise manner with regard to the element preceding them in the hierarchy. If two criteria are of equal importance, a value of 1 is given in the comparison, whereas a value of 9 indicates the absolute importance of one criterion over the other. The difference between two adjacent scores may not be highly distinct, however. Pairwise comparison data can be analysed using either regression analysis or an eigenvalue technique. In the eigenvalue technique, the reciprocal matrices of pairwise comparisons are constructed. The right eigenvector of the largest eigenvalue of matrix A (Eq. (1)) constitutes the estimation of relative importance of attributes. The pairwise comparisons made by the respondents can be synthesised into pairwise comparison matrices, which take the following form:
>
> $$A=\begin{bmatrix} a_{11} & .. & .. & a_{1n} \\ a_{21} & .. & .. & a_{2n} \\ .. & .. & .. & .. \\ a_{n1} & .. & .. & a_{nn} \end{bmatrix} \quad (1)$$
>
> wherea_{ij} represents the pairwise comparisons rating for attributes i and j.
>
> Given the reciprocal property, only n (n−1)/2 actual pairwise comparisons are needed for an n×n comparison matrix. Saaty (1977) proposed the right eigenvector method that constructs the vector of priority weights and facilitates testing for inconsistency. In the case of perfect consistency,
> $AW = nW$ (2)
> where A is the n×n comparison matrix and $W=(w_1, w_2, \dots w_n)^T$.
>
> Saaty (1977) proposed the following definition:
> $AW = \lambda_{max}W$ (3)
>
> whereλ_{max} is the maximum eigenvalue (Perron root) of matrix A.
>
> Saaty (1977, 1980) proved that the largest eigenvalue $\lambda_{max}$is always greater than or equal to n (number of rows or columns).

Expert Choice software (Saaty, 2005), which is based on AHP, was used to produce the aggregated weights for the criteria as shown in Table 6.6. Sectoral organisations formed alliances or coalitions based on their provincial allegiances in the weighting process. Two rounds of weightings were carried out : initially weights for the six criteria were assigned as given in Table 6.5. Then weights were assigned based only on four criteria, removing investment per capita and consumption per capita from the list (Table 6.5); the reason for this will be discussed in the next sub-section.

Criteria	Weights based on 6 criteria	Weights based on 4 criteria
Potential available surface water	0.182	0.161
Potential area for irrigation	0.167	0.362
Regional Domestic Product per capita	-0.118	-0.272
Population	0.101	0.205
Per capita investment in water	-0.27	-
Consumption per capita	-0.161	-
Total	1.00	1.00

Table 6.6: Weights applied to the criteria.

6.5.3 Technical support for water allocation using water balance modelling and system dynamic simulation

As already said, the process continued under knowledge uncertainty. The first NEC meeting was organised in parallel with the 5th WAWG and there was political pressure that a decision should be made in the 6th WAWG meeting ahead of the 2nd NEC meeting. The participants (actors) had to make some difficult decisions about the modelling approach.

Agreement on minimum ecological water requirement. The 2008 WAC requires system dynamic modelling for river basin allocation. Between 2003 and 2008, WPAC consolidated its know-how on the use of Vensim® system dynamic simulation software described in Chapter III (Ventana Systems, 2007) by preparing a prototype model for LUB. As a visual modelling tool, Vensim simulates the water balance (as in eq. 6.3) based on a feedback system or causal loop i.e. stock and flow diagrams. It allows visualisation of how changes in the parameters will affect the water balance simulation. The water balance model was implemented in Microsoft Excel and linked to the Vensim software as an input of data (MoE, 2010 b). The purpose of the simulation was to determine the amount of required inflow into the lake to maintain the ecological lake level of 1274.1 m asl.

The simulated results from the Vensim model indicated that, to keep the lake level at 1274.1 (minimum ecological lake level), an average annual inflow of 3900 MCM is required. This is higher than the minimum requirement predicted by Abbaspour and Nazaridoust (2007) which amounts to 3100 MCM. Initially, WPAC was not open about its Vensim Model for LUB. The author tried to encourage WPAC to share its results by allowing two representatives from each province to see how the model was built. This suggestion was not accepted and hence, everybody prepared for a heated negotiation ahead in the culminating 6th WAWG meeting to be held in Sanandaj (Kurdistan).

As stated, MoE accepted the figure of 3100 MCM at the High Water Council and did not block it becoming a legal requirement. But WPAC was adamant about presenting its case at the 6th WAWG meeting. Unlike Abbaspour and Nazaridoust (2007) which used a fixed evaporation rate, MoE (2010) used monthly estimates of evaporation and precipitation over the Lake. The result seemed to be more realistic than Yekom's (2005) but this method also involved a great deal of uncertainty about how evaporation and lake area have been estimated; hence, it is not as accurate as claimed by WPAC.

At the 6th Working Group meeting, WPAC presented the simulation result (3900 MCM needed by the lake) but it was rejected by all the other actors. They decided to use 3100 MCM as a constraint in the water allocation model (WAM). WPAC also did not accept the 3100 MCM and indeed recommended 3900 MCM. After long negotiations, it was agreed that, since 3100 MCM is a legal requirement, this value should be used for now and the final decision should be taken by the National Executive

Council (NEC). The gamble did not pay off for WPAC even after an emotional appeal. Other actors were not involved in building the Vensim Model for LU; thus, they easily overruled it despite clear evidence from the Vensim simulation. WPAC's motive will become evident in the next step of the process.

Water allocation shares: scenarios. WPAC had postulated to use two scenarios in the WAM model:

1. WPAC's favourite option was to use 6 criteria (as in Figure 6.12) with two constraints : a minimum lake allocation of 3900 MCM and existing abstractions of 2900 MCM; this means there is no water for further development
2. The second best option was to use 6 criteria with two constraints i.e. LU water requirement of 3100 and existing abstraction of 2900; this means that there is about 817 MCM for further allocation.

Both options were rejected and opposed as they completely ignored what the participants (actors) had agreed in previous meetings. The participants and CIWP wanted a re-allocation of the resources; otherwise, WA and EA would be rewarded for overstating their demands. The hidden message behind the WPAC position was that the basin has reached saturation level and dams under constructions should not be built as there is no more water left if the lake is considered as a demand site. WPAC felt responsibility for Lake Urmia and therefore wanted to take a precautionary route towards the wellbeing of the lake. The Commission made a staunch attempt to bring the 'environment' into decision-making but the other actors had other priorities. WPAC's motive was not purely environmental: the Commission wanted to block extra applications by the provinces for more allocation and dam-building projects in the basin as well.

As a facilitator, CIWP overruled the unilateral position held by WPAC. To resolve the turmoil, a very delicate balancing act was needed, and so a compromise had to be reached. The issue was that, if the existing abstraction was accepted, this would indicate that unfair development in the basin was accepted as well as legalising unauthorised abstractions, and no consensus could be reached. WPAC agreed to scrap this constraint if only two criteria were removed: existing investment in the water sector and consumption per capita. After a heated debate, this was agreed, and the simulation was made to allocate provincial water shares using four criteria, with 3100 MCM as a constraint. The shares were quite different from the previous simulation. Kurdistan which gained a 24% share under 6 criteria now had less than 16% of the total shares.

Kurdistan made a passionate appeal that they should get a greater share based on their upstream rights and given the historical injustices. The Energy Group (from the Vice President Office) played a major role to mediate and exert pressure on the negotiators to come to the agreement at the WAWG: "*no one is leaving here until a decision is reached*". EA happily accepted the results which give them even less commitment to the lake. WA was happy for more shares to be given to Kurdistan since the water flows downstream to WA and it is not used. Kurdistan was not happy with the figure of 16% and expected some 22%. Then, after long negotiations, it was agreed that the results should be accepted, but the issue of upstream rights of Kurdistan needed to be decided by the NEC.

The author and Eelco van Beek (International consultant) were asked to revise the WAM procedure and to look into Kurdistan's share. It was concluded that ExpertChoice AHP procedure uses binary rules attributing 0 weights to the lowest criterion. For example, the Kurdistan population was very small compared to the other two provinces (230,000 compared to 2.8 and 2.9 million) and hence increasing the Kurdistan population to 1,000,000 would not change the weights. Therefore, AHP method can produce an output with a great degree of discrepancy. However, despite this inconsistency, AHP was seen by CIWP and MoE as the most appropriate way to allocate resources and the allocation shares were agreed (Table 6.7)

6.5.4 Finalising the water allocation agreement

The agreement reached at the 6th WAWG meeting was not welcomed or sanctioned by higher ranking provincial actors outside the Working Group platform; for example, WARWC believed that WA representatives were "*misled and conned*"[6]. The re-allocation meant new developments should be halted or else future water rights would be compromised. Kurdistan was 'angry' about WPAC's attitude towards using the AHP approach which produced less than expected shares for Kurdistan. The results were presented in the 2nd meeting of NEC and a series of meetings and lobbying has followed as shown in Figure 6.12.

NEC sanctioned the establishment of a Technical Committee to harmonise the disagreement that spilled over after the last WAWG meeting. The Committee was a mini-WAWG inviting major provincial stakeholders (RWCs and AJOs) to agree on the potential irrigated land for each province which was disputed. NEC did not attempt to make the decision and invited the provinces to try to sort out their differences. Therefore, NEC acted positively to share power with the provinces by maintaining a"

[6] Personal communications to the author

non-coercive" approach to governance to enhance the effectiveness of the WAWG (see e.g. Verhallen et al, 2007).

Water Allocation Model

Options	1	2	3
	MoE's favorite option: existing abstractions as a constraint (6 criteria)	MoE 2nd best proposal: Criteria: 6 Constraints: Existing abstraction and lake Urmia water rights	Final agreement: 4 criteria only Lake Uremia water right as the only constraint
A- Water Availability using Vensim simulation software and WBM			
Average Potential surface water	6920	6920	6920
Lake Urmia water rights	3900	3100	3100
Existing abstraction	2900	2900	Not applicable
Total constraints	6800	6000	3100
Water available for allocation	nil	817	3700

B. Water Allocation Model Using ExpertChoice software based on AHP approach

Provinces	1: Weighed share %	1	2: Weighed share %	2: Share of water MCM	3: Weighed share %	3: Share of water MCM
Kurdistan	24	No new development	24	196	15.8	585.1
East Azerbaijan	37.4		37.4	305.5	29.2	1079.2
West Azerbaijan	38.6		38.6	315.5	55	2035.6
Total	100		100	817	100	3700

Table 6.7: Results of water availability and WAM showing provincial water shares.

WA wrote a letter to the Deputy Minister for Energy (Karimi, 2010). In the letter, Karimi (2010) asks for re-negotiation based on bilateral arrangement i.e. EA-WA and WA-Kurdistan. This offer was not accepted and NEC has decided to implement the agreement. On the other hand, the Kurdistan governor wrote to the First Vice President and formally accepted the results and asked for immediate allocation of funds to implement the plan. The author represented CIWP in its efforts to make Kurdistan engage with the participatory decision-making. If the results were overruled, the whole process would have been undermined. The AHP allows for inconsistent criteria weighting by the actors. Therefore, the actors influenced the weighting by showing inconsistency in their preferences and hence affected the allocation results. In real world decisions, inconsistent preferences and ranking are a reality. Therefore, AHP could be argued to be an appropriate method for participatory MCDA processes.

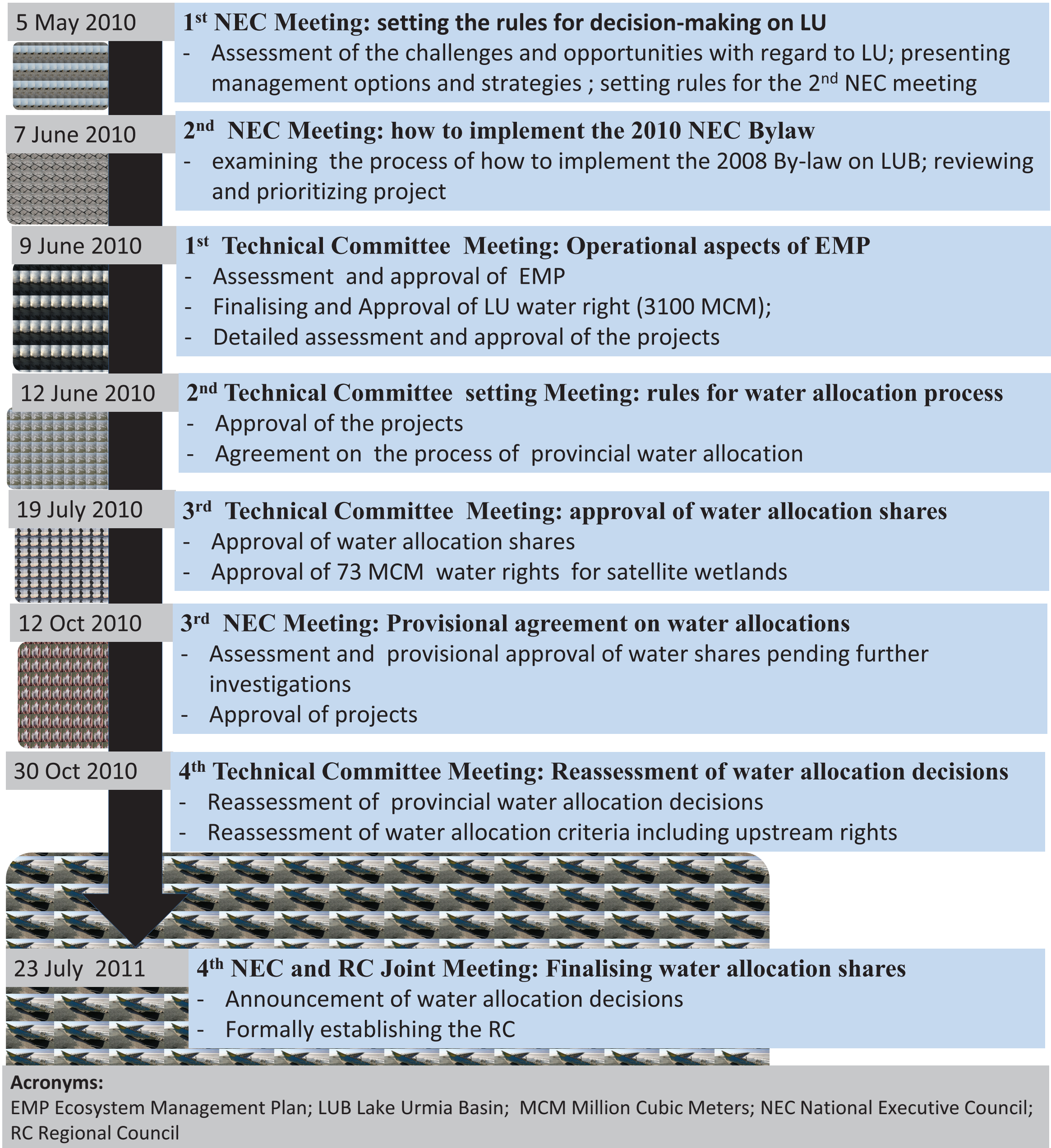


Figure 6.12: The timeline of NEC meetings to approve the water allocation decisions (some of the Photos by Jabbari, 2011).

6.5.5 Concluding remarks: fixed water allocation is not realistic

Political will. The controversy over the LU water allocation was complex and the manipulation of data and knowledge to suit negotiating positions caused a great deal of polarisation of opinions. Political support for CIWP and its shared vision with WPAC by accepting its rules have contributed to a successful conclusion of provincial water allocation shares. Without establishing formal water rights for the LU, it was difficult to allocate water to it. The institutional sustainability of the water allocation governance will be described in Chapter VII but it is necessary to appreciate that the provincial administrative divisions as a geopolitical Driving force (described in Chapter V) was an important factor in the final decision made by the NEC. Water allocation to Lake Urmia was a resounding success for the environmental movement in Iran. However, the implication of this decision has to be evaluated and it is not as simple as it is portrayed in the simple water allocation template (Table 6.4).

Uncertainty. Changes in the state of Lake Urmia have been dramatic and visual. Also, it has been politically sensitive because it registered on the national agenda. More recently, social networks and sport events such as football matches have been an avenue to express urban dissatisfaction. Press and media have compared this situation to that of the Aral Sea in Middle Asia which has been reduced by 98% of its size. The environmental discourse is getting stronger. But water availability lies at the heart of the matter; hydrology and, of course, climate are the determining factors. The strong environmental discourse has been undermined by lack of accurate, acceptable data and this has caused polarisation of opinions and confusion about what action plans should be taken forward. Although the significance of the threatening changes that have occurred were recognised by the participants (actors), it is still rather difficult to attain consensus among them regarding the causal relationship between different factors affecting the lake. There is a distinct concern about the appropriateness of the Detrending Method dictated by the 2008 WAC to calculate water availability. A trend in a natural phenomenon is not unusual in a short record; thus detrending is problematic as the effects of natural and human induced effects (e.g. due to the abstraction) are difficult to separate. This difficult issue will be dealt with in section 6.7.

Adaptive water allocation to deal with climatic variability. The outcomes of the process can only be valid for average (normal) conditions and it did not consider climatic variations which are important characteristics of the climatic system. It is strongly argued that this level of allocation to the lake and the users is not sustainable in the long-term future as there are many years in which water availability can be below the allocated volume. Therefore, it is postulated that there is a need for an adaptive water allocation strategy to be able to cater for climatic variability which exerts a strong control over the fluctuations in LUB levels.

Droughts were recognised by the participants as an important issue. Yekom (2005) concludes that the cyclical appearance of droughts is normal and should be expected every 6 years on average (Table 6.8). Therefore, actors should make a plan for the occurrence of drought in the basin.

Return period	***probability***	***Indicator***	Condition
6.3	0.1587	SPI<-1	drought
14.97	0.0668	SPI<-1.5	Intense drought
44	0.0227	SPI<-2	Extreme drought
Note: SPI: Standardised Precipitation Index			

Table 6.8: Probability of occurrence and return periods of different drought conditions (Yekom, 2005).

The second day of the 6^{th} WAWG meeting was assigned to the first Drought Taskforce meeting as part of the Drought Risk Management module of the CIWP. The Taskforce was established to design an adaptive water allocation strategy during drought conditions. The work will continue as part of next round of negotiations through WAWG meetings. The author is involved in an advisory role as will be described in Chapter IX.

Sustainability analysis. Based on the above argument, there is a need to assess the reliability of the water resources system, considering the historical data as well as possible future changes in climatic and hydrological parameters with reference to Lake Urmia. Hence, in the next section, the long term sustainability of LU under different climatic and water allocation scenarios is evaluated using a risk based analysis. Based on these concluding remarks, the main objectives of the second part of the chapter are as follows:

- To assess the water availability i.e. the natural runoff
- To make a risk based analysis of the future variability of the lake levels under different management scenarios and probabilistic projections of annual precipitation representing the next 41 years (2011-2051)
- To devise an adaptive water allocation strategy by assessing different management options
- To come up with a recommendation for implementation of the 2008 EMP

The methodological approach to achieve these objectives is described in the following sections.

6.6 Methodological approach

6.6.1 Assessment of baseline data

There is a concern about the Detrending Method used to estimate natural runoff. The on-going Updating of the Water Master Plan Project obtained a different result (i.e. lower values) of annual average runoff using a modified Detrending Method as shown above in Table 6.9 (Mahab, 2011). Therefore, it is paramount that this issue has to be considered to make an analysis of the sustainability of the proposed water allocations.

By using data from MoE (2010b), annual average rainfall and observed runoff records are plotted in Figure 6.13 which shows that, for the period 1969-1994,there is an upward trend in both records, while, from 1995-2008, there is a downward trend in both time series. This shows that (a) an upward trend observed over a short period of record may reverse as the record becomes longer and (b) that, when assessing the effects of abstractions on a runoff record, this must be done in conjunction with an associated rainfall record so that the effect of abstractions can be isolated. Figure 6.13 also illustrates that a trend cannot be relied upon as an indicator of future water availability and so stochastic modelling should be used which can reproduce this natural climatic variability.

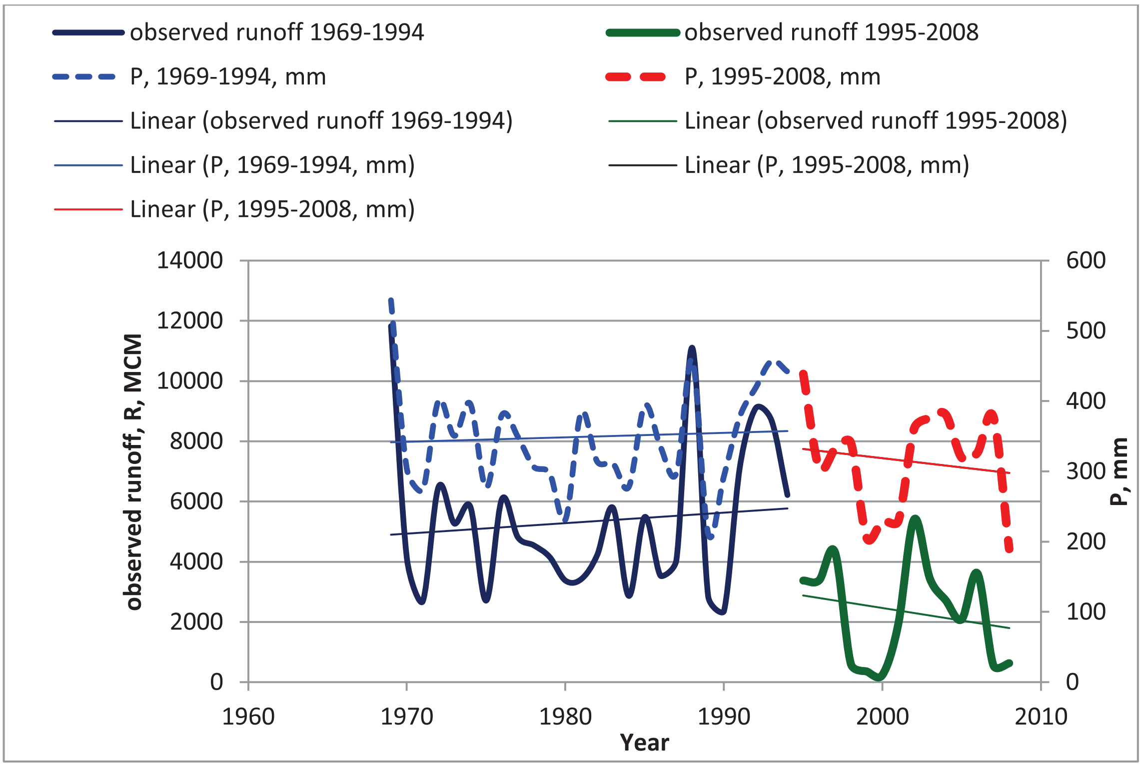


Figure 6.13: Trends in rainfall and observed runoff for 1969-1994 and 1995-2008.

The Detrending Method has also been the basis for the climate change discourse in which an attribution analysis was made (as stated in Chapter V) to ascribe

- 67% of the lake level's decline to droughts and climate change (and of course variability);
- 27% to extra abstraction; and
- 5% to direct impacts of dam-building.

These results were derived for the year 2000, a severe drought year, based on 1967-2000 data.

This attribution analysis has been used to shape the climate change discourse by MoE based on the argument that, in the last 15 years (i.e. since 1995) there has been a downward trend in average annual rainfall as illustrated in Figure 6.13. However, the concern is that, when determining natural runoff as described in section 6.5.1, 100% of the trend is attributed to abstraction. This ignores completely the climatic fluctuations which can appear as trends in short records. Thus, the Detrending Method is highly questionable, and so this issue is re-evaluated here as the whole process depends on how much water is available for allocation. Therefore, there is a need to evaluate the historical water balance of the lake and its climatic drivers to establish the amount of natural runoff that is available annually. A stochastic modelling approach which can reproduce quasi-cycles and quasi-trends (persistence) in the simulated rainfall data is the main driver for the inter-annual fluctuations in natural runoff.

Baseline data. Most of the data used for this part of the ISTA component is from MoE (2010b) i.e. the same data as used by the actors to make the water allocation decision so that the analysis in this section is consistent with part (1) of the ISTA framework. The data were scrutinised and agreed during the process where the water allocations were agreed. The data analysis approach is summarized in Figure 6.1. Lake levels have been recorded on a daily basis since 1966. This daily record was obtained from the West Azerbaijan Regional Water Company. The lake level on the 22nd of September marks the end of thewater year in Iran. In section 6.6.2, the methodology is outlined and the results are presented in Section 6.7- 6.9.

6.6.2 Components of the methodological framework

The methodological framework for this part of Chapter VI comprises of the following components:

- In Section 6.7, time series analysis of rainfall and runoff records is used to determine natural runoff and abstraction, and lake level analysis is used to assess the impact of climate and non-climatic parameters on the lake level drop.
- In section 6.8, a lake water balance model (WBM) for the historic data is used to understand the hydrological characteristics of Lake Urmia and validate the time series analysis made above. This will also be used as the basis for risk based analysis of lake management by simulation of future rainfall records using a stochastic approach

- Stochastic rainfall models (SRMs) for Lake Urmia basin are built to generate rainfall series that reproduce short-term and long-term climatic variability (Section 6.8).
- The water balance model is used in conjunction with the stochastic rainfall model to simulate an adaptive water allocation strategy based on reduction (scaling) factors (Section 6.9).

Overall conclusions and recommendations for the ISTA component are presented in Section 6.10.

6.7 Time series analysis approach to evaluating regional rainfall and runoff trends

6.7.1 Rainfall and runoff time series analysis.

First, the MoE discourse is that, since 1995, there has been a change in climate; a downward trend in precipitation has been noted. However Robson et al (2000; p. 59) note that "*climatic variability has a very marked effect on many hydrological series*" in two ways: (1) it can cause an apparent trend when the length of records are short; i.e. any records below 50 years are very difficult to assess; and (2) obscures other changes that might affect the trend as they are typically large.

Secondly, the Detrending Method was not an independent fact and involved a great deal of subjective judgement, particularly in assuming that abstraction effects started in the beginning of the runoff record. It is noted that Mahab (2011) also does not agree with the estimated value of 6927 MCM for natural runoff as well. Therefore, trends and fluctuations in runoff need to be analysed in conjunction with those in rainfall.

Recalling the information presented in Chapters IV and V, land reforms in the 1960s were followed by the introduction of hydraulic structures in the 1970s. Many of the dams lagged behind in terms of building irrigation networks. After the 1979 Revolution, the Imposed War continued until 1988. The first Post Revolution Development plan came into action in 1989 and was consolidated in the second and third plans. As a result, in the mid 1990s, two major dams came into operation. Since then, water consumption has increased dramatically.

Therefore, the regression is made for the pre-1995 period i.e. 1969-1994 to reconstruct the lake levels in the post-1994 period i.e. 1995-2009. Therefore, one of the main issues is to establish the relationship between lake level and precipitation and the separate impacts of hydrological drought (precipitation deficiency) and abstraction on the decreased lake level. For this analysis, up to date data are needed i.e. up to 2010 to be able to analyse the impact of abstractions on the lake levels.

Reconstruction of lake levels. Firstly, the annual average precipitation series, P_t over the catchment area draining to the lake for the period 1969-2010is plotted and secondly, the annual lake level increments (in m) are calculating as in equation 6.4:

$$\Delta Y_t = Y_t - Y_{t-1} \qquad \textit{for } t = 1, 2, \ldots, n \tag{6.4}$$

where Y_t is lake level on 22nd of September of each water year, t, ΔY_t is the annual change in lake level, and n is 42 years i.e. 1969-2010.Then, the following regressions are made for the period 1969-1994:

- Y_t against P_t:

$$Y_t = a + b\,P_t \tag{6.5}$$

- ΔY_t against P_t

$$\Delta Y_t = a' + b' P_t \tag{6.6}$$

where P_t is precipitation for the period 1969-1994 and a, b and a' and b' are regression coefficients.

Based on the results obtained, Model (6.6) was used to reconstruct levels for 1969-94 and 1995-2010 to show the effects of abstractions and climate variability.

Runoff time series analysis. The above procedure was repeated using observed runoff or inflow into the lake, I_t instead of Y_t. During years when there are no net abstractions i.e. 1969-1994, inflow I_t is assumed to be equal to natural runoff , R_t i.e.$I_t = R_t$. Therefore, from the regression of inflow on rainfall P_t, R_t can be reconstructed as in equation 6.7:

$$R_t = c + d\,P_t \tag{6.7}$$

where c and d are regression coefficients. Equation 6.7 is used to estimate natural runoff for the period 1969-2009. In the presence of abstractions, natural runoff is given by equation 6.8:

$$R_t = NA_t + I_t \tag{6.8}$$

where NA_t is net abstraction i.e. abstractions minus return flow. Then the abstraction is given by equation 6.9:

$NA_t = R_t - I_t$ (6.9)

which is the estimate of the net amount of water abstracted from the catchment.

Cumulative departures from the mean. To show the effects of sequences of consecutive wet and dry years, the cumulative departures from the mean can be calculated for the annual rainfall time series according to the following formula:

$CDM = \sum_{t=1}^{k}(P_t - \overline{P})$ t= 1, 2,…n (6.10)

where P_t is the annual rainfall in year t and $\overline{P}$ is the mean rainfall.

Reliability analysis. The sensitivity of Lake Urmia's water resources to new water allocation demands can be assessed with a reliability index defined first by Hashimoto et al (1982) which describe the failure status of a water resource system by measuring the frequency of failure (ASCE, 1998). The reliability index describes the performance of a water resources system such as the state of a variable (e.g. lake level, minimum ecological water demand etc.) in terms of failure, F, i.e. non-satisfactory state and non-failure, NF, satisfactory state (Kjeldsen and Rosbjerk;2004). So with reference to water supply to the lake, the F state describes the situation where the required water demand cannot be met at a given time t and vice versa. Hence, the reliability index can be calculated as in equation (6.11) (e.g. Walsh and Kilsby, 2007):

$$\text{Reliability} = \left(\frac{\text{total number of years} - \text{number of years of F state}}{\text{total number of years}}\right) * 100 \qquad (6.11)$$

Given that the minimum long term annual ecological requirement for the lake is 3100 MCM, the number of years (if any) where it is less than 3100 MCM is identified as the F state to calculate the reliability.

6.7.2 Results

Cumulative departures from the mean. In Figure 6.13, there is evidence of considerable short-term and longer term rainfall fluctuation in the 1969 – 2010 annual LU basin rainfall record. To reveal the likely effect of these fluctuations on lake levels, the CDM of the rainfall record is plotted in Figure 6.14 where it is evident that the scale of fluctuations in the CDM in the last twenty years is larger than for the earlier part of the record. This reflects increased climatic variability in the 1999 – 2010 period, which results in greater fluctuations in the lake levels as will be seen in the following section. There is a possibility that global warming may have influenced the increased variability in rainfall observed over the last twenty years. However, long climatic records show that there is inherent natural variability in the climate which can produce such fluctuations. It is therefore not possible to distinguish any global warming signal in the LUB rainfall record from natural climatic variability. However, the possibility of a more variable rainfall regime in the future, with more persistent runs of wet and dry years, cannot be ruled out.

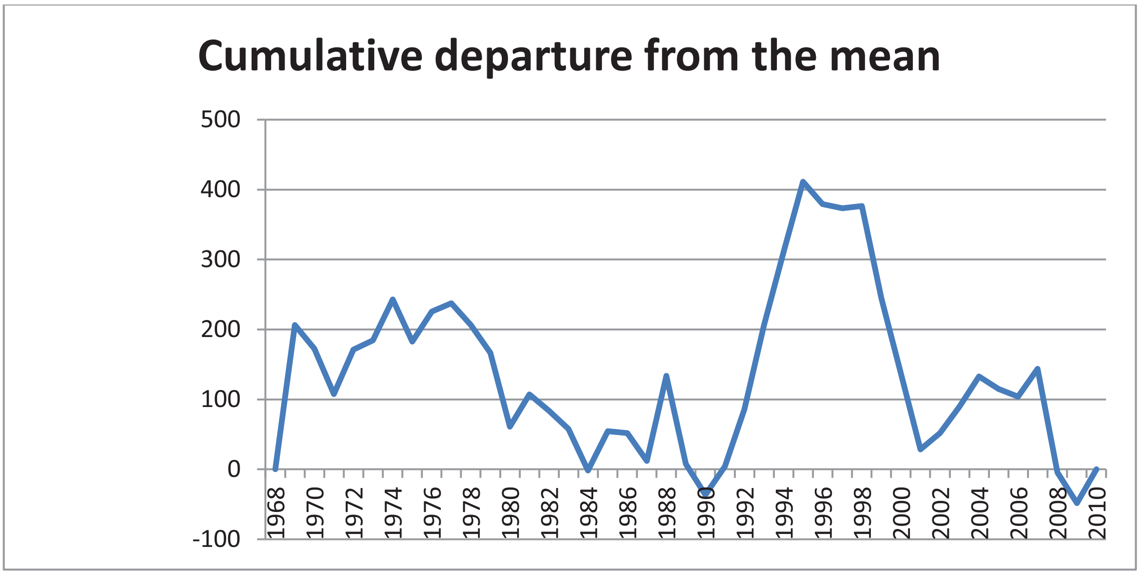


Figure 6.14: Cumulative departures from the mean for LU basin annual rainfall (mm) (1969-2010).

Lake level reconstruction based on regression analysis. The lake levels were reconstructed using the regression model in eq. 6.6 applied to the pre 1995 rainfall record. Figure 6.15 shows the impact of climatic variability as well as human impacts on Lake Urmia levels. The reconstructed levels match well overall with the observed levels, although they do not fit year by year. From 1991- 1995, there is a lake level rise which is reproduced very well. Then, there is a steady decline up to 1999, followed by a sharp fall continuing to the year 2001. The period 1999-2001 is characterised by a sharp reduction in precipitation (Figure 6.13). After that, the lake level does not recover despite an upward precipitation fluctuation. This shows that drought is not the only cause of the fall in lake level since 1995. In 1995, 2 major dams came into operation followed by 4 more dams in 2002 and 2006 and the impact of dam-building and increased water withdrawals have clearly registered.

The reconstructed lake levels show increasing divergence from the observed levels from 1995, which reflect the accelerated development referred to above. This clearly shows that new developments or abstractions have greatly amplified the lake level drop. Figure 6.15 suggests that, without abstractions, the lake levels post the high 1995 level would have returned to the levels observed in the earlier part of the record.

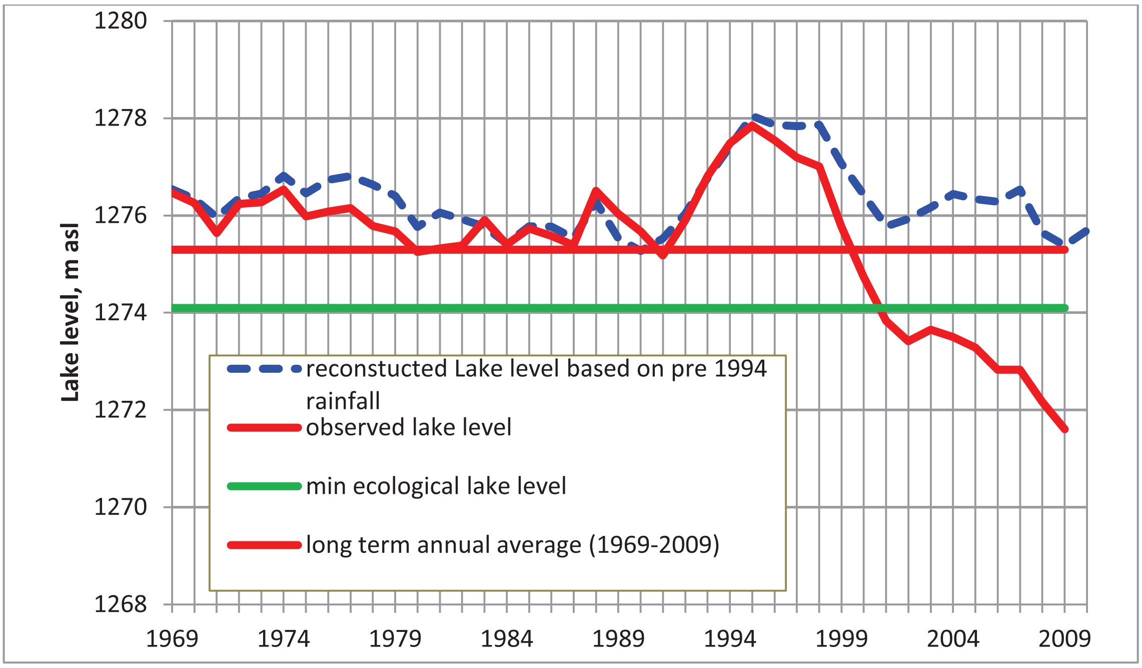


Figure 6.15: Observed lake levels (m asl) vs. reconstructed lake levels based on regression of annual change in lake level on rainfall (1969-1994).

