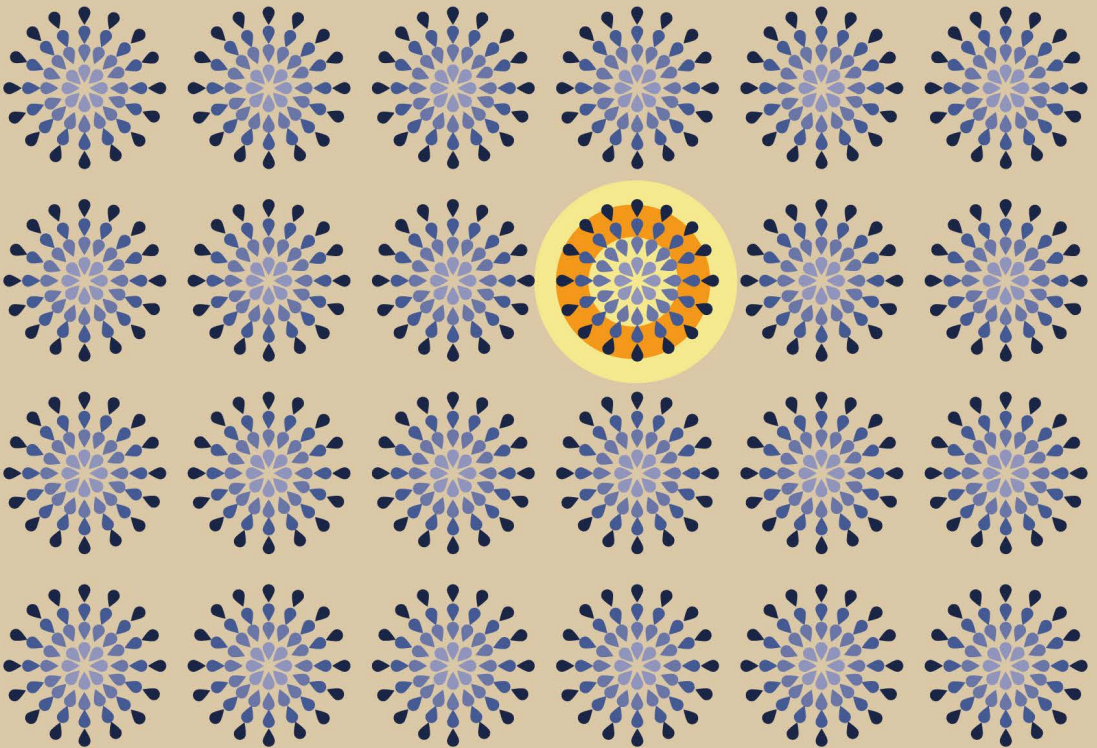


IN SEARCH OF INTEGRATION

Analyzing the gap between theory and practice of Integrated Water Resources Management with case studies from West Africa and international policy processes

Virpi Stucki

Dissertation for the degree of Doctor of Science in Technology



IN SEARCH OF INTEGRATION
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Abstract Integrated Water Resources Management (IWRM) is one example of integrated approaches to natural resources management that has been widely promoted during the past decades. In this thesis, IWRM is understood as a strategic management procedure that integrates the natural resources and society (users and institutions) around a body of water. Numerous international conferences and meetings have promoted IWRM as a key approach to water management and subsequently a way to sustainable development. Yet, practical implementation of IWRM on the ground has had uneven success. The overall objectives of the thesis were to increase understanding of the high-level, strategic issues that hinder or enable the translation of IWRM from policy into practice and based on that, to distil special considerations of IWRM in Senegal River and Lake Chad, for integrated approaches, and among practitioners. This was done by examining the gap between theory and practice of IWRM with the help of case studies representing IWRM in practice (Senegal River, Lake Chad), and IWRM in theory (IWRM in international policy, climate change adaptation policies as a driver for integration). A framework was developed and used in order to systematically analyze the appearance and implementation of IWRM in the four case studies. The methods used in examining the case studies varied from a literature review and field visits, to Bayesian Causal Networks, comparative analysis and qualitative data analysis. The thesis concluded with four high-level, strategic issues that hinder or enable the translation of IWRM from policy into practice. These include i) the importance of recognizing externalities, ii) defining and understanding the "IWRM area of influence" (the confluence between theory, practice and externalities), iii) the key role of institutions and especially management and communication aspects, and the fact that iv) understanding, analyzing and managing the above is more about nouns than numbers.			
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Väitöskirjan nimi INTEGRAATIOTA ETSIMÄSSÄ Kokonaisvaltaisen vesistösuunnittelun teorian ja käytännön välisen kuilun analysointi Länsi-Afrikkaan ja kansainväliseen politiikkaan liittyvien tapaustutkimusten avulla			
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Tiivistelmä Kokonaisvaltainen vesistösuunnittelu (Integrated Water Resources Management, IWRM) on yksi esimerkki monista luonnonvarojen integroiduista eli yhdenmetyistä hallintamentelmistä, joita on edistetty viime vuosikymmeninä. IWRM ymmärretään tässä työssä strategisena toimintatapana, jossa vesistön valuma-alueen luonnonvarat ja yhteiskunta, mukaanlukien käyttäjät ja instituutiot, integroidaan. IWRM:ää on pitkään edistetty lukuisissa kansainvälisissä konferensseissa ja kokouksissa yhtenä tärkeänä vesitaloudellisena lähestymistapana ja keinona kestävään kehitykseen. IWRM:n tulokset käytännössä kenttätasolla ovat olleet kuitenkin vaihtelevia. Tämän väitöskirjan tavoitteena on lisätä tietoa makrotason strategisista seikoista, jotka estävät tai edesauttavat IWRM:n toimeenpanemista politiikasta käytäntöön. Erityisinä tavoitteina väitöskirja listaa IWRM:n erityispiirteitä Senegal-jokeen ja Tsad-järveen, integroituihin hallintamentelmiin, sekä integroituihin hallintamuotoihin käyttäviin ammanttiharjoittajiin liittyen. Tutkimustulokset saavutettiin tutkimalla IWRM:n teorian sekä käytännön välistä kuilua tapaustutkimusten avulla. Näistä kaksi edustivat käytäntöä (Senegal-joki, Tsad-järvi), sekä kaksi teoriaa (vesi kansainvälisessä politiikassa, ilmastonmuutokseen sopeutuminen yhdentymisen ajajana). Tapausten järjestelmällistä arviointia varten kehitettiin viitekehys. Tapausten tutkimusmetodeina käytettiin eri tutkimusmenetelmiä. Nämä ovat kirjallisuusanalyysi, kenttävierailut, Bayesian kausaaliverkkoihin perustuva malli vesipolitiikan arvioimiseksi, vertaileva tutkimus, sekä laadullisen datan analyysi. Väitöskirjan johtopäätöksenä on neljä korkean tason strategista seikkaa, jotka estävät tai edesauttavat IWRM:n toimeenpanemista politiikasta käytäntöön. Nämä ovat: i) ulkoisvaikutusten tunnistamisen tärkeys, ii) IWRM:n vaikutusalueen määrittäminen ja ymmärtäminen, iii) instituutioiden ja niissä erityisesti johtajuuden ja viestinnän tärkeä rooli, sekä iv) huomio siitä, että edellä mainittujen seikkojen ymmärtäminen, analysointi ja hallinnointi vaativat enemmän sanallisen, kuin numerotiedon ymmärtämistä.			
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This thesis would not have been possible without the continuous inspiration and mentoring of my supervisor and instructor, Professor Olli Varis. In addition to the immeasurable amount of technical guidance received over the years, Professor Varis has set an example to continuously question the mainstream concepts in water resources management as well as to think out-of-the-box. It would not have been possible for me to finalize this thesis without the perseverance and encouragement of Professor Varis. My other instructor, Professor Steven de Bie, has played a similarly important role. Due to his encouragement, I dared to take on the task of finalizing the products of years of research into a completed thesis. Professor de Bie's way of combining scientific work with a demanding job at the private sector is an example to aim for during the remainder of my career. I also value the many discussions about ecosystems, biodiversity, private sector, and science that we have had during the past two years.

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In Vienna on 13.6.2011,
Virpi Stucki

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ABBREVIATIONS

CIFOR	Centre for International Forestry Research
ECOWAS	Economic Community of West African States
EUWFD	European Union Water Framework Directive
FAO	Food and Agriculture Organisation of the United Nations
FLR	Forest Landscape Restoration
GDP	Gross Domestic Product
GEF	Global Environmental Fund
GIWA	Global International Water Assessment
ICZM	Integrated Coastal Zone Management
INRM	Integrated Natural Resources Management
IWRM	Integrated Water Resources Management
IPCC	Intergovernmental Panel on Climate Change
LCBC	Lake Chad Basin Commission
LDC	Least Developed Countries
MSD	Multi Stakeholder Dialogue
NAPA	National Adaptation Programme of Action
NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
OMVS	Organisation pour la Mise en Valeur du fleuve Sénégal
QDA	Qualitative Data Analysis
SAED	Société Nationale d'Aménagement et d'Exploitation des Terres du Delta du Fleuve Sénégal
SAP	Strategic Action Plan
SSZ	Sudano Sahelian Zone
SWAC	Sahel and West Africa Club
TDA	Transboundary Diagnostic Analysis
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNOPS	United Nations Office for Project Services
WB	World Bank
WSSD	World Summit on Sustainable Development

LIST OF APPENDED ARTICLES

The thesis is based on the following Articles:

- I: Lahtela*, V. (2003). Managing the Senegal River – national and local development dilemma. *International Journal of Water Resources Development*, 19, pp. 279-293.
- II: Varis, O., Lahtela*, V. (2002). Integrated Water Resources Management along the Senegal River: Introducing an Analytical Framework. *International Journal of Water Resources Development*, 18, pp. 501-521.
- III: Varis, O., Rahaman, M.M., Stucki, V. (2008). The Rocky Road from Integrated Plans to Implementation: lessons Learned from the Mekong and Senegal River Basins. *International Journal of Water Resources Development*, 24:1, 103-121.
- IV: Stucki, V., Niasse, M., 2008. The Role of Domestic Security in the Functioning of the Lake Chad Basin Commission. In: N. Pachova, M. Nakayama, & L. Jansky (Editors), *International Water Security – Domestic Threats and Opportunities*. United Nations University Press, Tokyo; New York, pp. 110-126.
- V: Stucki, V., Smith, M. (2010). Integrated natural resources management in practice; the catalyzing role of National Adaptation Programmes for Action. *Ambio*, 40:4, Page 351.

* Lahtela is the author's maiden name

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Contribution of the author to Articles from I to V is as follows:

- I: The author is responsible for writing the Article.
- II: The author is responsible for writing portions of the Article. She formulated the general framework and hypothesis for assessing IWRM in Western Africa. Prof. Varis designed and conducted the modelling component of the Article. The author contributed to the modelling component by assisting in the selection of the main variables, in construction of the link matrix, and in choosing the scenarios. The results of the modelling activity were analysed together with Prof. Varis.
- III: The author is partly responsible for writing the Article. She wrote the Senegal River case study while Prof. Varis wrote the Mekong River case study, and Dr. Rahaman provided details on the international policy processes. The author participated, along with Prof. Varis and Dr. Rahaman, in formulating the Introduction and Conclusions sections.
- IV: The author is responsible for the basic idea and background research of the Article. Dr. Niasse wrote portions of the Article and provided access to local material and expertise.
- V: The author is responsible for the idea of the Article and all data analyses. Dr. Smith contributed to drawing the conclusions.

FOREWORD

The story of the Emperor's New Clothes by Hans Christian Andersen pointed out the gregarious characteristic of human nature. People admired the non-existing clothes of the Emperor just because everybody else did. Humans tend to go with the crowd. A number of authors suggest (Cambell *et al.* 2004, Merrey & Drechsel 2005) that something similar might have happened with the concept of Integrated Water Resources Management (IWRM). That is, the concept has become fashionable in the field of water resources management, and is promoted as the key water management method across geographic regions and institutions.

When I first started to acquaint myself with Integrated Water Resources Management (IWRM) around 10 years ago, I was intrigued by the concept's holistic nature. I thought that IWRM was the answer to everything that the water resources management discipline needs. It was only later, while working for an international organisation when I realized that IWRM was only one of many integrated concepts. Ecosystem Approach, Integrated Natural Resources Management, Forest Landscape Restoration, Integrated Coastal Zone Management, just to mention a few of the most well-known approaches, all view nature in a holistic manner. All of these concepts were equally appealing to their respective communities of practice.

It was with great surprise that I then followed the water-forest debate that was lively in the international arena a couple of years ago. The concept of "integration" seemed to be missing to a large extent from the discussions where the role of forests in water regulation was debated among world's leading scientists. This was despite the era of integrated approaches promoted by the various practitioners of natural resources management.

When looking back at the real-life examples of watersheds in West Africa that I had been studying in the past, the concept's initial appeal started to diminish. This impression was further fortified when reflecting my experiences of living and working in Burkina Faso, Ghana and the Niger Delta of West Africa over the past nine years. I was puzzled by the question of how the near- perfect concept of IWRM could have so few success stories in practice? Finding answers to this question has inspired the thesis.

1 INTRODUCTION

Integrated Water Resources Management (IWRM) is a widely-used concept in today's water literature and practice. One of the widely used definitions of IWRM is that of the Global Water Partnership (GWP), which defines IWRM as “a process that promotes coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (GWP 2003). Despite the wide distribution of the GWP-definition of IWRM, one should note it is merely a visionary –rather than a practical- statement. As will be exemplified in the summary section and appended articles of this thesis, balancing the needs of different users and institutions is often a question of power and politics.

The IWMR-concept¹ has been discussed and promoted at national (National Board of Waters 1974) and international policy levels for decades (GWP 2000, Biswas 2004a). Similarly, examples of IWRM plans are numerous from many parts of the world (e.g. EC 2010, AfDB 2000, Rahaman 2009, Keskinen 2010). The success of IWRM differs from area to area (UN-Water 2008).

IWRM is, however, only one example of integrated approaches to natural resources management that is currently popular and widely promoted these days (Article V). Other natural resources domains have their own integrated concepts: foresters talk

about Forest Landscape Restoration (FLR), the conservation community about the Ecosystem Approach, marine scientists about Integrated Coastal Zone Management (ICZM) and agricultural professionals about Integrated Natural Resources Management (INRM), just to mention a few of the most well-known ones.

In many parts of the world water basins continue to deteriorate (UNESCO 2009a) and the usefulness of IWRM is being questioned (Walther 1987, Lahtela 2002, Jones *et al.* 2006, Medema & Jeffrey 2007, Ioris 2008, Moss 2010). Nevertheless, integrated concepts, such as IWRM, are still being promoted at the international policy processes (Snellen & Schrevel 2004) and by international organisations (e.g. GWP 2005, UNESCO 2009b).

IWRM in this thesis is understood as a management procedure that integrates the natural resources and society around a body of water. The underlying research driver is the need to better understand the perceived mismatch between IWRM in theory and practice. This is done by examining a number of case studies using a common framework in which IWRM is divided into three axes:

- Nature;
- Society: users; and
- Society: institutions.

In this thesis, “Integration” of IWRM is understood as an act to combine components including the

¹ In the literature used in this thesis, IWRM is referred to as “process”, “concept”, “tool”, and “approach”. In the remainder of the thesis, the use of a particular term used in the literature is respected, i.e. not changed for the purposes of consistency. Therefore, the terms “process”, “concept”, “tool”, and “approach” in relation to IWRM should be considered interchangeable.

three axes listed above. In management terms, integration is here understood as the “means” needed to reach an “end” - not the end itself.

Geographically, the thesis concentrates on examining IWRM in one of the poorest areas in the world in terms of economic and socioeconomic performance as well as natural resources availability: West Africa. More precisely, the case studies of Senegal River and Lake Chad fall under the Sudano-Sahelian Zone, which is characterized by a low degree of resilience, such as irregular climatic conditions and proneness to locust invasion (Heinrigs & Perret 2006). Political instability and proneness to conflicts add further challenges to both water basins (EIU 2011). Both basins have a long history of IWRM plans, many of which have been developed with the support of international organisations (PNUD-OMVS 1974, OMVS 2007, 2008, LCBC 2008). Yet, implementation of the plans in a way that would contribute to sustainable development has had its shortcomings (Articles I, II, III, IV).

The case studies of theory represent international policy processes. The first purely water-related study examines how IWRM recommendations, as promoted by various international conferences and events, are reflected on the ground. The second study looks at the National Adaptation Programme of Action (NAPA) and the level at which integrated approaches, including IWRM, are promoted in the Least Developing Countries’ NAPA project profiles.

Various methods are used to analyse the case studies: literature review, field visits, comparative analysis, policy model based on Bayesian Causal Networks as well as qualitative data analysis. In addition to using the different methodologies for analysing the gap between theory and practice, their suitability as “IWRM methods” is assessed.

The Summary section of the thesis begins with defining objectives and boundaries, as well as presenting the materials, methods and approach used. This is followed by a presentation of the history and latest developments of the principles

of IWRM with a special emphasis on West Africa. Next, methods to assess IWRM in different settings are presented. Case studies of analyzing IWRM are then summarized and followed by Findings on the Specific Objectives and Overall Objectives sections. The Summary section ends with Conclusions.