Estimation of natural runoff and abstraction. The results of the natural runoff reconstruction analysis are given in Table 6.9. Natural runoff is estimated to be around 5000 MCM based on runoff regression on rainfall as shown in Figure 6.16. This result suggests that the value obtained by using the Detrending Method i.e. 6927 MCM/year highly overestimates the actual natural runoff. Applying the Detrending method to the aggregated inflow series for 1969-2009 gave nearly 6300 MCM/year (Figure 6.10)

	Observed runoff	*Predicted natural runoff*
Annual average runoff, 1969-2009, MCM	4211	4959
Average annual runoff for 1995-2009, MCM	2263	4308.0
Number of years that runoff is less than 3100 MCM for 1969-2009	14	6
Reliability of water resources system, %	66%	85%
Number of years runoff less than 3100 MCM for 1995-2009	9	4
Reliability of water resources system, %	40%	73%
Estimated abstraction, MCM	2045	

Table 6.9: Results of regression I v. P to estimate natural runoff and level of abstraction

Table 6.10 shows a breakdown of the each province's contribution to observed LU inflow, and natural inflow estimated by MoE using the Detrending Method. It seems that the biggest overestimation error can be attributed to WA where sharper downward trends in inflows have been noted, and the estimated natural runoff is double the observed inflow. This is partly because of a growth in unauthorised abstractions.

The original discourse started with a figure of 7400 MCM, then reduced it to 7200 MCM and finally it was lowered to 6927 MCM; this indicates that there has been some political manoeuvring and so 6927MCM was not only the outcome of an independent assessment.

Province	*LU inflow (MCM)*	*Estimated natural runoff (MCM)*
Kurdistan	1315	1583
West Azerbaijan	1839	3983
East Azerbaijan	1022	1361
Totals	**4176**	**6927**

Table 6.10: Breakdown of LU inflow and estimated natural runoff (MoE, 2010b) by province for the period.

From Table 6.9, the best estimate for current abstraction is about 2045 MCM. This again is different from MoE's(2010b) estimate of 2900 MCM.

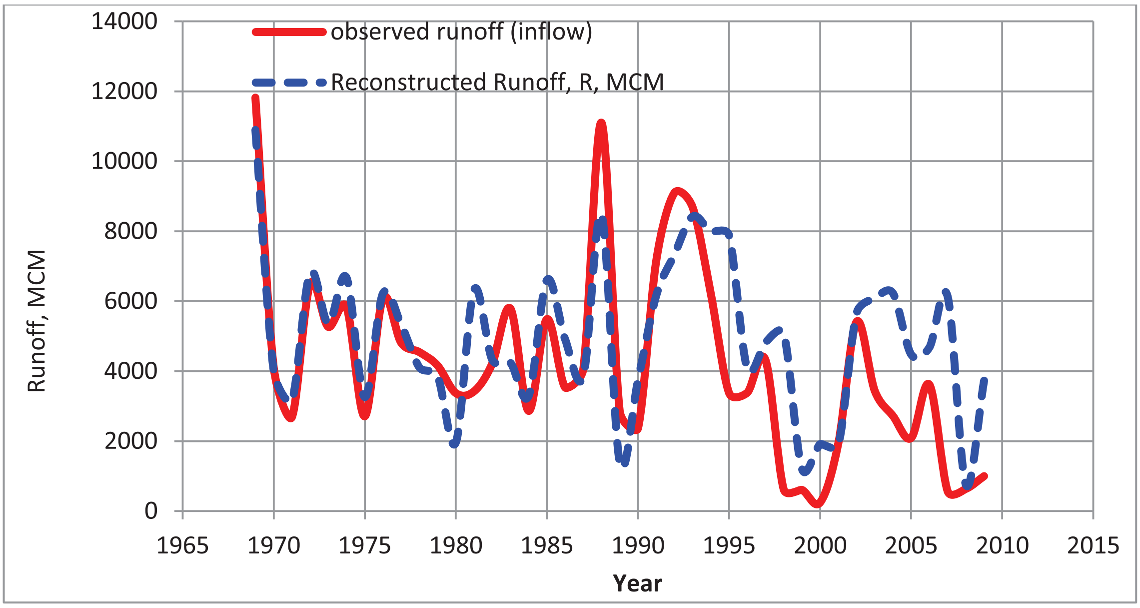


Figure 6.16: Inflows into Lake Urmia (1969-2009) and the reconstructed natural flow using the regression of the pre-1995 inflow record on rainfall.

6.8 Water balance modelling

6.8.1 Water balance of Lake Urmia

The main objective of the water balance model (WBM) is to assess the sustainability of the water resources system given the new requirement for allocating 3100 MCM to Lake Urmia to maintain its ecological and hydrological functions. For a sustainable water allocation strategy, lake restoration has to be part of the plan. Hence, lake storage has to be maintained above a minimum volume and in wet years it should be compensated by allowing more inflow into the Lake, while, in dry years, cutbacks in the lake's and users' allocations will be necessary.

The annual water balance model (WBM) of the Lake is given by:

$$S_t = S_{t-1} + I_t + A_{t-1}(PL_t - E_t) \tag{6.12}$$

where

S_t = storage volume at the end of year t (in MCM)

I_t = observed runoff (inflow from surrounding catchment) in MCM

A_t = average annual lake area at the end of year t in m^2

PL_t = annual average precipitation over the lake year t (in m)

E_t = evaporation from Lake Urmia during year t in m

A second model is constructed by replacing I_t with the natural runoff, R_t:

$$S_R = S_{t-1} + R_t + A_{t-1}(PL_t - E_t) \tag{6.13}$$

where R_t is calculated from equation 6.7. Results from both models are plotted and compared in Figure 6.17.

The initial storage was obtained by converting the observed initial water level using a parabolic ***Volume-Area-Level (VAL)*** relationship obtained by WRI (2005):

$$\begin{cases} A = -50057395 + 77908.14Y - 30.309046Y^2 \\ S = 5.970548 \times 10^8 - 940551.1Y + 370.419Y^2 \end{cases} \tag{6.14}$$

where A, S and Y are area (km^2), storage (MCM) and elevation (m asl), respectively.

The VAL curves have an important application in estimating the water balance of the lake since there is no bathymetric data which is the most accurate way to find the mathematical relationship between the VAL elements (a bathymetric study of Lake Urmia should be carried out in the future). WRI (2005) used maps or satellite images which cannot necessarily be interpolated to higher or lower elevations. However, the above relationship must suffice for the present study.

Originally, the VAL curves were obtained by studying a range of lake level varying between 1273-1280 m.a.s.l. however; the lake level in 2010 was 1271.6 which is below the level above which the VAL curves described by eq. 6.14 are valid. The measured area for this elevation is known to be 2700 km^2 (Jabbari, 2011). Therefore, for lower lake levels, a linear relationship was used based on this data point

Evaporation. As stated in Chapter V, there is a great deal of uncertainty about evaporation. Based on past research and MoE (2010b) estimates, the average is between 1180 and 1272 mm/year. By minimising the sum of the differences between the observed and simulated lake volumes over the period 1967-1994, the average evaporation rate was calibrated as 1244 mm/year.

6.8.2 WBM simulations of LU storage using natural and observed runoff

The WBM simulations of storage (Figure 6.18)correspond well with the regression results obtained in Section 6.7.1 for lake levels ; the same overall fluctuations are observed, as well as the same divergence between the lake storage series reconstructed from the (reconstructed) natural runoff data and that produced using the observed runoff series. However, Figure 6.17 shows that there is a time shift in the WBM simulated storage compared to the historical storage series derived from the VAL relationship, particularly for the recent period. There is no obvious explanation for this; however, it does not significantly affect the results of the analysis or change the overall conclusions.

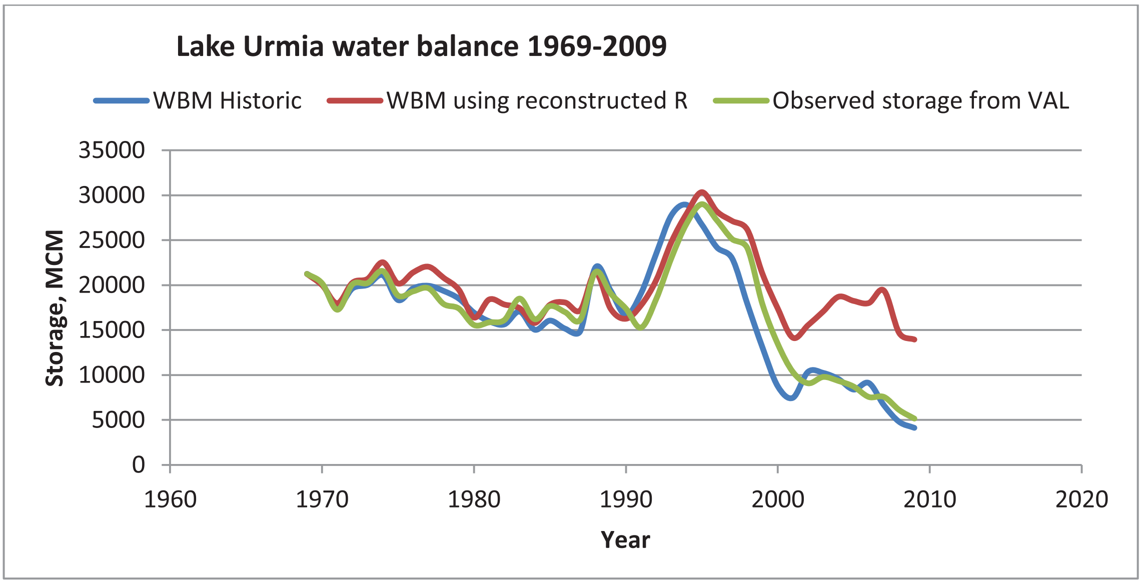


Figure 6.17: Water balance model simulations of Lake Urmia storage for natural and observed runoff.

Acknowledging the data uncertainty referred to above, it can be deduced that the lake volume in 2009 has reduced since 1968 to about one quarter of its original volume (assumed to be 21,000 MCM at the start of the simulation). The storage is now about 5000 MCM and the equilibrium volume is about 18000 MCM according to Mahab (2011).

6.8.3 Stochastic rainfall model

In analysing the trends in the historic catchment average rainfall record, it was noted that there was an upward trend for the period 1969-1994, and a downward trend for the period of 1995-2009 (Figure 6.13). This is evidence for persistence, where runs of years that are above or below average occur. Stochastic time series models provide a means of simulating such fluctuations using Monte Carlo simulation.

One of the key issues in modelling climatic and hydrological time series is the level of persistence present in a particular historical record. The higher the level of persistence, the higher the variability, with the possibility those periods of high and low flows can be unusually long, appearing as pseudo-trends in short records. Landwehr and

Matalas (1986) assert that hydrologic processes can exhibit a high level of persistence i.e. they have "*a tendency for high flows to follow high flows or low flows to follow low flows* (ibid, 239). Short term persistence in data describes any incremental changes (increase or decrease) for a short time span whereas "*If this span of time is many times the time-increment between successive data, especially in yearly data, it is called long-term persistence" (*Panu and Unny, 1980).

Hurst (1951, 1956) analysed a long record of annual flows for the River Nile and characterised long-term persistence /variability in terms of the rescaled range R/S which he related to record length n as:

$(R/S) \sim (n/2)^h$ (6.15)

where h is termed the Hurst coefficient. The range, R, of cumulative departures from the mean is defined as

$R_j = \text{Max } P_j - \text{Min } P_j$ (6.16)

where $P_j$are the partial sums given by

$$Pj = \sum_{i=1}^{j} X_i - j\overline{X} \quad (6.17)$$

and the mean is $\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$

The standard deviation S given by

$$S = \left(\frac{1}{n}\sum_{i=1}^{n}(\overline{X}_i - X_n\right)^2)^{\frac{1}{2}} \quad (6.18)$$

To estimate the coefficient h (now called the Hurst Coefficient), Hurst used the expression

$(R/S) = (n/2)^K$

from which

$$K = \frac{\log(R/S)}{\log(n/2)} \quad (6.19)$$

where K is an estimator of the Hurst Coefficient h.

For a large number of geophysical records, including Nile flows, Hurst found that the average value of K was 0.73, with a standard deviation of 0.09. For an independent process with no persistence, he showed theoretically that h= 0.50. He attributed the discrepancy between this theoretical result and the average value of 0.73 to long term persistence/variability. The discrepancy between the theoretical value of

0.5 and the average value of 0.73 obtained from observed data is known as the Hurst phenomenon.

The variability of River Nile flows and many other long records of runoff observed across the world is associated with natural climatic variability whereby periods of wet and dry years can be unusually long. It is expected that this variability will increase under climate change. Therefore, the aim here is to build a stochastic model of rainfall that can be used to explore the sensitivity of Lake Urmia levels to this type of variability.

O'Connell (1971, 1974 a, b) has shown that an ARMA (1,1) model can explain the Hurst phenomenon in the behaviour of R/S. Salas et al (1979) postulated that, since hydrological data are time dependent, the transient region in R/S with h>0.5 can be prolonged to reproduce the Hurst phenomenon. ARMA models have the capability to explain the Hurst phenomenon since their "*correlation structure dictates the behaviour of the rescaled range*" (ibid, p.7). Additionally, ARMA models not only have well known theoretical properties, but they possess physical foundations in hydrology (Hipel and McLeod, 1994; Salas and Smith 1981).

The autocorrelation function of the ARMA (1,1) model used by O'Connell (1971) to reproduce long term persistence is given by:

$$\rho 1 = \frac{(\phi-\theta)(1-\phi\theta)}{1+\theta^2-2\phi\theta)} \qquad (6.20)$$

$\rho_k = \phi\ \rho_{k-1}$, $k = 2, 3, \ldots$

where ϕ is the parameter of the autoregressive (AR) part; and θ is the parameter of the moving average (MA) part. An ARMA (1,1) model for annual precipitation, $X_{t,}$ can be written as (e.g. Hipel and McLeod, 1994):

$$(X_t-\mu_x)/\sigma_x) = \phi\ ((X_{t-1} - \mu_x)/\ \sigma_x) + \sigma_\varepsilon\ (\varepsilon_t - \theta\varepsilon_{t-1}) \qquad (6.21)$$

where ϕ and θ are model parameters, ε_t is a noise term that follows a normal distribution N (0, 1); σ_x is the standard deviation and μ_x is the mean of the rainfall time series.

The generated rainfall is given by

$$X_t = \mu_x + z_t\ \sigma_x \qquad (6.22)$$

where z_t is the standardised rainfall given as:

$$z_t = \phi\ z_{t-1} + \sigma_\varepsilon\ (\varepsilon_t - \theta\varepsilon_{t-1}) \qquad (6.23)$$

where σ_ε is the standard deviation of the noise term given by:

$$\sigma_\varepsilon = \sqrt{\frac{(1-\phi^2)}{1+\theta^2-2\phi\ \theta}} \qquad (6.24)$$

For a range of selected values of the ARMA (1,1) model parameters, O'Connell (1974) derived, through Monte Carlo simulation, expected values of the lag-one autocorrelation coefficient ρ_1 and the estimate K of the Hurst coefficient for samples of size 25, 50 and 100. To build the rainfall model, estimates of ρ_1 and K must be estimated from the available annual rainfall data. The lag-one autocorrelation coefficients $\rho_1$is calculated using

$$\rho_1 = \frac{\sum(X_{i+1} - \bar{X})(X_i - \bar{X})}{\sum_i^n (X_i - \bar{X})^2} \qquad (6.25)$$

The estimates of ρ_1 and K for the 42 years of historical annual LUB rainfall series (1969 -2010) are 0.1 and 0.59, respectively. The value of K indicates a low to moderate level of persistence. Due to sampling variability, it was not possible to match these values exactly with one set of values in the tables produced by O'Connell (1974), and so three sets of parameter values were selected to (a) reflect uncertainty in selecting the appropriate parameter set and (b) to allow for the possibility of a more variable climatic regime in the future due to global warming. As noted earlier, there is some evidence of increased variability in the historic record for the period 1990-2010.

The first parameter set is for the case where ϕ and θ are equal, which corresponds to an independent process with no persistence. The second set (ϕ= 0.14 and θ=0) corresponds to a moderate level of persistence /variability while the third set (ϕ=0.75and θ=0.60) corresponds to a higher level of persistence. The parameters are summarised in Table 6.11

Parameters / SRM	ϕ	θ	Level of persistence
SRM1	0	0	Corresponds to independent case, as a sort of lower bound on the persistence level i.e. no persistence
SRM2	0.14	0	corresponds to a first order autoregressive process with a moderate level of persistence
SRM3	0.75	0.60	this corresponds to a higher level of persistence, as might be encountered under climate change

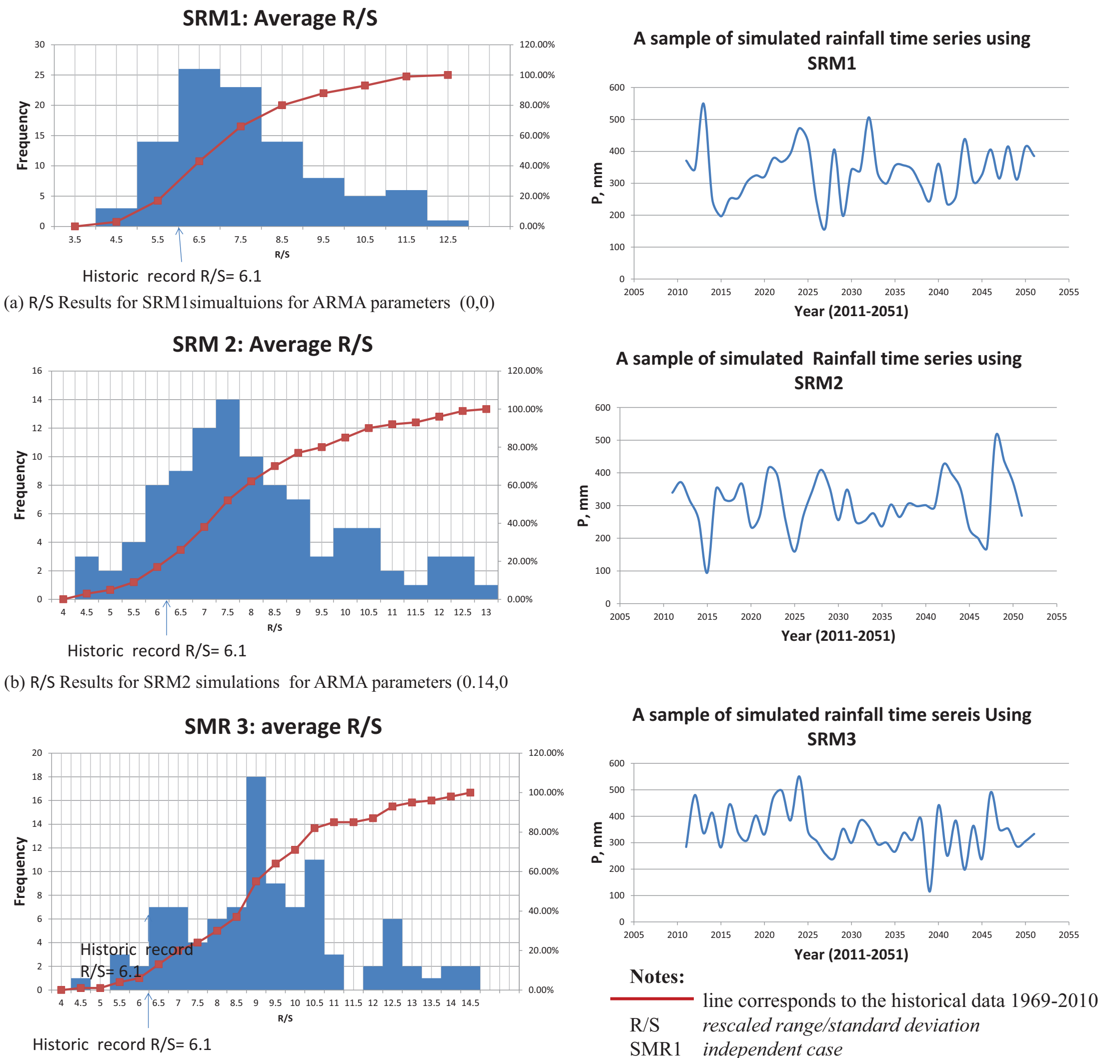
Table 6.11: ARMA model parameter values used in the stochastic rainfall models (SRMs).

100 series of 42 years in length were produced and tabulated using Matlab software code based on the following procedure:

1. 2010 was used as the starting year, so precipitation (X_{2010}) for that year was standardized using the mean and standard deviation to give the starting value z_{2010}.

2. 100 series of 42 years were produced using equations (6.21) and (6.22).

Validation of stochastic rainfall models. To compare the generated annual rainfall series with the historical series, R/S values for all the realisations were calculated and compared to the R/S value for the historical data (1969 – 2010). Figure 6.18 shows histograms of R/S for 100 realisations of 42 years in length. The historic value of R/S is 6.1. From the histograms (Figure 6.18), the probability of having a higher value of R/S in any future flows series is given in the table drawn in Figure 6.18 for the three sets of parameters. As expected, the historic value is more likely under the case of no persistence (reflecting the low variability/persistence of the early part of the rainfall record) and less likely under the higher persistence ARMA (1,1) model but, since the expectation is of higher variability/persistence in the future, given the recent increase in variability and the possible influence of climate change, the models with higher levels of persistence allow for the uncertainty over future climatic variability. The three sets of parameters should not be regarded as covering the range of variability that might occur in the future in a definitive way, but will illustrate the sensitivity of future lake levels to this variability under various management scenarios.



(a) R/S Results for SRM1simualtuions for ARMA parameters (0,0)

(b) R/S Results for SRM2 simulations for ARMA parameters (0.14,0

(c) R/S Results for SRM3 simulations for ARMA Parameters (0.75,0.60)

Notes:

—— line corresponds to the historical data 1969-2010

R/S *rescaled range/standard deviation*

SMR1 *independent case*

SMR2 *moderate persistence*

SMR3 *high level of persistence similar to climate change*

R/S for 100 41 year period synthetic data for the period 2010-2051			
	Mean	Min	Max
SRM1	7.1	3.7	12.0
SRM2	7.8	4.0	12.8
SRM3	9.0	4.3	14.4
Note: R/S for Historical data 1969-2010 is 6.1			

Figure 6.18: Validation of the stochastic rainfall models using R/S analysis.

6.9 Towards a sustainable and adaptive water allocation strategy

6.9.1 Adaptive water allocation model

As stated in Section 6.5, there has been concern about the recent higher variability in the rainfall record. There is a lack of knowledge about how climate change will influence rainfall variability in the future. In drought years, it will not be possible to meet the abstractions requirements and the lake’s requirement of 3100 MCM; thus, there will be a need to apply cutbacks to both and to capture how to balance the needs of the abstractions and the needs of the lake in a sustainable way. Therefore, there is a need for an adaptive water allocation model since fixed allocations are not realistic.

The stochastic rainfall model is linked with the water balance model to (a) simulate different levels of rainfall variability; (2) capture the sensitivity of lake levels to these; and (3) assess the ability to maintain the 3100 LU MCM requirement. The water balance model is based on eq. 6.9. The rainfall over the lake is estimated using the ratio of direct annual average rainfall over the lake to the catchment rainfall which is calculated as 0.75 based on the 1969 – 94 data. They are closely correlated.

The adaptive water allocation model uses a sliding scale approach based on two levels:

1. a warning (alpha) level: in which user allocation reduction will be initiated with a value of alpha in the range of $0<\alpha<1$;
2. a critical (beta) level which entails a further reduction from alpha. This should be linked to a drought risk management plan which defines 'exceptional circumstances' under which to apply a beta level reduction defined as $0<\beta<1$ and $\beta<\alpha$.

The procedure is as follows:

1. The WBM is used to simulate a sliding scale reduction of the target abstraction rate NA as the lake level approaches the critical level. If the storage drops below the warning level e.g. if $S_t < S_1$, then a reduced level of abstraction NA_t is determined as

$$NA_t = \alpha NA \text{ where } 0<\alpha<1. \quad (6.28)$$

2. If the storage the storage drops below the critical level ie $S_t < S_2$,then

$$NA_t = \beta NA \text{ where } 0<\beta<1 \text{ and } \beta<\alpha. \quad (6.29)$$

There are 4 sets of simulations (Table 6.12). In each set, three stochastic rainfall models (SRMs) are used with two abstraction rates; thus, there are six simulations for each set. Also, four pairs of alpha and beta values (sliding scale reductions) have been used as indicated in Table 6.12.

- Business as Usual (BaU): alpha and beta equal to 1
- Mild adaptive management option: alpha and beta are equal to 0.9 and 0.8 respectively
- Moderate adaptive management option: alpha and beta are equal to 0.8 and 0.6 respectively

- Strong adaptive management option: alpha and beta are equal to 0.75 and 0.5 respectively

For long-term sustainability of the lake, the warning level (and corresponding storage) was set at 1275 m asl, which is about half way between the long term average for the pre 1995 lake level series and the critical level which is set at1274.1 m asl. The starting level for all the simulation was 1271.6 m asl which was the level at the end of 2010.

A- Business as Usual : alpha= 1, beta=1						
Scenarios	**1**	**2**	**3**	**4**	**5**	**6**
Current lake level (m asl	1271.6	1271.6	1271.6	1271.6	1271.6	1271.6
θ	0	0	0.60	0	0	0.60
ϕ	0	0.14	0.75	0	0.14	0.75
α	1	1	1	1	1	1
β	1	1	1	1	1	1
NA (MCM)	2900	2900	2900	3700	3700	3700
B- mild adaptive management option: alpha= 0.9, beta=0.8						
Scenarios	**7**	**8**	**9**	**10**	**11**	**12**
Current lake level (m asl)	1271.6	1271.6	1271.6	1271.6	1271.6	1271.6
θ	0	0	0.60	0	0	0.60
ϕ	0	0.14	0.75	0	0.14	0.75
α	0.90	0.90	0.90	0.90	0.90	0.90
β	0.80	0.80	0.80	0.80	0.80	0.80
NA (MCM)	2900	2900	2900	3700	3700	3700
C- moderate adaptive management option: alpha= 0.8, beta=0.6						
Scenarios	**13**	**14**	**15**	**16**	**17**	**18**
Current lake level (m asl)	1271.6	1271.6	1271.6	1271.6	1271.6	1271.6
θ	0	0	0.60	0	0	0.60
ϕ	0	0.14	0.75	0	0.14	0.75
α	0.80	0.80	0.80	0.80	0.80	0.80
β	0.60	0.60	0.60	0.60	0.60	0.60
NA (MCM)	2900	2900	2900	3700	3700	3700
D- Strong management option: alpha= 0.75 beta=0.5						
Scenarios	**19**	**20**	**21**	**22**	**23**	**24**
Current lake level (m asl)	1271.6	1271.6	1271.6	1271.6	1271.6	1271.6
θ	0	0	0.60	0	0	0.60
ϕ	0	0.14	0.75	0	0.14	0.75
A	0.75	0.75	0.75	0.75	0.75	0.75
B	0.50	0.50	0.50	0.50	0.50	0.50
NA (MCM)	2900	2900	2900	3700	3700	3700

Table 6.12: Description of rainfall (climatic driver) and adaptive management scenarios.

6.9.2 Results

Four criteria has been used to make the analysis; water for users (abstractions); inflow into the lake; lake levels and the reliability of the water resources system to maintain the lake level at 1274.1 m asl. The means and percentiles of the average annual inflows and abstractions over the 41 year periods for the100 realisations are given in Table 6.13. Selected examples are given in the text.

BaU scenarios. In the long run, the BaU scenarios are not sustainable. If more persistence/variability is realized in the future, then the outlook based on the 3rd and 6th scenarios is bleak. Figure 6.19 shows that the reliability of the system in maintaining Lake Urmia at 1274.1m asl is almost zero. For example, in Scenario 3, the average lake level is below the critical level for 99% of the realisations. These statistics can be generalised for other parameters such as the3100 MCM minimum inflow requirement of the lake. For example in scenario 3, the average inflow is less than 3100 MCM in 97% of realisations. Therefore, it is concluded that fixed water allocations of 3700 and 2900 MCM will cause the demise of Lake Urmia in the short/medium term. Consequently, the decisions reached in Section 6.5 would have to be adjusted to take into account the role of climatic variability, and the overestimation of the available natural runoff.

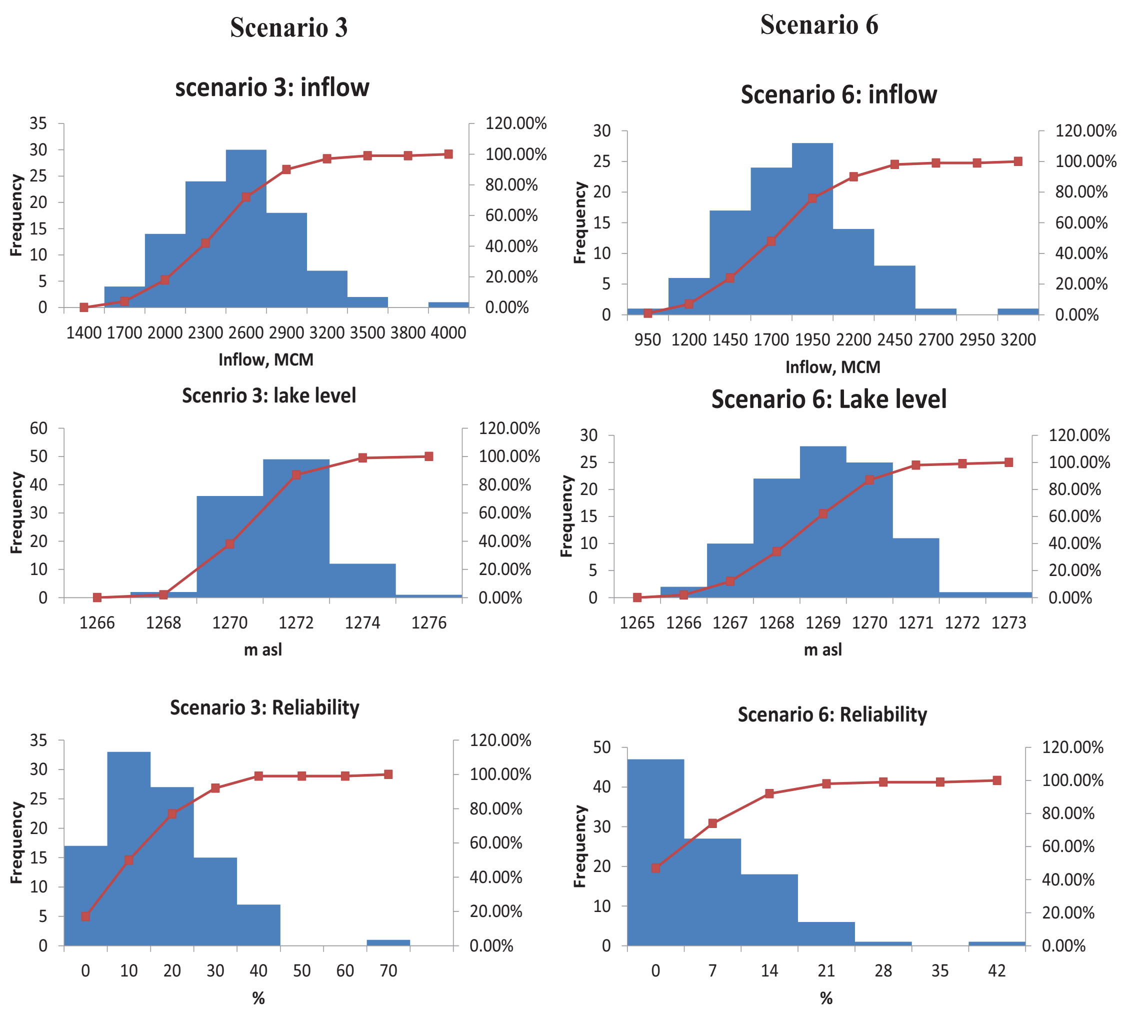


Figure 6.19: Risk analysis for BaU scenarios 3 and 6 with high persistence (SRM3).

	Scenario	Water allocation	Percentile				
			Max	90	mean	10	Min
A- Business as Usual (alpha, beta =1)	1	Lake Urmia	3170.9	2711.3	2326.8	1966.9	1706.3
		Users	2900	2900	2900	2900	2900
	2	Lake Urmia	3314.952	2796.399	2328.488	1935.674	1636.103
		Users	2900	2900	2900	2900	2900
	3	Lake Urmia	3935.5	2892.0	2366.4	1937.2	1404.9
		Users	2900	2900	2900	2900	2900
	4	Lake Urmia	2440.527	2029.328	1692.854	1382.184	1183.666
		Users	3700	3700	3700	3700	3700
	5	Lake Urmia	2572.199	2083.573	1699.494	1361.295	1146.216
		Users	3700	3700	3700	3700	3700
	6	Lake Urmia	3188.427	2171.56	1731.521	1311.021	931.0843
		Users	3700	3700	3700	3700	3700
B- adaptive: alpha= 0.9, beta=0.8	7	Lake Urmia	3545.003	3172.199	2786.228	2452.471	2152.968
		Users	2510.976	2426.098	2362.439	2334.146	2320
	8	Lake Urmia	3638.798	3216.347	2775.39	2413.274	2072.225
		Users	2567.561	2435.293	2369.512	2334.146	2320
	9	Lake Urmia	4183.03	3310.111	2805.406	2365.012	1822.043
		Users	2652.439	2490.463	2383.659	2334.146	2320
	10	Lake Urmia	3016.74	2621.011	2270.528	1913.358	1664.543
		Users	3104.39	3006.024	2978.049	2960	2960
	11	Lake Urmia	3104.638	2674.56	2249.782	1884.454	1594.062
		Users	3140.488	3041.22	2987.073	2960	2960
	12	Lake Urmia	3659.01	2774.456	2298.877	1851.151	1363.451
		Users	3212.683	3068.293	2987.073	2960	2960
C-adaptive, alpha= 0.8, beta= 0.6	13	Lake Urmia	3785.491	3517.959	3191.645	2911.931	2590.544
		Users	2263.415	2051.22	1923.902	1824.878	1782.439
	14	Lake Urmia	3865.14	3546.587	3164.474	2859.779	2503.644
		Users	2348.293	2095.073	1938.049	1824.878	1782.439
	15	Lake Urmia	4317.42	3575.592	3199.772	2755.986	2251.228
		Users	2518.049	2164.39	1966.341	1839.024	1754.146
	16	Lake Urmia	3785.491	3517.959	3191.645	2911.931	2590.544
		Users	2263.415	2051.22	1923.902	1824.878	1782.439
	17	Lake Urmia	3865.14	3546.587	3164.474	2859.779	2503.644
		Users	2348.293	2095.073	1938.049	1824.878	1782.439
	18	Lake Urmia	3947.791	3247.569	2824.667	2382.329	1869.604
		Users	2923.902	2580.976	2382.439	2256.098	2220
D- adaptive: alpha= 0.75, beta=0.5	19	Lake Urmia	3889.689	3660.299	3359.189	3095.834	2812.283
		Users	2157.317	1929.207	1732.927	1591.463	1520.732
	20	Lake Urmia	3967.701	3677.801	3339.233	3047.304	2711.643
		Users	2245.732	1964.573	1768.293	1609.146	1520.732
	21	Lake Urmia	4377.542	3684.073	3351.502	2936.43	2454.099
		Users	2457.927	2035.305	1785.976	1609.146	1538.415
	22	Lake Urmia	3591.201	3375.176	3063.193	2787.153	2495.322
		Users	2481.707	2233.537	2075.61	1940.244	1895.122
	23	Lake Urmia	3619.885	3373.888	3038.331	2750.005	2397.751
		Users	2594.512	2278.659	2098.171	1940.244	1895.122
	24	Lake Urmia	4051.571	3420.282	3045.269	2624.151	2157.692
		Users	2820.122	2368.902	2120.732	1962.805	1850

Table 6.13: Simulation results for average annual inflows and abstraction over the 41year periods for 100 realizations.

Adaptive scenarios. Three pairs of sliding scale parameters were chosen to simulate the impact of mild, moderate and strong adaptive management options.