1.1 OBJECTIVES AND BOUNDARIES

The thesis has two **Overall Objectives**: I) to increase understanding of the high-level strategic issues that hinder or enable the translation of IWRM from theory into practice and based on that, II) to distil special considerations of IWRM for Senegal River and Lake Chad, which both are located in West Africa, for integrated approaches, and among practitioners.

The Overall Objectives were attained by finding answers to the four **Specific Objectives** below:

- i. Development of a framework for systematic analysis of IWRM,
- ii. Using the framework to analyse two case studies of IWRM from West Africa and two from international policy processes,
- iii. Comparing the case studies of theory and practice in order to extract IWRM factors that would not be revealed by studying the cases separately,
- iv. Assessing the suitability of the methods used in case studies for analysing IWRM.

Findings on the Specific Objectives are presented in Chapter 5, and on the Overall Objectives in Chapter 6. Conclusions are drawn in Chapter 7.

The following gives details on the **boundaries** of the thesis:

- The geographical focus of the thesis is the Sudano-Sahelian Zone of West Africa.

- The thesis was done by an engineer, for the School of Engineering, and therefore the primary target audience of the findings is the academic engineering community.
- The diversity of the case studies included in the thesis as well as the choice of methods used in the analyses allow for “painting the big picture” of IWRM. The thesis thus provides a macro-level, as opposed to a detailed micro-level, analysis of IWRM.
- Due to the previous bullet point, as well as the strong role of policy and international organisations present in the case studies, the findings of the thesis are the most suitable at the strategic, macro level rather than practical, micro-level implementation of IWRM on the ground.

- The methods used in this thesis do not allow for examining IWRM from the perspective of local players or stakeholders.

1.2 MATERIAL, METHODS AND APPROACH

The **material** in this study consisted of the existing literature, articles, reports, and data from international databases. The quantity and quality of data are often a problem when researching developing countries. In this thesis, the quality of the material available on the Senegal River and Lake Chad was controlled by field visits and by interviews and contacts with local experts.

Material on forest-water relationships was collected mainly from current publications. In addition to

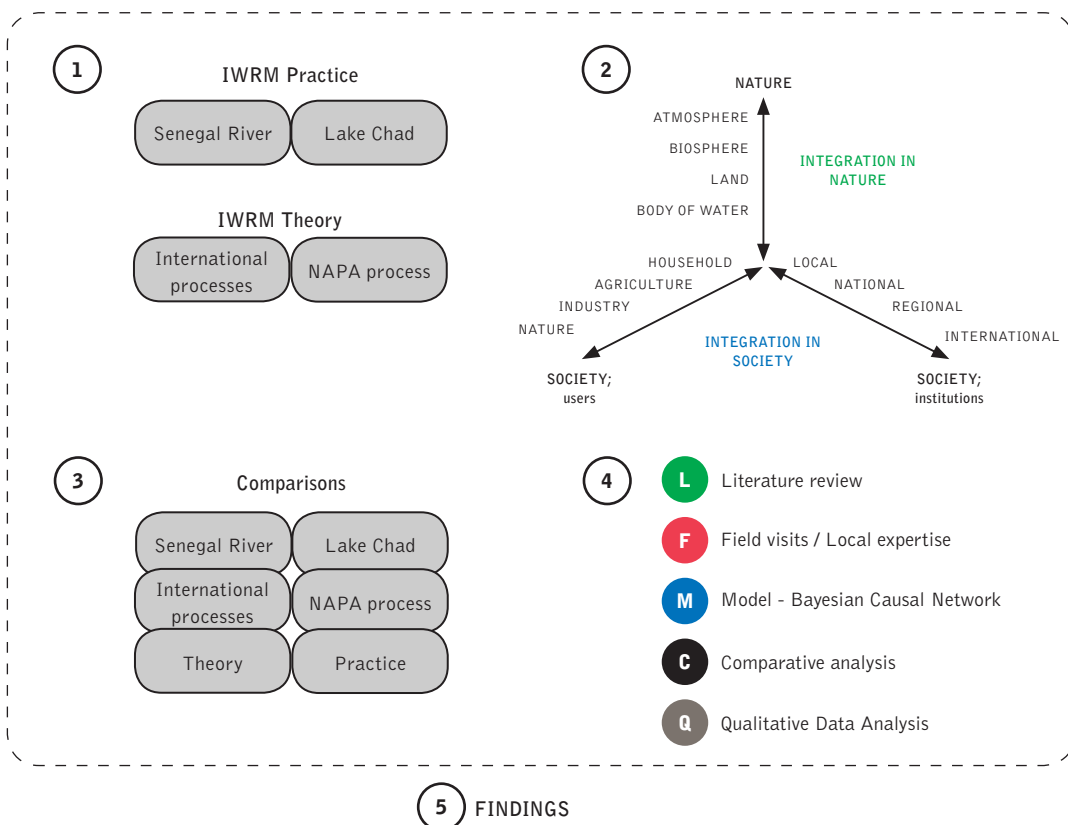


Figure 1 Analysis approach in the Summary section of the thesis

this, the author organised two expert workshops on the forest-water relationship, which were held during international conferences (The Fourth World Water Forum 2006, and International Conference on Cultivate Forests, Session Forests and Water 2006). The expert conclusions of these events have inspired this thesis.

Data on National Adaptation Programmes for Action (NAPA) were acquired from the United Nations Framework Convention on Climate Change (UNFCCC) NAPA project database, which is available in the public domain (UNFCCC 2009a).

The thesis builds on various study **methods**, which are presented in detail in Chapters 3 and 5.4. In summary, these include:

- Literature review
- Field visits/local expertise
- Policy options assessment model based on Bayesian Causal Network
- Comparative analysis
- Qualitative Data Analysis

The analysis in this thesis followed a five-step **approach** presented below. A visual demonstration of the approach is provided in Figure 1:

- 1) Compilation of case studies representing theory and practice.
- 2) Identification and analysis of the various IWRM components to formulate the most prominent IWRM features along the three axes.
- 3) Comparisons: between the two case studies of practice and two case studies of theory as well as between the case studies of theory and practice.
- 4) Analysing the suitability of the methods used in the case studies
- 5) Formulation of findings on strategic issues of IWRM with special considerations for Senegal River and Lake Chad, practitioners and other integrated approaches.

2 BACKGROUND

The purpose of this chapter is to introduce the basic concept of IWRM, how it is implemented in one example region: Africa, as well as how the concept relates to other integrated approaches to natural resources management. This is followed by an introduction to the geographic region covered in this thesis: West Africa.

2.1 INTRODUCING IWRM

2.1.1 The concept

Integrated Water Resources Management, IWRM, is a widely-used concept in today's water management policy and practices. The concept is not new, but it was revived in the early 1990s when a number of internationally-led policy processes, such as the Dublin International Conference on Water and Environment, started to promote IWRM as one of the key water management methods.

A number of definitions of the concept exist, but perhaps the most widely used is that of the Global Water Partnership (GWP 2003):

A process, which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

The very basic principles of IWRM – according to the Global Water Partnership definition – include the following aspects: ‘coordination’, ‘development’, ‘management’, ‘economic’, ‘social’, ‘equitability’, ‘sustainability’, ‘ecosystems’. In addition to that, the ‘basin’ (river, lake, or groundwater) has been recognized as a practical hydrological unit for

water resources management (GWP-INBO 2009). Hence, strictly speaking, coastal zones are out of scope of IWRM.

The reference to “equitable manner” implies that, according to the IWRM principles, water should be managed as a public good, i.e. in a way where “benefit received by any other party does not diminish the availability of the benefits to others” (GreenFacts 2011). The concept of “public good” differs from that of “common pool resource (CPR)”, with the latter referring to a resource where “the use by one individual or group means that less is available for use by others” (ibid.). Ostrom (1990) characterizes CPRs by difficult exclusion of users and subtractability of resource units. Subtractability means that use of the resource by some appreciators subtracts from the resource available for others. Oel *et al.* (2007) show that river basin can be considered a network of CPRs.

Successful IWRM contributes to sustainable development, which is a concept that combines ecology with development (Dasmann *et al.* 1973, in Holdgate 1999). For development to be sustainable, it has to be environmentally sound, socially equitable and economically viable.

2.1.2 From theory to practice

The gap between the IWRM theory and practice has been identified as one of the major problems in IWRM by numerous authors (Walther 1987, Lahtela 2002, Jones *et al.* 2006, Medema & Jeffrey 2007, Ioris 2008, Moss 2010).

Biswas (2004a) claimed that IWRM has been used as a rhetoric by many, but few know what exactly is meant by the concept, and that opinions vary widely

on what needs to be integrated and how. Jeffrey and Gearey (2006) concluded similarly stating that whereas IWRM as a concept promotes modern, holistic and adaptive management approaches, the practice of water resources management is very much driven by the contingency planning approach, and the “predict and prepare” paradigm.

Years of IWRM at the international policy level have not necessarily moved the concept towards more integration. For example, Rahaman & Varis (2008) analyse thoroughly the Ministerial Declaration of the Fourth World Water Forum held in Mexico City in 2006, and concluded that it lacks many of the globally accepted water management principles. Similarly, Biswas (2004b) states that the Mar del Plata Conference in 1977 concluded with more IWRM-related results than many of the international forums of the recent past.

Recently, a number of international organisations have geared their work towards translating the definition of IWRM into practice. UNESCO (2009b) has produced IWRM Guidelines at River Basin Level including an introduction to a spiral model of IWRM in order to illustrate the evolving and dynamic characteristics of the IWRM process. The key message of that model is that IWRM implementation can start immediately and evolve towards a fully integrated approach as capacity grows. The Global Water Partnership-International Network of Basin Organisations, GWP-INBO (2009) has produced a Handbook for Integrated Water Resources Management in Basins. The Handbook emphasises the creation of enabling institutional frameworks that promote IWRM principles through policy guidance, legislation and a well functioning regulatory framework.

2.1.3 IWRM in comparison to other integrated natural resources management approaches

IWRM is only one of the many integrated approaches that have been strongly promoted over the past decade. Another widely used concept related to integrated natural resources management is the ecosystem approach, which was formally accepted at the Earth Summit in Rio in 1992 (CBD

1995). The same conference put another concept, Integrated Coastal Zone Management (ICZM), high in the agenda (Pernetta & Elder 1993).

Douthwaite *et al.* (2004) anchor the birth of Integrated Natural Resources Management (INRM) to 1996, when agricultural scientists, and predominantly the International Agricultural Research community, increasingly started to promote the concept (Twomlow *et al.* 2008). The international forest community is familiar with the Forest Landscape Restoration (FLR) approach, which has been heavily promoted for the past 10 to 15 years (Wenger *et al.* 2005).

Apart from differences in wording, the underlying philosophy of the approaches is very similar. All promote the need to consider natural resources in the context of the broader landscape level and acknowledge the fact that humans are part of the landscape, and that they need to be involved in management and planning processes in an equitable way. Table 1 summarizes these approaches.

2.1.4 A snapshot of integrated water management approaches in Africa

The concept of integrated approaches has appeared in different continents and countries over time. The following gives a short description from Africa.

Africa as a continent faces various water-related challenges. These range from the traditional quantity- (droughts, floods) and quality-related challenges to more complex phenomena where water is a part of broader interconnections. Examples of the latter include issues related to competition over land use, food security and sovereignty, increasing demand for bio-fuels and political instability in some parts of the continent. When these are combined with socio-economic challenges, such as population growth and urbanisation, it becomes apparent that management of water resources in Africa calls for a holistic approach.

A particular feature in Africa is the big amount of shared water resources: more than 60% of the

Table 1 Comparison of a sample of integrated natural resources management approaches

Concept	Year	Basic idea initiated by	Definition	Supporters	Spatial scale
Integrated Water Resources Management	1926 (early forms) Varis et al., 2008.	Probably Spain, by adopting the concept of confederaciones hidrograficas. Other similar -and even older- examples exist in the literature. Varis et al. 2008.	A process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. GWP 2003.	Water resources professionals, international bodies, such as the Global Water Partnership, UNESCO, World Water Forum. Donor agencies.	Basin (river, lake, groundwater).
	Since 1977 - various international conferences.	The Dublin Principles were the result of the International Conference on Water and Environment.			
Ecosystem approach	1992.	United Nations Conference on Environment & Development (« Earth Summit «) in Rio de Janeiro.	A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. CBD 1995.	Ecologists, international bodies, such as the Convention on Biological Diversity. International organisations. Increasingly the private sector.	Within the limits of ecosystems functioning.
Integrated Coastal Zone Management (ICZM)	1992.	Earth Summit in Rio (Agenda 21 Chapter 17).	The process of combining all aspects of the human, physical and biological aspects of the coastal zone within a single management framework. Pernetta and Elder 1993.	Marine scientists.	All coastal and upland areas, the uses of which can affect coastal waters and the resources therein, and extends seaward to include that part of the coastal ocean that can affect the land of the coastal zone. Cicin-Sain et al. 1995
Integrated Natural Resources Management	1996. Douthwaite et al. 2004	Consultative Group on International Agricultural Research (CGIAR) system.	Responsible and broad-based management of the land, water, forest and biological resources base--including genes--needed to sustain agricultural productivity and avert degradation of potential productivity. ICARDA 2004.	Agricultural scientists. The Consultative Group on International Agricultural Research (CGIAR) community. Twomlow et al. 2008	Landscape.
Forest Landscape Restoration	2000. Wenger et al. 2005.	International Union for Conservation of Nature, IUCN and World Wildlife Fund, WWF.	A process that aims to regain ecological integrity and enhance human well-being in deforested or degraded forest landscapes. Wenger et al. 2005.	Foresters, international bodies, such as the Global Partnership on Forest Landscape Restoration.	Landscape.

continent is covered by international river basins (GWP 2010) and therefore there is a strong need for transboundary collaboration in water resources management. The predicted impacts caused by climate change (Boko *et al.* 2007) on Africa's water resources will not make their management in the future less of a challenge. Cognisant of the above-mentioned challenges, the IWRM –framework has been promoted as one of the tools to manage water resources in various parts of Africa.

Various events during the past decade internationally and in Africa have played an important role in raising awareness on water resource issues of the continent. Furthermore,

a number of political commitments have been made in order to highlight the importance of water resources in Africa (for a quick summary of the main water related declarations in Africa, see Figure 2). The African ministers responsible for water resources gave a **declaration in 2001 in Bonn** (BICF 2001), where the continent's main challenges were listed as the prevailing poverty and in relation to this, the lack of adequate water and sanitation. **In 2008, part of the Summit of the African Union** was dedicated to water and sanitation leading to commitments to accelerate progress towards the Millennium Development Goal (MDG) target on water and sanitation (African Union 2008).

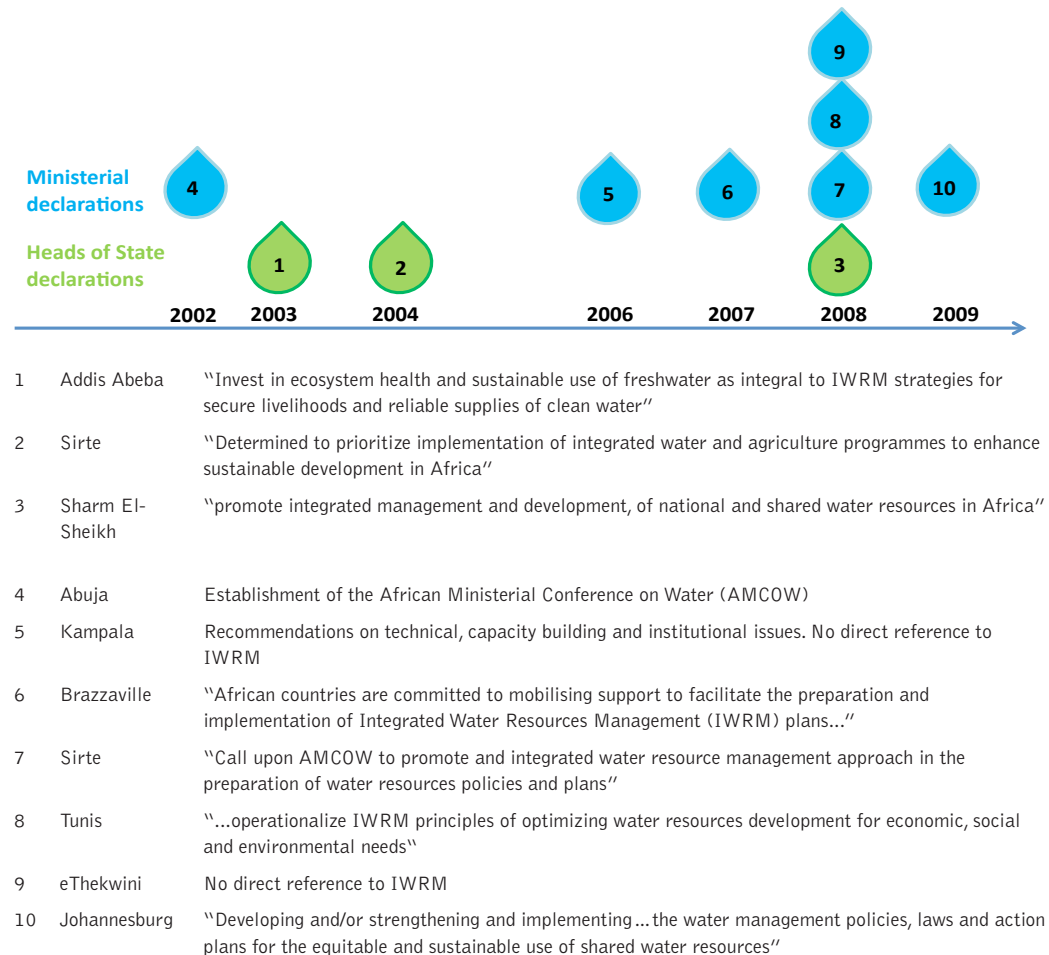


Figure 2 African Declarations on water and references to IWRM. Source: AMCOW 2010

A key policy milestone for IWRM in Africa was the development of **Africa Water Vision for 2025**, developed in 2000 which was formulated to avoid “disastrous consequences” of threats to the continent’s water resources (UNECA 2000). The Vision recognises that water has a vital role to play in addressing the socio-economic crisis in Africa; it recognises the links between poverty and lack of access to water and sanitation as well as the fact that water and socio-economic development are mutually dependent. The vision lists four key areas of intervention (governance, information, urgent needs, financial base) and sets milestones and targets for performance up to 2025.