For mild adaptive management (alpha=0.9 and beta=0.8), although the reliability of the system has increased compared with BaU scenarios, this level of reduction factor favours the users more than the lake, as shown in Table 6.13.If the target abstraction rate is increased, more water is given to the users at the expense of the lake. Therefore, in the moderate adaptive model, the target abstraction rate is the determining factor. For example, in scenarios 10,11 and 12witha target abstraction rate of 3700 MCM, the lake on average receives of the order of 2300 MCM, whereas, for scenarios 7, 8, and 9 with a target abstraction rate of 2900, the average inflow increases to 2800 MCM. Therefore, this level of adaptive management will not achieve the long term aim of the Ecosystem Management Plan (EMP).

Generally speaking, the strong adaptive approach has favourably influenced the three criteria used for Lake Urmia sustainability:

- the amount of water inflow into the lake has been greater than 3100 MCM;
- the lake level has recovered to more desirable levels;
- The reliability of the system to maintain the lake at 1274.1 masl has increased.

However, the amount of water available for users has been reduced. For example, for Scenario 22 in Figure 6.20, the inflow is above 3100 for about 50% of the realisations whereas none of the realisations achieve the target abstraction of 2900 MCM. Therefore, there is a need for a trade-off between water allocation to users and to the lake.

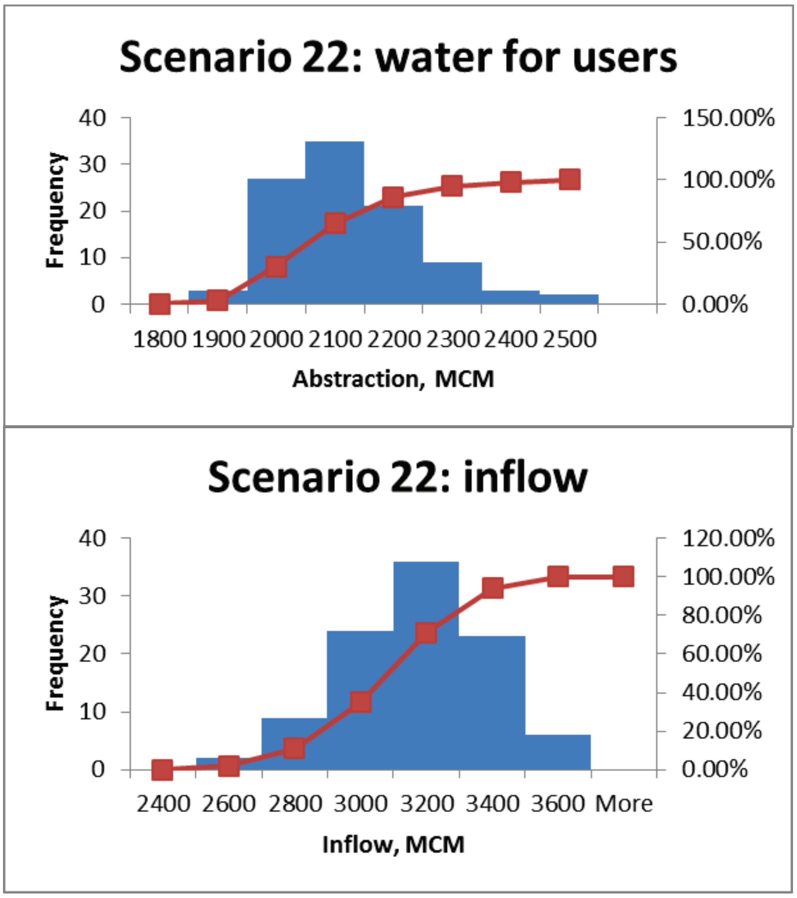


Figure 6.20: Comparison of lake inflow and users' allocation for a strong adaptive management option and the no persistence rainfall model (SRM1).

Table 6.13 shows that, for the moderate adaptive management option, and a target user allocation of 3700 MCM, the average inflow to the lake exceeds 3100 MCM except under high variability/persistence (i.e. scenario 18). However, the users receive less than 2000 BCM on average. This reflects the fact that, on average, there is just over 5000 MCM available to be allocated between users and the lake. However as shown in

Figure 6.21, it seems that the lake level under this level of abstraction will not recover from its current level i.e. the lake level is less than 1274.1 m asl for about 90% of the realisations, with this figure increasing for the high level of persistence

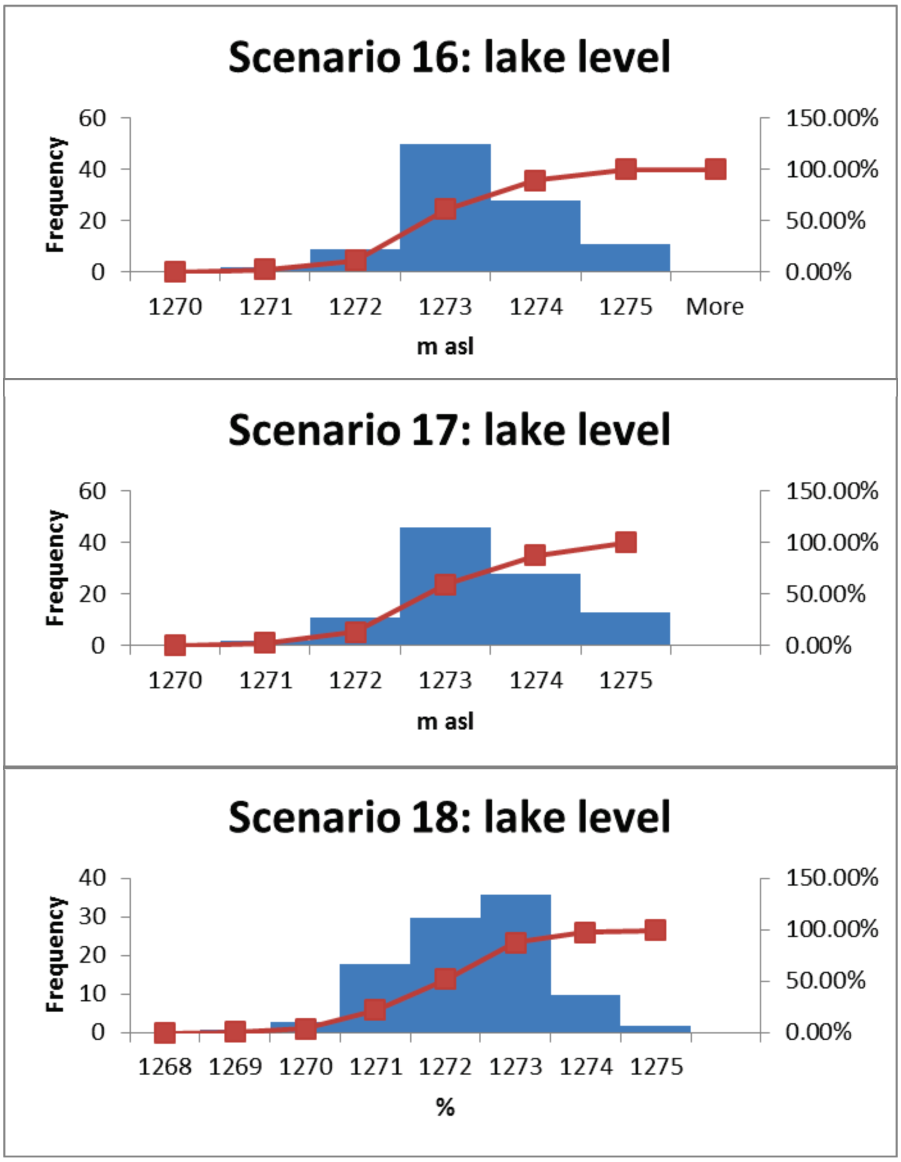


Figure 6.21: Risk analysis of lake levels for the moderate adaptive management option at 3700 MCM target level of abstraction and rainfall models SRM1-3.

The simulation of the moderate adaptive management option at the target abstraction rate of 2900 MCM is shown in Figure 6.22, and for the no persistence and high persistence levels. Generally, the users are expected to be allocated 2000 MCM for 50 % of the realisations i.e. on average this figure can be used while maintaining the lake level at 1274.1 m asl. This is in line with the current abstraction estimated by the regression analysis (2045 MCM). This indicates that there is no scope for further water resources development in the basin and it has reached a saturation point. Any development will heighten the pressure on the lake and will cause it to go into permanent decline.

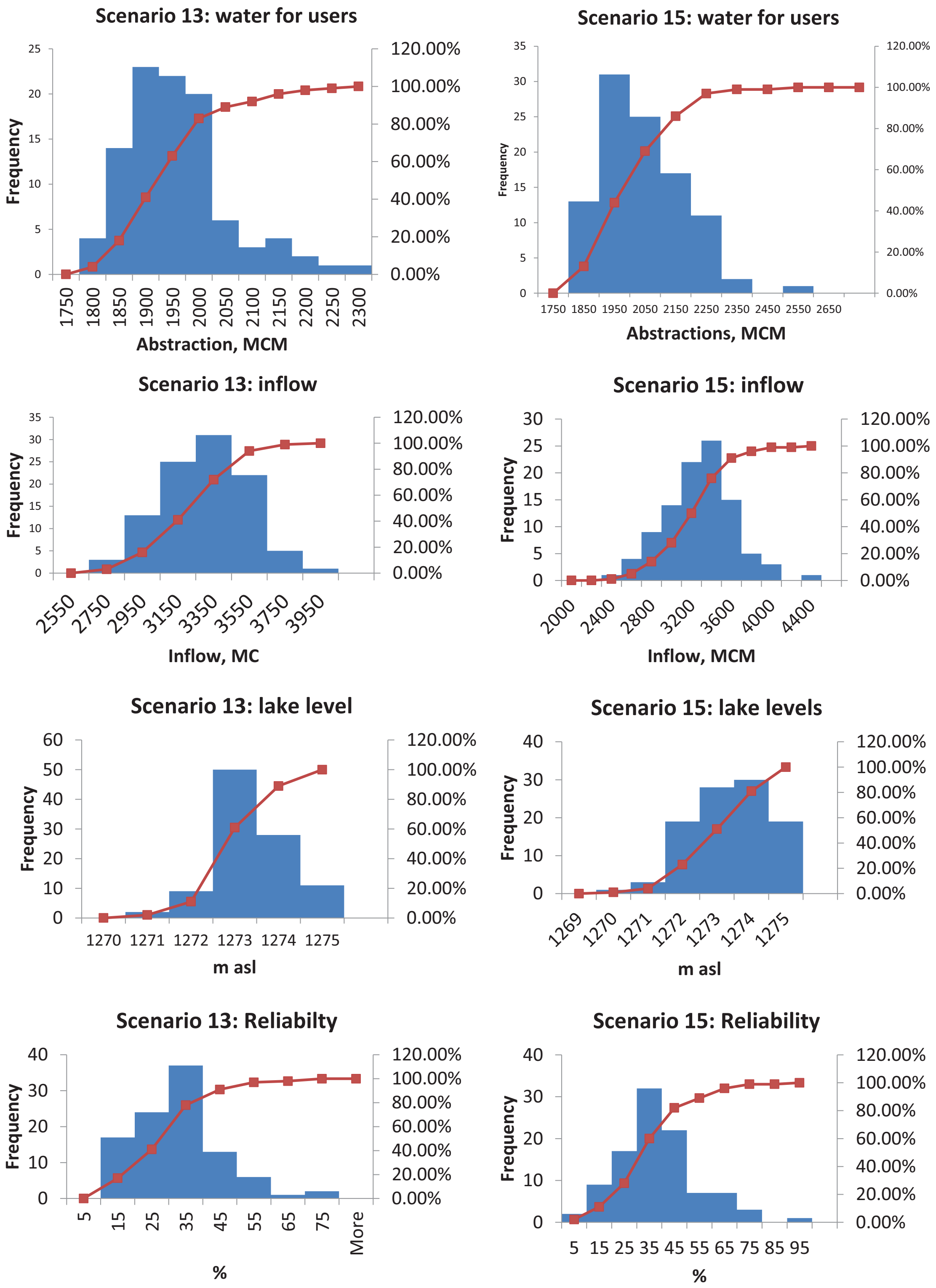


Figure 6.22: Risk analysis of moderate adaptive management option under the no persistence (scenario 13) and high persistence (scenario 15) rainfall cases (SRM1 and SRM3).

6.10 Conclusions and recommendations

The conclusions drawn in Section 6.5.5 for part (1) of this Chapter are not repeated here, but the main outcome of the ISTA component is that, although the efficacy of the governance system has improved, the effectiveness of the EMP i.e. achieving long term sustainability of the lake, is in doubt, considering the agreement on the level of water allocation, and what has emerged from part (2) of this chapter on overall water availability It seems that both sides of the water allocation equation have not been fully considered a basin-wide planning approach that requires rigorous hydrological assessments of water availability and potential for water use. The implications of the water allocation decisions have not been foreseen by the actors. On the one hand, the user water allocation ceiling of 3700 MCM lacks rigorous scientific assessment, and on the other hand, the minimum ecological requirement of the lake has become a legal right which ignores the hydrological and climatic variability and persistence.

In the first part of this chapter, the overall outcome of the water allocation process was that 3100MCM was allocated to Lake Urmia and 3700 MCM to users. This was based on the estimate of 6900 MCM for natural average runoff to LU derived using the Detrending Method prescribed by the MoE. However, an examination of the use of the Detrending Method has revealed that it was based on the highly questionable assumption that the downward trend in observed runoff over the 1950 – 2008 (58 years) period of record was attributed entirely to abstraction. By establishing a regression relationship between runoff and rainfall over the period 1969 – 1995 when the influence of abstractions was minimal, average annual natural runoff over the period 1969 – 2010 was found to be approximately 5000 MCM. The current level of abstraction was estimated as approximately 2000 MCM/year, so, based on these figures, there is no scope for further development/ abstraction if the lake is to receive its allocation of 3100MCM.

Due to climatic variability, fixed allocations cannot be sustained, and so a risk analysis of a number of management scenarios was carried out using an ARMA (1,1) to generate multiple realizations of future rainfall for different levels of persistence/variability. The management scenarios were based on fixed target allocations of 3700 MCM and 2900 MCM and an adaptive allocation strategy whereby sliding scale reductions to abstractions were made when the lake levels fell below warning and critical levels. Mild, moderate and strong levels of reduction were explored under different levels of rainfall variability.

Overall, the results reflect the overall natural runoff constraint of approximately 5000 MCM, so the fixed targets of 3700 MCM and 2900 MCM cannot be sustained. If the user abstraction increases above the current level of around 2000 MCM, the Lake will go into permanent decline. The moderate and strong adaptive options can initiate Lake Urmia level recovery but only if the target rate of abstraction is much lower than 3700 MCM. It was shown that, at the 2900 MCM target rate of abstraction, the moderate management option is effective in delivering the amount of water to the lake required to maintain the minimum ecological requirement (3100 MCM) based on the vision stated in the EMP which understandably focuses on Lake Urmia's water requirements. However, the average amount of water available to users reflects the overall constraint of 5000 MCM for average natural runoff availability.

However, the actors have chosen to allocate a higher level of abstraction ceiling which does not take into account the basin- wide hydrological and climatic conditions. Therefore, the following recommendations are made:

1. A thorough review of the hydrological and climatic baseline data to remove much of the uncertainty about the water allocation governance.
2. Modification of the 2008 Water Allocation Code by (a) by removing the Detrending Method in the estimation of the water availability for the basin since it produces a highly overestimated value of natural runoff; (b) allowing other MCDA approaches other than AHP to minimise the inconsistency about weighting water allocation criteria; and (c) using a stochastic approach in the water allocation strategy since trend analysis is highly unreliable and cannot account for the persistence and variability of rainfall records.
3. Vensim dynamic simulation has to be calibrated with more sophisticated generic water resources modelling systems such as WEAP, Mike Basin or RIBASIM.

To conclude, it can be said that the ISTA approach highlighted three main issues: (a) the need for an independent scientific assessment based on rigorous reliable data; (b) the revision of the existing water allocation rules i.e.the 2008 WAC; Although, the 2008 WAC has introduced basin-wide planning, it has a rigid scientific approach and uses highly unreliable methodology in assessing water availability and (c) the outcome of the WAC process is unrealistic as it ignores demand management which is the cornerstone of IWRM. To redress this, the reassessment calls for an adaptive water allocation strategy which is a form of demand management required to achieve long term sustainability.

In Chapter VII, the institutional implications of the results obtained in this chapter will be further assessed and further recommendations given.

Chapter VII.Re-assessment of Water Allocation Governance in Lake Urmia Basin: an Institutional Design

7.1 Introduction:

Chapter VI described Lake Urmia's new governance system as well as re-assessing the sustainability and reliability of the water resources system (WRS) to maintain Lake Urmia's minimum ecological status using the Integrated Socio-technical Assessment (ISTA) component. Without repeating the arguments and the conclusions, the main outcome of the technical assessment is that the participatory process has produced unsustainable water allocation outcome decisions because most of the participants in Water and Agriculture Working Group (WAWG) meetings failed to provide accurate data and information on water availability. It seems that there has been a degree of "*data fitting*" by all sides. Therefore, it is argued that the existing institutional set up has to instigate an inbuilt mechanism for independent assessment since we have a viable governance system and structure is in place for a re-evaluation process to take place.

Based on the conclusions in Chapter VI, it is argued that fixed water allocation is not just unrealistic but also (1) fosters zealous impractical expectations for water demands and (2) hides the realistic outlook of climatic variability and persistence. Hence, it is recommended to use an adaptive water allocation strategy which is a form of water demand management. In Chapter VII, we reassess the new water resources governance system (i.e. multitier MSPs) with the following objectives:

1. To make an analysis of institutional sustainability the MSPs
2. To evaluate the implications of adopting the adaptive water allocation
3. To propose revised Responses based on (1) and (2)

The methodological approach to achieve the above objectives is outlined in the next section.

7.2 Methodological approach

7.2.1 Data collection and the context of analysis

This chapter is a cross cutting chapter using results from previous chapters as indicated in Figure 7.1 which provides a schema of the focal level of analysis. The Institutional Analysis and Development (IAD) approach is used to assess the sustainability of the socio-political component of the WRS based on the objectives outlined above. The analytical approach is:

1. To assess the institutional sustainability of the water allocation decisions by evaluating the efficacy (Box 7.1) of the new rules in use at the operational level (Section 7.3).

> Box 7.1: Evaluative Criteria: the three E's based on Checkland and Scholes (1990, p 39).
>
> The rules in use can be judged based on
> - Efficacy (for 'do the rules work?) which "*checks whether the means chosen actually work"*
> - Efficiency (for' amount of output divided by amount of resources used') which "*considers whether the transformations is being carried out with the minimum use of resource"*
> - Effectiveness ('is the rule in use meeting the longer term aim') which shows that a "*transformation works and used minimum resources"*

2. To assess the socio-political context of the decision making by
    a. analysing the role of ideological aspects of actors in dominant policy discourses (Section 7.4.1);
    b. analysing the narratives behind policy discourses on water resources planning and allocation (Section 7.4.2);
    c. analysing the discourses that influenced the water resources allocation and management decision-making process (Section 7.4.3); and
    d. exploring the potential of a new water management paradigm to achieve sustainability within the socio-political context (7.4.4).
3. To revise Responses by proposing how to enhance the new institutional design for an adaptive water resources management in LUB e.g. crafting new rules to reflect the adaptive water allocation model described in Chapter VI (Section 7.5).

7.2.2 Evaluative Criteria

The Evaluative Criteria has been introduced in Chapter III (Section 3.5.3). Efficacy is used as the main criterion for analysing the rules in use. Economic efficiency did not appear to have been among the list of concerns in LUB- although the stakeholders mentioned it; they did not attempt to evaluate it in real terms. In addition to efficacy, several criteria have been considered:

a. Equity and justice in terms of water allocation outcome: the question of conformance to general morality was a big issue: can those who 'cheated the system' (i.e. EA and lately WA) be rewarded by getting more allocation of the resource (i.e. to have greater payoff)? It was decided to re-allocate the water resources regardless of existing abstractions

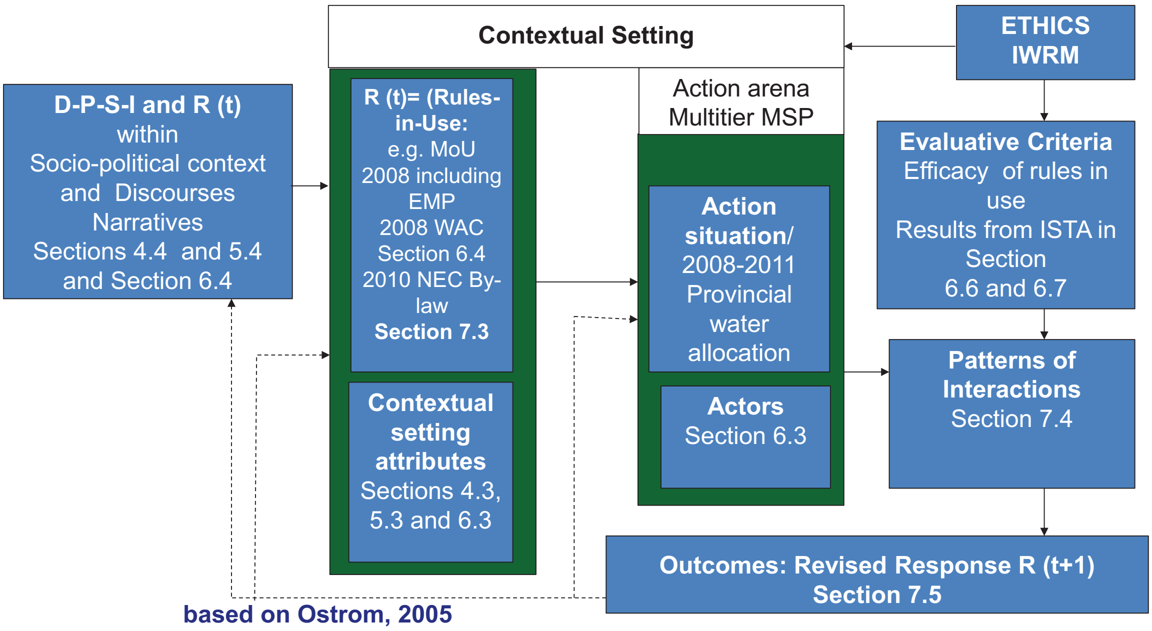


Figure 7.1: Focal level of analysis in Chapter VII.

b. Accountability and transparency of the participatory decision-making process provided the legitimacy of the decisions outcomes

c. Reliability of the WRS in terms of the degree of ability for lake restoration from ISTA analysis

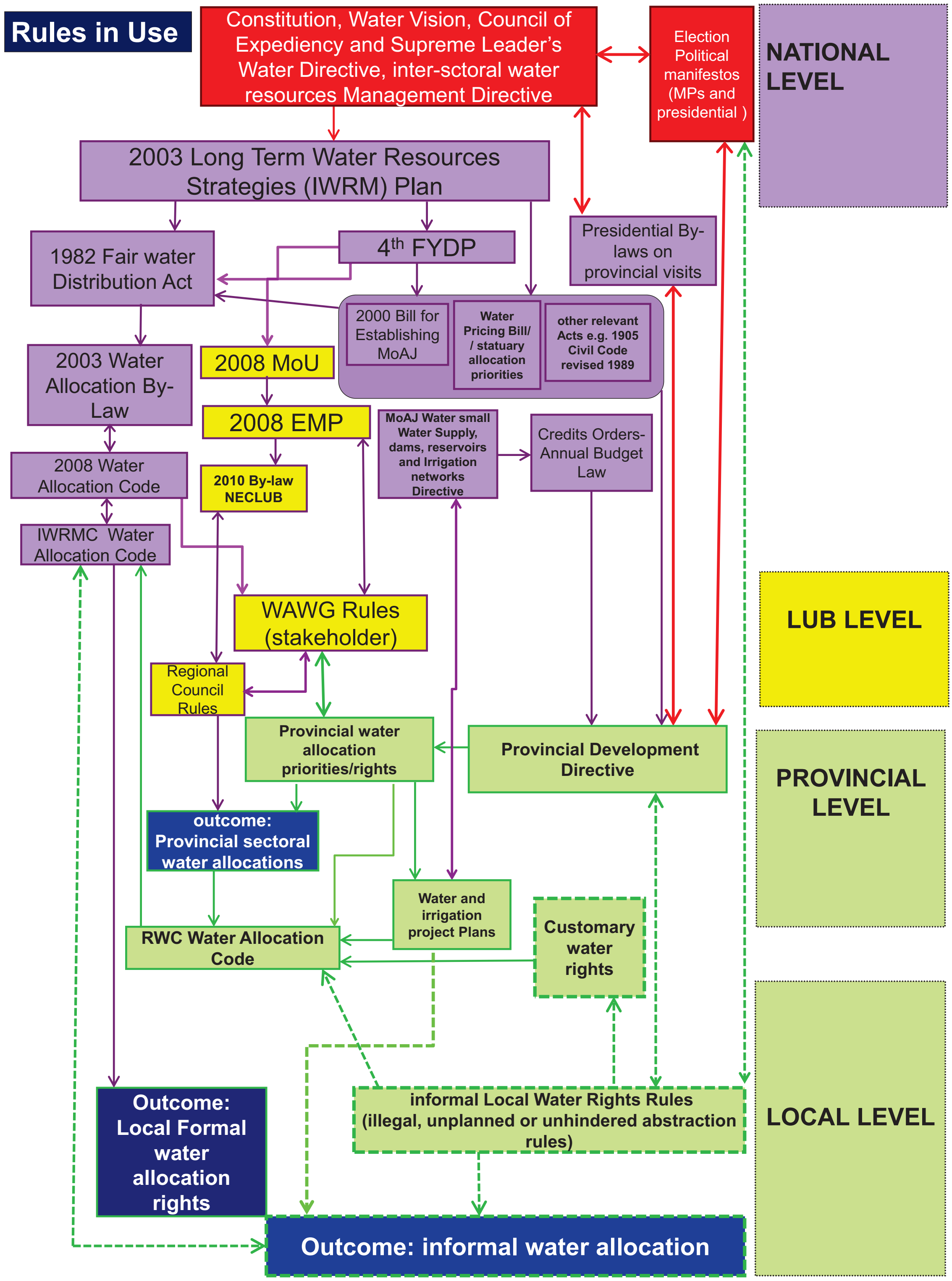
d. As Ostrom (2005, p.68) notes that it is very difficult to compare the performance of alternative institutional arrangements; thus trade-offs are often required in using performance criteria. The trade-off process used are as follows (a) socio-technical criteria used in the MCDA of the ISTA component to allocate water resources using multi-criteria water allocation model (WAM) and (b) risk based technical evaluation of the allocation decisions using adaptive WAM for different management options and climatic scenarios (i.e. a trade-off among different criteria used in the allocation model; then the allocation was evaluated using the risk-based assessment based on water balance and stochastic rainfall modelling).

In this chapter, we concentrate on the efficacy of the rules in use in addition to the above criteria. In Chapters IV, and V, the efficacy of the rules in use was measured in terms of the adequacy of their design and the implementability.

7.3 Rules in use: an assessment

Several new rules have evolved as part of a well organised effort by CIWP and high level political support for sustainable water managements in LUB. The new rules have been ‘inserted’ onto the rules map as shown in yellow in Figure 7.2.

As the main rules have been described in earlier part of the thesis; we will concentrate on the operational decision-making level rules i.e. the 2010 NEC Bylaw on implementing the 2008 EMP and the WAWG rules or Terms of Reference (ToR). The latter is discussed first.



Note:
dotted lines indicate informal rules in use

Figure7.2: Post MoU rules in use.

7.3.1 Crafting new rules for participation

With reference to the ToR of the author as national IWRM consultant (Appendix A2), a capacity development strategy was agreed for facilitating the Working Group meetings in consultation with the CIWP. The strategy was centred on the following rules (Appendix A1, Table A1.4):

1. Boundary and scope rules: there was a need to create a basin perspective rather than sectoral and provincial approaches to water and land management in the basin. Therefore, in order to foster the emergence of a new water management paradigm, river basin approach was chosen as a boundary unit for water resources planning and allocation.
2. In addition to the position rule on the author's role as described earlier, there was an emphasis on
    a. a new general position rule based on the new scope and boundary rules was established to foster (institutionalise) a basin-wide role for the participants so that members of the WAWG are disengaged (detached) from their official provincial roles as representatives of different organisations;
    b. national stakeholders were invited to the meetings to enhance the ownership of the results and to give MoE assurances that it will act according the 2003 WAD and the 2008 WAC. This was based on the assumption that the success of the WAWG depended on how the WAWG transmits its higher decision-making levels since water allocation decision is highly centralised. De Jong and Spaans (2009) assert that" an active government is particularly needed in the initial stage in which a decision has to be made about the creation and design of the trade-off scheme". As a result, the process was 'blessed' by the MoE.
3. New information rules were created: (a) a databank to be created i.e. data should be shared across the sectors; (b) transparency about the quality of the data i.e. data is scrutinised in an open participatory way and (c) uncertainty should be communicated to the decision-makers by considering the available facts and figures and acknowledge any information inadequacy i.e. to foster the belief that we have enough evidence about the water resources in the basin to make sound decisions.

4. An aggregation rule was established to adjust the balance of power among actors i.e. national and provincial stakeholders were on the same level and decision to be made based on consensus.
5. An empowerment (scope) rule was used to foster the belief that decisions made at the WAWG will be used by decision-makers at higher levels i.e. unlike previous projects such as WRI (2005), this is for real and the outcome will be approved by the national and provincial decision-makers and implemented accordingly. CWIP had an added advantage in the legal sense compared to other national and international projects: MoU provided the legal mandate of the Working Group work and hence part of the strategy was to "sell" the unique status of CIWP in the water allocation process.
6. Payoff rule was centred on the notion that if the participants fail to reach a decision; then the decision is made at a higher level. Therefore, there should be no complacency as local problems require local solutions.
7. Choice rule to make LU a water demand site: on the onset of the process, it was important to emphasise the need to make hard choices and to accept a compromised outcome. McShane et al (2011) have demonstrated the difficulty to attain win-win outcomes in complex environmental action situations in which socio-economic prosperity is a prime objective based on 20 years of empirical research results by different researchers. The win-win approach has been rather rare compared with trade-offs and 'hard choices 'approach which is norm. However, the ethical and morality of win-win approach was maintained in terms of making Lake Urmia as a priority demand site in the water allocation process.

Other contextual factors include improving the democratic nature of the decision-making or accountability by encouraging self-belief among the stakeholders i.e. there was a need for decisions as the problems are well known; hence stakeholders should not be afraid of taking responsibilities for their decisions.

The successful outcome of the WAWG meetings can be attributed to the ability and the flexibility to craft new rules at the local level (operational level) by dealing with issues related to the participation arrangements such as power relationships among actors.

7.3.2 2010 NEC By-law: dynamic rule-crafting powers

The typology of the rules used in the 2010 NEC By-law is given in Table 7.1. There are 8 Articles dealing with the issues at the operational level decision-making.

LU water rights. The 2010 NEC By-law recognises LU's water rights of 3100 MCM which provided a new lifeline for the Working Group bearing in mind that neither the Regional Council nor the Working Group are explicitly mentioned in the Bylaw but it refers to the Ecosystem Management Plan which refers to both. For the first time ever, water allocation in LUB was based on an ecohydrological policy. This in itself is an achievement for environmentalism in Iran.

Lack of aggregation rules. The By-law lacks clear aggregation rules on how position and choice rules are evaluated, assessed and agreed upon. Also, the 2008 NEC Bylaw takes a top-down approach[1] by centralising all the work in the NEC which makes it almost impractical: designing, planning and monitoring are bestowed upon the NEC which comprises of several ministers and led by the First Vice President.

Article	*Rule Typology*	*Description*
1	Boundary	Members of NEC are selected (Figure7.1)
	Position	Actors are assigned to coordinate and implement 2008 EMP
2	Position	DoE will act as a secretariat of the NEC
3	Position and Boundary	Chairperson can invite any other relevant organisations to attend the meetings
4	Aggregation	Decision-making is by the majority rule;
	Scope	The presidential powers are delegated to the members of the NEC and any ruling can become legally binding and issued as a By-Law of Council of Ministers.
5	Position	NEC Terms of reference has been outlined;
	Choice	design and planning of action and implementation plans especially during environmental crisis and droughts conditions;
	Choice and Scope	Assessment of management proposals and planning
	Choice	Make sure the supply of 3100 MCM of min ecological of LU and allocate provincial water shares
	Choice and Scope	Monitoring the performance of governorates and organisations on the implementation of the EMP
	Choice and Scope	Allocation of budgets and assessment of project proposals
6	Scope, Choice and Position	Sets out in detail the responsibilities of each of MoE, MoAJ, DoE and provincial governorates in implementing the 2008 EMP by assigning to them positions to act with a target outcomes
7	Payoff	provinces are given public finances according to their share and role in the 2008 EMP
8	Position and choice	NEC reports each year to the President

Table7.1: Typology of rules in the 2010 NEC By-law.

This requires a high level of coordination at the collective choice level decision-making to make operational decisions such as water allocations. For example, the Vice President (VP) is responsible for nearly 40 collective choice level (i.e. policy-making) committees and part

[1] In practice, NEC has not exercised its powers and delegated it to WAWG meeting decisions but there is a potential to apply the rule in a different way.

of the delay for finalising the Sanandaj agreement was due to lack of time and difficulty of managing the time of collective choice level actors such as three Vice Presidents and other ministers. Therefore, NEC has been interlocked in the governmental web and has become ineffective for a long period until the 4th joint meeting.

Government without coercion. After the Sanandaj (6th WAWG) meeting, NEC had a strong mandate to act but it preferred to referring back to the WAWG and establishing a technical committee based on smaller WAWG members to finalise the Sanandaj agreement. This clearly shows that NEC abstained from top-down approach of the By-law by not did forcibly issue a decision on the provincial water shares and looked to establish consensus. . Government is needed in the form of political support for the process but with no coercion.

Polycentricism. To deliver the water to LU requires an unprecedented cooperation between multi-level and multi-sectoral institutions; thus it seems that NEC has recognised the polycentricism of nested interests in the water allocation process. Since late 1960, Elinor and Vincent Ostrom have worked on the idea of polycentric institution as opposed to homocentric conception of public administration (Toonen, 2010). The IAD framework is used to comprehend institutional diversity in the form analysing and formation of robust governance in polycentric institutions (ibid, p.198). As described in Chapter III, Ostrom (2011, 2010) which has crafted the idea of Social-Ecological Systems (SESs) Framework asserts that actors in the action situation "*are not external, but are endogenous to the development of ecosystems* (Toonen, 2010). Ostrom (2005, 2007, 2011) conceives robust governance system to be polycentric and multi-layered nested enterprises representing the diversity and complexity of SESs; diversity and complexity should be recognised and not eliminated from institutional design (e.g. Toonen, 2010).

Lack of community level involvement. Article 6 deals with identifying water-saving projects to implement the EMP but there is no guidance of how to coordinate and monitor water demand management programme. There is no mention of how to deal with existing informal abstraction in terms of its equitable re-allocation and provinces such as WA consider these as downstream water rights (Karimi, 2010). The absence of community level actors (farmers) can jeopardise the process as they are one of real *game-changers* in LUB. As with the land reforms narratives (Chapter IV), farmers have a strong political niche in the Iranian political system and they can exercise immense power in elections and especially local MPs will not disenfranchise these local constituents.

There are two main conclusions from above analysis of the rules. First, insertion of new rules as in the case of LUB (Figure 7.2 shown in yellow) without revamping existing laws and rules are going to produce confusion among actors. The legal frameworks need to be streamlined to make sure that any contradiction and duplication are removed. Secondly, creating position rules without considering the capacities required to fulfil the positional role is rendered useless. All of the actors have had many other responsibilities and basically, they had little free time to prepare for their new roles. Many could not reconcile their new position by breaking from their existing jobs and hence there was a conflict of interest between fulfilling their official duties and work for the new institutional setup. The financial costs of these rules were not considered and this threatens the long-term institutional sustainability of the multi-stakeholder participation platforms.

Dynamic rule crafting. The 2010 NEC By-law gives an important legal mechanism to NEC with delegating presidential powers. This means that the NEC decisions have a legal stature same as the Council of Ministers By-laws. Law-making is a long process; it takes decades for an Act of *Majlis* to be ratified. Council of Minsters' By-laws can take years to be endorsed. Therefore, to address immediate operational level needs, this mechanism can be very effective. Some of the issues which were missing from the 2010 NEC By-law have been addressed by the third and 4th NEC meeting Directives which includes important choice, payoff, position and scope rules as shown in Table 7.2

From Table 7.2, there are some important rulings:

1. It gives MoE the power to reassess the water development plans in the provinces and asserts LU's water rights by specifying any water allocated from dams to be deducted from surface water allocation given to provinces.
2. It allocates financial resources to the implementation of the projects and the establishment of a permanent secretariat for the management of the LUB.
3. Recognising the need for political support for the RC, it implicitly calls for the merger of the RC and NEC.
4. It recognises unauthorised abstraction as the one of the main issues but asks the provinces to manage informal abstractions without providing clear guidance of how this should be done.