The African Ministers’ Council on Water (AMCOW) that was formed in 2002 has a mandate to provide political leadership, policy direction and advocacy in the provision, use and management of water resources. AMCOW has been recently integrated into the African Union to work as a specialized committee for water and sanitation (AMCOW 2011). The AMCOW Workplan 2011-2013 includes several key areas of involvement, which must be urgently addressed. These areas are: (i) Integrated Water Resources Management and water for growth and development; (ii) climate change and variability; (iii) sanitation; and (iv) sustainable use of groundwater (Pegasys 2010).

At the regional level, **economic commissions** (SADC in southern Africa and ECOWAS in West Africa) have developed regional strategies for IWRM for Southern and West Africa respectively (SADC 2005, Ayibotele & Afouda 2000). The UN Economic Commission for Africa published a report “Water in Africa – Management Options to Enhance Survival and Growth” in 2006, which lists key issues related to water resources in Africa and potential ways of addressing these (UNECA 2006). The UN-Water/Africa publishes biennial African Water Development Reports in order to monitor the progress of the African Water Vision (UN-Water/Africa 2006). The report refers to IWRM as an approach to meeting the set milestones and targets.

2.1.5 IWRM in international policy

Various international meetings have dealt with IWRM. Below is a summary of these in chronological order.

Mar del Plata 1977:

The United Nations Conference on Water

The UN Conference on Water (Mar del Plata) in 1977 approved a set of recommendations and an action plan on a wide number of water issues: Assessment of water resources; Water use and efficiency; Environment, health and pollution control; Policy, planning and management; Natural hazards; Public information, education, training and research; Regional co-operation; International co-operation (UN 1977). The Mar del Plata conference can be seen as “a major milestone in the history of water development during the second half of the 20th century” (Biswas 2004b) and Rahaman & Varis (2005) describe the Mar del Plata action plan as the first internationally coordinated approach on IWRM.

Dublin 1992:

The International Conference on Water and Environment

The International Conference on Water and Environment in Dublin in 1992 was a gathering of water experts and practitioners as a preparation for the Rio Summit later that year. The Dublin Conference concluded with four guiding principles for water out of which Principle 1 referred to IWRM: “water should be managed in an integrated manner” (ICWE 1992).

Rio de Janeiro 1992:

The UN Conference on Environment and Development (Earth Summit/Rio Summit/Rio Conference)

The summit concluded with a number of documents, including the Agenda 21. Its Chapter 18 on Freshwater Resources refers to “integrated approaches to the development, management and use of water resources” (UNCED 1992).

Marrakech 1997:The First World Water Forum

The forum concluded with the Marrakech Declaration. This called for a “Blue Revolution” to ensure the sustainability of Earth’s water resources. It emphasized the need for different players to work together in a renewed partnership to put into practice the Mar de Plata and Dublin Principles as well as Chapter 18 of the Rio Summit. The Marrakech Declaration mandated the World Water Council to develop a Vision for Water (Marrakech Declaration 1997)

The Hague 2000:The Second World Water Forum and Ministerial Conference

This was the first forum that gathered a wide variety of stakeholders, in addition to the intergovernmental representatives. Another new topic presented in The Hague was the need for public-private partnerships and privatization. Unlike its predecessors, The Hague Forum put a strong emphasis on implementing the outcomes of the Forum. As a result, a Framework for Action was created. (Article III).

Bonn 2001:The International Conference on Freshwater

The aim of the conference was to support preparation of the Johannesburg conference and The Third World Water Forum. The conference

concluded with The Bonn Keys, with a suggestion of IWRM as the most important tool for achieving these (Tortajada 2001).

Johannesburg 2002:The World Summit on Sustainable Development

The WSSD Plan of Implementation refers to IWRM as one of the key components for achieving sustainable development. It also provided specific targets for implementing IWRM worldwide, including the goal of having an IWRM and water efficiency plan for all major river basins of the world by 2005 (UNDESA 2002) – a target yet to be met (UN-Water 2008).

Kyoto 2003:The Third World Water Forum

IWRM was yet again recognized as the recommended method to achieve sustainable water resources management. A new issue in Kyoto was to bring different stakeholders together in a Multi Stakeholder Dialogue (MSD) (Rahaman & Varis 2005) – an approach that has been later supported by a number of international organizations.

Mexico City 2006:The Fourth World Water Forum

The forum was attended by around 20 000 people. The Mexico Declaration was heavily geared towards water supply and sanitation issues with less focus on the holistic approach promoted by its

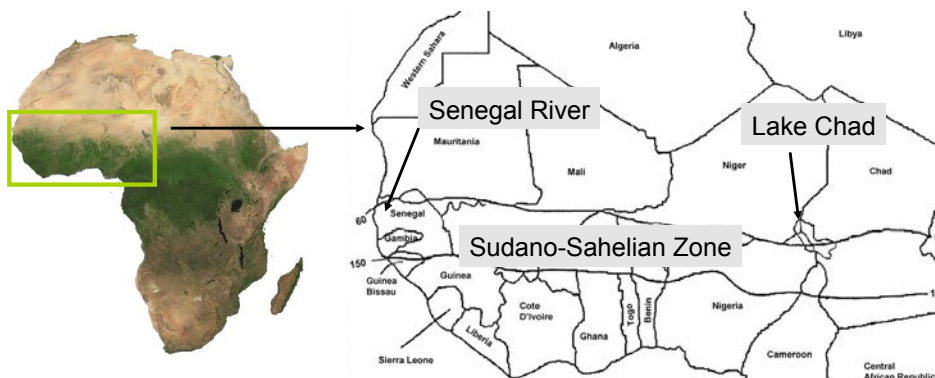


Figure 3 Sudano-Sahelian Zone of West Africa (source: Siwakumar & Wallace 1991) and the location of Senegal River and Lake Chad

predecessors. The outcomes of Mexico were seen as a dramatic shift in global water policy towards a more non-holistic and fragmented approach (Rahaman & Varis 2008).

Istanbul 2009:

The Fifth World Water Forum

The outcome declaration of this forum emphasized water security and climate change. Istanbul also led into Istanbul Water Consensus with a commitment to prepare and implement action plans and strategies for water-related issues in cities (Jacques & Herron 2009).

2.2 GENERAL FEATURES AFFECTING THE WATER SECTOR AND IWRM IN WEST AFRICA

2.2.1 Introducing the region

The two case studies of IWRM practice presented in this thesis are from the Senegal River and Lake Chad basins, which both fall in the Sudano-Sahelian Zone of West Africa (Figure 3). The Sudano-Sahelian Zone has various definitions. In this thesis, the length of the growing season is used to delineate the area, where this average length varies from 60 to 150 days. Based on this definition, the zone is understood to extend from Senegal in the West to Chad in the East (Sivakumar & Wallace, 1991). Geographically, both of the basins are located in the desert of Sahara, which extends from the Atlantic to the Red Sea and from the Mediterranean to central Mali, Niger, Chad, and Sudan (HarperCollins Publishers 2003).

In this thesis, the definition of ECOWAS-SWAC/ OECD (2006) of West Africa is used where the region is understood to cover the 15 states of the Economic Community of West Africa², as well as Cameroon, Chad and Mauritania. The countries included in the analysis include Senegal, Mali, Mauritania, and Guinea for the Senegal River basin and Chad, Cameroon, Niger, and Nigeria for Lake Chad. In addition to that, data on the Central African Republic (CAR) are included

when describing the economic, socioeconomic and political development due to the fact that the country belongs to the Lake Chad conventional basin.

2.2.2 Hydrology and climate

The typical hydrological features in the Sudano-Sahelian Zone include high variability of the rainfall, high evaporation and evapotranspiration, rapid and violent flows due to seasonal rains and the state of land surface, low infiltration due to the soil surface conditions and the shortness of the rainy period (Ayibotele & Afouda 2000). According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) released in 2007, the east-west band from Senegal to Sudan is classified as “critically unstable” in terms of climate change impacts on hydrology (Boko *et al.* 2007).

The climate of the Sudano-Sahelian Zone is arid and characterized by two alternating aerial fluxes: Harmattan, a flux of dry air blowing from the north-east to east from December to March; and another flux of humid air blowing from the south-west to west. The zone of separation between these two fluxes, the Intertropical Front, oscillates between the Gulf of Guinea (in January) and the 25° N parallel (in July–August) and determines the rhythm of the humid and dry seasons. This seasonal reversing wind accompanied by corresponding changes in precipitation is often referred to as monsoon. There is rain in the zone from April to June until September to October depending on the parallel position. Variation of precipitation is normal in arid zones, particularly in the Sudano-Sahelian one. (Koechlin, 1997).

An important feature of the region’s hydrology is related to the climate, more precisely droughts. There have been three major droughts past century in the Sahel, namely in 1910-1916 and in 1941-1945, and a long period of below average rainfall starting from the late-1960s to the 1980s. (Batterbury 1998). Droughts have a direct link to agriculture and hence people’s livelihoods. Boko *et al.* (2007) estimate that parts of the Sahara are likely to lose between 2-7% of the Gross Domestic

² Benin, Burkina Faso, Cape Verde, Côte d’Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo

Product (GDP) due to vulnerabilities³ affecting the agricultural sector. The broader area of Western Africa is similarly classified as vulnerable, with estimated agricultural losses of 2-4% of GDP.

2.2.3 Economic and socioeconomic development

The economic and socioeconomic conditions in West Africa in general, and in the two basins included in this thesis in particular, are challenging. The countries along the Senegal River basin are among the world's poorest in terms of both economic and human capital. Out of the total of 182 countries, Mali is ranked as 178, Guinea 170, Senegal as 166, and Mauritania as 154 in human development as measured by the Human Development Index (HDI) of the United Nations Development Programme (UNDP). The ranking for the Lake Chad basin countries is as follows: Niger 182, CAR 179, Chad 175, Nigeria 158, and Cameroon 153.

The Gross Domestic Product per capita in 2007 was USD 487 in Guinea, US 556 in Mali, US 847 in Mauritania, and US 900 in Senegal. The figures for the Lake Chad basin countries are: USD 294 in Niger, USD 394 in CAR, USD 658 in Chad, USD 1116 in Cameroon, and USD 1118 in Nigeria. For comparison, the average per capita GDP in high human development countries is USD 8470 (UNDP 2009).

The Gini index measures inequality within a country. It lies between 0 and 100 where the value of 0 represents absolute equality and 100 absolute inequality. The Gini index in the countries along the Senegal River was: 43.3 in Guinea, 39 in Mali and Mauritania, 39.2 in Senegal. Along Lake Chad the Gini index was 44.6 in Cameroon, 43.9 in Niger, 43.6 in CAR, 42.9 in Nigeria, and 39.8 in Chad. For comparison, the index in the country with the most equality (Norway) was 25.8, and in the country with the most inequality (Namibia)

³ Vulnerability here is understood as "the degree to which a system is susceptible to, and unable to cope with, adverse effects on climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitive, and its adaptive capacity" (IPCC 2007)

74.3 (UNDP 2009). Even if the countries covered in this thesis are ranked among the lowest in terms of economic and human development, equality-wise the countries fall merely in the middle than the worst-off class.

2.2.4 Ethnicity and conflicts

A specific obstacle to IWRM in Western Africa is the prevalence of conflicts. To some extent, the conflicts have historical roots; about 1000 ethnic groups in Sub-Saharan Africa live in 49 often arbitrarily drawn states (Laakso *et al.*, 1997). Conflicts have caused disruption in society when the old tribal based social structures were fit within new artificial borders. Political instability is still prevalent in some countries in the region (Sawyer 2004, Adekanye 2008).

Other types of conflicts relate specifically to natural resources and changes brought about by modernisation. Desert societies used to specialize in various trade or service activities in a way that was suitable and profitable for all the different societal groups. Since the cash crop cultivation and intensive grazing were introduced, the balance between nature and human activities has been twisted in a way that occasionally creates conflicts between different interest groups (e.g. nomads and sedentary people) that now depend on and exploit the same scarce resource. (Furber 1997).

Both the Senegal River and Lake Chad basins can be considered prone to conflicts. Homer-Dixon (1999) reveals examples where environmental scarcity has caused ethnic friction. This was the case along the Senegal River at the end of the 1980s when the powerful elite in Mauritania, the white Moors, altered the land tenure rights in a way that was unfavourable towards their compatriot ethnic minority: the black non-Arabs. As a result, the two countries, Mauritania and Senegal, came close to waging war. Understanding the ethnic composition and the ancient, delicate system of land use is essential before any act of modernization in the water sector is carried out (Traore, 2004).

There are roughly four major ethnic groups along the Senegal River with traditionally different types

of livelihood activities. The Wolofs with some Peuls and Moors inhabit the delta area. The lower basin is mainly a Tukulor area with the Peuls, Moors and Soninkes as minority groups, while the upper basin is a Soninke area (Euroconsult/Institut National de Recherche pour la Conservation de la Nature, 1990). The Wolofs, the Tukulors and the Soninkes are all sedentary agriculturalists, while the Peuls lead a nomadic way of life, raising livestock. The Moors are mainly pastoral nomads but there are also sedentary farmers and fishers among this group. Division of labour, i.e. who is allowed to farm, herd, fish and make handicrafts, between different castes is notable (Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program, 2000).

Along Lake Chad, a history of political instability has characterized the basin countries since their independence from their colonial powers around the beginning of the 1960s. All of the basin countries have gone through a civil war of some degree and some of them are still in a rather unstable condition. (CIA 2002, Encyclopedia Columbia 2003)

The political instability index is developed by the Economist Intelligence Unit (EIU 2011) and shows the level of threat posed to governments by social protest. The index scores are derived by combining

measures of economic distress and underlying vulnerability to unrest. Countries are ranked from 1 (country with the most political instability) to 165 (country with the least political instability). Table 2 below shows the index for countries in the two study basins. Two countries along the Senegal River basin are ranked as having ‘very high risk’ for political instability. Along the Lake Chad basin, three countries fall into this category. It is worth noting that Chad is ranked as number two globally with possibility of political instability.

2.2.5 Institutions

An institution is defined as “*a significant practice, relationship, or organization in a society or culture*” (Merriam-Webster, 2011).

“**Organizations**” that deal with water resources management in West Africa include a number of formal ones, such as transboundary basin organisations (e.g. the Senegal River basin management organisation, the Lake Chad Basin Commission, and the Niger Basin Authority), national bodies (e.g. different ministries and other governmental institutions), research institutes, as well as local organisations with or without a formal status. In addition to that, a number of national and international non-governmental organisations (NGOs) and international organisations deal with water resources issues in the region. International

Table 2 Political instability index. Source: EIU 2011

Rank	Country	Index score	Classification
Senegal River basin			
19	Senegal	7.5	very high risk
19	Guinea	7.5	very high risk
44	Mali	7	high risk
47	Mauritania	6.9	high risk
Lake Chad basin			
2	Chad	8.5	very high risk
7	CAR	7.8	very high risk
19	Niger	7.5	very high risk
44	Nigeria	7	high risk
47	Cameroon	6.9	high risk

donor agencies and bilateral financing institutions as well as the private sector can also be considered falling into this category of institutions.

“**Relationship**” in the context of this thesis is understood as a regulatory framework (formal or informal) stating the rules of water use along a particular basin. According to Garane (2008), in West Africa there is “no sufficient or appropriate guiding legal frameworks among basin states for the management of international watercourses”. However, the major watersheds in the region (Gambia, Niger, Senegal, Volta, and Lake Chad basins) have enforced agreements on the use and management of the water resources. The agreements along the Senegal River include the following: Convention pertaining to the Creation of the Organization for the Management of the Senegal River, Convention relating to the Statute of the Senegal River and Charter of the Waters of the Senegal River. The agreement along Lake Chad includes the Convention and Statutes relating to the Development of the Chad Basin (ibid.).

In addition to the formal agreements, there are numerous examples in West Africa of informal relationships with water. These range from cultural and religious relationships (Kedowide, 2004), to traditional management practices that continue to co-exist despite the attempts at modernization (Ballo, 2004, Traore, 2004).

“**Practice**” can be understood as common ways of doing things, whether formal or informal, legal or illegal. In West Africa, in addition to formal practices, informal practices for natural resources management exist and relate often to culture or religion as described above.

Niang (2007) lists, classifies and analyzes key institutions (strongly linked with climate change) in West Africa as the following: economic and political institutions, basin organisations, scientific institutions, peasant organisations, international non-governmental organisations, foreign partners working in West Africa, and specific programmes. Even though the analysis of Niang (ibid.) was not

done directly with water resources management in mind, the findings by Niang can be considered a useful reflection of key institutions influencing IWRM in the region. Based on a questionnaire Niang (ibid.) sent out to the institutions listed above, two issues stand out as critical flaws in the institutional setting in West Africa: i) a chronic lack of communication between political decision-makers, people and researchers, and ii) the lack of institutions collaborating with vulnerable populations (such as peasant associations).

A number of African and West African water institutions are active in IWRM implementation in the field. The chapters below introduce some of the most active ones.

The African Water Facility’s (AWF) objectives are to attract and make effective use of increased and appropriate investments needed to achieve national and regional water sector targets in Africa and to help enable them to successfully implement the Africa Water Vision (2025) and meet the Millennium Development Goals (2015). One of its’ areas of support is to “direct capital investments for the purpose of triggering larger investments for sustainable development, focusing on Integrated Water Resources Management (IWRM) at the national level and Transboundary Water Resources Management (TWRM) at the regional level...” (AWF 2009).

There are a number of **River/Lake Basin Organisations** in West Africa. Those relevant to this thesis include the Lake Chad Basin Commission (LCBC) and the Senegal River Development Organisation, OMVS (Organisation pour la Mise en Valeur du Fleuve Senegal). Whereas the role and mandate of these river basin organisations can vary based on the particular legal and geographic context, the basic function for such organisations is to facilitate water resources development and management in a transboundary context.

A number of African **Regional Economic Commissions (REC)** in general have institutionalized and assisted in developing regional IWRM policies. This is the case for the Economic

Community of West African States (ECOWAS), which has taken a role is to implement policies, programmes and projects on various fields, including IWRM as presented in chapter 2.1.4.

The role of **African governments** in IWRM is crucial in a sense that they are responsible for not only establishing the legal framework required for transforming IWRM from policy to practice, but also for enforcing the implementation and follow-up of these laws. The role of political declarations was presented in chapter 2.1.4.

The **civil society** and both local and international Non-Governmental Organisations (NGO) play an important role in ensuring that the civil society views are taken into account in the highly politicized processes related to the development and management of water resources. One of the key local organisations in Africa include the **Africa Civil Society Network on Water and Sanitation** (ANEW), which promotes dialogues, learning and cooperation on water and sanitation issues in Africa and provides a platform for sharing and coordinating the activities of its members. ANEW has regional offices in Chad and Senegal (ANEW 2010). Numerous international organisations are involved in IWRM development in Africa. For example, the **Global Water Partnership** (GWP) has been active on promoting IWRM in various parts of Africa and helped in operationalizing the IWRM principles through national partnerships (UN-Water & GWP 2007). The **International Union for Conservation for Nature** (IUCN) has promoted the concept of IWRM through its Water and Nature (WANI) initiative in a number of African river basins including Senegal, Volta River and Komadugu-Yobe River basins in West Africa (IUCN 2009). The **International Water Management Institute** (IWMI) is conducting IWRM-related research in Africa, including the West African sub-region (IWMI 2011).

The role of the **private sector** in boosting water resources development through investments can be seen as one of the key features towards long-term sustainability along the lines of the Millennium Development Goal 7 (Global

Partnership). With regards to the water sector in West Africa, the private sector has mainly been involved in water supply and other infrastructure-related development. In terms of IWRM, there is currently less involvement of the private sector, but this tendency might change in the light of new initiatives that are emerging in relation to the concept of ecosystem valuation (for example, the wet carbon initiative with Danone's involvement which one of the target pilot countries is Senegal) (Earthmind 2011).

2.2.6 Constraints and current situation of IWRM in the Sudano-Sahelian Zone

Ayibotele & Afouda (2000) list the main constraints on water resources management in Western Africa as the following:

- Economic constraints: e.g. balance of payment difficulties, high inflation rate, and strong state involvement in most of the economic sector.
- Political constraints: Wars and coup d'états.
- Participation: Lack of decentralization.
- Water Sector Infrastructure: Inadequate investment in operation and maintenance of water services.
- Cost Recovery: Water is not treated as an economic good.
- Institutional and Legal: Responsibilities spread over several agencies, which do not interact. Laws either absent or inadequate.
- Data and Information: Inadequate data leading to wrong decisions.
- Investment: Water infrastructure is inadequate due to the lack of investment funds.
- International Rivers: Lack of protocol for dealing with the shared water resources.

The above challenges are recognized and agreed by international organisations. For example, the United Nations Environmental Programme (UNEP) is currently addressing the IWRM challenges of Gambia, Guinea Bissau, Guinea Conakry, Sierra Leone, Togo, Cote d'Ivoire and Liberia. These countries were identified as lagging behind in IWRM development and having received little support (UNEP 2010).

The Global Water Partnership has been supporting IWRM implementation in West Africa along the lines of the regional water policy (GWP 2007). For example, it has formed country and regional water partnerships (GWP 2009), commissioned and funded a number of studies on IWRM implementation (Ministère de l'Énergie, des Mines et de l'Eau 2007, GWP/AO 2009a, GWP/AO 2009b, GWP-PNE/Benin 2010), and contributed to regional initiative aimed at IWRM capacity building (Yillia et al 2004). The Economic Community of Western African States (ECOWAS) is promoting activities that strengthen IWRM implementation in West Africa (ECOWAS, 2008).

Apart from the regional IWRM plan, national plans exist in a number of West African countries including Ghana (Odame-Ababio, 2005), Burkina Faso (Ministry of Agriculture, hydraulics and fishing resources of Burkina Faso 2003), and Senegal (PNUD-OMVS 1974). UNEP has developed roadmaps for development and implementation of IWRM plans for Guinea Bissau, Gambia and Sierra Leone (UNEP 2007).

3 METHODS USED IN THE CASE STUDIES

Scientific methods are defined as principles and procedures for the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of hypotheses (Merriam-Webster 2011). This chapter presents the scientific methods used in this thesis to find answers to the study objectives as described in Chapter 1.

The rationale behind the chosen methods stems from the geographic region and the interdisciplinary nature of the topic under study. Academic, peer reviewed material on IWRM from Africa in general and West Africa in particular is scarce. Getting information from institutions responsible for IWRM is challenging and timely. In the course of writing this thesis, a personal visit to an institution or an organisation was the only way of acquiring material. A great deal of the data used in this thesis was collected while living and working in West Africa over the past nine years. When material does exist, for example, on the factors influencing climate change vulnerability, these factors interact “in complex and ‘messy’ ways” (Boko *et al.* 2007).

The scarcity of data, its poor quality, and the interconnectivity between the different factors having a role in IWRM, influenced the choice of study methods used in this thesis. The use of different methods also allowed for the examination of IWRM through different viewpoints, which is an important aspect when examining such a broad concept.

3.1 LITERATURE REVIEW

Literature review was an important method in each of the case studies, and the main method in the case of Lake Chad.

Literature review can be seen as a basic scientific method that ensures that one is not “reinventing the wheel”. It also allows for the thorough set-up of the research problem and its systematic analysis while giving credit to other researchers studying the same topic. Mulrow (1994) describes systematic literature review as a “fundamental scientific activity”, which allows for efficient integration of existing information into a format that facilitates rational decision-making. Webster & Watson (2002) describe the literature as a firm foundation for advancing knowledge, facilitating theory development, identifying areas where plenty of research exists as well as uncovering areas that need further examination.

The challenge concerning this method relates to the quality and quantity of material available especially in the developing world. A large proportion of the material available is classified as “grey literature”, which is defined as “information produced and distributed on all levels of government, academics, business and industry in electronic and print formats not controlled by commercial publishing i.e. where publishing is not the primary activity of the producing body” (Schöpfel & Farace 2010).

The rapid development of electronic communication and distribution channels has increased the use of grey literature. The definition, impact, and perspectives of grey literature are a field of academic research itself. Professionals favour the use of grey literature due to a number

of reasons: research results in grey literature are described as more detailed than in official journals, the results are distributed much faster, and in some cases results are not published elsewhere (Abel 2004).

There are differences between different scientific fields and the amount of grey literature used. Farace *et al.* (2005) reviewed 64 citation analyses published between 1987 and 2005 and revealed that 39-42% of citations in engineering sciences were from grey literature.

The above explains the relatively wide use of grey literature in the study context of this thesis.

3.2 FIELD VISITS/LOCAL EXPERTISE

Due to the poor quality and quantity of information available from the West African basins studied in this thesis, field visits and using of local expertise were complementary methods in assessing the practical occurrence of IWRM. The method is important in the sense that it allows for the establishment of personal contacts with people at organisations dealing with water resources management, who can provide information and data that are normally scarcely available through public sources. Additionally, the access to local expertise is useful when critically analysing the literature or data available and when validating research findings and their accuracy.

Field visits and local expertise were used in the case of the Senegal River. A field visit was carried out at the beginning of the case study development in order to collect baseline data to be used in the modelling exercise. Key documentation was provided by the river basin organisation, OMVS, after the visit. During the time spent working in West Africa, further connections with Senegalese water experts were established through which data on the recent developments along the basin were acquired. Local expertise was used when analysing the case of Lake Chad. A West African water expert provided access to the literature from Lake Chad that would have been difficult to acquire from public sources. Another local expert, directly

involved in a project implementation along Lake Chad, was used to validate findings based on the literature review. These contacts are listed in Annex 1.

Building personal relationships is important yet time-consuming. Additionally, tracking trends in the phenomena under study based on field visits and local expertise can take years. This was experienced while studying the cases from West Africa, where certain trends were only observed after years of follow-up. Hence, the method is not the most suitable for research that aims to deliver results quickly.

3.3 BAYESIAN CAUSAL NETWORKS

"Bayesian" refers to conditional probabilities. "Causal" means that the model structure is constructed using causal assumptions concerning the interconnections of the model variables. The following list includes the basic philosophy of Bayesian inference:

- All information is uncertain except when full information on some issues is available.
- These uncertain entities influence one another.
- The prior information on each entity is described with an unconditioned, ordinary probability distribution (usually called prior distribution).
- The interconnections between them are modelled using conditional probabilities.
- With them, the prior information on the variables is updated.
- These updated probability distributions are called posteriors. Besides the prior information, they include all the other information incorporated in the model. This other information is included in the structure of the system and the prior distributions of the other model variables.

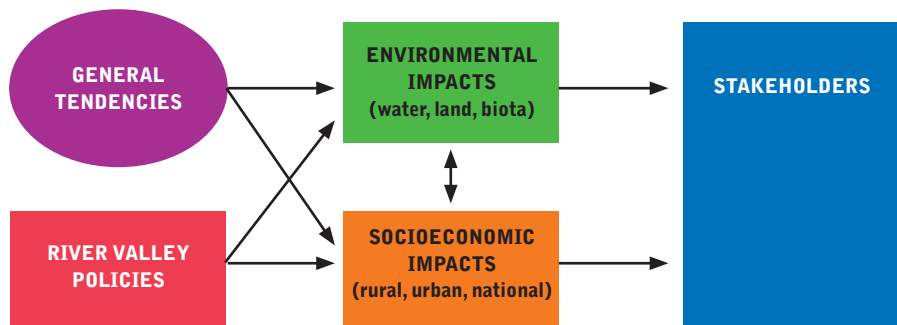


Figure 4 Logical chart of the Bayesian model. Model variables are listed under five main groupings

“Network” reveals that it is possible to construct a highly complex net of the information available.

In the case of Bayesian networks, one of the most used approaches is the one presented by Pearl (1988). It was chosen for use in this study, with the extensions developed by Varis (1998). These extensions were designed with a particular insight into a set of common issues encountered in modelling of natural and environmental resources management. These elements were the cornerstones of the Bayesian Causal Network approach used in this thesis.

The method was used for testing different management scenarios for the Senegal River basin with a time interval of 10 years. The modelling of the three IWRM management scenarios started by listing the variables included in the Senegal River management process. The variables were grouped under five headings and amounted to 45 in total (Figure 4). Details of the model variables are presented in Article II.

The next process was the building of a link matrix, which allowed determining the connections between each variable. The link strength varied from -0.1 to $+0.1$; also “no link” was allowed. Due to the property of the approach used—which allows the interconnection of all variables with any other by a conditional probability distribution—a flowchart of a model of this type is

fairly complicated. Theoretically, the total number of links in this model is $45 \times (45-1) = 1980$. Out of them, 840 were used (the rest had “no link”).

After this the prior tendencies for the impact variables (cf. boxes in Figure 4) were determined. The tendency could be small increase/decrease, modest increase/decrease, large increase/decrease or no change. In addition, the accuracy of the change was indicated with a scale that reached from unknown to fully known. The prior tendency showed the probabilistic distribution of the variables without taking into account the link matrix.

The last part in the modelling activity included constructing the model scenarios. This was done by indicating the amount and direction of change as well as the confidence level for the variables under the groups “general tendencies” and “river valley policies”. This was done in the same way as for the prior tendencies described above. The outcome—the posterior distribution—uses the variables and the link matrix to update the prior distributions.

The model was operated with three scenarios: strong national development; strong rural development; and IWRM. The direction and amount of change, as well as the confidence level for each variable, were determined. The amount and direction of change for each variable were determined to simulate the views of rural and

national development goals in a characteristic way described in Article I. The confidence levels in each case revealed the actual possibility of such a change happening. The scenarios can be understood as extremes of national and rural views, respectively. The IWRM scenario was constructed to fit within the amount and direction of change as well as within the confidence level of the rural and national scenarios. This scenario was not an absolute mean of those two, but rather a compromise between them. Therefore, in some cases the optimum is closer to either one of the 'extreme' scenarios. The amount and direction of change were chosen by iteration, whilst the confidence level revealed the degree of certainty that such a change would actually take place.

3.4 COMPARATIVE ANALYSIS

Comparative analysis involves comparing and contrasting two things, issues, phenomena etc. in order to identify similarities and differences between the two and based on that, draw new findings on the research question (Walk 1998). The Frame of Reference describes the context in which the things to be compared are placed. In this thesis, the IWRM framework as presented in Chapter 4.1 (Figure 5) was used as the frame of reference.

In this thesis, comparative analysis was done at the macro-level. Historical activities of two river basin organisations from West Africa, and from the Mekong were compared against each other and mirrored against international IWRM policy

processes. Similarly, two case studies of IWRM at the international policy level were compared. Finally the two cases of practice were compared against those of theory. The objective was to increase understanding of the underlying factors between theory and practice by comparing the various cases instead of studying them separately. Use of comparative analysis at the micro-level of institutions of IWRM in river basins is presented in Kurian (2004).

3.5 QUALITATIVE DATA ANALYSIS, QDA

Qualitative data consist of words or observations as opposed to numbers. The data and material used in this thesis were mostly qualitative and therefore QDA was a key method in drawing the new findings. QDA was used in analysing the IWRM disconnections in the case studies of Senegal River and Lake Chad as well as in analysing the NAPA project profiles.

QDA is defined as the range of processes and procedures whereby qualitative data that have been collected are processed into some form of explanation, understanding or interpretation of the situation under investigation. The steps usually include writing, coding, interpreting and organising the data either by using manual or computer based methods. (Lewins *et al.* 2005). The method is commonly used in social and art sciences.

4 PRESENTING THE FRAMEWORK AND CASE STUDIES

The following section describes the analytical framework used in the assessment of IWRM and presents the four case studies that were examined in this thesis. The purpose is to set the scene while a detailed analysis and findings are presented in Chapters 5 and 6.

4.1 THE FRAMEWORK

In order to systematically analyze the effectiveness of IWRM, it needs to be clustered into analyzable components. This thesis uses a specifically designed IWRM analytical framework introduced by the author in 2002 (Lahtela 2002, Article II).

At the **theoretical** level, IWRM is understood as a management⁴ approach that integrates the natural resources and society around a body of water

(Figure 5). Each of the axes is further divided into components. These components demonstrate the practical aspects of IWRM, i.e. those variables that play a role and should be taken into account in IWRM management. In this thesis, IWRM done at the academic and policy level are categorised under IWRM theory, whereas practical examples of IWRM implementation on the ground are understood as IWRM practice. It is acknowledged that in the real world such a division is rarely straightforward and clear, yet for the purposes of demonstrating the approach used in the analysis, classification of the cases into theory and practice is used.