A. 3rd NEC Meeting Directive

Article	Rule Typology	Description
1	Choice	3100 MCM minimum environmental water rights of LU to maintain lake level at 1274.1 m asl
	Choice	73 MCM water to be allocated to Satellite wetlands to be jointly agreed by MoE and DoE
2	Payoff	47,000,000,000 Riyals for environmental projects to implement the EMP (equivalent to UD$5,000,000)
3	Payoff	Water use efficiencies projects to implemented; 50% of the cost of upgrading irrigation technology (20,000,000 Riyals= US$2000) per ha to be given to farmers; bank loan facilities to provide the other 50% as incentive
	Choice	Water saving from water demand management to be allocated to Lake Urmia
	Position/ Scope	First Vice president delegates its power to Mr Aliabadi, Deputy Vice President for Coordination and Monitoring Public Organisation.
4	Choice	Provincial water shares to be reviewed and agreed within 10 days. (Sanandaj Agreement was finally endorsed
	Choice and Scope	In reassessing provincial water shares, MoE is given power to review the water allocated to the dams built in each province and how much provinces can use with the aim of increasing Lake Urmia's water allocation i.e. volume of existing allocated water from dams are deducted from their provincial shares
5	Choice	Due to limited water resources, further water resources development should be stopped and no more water rights should be given
	Scope	Kurdistan Province is exempted from the above rule to allow equitable development
6	Choice	All the projects as listed has been approved; NEC should review allocated budgets for these projects in the next meeting
7	Position and Choice	Unauthorised water abstraction should become an agenda and precisely monitored with greater control by MoE and MoAJ
8	Position	MoE and MOAJ reports every 6 months to the NEC on the issue of unauthorised abstraction

B. 4th NEC and 1st RC meeting Directive

1	Choice	Shares are allocated as per 6th WAWG meeting in Sanandaj
2	Position/Scope	Provinces to establish a monitoring system and a plan to provide LU with water
3	Position/Scope	With the support of judicial and political actors, unauthorised abstractions to be managed
4	Position/Scope	ToR of the Working Groups agreed
5	Payoff	3 Billion Rial to establish the Secretariat
6	Scope	Joint RC and NEC meetings Twice a year
	Position/Scope	WAWG to draw water allocation strategy (plan)

Table 7.2:Typology of rules made by the 3rd NEC and 4th Joint NEC/RC meeting.

Therefore, there are still gaps in these Directives which have to be filled. As IWRM is a "*process and not a goal in itself"* (see Chapter II), then it is understandable that this process is gradual and can be improved when the participatory process is refined through the process of social learning.

7.4 Interactions-Outcome Pathway: Socio-political context

7.4.1 Understanding the ideological aspects behind decision-making

The negotiations over provincial shares were overshadowed by the predicament of LU water level which has dropped considerably since 1999 (Figure 7.3). The actors appeared to agree with a sentimental narrative that "*the lake is drying up and has to be saved and should be provided with water; we need urgent actions not talks*" (Source: Appendix A1). On the other hand the actors maintained their rights to use and consume water resources in the basin due to socio-economic Driving forces. The deadlock was complicated by lack of adequate knowledge about the biophysical system and incoherent and scattered databanks and information.

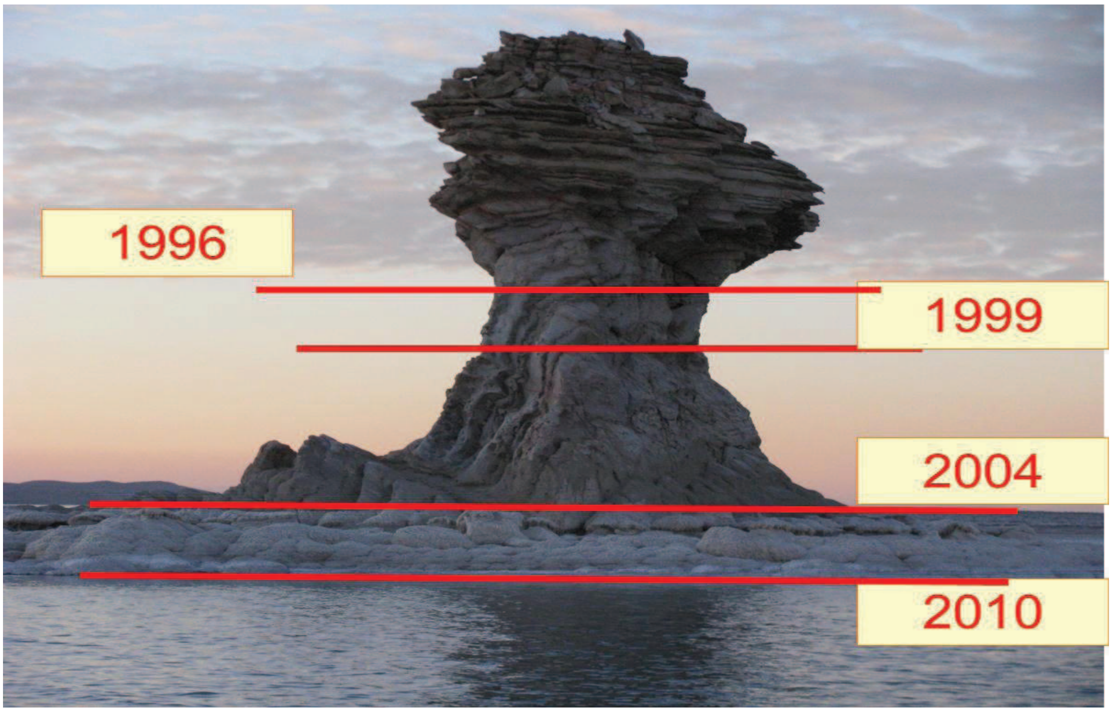


Figure 7.3: Historical account of lake levels (Jabbari, 2011).

The controversy was heightened by the issue of water (re) allocation in LUB. The diabolical status of LU had made it into national agenda and the government increasingly became vocal about saving the Lake as a 'national interest'. The actors in the WAWG were mainly chosen from the "*technical and engineering offices*" of the provincial departments. The whole process was under the influence of the so called "hidden actors" represented by experts in different departments and subsidiary organisations of the MoE and MoAJ including more than 50 research institutes and centres, consulting companies, irrigation design and manufacturing companies, water and agriculture associations, university departments on water and agriculture and technical offices and lobbying groups (see e.g. Keshavarz and Dehghanisanji, 2007).

Reverence for water. Almost all the meeting started with the recitation from Holy Quran on water: "*We made from water every living thing*" (21:30). This strong religious reverence for water is embedded in the development discourse i.e. the belief system of the community of actors. But also, there is a reverence for land and farming is considered as the noblest profession. This has resulted in distinctive and dominant polices such as the populist agricultural polices of land reforms in the 1960s and the farmer -welfare oriented policy of the successive governments after the revolution in 1979 (Chapter IV); self-sufficiency and food security polices and pro-development polices . The actors' perspectives (mental models) have been affected by the cultural and religious ethics in LUB. As mentioned in Section 2.3.5 (Chapter II), the religious ethics of environmental stewardship can be overridden by other meta-beliefs such as attaining basic human needs which is reiterated by the sustainable development concept and the idea of win-win solutions.

Cultural and ethical factors. The evidence based decision-making stems from a tradition of strong esteem for knowledge and scientific deliberation in Iranian and Islamic culture. Knowledge is the way to enlightenment: it is the light or *'Noor*' in terms of spiritual development of human capacity to make sound decisions (see e.g. Rosenthal, 2007). This rational approach is firmly embedded in the cultural and religious values making knowledge or '*ilm*', an essential part of narrative form of the discourses. These research and technical centres within the water sector organisations have an important role in shaping the narratives as well as providing alternative policy options.

Role of hidden actors. Qolipour and Gholampour-Ahangar (2010) assert that experts employed by Iranian governmental organisation have a great role in drafting laws and policies but later their drafts are changed by the policymakers to an extent that it no longer addresses the policy problems due to the impact of "hidden" lobbying groups. Also, the religious organisation including their research bodies have a very instrumental role in policymaking and they contribute to the discourses on wider policy implications. We will come back to the theme of hidden actors later.

Qolipour and Gholampour-Ahangar's (2010) work which was commissioned by the influential *Majlis*[i.e. Parliament] Research Centre (MRC) proposes a framework for public policy analysis which appreciates the role of "*politics and political streams*" and "*interests*" associated with power relationships within the socio-political and religious arena i.e. policy discourses framed by these hidden actors play a vital role during information and knowledge sourcing, utilisation and application. .Therefore, they acknowledge that policymaking is not just based on rational choices but involves policy discourses within the political environment.

The concept of ‘hidden actors’ was postulated by Kingdon (2002) describing the role of these actors in the policy making process. They play a far greater role after a policy issue (idea) gains an agenda status (see Chapter II) and the evidence-based decision-making pathway is initiated. Kingdon (2002) states that “*visible participants (actors)*” have a major role in agenda setting but “*hidden participants*” including academic researchers, consultants, career bureaucrats and official and advisors of governmental departments and so forth are influential in crafting alternative policies and proposing solutions to policy problems. The presence of these actors manifested in the presence of WPAC and IWRMC in the WAWG meetings dictating how information and knowledge is used in the decision-making process as described earlier (Figure 7.4).

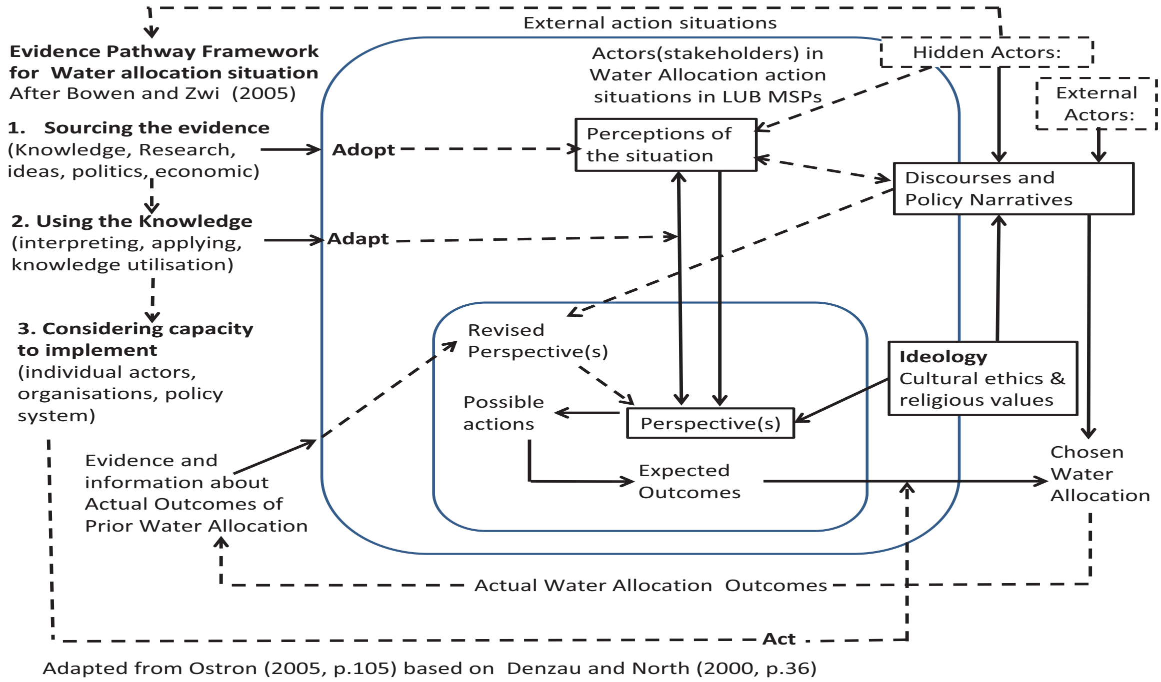


Figure 7.4: The role of ideological aspects of actors and the hidden actors on water allocation decision outcomes in LUB.

Figure 7.4 refers to the perspectives (mental models) of actors involved in the WAWG knowledge-based decisions and the role of discourses and ideological aspects (cultural and religious values) on the actual water allocation outcomes based on "*Shared Mental Model*" (SMM) developed by Denzau and North (1994, 2000). Ideology is not uniquely defined in the political sciences but Jackson and Kingdon (1992) define ideology "*whether unidimensional or multidimensional"* as *"a set of core beliefs that organize perceptions of political issues and that underlie individual preferences*." According to Denzau and North (1994) SMM are "*internal representations that individual cognitive systems create to interpret the environment*". Thus ideologies are a framework of path-dependent SMMs held by actors which process knowledge about the environment and prescribe "*how the environment be structured*" (Denzau and North, 1994). SMMs are intertwined with history (path-dependency feature) and represent religious and cultural attributed of the community.

Refereeing to Figure 7.4, the evidence-based pathway framework proposed by Bowsen and Zwi (2005) consists of three phases: sourcing the evidence, using the evidence and considering capacity to implement. These are related to three decision making factors (Figure7.4): adopt, adapt and act. According to Bowsen and Zwi (2005), once adopted, the evidence is adapted or changed by actors and then it will be implemented once certain capacities are in entrusted in individuals or organisations. The dominant anthropocentric perspective on water allocation in LUB stems from welfare-oriented cultural and religious ethics of fulfilling the basic human needs which were shaped by developmental and climate change discourses of the actors within the process and "*hidden actors*" in the water and agriculture sector as represented in Figure7.4.

The 2008 WAC which provides guidelines on how evidences are acquired, used and applied is the brainchild of the WPAC. With reference to results from ISTA in Chapter VI, the actors involved in the WAWG rejected the evidence provided by the WPAC on dynamic modelling simulation which was based on the documented information provided by them; they rejected the proposition to keep the lake level at the minimum ecological level of 1274.1 m asl, LU has to be allocated 3900 MCM; instead, the actors endorsed the proposition of 3100 MCM which was made by Nazaridoust (2006) and Yekom (2005) as part of research work and promoted by CIWP through the synthesis report prepared by the author (Hashemi, 2008). A "*window of opportunity*"[2]was opened for WPAC to postulate a "*hidden*" discourse that there is no further potential for development in the basin after finishing the on-going dam projects and the idea of water requirement for the lake provided an opportunity for basin-wide planning and allocation. But, the actors rejected WPAC's favourite strategy instead they chose to make a complete reallocation of water resources (see Figure 6.12). Also, provinces ascertained shared perspectives or SMMs based on the local needs in weighting the water allocation criteria. They formed blocks based on political boundaries and not sectoral affiliations. For example, Environmental Protection Organisations (EPOs) joined other organisations in their respective provinces.

7.4.2 Loops of narrative behind policy discourses

In the previous section, we shed some light on the interplay between information and knowledge utilisation processes and ideological attributes of the community shaping the policy discourses. The discourses will be discussed in the next subsection but there is a need to understand the stories (narratives) behind the argumentations provided behind these discourses to show the level of complexity which caused polarisation of opinions among the actors. The outcome of LU water allocation can be analysed based on narratives (stories) which were told by the participants reflecting a complex multi-layered mental maps or perspectives of actors. Media stories about LU drying up prompted 'save the lake'

[2]This term is used to indicate a practical mechanism for institutional change or reform e.g. with respect to administrative changes in political office, Groenewegen and de Jong, 2008 note that "*to shift the balance of power, a window of opportunity is required*".

as a policy meta-narrative. In the blame game, MoE was accused for not supplying the lake with enough water and MoE blamed mainly farmers for their unauthorised or informal abstractions. Droughts and climate change stories have also dominated the arguments.

The negotiations began under a great deal of pressure from the government that a solution must be agreed by all the actors promoting an environmental discourse based on giving priority to LU as a demand site. The question was whether the actors accept the implication of implementing the EMP.

The official position taken by the actors[3] was that the lake should be saved. However, neither the causal relationship for the lake's predicament was shared by everyone nor any clear cut solutions were offered. As a WARWC delegate noted "*if all the water behind the dams are released, it will not solve the problem*". The lake's storage has decreased by nearly 18000 MCM in the last decade and there was less that 3000 MCM water stored in dam reservoirs. There was a sense of resignation by some actors that LU is beyond saving. Initially, most of the negotiations were about the symptoms rather than any solutions. CIWP facilitation was based on the meta-narrative: 'we all agree to save the lake'. This phrase was used to break deadlocks and remind the actors that their position rule is sanctioned by this meta-narrative.

Field works (Appendix A1) were undertaken to get a picture of how actors depict the problem and whether they support the aim of the EMP i.e. giving water rights to the lake. There was some confusion among provincial actors about what has to be done and what has caused the problem. They offered different perspectives of the problem. Generally, they could not describe very well the problem at the basin level.

MoE understood very well what is happening on the ground using simulation modelling of the basin. Results from a climate change study has terrified MoE (See Chapter V) about the impact of climate change on river flows but was not prepared initially to share their discourse with the WAWG. They wanted to obtain the evidence through documentations of the baseline data and so WPAC was waiting for a chance to produce its work[4]. CIWP tried to gain knowledge about WPAC's motives and found that the Commission is trying to validate their evidence through corroboration of the data from provinces. WPAC was waiting for a political mandate to review the allocation process in

[3]stakeholders and actors interchangeably used
[4] Referring to the idea of window of opportunity described by Denzau and North (1994)

Lake Urmia basin. IWRMC was critical of the WPAC's inaction on provincial applications for water allocations. The tension between the MoE groups was evident.

From the Problem Statements (PS) (described Chapter III, Roe, 1994), two distinct strategies (management options) have been considered in LUB:

1. *non-structural Responses* i.e. to have irrigation water efficiency measures within a change in regional development (agricultural) policy (change in type of crops); and
2. *structural interventions (Responses)* i.e. continue with water resources development plans.

Both of these policies were found to have loops or as described by Roe (1994) to have circular arguments. Loops in the policy narratives illustrate a high degree in complexities. One of the solutions mentioned in the negotiations was change in regional development policy i.e. changing crop types to deal with water scarcity problem in LU. The actors presented the following PSs: changing crop types

- *leads to irrigation efficiency i.e. more water saving;*
- *leads to more irrigated land i.e. an incentive to farmers to own this extra water (explicitly stated in the Directive);i.e. less water saving*
- *is financially unfeasible and cannot be controlled i.e. market forces will have a control;*
- *requires subsidised help and incentives i.e. it has an economic burden;*
- *leads to economic valuation of water i.e. more appreciation of water price;*
- *should be based on socio-economic aspects of farmers i.e. it should be driven by anthropogenic pressures;*
- *can cause less water for the Lake.*

Based on the above PSs, (a) water savings (if any) is mainly used to irrigate new lands rather than delivered to the lake; (b) it will cost more because incentives should be given to the farmer (usually financial incentives like price guarantees); and (c) consequently, changing crop type means less water for LU.

Water development loop arises from regional agricultural policy which justifies dam-building and development of irrigation networks to maintain the environmental low flow of rivers in dry spells (i.e. drought conditions) and for irrigation. The PSs on dam-building were:

- *Climate change and droughts necessitate to build dams to harness access to water*
- *Climate change and droughts cause low flow*

- *Low flow causes LU water level to fall*
- *LU water level is not helped by releasing all the volume of water behind the dam*
- *Climate change (variability) and droughts has caused the lake to dry up*
- *Dams are built to regulate low flow*
- *Dams recharge groundwater tables*
- *Dam reduce groundwater abstractions i.e. more surface water used*
- *Dams use more water for irrigation (i.e. more water abstractions)*
- *Dams cost money and over designed; i.e. partially full*
- *Regulated water from dams to be given to the highest bidders*
- *'Trading' water as Virtual Water has to be considered and is not considered*
- *Water markets have no place in this problem*
- *Social unrest happens if to charge for modern dam facilities- people want free water*
- *Social unrest will be caused by not building dams*
- *Lack of environmental criteria has caused the Lake to dry up*

The fear of droughts and climate change is a dominant meta-narrative: dams will provide the means to control water resources in droughts and water scarce areas. Dam building seems to offer a solution to important socio-economic problems of water scarcity. So the main questions are: can the lake be given priority over the societal needs? And who pays to buy water for the Lake?

As noticed, the social and political aspects dominated the narratives. It is noted that LU was not clearly on the mental map of the provincial actors. The only credible solution i.e. changing crop types and irrigation water use efficiencies were dismissed as non-practical. With this in mind, WAWG meetings embarked on a difficult task to put Lake Urmia on the 'issues map' and making it central to any water allocation in the basin. Therefore, the momentum of the participatory process was kept by high political support for WAWG. It can be concluded that there are many loops in the arguments and the actors have no idea how to implement a win-win strategy to save the lake. In fact, saving the lake was not on their issues map despite paying a lips service to it as mentioned earlier.

7.4.3 The discourses

By analysing the narratives form of the main discourses in the LUB in the last section, it was demonstrated that provincial water resources planning did not consider LU as an environmental 'demand site'. In this part, we want to show how LU dilemma shaped the perspectives of the actors based on their discursive deliberation on the policy in question i.e. saving the lake by recognising its formal rights.

Fostering environmental law-making. MRC (1995) recognises that MoE lacks institutional capacity to protect the environment (rivers and wetlands) and hence, there is a need for water and land management paradigm shift towards environmental sustainability within the water sector and MoE in particular for any successful implementation of EMPs in Iranian river basins. There are no explicit provisions of environmental water allocation in the existing water legislation (1982 FWD Act). Therefore, according to Ramsar Convention Secretariat (2007), one of the options is to follow the path of law and policy-based decision-making[5] : either to make the wetland a higher or equal priority than others uses. Under this option, "*there is a need to remain realistic, especially where the short-term demands and economic development may be pressing, although the long-term requirement and for protection of ecosystems are recognised*" (ibid). In LUB, the 2008 NEC provides the institutional basis for environmental sustainability by explicitly stating that the MoE has to deliver 3100 MCM to the lake.

The environmental discourse has not been part of the mainstream polices and lacked political support. So, the development in LUB is a welcome sign for the environmentalists. Additionally, the environmental discourse been marred by 'mixed-bag' polices i.e. polices that endorse only some aspects of environmental sustainability and presented as IWRM policy. For example, Fadeifard (2009) is reconstructing the environmentalist discourse in this way:

We ask them [i.e. environmentalists] to provide alternative options; these friends concentrate on three options and I can say with great confidence that they are pursued [by policy-makers] and the government fortunately has invested on these issues: for example: recycling water; water efficiency, use of gray water; more research on water management … use of desalinations… water cost recovery …[Fadaeifard, 2009].

Fadeifard (2009) capitalises on the environmentalists' lack of politically acceptable alternative policy narrative. According to him much of the environmental discourse has been debated and approved by public policy-makers such as non-structural responses in terms of demand management and water efficiency measures and adaptive management policies. Also, environmentalists are portrayed as alarmists with no real alternative policy.

[5] The other path is valuation-based process.

The environmentalists such as Muhammadi (2010) have used media to expose "*the myths of dam buildings*". Muhammadi (2010) acknowledges the weakness of the environmental voice but envision an activist approach to deal with the "*catastrophes*" caused by dams as he mentions some successes achieved by public protests resulted in e.g. lowering a dam height or stopping dam-building altogether. MoE had responded to some of the criticism through mass media. With regard to Lake Urmia, the environmental discourse is gaining momentum and there has been an urban show of protest in recent times. However, it is suggested that politicising the environmental discourse will further fuel ethnic tensions in both EA and WA. Since Lake Urmia water right has been established, it is time for independent objective technical re-evaluation and not political maundering on Lake Urmia. The blame game might not be effective to achieve the goal of the EMP.

Most environmentalists believe that we have enough laws and polices but they are not implemented mainly due to DoE's lack of logistical instruments to monitor the environment. Thus, there is a lack in data related to the environment. Therefore, the impact of the policies cannot be completely assessed. The environmental discourse relies upon the general public perception of environmental degradation which can polarise the policy issue and policymakers be made to defend their positions. There is a high level of risk that any future environmental meta-narrative is going to be rejected when the socio-economic interests and security (food, water, social welfare etc.) are balanced against environmental protection (i.e. the perspective of the actors may be modified during cost-benefit analysis of the action-outcome linkage). The 1974 Environment Protection Act needs to be updated and streamlined with water and land laws.

More research on climate change needed. Climatic variability and change is neither well defined in Iran nor in Lake Urmia. There is some linguistic confusion in the Iranian (Persian) literature between changes in climatic parameters and climate change. However, the term "droughts" is used by provincial stakeholders to get extra revenue for developmental works or some of other programs (Appendix A1, Table A1.4). For Lake Urmia basin as an arid to semi-arid region, droughts are not unusual. The discrepancy in the WPAC's climate change discourse (see e.g. Attarzadeh, 2009; MoE, 2010b) is that on the one hand it places a great weight on the "droughts" component but put less importance to the human induced impacts such as dam-building. On the other hand, in the water allocation process, it attributes 100% of the trend to the abstraction (see Chapter VI). Therefore, MoE is happy with building the dams since they attribute very little to the Lake

Urmia crisis (only 5%) and can provide a buffer for hard times such as droughts. Thus, MoE agrees to continue with the development but would like to restrict water allocation. However, it is politically very difficult to restrict water allocation once the infrastructure is built. For example, Tabriz mega city's (Chapter V) urban and industrial water demands are rising and there are calls for more investments to transfer water from dams in WA.

The prospect of dam decommissioning. Furthermore, the defenders of expanding irrigation development use the uncertainty of climatic parameters as shown in this statement by a member of Iran's Committee on Large Dams (IRCOLD):

Building a dam has a prime advantage in controlling waters which we could not previously control. They are collected in a place (reservoir) and we can ensure downstream water rights and even environmental requirements with a greater confidence……like controlling traffic in Tehran city; we control the waters during floods and prevent damage. The extra water available [behind the dams] can be used for our developmental needs and downstream water rights… (Fadaeifard, 2009)

Therefore, there is need for more rigorous research on topic of climate change in LUB to deal with the knowledge uncertainty. Based on the results in Chapter VI (i.e. results from ISTA component); it is not possible to conclude that climate change has occurred. The 3rd NEC meeting Bylaw-Article 5 (Table 7.2) calls for immediate halt to dam-building and so there is a hint of dam decommissioning. This paradigm will send shock waves to the quarters of those who call for more developments. The new environmental discourse is also hinging around the decommissioning of dams around the globe.

Reconciling National vs. local interests. The hidden perspective of MoE is that local short-termism is not compatible with long term national interests. There is a need to reconcile this mismatch. Since 1940s and the implementation of the first SYDP (1948-1955) (See Chapter IV), the Iranian policymakers have made water allocation a centralised 'national' issue (MRC, 1995) and according to MRC[6] (1995) any change in policy will cause vulnerability and damage the national interest. The local needs can be met by allowing the regions to continue with the "*desired local development*" and this offers incentives for local aspirations. So for example in the 2nd post Revolution FYDP (1994-1999), regional water resources development budgets were bigger than 50% of the national development plans of the 1st FYDP (MRC, 1995). MRC (1995) asserts that water allocation should be centrally managed by the state and should not be based on administrative divisions. Small dams and irrigation projects can be used to satisfy local demands and the

[6] *Majlis* Research Centre

water budget can be used to allocate water from groundwater resources for local demand sites (industrial, agricultural and so forth). The recommendation made by the parliament in this report can explain the drive to over-exploit groundwater resources (See Chapter IV for a national picture). The legacy have come about because water allocation is seen a national security issue.

The current decentralisation drive to give more fiscal powers to provincial governors have come into conflict with centralised water allocation practice as governors have been acting to protect the rights of their provincial constituents. The governors' dilemma is that they represent central government and appointed by the Ministry of State (MoS)[7] but they have to be faithful to their provincial constituents. Thus the three provincial governors in the LUB have pursued a local agenda for water and agricultural development. Therefore, the role of MoS in implementing the water allocation strategy is critical especially under climatic variability and droughts conditions. Droughts budgets are under the direct supervisions of the governors' Office of Disaster Reconstruction.

Harmonising cross-sectoral multiple perspectives. At collective choice level, MoE and MoAJ have different perspectives on major discourses. There are two distinct discourses within the agricultural sector shaping MoAJ's perspective on irrigation perspective as noted by Keshavarz and Dehghanisanij (2007): (1) the agricultural water allocation is not enough to provide sufficient food for the growing population; thus there is a potential to increase irrigation water development by 11%; and (2) Increasing water use productivity is going to provide the basis for sustainable water allocation and food security. Water use productivity is defined as the amount of dry produce (in kg) produced by 1 m^3 of water use. In Iran this figure is below 0.8 kg. Therefore, technological interventions can be applied to produce 'more crops per drops of water'.

The narrative behind the discourses is that agricultural sector plays a major role in the Iranian economy providing 18% of GDP, 25% of employment, 85% of food supply and 90% of raw materials used in industry (Keshavarz and Dehghanisanij, 2007). Irrigation water is the blood life to keep the agriculture sector in a healthy state since Iran is characterised by Aridity "*which is a non-avoidable fact*" and "*drought is also an important threat to agriculture in Iran*" thus, optimal and efficient use of water is unavoidable (ibid). Therefore, MoAJ strategy is to secure more agriculture water in a water resource regime characterised by rivalry of different uses.

[7] Same as Home Office in the UK

Mismatches in the IWRM Plan. Iran's IWRM discourse has not been immune from the irrigation discourse: Iran's IWRM Plan (2003 Strategic Water Resources Planning Bylaw) endorsees more surface water irrigation development e.g. Articles 1 and 2 state as follows:

1. Increase of surface water use (currently more than 56% of total consumption and 70% of agriculture use is from groundwater) i.e. more developments for agriculture
2. Agricultural water use to be reduced from 92% to 87% by 2020 through water efficiency measures only.

The demand in real terms increases from 8520 MCM in 2005 to 9970 MCM in 2020[8] which is contradictory to the IWRM approach. There is a need to issue Directives to rectify this imbalance in the IWRM Plan.

In Lake Urmia, groundwater withdrawal is more than 2000 MCM. There are many aquifers with continuous lowering in water table (Chapter V). The issue of groundwater did not enter in the water allocation debate. Groundwater is controlled by private ownership and hence, MoE is not confident that this can be done at this stage but the scope exists to include groundwater is the strategy in the future. This can only be done if current agricultural policies on food security and self-sufficiency are revised. This is a major gap that has to be addressed in future.

Evading responsibilities. The MoE has not delegated agricultural water allocation to MoAJ despite the assertion of the 1982 FWD Act (Etimad-Fard, 2007). Thus, the sticking point between these two ministries has been the fact that Article 11 and 13 of the 1982 Act has been ignored by MoE giving power of water allocation to MoAJ (Zare, 2007). Accordingly, both ministries failed to act according to the 1982 FWD Act:

On one hand, MoE has legally violated the rule on the formation of the water user associations (WUAs); instead of establishing WUAs with 25% shares from MoAJ, 24% shares of MoE and 51% people participation, 100% public WUAs have been formed….e.g. Qazvin network is 100% public (state owned). On the other hand, MoAJ legally had a duty to divide and distribute its water share. In practice it has not done this so far[Source: MoAJ, 2008]

Also, MoAJ criticises MoE for lagging behind building the primary irrigation networks for the dams; the water companies have been engaged in dam-building since the developments are a lucrative business:

[8] In percentage terms the water allocated decreased from 92.5% to 85.3 assuming the water behind reservoirs increases the potential renewable water resources by 30000 MCM. This does not consider climate change and variability as well

There is not volumetric allocation of water to the agricultural sector neither in the time nor in the place required……… (MoAJ, 2008)

The concept of establishing water user associations (WUAs) has not gained any ground due to lack of users (mainly farmers) in being part of these associations which bring extra responsibilities and financial burden. So, MoE has embarked on establishing splinter companies owned by the provincial regional water companies (RWCs). On one hand, MoE has been moving to privatise the existing public WUAs to create a water market i.e. selling water to the customers through these companies (Appendix A1, Table A1.4). This is unlawful under the current FWD Act. On the other hand, MoAJ has evolved from an internal battle with its old adversaries Ministry of Jihad-e-Sazandegi (MJS) and has been ineffective in managing the agricultural water sector by evading its responsibilities to start farmer participation for sustainable water and land management. In order to implement the adaptive water allocation strategy in Lake Urmia, the role of informal institutions and WUAs need to be considered in further work.

Reviving traditional water governance. MoAJ also criticises MoE for neglecting tradition water structures such as *qanats* and *aab-bandans* (natural water ponds in the north) and have made a great deal of efforts in reviving the traditional systems which became part of the Iran's IWRM Plan (e.g. Dargahi, 2007 a, b):

Major problem of the water [sector] is that 70% of the [available] agricultural water is from wells, qanats and springs and 30% from surface waters. Nevertheless, 95% of the governmental investment is on surface waters. Surface water consumption efficiency is far less than groundwater consumption rate

40% of agricultural water is supplied through wells. The ownership of wells in Law is better clarified and people are willing to take out loans and banking facilities so they can use water saving measures such as piping systems –but the government provide little [financial] facilities to the well owners [Source: MoAJ, 2008]

MoAJ (2008) believes that traditional water and land governance system has been affected by large dams-building drives while not replacing it with a viable modern governance system. Thus, it has opted for more small scale dam-building projects which is less damaging and repair of old *qanat* and *aab-bandan*s (natural or artificial ponds) which have been destroyed in the last five decades.

Sayar-Irani and Muradinejad (2007) outline the deficiencies in the legislation on maintenance of traditional governance and hydraulic system including irrigation networks.

In Chapter VIII, we will return to the theme of bridging the gap between tradition and modern day governance of land and water resources.

Sustainable agriculture. It is paramount that to implement adaptive water allocation, the concept of sustainable agriculture has to be explored in further work on Lake Urmia basin. To achieve sustainable agriculture, cross sectoral alliances are required. The mistrust between agriculture and water sectoral governance system as well as the mismatch between the sectoral policies have to be resolved. It seems that MoE and RWCs view the agricultural sector as a challenge rather than an opportunity. It is argued that MoE should link with MoAJ to develop a shared understanding of the challenges ahead and to better recognise the dynamics of cross sectoral interactions. For example, MoAJ (2008) believes that there is little regards on behalf of MoE for many farmers who have invested thousands of dollars in new irrigation technologies and have faced investment insecurity by diverting water from agricultural use to urban drinking requirements (MoAJ, 2008*)*. In LUB for instance, a second pipeline scheme to transfer water to provide drinking for EA capital, Tabriz, is underway which means less water for irrigation in WA and Kurdistan. Business as Usual is no longer sustainable. If the allocations to Kurdistan materialise, then it is very difficult to foresee how the water transfer can go ahead.

Small dams vs. large dams. The MoE's paradigm shift towards IWRM and adaptive management has caused a friction with MoAJ on the construction of small water supply projects (small dams) by MoAJ. MoAJ (2008) believes that concentrating on large dams is environmentally and socially damaging (MoAJ, 2008). The small dam discourse has evolved due to lack of progress in supplying water because of lag of construction irrigation networks of the large dams. This discourse is based on the environmental and socio-economic services offered by small dams:

- alleviating water scarcity in droughts;
- limiting flood risks;
- providing groundwater recharge;
- stopping erosion and sedimentation of large dams;
- requiring much less investment;
- less technological complexity;
- equitable distribution and allocation;
- ensuring local participation; and
- reducing maintenance problems.

However, as illustrated in a Pakistani case study by Ashraf et al (2007), the full use of small dams are hindered by several challenges including "(i*) unauthorised water cutting; (ii) non-functional water user associations; (iii) improper maintenance of watercourses; (iv) broken outlets; (v) poorly maintained field channels; (vi) undulated fields; and (vii) lack of agricultural support services, etc.*". Building small dams without overall assessment of the water resources in a river basin context is problematic to say the least and MoE has strongly opposed to such activity by MoAJ which has been limited in scope and size in recent years due to change of paradigm shift to river basin management.

Water-Land-Food-Energy Nexus. MoAJ claims water for agriculture is inflated by the MoE. For example: much of water used for hydropower is also considered as agricultural water; in fact, the water is released but is not used in agriculture:

Water used for hydropower production is accounted as agricultural water but in practice it is not used for farming… [Source: MoAJ, 2008]

The above statement reveals two dilemmas: first, the trade-offs between water for food and water for energy i.e. water used for hydropower production. In LUB, there are no substantial hydropower dams. However, the issue of water-land-food-energy nexus is an important issue that need to be explored in further work. In late 2010, the 5th Five-Year Development Plan (FYDP: 2010-2015) was enacted with introduction of economic austerity measures centred on removing agricultural and energy subsidies. The cost of a litre of petrol has moved from $0.1 to $0.7 on average. The impact of the new energy policy on water allocation and use as well as agricultural productions needs to be thoroughly examined in re-evaluating the land and water resources plans. The financial viability of agricultural developments needs to be re-evaluated.