The environmental aspect of sustainable development is represented in the nature axis whereas the social and economic aspects are

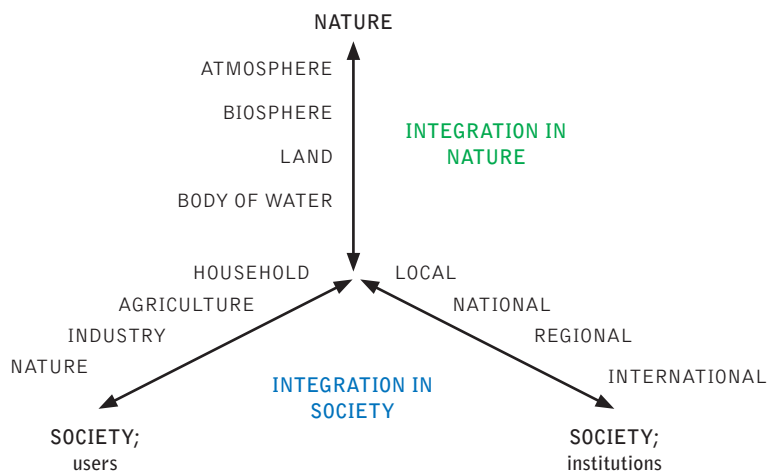


Figure 5 The IWRM framework

⁴ Various definitions of management exist. In this thesis, reference to management is done at the general level. It is understood as “the guidance and control of action required to execute a program. Also, the individuals charged with the responsibility of conducting a program” (BJA 2011)

Table 3 The three axes of IWRM, their components, and concrete examples of issues that can fall under the different components

IWRM axes (theory)	IWRM components (practice)	Examples
Nature	Atmosphere	Climate change
	Biosphere	Biodiversity
	Land	Forestry, land-use
	Body of water	River
Society; users	Household	Water supply and sanitation
	Agriculture	Farmers
	Industry	Water-intensive industries, hydropower development
	Nature	Maintaining ecosystem functions, replenishing groundwater aquifers
Society; institutions	Local	Farmers' associations, village committees, municipalities
	National	Ministries, universities
	Regional	Regional bodies either directly or indirectly linked with water
	International	International conferences, organisations, conventions, Overseas Development Assistance

represented among the two axes of society. An outcome of the integration between the three axes is sustainable development.

As can be seen in Figure 5, the societal axes are divided into two. The first is the institutional axis. This includes local, national, regional, and international organisations that operate in policy and decision-making processes. The second societal axis consists of different water users: domestic, agricultural, and industrial. In addition, nature is here considered one of the societal water users. Even though a “silent stakeholder”, nature reacts to the decisions made considering water resources, which, in turn, affect society. The nature axis includes the body of water, surrounding land, biosphere and atmosphere. A comprehensive IWRM should take into consideration the two axes of society as well as the axis of nature.

The framework differs from the approach to sustainable development in the sense that the three aspects of sustainable development: economic, social, and environmental, are embedded along the three axes of the IWRM framework (nature, institutions, users) instead of devoting an axis for each of them separately. For example, “nature”

is also a component of the “user” axis while the “institutions” axis can embed social and environmental issues within its components. Thus, the framework attempts to allow simultaneous examination of sustainable development and IWRM.

IWRM includes integration in all three directions. A theoretically ideal situation of IWRM appears when components along both of the societal axes and those along nature are included in the IWRM process. Even though there can be a high level of integration among the components of individual axes, the ideal IWRM situation only materializes when all of the three axes are integrated. To demonstrate the framework further, example issues that can be considered along the components of each of the axes are given in Table 3.



Figure 6 Senegal River basin. Source: Revenga et al. 1998

4.2 INTRODUCING THE IWRM CASE STUDIES

4.2.1 The Senegal River basin (Articles I, II, III)

The Senegal River is located in Western Africa in the Sudano-Sahelian zone. The 1800 km long river begins from Guinea and flows via Mali, Mauritania, and Senegal to the Atlantic Ocean. The total drainage area of the basin is around 290,000 km² (Figure 6). The hydrology of the Senegal River system has changed since the construction of two dams. The Diama dam, located 27 km upstream of St. Louis in Senegal and completed in 1985, was designed to prevent the intrusion of saline water from the Atlantic Ocean. The Manantali dam in Mali, about 1,200 km upstream from St. Louis, is a hydroelectric dam completed in 1988 (UN-WWAP 2003).

As presented in Articles I, II, and III, the river and the surrounding valley has faced various development schemes since the early 1970s, which have not brought the desired results. Similar conclusions have been drawn lately by Yu (2008). Many problems stem from the overall lack of economic and human development and

weak institutional settings. Droughts and ethnic complexities add to the problem. The environment and the local population have continuously been exposed to negative changes (Article I).

The earliest IWRM plans date back to 1973 when OMVS, the river development organisation of Mali, Mauritania and Senegal, announced its programme for integrated river development with three components: electricity generation, large-scale irrigation and navigation. Around the same time, SAED, the Senegalese state corporation responsible for developing agriculture on the Senegalese side of the river, developed plans on extending small village-level irrigation schemes.

In the 1990s, the Government of Senegal developed two sets of plans for the river development with social, economic and ecological goals while SAED presented a programme aimed at further irrigation development. A thorough analysis on these plans is presented in Article I.

The plans in the 2000s include the development and approval of the Water Charter in 2002, Nouakchott Declaration in 2003, as well as inclusion of Guinea as the fourth OMVS member in 2006 (UN/WWAP



Figure 7 Lake Chad basin. Source: Revenga et al. 1998. 1998

2003). Further, a Transboundary Diagnostic Environmental Analysis (TDA) outlining the most pressing environmental problems in the basin and a Strategic Action Plan (SAP) aiming at addressing those problems have been developed with the financial support of GEF (Global Environmental Fund) in 2007 and 2008, respectively.

The management of the Senegal River is characterized by a high number of objectives, impacts, policies, and stakeholders, which are strongly interconnected. The variables belong traditionally to different scientific disciplines (chemistry, biology, engineering, socio-economics, etc.). An objective analysis of the development plans was done in order to formulate policy guidance that would not repeat past mistakes (Article II). The analysis was done using a policy analysis model based on Bayesian Causal Networks in which three management scenarios with a 10-year time-scale were tested: 'strong national development'; 'strong rural development'; and 'IWRM'.

4.2.2 Lake Chad (Article IV)

The Lake Chad basin is situated in the Sudano-Sahelian Zone of Western and Central Africa. It is the main body of water in the region and crosses

three different climatic zones: humid tropical, semi-arid Sahelian and arid Sahelian. Annual rainfall varies from 1,500mm in the southern parts of the basin to under 100mm in the northern parts. The size of the lake has undergone an extreme change since the 1960s. This has raised concerns at the national, regional and international levels (e.g. Lemoalle 2004).

The basin spreads across a total of seven countries: Algeria, Niger, Nigeria, Cameroon, Central African Republic (CAR), Chad, and Sudan (Figure 7). Traditionally, part of the basin has been called the Conventional Basin, which includes the states of Niger, Nigeria, Chad, Cameroon, and CAR. This conventional basin is under the mandate of the Lake Chad Basin Commission (LCBC).

The LCBC was created in 1964 between Cameroon, Chad, Niger, and Nigeria in a situation where the member states' activities were seen as alarming in terms of water utilization and possibility of conflict. The Sahelian drought at the beginning of the 1970s motivated the LCBC to take urgent action in a number of natural resources sectors; agriculture, livestock breeding, fishing, forestry, and water. In 1985 the member states realized, however, that

instead of being proactive and developing the basin in an integrated and sustainable way, the LCBC had been rather reactive and had concentrated on national – instead of regional – activities. Since 1990 the LCBC has been undertaking activities with a regional approach.

The socioeconomic situation in the basin is challenging with prevailing poverty, high population growth, and low human development. Politically, all of the basin countries have experienced coups, coup attempts and civil unrest since their independence from their colonial powers. The LCBC is thus operating under extremely challenging conditions. The following gives an overview of the economic and political situation of the LCBC member countries.

Central African Republic (CAR) is a country with seven major ethnic groups. It had a parliamentary government until the end of 1965, after which various military regimes controlled the country until 1993 when the country had its first multi-party elections. However, army mutinies and fighting have characterized the country ever since, resulting in a large number of victims. A pan-African peacekeeping force has been present in CAR since 1999. In economic terms, CAR faces constraints owing to its landlocked position, weak transportation system, unskilled labour and poor macroeconomic policies. Its economy is based on subsistence agriculture and forestry, the former accounting for 50 per cent of GDP. The major export products are timber and diamonds. The economy has been seriously affected by the civil unrest (Encyclopedia Columbia 2003).

Cameroon, with some six major ethnic groups, has experienced relatively peaceful development since the unification of the French and British parts of the country in 1961. This has allowed the country to develop a fairly functional system of transportation, as well as a petroleum industry. Despite attempts to form a democratic regime, there is a perception that political power is increasingly controlled by an ethnic oligarchy. Cameroon's economy is classified as one of the best performing in sub-Saharan Africa because of its oil resources and favourable climatic

conditions for agricultural production. However, the economy is greatly affected by fluctuations in world oil prices as well as by corruption (CIA 2002).

Chad has some 200 distinct ethnic groups and a history of ethnic warfare that has lasted three decades since the country's independence in 1960. Even though the government drafted a democratic constitution in 1990 and multi-party elections were subsequently held, power remains in the hands of a northern ethnic oligarchy. In 1998 ethnic rebellion broke out again and a peace agreement between the government and the rebels was signed only in 2002 (CIA 2002). The security situation in the country remains rather unstable. In economic terms, Chad struggles owing to its landlocked position and mainly agricultural economy, which is vulnerable to climate conditions and also relies on only a few agricultural export products (cotton) that are very susceptible to fluctuations in world market prices. Instability and high energy costs add to the unfavourable situation. Oilfield and pipeline projects planned to boost the country's economic situation are under development, but are highly controversial (CIA 2002).

In 1993, 33 years after its independence from France, **Niger** made the transition to civilian rule. The country has eight major ethnic groups and has experienced much rebel warfare; most recently, a five-year insurgency between the government and the Tuareg ended in 1995. Niger's economy is very weak, being mainly reliant on agriculture and to a small extent on uranium. The country is landlocked and suffers strongly from unfavourable climatic conditions; the country was profoundly affected by the Sahelian drought in 1968–1975. Niger has long been among the very least developed countries in terms of human development and remains highly dependent on foreign aid (CIA 2002).

Nigeria is no exception among the African countries in having a long history of military rule. After 16 years of military rule, the biggest country in Africa in terms of population, with more than 250 different ethnic groups, adopted a new constitution and moved to civilian government

in 1999. Nigeria's economy is among the five biggest in Africa. Yet its heavy dependence on the oil industry makes it extremely vulnerable to world price fluctuations. Massive corruption, money-laundering, drugtrafficking and poor macroeconomic management, as well as a rapidly growing population, are factors negatively affecting the nation's economic development (CIA 2002).

Despite the numerous plans and projects, the outcomes of water management have not been successful, leading to the current state of degradation and water shortages (UNEP 2004, FAO 2009). In order to better understand possible reasons behind these shortcomings along the Lake Chad basin, a case study examining the role of internal security and its effects on the basin commission and the ecosystem of Lake Chad was undertaken in 2003 (Article IV).

4.2.3 IWRM in international policy (Article III)

The need to coordinate and harmonize water sector policies at the global level, particularly those in large, transboundary river basins is currently widely agreed (e.g. Raadgever & Mostert 2005, ECOWAS-SWAC/OECD 2006, Foster & Briceño-Garmendia 2010). The past decades have witnessed a number of large international summits and other important events for that purpose, events that have expanded substantially both in size and frequency. These international IWRM-led processes are supposed to be general enough to be applied in any watershed of the world regardless of geographic, climatic or socioeconomic context.

The merit of the first internationally coordinated approach to IWRM is often given to the UN Conference on Water in Mar del Plata in 1977 (Rahaman & Varis 2005). The Mar del Plata conference approved a set of recommendations and an action plan covering all the essential components of water management (Biswas 2004a). The International Conference on Water and Environment in Dublin in 1992 and the UN Conference on Environment and Development (Earth Summit) in Rio de Janeiro the same year

concluded with a number of basic principles of IWRM (ICWE 1992, UNCED 1992).

The First World Water Forum took place in Marrakech in 1997, which was the start of a series of regular Forums that have grown considerably in size. The Forums usually conclude with a set of recommendations whose contents vary notably from truly IWRM-oriented to a narrow sector type approach (Rahaman & Varis, 2005, Rahaman & Varis 2008).

Additionally, two events in the past have had a clear role in IWRM development: the International Conference on Freshwater in Bonn in 2001 and the World Summit on Sustainable Development (WSSD) in Johannesburg in 2002. The former concluded with the Bonn Keys, with a suggestion of IWRM as the most important tool for achieving these (Tortajada 2001). The latter produced the WSSD Plan of Implementation (WSSD 2002), which refers to IWRM as one of the key components for achieving sustainable development.

An analysis of international IWRM recommendations and realities on the ground using two basins as an example, the Mekong and Senegal Rivers, was conducted in 2008 by Varis *et al.* This case study allowed broadening the analysis to another geographic region, the Mekong River, in order to determine whether there are commonalities between theory and practice between two geographically distinct regions.

4.2.4 Climate change adaptation policies as a driver for integration (Article V)

Climate change is probably the topic that has gained the most attention out of the environmental sectors over the past decade. Climate change is one of the externalities that directly affects natural resources. Similarly, natural resources management actions can directly contribute to or halt climate change. Climate change is an integrated issue.

Ecosystem restoration is one tool to adapt to climate change. A recent study of The Economics of Ecosystems and Biodiversity (TEEB,

2009) concluded that up-front investments in maintenance and conservation of nature are almost always cheaper than trying to restore damaged ecosystems. Ecosystem restoration requires integrated approaches.

The National Adaptation Plan of Action (NAPA) is a way for the Least Developed Countries (LDCs) to address their urgent adaptation needs. The NAPA process is an initiative agreed under the UN Framework Convention on Climate Change. It is an internationally initiated and driven process with an agreed process format. An analysis was carried out to determine how widely ecosystem restoration and integrated approaches have been incorporated into the LDCs priority adaptation projects. The objective was to determine if the emerging priority given to climate change adaptation is catalyzing a shift from a focus on policy to practical applications of integrated natural resource management approaches.

5 FINDINGS ON SPECIFIC OBJECTIVES

The specific objectives of the thesis included the development of a systematic framework for analysing IWRM, using the framework to analyse two case studies of practice and two of theory, comparing these in order to extract IWRM factors that would not be revealed when studying them separately, as well as assessing the suitability of the methods for analysing IWRM. Findings on these specific objectives are summarized in Table 4 below and presented in detail in Chapters 5.1-5.4.

5.1 FRAMEWORK FOR SYSTEMATIC ANALYSIS OF IWRM

The three-axis approach presented in this thesis and used for analyzing the case studies (Figure 5) appeared useful in that it allowed for simultaneous, systematic consideration of the three components of IWRM:

- nature,
- society; users, and
- society; institutions.

Detailed use of the axes and their components was useful in the two practical case studies of IWRM, where the framework allowed for consideration of the potential disconnections between the IWRM components on a step-by-step basis and in detail. For analyzing the IWRM in international policy processes, the framework with all of its components was too detailed to reveal specific findings on the gap between theory and practice. Therefore, in these case studies, only the three broad IWRM axes (instead of all the components included in these) were used as a frame of reference.

The flaws of the framework become evident in a situation where little information on a basin or a specific IWRM case was available. In such a setting

Table 4 Summary of findings on Specific Objectives

Study objective	Finding
Specific Objective I Framework for systematic analysis of IWRM	Three-axes approach: Nature; Society, users; Society, institutions
Specific Objective II Case studies of practice Case studies of theory	Senegal River, Lake Chad, IWRM in international policy processes, climate change adaptation policies as a driver for integration
Specific Objective III Comparative analysis	Comparative analysis helped to extract two of the high-level, strategic issues: externalities, area of influence
Specific Objective IV Suitability of methods	No method is above another, but usually the starting point is a Literature review, which is complemented with Field visits/local expertise. The tool to be used afterwards depends on the data available: for qualitative, unscattered data qualitative data analysis is recommended. For inhomogeneous, scattered data, a Model based on the Bayesian Causal Network approach is recommended. For cases where detailed information is already available, comparative analysis is the most recommended tool.

the analysis of the components along the axes was difficult. This was exemplified especially when analyzing Lake Chad: relatively little information was available on the twelve components along the three IWRM axes. In order to be able to use the framework for a detailed analysis, the practitioners should be relatively well familiar with the conditions along the basin under study.

Another drawback of the framework related to a situation where it was used to identify the IWRM disconnections. The term “disconnect” is relatively subjective and the decision on whether there is a “disconnection” between particular two components depends strongly on the users’ knowledge of the particular case or situation being analyzed.

Further, the framework does not allow for a lot of granularity in analysis. In some cases, the components along the two societal axes incorporate many stakeholder groups within one heading. For example, the component “local users” can incorporate diverse groups, such as farmers and pastoralists whose relationships with components from the other axes can often differ greatly. For example, one user-group might be “disconnected” from the national plans, whereas another group supports them. Such a situation cannot be incorporated in the IWRM analysis when using the framework presented in this thesis.