The second dilemma is that both sides do not agree on basic facts about water for food. As shown in Chapter VI, driven by the mistrust between the actors, the level of abstraction was overestimated and most of the errors came from almost doubling the abstraction in WA. This was also true for data on land use and potential irrigation area. Therefore, it is argued that without a shared data sets or scientific facts sustainable agriculture cannot be achieved.

7.4.4 Emerging water management paradigm in Iran: toward reflexive modernity?

Allan (2005) describes the historical development of five water management paradigms in Europe (or North) from pre-modern to reflexive modernity[9] or second modernity (Figure 7.5). Allan (2005) divides the reflexive modernity era into three paradigms: the 1980's perspective on water allocation for the environment (3rd Paradigm); the economic valuation of water in the 1990s (4th paradigm) and the IWRM paradigm which recognises the political processes as well as encompassing the other two paradigms.

There are signs that Iran is moving towards reflexive modernity paradigm (Balali, 2009). However, Iran's route is somehow different form the North's route as shown in Figure 7.5. IWRM (5th paradigm) was adopted in 2003 (see Chapter IV) and in April 2008, the Council of Ministers has approved a By-Law which states that "*the commercial value of water should be established*" by MoE[10] (4th paradigm). Article 67 of the 2005 4th FYDP established the ecological needs of the river basins (3rd paradigm).

It is argued that prescribing a similar North (European) route of paradigm change for the non-European (South) including Iran by Allan (2005) can be troublesome. To elaborate this point we consider the following concepts:

- Modernity;
- modern state; and
- the Marxist theory on the development of 'hydraulic' despotism.

The concepts of **modernity** and **modern state** which are both political in nature and Eurocentric associated with democracy and Western modern state ideals. Beck et al (2003) point out the South or non-European route to reflexive modernity can be distorted and need to be discovered:

Naturally this European constellation must be enlarged and reassessed by studying the effects of second modernity on non-European constellations, where the dynamic of reflexive modernization displays its effects not on first modern societies but rather on the distorted constellations of postcolonialism. Different non-European [i.e. South] *routes to and through second* [i.e. reflexive] *modernity still have to be described, discovered, compared and analysed.*

[9]Zinn (2007) states that Ulrich Beck coined the term reflexive modernity "*by explicitly demarcating himself from postmodern approaches which would imply that current developments go beyond modernity*:

[10]Article 3 of the By-Law.

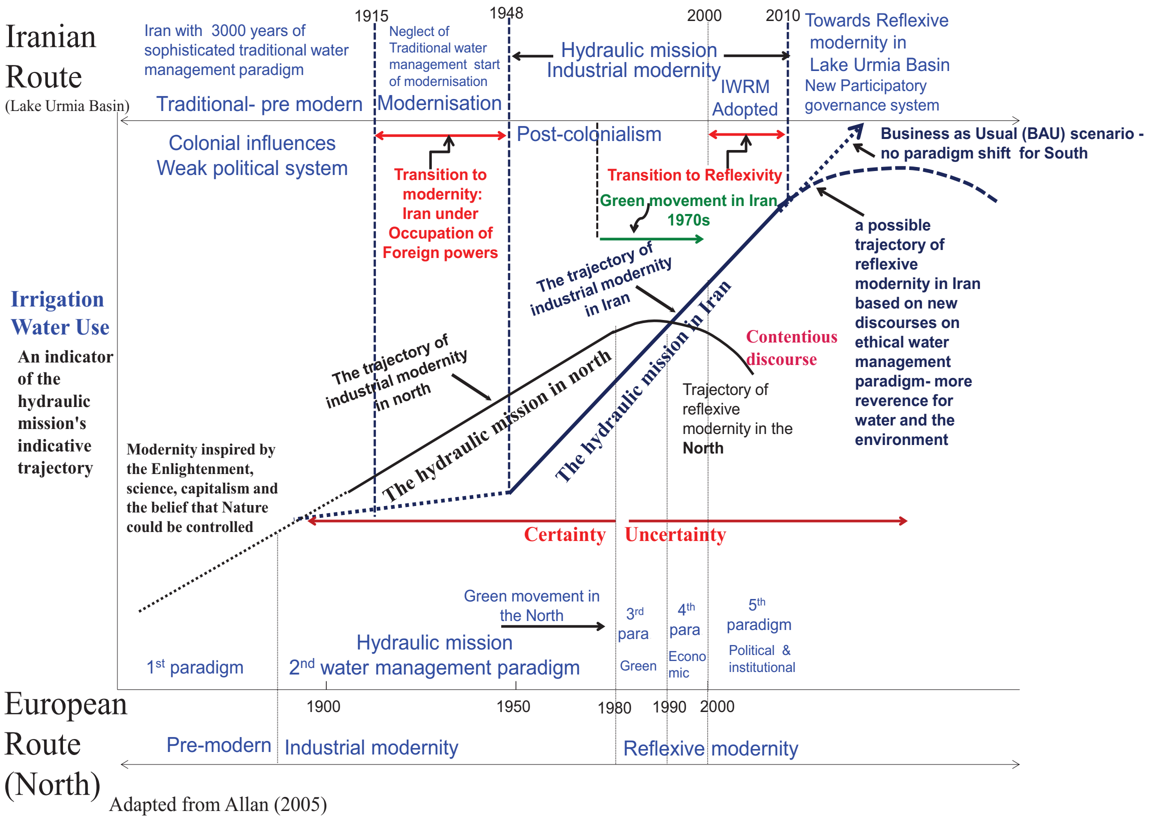


Figure 7.5: A comparison between European (North) and Iranian (South) routes to reflexive modernity water management paradigm.

Colonialism has been an important factor in shaping the non-European (South) journey to modernity and reflexive modernity. There are historical gaps or breaks appear in the transformation which is described as transitional state in Figure 7.5. The influence of modern societies (the North) on the South route of water and land management has been remarkable in the Post-colonialism. The 'hydraulic mission' and welfare state have been the backbone of the modernisation efforts and political polices of the emerging modern societies helped by Northern polices based on creating markets and jobs in the North. The South has been inspired by the notion of nation-state and modernity to create full employment and provide a good standard of living. In Iran, there is a strong belief that modernisation is required to fill the historical gaps left by political instability in the post-colonial era.

As stated in Chapter IV, many scholars believe that the modern state in Iran began with the reign of Reza Shah who started a great deal of 'modernisation' of the army and administrative institutions of the government. There are several theories analysing the idea of the formation of the modern state and these are outside the scope of this study. The start of the modern state in the west initiated with the Westphalia Treaty in 1648 (Samiei, 2007). This meant an end to the political, social and economic subsidiaries of the feudalism system. However, the beginning of modern state in Iran does not fit the pattern of historical events that describes the idea of formation of the western modern state. For example, there was not a fully developed feudal system outside Europe so the idea of a modern state is essentially a European concept and cannot be easily compared to the rest of the world.

Oriental Despotism theory is relevant to the modern state analysis of irrigational water use (our indication of hydraulic mission as postulated by Allan, 2005). The theory of the Asiatic Model of Production (AMP) of water deficient and scattered society which is given by Karl Marx in his book 'Grundriesse' (1858) was elaborated by Wittfogel's so called Eastern hydraulic (water-based) despotism in 1957 (Samiei, 2007). AMP suggests that the water scarcity conditions never allowed the formation of a true feudalist regime which is a prerequisite to the formation of the modern state by preventing the formation of autonomous economic units; instead networks of small, independent but scattered villages were formed. These required a strong central bureaucracy to provide water supply and irrigation to cities and villages in the deserts and arid/semi-arid region of the country.

The oriental despotism theory is a good description for some of the historical periods of Iran but cannot represent a complete analysis. For example, in the Qajar Dynasty rule (1722-1925), there was neither a strong central bureaucracy nor a central irrigation administration. *Qanats* were constructed and serviced by the beneficiaries and not the state. Samiei (2007) reviews several critiques of the Marxist ideas by Iranian scholars[11] whom assert that there is no strong evidence that a central Iranian State:

1. controlled, supplied or allocated water,
2. controlled or managed Iran's agricultural sector or production,
3. had a large central irrigation bureaucracy,
4. had serviced or drilled *qanats*-it was done by villagers,
5. had owned all the land- there were other types of property land tenures
6. had a nation-wide irrigation plan-it did not consider economic advantages of irrigation.

In addition, the Marxist theories did not consider the societal forces that influenced the power of states such as the weakening factor of nomadic lifestyle and the role of religious scholars. Despite criticisms of Allan's unilinear depiction of institutional change (e.g.

[11]such as A.Wali, H. Katozian, Y .Abrahamian and M.A Khonji

Balali, 2009) and the deficiency of the Marxist theory on the formation of South's modern state and the APM, these represent a partial description of the water and land governance in Iran.

There is a cause for optimism: as there are many signals illustrating that Iran has entered a transitional phase towards reflexive modernity as illustrated by the Lake Urmia case study. The institutional (policy, legislation and administration) evolution or changes have shown that since 1970s, Iran is moving towards sustainability in terms of water and land management (see chapter IV). Iran was actively involved in the 1972 Stockholm Conference on the Environment. In 1974, DoE was established and the 1974 Environmental Protection Act was enacted. Environmental conversation and protection have been endorsed in the Article 50 of the 1979 Constitution. Since 1999s, the institutional fluxes have been driven by the IWRM paradigm.

7.5 Revised Responses: *institutional re-design for resilience and sustainability*

From the analysis in Section 7.4, it seems that a dual approach has been taken by simultaneously enforcing 'top-down' and participatory bottom-up approaches. This imbalance has to be redressed. The professionals and experts (hidden actors) within ministries have been instrumental in keeping the status quo i.e. top-down approach of management. According to Beck et al (2003) the first modernity has restructured social knowledge by (1) devaluing "*experiential and occupational knowledge*" and (2) enhancing the status of the theoretical and supervisory knowledge which has resulted in "*the creation of a hierarchy between experts and laymen which was grounded on the monopoly of knowledge by professionals*". Therefore, participation of civil society is not yet welcomed. This has to change if participatory decision-making to be institutionalised in Iran.

In this section, first, the factors which affect the interplay of the actors in the decision-making process are discussed to revise the design principles used in institutional reforms. Secondly, the implication of adaptive water allocation strategy is discussed.

7.5.1 Rethinking design principles:

As stated before, the design principles postulated by Ostrom (2005) are not blueprints and it should be able to deal with factors influencing the interplay of actors in the decision making arena. The Water allocation process described in Chapter VI points out to certain factors which have been influential in the decision-making. In the following part of this subsection these are introduced.

Mistrust. The community of stakeholders in the water sector has been characterised by mistrust. This was clearly illustrated by the lack of trust about data provided by the stakeholders. Data uncertainty and mistrust continued even after the decision made in the 6th WAWG meeting. The process required arbitration in addition to the negotiation. The author for example has acted as an arbitrator to diffuse disagreements on specific issues related to the MCDA approach. Therefore, fostering trust among actors is of paramount importance to the long term sustainability of the MSPs.

Lack of shared understanding. Knowledge uncertainty played an important role in shaping multiple and parallel discourses on water development policy, droughts and climate changes and the level of mistrust prevented the convergence of perspectives among the actors. Therefore, Lake Urmia issues were neither well defined nor well understood. Most of the actors have transposed and transformed a simple discourse into strongly held meta-beliefs which has caused the polarisation of opinions.

Lack of shared vision and mutual interest. There was a disparity in the provincial priorities e.g. EA was content with its level of development and have achieved most of its plans whereas WA and Kurdistan wanted to build more dams and catch up with “wasted opportunities”.

Greater choice of management options. The participants were not just happy about saving the lake but wanted to have more policy options including implementing structural and non-structural Responses. For example, ‘saving the lake’ was considered as one of the management options. Therefore, the demand management proposal in the 2010 NEC Bylaw has to be streamlined with local development drives. The Bylaw offers incentives for water saving activates. For example nearly $US5,000,000 has been allocated for Water use efficiency projects to be implemented; in the process 50% of the cost of upgrading irrigation technology (20,000,000 Riyals= US$2000) per ha to be given to farmers; and the other 50% to be provided by bank loan facilities. Based on the results from the ISTA component (Chapter VI), water demand management approach has to be a key to any strategy for sustainable water use in the basin.

Equity and intrinsic rights. Actors wanted to safeguard the ’intrinsic rights’ of their respective provinces in allocating water shares. They wanted to secure the maximum possible share of water resources.

Political support. The momentum of the meetings was kept by receiving the highest political support possible from the office of the President and First Vice President. The political commitment to institutional change or the political temperature has to be kept high. Implementing IWRM in SESs requires a strong political well that starts the process. The implementation of the EMP in Lake Urmia was sanctioned by the 67th Article of the 4th FYDP without which the whole process would not have started.

Ability to craft rules at local levels based on principle of capacity development is required. This entails empowerment of actors and the enabling Environment for cooperation and trust as well as education and knowledge acquisition. The tenacity of provincial actors in negotiating their way in the first ever experience of MSP in Iran, and their capacity to analyse a complex situation hearten and inspire those who support 'community-based or bottom up' governance system. With a careful capacity development as described earlier, local actors were able to see a wider vision than their local interests. They did not question why 3100 MCM of freshwater should be delivered to a salt-lake. The disparity among the communities and the equalities in terms of sharing benefits were more controversial. The actors who were involved in the WAWG process went through a learning curve and they become closer at the end. The process was hijacked by the outside actors who did not understand the process. They could not see the benefits of sharing godly given resources. Jabbari (2011) asks for a capacity development to introduce the process to the wider institutional sub-system of the water and land resources system. The political forces (MPs, governors and so forth) need to be educated about the process.

It is argued that the re-design of the governance system in LUB is not a sign of total failure. After all, institutional designs and rule changing should be viewed as experiments (Ostrom, 2005) and since the socio-political and environmental and ecological setting are changing, we can assume that "*no specific set of rules will produce the same distribution of benefits and costs over the time*" (ibid, p.255). Ostrom makes a valid point that institutional design is not an absolute science as we have limited but growing knowledge of the complex interactions of various rules and policies to result in outcomes. However, we are not "*hopeless*" to design institutions to enhance the performance of complex ecological commons systems (or SESs).

It is most interesting to note that the empirical findings of this research support what Imperial (2009) found in his study about IWRM and rational choice literature. Imperial notes that for large river basins (such as LUB) with complex resources systems additional design principles are required as follows:

1. Development of trust across organisations

2. To Develop shared definition and understanding
3. Recognising mutual interest
4. Balance of power among stakeholders
5. Wide range of policy instruments (management options)

Finally, it is argued that we have to create structural mechanisms to bring in to the picture of the issue of unauthorised abstractions which will be discussed in the next sub-section. Therefore, the new intuitional reform (revised Responses) should recognise all the factors mentioned in this section.

7.5.2 Establishing adaptive water resources governance

This part which deals with the implication of adaptive water allocation strategy on the institutional reform is complementary to the previous section. The effectiveness of the EMP might be enhanced by a strategy (i.e. revised Responses) which can have the following elements:

(a) Collective Choice Arrangements. Most of the participants felt that community-based water and land governance system can help to achieve the objectives of water allocation strategy (Appendix A, Table A1.4). There is little knowledge about the watershed and farm level management: e.g. water may not be delivered to the lake if it is consumed illegally (i.e. unauthorised use) or informally on the way to the lake. Local political support is needed and so the representation should be enhanced by including civil society and NGOs. In addition to linking the current institutional setup to existing MSPs such as water user associations (WUAs), incorporating local nested enterprises by recognising the informal institutions and their knowledge systems seems to be necessary to implement the EMP. Bringing the informal institutions into the formal set up can be achieved gradually through the social learning processes and adaptive management practices.

(b) Monitoring is non-existent. Monitoring system is required not just to monitor water inflow into the lake, but also to reflect the adaptive nature of water allocation under different climatic conditions. Monitoring system can be part of a Drought risk management (DRM) plan which is an integrated part of the EMP and should be seen as a major component which has a bearing on water allocation among provinces and different uses and sectors. Therefore, DRM plan is an IWRM plan in the condition of droughts and have five constituents: (1) a drought mitigation plan before the drought; (2) a crisis plan during the drought; (3) an emergency state plan during severe and long term drought; (4) monitoring system and (5) forecasting and public information system which include education programmes as well as research

In addition, the monitoring system requires investment and therefore, it has to be considered in the financial plans. Most of the participants felt that monitoring should be done by an independent organisation.

(c) Revising the EMP. The EMP understandably concentrates on LU's water rights and its management. However, EMP's scope has to be widened to consider the whole basin based on river catchment governance. The EMP has achieved its goal to put Lake Urmia's water rights on water resources planning map. But now it has to be streamlined with river basin planning which require a wider vision.

(d) Graduated Sanctions. Ostrom (2005) reports that many self-organising system use graduated sanctions against those who break rules. Involving farmers in the collective choice arrangements (i.e. decision-making process) may enhance mutual monitoring and better compliance. So far this element has been missing from the institutional reform. Informal or unauthorised abstractions have been highlighted in the 3rd and 4th NEC Meeting Directives. This level of monitoring is very difficult to police. Therefore, it is argued that smaller watershed units should be considered in the institutional design as there are about 31 river catchments in the basin. This level of monitoring requires community based water and land governance. This theme will be discussed in Chapter VIII in which a revised Response is proposed by considering community culture and ethics as a basis for the governance system. It must be stressed that the revised Response will not be analysed and postulated for future research.

7.6 Concluding remarks: towards Ethical decision-making

Based on the detailed analysis, the major issue is to understand how community participation or community-based governance can help the adaptive land and water management in Lake Urmia basin i.e.(a) how to create a culture for the wise use of the limited and scarce resources? How to deal with the issue of informal and unauthorised abstractions and (b) how to ensure compliance?

It has been argued that community belief systems and culture can be used in an institutional context to create a culture of self-organising governance system that not only use but also conserve the resources. It was shown that IWRM requires a high political support to be initiated but to implement the decisions, local informal institutions may play an important role. Turner et al (1998) argue that the issue of environmental problems can not only have technical or technological solutions but require considering ethical systems. Therefore, it is required to consider how community belief systems can be used in this process.

As an Islamic Republic, Iran takes its Constitution from the Islamic principles '*sharia*' as in Article 4 of the Constitution. Therefore, one of the important issues is to understand whether Islamic beliefs are compatible with IWRM.

The political inquiry about Islam and democracy has been the subject of research and study by many researchers including Gudrun Kramer (1993) who makes some scholarly observations. Kramer (1993) concludes since government is a matter of convenience and mere technique, then democracy or elements of it such as pluralism (within the framework of Islam), political participation, government accountability, the rule of law and the protection of human rights can be adapted and even become mandatory. Water management reforms (i.e. water policy, law and administration) can take place from the *Sharia* perspective since it is part of transactions aspects of Islamic legal theory. Thus, As Kramer suggests, it can be reformed on different models outside the sphere of Islam and adapted even from non-Islamic concepts such as IWRM.

Faruqi et al (2001) conclude that Islam relates to IWRM and sustainable development concept very well. Beaumont (2005) believes that it certainly includes all the concepts for a sustainable management of water. The new theory as put by Larijani (1993, 1994) asserts that reaching postmodernism (reflexive modernity) state is a national goal or vision: "*The Islamic society can be a comprehensive modern society fulfilling the criteria (e.g. authentic and technical rationality) of modernity*" (ibid, p 41). '*Islamic rationalism*' as postulated by Larijani (1995, 1998) can offer four bases for water and land governance:

1. **Legitimacy**. It provides a framework for legitimacy. This element has been a problem in modern history of Iran. The framework has an ethical dimension: we can reach a goal not only with the best mean but it has to be legitimate (ethical).
2. **Transparency, accountability and distribution of power**. A community orientated government which adheres to Islamic rationalism- the government is recognised as a legal entity, its efficacy is the measure of its legitimacy.
3. **Participation.** The formation of an organised civil society enhancing participatory approach or functional democracy as described by Larijani.

4. **Environmental protection**. Civil tolerance or freedom should be exercised with responsibility. The 'no harm, no injury principles open the door for governmental intervention and to implement laws which might restrict peoples freedom of actions; especially with relation to the environmental issues.

Community-based approach should not be a recipe for chaos but the community knowledge systems need to be bridged with modern principles of conservation and sustainability to facilitate the involvement of local actors by widening their perspective to move away from territorial thinking into a basin-wide thinking.

Hanberger (2003) notes that (i) the erosion of public confidence together with (ii) complexity of the issues have made it difficult to actively address pressing social problems. Thus, according to Larijani's theory, under Islamic guidance, water policymakers can legitimize their policy. Complexity is associated with implementation of legal codes (whether secular or Islamic) to resolve conflicts. The question of legitimacy is a profound issue and assertion of moral (Islamic) codes to agreed universal principles may create a new dimension in the implementation process.

Participation which is the cornerstone of IWRM can be found in the Islamic Principle of '*shura*' (or consultation) which provides a strong basis for human participation based on ethical values. Prophet Muhammad is ordered in the Holy Quran to "*consult them* [i.e. the companions] *in all the matters*" (3:159)[12]. This clearly shows the fallacy of some opinions that associate Islam with allowing only the divine rules. The word 'them' means the whole community and cannot be narrowed to a particular group. Not just scholarly consensus is valued but community involvement is an essential prerequisite for any policy and law making as given by traditions from the Holy Prophet."(Khallaf, 1977: 47; Keller, 1997: 24-5):

My community shall not agree on an error"; "Allah is not wont to make my community concur on misguidance"; "That which the Muslims consider good, Allah considers good"

Based on the above argument, the role of cultural values and belief systems in attaining land and water good governance will be examined in Chapter VIII by proposing an Ethical legal framework for community- based land and water resources governance systems.

[12] The community is also asked to consult each other: "*their affairs are conducted by consultation 'shura' among them*" (42:38)

Chapter VIII. An Ethical Legal Framework Towards Good Governance: A Community-based Approach

8.1 Introduction

Lake Urmia case study is a classic example of common pool resources conflict which has resulted in overexploitation of natural (water and land) resources and subsequently created environmental degradation. As shown in previous chapters, to implement the Ecosystem Management Plan (EMP) in LUB, a strong political commitment is not enough to deliver water to Lake Urmia. Water allocation for the Lake will be only on paper if (1) the current development programs go ahead; (2) the current informal or illegal abstractions continue and (3) no water demand management is taken. The key to a successful implementation is getting on board the agriculture sector which consumes 94% of the total usage.

The inter-provincial conflicts, diverse ethno-religious perspectives, politics of irrigation and the "*hydraulic mission*" have created an environment of mistrust. With no monitoring system and polarization of opinions among decision-makers at national and basin levels, delivering the required water to the Lake is almost impossible. The pace of the multitier participatory decision-making has been slow. The impacts of lobbying groups and hidden actors have been registered in the inability to reach agreement on time. Despite fostering evidence-based decision-making, the empirical scientific evidences were ignored in the water allocation.

The participation process has been inadequate for the following reasons:

1. The real actors (i.e. farmers) have been overlooked: informal and unauthorised water users who made an informal rule of abstraction for generations. This has been acknowledged in the 2011 Directive of the 3rd and 4th NEC meetings. Farmers are not the only monsters of this environmental catastrophe. Perhaps they are a victim of a legacy of unsustainable land use polices. Most farmers have made a great deal of investments in pumping and irrigation technologies. They feel insecure and vulnerable and have a great deal of financial debts and little choice but to continue with irrigating and developing:
   Major problem of the water [sector] is that 70% of the [available] agricultural water is from wells, qanats and springs and 30% from

surface waters. Nevertheless, 95% of the governmental investment is on surface waters. Surface water consumption efficiency is far less than groundwater consumption rate (MoAJ, 2008)

2. Provincial stakeholders have been elevated to basin-wide actors whom at most times could not break from their provincial ties. There was not a sense of belonging to the new multitier Multi-stakeholder Platforms (MPSs).

There is a great of deal empirical evidence that community based approach to natural resources management has been effective in deal with common pool resources such as water and forests e.g. Ostrom (2005) make a summary of tens of case studies that self-organising nested enterprises have been able to monitor resource use; thus the presumption is that the cultural and ethical values together with respect for informal institutions can bring about change in attitudes and cultures.

In the water allocation process described in previous parts of this thesis, the importance of culture and belief systems have been acknowledged - In addition to socio-economic and political realities, cultural and ethical discourses need to be considered in a strategy based on multi-stakeholder participation. Anthwal et al (2010, p.969) conclude that:

Religion and belief should be respected before declaring them odious, as they have an important role toward the conservation of the natural resources that sustain the biospheric life support system (ibid, p.969)

Hence, institutional strengthening is not enough without considering the cultural and ethical perspectives in the capacity development.

Therefore, the aim of the chapter is to bridge the gaps between tradition (religious, cultural, etc.) and modern land and water governance systems and to explore the potential role of belief systems in achieving good governance (see Chapter II for the definition of good governance). The intrinsic link between land and water has been acknowledged by many scholars such as Calder (2005) thus, the term 'land and water' is replaced by the term 'natural resources'. In this chapter, the Principles of *Hima* which is a traditional community-based natural resources (CBNR) governance system is used as an entry point to develop an Ethical legal framework for CBNR governance system for West Asia and North Africa (WANA) region including Iran.

WANA countries including Iran have a predominantly Islamic common heritage, culture and religion. Therefore, it is reasonable to consider Iran within WANA region as a case study to assess the application of predominately Islamic ethics by developing an Ethical legal framework. The Islamic legal theory describes land and water resources as natural wealth of the community.

In the next section, the attributes of the case area is briefly described followed by the methodology in Section 8.3. Then, an overview of key Islamic concepts is given in Section 8.4. Next, the Islamic legal theory is outlined in Section 8.5. The principles for *Hima* CBNR governance system is described in Section 8.6 followed by the applications of the framework in LUB case study (Section 8.7). Finally conclusions are made in Section 8.8

8.2 Contextual setting

WANA region (Figure 1.1, Chapter I) is characterised by environmental degradation and resource depletion. There is an emerging discourse that the destruction or depletion of the natural resources occurred by concentrating on economic developments and leaving cultural, ethical and institutional aspects behind (WANA, 2011; p26). The problem has been aggravated by lack of good governance and a gap between ruling elites and the people. Water scarcity is one of the major issues that threaten the security and the well-being of the region. There are trans-boundary resources (oil, water etc) that require regional policymaking mechanisms. For example in Iran, the implementation of so called ‘short term ‘Development Plans’ using revenues from oil and other non-renewable resources threatens the long term sustainability of the nations and will cause socio-economic decline (Chapters IV and V).

The WANA action arena is a complex system of nested enterprises within diverse communities and cultures and mainly characterised by disunity and fragmentation, lack of regional cooperation, social unrest, disintegration and segregation. The main assumption is that the ‘common good’ values can be the basis of a shared vision on natural resources sustainable use and conservation. The new action situation is regional policymaking process on water scarcity and revival of an ethical CBNR governance system in WANA region.

8.3 Methodological approach

Basic definitions. In order to understand the institutional role of Islamic principles in natural resources governance, there is a need to define the meaning of *Sharia* and *Fiqh* and there is a need to differentiate between them. *Sharia* (which literally means a waterway or path) is the Islamic principles framework which is unchangeable and unquestionable in terms of religious enquiries. But *Fiqh (literally meaning wisdom)* is the human comprehension of the *Sharia* and is a collection of human opinions (*fatwas*) and judgments i.e. it is a set of legal codes. Islamic legal theory[1]or jurisprudence provides the mechanisms for drawing legal codes from *Sharia*. The word 'Islamic principles (IP) and 'Sharia' are interchangeable throughout this chapter. The Objectives (*Maqasid*) of Sharia which we refer to it as the *Maqasid* model, is the Islamic vision of human development, prosperity and wellbeing. This describes the relationship of human with its environment.

Referring to Chapter III, Islamic legal theory provides three categories of rules namely principles, norms and strategies. The instructions (directives and guidelines or operational rules) can be deduced based on the three main categories. In Chapter VIII, a proposal is made to use Ethical legal framework for *Hima* CBNR governance system as part of revised Responses based on the three levels of rules as shown in Figure 8.1. As noted on Figure 8.1, Chapter VIII describes the proposed Ethical legal framework; hence it is only a proposal and should be tested in future research.

The approach. This chapter fulfils Objective 6 of the research (Chapter I) to use Islamic Ethics to develop the principles and legal framework for *Hima* CBNR Governance system. The assumptions and the rationale for this chapter are given in Chapter III. The methodological approach to achieve the above aim is as follows:

[1] It is called *Usulol-Fiqh* or Principles of *Fiqh*

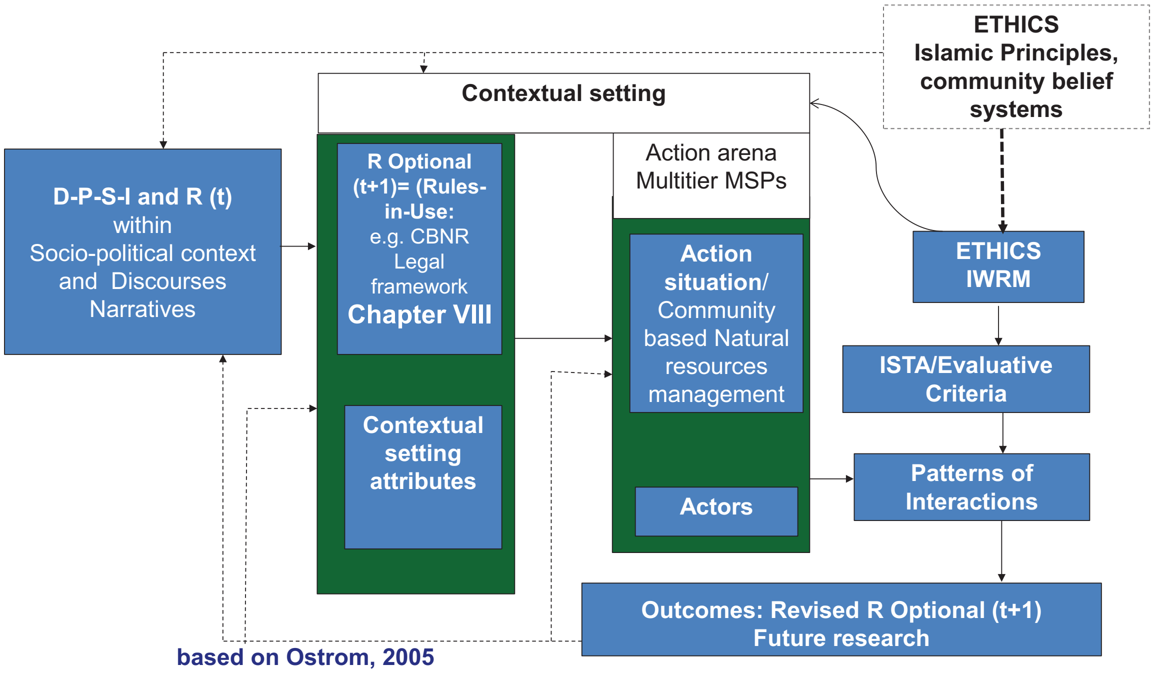


Figure 8.1: Optional Ethical component within the focal level of analysis

1. To make a Historical analysis (evolution) of land and water management practices in Iran within a cultural context; the reason for taking Iran as a case study for the historical analysis is two folds: (1) looking at ancient history of Iran has an advantage since the ancient Persian empires ruled over a vast area of the WANA region maintaining laws and customs of those nations (e.g. Ravandi, 1975); thus, Iran's cultural heritage is not extraneous to the region and (2) Iranians have greatly contributed to the Islamic civilisation and history. The historical analysis is from the start of Islam till 1909[2].
2. To show the relevance of the *Hima* concept to contemporary CBNR systems by zooming into the evolution of the *Hima* concept and its chances for revival.
3. The *Maqasid* model is outlined as basis for ethical principles of *Hima* governance. This will provide a vision and a strategic framework for *Hima* governance
4. Principles of Islamic environmental ethics are outlined to form the basis for the Ethical legal framework for *Hima* governance
5. Islamic legal theory will be described as a mechanism for policy/law-making appraisal.

[2]In Chapter IV, the evolution of modern water and land governance in Iran from 1909 till present day has been presented.

6. The framework for *Hima* governance will be outlined based on (1) to (4).
7. Based on (6), a proposal is made to revive the *Hima* concept in WANA region.
8. The potential application of *Hima* governance system for Lake Urmia basin is also assessed.

8.4 An overview of key Islamic concepts

8.4.1 Land and water inter-linkage: evolution of natural resources governance

The rise of Islam started in 622 when Prophet Muhammad (d. 632) went to *Madina* (*Yathrib* as it was called) establishing a new Abrahamic religion and subsequently a simple administration. The administration was governed by '*Al-Wathiqa*' or '*Dastor*' [meaning the Document] and known as the first Islamic state Constitution outlining the relationship between different people in *Madina* (e.g. Berween, 2003; Ahmadian, 2002; Shalabi, 2003).*Al-Wathiqa* (Provision VI, clause 2)defines *Yathrib* as a sanctuary (*Hima*) conservation zone. *Hima* is a land use zoning concept which literally means 'protected zone' and refers to a pre-Islamic practice in the Arabian Peninsula. However, Islamic principles revived the *Hima* concept to incorporate conservation and environmental protection principles as well as supporting sustainable livelihood and social justice (Section 8.4.2). Later the *Haram* land use concept was introduced: *haram* (*harim*) sanctuaries are to be used for protection of groundwater sources and stop overexploitation and conflicts among well owners.

The adaptability of Islamic doctrine and the pragmatism of its approach had been historically noted by Wilkinson (1990): "*the Islamic State kept customary laws regarding water and land practices from earlier Byzantine, Roman, or Persian codes*". For example, the traditional "*Tumar*" code of water allocation based on pre-Islamic customary laws for irrigation on the River Zayandeh in Esfahan survived until the early 20th century (Lambton 1998).

Land reforms at the time of Umar bin Khatab(634-644), the second Caliph, revolutionised the economy of the emerging Islamic State by giving private land ownership to farmers based on the Islamic principle of *Ihyaul-amowat* (bringing life to dead land) converting neglected and dry lands to irrigated lands which brought about immense wealth and prosperity unknown during the pre-Islamic era. Water institutions and laws were established as a sub set of *"the laws and practices subsumed under land management"* (Wilkinson, 1990). Umar introduced the principle of cost recovery with a new tax: a 10%

tax was levied against agricultural products and established Tigris and Nile Irrigation Departments. Also, a 69 miles long navigation canal was built connecting Nile and Red Sea with the main purpose of irrigation.

Umar also declared natural resources (grazing and forestry) as well as water as common property [3](Faruqi et al, 2001, Izzi Dien, 1990, 1997; Azmi, 2002). Also, private water ownership was recognised and limited to waters in containers, reservoirs, wells, qanats (aflaj, Kariz etc) and small pools or ponds within private lands (Ahmadian, 2002).

A new urban land use policy emerged at the time of Umar which had a bearing on water resources system. For example, Ahmadian (2002) recalls that in 635, Umar ordered to build Basra City and to divert a canal from River Tigris for water supply of the city by employing Iranian architects and Roman engineers.

Ali (656-661 AD), the 4th Caliph[4], introduced a policy document[5]on governance issues including agricultural policy, land tax (kharaj) (Lambton, 1998; Rahbar, 1985, 1987). Ali envisaged that the taxation should be based on different land conditions and water availability. He wrote that the State can impose land taxes but can give incentives (tax reliefs) in certain cases: if the overall tax burden is high, crops suffer from disease, water shortages, drought conditions, flooded lands or water logging as well as land degradation. In fact, he refers in a way to sustainable development and links it with prosperity, social justice and eradication of poverty.

During a stable period of the Caliphate Era (661-1258) many fiscal and administration literature were produced which contained consolidation of previous practices and cases of land and water resources development strategies (e.g. Azmi, 2002) which are given in Box8.1. Notably, institution of *Iqta* or land grants was legally established to promote agriculture in lands without owners (common pool resource).

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[3] This refers to a prophetic tradition narrated by Abo Dawood, tradition number 3470: *Muslims have common share in three [things]: grass (pasture), water and fire (fuel)* (Faruqui et al, 2001; p. 2).

[4] Ali is ideologically considered as the First Imam and the heir to Holy prophet by the Shiite branch of Islam; we take his legal status as the 4th Caliph which is accepted by both the Sunnis and Shiites.

[5] The famous 'Letter' to Malik Ashtar, the Governor of Egypt,.