Yet, the framework can be considered a useful check-list on IWRM practical applications. Water

Table 5 Specific findings from the appended Articles

Article	Study objective	Finding
I	Underlying, special challenges for water management along the Senegal River	Climate, ethnic composition, economic, human development
	Characteristic management features along the Senegal River	Dispersed management plans, local-national juxtaposition
	Future challenges along the Senegal River	Weak institutional structure, lack of organisational ability
II	Framework for assessing IWRM in West Africa	Three-axes approach
	Hypothesis for assessing IWRM in West Africa	Proved correct in the case of Senegal River
	Stakeholder analysis of key policy options	IWRM the best overall option
	Suitability of framework, hypothesis and Bayesian Belief Network approach	Bayesian approach worked in the case of Senegal River where little quantitative data are available
	Conclusions about IWRM along the Senegal River	Plenty of plans, lack of implementation
III	What are the effects on Lake Chad’s ecology if domestic security in a basin country deteriorates	History shows that the effects are negative
	What are the effects on the functioning of the LCBC if domestic security in a basin country deteriorates	Negative effects since the LCBC does not have mandate to settle disputes within member states.
	What are the indirect effects of the previous point on Lake Chad	Negative
IV	Lessons learnt based on the comparison of the two case studies and international policy	Mismatch and gap between the theoretical recommendations and realities of IWRM The water sector should be more conscious of the present state and future expectations of externalities
	Key IWRM points based on the Mekong and West African basin organisations	List of ten IWRM issues
V	Testing hypothesis: an external factor, such as climate change, is needed to put theoretical concepts into practice	Yes, data show that

resources managers could use the axes and their components for a quick identification of potential issues, organisations and stakeholders as well as their water demands and supply possibilities along a basin. Users of policy models could use the framework as a basis for systematic listing and analysis of the model variables and their potential disconnections.

Further, the framework is useful in that it allowed for reminding that IWRM is about holistic consideration of the three components simultaneously; nature, users, institutions. This aspect –albeit simple it sounds- has not been fully taken into account in either of the practical IWRM cases studied in this thesis.

5.2 ANALYSIS OF THE IWRM CASE STUDIES

A brief analysis of each of the four case studies of IWRM is presented in this Chapter. Detailed analyses can be found in Articles I, III, and III (for Senegal River), in Article IV (for Lake Chad), in Article III (for IWRM in international policy), and in Article IV (for climate change adaptation policies as a driver for integration). Findings from the Articles are summarized in Table 5.

5.2.1 Senegal River (Articles I, II, III)

As was presented in Articles I, II, and III, and later by UN/WWAP (2003) and Yu (2008), the practical achievements of the various IWRM plans along the Senegal River have not been rated as successful. This has been either because they have not been implemented at all, they have contradicted each other, or they have had significant negative changes on the environment and the local livelihoods.

In order to objectively analyse the development future of the Senegal River valley, a model based on Bayesian Causal Networks was built in 2002. Three management scenarios with a 10-year time-scale were tested: ‘strong national development’; ‘strong rural development’; and ‘IWRM’. The exercise revealed rather negative results as summarized below:

- *The conditions expected to prevail in the Senegal River valley within the model’s temporal resolution are somewhat worse than at present.* Even maintaining the situation at its current state presupposes effective actions.
- *The strong national policy scenario would weaken the situation of all stakeholders except the national economy.*
- *The uncertainty in the IWRM scenario was the smallest in each case.* This implies a far more robust and feasible outcome of this scenario in comparison to the other ones.
- *The model reveals the main lines of the situation along the Senegal River valley.* During the scenario iteration, the model revealed the variables that were the most sensitive (hydropower, large-scale irrigation and human development) and those in strong competition with each other (flood support–hydropower generation, small-scale irrigation–large-scale irrigation).
- *The advanced risk and uncertainty scheme.* No agency operating in the river valley has accurate information on the most important issues affecting the river management policies. Yet, their analyses ignore any aspects of risk and uncertainty, which can be considered a serious shortfall. The proposed approach offers clear benefits in this respect.
- *Win–win solutions are hard to find.* Finding a scenario that would compromise the needs of both national- and local-level actors is difficult. Commonly, improving the situation of either group diminishes the benefits of the other.

Full details of the modelling exercise can be found in Article II.

A literature review of the latest documents developed for the Senegal River, namely the Transboundary Diagnostic Analysis (TDA) (OMVS 2007) and Strategic Action Plan (SAP) (OMVS

2008), reveals that many conclusions drawn in 2002 have proven to be correct. The situation in terms of ecological conditions or people's livelihoods has not notably improved, invasive species continue to cause major distress, and the full potential for rice-irrigated agriculture has not been harnessed since the modelling exercise of 2002 (OMVS, 2007). The energy production has begun to meet expectations due to "significant recent additional investments" (Yu, 2008). The Strategic Action Plan (SAP) mentions that a "catastrophe scenario both for ecosystems and for the people is not excluded" (OMVS, 2008). These findings were very similar to those modelled in 2002.

5.2.2 Lake Chad (Article IV)

The case study revealed that the weak domestic security in the Lake Chad basin countries has had a notable effect on the functioning of the Lake Chad Basin Commission (LCBC). This is seen in the lack of political will, the location of the headquarters in a war-damaged country, and the inability of the member states to pay their membership fees. This, in turn, has hindered the planned activities for the improvement of the condition of Lake Chad.

The member countries, as stakeholders of the LCBC, are all challenged for what comes to their economic and political situation as explained in Chapter 4.2.2. In such a challenging situation it was estimated that international support might be needed to ensure the functioning of the Lake Chad Basin Commission and implementing actions under its mandate. By the time of conducting the case study in 2003, it was estimated that an internationally financed project might be able to move IWRM one step closer to practice through enabling the implementation of a comprehensive management plan for the basin. The project "Reversal of Land and Water Degradation Trends in the Lake Chad Basin Ecosystem" was estimated to be "promising" in delivering IWRM implementation. GIWA (UNEP 2004) came to a similar conclusion in its analysis of policy options.

The project was funded by the Global Environmental Fund (GEF). The implementing agencies were the United Nations Development

Programme (UNDP) and the World Bank (WB), while the executing agency was the United Nations Office for Project Services (UNOPS). The project implementation completion and results report states that the project's outcomes were "moderately unsatisfactory" (World Bank 2009). The project design was deemed as "overly ambitious". Prevailing security conditions and civil strife were mentioned as obstacles to project implementation. The main achievements, as stated in the project completion report, include the development of National Action Plans for the implementation of IWRM, and a slight increase in donor interest to support the implementation of LCBC plans. The activity aiming at more effective LCBC was partially successful. A somewhat more positive feedback on the success of the project was given by Mr. Anada Tiega, Secretary General of the Ramsar Convention (Tiega 2010), who was at the time of the GEF project the Ramsar focal point for Western Africa and involved in the project implementation. Mr. Tiega held the view that without the GEF project, the "LCBC might have disappeared; the GEF maintained some hope and showed the interest of external bodies in the issues prevailing along the Lake Chad".

The World Bank summarizes an important learning experience with regards to the GEF project and the role of international organisations (World Bank 2009). It demonstrates a mismatch between regional and international components of the "institutions" axis of the framework used (cf. Figure 5):

In the absence of a strong regional institution, development assistance should focus on capacity building and institutional strengthening of the Recipient, rather than attempting to resolve or bypass the institution's shortcomings by introducing outside agencies for project management and execution. In the case of the Lake Chad Basin GEF project, the employment of UNOPS as Executing Agency for the UNDP components and Management Services Provider for the Bank components diminished the interest of LCBC's management in the project.

5.2.3 IWRM in international policy (Article III)

An analysis of international IWRM recommendations and realities on the ground using two basins as an example, the Mekong and Senegal Rivers, was conducted in 2008 (Article III). The analysis revealed that the gap between international IWRM-related recommendations and reality in large international river basins appears to remain considerable. Similar conclusions have been drawn by a number of authors (e.g. Ayibotele & Afouda 2000, Biswas, 2004, Jeffrey *et al.* 2006, LCBC 2008, Rahaman 2009, Keskinen 2010). Based on such analyses, lists of either problems or success factors related to IWRM have been created. The complexity and vagueness of IWRM as a concept is dominant in all these lists.

The practical realization of IWRM in the Mekong and Senegal River basins reflect well the list of the ten IWRM issues presented below (Varis 2004, Varis *et al.* 2006, Mehtonen *et al.* 2008):

- *Strategic philosophy vs. tactical technique.* IWRM is a strategic tool. Practical implementation needs to be linked to action plans that are relevant at the local level.
- *The water sector is not alone.* Water is linked with many other sectors, which also suffer from integration challenges. Water should be seen in a broad, cross-cutting framework.
- *Institutions are a grand mix.* Water is dealt with at different levels by different stakeholders – many of which are outside the basin itself.
- *Stakeholder inclusion.* IWRM does not always benefit all stakeholders equally.
- *External vs. domestic interests.* Many IWRM institutions are influenced by their external donors and their interests.
- *Regulation vs. development.* There are examples where an agency has been responsible for issuing permits while being active in, e.g. dam construction

- thus judging its own operations. The two functions should be kept separate.

- *International river basin agencies tend to have weak coordination with other agencies,* particularly with national authorities. This hinders the real-life practical implementation of IWRM.
- *Plans exist but they are not realistic and profound enough.* IWRM plans often suffer from a scope that is too broad, which hinders implementation.
- *Shortcomings in communication and participation of stakeholders.* Both aspects have been relatively weakly managed in the past.
- *National borders cross many basins.* Having one plan for transboundary watersheds is attractive, but not always realistic.

The case study concluded that many of the key problems faced by the Mekong River Commission are similar to those in the West African basin organisations. In both cases, the recommendations from the main international IWRM events have remained poorly implemented.

5.2.4 Climate change adaptation policies as a driver for integration (Article IV)

An analysis of the National Adaptation Programme of Action (NAPA) project profiles was carried out in order to see how broadly ecosystem restoration and various integrated approaches for natural resources management are reflected in practice. The data show that the NAPA process has pushed ecosystem restoration and integrated approaches a step closer to their practical applications. An increasing number of countries are seeing ecosystem restoration as an important option for adaptation. In 2009, 42% of all NAPA project profiles included ecosystem restoration as a means of adaptation. The proportion in 2004 was 11%. The proportion of project profiles using at least one of the integrated approaches was 33% in 2009 in comparison to 4% in 2004.

The analysis revealed that the water sector should integrate more with other sectors. The data showed that significantly less NAPA projects under the Water Resources category aimed at ecosystem restoration than under Terrestrial Ecosystems and Coastal Zones and Marine Ecosystems. Further, the number of water-sector project profiles using integrated approaches was almost three times higher than projects aiming at ecosystem restoration.

The challenge ahead is to ensure that the restoration is undertaken using integrated approaches. A particularly important aspect is the broad, landscape-level scale. All of the integrated approaches referred to in this article emphasize the importance of the landscape, basin, or ecosystem scale. Yet, this aspect was missing the most in the NAPA project profiles.

In many of the NAPA project profiles “lack of capacity” was listed as one of the risks in or barriers to implementing the NAPA. Financing was listed as another potential barrier to the NAPA implementation. Putting into practice NAPA projects aiming at ecosystem restoration with integrated approaches would require less than 1% of the amount pledged for climate change mitigation and adaptation at the Copenhagen Climate Conference (Paper V, UNFCCC 2009b). There is increasing evidence on the high Internal Rates of Return from investing in natural ecosystems (e.g. TEEB, 2009). Building the investment case for mobilizing financing for the practical implementation of natural resources management using integrated approaches could be a way for international and local organizations to advance the sustainable development agenda.

5.3 COMPARATIVE ANALYSIS OF THE CASE STUDIES

The four case studies presented in this article provide findings on IWRM on their own. In an attempt to go beyond geographically-bound or context-specific findings, a comparison of the four relatively distinct cases is made in order to increase

our understanding of the underlying, strategic factors between theory and practice.

The frame of reference for the case studies was the three-axis approach as presented in Figure 5. With the help of a literature review and field visits/local expertise, issues falling under the different components of the framework were identified and listed. When comparing the two cases of IWRM practice, disconnections between issues along the different components were also identified. The ground for comparison was the gap between IWRM theory and practice. The preliminary relationship between each of the case studies under comparison was clarified and examined. In the end, general, high-level conclusions on the relationship between the case studies were drawn.

5.3.1 Comparison between Senegal River and Lake Chad

The two case studies of IWRM practice from West Africa have many shared features: unforeseeable climate, proneness to droughts, socioeconomic challenges, notable influence of international organisations, and a history of plans and planning. Aims such as large-scale irrigated rice agriculture projects, and the importance of traditional agricultural methods, e.g. flood recession farming, add to the list of commonalities. The outcomes of IWRM practice have not, however, been as desired in neither of the basins. The practical implementation of IWRM in the Lake Chad basin has struggled even more than along the Senegal River.

Interestingly, the future plans in both basins have followed, or there are intentions to follow, an approach already piloted in the other one: development of Transboundary Diagnostic Analysis and Strategic Action Plan for the Senegal River (OMVS 2007, OMVS 2008), and plans for irrigation, navigation and hydropower generation for Lake Chad (Kombe 2009).

For both water basins, further deterioration of the situation is not excluded (OMVS 2008, FAO 2009). It is therefore crucial to look back to previous management practices and decisions and

try to understand the strategic drivers behind the shortcomings in the past.

In order to do that, a systematic analysis of the IWRM components in both case studies was carried out according to Figure 8. In this approach, disconnections were identified between the different components of the three IWRM axes of the framework used in this thesis (see Figure 5). In the case of Senegal River, most disconnections appeared between the axes of ‘Society; users’ and ‘Society; institutions’. This was followed by disconnections between the ‘Nature’ and ‘Society; users’ axes. Most disconnections within an axis (i.e. between its components) were located along the ‘Society; users’.

Along Lake Chad, most disconnections appeared between the ‘Society, users’ and ‘Nature’ axes. This was followed by ‘Society, institutions’ and ‘Nature’ as well as ‘Society, institutions’ and ‘Society, users’. Figure 8 provides details of the comparison matrix and analysis.

Hence, both case studies had the most disconnections between the axes of ‘Society; institutions’ and ‘Society; users’ as well as between ‘Society; users’ and ‘Nature’. This suggests institutions and governance issues, as well as disconnections between nature and institutions, hindering some of the potential positive outcomes of IWRM.

The comparison also reflects the two competing development poles: local and national. The latter aims at large-scale agriculture activities, creation of hydropower and improvement of navigability of the water courses while the former one builds on existing small-scale livelihood methods, such as flood recession farming. The impacts on the ecology of the water basin as well as people’s socioeconomic conditions vary notably between these two development foci. Further, in both basins, the influence of international organisations on developing and implementing the plans (either through funding or actual involvement) has been strong.

Recognizing these similarities, a question remains on what might be behind the slightly more negative situation along Lake Chad? I argue that the issue of domestic insecurity has played a key role in the way IWRM has materialized in the basin. Surprisingly, the aspect of internal security has been neglected in the recent thinking along Lake Chad (e.g. UNEP 2004, FAO 2009; LCBC 2008, Kombe 2008, Musa *et al.* 2008). This is despite the facts that one of the main issues hindering the implementation of the GEF project was said to relate to the issue of internal security (World Bank 2009), and that Chad is ranked number two world-wide with possibility of political instability (EIU 2011).

5.3.2 Comparison between IWRM in international policy and the NAPA process

The two case studies of IWRM theory represented international policy processes. The first, purely water-related study examined the role of IWRM in international events and the way that recommendations from these are reflected on the ground. The second study was related to climate change and examined if and how integrated approaches, including IWRM, are reflected in the National Adaptation Programmes for Action (NAPA) project profiles. Comparison between these two case studies aimed at discovering high-level factors that can either hinder or advance the translation of concepts driven by international policy processes into practice. Whereas in both of the case studies the processes are internationally-driven, the NAPA process seems to have succeeded better in bringing various disciplines and integrated concepts together.

Similar to both processes is the strong involvement of international bodies in organizing the events as well as drafting their final recommendations. Further similarities include the establishment of targets to achieve implementation progress.

Whereas the internationally-led water related policy processes are aimed at the water community, and in many occasions at promoting the IWRM approach, the results of such events are not strongly demonstrated at the practical level. For example,

the WSSD in Johannesburg provided specific targets for implementing IWRM worldwide, including the goal of having an IWRM and water efficiency plan for all major river basins of the world by 2005 (UNDESA 2002). This target has not been met. The status report on implementation from May 2008 (UN-Water 2008) concluded that both developed and developing countries have yet much room for further improvement in this sense. Similarly, the case studies in this thesis, as well as further studies from other regions (Rahaman 2009, Keskinen 2010), show that the strategies and visions of the international processes are far from being implemented in practice.

The NAPA process, on the other hand, is driven by climate change, not water. Climate change is perceived as a concrete environmental issue

requiring urgent attention. Interestingly, the analysis showed that the NAPA process has been relatively successful in promoting integrated processes, including IWRM, in the NAPA project profiles. This suggests that external pressure with high publicity and donor interest, in this case climate change, can be a strong catalyst in moving the theory into practice.

5.3.3 Comparison of theory and practice

The comparison was done by listing key issues falling under IWRM theory and practice in each of the four case studies under scrutiny. In addition to that, issues having the greatest effect on the practical realization of IWRM were listed. The way these three; theory, practice, externalities, interacted in each of the case studies was examined and compared (Figure 9).

SENEGAL RIVER

		IWRM components											
		Nature				Society; users				Society; institutions			
IWRM axis		Body of water	Land	Biosphere	Atmosphere	Household	Agriculture	Industry	Nature	Local	National	Regional	Int.national
Nature	Body of water									n/a			
	Land					n/a		n/a		n/a			n/a
	Biosphere					n/a				n/a			n/a
	Atmosphere					n/a		n/a	n/a	n/a			
		Society; users				Society; institutions				Nature			
		Household	Agriculture	Industry	Nature	Local	National	Regional	Int.national	Body of water	Land	Biosphere	Atmosphere
Society; users	Household												
	Agriculture												
	Industry												
	Nature												
		Society; institutions				Nature				Society; users			
		Local	National	Regional	Int.national	Body of water	Land	Biosphere	Atmosphere	Household	Agriculture	Industry	Nature
Society; institutions	Local												
	National												
	Regional												
	Int.national												

Figure 8 IWRM comparison matrix for Senegal River and Lake Chad. The components included in each of the three axes of IWRM: "Nature", "Society; users", and "Society; institutions" (rf. Figure 5) are laid out in a matrix format. Each component is being assessed against others for disconnections in order to identify potential common areas of IWRM shortcomings

This comparison revealed two new issues that were not evident when examining the case studies separately: i) the importance of managing externalities and ii) understanding the area of influence. Both of them can be considered high-level factors that are helpful at the level of strategic decision-making or at the level of planning rather than day-to-day implementation of IWRM. On the latter, numerous toolboxes and handbooks already exist, e.g. Guidelines at River Basin Level (UNESCO 2009b), and Handbook for Integrated Water Resources Management in Basins (GWP-INBO 2009).

• **The importance of externalities**

The Merriam-Webster dictionary defines externality as: “The side effect on an individual or entity due to the actions of another individual or entity”. In the field of economics the term is used

commonly and Bishop *et al.* (2008) and TEEB (2010) have recently presented the principles of internalizing environmental externalities into business accounting.

I define externalities in the context of this thesis as “key factors that are not directly related to the IWRM process, but affect positively or negatively the theoretical and/or practical implementation of IWRM”. Using the terminology of systems dynamics, the externalities are similar to leverage points, which are “places within a complex system...where a small shift in one thing can produce big changes in everything” (Meadows 1999).

I differentiate externalities from underlying drivers in the sense that the latter covers all factors affecting IWRM, such as globalization, urbanisation, food

LAKE CHAD

IWRM components

IWRM axis		Nature				Society; users				Society; institutions				
		Body of water	Land	Biosphere	Atmosphere	Household	Agriculture	Industry	Nature	Local	National	Regional	Int.national	
Nature	Body of water									n/a				
	Land				n/a					n/a				
	Biosphere				n/a	n/a	n/a			n/a				
	Atmosphere								n/a	n/a				
Society; users		Society; users				Society; institutions				Nature				
		Household	Agriculture	Industry	Nature	Local	National	Regional	Int.national	Body of water	Land	Biosphere	Atmosphere	
		Household												
		Agriculture												
		Industry												
Nature					n/a									
Society; institutions		Society; institutions				Nature				Society; users				
		Local	National	Regional	Int.national	Body of water	Land	Biosphere	Atmosphere	Household	Agriculture	Industry	Nature	
		Local		n/a	n/a	n/a								
		National												
		Regional												
Int.national														

- overlap already taken into account
- disconnection
- the most disconnections
- n/a not applicable, or no data available

production, and poverty. Externalities are those factors that can make the system either succeed or fail.

Common to these factors is their unpredictability, uncertainty and “silent” nature meaning that their influence is often noticed only in a retrospective manner by water experts. This calls for the need to study past cases, where externalities have been identified and analysed, and to apply these lessons learnt in similar contexts. The unpredictability and uncertainty call for the use of management

methods that can take these factors into account, e.g. models based on Bayesian Causal Networks as presented in Article II. Externalities can also work in a positive manner. The challenge posed to IWRM is to recognize and harness these for the advancement of IWRM.

Externalities can also be considered “change agents” meaning that they are the key factors that can either bring theory closer to practice or vice versa. The key externalities identified in this study include the lack of domestic security

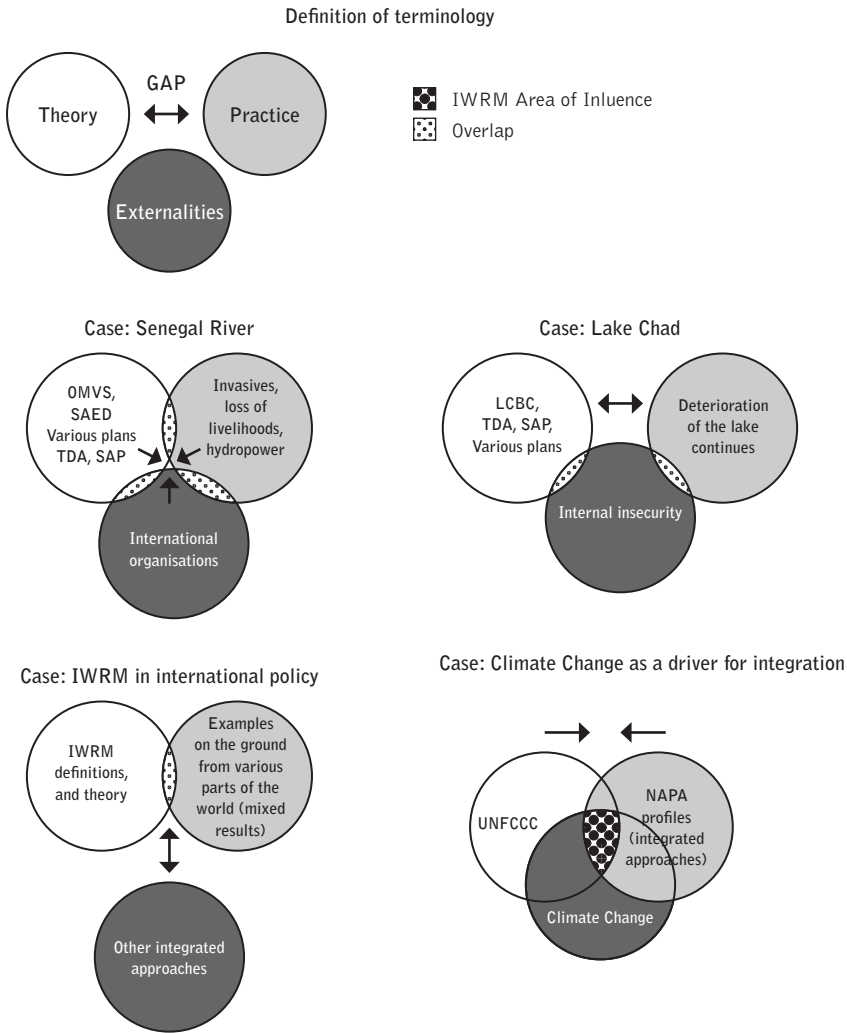


Figure 9 Examples of how externalities affect the theory and practice of IWRM and thereby the formation of the area of influence

along Lake Chad (negative externality), and the NAPA process as a vehicle for moving integrated approaches, including IWRM, closer to practical applications (positive externality). Realizing what the externalities in a specific basin are will enable managers or management to concentrate on the key factors enabling (or disabling) IWRM.

- **Understanding the area of influence**

I define the confluence between theory, practice and externalities as the “IWRM area of influence”. I call confluence between only two of the components an overlap. The IWRM area of influence is not only geographically bound, but also refers to boundaries defined by institutional settings and the different water users. In practice, defining the area of influence will involve activities such as delineating the physical landscape (which can extend beyond the “basin”), understanding the institutional setting, and conducting thorough stakeholder analyses. The differentiation between theory, practice and externalities is not necessarily clearly-cut. Components along the three axes of the IWRM framework used in this thesis can cross the lines of the different axes, and be part of more than one axis.

The comparative analysis indicated that externalities play a key role in either bringing theory closer to practice or doing the opposite. This is demonstrated in Figure 9. The area of influence is where institutions and management play a key role: it is the space where active management happens, and where managers have the most possibilities to influence the outcomes of IWRM. Big challenges relate to the externalities component: recognising what the existing and possible future externalities are, and how to factor these and related uncertainties into day-to-day management. Another important aspect is communication: sharing information, discussing options, learning from each other, agreeing on plans, and finding solutions to jointly defined problems.

I argue that the underlying problem in IWRM implementation along the Senegal River relates to the weak understanding and management of

the area of influence. While it can be stated that some of the plans and their implementation have followed the principles of IWRM, the large-scale development plans did not take into account their influence on the ecology or local livelihoods. On the other hand, the influence of international organisations has not been necessarily sufficiently managed leading to a situation where their plans sometimes contradict the national ones, or new plans are being developed before understanding what has gone wrong with the previous ones, as presented in Article I. Hence the international organisations (externality) have sometimes influenced the theory (e.g.), sometimes the practice (e.g.), but the three as a whole have not been managed properly. Further, the above-listed items of communication have been lacking.

In the case study of IWRM at the international policy level, the existence of numerous other integrated approaches has not been sufficiently taken into account hence leaving the water sector work too much in a vacuum. The lack of communication can also be identified as one shortcoming.

Figure 9 summarizes theory, practice, the key externalities, and the area of influence in the four case studies included in this thesis.

5.4 METHODS AND THEIR SUITABILITY: AN EVALUATION

One of the specific objectives in this thesis was to assess the suitability of the methods used in the IWRM case studies and subsequently, their suitability for further similar top-down, macro-level assessments.

5.4.1 Methods used in the case study of Senegal River (Articles I, II, III)

A literature analysis was needed in order to identify the different variables and the way they intertwine. A field visit complemented the analysis by helping to assess the quality of the available literature and data. This was useful when setting the confidence levels.

The model approach used enabled systematic analysis of multivariable problems. It supports a learning process from scattered, scarce, inconsistent, and subjective information towards a transparent, causally structured, consistent, and communicative model, which allows the analysis of policy-related scenarios and is a tool for decision analysis. The focus is on a probabilistic, risk-analytic way of interconnecting semi-qualitatively defined variables, which are expressed on relative scales.

A problem in the modelling activity was related to the available material. The data for the model were mainly qualitative due to the difficulty of acquiring quantitative material from the Senegal River basin. Even though some quantitative material was available, it was of dubious quality. In addition, the data were mainly available from a rather small geographical area while the model included a larger area of the basin.

The main lines of the findings of the modelling exercise were similar to those acquired in a similar study by the river basin management organisation (OMVS, 2000). Further, the conclusions drawn in 2002 about the situation ten years ahead are close to those recently described in the Transboundary Diagnostic Analysis for the basin (OMVS 2008).

The clear advantage of the model was the ability to include qualitative and often inhomogeneous data in the activity. The data available in international water basins especially in the developing world are often scarce and of weak quality. The latter issue relates to the second advantage of the approach: the model allows usage of confidence levels, which allow evaluating the validity of the data used in the modelling activity.

The disadvantage of the approach is the need to know the situation under study rather comprehensively. Even though quantitative data are not necessary, the linkages and interconnections between the different variables have to be known.

Another drawback relates to the situation where the initial conditions or confidence levels are poorly

known. In such a situation the model outcome gives rather little information on the suitability of the different policy options. This was the case in the Senegal River modelling activity and therefore the results did not give strong indications of the success of the different management scenarios. Yet, choosing the right management scenario in the real world is a highly sensitive activity and therefore the model can be said to represent the actual situation.

5.4.2 Methods used in the case study of Lake Chad (Article IV)

Methods used in this case study included a literature review, which was conducted jointly with a local water resources management professional while living and working in West Africa. Local expertise was used when updating the situation of Lake Chad in 2010. This included an interview with a person working in a project in Lake Chad during the time of the analysis, as well as access to the literature provided by local experts currently working in Lake Chad.

The methods used were suitable for this type of case study where relatively little information is available. The author would not recommend using mathematical methods, such as models based on Bayesian Causal Networks for this type of situation. Although the complexity of IWRM implementation is similar to that of the Senegal River, the availability of even less good quality material would not make the modelling exercise useful: uncertainties related to the data and built into the model would not show vast differences in the different scenarios. The advantage of using the model would be in the model building process itself, which would provide a structured framework for identifying the different variables and their interconnections.

Another important recommendation is to learn from past processes and projects, e.g. the GEF project from which the lesson learned have been distilled and are publicly available.

5.4.3 Methods used in the case study of IWRM in international policy (Article III)

Comparative analysis was the method used for analyzing this case study. IWRM as an international policy process was used as the frame of reference.

The method did not allow for new profound findings on IWRM but it did confirm what has been identified as key problems with IWRM previously: mismatch between international processes as well as regional, national and local development needs. According to Pickvance (2001), “Since comparative analysis is interested in the general not the specific or the unique, it inevitably simplifies and leaves out a lot of the full complexity of reality. Hence it is not a substitute for description or for the detailed analysis of a single case”.

Comparative analysis can be recommended as a method when a detailed analysis or information on cases to be compared already exists, but there is a need to identify or validate common trends in order to draw broad level conclusions.

5.4.4 Methods used in the case study of climate change adaptation policies as a driver for integration (Article V)

The methods used included a literature review, comparative analysis, and qualitative data analysis (QDA).

Literature review was necessary in order to set the objectives and the analytical framework for the study. The comparative analysis was done in order to show the similarities of a sample of integrated approaches in comparison to IWRM and point out the importance and need for “cross-fertilization” across disciplines and practitioners. The qualitative data analysis included reading through the information available in the form of the NAPA project profiles. The project profiles were coded into two categories: i) number of projects using ecosystem restoration as an adaptation method, and ii) number of projects following the underlying philosophy of (at least) one of the integrated natural resources approaches: Ecosystem Approach, FLR, ICZM, INRM, IWRM.

The NAPA project profiles were analyzed using the following logic:

1. Based on the NAPA project profile’s Justification/description, the project was classified either following or not following one of the five integrated approaches categories as presented in Chapter 2.1.3: Ecosystem approach, FLR, ICZM, INRM, IWRM. The decision was driven by the high-level definition of each of these concepts using a selection of key words as trigger in the classification process. The NAPA profiles provided only a high-level summary of the proposed projects and therefore, using the high-level definition of the different integrated approaches was deemed as an appropriate approach for the purposes of this analysis. Hence, the analysis gives a rough indication of the approaches in the different NAPA project profiles. A detailed analysis would require access to detailed project descriptions.
2. Based on the NAPA project profile’s Objectives/activities, decision was made on whether the project was directly aiming at ecosystem restoration. By “direct” was meant that the project’s activities physically and within the project’s time frame improve the condition of the ecosystem. Hence projects aiming at, for example, alternative livelihood methods in order to eventually reduce the pressure on the natural resources did not fulfil the “ecosystem restoration” criteria used in this analysis.

Qualitative data analysis was useful in revealing general tendencies included in the over 400 project profiles. Based on the analysis, general recommendations for the direction of the NAPA process could be identified. This might have been difficult only by reading the relatively big amount of documentation.

5.4.5 Summary of the suitability of the different methods

There is a suite of methods for analyzing IWRM. These range from decision-making support tools

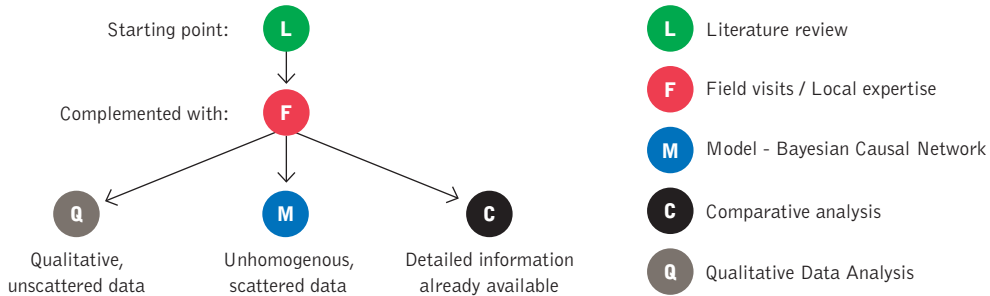


Figure 10 Recommendation for the use of methods in analysing the IWRM case studies in the context of this thesis

(e.g. Bayesian) to tools that analyse the different sector-specific components of IWRM (e.g. Rapid Rural Appraisals, hydrological models, analysis of databases). The choice of the methods used in this thesis was driven by the special characteristics of the study region, as well as the broad extent of the IWRM case studies presented in the appended Articles. More details of the rationale behind the methods chosen are presented in Chapter 3.

Some of the methods used fall more typically into the domain of social sciences or the art while others are methods that engineers are traditionally accustomed to. In general, studying IWRM requires interdisciplinary approaches and stepping out of one's comfort zone. The following summarizes findings on the suitability of the different methods used to analyze IWRM in the context of this thesis.

- **Choose method based on the type of data available**

The thesis did not find clear evidence that a particular method would perform better than others when finding answers to Overall and Specific Objectives. However, Figure 10 presents the ideal method for the type of data available. It does not mean that a particular method is unsuitable, per se, for analysing case studies with different types of data. The figure suggests the best fit-for-purpose method for each particular situation. More details on each method are provided thereafter.

- **The foundation of all: literature review**

The literature review was found as a necessary starting point in each of the IWRM case studies. This method is sometimes underestimated in engineering sciences, which are more declined to mathematical approaches. Increased emphasis on the importance of literature review is a necessity for engineers to truly understand the practical challenges of IWRM.