The first ever book on groundwater hydrology appeared around 1017 written by *Al-Karaji*, called ‘*Withdrawal of Hidden Waters*’ (Al Karaji ,1966). He dedicated two chapters on legal boundary (*haram*) of *qanants* and wells: the first chapter is according to Islamic principles and the second chapter is according to geo-morphological condition of the land (soil types). He has differentiated that some *haram* or boundary need to take into account not only *Fiqh* but also scientific considerations.

Box 8.1: Land and Water development strategies during 661-930

- Leasing state lands with free holdings on water courses to generate revenue for the treasury
- Private ownership of lands through *Ihyaul-amowat , revival of dead land,* policy
- *Hima* land use system for sustainable resource use
- *Haram* sanctuaries for groundwater protection
- Promotion of agriculture through land grants or Iqta’ (un-claimed land).
- Provide loans for land regeneration and cultivation
- Taxation system based on fertility of land, types of crops and irrigation system; e.g. 10% tax on irrigated lands from canals
- Tax relief or ‘zero tax’ for ‘infertile’ lands, flooded or drought conditions.
- Dams and water locks to be built by the state: tax for dam building projects are allowed if necessary.
- Welfare tax is allowed to carry out social programmes according the economic climate.
- Central treasury to pay for building canals and waterways
- Central treasury to pay for embankments of rivers to avoid flooding
- Help with famine victims and poverty eradication.
- State responsible to remedy drinking facilities in the cities and water supply to urban dwellers
- Private canals should be cleaned and maintained by the owners.
- Voluntary sector to be involved in public finance e.g. *waaqfs* (endowments); public borrowing was allowed in water related projects.

During this period, three main intellectual lines of thinking about land-use policy (agriculture) were developed: (1) *Nizam al Mulk* ‘s social charter for the welfare of farmers based on equity and justice (Nizam al Mulk, 2002); (2) *Ibn Khaldon*’s a social cohesion and integrity policy based on eight-dimensional development model with general, historical heritage, geographical, social governance and governmental (political), economical (exploitation & consumption) and cultural (thought) aspects. (Ra’ad, 1993; p. 22); and (3) *Najmaddin Razi*’s (d.1247) spiritual (*Sufi*) discourse on ethics of farming:, in his famous book ‘*Mirsad al Ibad*’; narrating from Prophet Muhammad that a farmer who plants a seed or cultivates land will get a reward if creatures like birds and wild animals eat the by-products. The farmers' main mission is to conserve God's bounties including the entrusted land (Razi, 1982).

During Medieval Islam (1258-1500) which started after the Mogul attack and fall of Baghdad in 1258, the Islamic world went into a socio-economic and political recession. Feudal system of land ownership was widespread and continued till the land reforms in

1960s (see Chapter IV). However, there were some enlightened cases as Lambton (1998) recalls that at the time of *Ghazan Khan* (1295-1304) there was a distinct agricultural policy. One of the major reforms was to tax the farmers according to their ability to pay as well as introducing legislative reforms to stop bogus claims on lands by powerful elite (Razi, 1983; p. 326-7).

The Safavid dynasty (1500-1722) was influenced by the Ottoman practices for their land property system (Sabbagh, 1999). The state lands were classified into four categories (Sabbagh, 1999): (1) Crown land known as *Khassah*; (2) *Siuoghal* lands (or '*Iqta*'') was given to powerful families and crown court members; (3) *Tiuol* lands, a temporary allocation of land to state officials as part of their annual salary; and (4) *Mamalik* land: which was given to provincial service officials and local governors. There was an attempt to reform and change the land division practice which faced resistance from powerful elites (Sabbagh, 1999).

During the Qajar Dynsty (1722-1925) traditional water resources management system, i.e. the *qanat* system, was in a desperate condition. Attempts to renew the *qanat* systems were hampered by mismanagement at all levels of government (Ettehadieh Nezam-Mafi, 1993). Water rights were noted to be separate from land rights (Afary, 1991; quoting from Lambton, 1969). IRNCID (2005) shows purchase documents of water shares; these had been as part of land or individual water shares sold in the period 1790-1956 in *Na'en* City. Private water rights had been in practice without any religious or political hindrances.

The Constitutionalists movement (1905-1909) tried to dismantle the feudal land and water property system. This is illustrated by buying the land and water rights of the *Baharestan* building which is the seat of Iranian Parliament (*Majlis*) during the second term of the Legislative council (1909-1911) from the heirs of *Mirza Hussein khan Sepahsalar* for 500 *Toman* with 10 Toman registration fee (Shahrokh, 2003). The reform succeeded to produce the Civic Code which was based on Islamic principles and was similar to the Ottoman's *Macelle*[6]. The *Civic Code* (was revised in 1989) contains implicit references to private water rights and an awareness of land and water relationship.

8.3.2 Hima approach: community based natural resources governance system

In the tribal power set up of the Arabia, *Hima* zones (as described earlier) were almost exclusively used by powerful tribes and elites within the tribal communes. Islam

[6] In 1870, the Ottomans produced a Civil Law document called *Macella* (the Gazette). This was the first version of modern Islamic law.

brought an element of social justice to the *Hima* concept (Draz, 1969). Islam provided a legal and institutional framework to establish *Himas*. In Arabia, *Himas* were mainly used for pastoral activities and the new governance system encompassed conservation and biodiversity principles in terms of allowing for rangeland regeneration and water management during droughts (Bourn, 2003). Abu Izzedin (2004) asserts that *Himas “played important roles in restoring rangelands, stabilising and controlling nomadic grazing, indicating rangeland potential, animal husbandry, the management of water catchment areas, and the protection of biological diversity*”.

In governance terms, *Hima*:

- has to be institutionalised by a legitimate authority
- is a common property which provides rights and benefits with no exclusive rights
- is based on equal access to natural resources for sustainable livelihood
- is a CBNR management approach that fosters shared responsibility among the community.
- use rights can be prohibited or restricted if needed
- can be used as a conservation zone; the first *Hima* sanctuary was declared was a “*strip of 12 miles-wide around Madina City*” (e.g. Muinul Islam, 2004; Al-Mawardi, 2004)

As a usufruct system of property, *Hima* institution had a broad legal mandate to promote beneficial use of the ‘protected zone’ (Abu Izzedin, 2004). A controlled (restricted) right use ensures conservation. Islamic legal framework also recognised that a social institution needs to apply socially accepted sanctions depending on the cultural context of the *Hima* community. So, for example, the meaning of equitable distribution or access was determined by the community (Abu Izzedin, 2004). This provided a flexible legal framework which allowed those who are affected to modify it according to local knowledge. For example, *Hima* communities were able to make boundary and position rules as required in time and place.

Himas have been practiced throughout the Muslim World and sometimes under different local names (Kilani, et al, 2007; Abu Izzedin, 2004). *Hima*-style traditional natural resources management has been reported outside the Arabian peninsula and WANA region; for example in Kenya (Wishitemi and Okello, 2003). Tiwari et al (2010) report about a sophisticated *Hima* governance system in Northern India comprising of a territorial area, a political local institution and a community of several villages. The *Hima* approach has been providing welfare for the community, management of natural resources and control over a territory. It is worth mentioning that *Hima* land system was part of the land taxonomy in the Sokoto Caliphate, Nigeria enacted in 1810 by Abdulahi dan Fodio (1766-1828), the Sultan of Eastern part of present Nigeria (Barau, 2009). In Indonesia, the *Hima* is commonly used in forestry resource management. (Bhagwat et al, 2011).

The disintegration of traditional land rights in the last centuries and nationalisation of the natural resources by central governments have been a global trend. Since the 1950, there has been a decline in the number of *Himas* in WANA region (Bourn, 2003). For example, in Kingdom of Saudi Arabia (KSA), there was 3000 *Himas* and this number has dramatically reduced (Abu Izzedin, 2004)) bearing in mind that in 1953 the *Hima* system was abolished due to territorial conflicts among tribes and governmental settlement policy of the nomadic communities, technological changes and better living standards in the cities (Al-Hathlouland Edadan, 1993). Al-Shayaa et al (2007) asserts that creating protected areas in the KSA did not stop over utilisation of the resources. They note that there has been "*confusion between the principles of the Hima systems and the laws of the reservation modern administration*" (ibid, p.125). Al-Shayaa et al (2007) make an important observation: the participation process failed due to lack of a clear position rule to define the role of participation of the local people. In addition, they recommended that training is needed for conservationists of how to deal with local people. But, Sillitoe et al (2010) noted that there has been a problem to accommodate local views by policymakers and researchers and managers.

The revival of these traditional knowledge systems to natural resource management has started in more recent times such as the 1990s HIMA project in Tanzania (Minja and East, 1996) which aimed to revive the community-based management of the natural resources. Gladstone (2000) describes a project based on *Hima* systems: he defined 6 types of *Hima* zones in the Red Sea marine protected area of Farasan Islands, KSA based on their biophysical characteristics and management objectives: sustainable resource use; biological, natural, special natural and recreational *Hima* zones.

FAO (2009a) calls for the incorporation of *Hima* in the forestry management and noted the quasi-religious force of *Hima* prescriptions. In 2000, Mauritania enacted '*Code Pastoral'* to revive nomadic rights to common property based on Islamic legal theory which has been described by Wabnitz (2009) as an adaptive, effective legislation.

According to Wabnitz (2009), the *Code pastoral* builds on Islamic law and has effective self-executing conflict resolution procedures and recognizes the Islamic *Hima* principle of use rights instead of exclusivity and ownership rights.

The traditional communities have been much influenced by the of socio-economic Driving forces and so their outlook and knowledge has changed and so applying traditional knowledge systems is not as straightforward as it sounds (e.g. Sillitoe et al , 2010); the tide of modernity has change perceptions and *Hima* might not be wanted in younger generations in its primitive nomadic form. We need to understand the informal (traditional) institutions in order to be able to revive the concept in the modern settings. Institutional analysis is an important part of the strategy. It is interesting to note that Colding et al (2003) reports that Bennet (1990) argued early anthropologists did not believe that traditional (informal) institutions existed in traditional communities; nevertheless, the recognition of the importance of "*informal institutions in sustainable resources and ecosystem management is on the rise*". That is why the *Himas* seems to be relevant in modern times.

8.3.3 Islamic Vision on human development: 'Maqasid' model

The concept of human development is defined by HDR/UNDP (2006) as "*first and foremost about allowing people to lead a life that they value and enabling them to realise their potential as human beings*". To achieve this goal, a visionary framework is set out in the Millennium Development Goals (MDGs). The objectives are to reduce "*extreme poverty, extending gender equality, and advancing opportunities for health and education*". So this internationally agreed set of time bound goals centres around human wellbeing.

The Islamic worldview (ethical principles) on development have five main components (see Chapra, 2008, Ahmad, 1994, Khallaf, 1977 among others):

- Unity of God '*tawhid*' denotes both the divine relationship with humans andthe societal interactions
- Message' *Risala*' of Prophets providing guidance for interactions
- Vicegerency' *Khilafa*' of humans which brings accountability to the positions held in all action situations
- Refinement 'Tazkiya' of spirit which an indicator of human development
- Day of Judgement '*Akhira*' which is about how humans utilised the resources provided by God.

The Islamic version of human development based on the above worldview is very much comparative and consists of five compulsory or essential *Maqasid*[7] as derived from Quranic and Prophetic sources by great Sufi and reformist scholar, *Imam Ghazali* (d. 505 AH/1111 AD) and approved by other prominent scholars such as *Imam Eshaq Al-Shatebi* (d.790/1388) and *Imam Fakhrad-din al Razi* (d. 606/1209) (e.g. Chapra, 2008; Khallaf, 1977; Al-Alwani, 2005; Al-Resoni, 2008):

1. invigoration of the human self (*nafs*)
2. enrichment of human faith (*din*)
3. enrichment of intellect (*aql*)
4. enrichment of posterity (*nasl*)
5. development and expansion of wealth (*mal*)

Chapra (1996) and Ahmad (1994) provide a comprehensive review of the Islamic vision on economic and sustainable development in the light of the *Maqasid* model. The Islamic development vision is based on social and economic justice and environmental integrity:

- Optimal utilisation of the resources based on thankfulness '*shukr*', i.e. no excessive use.
- Equitable use and distribution based on Justice '*adl'*.
- Environmental integrity based on condemning disvalues of '*kufr*' (denial or rejection of God's blessings) and '*zulm*[8]' (aggression, harm, abuse)

Chapra (2008) provides a detailed account of how to achieve the above essential *Maqasid*[9]. The main need for human self-enrichment is: its dignity, self-respect, brotherhood and social equality. This can be achieved through justice and maintained by spiritual and moral uplift (see strengthening faith). Self-enrichment can be realised if the life, property and honour of individuals are secured by (1) creating a free environment for self-development; (2) providing affordable education; (3) strengthening good governance; (4) providing equal opportunities in employment and wealth creation and (5) supporting family and social solidarity (Chapra, 2008).

Spiritual (non-material) needs of the community deal with the second criteria, enrichment of faith which is based on interpreting how self-interest of an individual is

[7] *Maqasid* is the plural of a *Maqsad*
[8] *Zulm* is a set of acts that brings injustice and can vary within different contexts
[9] There are many other references in Arabic and Farsi on this subject; however, Chapra (2008) is one of the few good references in English.

matched with the individual's responsibilities before the God and hence his worldview is constructed to accept values sustained by proper motivation and maintained by moral and material education. Chapra (2008) acknowledges that *Maqasid* model emphasises the role of State in providing good governance and providing enabling environment for the protection of self-dignity and establishment of freedom and justice and security. However, this role in enforcing laws and regulations will be lessened if there is uplift in moral standards motivated by high ethical ideals. This will increase the effectiveness of socio-economic, judicial, financial, social, educational and cultural institutions.

Enrichment of the intellect provides a basis for social integration and harmony. As a result, intolerances, fanaticism and conflicts will be avoided. According to Ghazali, intellect is the Driving force behind development and growth since it the "*foundation of knowledge*" and the "*source of success in the world and hereafter*" (Chapra, 2008). There must be an enabling environment for freedom of thought and expression as well as incentives and rewards for creative work.

The strategy to attain Enrichment of the Posterity is to have clean and healthy environment and be free from fear of conflict and insecurity (see e.g. Chapra 2008). So there is a need for conflict resolution within an institutional and governance system. The environmental ethics are neglected by Islamist literature despite many indications of environmental protection in the Holy Quran. The depletion of natural resources and destruction of ecosystems are a threat to the community's security and prosperity. Indeed, the other objectives will not be achieved if this objective is ignored. We will discuss this theme in the next sub-section

For a community to be vibrant it has to be able to create wealth which is a trust (*amana)* from Allah. Wealth creation ability is paramount to the success of other objectives. The strategy to achieve this is to eradicate poverty, minimising inequalities of income by providing social support to those in need relying on redistributive mechanisms such as different forms of taxes (*zakat*[10]*, sadaqa*[11]*, awqaf*[12] etc.). Therefore, the economic development should not be ignored in an overall strategy. Concentrating on economic developments alone will be beneficial in a short term but it might not be sustainable in a longer run due to the "*rise in inequalities, family disintegration, juvenile delinquency, crime and social unrest* (Chapra, 2008)".

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[10] Income Tax
[11] Charity Gifts
[12] Benevolent Funds

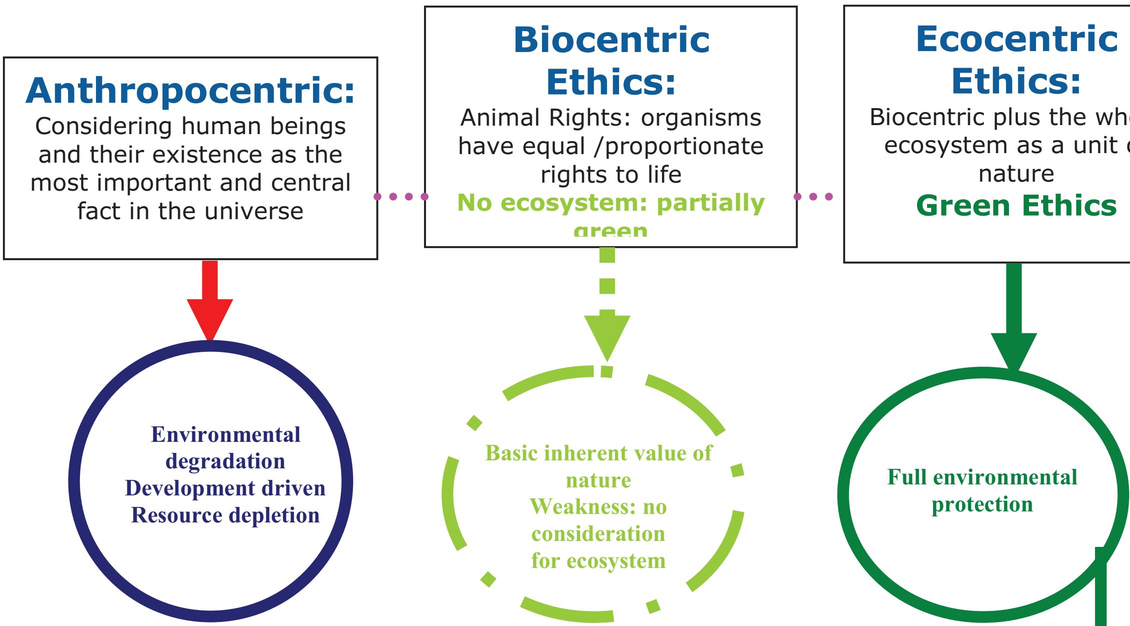
8.3.4 Principles of Islamic environmental ethics

The principles of Islamic environmental ethics (Figure 8.2a) have been discussed by many researchers e.g. Bagader et al, 2007, Izzi Dien, 1990, 1997; Khalid, 2002, Adam, 2007; Schwarte, 2003, Faruqi et al, 2001; Jusoff and Abu Samah, 2011). The Islamic environmental ethics is comparable to the modern version defined by Des Jardins (2001) in Chapter II.

The Islamic environmental ethics which are governed and guided by the *Maqasid* model, are compatible with the ecocentric ethics (Figure8.2b). Humans are considered as trustees of the earth and God's vicegerents (Caliphs) and should not spoil (do mischief or *fasaad*), harm or damage the natural world and avoid excessive use of the resources. Islamic ethics considers both animal rights[13] (e.g. Masri, 1989; Wescoat, 1995; Foltz, 2002) which Roman and Anglo-Saxon laws have ignored (Green, 2003) and there is clear indication to protect the ecosystem as a unit by not interfering with the balance and measured nature of the creation. Islamic ethics is pro afforestation and specify that wild plants and forests should not be cut. Furthermore, Islamic theory is more applicable to the ecological principles than the liberal and democratic theories as shown in Table 8.1.

Water and Earth (land) are considered to be sacred. Water appears 63 times in the Quran "*And His [i.e. God's] Throne has been resting on water*". Paradise is described as" *Gardens beneath which rivers flow*" [47: 12]. Water is a source of life: "*And Allah has sent down the water from the sky and therewith gives life to the earth after its death*" [16:65]; "*We made from water every living thing*" [21:30]. Water is a source for purification and its quality has a special importance in Islam since before performing every prayer ablution is necessary and after each sexual contact, bathing is required. So water has a psychological dimension in Muslim's daily life. Equitable right to water is entrenched in Islam including right of animals to drink (Quran, 26:155)[14].

[13] Reference to '*haqq al-shurb*' or the right of thirst"
[14]Referring to the verse: "*He said: (Behold) this she-camel. She hath the right to drink (at the well), and ye have the right to drink, (each) on an appointed day*".



(a) A historical Development: The Relationship between Ethics (adopted from Proops and Wilkinson, 2000)

Islamic Ethics for environmental sustainability

- God as sustainer; Any damage to the Environment considered as going against God's wil
- Humans are trustee with responsibility
- Humans are stewards and accountable
- Holism of nature: All creatures (animal and plant species) are Nations like humans (possesses intrinsic value and rights for others in the ecosystem.
- Ecosystem equilibrium: "*Creation is a balance and measured way*"
- No harm and Fassad principles
- No excessive use
- *Hima*(protected)zones for sustainable natural resource use and conservation
- *Haram* (boundary) and environmental protection
- Wild and planted trees and vegetation need to be conserved should be protected from deliberate fire or cuts (pro-afforestatio)
- Respect for rule of law: the principle of Maintenance of Order '*hefz-e-al-nizam*'

(b) Islamic Environmental Ethics

Figure 8.2: A historical Development of Environmental Ethics and Islamic 'environmental' ethics

Quran mentions the word 'earth' in more than 400 occasions (Jusoff and Abu Samah, 2011). It considers land 'earth' as a medium for development in the context of better living standards and place for worship. Quran refers to the colonial nature of human organisation and settlement and societal behaviour (Quran 11:61)[15]. The choice of word "colonised" refer to the human activities and developmental pressures as a result of demographic Drivers. But there is an explicit prohibition of land pollution (*fassad*) or any other harm done to the environment.

There is noticeable challenge in applying the Islamic environmental ethics despite the notion of stewardship because of the anthropocentric elements in the Islamic principles towards natural resources use: natural resources are bounties from God and it has created for the welfare of mankind. Similarly, as mentioned in Chapter II, the conservation ethics propagated by the ideals of the Sustainable Development is centred on the human needs and the needs of future generations (WCED, 1987). This implies that humans are given priority in terms of their needs. The balance has been shifted towards anthropocentric ethics within both the Islamic and Sustainable Development discourses. The religious discourses centre on several themes:

- The Earth belongs to God and we all have a share i.e. it may imply a non-restrictive rights to the resources as described by Simmons (1993) as the ethic of "*instrumentalism*" or the "*use of the environment*".
- We have freedom to work and create wealth using God's bounties. Holden (2003) reports that "*Nash (1989) suggests, inherent within the concept of stewardship is the notion that God has given nature to humans*".
- Humans are superior or masters of the world. This implies that human needs have greater priority over other creations.

In the past, the strong welferist and anthropogenic nature of religious teachings with regard to various aspects of human rights has been shaped by these dominant discourses which did not came into conflicts with Islamic environmental principles and the *Maqasid* model before the modern age. However, in modern times, with the overpopulation and expansion of human existence on earth, the overuse and over exploitation of resources are in direct conflict with the religious moral codes. Thus, these discourses cannot be supported by the Islamic legal criteria on environmental integrity. Therefore, these intrinsic human developmental aspirations and needs have to be balanced with ecological needs of the universe and its sustainability. Jenkins (2005) calls for using Islamic legal theory (jurisprudence) to "*envision an alternative practical strategy for Islamic environmental ethics"*. On this basis, the ethical legal framework is developed for community based

[15]Reference to the verse: "*It is He Who hath produced you from the earth and colonised (settled) you therein*"

natural resources governance. There are some examples for producing practical guidelines using Islamic environmental ethics; e.g. in Philippine which depends heavily on forest and marine resources (dependence rate is more than 70%), the Islamic environmental governance has been successfully developed and promoted in the Muslim area as part of the U.S. Agency for International Development (USAID)s Philippine Environmental Governance 2 Project (EcoGov2, 2008). The document is called the Steward (Al- Khalifa) and sets governance rules on environmental protections.

Criteria	Ecological Law	Liberal Theory	Democratic theory	Islamic theory
Enforcement Of environmental morals	Enforcement of environmental morals is implicit in the ethics to save the ecosystem	Tenets of liberalism asserts that one should not interfere with matters of personal morality	Popular support can approve non-enforcement strategies such as short-term plans (e.g. development plans)	Duty to preserve God's Creature: so enforcement is implicit in the ethics
Scope rules and right of access	Based on what is right, good and virtue	No interference except on the ground of harm	Based on popular support 'participation	Based on what is right, good and virtue
Boundary of enquiry	Community as a unit	individual	Popular majority rule	Community as a unit

Table 8.1: The degree of applicability different dominant theories in conjunction with Ecological Law

8.5 Islamic Legal Theory

Islamic legal theory was founded by Imam Shafei (767-820) in the second century of Islam (Khallaf, 1977). It is a mechanism to transform the ethical principles into normative and strategic rules. In this section, the role of Islamic legal theory as an interface between the environmental ethics within the framework of Islamic developmental vision (*Maqasid* model) and the IWRM and sustainability science is discussed.

Islamic legal theory is a powerful approach to translate Islamic environmental ethics into practical governance rules (Jenkins, 2005). Therefore, it is assumed that if we want to make a genuine attempt to deal with the environmental problems in the WANA region or Iran; the Islamic environmental ethics and the *Maqasid* model should be accommodated into the existing governance system. Ragab (1980) believes that this is also dictated by the

Islamic faith since in Islam the social and belief systems are seen as one entity (Ragab, 1980).

8.5.1 Linking to IWRM and Sustainability concepts

Islamic legal theory needs to be benchmarked with the sustainability science to be harmonised and streamlined with modern day principles. Therefore, we need to establish how a belief system (in our case Islam) can be linked to non-religious concepts such as IWRM[16].

Islamic legal theory distinguishes between two sets of laws: (1) acts of worship ('ibadat) which are a set of unchangeable religious values; and (2) transactions (mu'amalat) which are the way how a society is organised socially, economically and politically. Natural resources management reforms can take place from the *Sharia* perspective since it is part of the transactions aspects of *Fiqh*. As Kramer (1993) suggests it can be reformed on different models outside the sphere of Islam and adapted even from non-Islamic concepts such as IWRM. Faruqi et al (2001) and Beaumont (2005) conclude that Islam relates to IWRM and sustainable development concept very well.

Box8.2: Some of the main Legal maxims from Islamic legal theory
(Source: Khallaf, 1977; Kamali (2006) and Old Islamic texts)

Action situations
- Acts are judged by its goal and objectives (i.e.Maqasid)
- *Original Allowance Rule*: the foundation of all things is allowance
- Certainty is not overruled by doubt
- Custom is the basis of judgment
- Necessities should not be exaggerated (i.e. limited by a proportion)
- Necessities permits prohibitions

Public interest or Masalaha
- *Masalaha :* entrustment of governance power over the citizens to the Head of the State (Imam) is dependent on serving public interest

Repulsion of Harm
- Harm must be eliminated
- Repulsion of harm(spoil, corruption, damage) takes precedence over the acquisition of benefit
- A harm cannot be eliminated by conflicting another harm
- A greater harm can be avoided by accepting a smaller harm
- Choosing the worst of two evils to avoid their full potentials

Removal of difficulty
- Hardship brings facilitation i.e. elimination of hardship brings satisfaction and wellbeing
- Discomfiture is lawfully removed

8.5.2 Basis of policy appraisal and law making process

The *Maqasid* science was ignored for centuries until late 19th century (e.g. Alwani, 2005). Recently, there have been a huge movement towards rekindling the *Maqasid* model

[16] The philosophical and theological arguments are not relevant as we take religion as a cultural attribute of the community.

into Islamic legal theory (e.g. Chapra, 2008; Al-Resoni, 2008; Alwani, 2005; al-Qardhawi, 1998; Azmi, 2002).

The *Maqasid* model provides the governing principles of the Islamic legal theory. The main aim of the Islamic legal theory is to serve public interest (*Masalaha*) by achieving two criteria: repulsion of harm 'daf'e zarar' and removal of difficulty '*raf'e haraj*'.A set of sophisticated legal maxims have been developed on these two criteria as given in Box8.2 (e.g. Khallaf, 1977; Kamali, 2006). The legal framework to achieve the criteria has three *Maqasid* levels (e.g. Alwani, 2005; p. 138; Khallaf, 1977):

1. The obligatory *Maqasid* level: the five necessities (Section 8.3) are considered to be high level governing objectives and form the basis of the source methodology in coming up with a ruling or a policy.
2. The complementary necessary level: one of the main Islamic principles is to make the law easier to implement and remove any unnecessary restriction and difficulty to achieve the five main *Maqasid*. It can be considered as a refinement of legal application to deal with social and ecological vulnerabilities. At the time of droughts for example, additional rules can be enforced to reflect the new realities. Hence at this level, the benefits or costs of a ruling is distributed.
3. The enhancement level: is a level in which the aim is to reach a desirable status in terms of moral conduct.

8.5.3 Gathering data or evidence for the legal framework

Data sources for the Ethical legal framework are based on three pillars: (1) divine revelation (texts), (2) intellect and (3) cultural experiences (customs) as shown in Figure 8.3.

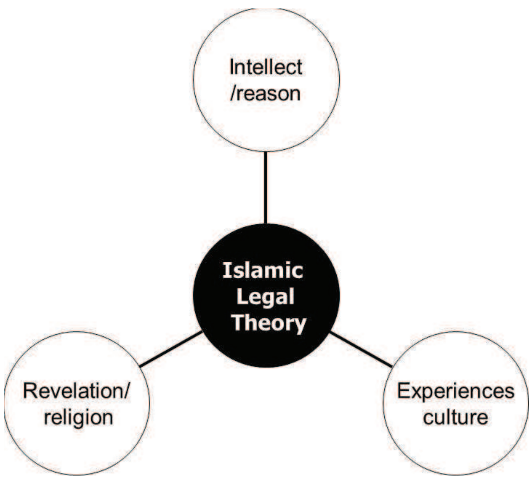


Figure 8.3: The Pillars of Islamic legal theory.

The evidences can be divided into four classes[17] (see e.g. Khallaf, 1977; Johnston, 2004):

1. First order evidence is taken from the revealed (divine) texts:
    a. the Holy Quran and
    b. Narratives (*Hadith*, traditions or Sunna) of the Holy Prophet; and
2. Second order evidences from non-divine sources are:
    a. analogical reasoning of experts for the public interest ‘*qiyas*’or ‘reason’
    b. Consensus on scientific evidences from experts
3. Third order evidences:
    a. Customs and cultural experiences
    b. *istihsan* ("legal equity" or "preferential choice")
    c. *istishab* (presumption of continuity)
4. Fourth order sources
    a. *maslaha mursala* (social welfare not mentioned in the texts)
    b. *sadd-al-zaria* (closing the gate to evil): necessity rules
    c. *Shar' man qablana* (revealed norms and principles from those before us-cross-cultural experiences)
    d. *Madhhab al-sahdba* (the school, or juridical method of the companions of Prophet Muhammad).

The authenticity of the sources is indicated by their order. Quran represents the most authentic source; first and second order sources are agreed among most scholars. Quranic texts (verses) are of two categories:

1. explicit as evidence ‘*muhkamat*’ i.e. they are precise in their meaning and cannot be open to different interpretations or
2. probabilistic as evidence ‘*mutashbehat*’; which are open to different interpretations

Most of the Quran is from the latter category as stated by Keller (1997). On the above bases, the dynamic nature of Islamic legal basis makes it adaptive to changing environments and circumstances. The idea of absolute divine rule is a misconception and there is a large degree of freedom with regard to interpreting even the divine ‘sacred’ sources and this is highlighted by the strong presence of human dimension in the policy/ law-making process.

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[17] Classification is made by the author

8.5.4 A framework for legitimacy: rules-obligation inter-linkage

Fiqh provides a framework to understand the relationship between action-actor as a basis for legitimacy and enforcement of the rule of law. This is based on rule-obligation concept (e.g. Khallaf, 1977; Al-Alwani , 2003). A rule assigns a task (a human-induced act) to be performed and actors will respond according to their worldview. In the analysis of the dynamics of 'act- actor' relationship, there are certain criteria that should be met with regard to the 'act' and the process of 'acting'. The dual analysis can be based on the following algorithm:

1. The act (the actual task):
    a. the clarity of the act to the actors
    b. the ethical nature of the act- measure of its legitimacy based on the constitutional level decision-making principles
    c. degree of hardship associated with an act: how practical is the act:
        i. impossible acts are invalid
        ii. probable acts with absolute hardship is invalid
        iii. probable acts with a relative hardship (tolerable and acceptable level) is acceptable
2. Actors:
    a. their ability to understand the process of acting without any ambiguity
    b. are they fit to carry out the act? I.e. do they have the capacity to act?

A legitimate rule should satisfy the above criteria of no hardship, ability to understand and capacity to perform according to the rule. Legitimacy is then a measure of the successful implementation of the CBNR management plans. This means that Islamic *Fiqh* should not be only about law making but it should take wider societal dimensions into consideration. Introducing a new rule might not be enough to ensure its implementation. Therefore, there might be a need for capacity development strategy. The participation of the community might need an adjustment to the socio-political setting and the community has to be empowered by creating boundary and positions rules.

8.6 Revised Responses: revival of *Hima* governance in WANA region

The *Hima* governance system has been deduced based on Islamic environmental ethics, *Maqasid* model and legal theory. It can have three main elements

1. The principles of *Hima* governance which refers to constitutional governance level
2. The Ethical legal framework which refer to collective choice governance level
3. *Hima* organisations (institutions) which refers to operational governance level

The thesis provides a proposal on the first two elements. The operational (procedural) level governance are not discussed since this depends on community based knowledge and scientific good practice principles which varies in time and place.

8.6.1 Principles of Hima governance

The principles of *Hima* governance are categorised into four broad categories which are not mutually exclusive and presented in Table 8.2.

I. *The Ethical principles* which include the *Hima* development vision and describe the aims and objectives and the ethical dimension of *Hima* governance system.

II. *Environmental sustainability principles* are based on reverence to natural resources and no harm and no *fassad*.

III. *Institutional principles* recognise (a) the role of the State in providing basic needs; (b) the role of the voluntary sector to contribute to socio-economic and non-material development of the community and (c) the devolution of *Hima* management within the local community.

IV. *Good governance principles* provide a framework for the adequate management of the natural resources in *Hima* zones.

The specific principles deals with the three elements of *Hima* approach:

1. Social cohesion and sustainable livelihood for *Hima* communities
2. Criteria on property rights and resource use which is based on carrying capacity and regeneration of resources
3. Environmental protection and conservation and adaptive management

8.6.2 Ethical legal framework

Islamic legal theory also provides an Ethical legal framework for *Hima* governance system. This describes the journey of translating the principles into strategies and normative rules. There are two important issues in contemporary CBNR that has to be well defined: property rights and right of use. The proposed legal framework which is given in Table 8.3, deals specifically with these issues.

We can conclude that Islam put a coherent set of principles for an equitable and sustainable use and management of natural resources and is comparable to

- nine contemporary CBNR governance principles presented by Dudley (2008) representing IUCN's guidelines on protected area and
- twelve organisational principles based on a survey of latest research (Gruber, 2010).

The comparison is shown in Table 8.4.

However many WANA countries including Iran have been experiencing lack of implementation of these principles due to many factors including resistant to change, unfair distribution practices, lack of good governance as well as weak operational and financial management of the natural resource. Therefore, there has been a renewal of interest in traditional governance systems as an entry point for CBNR management programmes. The Islamic belief system provides a coherent governance system: principles, norms and legal frameworks. It is proposed that that the developed *Hima* governance system can be adopted in WANA region and beyond. But this has to be tested in case studies.

The PhD work has been linked to international and regional initiatives (Source Appendix A1, Table A1.5) including

- World Justice Forum (WJF)
- WANA Forum
- United Nations University- Institute for Water and Environmental Sciences (UNU-IWES) in Dubai.

The work will also be part of WANA Forum policy brief on '*Hima* CBNR Governance for WANA Region". The work has already presented at a recent workshop in Istanbul (Appendix A1) and the third World Justice Forum (WJF) meeting, Barcelona, Spain. The work will also form the basis of '*Hima* Global Initiative' to be launched in May 2012. The author is involved currently in writing the proposal for this global initiative.

Table 8.2: Principles of Hima (CBNR) governance based on Islamic principles

Part I: Ethical principles

(1) *Hima development vision*: based on the ethics and the *Maqasid* model, this outlines the aim and objectives of establishment of *Hima* zones: the aim is '*fallah*' or human wellbeing which can be achieved at three *Maqasid* levels (criteria) which can be attained if justice, equity and public interest are established.

(2) *General policymaking criteria*: are Justice, equity and public interest Justice can only be achieved if there is social solidarity or cohesion (e.g. Chapra, 2008a)

(3) *Integration and social cohesion*: a multi-dimensional principle based on the notion of community as an integrative unit. We can have different communities as 'holons' that can be part of the whole or considered as a whole at the same time:

(a) *Collective duty and responsibility:* the notion of Umma provides individual rights for the community members but it also provides sense of collective duty and responsibility.

(b) Hima zones should create no hardship for other communities around the zone.

(c) '*Fraternizing' principle*: the level of associations and cooperation among *Hima* communities. The social fabric of *Hima* communities is heterogeneous and hence The Fraternizing 'Brotherhood' principle creates a coalition alliance to implement *Hima* governance system.

(d) Diversity principle**:** pluralism in the human society is a Quranic concept: *"if Allah had so willed, He could have made them a single people*"; "*And among His Signs is the creation of the heavens and the earth, and the variations in your languages and your colours: verily in that are Signs for those who know*. 30: 22).

(e) Integration and social cohesion require having a broader holistic and aesthetic worldview about the nature: "*Indeed, God is beautiful and loves beauty*[1]" as a prophetic narration. Therefore, the splendours of nature and its equilibrium should be acknowledged.

(4) Holism principals are based on the followings principles which describe human rights within the greater environment: humans are part of the holistic system:

(a)All creatures (plants, animals and inanimate) are signs of God.

(b) All creatures are nations like human with intrinsic rights.

(5) No excessive use principle: right to use for sustainable livelihoods based on these principles:

(a) Allah is the definite and factual Proprietor: "…*to Allah doth belong the dominion of the heavens and the earth and all that is therein*…" (5: 17 and 120).

(b) Humans are beneficiaries of the creation: "*It is He Who hath created for you all things that are on earth* (2: 29); "*It is He Who has made the earth manageable for you, so traverse ye through its tracts and enjoy of the Sustenance which He furnishes: but unto Him is the Resurrection*" (67:15).

(c) Original allowance rule (Box 8.2) can be restricted if required.

(6) Respect for international treaties and conventions: This is based on Al-Wathiqa Constitution (e.g. Berween, 2003). This can provide a linkage to principles from other CBNR paradigms which are either mutual or complementary. .

Part II: Environmental sustainability principles

(7) Reverence for natural resources: God is the sustainer: Any damage to the Environment considered as a going against God's will

(8) Environmental equilibrium : "*Creation is a balance and measured way*"

(***9)No Harm principle***– psychological, opportunities, environmental etc

(10) No Fassad (spoil, corruption or damage) to the Environment

Part III: Institutional principles

Continue on next page

Table 8.2: Principles of Hima governance….. continue

(11) Devolution to local community by recognising informal institutions and local traditional knowledge systems
(12) Collective action Principle as basis for the role of the State and voluntary sector: Fulfilment of the needs Principle- everyone in the community should have enough of basic goods and services. This are collective (socially- obligatory) duties that has to be fulfilled by the state.“*Allocative and re-distributive role of voluntary sector*” (Sediqqi, 1988) to be enhanced in achieving socially obligatory duties
(13) Financial sustainability principle is based on
(a) Upkeep of social welfare of the vulnerable members of the Hima community such as establishing Child Welfare Fund, Zakat Wealth Fund, reduction of tax burden and so forth.
(b) Economic efficiency: e.g. extra taxes on goods and service to recover costs and enhance community accountability
(c)Payoffs for efficiency targets and penalties for non-compliance
(14) Conflict resolutions based on
(a) Acknowledging and understanding rights of each other in terms of nationality (i.e. ethnic, cultural), loyalty and kinship, gender : “*Created you from nations and tribes, men and women to acknowledge [rights of] each other*”
(b) Peaceful existence as Quran calls for Home of Peace: "….and God calls to the Home of Peace.." [10:25]
(c)Mutual consultation process: “*who (conduct) their affairs by mutual Consultation* (42:38)”.
(d) Conflict resolution should lead to Eslah which can have several meaning:
i. Reform: *I only desire reform to the best of my ability. And my guidance cannot come except from Allâh, in Him I trust and unto Him I repen*t. (11: 88)
ii. Betterment of conditions: *The best thing to do is what is for their good* 2: 220
iii. *reconciliation between people*’ (4:14)
Part IV- Good governance Principles:
(15) Responsive : principle of humans are Trustees.
(16) Accountable: principle of humans are Stewards; participation in decision-making; “*It is He who hath made you (His) agents, inheritors [stewards] of the earth* “(6:165)
(17) Consensus oriented: Principle of Consensus or *Ijma* of experts
(18)Participatory based Principle of *shura* or consultation and community participation: “*and consult them in affairs of moment)*”(3:159)
(19) Proclaiming the clear message: transparency and clarity in information dissemination and policymaking.
(20)Follow rule of law: principle of Maintenance of the Order is to avoid chaos and injustice. Sanctions can be enforced as well as incentives to achieve environmental sustainability principles.
(21)Legitimacy and capacity development: effectiveness and efficiency of the governance system is a measure of its legitimacy; capacity development and empowerment ethical and moral obligations provide a basis for the legitimacy of the governance system.
(22) Exercise of Knowledge and intellect: knowledge is more than acquiring information; knowledge can be considered as a societal force embracing theory (belief system i.e. Islam), enlightenment (Spiritual), thought (philosophical and scientific), and society (educational), Rosenthal (2007). Therefore, knowledge system is vital to any governance system

Table 8.3: ***Proposed Hima (CBNR) legal framework based on Islamic principles***

Part I: Preamble:
This includes an introduction, goals and objectives of *Hima* governance system for sustainable livelihood and based on the Principles in Table 8.2

Part II: Definitions
(a) Natural resources are considered to be public and owned by the State or the legitimate authority.
(b) Natural resources include
1. Water resources (surface and groundwater)
2. Sources of Energy and
3. Land resources including minerals, wastelands rangelands, woodlands and forests etc.

Part II: Provisions for Right to use
(a) Non-exclusive (open) and equitable access rights to public and common properties such as *Hima* land allocation for development system
(b) Right to use natural resources can be given to individuals or legal entities.
(c) Right in (b) is a restrictive right to use in accordance with public interest criterion

Part III: General provisions for Private ownership
(a) Private property right can be achieved by 8 mechanisms (al-Dibani, 1998): p.53): inheritance, compensations and trade-offs, gifts, will, benevolent, charity, war bounties and regenerated or revived (ihya) lands. Revived Lands can be owned after their allocation.
(b) Chattel (movable) properties can be owned within *Hima* zones.
(b) Private ownership of natural resources is limited by
1. No waste/ conservation principle: *Verily spendthrifts are brothers of the Evil Ones (17:27).*
2. It can be accumulated but spend it the way of Allah: *"and those who treasure up gold and silver and expend them not in the way of Allah -announce thou unto them a torment afflictive (9:34)*
3. Taxes can be introduced on wealth accumulated by use of natural resources.

Part IV: Provisions for Water use and ownership
(a) Water is the source of life and equitable water rights for all (humans, animals and the environment) should be ensured.
(b) Right of drink is recognised for humans and animals
(b) Customary water rights are recognised including groundwater resources system.
(d)Riparian water rights are recognised as priority of use.
(e) Private groundwater rights to groundwater by owners of private wells
(f) Return river (excess) flows is publically owned and should not be stored and should be directed back to the river
(h) Private water are water in private containers, treatment plants, distribution systems, and reservoirs (Kadori, 2001; Sabeq, 1981; Zohaili, 1997)
(i) Private waters can be traded. Pricing is decided by market forces. No fix pricing except for the public interest criterion.
(J) Right to thirst clause (b) implies that public drinking water installations for human and animal consumption can be built in *Hima* zones.
(k) Aesthetics water needs should be established: *three things bring joy to the eye sight: greenery, flowing streams and good looking humans* (prophetic tradition, e.g. al-Khashin, 2004):
1. Water for Green belts and parks
2. Enough Water for rivers to keep their aesthetics or basic functions

Next page continue

Table 8.3: **Proposed *Hima* Ethical legal framework continue**

Part V. Provisions for Land use and ownership

(a) publically owned land allocation system are:

1. *Hima* zone land allocation system is for sustainable development and conversation
2. *Haram* (boundary) sanctuaries can be established for source protection including rivers and wells
3. Green spaces around populated areas in *Hima* zones

(b) Privately owned land use systems are

1. Irrigated and dry farmland can be owned privately. Sustainable agriculture is encouraged including farming and fruit growing: "*Agriculture is the greatest treasure*"
2. *Ihaul-Mowat* land allocation system is for development and the regenerated land can be owned privately.
3. the provision in (2) is a restricted private ownership and is only provided if it is not neglected

Part VI: Provisions for Environmental protections

(a) Land resources

1. *Hima* zones can be assigned as conservation zone if necessary and use rights can be restricted or prohibited for a prescribed time in exceptional circumstances such as droughts or i
2. During Easement and restricted right to use in *Hima* conservation zones is only established if there is no hardship to local community and general public and extensive damage to the environment.
3. *Haram* (boundary) sanctuaries can be established for source protection including surface and groundwater resources. Landfills and sewage should be kept out of the sanctuaries.
4. Wild and planted trees and vegetation need to be conserved should be protected from deliberate fire or cuts.

(b) Water resource

1. No sewage should be dumped in streams, rivers and water bodies.
2. No poisonous chemical should enter water resources
3. Polluted water should not be used as it is potentially a health hazard
4. Groundwater resources to be protected from sewage and dumping sites
5. River and sea coasts to be protected from human and animal sewage

Part VII: Provisions for Natural resources management

(a) *Hima* zones are managed by community based local institutions which are non- rigid self-governing entities. The devolution is based on good governance principles.
(b) Informal local institutions are nested within the institutional system to ascertain local needs and provide traditional and local knowledge systems for an effective management.
(c) Research and development are undertaken to understand both local and scientific knowledge about *Hima* zones
(c) Recognising adaptive (and demand) management: Principle of 'Necessity' Rules: new rules can be made according to new conditions
(d) Management of the *Hima* zones are based on no hardship clause to allow for Social justice in addition to the conservation and protection of the natural resources.
(e) International good practices and standards from conventions and treaties can be incorporated into *Hima* governance system.
(f) Monitoring *Hima* zones are supervised by the relevant authorities in cooperation with local administration.
(h) Sanctions are based on Environmental sustainability and good governance principles should reflect local realties and social justice principles.

IUCN 's protected area Principles (Dudley, 2008)	Contemporary CBNR Principles (Gruber, 2010)	Some of the relevant Hima Governance principles
1. Legitimacy and voice	1. Public trust and legitimacy	1. Legitimacy and capacity development
2. Subsidiarity	2. Public participation and mobilization 3. Devolution and empowerment 4. Adaptive leadership and co-management 5. Participatory decision making	2. consultation and community participation 3. Devolution by recognition of the informal local institutions 4. Recognising adaptive management: Principle of 'Necessity' Rules 5. Consensus oriented
3. Fairness	6. Resources and equity	6. Principles of policymaking (Justice and equity and public interest
4. Do no harm		7. No harm Principles 8. No *fassad* (damage, corruption, pollution)
5. Direction- clear vision		9. *Hima* Development Vision
6. Performance	7.Social capital and collaborative partnerships	10. Principles of Integration and social cohesion
7. Accountability	8. Monitoring, feedback, and accountability	11. Principle of Humans are Stewards
8. Transparency	9. Cmmunication and information dissemination	12. Proclaiming the clear Message Principle
9. Human rights		13. Holism principles 14. No excessive use
	10. Research and information development	15. Principles of Exercise of Intellect (Knowledge acquisition)
	11.Enabling environment: optimal preconditions or early conditions	16. Collective action Principle 17. Financial Sustainability Principle
	12. Conflict resolution and cooperation	18. Principles of reform, betterment of conditions and reconciliations and cooperation

Table 8.4: Comparison of contemporary CBNR governance principles with *Hima* Governance system

8.6 Sustainable CBNR governance for Lake Urmia basin

In Lake Urmia basin (LUB) case study, resource regime and property rights, monitoring system and environmental ethics are the determinant factors on the path to sustainability.

It is proposed that the *Hima* governance system:

- can directly deal with the use right issues; referring to Table 8.2, *Hima* legal framework provisions recognise a mixture of public-private water rights and use rights as shown in Table 8.3;
- will foster collective choice arrangements which is also advocated as one of the eight design principles by Ostrom (2005) as a basis for establishing a viable monitoring system which is owned by local community and regulated by relevant authorities; and
- can provide robust environmental ethics which have to be strengthened in LUB to bring about changes in attitudes and cultures.

8.6.1 *Strengthening environmental ethics*

Environmental policy debates are more or less about morality and ethics. Therefore, ethical consideration in land and water resources (natural resources) use and conservation (i.e. the environment as a whole) is vital for attaining sustainability criteria. This is important in persuading general public to comply with management strategies and create a basis for a participatory involvement of stakeholders which either have to be restricted or asked to pay for the upkeep of natural resources.

The Islamic 'green' credential has earlier been demonstrated by noticing a close match between ecological laws and Islamic environmental ethics. Some Scholars such as *Ibn Khaldon* acknowledged that sustainable development is a condition for developmental needs in addition to advocating social harmony principles (e.g. Ra'ad, 1993). However, historically, sustainability has been overlooked by Muslim policymakers because political thinkers dominated the policy debate and they thought of political stability as a result of developmental works within equity principles. So the ethical approach to environment advocated by some Sufi writers such as *Najmadin Razi* was overlooked[18]. As shown in Tables 8.2 and 8.3, *Hima* governance framework represents a strong environmental ethics

[18]. As mentioned, Razi (1982) introduces the idea of ethics into activities such as farming and allowing a share for other creatures.

which is based on community's belief systems and this can be used to strengthen environmental ethics in LUB within a capacity development strategy.

8.6.2 Fostering collective choice arrangements and nested enterprises

Referring to rule-obligation concept; rules-actors relationship can be visualised as a Rules-Actors Mesh (RAM) : the cells of a mesh are spatial representations of human's action in space (action situations) and the threads represent the boundary and position rules that define human's relationship with other action situations. The dynamics of the RAM process can be assessed by relating rules to the nature of the act (task, duty, obligation) itself which is prescribed to be sanctioned. In terms of community participation (i.e. farmers or their representative), it is not enough just to create a simple position rule of membership. In order to create the new position rules, a set of other rules has to be changed. With regard to the position rule, the fitness or the capacity of the actors is important as well the information that controls the action-outcome path.

The RAM concept suggests three main interventions: (1) an information rule has to be created to increase the understanding about the underlying principles of the CBNR management process; (2) a payoff rule is needed to monitor the resource use and (3) a scope rule is needed to recognise the role of community of users including informal users. Giving a legal mandate to the community to participate in decisions about resource regime and property rights implies that actors who are affected by a resource regime can participate in modifying their rules. They are empowered to enter a decision making process (boundary rule) and decide on the resource regime (choice rules) and can monitor by applying the payoff rules.

In terms of institutional design; the scale (boundary rule) of LUB with an area of 52,000 Km^2 is a very large action arena to coordinate a community-based management. Therefore, there are inter-boundary rules that have to be recognised: provinces, river watersheds, local village level and so forth. Lake Urima is engulfed by these boundaries as it lies to the downstream of each of the watersheds. This is advantageous since LU can become a central node on the RAM. As was shown in Chapter V, LU is a good environmental State/Impact indicator and hence can be the central theme for a monitoring system which is needed in any institutional design. Based on the RAM concept, the LUB *Hima* governance can have three levels of decision making:

1. LUB *Hima* authority to oversee 31 watershed zones in LUB (17 permanent rivers and 14 seasonal rivers)

2. Catchment *Hima* authority to be managed collectively by representatives the communities in a river catchment
3. local community *Hima* authorities are managed directly by the users

There would be inter-boundary *Himas* and so there is a need for a LUB basin authority that sanctions rules on the allocation (choice) rules at watershed levels.

Fostering water demand management and resource conservation. In Iran, every village has a council. Village Councils which are elected by the villagers can provide the legal base for local *Hima* authorities. A local *Hima* authority can be made up of several villages depending on the biophysical conditions of the natural resources system. Each of the local *Hima* will be responsible for the management of the area and accountable and have to monitor the status of the natural resources in accordance with the Lake Urmia as an ultimate criterion. Water demand management and resource conservation will be an important element in the strategy of *Hima* institutions. A network of smaller nested enterprises then will be able to deliver the plan of the EMP.

8.7 Concluding remarks

Contradictory to some popular belief, the hallmark of the Islamic legislative process has been its human dimension. A wealth of opinions has been reordered in different schools of thoughts. Azmi (2002) points out that the most important feature of Islamic law making is innovation or legal reasoning (*Ijtihad*). It can be concluded that Islamic principles are compatible with CBNR management and IWRM paradigms and provide a viable ethical governance framework.

According to the rule-obligation theory in *Fiqh*, environmental policymakers can legitimise water demand policy based on the tolerable hardship criteria. Therefore, careful capacity development and empowerment is needed at community level to achieve the sustainability criteria.

Hima governance seems to have a wide application in sustainable resource use based on demand management and conservation of natural resources in LUB, WANA region and beyond. This theoretical treatise should be tested in case studies and the scope of the research can be widened by considering other belief systems as all religions have similar value-laden principles.

Chapter IX. Lessons Learned, Conclusions and Recommendations for Further Research

Figure 9.1: The environmental discourse is gaining more ground; the figure shows graphic designs by local artists to save LU (Source: Barzakh Cyber Magazine; available from http://www.barzakhmag.com/?p=1369)

9.1 Introduction: restating the Aim and Objectives

The scope of the PhD programme has focussed on developing a socio-technical framework for implementing the IWRM paradigm in general, and in Iran specifically, by considering the water allocation decision-making in Lake Urmia basin.

Bearing in mind the financial and time constraints, eight objectives were identified as follows:

1. To assess the applicability of IWRM through a critical analysis of the underlying principles, and to assess progress made with implementation (Chapter II);
2. To develop an integrated methodological framework which can be used to implement the IWRM paradigm by integrating the elements of social and technical assessment (Chapter III);

3. To assess the status of progress towards implementing IWRM in Iran (Chapter IV);
4. To assess the status of water resources planning, management and allocation in the Lake Urmia Basin (Chapter V);
5. To make an integrated socio-technical assessment of the water resources availability for sustainable water allocation management in the Lake Urmia Basin, Iran (Chapter VI);
6. To make a re-assessment of the institutional sustainability of the water allocation strategy in Lake Urmia basin. (Chapter VII);
7. To develop an ethical and cultural framework that can provide a basis for good governance based on Islamic principles (Chapter VIII);
8. To demonstrate the applicability of the overall framework through the Lake Urmia case study approach (Chapters VI - VIII)

Chapter IX describes how each of the objectives have been realised which can be considered as a contribution to the advancement of IWRM theory and practice. In Section 9.2, major conclusions and recommendations are outlined. The applicability of the overall Framework is discussed in Section 9.3 together with contributions of the work to scientific knowledge as well as dissemination of the research findings. Further work is discussed in Section 9.4

9.2 Summary of major conclusions and recommendations

9.2.1 Objective 1: Evolving the IWRM paradigm

Need for socio-technical approach. It is argued that the IWRM normative package has very little to offer on implementation. New methodological frameworks are needed to enable the implementation of IWRM. The neglect of the institutional (socio-political) dimension has created a huge drawback in implementing the IWRM paradigm worldwide. Lack of implementation has been attributed to the gap between technical outcomes and policy decisions. Hence, there is a need to move from a technical to a socio-technical approach to bridge this gap.

Need for paradigm shift. Chapter II shows that implementing sustainable land and water resources management poses five main challenges: (1) the integration of the complex and overlapping dimensions of water resource system; (2) dealing with the dynamism of the system; (3) measuring sustainability; (4) dealing with various levels of decision-making (institutional levels) and ethics and values held by decision-makers; and (5) creating mechanisms for gaining participatory consensus.

To deal with the above challenges, many scholars have called for a paradigm shift towards:

- Consideration of full water cycle in IWRM i.e. Green Water and Grey Water concepts should be considered in IWRM plans (e.g. Falkenmark et al (2004), Falkenmark and Rockström (2006).
- Virtual Water Trading (Zeiton et al 2010) can offer real alternative policy instruments to deal with water security (and scarcity).
- Inter-linkage with land use management *(e.g.* Calder, 2004, 2005; Amezaga, 2005)
- Adaptive management (e.g. Pahl-Wostl, 2007; 2009, Merrey, 2008)
- A more politicised IWRM (e.g. Allan, 2003a; Merrey, 2008).
- Mapping institutional elements beyond hydrological boundaries such as influential actors in the decision-making process (e.g. Merrey, 2008)
- Social learning processes and multi-stakeholder platforms (MSPs) for effective engagement and participation of actors in the IWRM process (e.g. Warner, 2007)
- Greater emphasis on culture and ethics (e.g. Daniels and Endfield, 2009)

However, it is argued that despite these conceptual constraints, IWRM is a relevant concept for addressing the ever increasing water management problems.

9.2.2 Objective 2: developing an integrated methodological framework

In Chapter III, an Integrated Socio-technical Framework has been developed to deal with the complexity of water resources systems and capture the diverse dimensions of Social-Ecological Systems. The adopted research design moves away from multidisciplinarity to interdisciplinarity by working at the interface of the physical and social sciences. The Framework uses the Drivers-Pressures- States-Impacts-Responses (DPSIR) component as a platform for socio-technical analysis. The Outcomes of the DPSIR strategic assessment i.e. the Responses are then analysed using the Institutional Analysis and Development (IAD) and Integrated Socio-technical Assessment (ISTA) components comprising of modelling systems and Multi-Criteria Decision-Making (MCDA) tools.

The IAD component is the engine or the ‘motherboard’ which provides the linkages or points of interaction for different components of the Framework. While DPSIR provides a wider approach for analysing changes in the system, IAD provides the focal level for socio-technical analysis; thus presenting a robust and rigorous analytical component for implementing IWRM.

Politicising IWRM through institutional analysis. There has been a call for politicising IWRM (e.g. Allan, 2003; Merrey, 2008). This has been done through the use of a politicised IAD approach. IAD has also been criticised for the inadequate handling of power issues and political interests within the institutional design (Clement, 2009). IAD has been used as the core institutional analytical tool in the Integrated Socio-technical Framework but complemented with the discourses and narratives behind the discourses that shape actors’ beliefs and mental models or perspectives. These ***Socio-political variables*** i.e. linguistic parameters have been incorporated since they are central to policy analysis and they emphasise the need for participatory decision-making involving all the three main participatory domains: citizens (or civil society), analysts (e.g. researchers) and decision-makers (actors) to seek solutions outside the “*water box*” (WWAP, 2009).

To deal with highly complex and polarised issues, narrative analysis (Roe , 1994) is used to provide a structured approach to establishing the problems or “Problem Statements” (PSs) and their causal relationships. This demonstrates how uncertain or how complex the issues are (Chapter VII) and how an alternative narrative policy is formed to enable us to understand better how arguments are articulated within a participatory decision-making process.

Highlighting the role of Ethics. In addition to the contextual use of discourses in the institutional analysis, societal values and culture are taken into consideration by incorporating the Ethics component to provide perspectives or a mental model of actors shaped by the discourses. Ethics, which form part of the community attributes, are usually overlooked in the institutional analysis. This theme is highlighted through the work on Objective 7.

Integrating synthesis. Unlike multidisciplinary research, the thesis aims to achieve interdisciplinarity by producing an “*integrating synthesis*” (Max-Neef, 2005) of the assessments. Therefore, we have to overcome language barriers between the physical and social sciences. It is not desirable to omit well-established terminologies used by the different disciplines but it is reasonable that they can be conceptualised so as to be complementary to each other. The integrated synthesis of the assessments is presented within a contextual setting i.e. a unit of analysis which describes the relatively unchanged attributes of the water resources system including:

- The geopolitical characteristics of the action arena
- Actors or stakeholders
- Community attributes
- Socio-economic conditions
- Biophysical conditions as an element in the IAD approach are enhanced to include not only institutional attributes but ecological, hydrological and hydraulic attributes of the water resources system.

The interface between the four analytical components of the Framework is achieved by considering the *Interaction-Outcome pathway* in the action situation.

9.2.3. Objective 3: Implementation of IWRM in Iran

Chapter IV describes the move towards IWRM since the establishment of water governance in the 1940s. Iran has formally adopted IWRM since 2003 but the implementations have lagged behind. An overwhelming majority of water managers believe that there is a need for institutional reform but there is no consensus about the nature of the reforms (Source: Questionnaire Survey, Appendix A1).

The DPSIR analysis at the national level has shown that, as a result of the historical economic growth Drivers, there are great pressures on the water resources both in terms of quality and quantity. Informal unauthorised abstractions for agricultural use have become an important common practice and account for nearly 11% of the total water use (nearly 10 BCM) of groundwater and about 50% of the surface waters. The use of water cannot easily be policed.

Lack of consideration for environmental concerns has been noticed. The 1974 Environmental Protection Act has not been updated and clearly, this cannot satisfy the environmental sector. A major shift occurred in the late 1980s and 1990s where the question of sustainability was highlighted, but the war-torn Iran embarked on more developments, and since 1989, has implemented four Five Year Development Plans (FYDPs).

The ***institutional changes*** have been dramatic and progressive but have failed to completely tackle private water rights and enforce water laws. The evolving nature of water sector institutions shows that institutional equilibrium has not been reached. Since the

1990s, Iranian policymakers have been aware of climatic change as a major Driver and so embarked on a policy of executing basin-wide planning exercises. Water allocation has been a source of conflicts between different provinces. So the Iranian Ministry of Energy (MoE) has been trying to implement the 2003 Water Allocation Directive (WAD) which is based on basin-wide planning. The idea has not been welcomed at provincial level.

Sign of paradigm shift. Senior managers and experts in the Office of Macro-Planning at MoE have come to the conclusion that dam-building as a Response to the Drivers in years gone by, has created unsustainable Pressures on the resources, as has happened in many other countries; hence the need for revised Responses based on IWRM principles to make a reassessment of the development programs. However, these decisions are solely political and the socio-political Pressures such as lobbying MPs, provincial governors and farmers have created a two tier discourse within MoE: the regional development discourse is favoured by Regional Water Companies and IWRMC, and the IWRM discourse is strongly advocated by some sections of MoE.

Emergence of centralised water resources governance. There has been some success with regards to the control of groundwater resources. The 1982 Act required well owners to register their wells to provide them with permits. However, this controlling measure has been marred with over subscription of permits which has caused a great deal of problems. Groundwater resources are literally managed by farmers and well owners (Memari, 2006). MoE's policy has been to bring some order to surface water management through the enactment of the 1982 Act. MoE overlooked groundwater and concentrated on controlling surface water by investing in dam-building and irrigation network projects. Some 90% of the investments has gone towards the projects (MoAJ, 2008), but, in the process, they have created more water rights, much tension among upstream and downstream stakeholders and lost some control to socio-political forces (MoE, 2010a).

Need for reform. There is a consensus that there is a need for a better institutional design to cater for complex governance systems which exist within multilevel smaller nested agricultural enterprises. A community-based participatory water resources management approach has been advocated by most of the stakeholders in Lake Urmia basin (LUB) based on the social research conducted by the author.

Data uncertainty. Lack of information about abstraction from rivers and streams and data uncertainty and lack of cooperation between provincial water companies have led to a lull in the progress of enforcing the IWRM strategy.

Water allocation is central to the implementation of IWRM. Therefore, Lake Urmia basin has been taken as a case study to show the applicability of the proposed Integrated Socio-technical Framework (Chapters V-VII).

9.2.4. Objective 4: Towards Implementation of IWRM in Lake Urmia basin

DPSR analysis

In Chapter V, the DPSIR analysis has shown that, in Lake Urmia basin, most of the Pressures come from the agricultural sector in terms of increased agricultural demand driven by land use policy and the politics of irrigation. The developmental discourse is dominant and has had far reaching consequences for environmental degradation in terms of poorer water quality of rivers and loss of wetland areas as well as a huge drop in Lake Urmia's water level. Informal and unauthorised abstractions have become an important norm with virtually no monitoring systems. Thus, a better institutional design is needed to cater for complex governance systems which exist within multilevel smaller nested farming enterprises.

The institutional analysis has shown that the formal rules (1982 Act, 2003 WAD) have not been implemented in LUB due to several important factors including:

- Lack of cooperation between Regional Water Companies (RWCs) and MoE on the one hand and MoE and IWRMC on the other hand i.e. internal conflicts within water resources organisations;
- Lack of mechanisms to bridge the gap between 2003 Water Allocation Directive and established water allocation practices (pre 2003 era);
- Lack of capacity building to institutionalise the new rules in RWCs;
- Lack of inter-provincial cooperation in terms of water planning;
- The impact of non-water legislations such as Five Year Development Plans (FYDPs) and provincial Development Directives on water resources planning i.e. an FYDP is a project-driven plan and is different from an IWRM Plan.

It can be concluded that the integrated analysis has shown that the present institutional set up has failed because it could not deal properly with an increased water demand from the agricultural sector. There is a need for re-orientation of the Lake Urmia basin water sector institutions so that it can deal with the pressures exerted on the system. However, any institutional design should consider the informal rules in use which have been long practiced in Lake Urmia Basin. Therefore, a participatory water allocation process has been recommended.

IWRM plan for Lake Urmia Basin. Article 67 of the fourth Five Year Development Plan (FYDP) initiated a move towards implementing an integrated ecosystem management plan for Lake Urmia. The Ecosystem Management Plan (EMP) was agreed by the stakeholders through the Memorandum of Understanding (MoU) on Lake Urmia management. Earlier, in November 2007, a new institutional design was undertaken by creating several Multi-Stakeholder Platforms (MSPs) i.e. working groups on water resources and agricultural management, biodiversity and public awareness issues.

Window of opportunity. In March 2009, the author officially became the IWRM National Consultant for the Conservation of Iranian Wetlands Project (CIWP) to facilitate the agreement on water allocation through the formation of the Water and Agriculture Working Group (WAWG). He has been given specific tasks in facilitating the Water and Agriculture Working Group meetings and the water allocation process. The new participatory approach to water allocation based on a new institutional design as provided a window of opportunity to apply the proposed Integrated Socio-technical Framework.

9.2.5 Objective 5: Integrated socio-technical assessment (ISTA) for sustainable water allocation in Lake Urmia basin

Chapter VI describes the new water allocation governance system in Lake Urmia basin based on the agreement among stakeholders to implement the Ecosystem Management Plan (EMP) through the establishment of multitier Multi-stakeholder Platforms (MSPs). The aim was to agree on a water allocation strategy for all the provinces and on allocating water to Lake Urmia. By using the ISTA component of the Integrated Socio-technical Framework comprising of two main elements, the author carried out an analysis of:

a. the process whereby the actors made water allocation decisions; and
b. the sustainability of the water allocation decisions.

The main ***conclusions*** **are** as follows:

1. ***Environmental water rights***. The new governance system provided water rights to Lake Urmia which can be considered as a considerable achievement for the environmental movement in Iran.
2. ***Water availability is less than that adopted by actors using trend analysis***. By establishing a regression relationship between runoff and rainfall over the period

1969 – 1994 when the influence of abstractions was minimal, average annual natural runoff over the period 1969 – 2010 was found to be approximately 5000 MCM whereas MoE (2010b) produced a value of 6927 MCM using a highly questionable Detrending Method.

3. ***Unsustainable water allocation***. In achieving Objective 5, it was concluded that the participatory process which has produced unsustainable water allocation outcome decisions has been marred by data uncertainty and ambiguity about scientific methodology. However, it has to be noted that the governance system and structure is in place for a re-evaluation of the decisions.
4. Although the efficacy of the governance system has improved, the effectiveness of the EMP i.e. achieving long term sustainability of Lake Urmia , is in doubt, considering the agreement on a target water allocation of 3700 MCM, and what has emerged from the re-evaluation of overall water availability.
5. ***Ignoring scientific knowledge***. It seems that both sides of the water allocation equation have not fully considered a basin-wide planning approach that requires rigorous hydrological assessments of water availability and potential for water use. The implications of the water allocation decisions have not been foreseen by the actors. On the one hand, the user water allocation ceiling of 3700 MCM/year lacks rigorous scientific assessment, and on the other hand, the minimum ecological requirement of the lake has become a legal right which ignores the hydrological and climatic variability and persistence.
6. ***No scope for further development***. The current level of abstraction has been estimated to be approximately 2045 MCM/year, so, since the average annual natural runoff has been estimated as 5000 MCM there is no scope for further development/ abstraction if the lake is to receive its allocation of 3100MCM/year.
7. ***The results support the concept of a minimum water requirement*** for Lake Urmia of about 3000 MCM. Given that the annual average natural runoff available is 5000 MCM, and assuming that no further abstraction above 2045 MCM/year is allowed, this leaves about 3000 MCM/year for the Lake.
8. ***Proposing adaptive water allocations based on stochastic modelling***. Due to climatic variability, fixed allocations cannot be sustained, and so a risk analysis of a number of management scenarios was carried out using a stochastic ARMA (1,1) rainfall model to generate multiple realisations of future rainfall for different levels

of persistence/variability. The management scenarios were based on fixed target allocations of 3700 MCM and 2900 MCM so an adaptive allocation strategy (a form of demand management) was explored whereby sliding scale reductions to abstractions were made when the lake levels fell below warning and critical levels. Mild, moderate and strong levels of reduction were explored under different levels of rainfall variability. The results of the risk-based analysis showed that the moderate and strong adaptive options can initiate Lake Urmia recovery but only if the abstraction target is much lower than 3700 MCM. It was shown that, at a target abstraction rate of 2900 MCM, the moderate management option is effective in delivering the amount of water to the lake needed to maintain the minimum ecological requirement (3100 MCM/year) based on the vision stated in the EMP

Independent scientific assessment needed. The results of the reassessment highlight three main issues: (a) the need for independent scientific assessment based on rigorous reliable data; (b) the revision of the existing water allocation rules i.e. the 2008 WAC; although, the 2008 WAC has introduced basin-wide planning, it has a rigid scientific approach and uses highly unreliable methodology in assessing water availability and (c) the outcome of the WAC process is unrealistic as it ignores demand management which is one of the cornerstones of IWRM. To redress this, the reassessment calls for an adaptive water allocation strategy which is a form of demand management which, together with basin-wide water use efficiency measures, is required to achieve long term sustainability.

Therefore, the following ***recommendations*** are made:

1. A thorough review of the hydrological and climatic baseline data to remove much of the uncertainty about the water allocation governance.
2. Modification of the 2008 Water Allocation Code by (a) by removing the Detrending Method in the estimation of the water availability for the basin since it produces a highly overestimated value of natural runoff; (b) allowing other MCDA approaches other than AHP to minimise the inconsistency about weighting water allocation criteria; and (c) using a stochastic approach in the water allocation strategy since trend analysis is highly unreliable and cannot account for the persistence and variability of rainfall records.
3. Vensim dynamic simulation has to be calibrated with more sophisticated generic water resources modelling systems such as WEAP, Mike Basin or RIBASIM.
4. Implementation of water use efficiency measures.

9.2.6 Objective 6: Institutional sustainability of water resource governance

Chapter VII makes (a) an analysis of the institutional sustainability of the new governance system i.e. the MSPs; (b) evaluates the implications of adopting the adaptive water allocation approach and (c) proposes revised Responses for sustainable management of water resources in Lake Urmia basin.

In Chapter VII, ***first, the efficacy of new operational level rules*** in use is assessed. It is concluded that the successful conclusion of the WAWG meetings can be attributed to the ability and the flexibility to craft new rules at the local level (operational level) entrusted in the 2010 NEC bylaw. Law-making is a long process; an Act of Majlis can take decades to be ratified. Council of Ministers' By-laws can take years to be approved. Therefore, to address immediate operational level needs, this mechanism can be very effective.

Secondly the mental models and perspectives of the actors within the evidence-based decision-making process were analysed. This provides an understanding of how discursive deliberations are used by the actors. There is a strong evidence of the influence of "invisible" or 'hidden' actors (mainly career bureaucrats, and officials and advisors of governmental departments) in crafting alternative policies and proposing solutions to policy problems. The presence of these actors was manifested in the presence of Water Policy and Allocation Commission (WPAC) and the Iran Water Resources Management Company (IWRMC) in the Working Group (i.e. WAWG) meetings dictating how information and knowledge is used in the decision-making process

Thirdly, by examining the narratives told by the actors and participants, it is noted that Lake Urmia is not clearly on the mental map of the provincial actors and some of national actors. Therefore, the Working Group (i.e. WAWG) meetings embarked on a difficult task to put Lake Urmia on the 'issues map' and making it central to any water allocation in the basin. The momentum of the participatory process was maintained by high political support. It can be concluded that there are many loops in the arguments and the actors have no idea how to implement a win-win strategy to save the lake.

Fourthly, discourse analysis shows how different discourses made actors to have multiple perspectives with regards to the issues of concern or solutions to stop the demise of Lake Urmia. The diverging cross-sectoral multiple perspectives need to be harmonised to establish a common understanding between national and provincial actors.

Based on the discourse analysis, major recommendations are as follows:

- ***To incorporate environmentally friendly clauses in a revised water law*** since there are no explicit provisions of environmental water allocation in the existing water Act (i.e.1982 FWD Act)
- ***To strengthen the environmental discourse*** (Figure 9.1) by scientific arguments rather than alarmist activism which has characterised Iranian environmental movement; this will help to gain political support and provide an alternative meta-narrative on the environment.
- ***Reconciling national vs. local interests***. The hidden perspective of MoE is that local short-termism is not compatible with long term national interests. There is a need to reconcile this mismatch. The Iranian policymakers have made water allocation a centralised 'national' issue (MRC, 1995) and, according to MRC (1995), any change in policy will create vulnerability and cause damage to the national interest. The local needs can be met by allowing the regions to continue with the "*desired local development*" and this offers incentives for local aspirations. Small dams and irrigation projects can be used to satisfy local demands and the water budget can be used to allocate water from groundwater resources for local demand sites (industrial, agricultural and so forth). The recommendation made by the parliament in this report (i.e. MRC, 1995) can explain the drive to over-exploit groundwater resources (See Chapter IV for a national picture). The legacy has come about because water allocation is detached from local attributes and seen as a national security issue.
- ***To rectify mismatches in the national IWRM Plan which is*** based on more surface water for irrigation i.e. the 2003 Strategic Water Resources Planning Bylaw endorsees more surface water irrigation development so there is a need to rectify this imbalance
- Reviving traditional water governance such as the *qanat* system has been identified as a key management option for the future

Towards modernity. Next, we have demonstrated that there has been a paradigm shift in Iran and there are signs that Iran is moving towards a reflexive modernity paradigm as illustrated by the Lake Urmia case study. Iran's route is somehow different form the North's route depicted by Allan (2005).Political instability and short term interests of political actors are instrumental in striving toward sustainability. These will hamper any attempts towards implementing IWRM in Iran.

Institutional analysis. Finally, the institutional sustainability of the governance system has been analysed and some recommendations have been made i.e. new Responses have been suggested. First, the design principles have been reviewed; then recommendations have been made for the adoption of adaptive water allocation.

Re-thinking design principles. One of the major findings is that the empirical evidence from the Lake Urmia basin case study showed that the original eight design principles developed by Ostrom (2005; 2011) and verified by Cox et al (2009) are not enough for the institutional sustainability of large river basins with complex Social-Ecological Systems. The findings support Imperial's (2009) suggestion to include additional principles to attain institutional robustness. It is recommended to include new design principles including:

1. To develop trust across organisations
2. To develop shared definition and understanding
3. To recognise mutual interests
4. To maintain the balance of power among stakeholders
5. To employ a wide range of policy instruments (management options)
6. it is argued that we have to create structural mechanisms to bring into the picture the issue of unauthorised abstractions

The implication of adaptive water resource governance. Adaptive water resources governance may be established as part of proposed revised Responses that may have the following elements:

(a) Collective Choice Arrangements: most of the participants felt that community-based water and land governance system can help to achieve the objectives of water allocation strategy as there is a high level of informal and unauthorised abstractions i.e. without community support, the adaptive management approach cannot be put into practice (Appendix A, Table A1.4). Local political support is vital and so the community level representations should be enhanced by including civil society and NGOs. Incorporating local nested enterprises by recognising the informal institutions and their knowledge systems seems to be necessary to implement the EMP. Bringing the informal institutions into the formal set up can be achieved gradually through the social learning processes and adaptive management practices.

(b) Monitoring: is non-existent. Most of the participants felt that monitoring should be done by an independent organisation. Monitoring system is required not just to monitor water inflow into the lake, but also to reflect the adaptive nature of water allocation under different climatic conditions. Monitoring system can be part of a Drought Risk Management (DRM) plan which is an integral part of the EMP and should be seen as a major component which has a bearing on water allocation among provinces and different uses and sectors. However, the cost of monitoring has to be taken into account.

(c) Revising the Ecosystem Management Plan (EMP). The EMP understandably concentrates on Lake Urmia water rights and its management. However, the EMP's scope has to be widened to consider the whole basin based on river catchment governance. The EMP has achieved its goal to put Lake Urmia's water rights on the water resources planning map. But now it has to be streamlined with river basin planning which requires a wider vision. The effectiveness of the EMP is in doubt if the recommendations in Chapter VI are not dealt with (see Objective 5)

(d) Incorporating demand management within wider management options. The participants were not just happy about saving the lake but wanted to have more policy options including implementing structural and non-structural responses. For example, 'saving the lake' was considered as one of the management options. Therefore, the demand management proposal in the 2010 NEC Bylaw has to be streamlined with local development drives. The Bylaw offers incentives for water saving activities. For example, nearly $US5,000,000 has been allocated for implementing water use efficiency projects, in the process 50% of the cost of upgrading irrigation technology (20,000,000 Riyals= US$2000) per ha to be given to farmers; and the other 50% is to be provided by bank loan facilities. Based on the results from the ISTA component (Chapter VI), a water demand management approach has to be a key to any strategy for sustainable water use in the basin.

(e) Graduated sanctions. Ostrom (2005) reports that many self-organising systems use graduated sanctions against those who break rules. Involving farmers in the collective choice arrangements (i.e. decision-making process) may enhance mutual monitoring and better compliance. So far this element has been missing from the institutional reform. Informal or unauthorised abstractions have been highlighted in the 3rd and 4th NEC Meeting Directives. This level of monitoring is very difficult to police. Therefore, it is argued that smaller watershed units should be considered in the institutional design as there are about 31 river catchments in the basin. This level of monitoring requires community based water and land governance. This theme has been dealt with in Objective 7 (Chapter VIII).

9.2.7 Objective 7: an Ethical legal framework for good governance

In Chapter VIII we established a clear link between land and water resources and thus the term natural resources has replaced the term land and water. This chapter fulfils Objective 7 of the research by using Islamic environmental Ethics to develop the principles and legal framework for a *Hima* community-based natural resources (CBNR) governance system.

The analysis in Chapters IV-VII has shown that there is paradigm shift towards community based governance and this has been recommended by many participants since the livelihood issues need to be considered. A general consensus was that ethical and cultural aspects of the community have to be considered. The normative format of ethics is not enough. These norms and principles have to be translated into practical rules in use.

Chapter VIII highlights that Islamic legal theory is a powerful approach to translate Islamic environmental ethics into practical governance rules (Jenkins, 2005). Some examples of the use of Islamic environmental ethics have been noted in parts of Africa and Asia. Therefore, it is argued that the *Hima* concept is relevant in modern times.

Islamic legal theory provides a framework for understanding the action-actor relationship as a basis for legitimacy and enforcement of the rule of law. A legitimate rule should satisfy the criteria of no hardship, ability to understand and capacity to perform according to the rule. Legitimacy is then a measure of the successful implementation of the CBNR management plans i.e. the efficacy of a governance system is a measure of its legitimacy. Therefore, careful capacity development and empowerment is needed at the lowest level of decision-making (i.e. community-based) to achieve institutional efficacy i.e. community based governance will foster legitimacy by improving the effectiveness and the efficiency of the administrations.

The proposed *Hima* governance system consists of:

1. The principles of *Hima* governance which refer to the constitutional governance level are divided into four broad categories fulfilling the three objectives of the *Hima* approach: social cohesion, sustainable resource use and environmental protection. It is concluded that Islam provide a coherent set of principles for an equitable and sustainable use and management of natural resources and is comparable to (a) the nine contemporary CBNR governance principles presented by Dudley (2008) representing IUCN's guidelines on protected areas and (b) twelve organisational principles based on a survey of latest research (Gruber, 2010).

2. The Ethical legal framework for a *Hima* governance system which refers to a collective choice governance level is derived from Islamic legal theory. This describes the journey of translating the principles into strategies and normative rules.

   On Islamic environmental ethics, it is postulated that

   - Environmental policy debates are more or less about morality and ethics. Therefore, ethical consideration in land and water resources use and conservation (i.e. the environment as a whole) is vital for attaining sustainability criteria.
   - The Islamic ‘green’ credential has earlier been demonstrated by noticing a close match between ecological laws and Islamic environmental ethics.
   - *The Hima* governance framework represents a strong approach to environmental ethics which is based on the community’s belief systems and this can be used to strengthen environmental ethics in Lake Urmia basin within a capacity development strategy.
   - the *Hima* concept will foster collective choice arrangements and nested enterprises based on the legitimacy framework provided by Islamic legal theory

Proposed Responses for Lake Urmia basin. There are two important issues in contemporary CBNR that have to be well defined: property rights and right of use. In Lake Urmia basin, resource regime and property rights, a monitoring system, and environmental ethics are the determinant factors on the path to sustainability.

It is proposed that the *Hima* governance system:

- can directly deal with the right of use issues; the *Hima* legal framework provisions recognise a mixture of public-private water rights and use rights
- will foster collective choice arrangements which are also advocated as one of the eight design principles by Ostrom (2005) as a basis for establishing a viable monitoring system which is owned by the local community and regulated by relevant authorities; and
- can provide robust environmental ethics which have to be strengthened in LUB to bring about changes in the attitudes and cultures.

Hima governance which is based on ethical community -based natural resources management seems to have a wide application in sustainable resource use and the conservation of natural resources in LUB, the WANA region and beyond. This theoretical treatise should be tested in case studies and the scope of the research can be widened by considering other belief systems as all religions have similar value-laden principles.

9.3 Applications of the Framework

9.3.1 A reflection

The integrated methodological approach provides an innovative analytical framework to understand the discursive deliberations in a complex Social-Ecological system heightened by (1) scientific uncertainty over climate variability and change and (2) dynamic institutional transformation and evolution.

To work at the interface of social and physical sciences, the linguistic attributes and language barriers have to be well understood in order to be able to navigate through multiple approaches and concepts. The social-physical discipline divide and critical inquires about the nature of the epistemological[1] aspect of the interdisciplinary research should be treated with care and due diligence and should not be treated as naïve expectations from single discipline research. The points of interaction and linkage have to be found to present a coherent integrating synthesis as well as preserving the internal consistency of the methodological framework.

The proposed Framework is characterised by coherency and internal consistency to make it a powerful analytical approach to resolving water resources problems. For example, IWRM as a conceptual framework has a strong institutional (decision-making) orientation; the DPSIR component provides logical sequential linkage to the issues and problems facing a water resources system and can be used to describe the institutional change and evolution over time; and IAD component is used to make an ex-post analysis of the Responses element of the DPSIR.

Although the methodological approach has been useful in integrating the complex and overlapping dimensions of the water resource system and the dynamics of the evolution of non-structural Responses (policy options) i.e. providing a study of change and institutional dynamism, it can be further improved. The combined DPSIR-IAD approach can be considered as the core analytical framework. There is a possibility to incorporate different analytical tools in the proposed Framework.

[1] Epistemology is the branch of philosophy of science that study the nature of knowledge, its scope and validity i.e. how we find reality

Although the Framework has captured certain characteristics of the Interaction-Outcome pathway, it could not provide a thorough basis for analysis. With reference to the Lake Urmia basin, for example, the results have shown the interplay of various policy-making actors, the presence of hidden actors as well as group formation and coalition buildings in the negotiations. Therefore, it is suggested that other institutional and policy analysis tools can be considered to capture different aspects of the multi-level complex action situation. The Advocacy Coalition Framework (Sabatier and Jenkins-Smith, 1999) may be used to assess the inter-personal competitions and group formations by provincial actors which showed a degree of aggregation in decision-making patterns. Similarly, the Multiple-Streams Framework (Kingdon, 2003) can give an insight into how different streams of actors work together if a window of opportunity arises in the form of MSPs. Also, the ISTA component may also be modified to accommodate the requirement of different action situations. Therefore, as a pioneering work, the Framework has to be tested in different action situations to develop a more robust theoretical basis.

Also, we have to recognise the limitations of the different components used in the analysis. In Chapter III we have dealt with the criticisms made on the use of the DPSIR for not being "*a tool for generating neutral knowledge*" (Svarstad et al , 2008). However, in Chapter III, the ontological and epistemological approach of the research design has been clearly outlined.

The IWRM is a global concept. Therefore, the developed Integrated Socio-technical Framework has a universal dimension, and it could be applied in any developing or even developed countries. Hence, the degree of transferability of the methodological framework is very high. However, due to the physical and financial limitations, only an Iranian case study has been considered**.** The Framework has to be refined and tested in more case studies.

9.3.2 Contribution of the research: from research to policy briefs

Researchers as facilitators. In Iran and worldwide, numerous researchers are involved in a variety of IWRM research themes, but their efforts are dispersed and there is a lack of communication between different research groups as well as between policy - makers and the research communities. A dialogue between the research communities and stakeholders is essential to create a platform for a wider dialogue among policy makers, the scientific community and the public at large (Hashemi and O'Connell, 2011). This work has contributed to the notion that researchers can become facilitators in difficult public policy debates and create a foundation for participatory decision-making processes.

The PhD work contributes to greater understanding of ***real world action research on water allocation governance*** through the work on the Lake Urmia case study led by the UNDP/GEF Conservation of Iranian Wetlands Project (CIWP). In the context of this PhD work, the real world research is concerned with (a) involvement in, improvement and broadened understanding of the water allocation decision-making process; (b) evaluating the outcome of the decisions using analytical components; and (c) studying change where there is concern for actions.

The author was involved in the consultation and implementation of multitier Multi-Stakeholder Platforms (MSPs) which opened unique windows of opportunity to test the innovative methodological framework. Also, the author has experienced a transformation in his role and status by holding multiple positions as a researcher, facilitator, actor and advisor.

Development of methods for institutional analysis. In addition to developing a pioneering work towards the implementation of IWRM, the research has contributed to the Newcastle Institute for Research on Environmental Sustainability's (NIReS) and the School of Civil Engineering and Geosciences' line of research on methods for institutional analysis which has previously been applied in the land and water policy process in India, Vietnam and Spain. This thesis has developed further the methodological innovation produced by Clement (2009). This work was presented in the 6th International conference of Environmental Futures session led by Professor Elinor Ostrom (2005, 2011) who won a Nobel Prize for economic sciences in 2009 on her works related to the IAD namely "*"for her analysis of economic governance, especially the commons"*[2].

Policy briefs for regional and global initiatives. The PhD work has been linked to international and regional initiatives including

- United Nations University- Institute for Water and Environmental Sciences (UNU-IWES) in Dubai.
- WANA Forum, Jordan
- World Justice Forum (WJF), New York

[2] Deatails can be found on the official site of the Swedish Academy of Sciences: http://www.nobelprize.org/nobel_prizes/economics/laureates/2009/press.html

The author has made several contributions on water scarcity policy and *Hima* governance for the West Asia and North Africa (WANA) Forum. Furthermore, a proposal was presented at the Third World Justice Forum meeting in Barcelona to foster community-based governance with an emphasis on Rule of Law. The work will also form the basis of the Hima Global Initiative to be launched in May 2012. The author is involved currently in writing the proposal for this Global *Hima* Initiative.

Contribution to the national IWRM project in Iran. The author has been involved on an informal basis with Updating the Water Master Plan-IWRM Project at the Office of Macro Planning at the Ministry of Energy. The office of Applied Research at IWRMC has also supported the PhD work and the author has worked with its various departments. Additionally, the author organised four workshops (8 days in total as described in Appendix A1) to introduce IWRM and institutional aspects to senior water sector managers. He also contributed to three national conferences on the theme of IWRM and its implementation in Iran which is described in the next sub-section.

9. 3.3 Disseminations of the results

Research findings and results were disseminated through international and national conferences and workshops as well the publication of two chapters in a book. The details are as follows:

Two chapters in the Handbook of Research in Hydroinformatics

1. Hashemi, M. and O'Connell, P.E. (2011a). Historical perspectives: from hydrological models to decision support systems (DSSs). In. Gasmelseid, T. (ed.). *Handbook of Research on Hydroinformatics: Technologies, Theories and Applications*, USA/Hershey PA: IGI Global.
2. Hashemi, M. and O'Connell, P.E. (2011b). Science and Water Policy Interface: An Integrated Methodological Framework for Developing Decision Support Systems (DSSs). In. Gasmelseid, T. (ed.). *Handbook of Research on Hydroinformatics: Technologies, Theories and Applications*, USA/Hershey PA: IGI Global.

Seven international conference papers (oral presentation with the papers or abstracts being published in the proceedings or available online)

3. 2011: An Integrated Socio-technical and Institutional Framework for Sustainable Water Allocation Decisions in Lake Urmia Basin (LUB). Paper presented at 6th International Conference on Environmental Futures 18 - 22 July 2011 Newcastle University, England.

4. 2010: A Socio-technical Framework for Implementing the Integrated Water Resources Management (IWRM) Plan in Lake Urmia Basin, Iran. Paper presented at the International Symposium of BHS, 19-23 July, Newcastle upon Tyne, England
5. 2009: A Strategic Framework for Institutional Capacity Building in the MENA Region: Cultural and Ethical Context. Paper presented at the International Conference on Capacity Building in Urban Water Management Under Water Scarcity Condition, 13 - 15 December Muscat, Sultanate of Oman.
6. 2007: Sustainable Water Policy in Arid regions: Ethical Dimension. The 4th UNESCO International Conference on Wadi Hydrology, Muscat Oman December 2007.
7. 2007: Urban Water Management: need for institutional reforms. UNESCO International Symposium on New Direction in Urban Water Management, Paris, France, September 2007.
8. 2007: Water Policy in Iran: an ethical Dimension. UNESCO/ISESCO/ UWMRC International Conference on Water Resources management in the Islamic Countries, Tehran Feb 2007.
9. 2006: Institutional Aspects of Integrated Coastal Zones Management: Case study Lake Urmia. 7th International Conference on Coasts, Ports and marine Structures ICOPMAS, Nov 2006, Tehran.

Three papers at National Conferences

10. 2010: A Framework for Re-assessing the IWRM Paradigm: A New National Strategy for Research. Paper presented at the 1st National Conference on Natural Resources, September 2010.
11. 2010: A New Hydroinformatics paradigm to Attain Science and Water Policy Interface. Paper presented at the 1st Iranian national Conference on Applied Research in Water Resources, Kermanshah, 13-15 May 2010
12. 2006: The Importance of Institutional Dimension in Integrated Urban Water Management and Urbanization in the Lake Uromiyeh Basin: The Role of Stakeholder participation. *1st National Conference on Urban development*, Sanandaj, Iran, December 2006.

Five contributions to Policy briefs for West Asia and North Africa (WANA) Forum and World Justice Forum workshops

13. Evolving the Integrated Water Resources Management (IWRM) Paradigm: Reassessing the underline policy assumption
14. Science-Water Policy Interface: An integrated methodological framework to deal with water scarcity in WANA region
15. Allocating Environmental Water requirements of Lake Urmia, Iran: an Ecohydrological Approach
16. Principles of *Hima* Governance: a Community-Based Natural Resources Management (CBNRM) System
17. A Social Model towards WANA Union: *An Islamic Governance Perspective on Non-sectarian policy for Social Cohesion*

Six discussion and resource papers for Conservation of Iranian Wetlands project (CIWP)

18. Discussion paper series 1: Sustainable Agriculture: true or myth
19. Discussion paper series 2:Analysis report: Comparative study of Salt lakes: putting more salt into the Lake
20. Discussion paper series 3: Irrigation Pricing
21. Discussion paper series 4: Droughts in the LU basin: concepts, Issues, challenges and methodologies: to develop Drought Risk Management (DRM) Plan
22. Resource paper 1: Principles of Designing & Developing an Integrated Modelling System (Decision Support System, DSS) for Lake *Urmia Basin*
23. Resource paper 2: Lake Urmia Basin DSS(LUB DSS): Design and Development Plan

9.4 Further works

There has been a call for a paradigm shift and this necessitates a call for an integrated international strategy for research into IWRM that can cater for the required paradigm shift and the change of boundaries of research inquiries. For example, the inclusion of Green Water (Objective 1, Chapter II) requires better understanding of the physical processes. Therefore, much greater emphasis should be placed on our understanding of the physical processes. As shown by the controversy over water availability in Lake Urmia, there is a need to come up with technical methods that can accurately reflect the physical processes (Hashemi and O'Connell, 2011b).

With reference to Lake Urmia basin**,** more research on climate change is needed since natural climatic variability and human-induced climate change and their interaction are not well defined. Therefore, this theme requires much more attention since higher climatic variability is expected in future climates. The climate change discourse which dominates the MoE perspective (see e.g. Attarzadeh, 2009; MoE, 2010b) is misleading since it overemphasise 'natural' droughts as the main cause of Lake Urmia's demise and in the process giving a wrong signal to the provincial stakeholders about the importance of the human induced impacts such as water utilisation and abstraction and global warming. For example, many politicians in the provinces easily dismiss the importance of the impact of dam-building and abstractions on the Lake. Therefore, there is a need for more rigorous research on topic of climate change in Lake Urmia basin to deal with the knowledge uncertainty. Furthermore, groundwater resources did not enter the debate and this represent a major gap in the water allocation governance system in LUB. Chapters VII provides a detailed proposal for institutional design (i.e.revised Responses) to be considered in further works. Chapter VIII present a proposal for *Hima* CBNR governance system. Also, further work is needed on:

- How the water-food-energy nexus will affect the water sector after the introduction of economic reforms set out by the 5th FYDP (2011-2015)?
- How to establish a monitoring system which is needed to monitor outcomes and to re-evaluate the water allocation process?
- How to design an institutional mechanism to make a proper independent technical review or re-evaluation of water allocation decisions?
- How to prepare a strategic plan to assess baseline data as a prerequisite for further work since publically available reliable data are the backbone of any further research?
- How to establish a viable water allocation governance system by considering water user associations (WUA) and other informal local institutions i.e. how to formulate community based governance systems?
- How to link water allocation and sustainable water use to the provincial land and water planning process i.e. how to achieve sustainable agriculture by applying water saving and water use efficiency measures?
- How can water allocation go through the politics of the decentralisation process e.g. how to bring local actors into the formal institutional set up?

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Appendix A1. Data collection sources

The data collection methods and sources are arranged two parts: Part I is arranged in explanatory table format and Part II is arranged in a diary format. In the main text of the thesis, the data source is mentioned with reference to the Appendix number or Table number or both e.g. (Appendix A1, Table A1.1). The acronyms are given in the nomenclature list.

Part I: List of workshops, working group meetings with key stakeholders

Activity/ Date/ Location	Outcome of activities	Participants (organisations)
Lake Urmia Second Integrated Management Plan Workshop, 17-18 November 2007, Tabriz, EA	Draft EMP	51 people from national stakeholders (MoAJ, MoE,); academic centres in EA and WA; NGOs from EA and WA; Governor's office (EA and WA); provincial departments of RWCs, AJOs, EPOs (EA and WA); Kurdistan representative from EPO.
Wetland Monitoring Training Workshop, 29 April- 1 May 2008, Urmia City , WA	Monitoring Protocol	**40 people:** 51 people from national stakeholders (MoAJ, MoE,); academic centres in EA and WA; NGOs from EA and WA; Governor's office (EA and WA); provincial governmental departments (RWCs, AJO, EPOs) from EA and WA; Kurdistan representative from EPO.
Urmia Zoning for Sustainable Management Workshop, 26-27 May 2008, Urmia City, WA	Lake Urmia Zoning map	**57 people**: 51 people from national stakeholders (MoE, MoAJ,); academic centres in EA and WA; NGOs from EA and WA; Governor's office (EA and WA); provincial governmental departments of RWCs, AJO and EPOs (EA and WA); Kurdistan representative from EPO.

Notes:
My role was participant and facilitator. Data collection methods used are: (1) qualitative survey including many informal interviews and 78 fully completed questionnaires based on European Commission (2006) and Saleth and Dinar (2004); (2) observational data including stakeholder meetings and discussions; (3) secondary data analysis including major past work reports; (4) baseline data on Lake Urmia basin.

Table A1.1: Main interactive stakeholder consulting workshops (2007-2008)

Activity/ Date/ Location	**Participants** (organisations)
Institutional Building Capacity to Implement IWRM, 25 April 2007 Kermanshah City	31 people mainly senior executive water managers from regional water companies in 4 western provinces: Kermanshah, Kurdistan, Lurestan and Ilam; IWRMC, Tehran University academic and consulting companies.
Implementing IWRM- Conflict resolutionWorkshop; 2-3 March 2008, Sanandaj, Kurdistan	24 people mainly senior executive mangers of regional water companies of Kurdistan and WA as well as participants from the Sanandaj city Municipality, city planning office and local consulting company
Institutional Aspect of Water Management (Open event), 7th May 2008 Karaj, School of Water and Land, Tehran University	Nearly 60 people representatives from MoAJ as well as academics and postgraduate students from the Faculty of Agriculture: Department of Land and Water, Tehran University

Note:
My role was trainer; I organised these interactive workshops providing (1) *qualitative survey and (2) observational data* as in Table A1.1.

Table A1.2: Main interactive capacity building workshops (2007-2008)

Reference used in the thesis	Interview/ forum	Participant (s)
Memari (2006)	Interview with Advisor to Deputy Minister for Water Affairs, November 2006	Mr Memari
Kashfi (2007)	Interview with the World Bank Co-ordinator of the Iran Water and Wastewater Company, Feb 2007	Mr Kashfi
MoAJ (2008)	Forum at the Agricultural Water Productivity Management Department, MoAJ, Karaj, 30 June 2008	Mr Janbaz (deputy director); Mr Bijan Dargahi (wetlands and irrigation networks); Mr Sayar Irani (Institutional); Mr Bahri (Agricultural Water use) Mr Kiamars Nazarpor I (Agricultural Water use); Mr Riazi (water economics); Mr Etrmadfar (Lake Urmia)

Notes:
The transcripts of these forums have been approved and can be quoted as data in the thesis.

Table A1.3a: Formal interviews and forums (2006-2008)

Participant	Position
Mr Ali Daemi	Director General, Office of Macro Planning, MoE
Dr Hedayt Fahmi	Director, Water Resources Planning
Dr Sedegha Torabi,	Director, , WAPC, MoE
Mr Kakahaji	Deputy Manager, Office of Lake Urmia and Caspian Sea Basins IWRMC
Mr Tehrani	Manager, Office of Lake Urmia and Caspian Sea Basins, IWRMC
Dr Ali Nazaridoust	National manager, CIWP
Mr Esfandiari	Manager, Water Economics section, IWRMC
Mr Mustafa Qadri	Director General, MoE ParliamentaryAffairs Office; Advisor to the Minister for Energy
Mr sayari	Director of Planning, IWRMC
MR Rozbeh Javaheri	Director, Applied Research Office, IWRM
Mr Mustafa Fedaeifard	Manager, Updating Master Plan - IWRM project, Office of Macro Planning, MoE
Mr Bijan Dargahi	Wetlands and Qanats Expert, Agricultural Water Productivity Management Department, MoAJ

Note:
I had a number of informal meetings and discussions with key stakeholders in MoAJ, MoE and IWRMC during the PhD work. They have contributed to my understanding about the issues in Iran's water sector.

Table A1.3b:List of Key national stakeholders (2007-2011).

1. Water and Agriculture Working Group (WAWG) meetings				
Date	**Place**	**Activity**	**Type of data**	**MoM**
23-4 Nov 2007	Urmia	1st WAWG meeting	Notes on the meeting	✓
26 May 2009	Urmia	2nd WAWG meeting	Observation data: 8 hours audio tape	✓
26 Sept. 2009	Sanandaj	3rd WAWG meeting	Observation data: 9 hours video tape	✓
16 Nov 2009	Tabriz	4th WAWG meeting	Observation data: 9 hours video tape; Mission Report by Eelco van Beek, International IWRM Consultant	✓
8-9 May	Urmia	5th WAWG meeting	Observation data: 12 hours video tape	✓
3 July 2010	Sanandaj	6th WAWG meeting	Observation data: 8 hours video tape	✓
2. Drought Taskforce meetings and Droughts Risk Management Workshop				
4 July 2010	Sanandaj	1st Taskforce meeting	Observation data: 4 hours of video tape	✓
9 Aug 2010	Tabriz	2nd Taskforce meeting	Personal Notes on the meeting	-
6-12 Feb 2011	Kish Island, Persian Gulf	Droughts Risk Management DRM Workshop	6 Draft consultancy reports on different aspects of droughts including hydrological, climatic and drought management plan Summary of Qualitative questionnaires	-

Notes:
Minute of Meeting (MoM) contained a detailed transcript of the proceedings of the meetings. All the meetings were documented either by audio or video recorders and the MoM was sent to stakeholders for approval.
1st meeting was attended by 21 people EA:AJO, Governor's Office, EPO, RWC, HTO, NRWMO and an Environmental NGO; WA: AJO, Governor's Office, EPO, RWC, HTO, NRWMO; Kurdistan: EPO
Other meetings the numbers and participants varied from meeting to meeting but a core of people attended the meeting including; national: WAPC (MoE); CIWP consultant and project co-predicators in Tehran as well as provincial co-ordinators in EA and WA. I played the role of Kurdistan project coordinator as well as the facilitator and organiser of the meetings. Between 38 to58 people attended the remaining 5 meetings. Permanent members for all three provinces include representatives from: RWC, AJOs, Governor's office and EPOs.
***Members who attended all the meetings*:**
I am indebted to the permanent WAWG members who have engaged with me with respect and trust:
National stakeholders: Dr Sedegha Torabi, WPAC
CIWP team:, MoE, Dr Ali Nazaridoust, Mr Saber Masomi, Mr Najafi (EA CIWP office), Dr Qureshi (WA CIWP Office)
EA: Mr Husseinlar and Mr Torabi (EARWC); Mr Musavi (MoAJ);
Kurdistan: Mr Khaleqpanah and Mr (KRWC); Mr Amerifar (KEPO), Mr Zulfaqarnejad and Mr Saeidi (KAJO), Mr Husseini (Governor's Office)
WA: Mr Torabi, Mr Rezaei and Mr Rajabi (WARWC); Mr Hafezi (WAAJO) and Dr Hojat Jabbari (WAEPO and unofficial Secretariat of the Regional Council who has also provide some of the photos of Lake Urmia)

Table A1.4: Working group meetings, Droughts Taskforce meetings and Droughts Risk Management Workshop (2007-2010);

Part II: Diary of the main Official Fact- finding Missions and meetings

Date	*Mission*	Activity
8 April 2009	Tehran	- meeting with CIWP management team and consultants
17 May 2009	Sanandaj	- provincial Water and Agriculture Commission meeting
21 May 2009	Sanandaj	- provincial Water and Agriculture Commission meeting
25 May 2009	Satellite Wetlands	- field visits to different satellite wetlands in the Gadarchai and Mahabad chi river basin
27 May 2009	Urmia	- meeting with provincial stakeholders in WA: AJO and RWC
15 June 2009	Sanandaj	- meeting with provincial stakeholders in Kurdistan: AJO and RWC
17 June 2009	Tabriz	-meeting with provincial stakeholders in EA: AJO and RWC
18 July 2009	Sanandaj	- meeting with Deputy Governor for Development , Kurdistan
25 July 2009	Tehran	- MoE and DoE's joint working group meeting on LU
27 July 2009	Tehran	- IWRMC: meeting with Director of newly established north and LU river basin organization (Eng. Tehrani) and Water allocation unit of the Water Resources Planning Office
28 July 2009	Tehran	- meeting with CIWP management team and consultants
5 Sept. 2009	Sanandaj	- meeting at Farmer's Association (NGO) and governor's office
6 Sept. 2009	Sanandaj	- meeting with RWC
9 Sept2009	Sanandaj	- Water and Agriculture Commission meeting
14 Sept.2009	Sanandaj	- meeting with Planning and Budget Deputy Governor
16 Sept 2009	Sanandaj	- meeting with major stakeholders at KRWC
24 Sept 2009	Sanandaj	meeting with KRWC & Governor's office
18 Oct 2009	Tehran	- meeting with CIWP management team and consultants
13 Oct 2009	Sanandaj	- meeting: Agricultural Engineering Council of Kurdistan and Deputy Governor of Kurdistan for Development
17 Oct2009	Sanandanj	- meeting: Director general of Kurdistan Natural Resources Organisation introducing IWRM into Land and Water Plans
13-20 Nov 2009	Tehran, Tabriz and Urmia	• meeting with staff and international consultants, Eelco van Beek • Stakeholder meetings with provincial representatives of EA, WA and Kurdistan • meeting with Dr Mnihaj and his team on their proposal for monitoring system
23 Feb 2010	Tehran	- meeting with CIWP management team and consultants
19 April 2010	Tehran	- CIWP seminar
20 April 2010	Tehran	- meetings with Dr Riahi, Director of Water Research Institute WRI; Dr Fahmi (MoE) and Mr Pourzand (Mahab Ghodss); Mr KakaHaji, Deputy Manager, Office of Lake Urmia and Caspean Sea Basins
21 April 2010	Tehran	- meeting Dr Minhaj on Monitoring DSS - Mr Ferdosi, UNDP
5 May 2010	Sanandaj	- meeting Kurdistan governor's Office
10 May 2010	Urmia	- WARWC data collection
30 May 2010	Sanandaj	- stakeholder meeting at KRWC
3 June 2010	Sanandaj	- meeting at KAJO- Potential irrigation report
13 June 2010	Sanandaj	- stakeholder meetings at KRWC
26-29 June 2010	Tehran	- several Meetings with international consultant; MoE, MoAj, Mahab Ghods
8-9 Aug 2010	Tabriz	- Stakeholder meetings and Drought Risk management Taskforce meeting
23-26 Aug 2010	Tehran	- various National stakeholder meetings
9 Oct 2010	Sanandaj	- meeting Mr Azhari Deputy Governor and his staff
11Oct 2010	Sanandaj	- meeting with Mr Khaleqpanah and KRWC staff
14 Oct 2010;	Sanandaj	- attending Water & Agriculture Commission
16 Oct 2010	Sanandaj	- meeting Deputy Governor of Kurdistan for Development with regards to 6th WAWG outcomes
3 Jan 2011	Tehran	- meetings at MoE with key stakeholders
24 Jan 2011	Sanandaj	- attending Water & Agriculture Commission
6-12 Feb 2011	Kish Island, Persian Gulf	-stakeholder meetings during Droughts Risk Management DRM Workshop
14 March 2011	Sanandaj	- meeting Deputy Governor of Kurdistan for Development

Notes:
I had several positions: (1) National IWRM Consultant to CIWP project; (2) unofficial Kurdistan co-coordinator for CIWP; and (3) researcher as PhD candidate.
As a, my role was facilitator and advisor, I was invited to many stakeholder meetings on fact finding missions as listed below. I had to liaise with many organisations on various matters related to the Lake Urmia case study. Types of data are: notes on these stakeholder meetings; Mission and Quarterly Work Progress Reports written for CIWP; and several analytical and discussion papers for CIWP analysing stakeholder narratives and discourse by the author.

Table A1.5: Diary of main Official Fact- finding Missions and stakeholder meetings (2009-2011)

Activity/ Date/ Location	contribution	Type of data	Participants (organisations)
Workshop on Towards Supernational Mechanisms in Addressing the Challenges of Water Scarcity in WANA, 22-24 Feb 2011 atKempinski Hotel, Amman- Jordan	Three contributions to Policy brief on water scarcity	MoM Concept Note Perspectives of regional actors	17 people from various universities and professional bodies Mediterranean in WANA region
* Workshop on Hybrid Hima Approach to Community based Resources Management: Bridging the gap between tradition and modern-day governance, 14-16 April 2011 at IRCICA, Istanbul-Turkey	** Policy brief paper on Principles on Hima Governance	MoM Concept Note Feedback on research results Perspectives	About 40 people attended from different parts of WANA, the Principles of Hima Governance was presented at this meeting
WANA FORUM Annual Meeting, 9-10 May 2011 at Kempinski Hotel, Amman- Jordan	Keynote speech on the issue of integration towards creation of supernational mechanisms for cooperation in WANA	Concept Note Feedback on results of PhD; Perspectives on various policy issues	An audience of 100 people from WANA region, UN agencies, European and American academic and policy institutes

Notes:
* This workshop was sponsored by World Justice Forum (WJF) and co-organised by Society for the Protection of Nature in Lebanon (SPNL)
** a paper based on the research and the feed from this workshop was presented at the 3rd meeting of World Justice Forum in Barcelona in July 18-21, 2011.

Table A1.6: WANA Forum workshops and meeting (2011)

Appendix A2: ToR of National IWRM Consultant (i.e. the author)

Specific tasks with reference to water allocation process in Lake Urmia are as follows:

(a) Water Allocation between provinces

a. Facilitate agreement provincial water shares - normal conditions
b. Facilitate development water allocation protocol by WAWG
c. Development of monitoring protocol by WAWW
d. Decision making on water allocation by Regional Basin Council
e. Implementation of monitoring system

(b) Supporting studies

f. Support provinces to develop provincial IWRM plans
g. Study/awareness on relative importance drought / development
h. Workshop and awareness material on drought and climate change including Drought conference and Taskforce
i. Develop ToR for bathymetry study of LU
j. Support study on options for reducing evaporation from LU
k. Support study to determine full cost of water for agriculture

(c) Water & Agriculture Working Group (WAWG) meetings

l. Supporting and participating Lake Urmia WAWG meetings