- **The essentials of the local context**

The importance of field visits and using of local expertise was clear in the two case studies from the developing world where the available data were scarce and of dubious quality. At the minimum, this allows access to a wider variety of data. This method is not particularly useful as the sole methodology but needs to be combined with other study methods.

It should be noted that the focus of this thesis was on a macro-level, academic, internationally-driven IWRM, as opposed to micro-level, grass-roots, locally driven IWRM. Methods suitable for the latter differ from the methods described in this thesis.

- **A few words on policy modelling**

A scenario modelling based on Bayesian Belief Networks appeared a useful method since it allowed the inclusion of the qualitative and inhomogeneous data that were available from




















Tool	Advantages	Disadvantages	Well suited for	Best used in combination with
 Literature review	Low cost; Can be done quickly.	Literature/data availability and quality.	Each type of case.	   
 Field visits / Local expertise	Possibility to validate literature/data; Local sources have usually the best in-depth knowledge of the issues.	High cost; Time-consuming; Security issues in certain basins; Availability and quality of material.	Cases with limited amount and quality of data.	   
 Model - Bayesian Causal Network	Can be used without technical knowledge on modelling through its user-friendly interface; Can incorporate qualitative and inhomogenous data; Model building itself is a useful, systematic learning process.	Can be lengthy process; Building the model requires specific technical capacity; Need to know the start situation comprehensively; In the case of unreliable data, model outcome brings little new information.	Cases with lots of scattered, interconnected variables; Cases with little amount of numerical data.	 
 Comparative analysis	Allows cross-sectoral/cross-disciplinary learning. Useful for tracking general tendencies.	Will not provide detailed information on a single case.	Situations where detailed information on a number of cases already exist.	 
 Qualitative Data Analysis	Allows tracking trends out of a big amount of qualitative material.	Not exact science: coding and interpreting the data involve personal judgement.	Cases with lots of unscattered, qualitative material.	 

Figure 11 Advantages and disadvantages of the different methods used in this thesis as well as their suitability for the type of material available

the river basin. It also allowed for the inclusion of uncertainties related to the data and hence a more realistic reflection of the real situation. The model building itself was a useful process since it provided a systematic method to organise scattered data into a systematic model architecture. The big advantage of the model used was in the model building and testing itself. This finding is validated by the following quote from Jeffrey & Gearey (2006):

Modelling (in the broadest sense of the word) can make a significant contribution to closing the knowledge gap between the theory and practice of IWRM. In general terms models allow us to represent the world around us in alternative formats; to abstract, simplify, conceptualise, and structure our beliefs about how the world works. In so doing they support analysis, experimentation, theory testing,

communication, and planning. However, we would argue that the water sector will struggle to exploit this potential if its contemporary science and policy cultures continue to view the contribution of models primarily as product rather than process.

Cognisant of the level of uncertainty and quality related to the data available in a number of basins in the world, the author would discourage the use of models that do not incorporate uncertainty in their architecture.

• **Learning from others and “seeing the bigger picture” through comparative analysis**

Comparative analysis was the main method used in this thesis. It revealed a number of underlying issues on IWRM that would not have been recognized when analysing the case studies separately. Learning from the past and from each other is a key factor in the process of improvement. For example, the case studies revealed that water

professionals have promoted the use of IWRM for decades, without necessarily recognizing the evolution of integrated approaches promoted by other disciplines. Further, the case studies of Senegal River and Lake Chad revealed that practitioners still tend not to learn from the past but instead undertakings that have failed in similar contexts are repeated elsewhere.

• **In search of a common thread: QDA**

IWRM and other concepts aiming at practical changes on the ground necessarily involve using and analysing qualitative data. If the quantity of such data is not big, QDA is not necessary. Instead, a literature review, combined with field visits/local expertise, is sufficient to analyse the issue under study.

Figure 11 summarizes the advantages and disadvantages of the methods as well as the situation for which they are well suited, and the methods with which they are best used in combination.

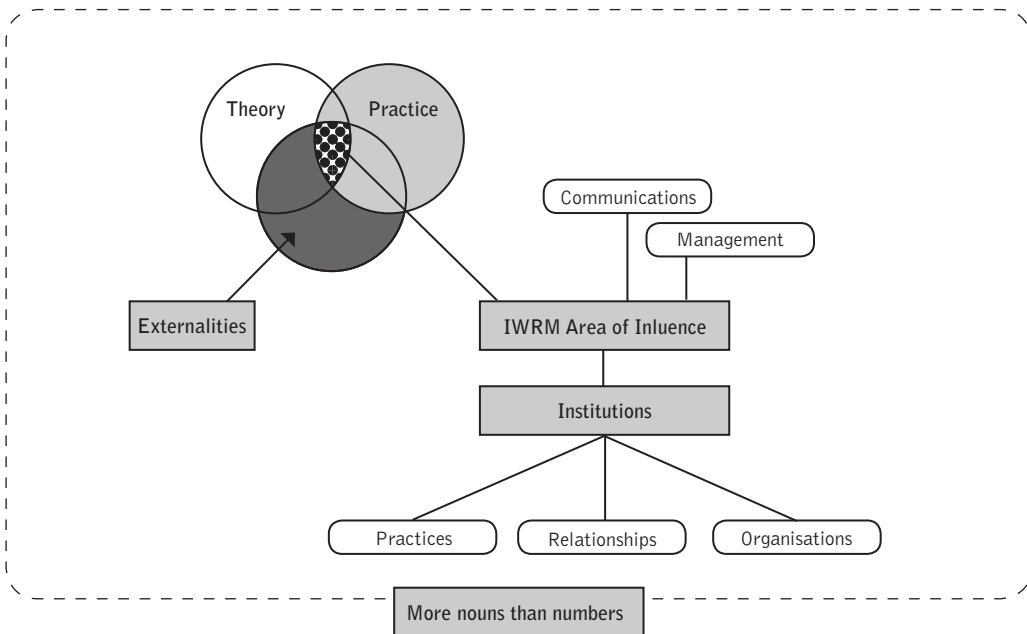


Figure 12 Four key issues affecting the theory and practice of IWRM: Externalities, Area of Influence, Institutions and More nouns than numbers

6 FINDINGS ON OVERALL OBJECTIVES

The Overall Objectives of the thesis were to increase understanding of the high-level, strategic issues that hinder or enable the translation of IWRM from policy into practice, and based on that, distillation of special considerations for IWRM in West Africa, for integrated approaches, and among practitioners. Findings on these are summarized in Table 6 and presented in more detail in Chapters 6.1-6.4.

6.1 HIGH-LEVEL, STRATEGIC ISSUES THAT HINDER OR ENABLE TRANSLATION OF IWRM FROM POLICY INTO PRACTICE

A number of analyses have been conducted of success factors, constraints, and key elements of IWRM in similar geographic regions and study settings as presented in this study (e.g. LCBC 2000, Ayibotele & Afouda 2000, Varis *et al.* 2008, Rahaman 2009, Keskinen 2010). While all the findings reported by these authors can be agreed upon, the following four lessons can be extracted based on the Findings presented in Chapter 5. These can be considered the high-level, strategic issues that hinder or enable the translation of IWRM from policy into practice in the context and study setting included in this thesis. The four lessons are the following (see also Figure 12):

- **Recognizing externalities**

The high-level, strategic reasons that can trigger either success or failure in translating IWRM theory into practice. These are difficult to predict in the present moment and they therefore call for the use of methods, such as comparative analysis, qualitative data analysis, using of local knowledge,

literature review, and modelling methods that can incorporate inhomogeneous data.

As the case studies presented in this thesis have exemplified, externalities play a key role in the success or failure of IWRM. This suggests that there are limits to “integration”, which is demonstrated by the presence of externalities.

- **Understanding the area of influence**

This is the confluence between theory, practice and externalities, i.e. the area where IWRM managers have the most possibilities to successfully influence the outcomes of IWRM. Recognising externalities, integrating them within the boundaries of the area of influence, managing the area, and efficiently communicating with the players within the area are key challenges for IWRM managers and management.

- **The importance of Institutions**

Institutions are often held culpable for negative IWRM outcomes. While this can be true in many cases, it should be noted that institutions do not manage water but the people who do that make up the institutions. Management bodies and managers of water should be given clear accountabilities and mandates. Reaching targets should be positively recognized, and equally, cases of mismanagement should not go unnoticed. Personal management skills have not necessarily received sufficient attention within the water sector; the sector could perhaps learn from the private sector where management capabilities are one of the key competencies emphasized. Another “people” aspect relates to the training of water professionals and typical IWRM practitioners. Practitioners of integrated approaches do not

Table 6 Findings on Overall Objectives

Study objective	Finding
Overall Objective I High-level, strategic issues that hinder or enable translation of IWRM from policy into practice	Recognizing externalities Understanding the area of influence The importance of institutions Understanding, analysing and managing all the above is more about nouns than numbers
Overall Objective II Special considerations for IWRM in West Africa, in integrated approaches, among practitioners	<u>West Africa:</u> No shortage of planning but lack of implementation Win-win solutions are hard to find Institutions play a key role in successful IWRM, but are often weak Strong influence of externalities Failure to learn from the past? <u>Integrated approaches</u> Vagueness around concepts Water professionals need to integrate more Scale not well understood Little emphasis on institutions <u>Practitioners</u> IWRM is a concept that has international policy support International organisations have a role to play but it comes with responsibility There is need to emphasize a "IWRM-friendly" curriculum Need to pay more attention to the "M" of IWRM

necessarily have training/expertise on skills that are needed in the institutional axis as presented in Figure 5. This axis calls for qualifications in fields such as law, diplomacy, negotiation, culture, and religion – none of which are traditionally taught in engineering or natural science faculties.

- **Understanding, analysing and managing all of the above is more about nouns than numbers**

The methods needed to study and analyse IWRM, especially at the practical level, do not fall into the traditional engineering domain. Data rarely come in numbers, which calls for the need to use qualitative research and analysis methods. Significant uncertainties are involved in the understanding and managing of externalities, which calls for the use of mathematic models that can incorporate inhomogeneous data (if modelling is used at all). Finally, as the case studies showed, learning from the past is not common in practical applications of IWRM. This calls for a significantly wider use of methods that take into account the historical development of a particular basin.

6.2 SPECIAL IWRM FEATURES IN WEST AFRICA

- **No shortage of planning but lack of implementation**

In both the Senegal River and Lake Chad basins plans have succeeded each other. The implementation, however, has not always followed the pace of planning.

The lack of implementation can partly relate to the fact that in reality "implementing IWRM is a political process..." (Jonch-Clausen & Fugl 2001).

Keskinen (2010) identified "Politics" as one of the six key elements affecting water management based on case studies from the Mekong. The role of politics in transboundary management of water has been discussed widely (Haddad 2004, Mirumachi & Allan 2007, Mylopoulos et al 2008). Yet, the role of politics within a country – as it relates to collaboration or segregation of water-related issues between different ministries and stakeholders –

also plays a key role (Bhat 2004, Molle & Renwick 2005). Further, politics play a role in decision-making and the way the views and needs of different stakeholder groups are reflected in the final outcome. As exemplified in Chapter 2.2.5, the voices of the most vulnerable stakeholders in the decision-making are often low or non-existing.

The role of politics can also be seen along the Senegal River where one of the constraints on success in IWRM has been the constantly changing and dispersed institutional settings and political ethos (Articles I, II, III). The role of politics as it relates to internal security has been the key reason hindering implementation along Lake Chad (Article V).

Another reason might relate to the role of international organisations, funding, and ownership. As the case studies revealed, many of the integrated plans along the two basins are funded by international donors and as such, follow the process and format spelled out by them. As soon as the plans are done, funding and implementation relies on local authorities and organisations (even though in some cases international organisations are involved in both funding and implementation of the plans as well). If ownership of the process and plans has not been created during the planning process, the implementation has little chance to succeed.

The socioeconomic context plays a key role in implementing IWRM and is one reason behind the identified lack of implementation. In order to “land” IWRM, the necessary “societal infrastructure” needs to be in place. This means securing people’s basic needs. In a situation where people are in a day-to-day survival mode, any approach lacking improving people’s livelihoods is doomed to fail.

- **Win-win solutions are hard to find**

In the case of the Senegal River, finding a scenario that would equally satisfy the needs of both national- and local-level actors was difficult. In the modelling exercise, improving the situation of either group diminished the benefits of the others. This finding

indicates that water resources management in West Africa should be seen from the viewpoint of Common Pool Resources (CPR), i.e. “resources that are characterized by the difficulty of excluding actors from using them and the fact that the use by one individual or group means that less is available for use by others” (GreenFacts, 2011). As described earlier in Chapter 2.1.1 CPR differs from the concept of public good in the sense that the latter refers to a situation where “a benefit received by any other party does not diminish the availability of the benefits to others” (ibid).

Realizing and admitting that win-win solutions are not realistic could be helpful in planning for the future water governance options in West Africa. If the concept of CPR is to be considered a potential future starting point for water governance, the attributes associated with an increased likelihood of appropriators to engage in designing and modifying governance arrangements as defined by Ostrom (2000) should be carefully taken into account:

1. **Possibility of feasible improvements:** resource conditions are not at a point of deterioration such that it is useless to organize or so underutilized that little advantage results from organizing.
2. **Availability of reliable and valid indicators:** indicators of the condition of the resource system are frequently available at a relatively low cost.
3. **Predictability of resource flows.**
4. **Limited spatial extent:** the resource system is sufficiently small, given the transportation and communication technology in use, for appropriators to develop accurate knowledge of external boundaries and internal microenvironments.

Oel *et al.* (2007) studied the applicability of CPR concepts in order to understand governance of water resources in semi-arid river basins (with a case study from Brazil). The study included assessment of how the above-listed attributes manifest for CPRs in the upstream and downstream parts of a river basin. The authors conclude that the CPR concepts

are useful for explaining agricultural productivity, stability, and equitability in a semi-arid river basin. The idea of applying CPR concepts to understand and improve the water governance in West Africa would be worth further exploration and might provide useful insights into management practices.

- **Institutions play a key role in successful IWRM, but are often weak**

In the two case studies from West Africa presented in this thesis, one item was clearly highlighted as problematic: institutions. This was reflected by the mismatch between the axes of ‘Society; institutions’ and ‘Society; users’ as well as between ‘Society; users’ and ‘Nature’.

The area of influence is where institutions play a key role. As defined in Chapter 2.2.6, this includes practices, relationships, and organisations. In West Africa, the role of informal institutions in each of the three components of institutions is strong and therefore, the IWRM managers should carefully define the area of influence taking into account not only the formal agreements and players, but also the boundaries created by customary law and practices. This calls for specific emphasis on the management qualifications of the people in charge of implementing IWRM.

Communication between the different players included in the area of influence is crucial. It should be seen as a continuing process of sharing information, discussing options, learning from each other, consulting, involving, and participating. This calls for a specific set of skills that should be included in the IWRM implementation set-up.

- **Failure to learn from the past?**

A retrospective analysis and comparison of the two basins reveal that plans in both of them tend to follow what has been already tried in the other one. The Lake Chad basin started with the development of a diagnostic study of environmental degradation in 1989, a Master Plan and Action Programme in 1992, and Strategic Action Plan in 1998 (GIWA, 2004). The LCBC is now considering a large scale water transfer project with irrigation, navigation, and hydropower components. The project, which

would transfer water from Oubangui River of the Congo basin through a 1350km long feeder channel to Lake Chad, is in its feasibility study phase (Kombe 2009).

On the other hand, Senegal River started with a large scale water infrastructure project aiming at irrigation, navigation, and hydropower. After the negative consequences caused by these undertakings, OMVS has recently carried out a Transboundary Diagnostic Analysis and Strategic Action Plan exercise for the basin.

Even though the two basins share many similarities related to the climatic, hydrological and socioeconomic conditions, there is only one cross-reference between the two (the Strategic Action Plan for Senegal River refers to the water hyacinth problem along Lake Chad). The reason for this cyclic repetition of the approaches might have roots at the international level and in the fact that such approaches are often promoted by development banks and other players that fund some of these studies and actions.

6.3 SPECIAL CONSIDERATIONS FOR INTEGRATED APPROACHES

Realization that IWRM has many similarities with a number of other types of integrated approaches is increasingly being acknowledged in reports (e.g. Cambell *et al.* 2004) and scientific articles (e.g. Merrey & Drechsel, 2005). This repetition is important and should continue in order for the IWRM paradigm to shift closer to other integrated approaches.

The qualitative data analysis carried out in relation to NAPA project profiles (Article V) provided an interesting learning experience of the practical applicability of the different integrated concepts. The following observations were made during the analysis process:

- **Vagueness around concepts**

Out of the five concepts studied in Article V, “Ecosystem Approach” is the most vaguely defined

and had the least differentiating characteristics in comparison with the other four concepts: IWRM's key differentiating feature is the "basin," INRM's "agricultural," FLR's "forest landscape" and "ecological integrity," and ICZM's the "coastal zone." "Ecosystem Approach" can be considered more an overarching philosophy, whereas the rest of the integrated concepts are more precise and therefore might be more useful for practical implementation purposes.

The terms INRM and IWRM were used even if the project profile did not meet the official definition of these (cf. Article V). This suggests a tendency of these concepts to be used as "buzzwords" without necessarily following the philosophy of the concepts as described in their official definition. The differentiation between the classifications of INRM and FLR was often difficult to make. Often the approach described in a project profile met both the INRM and FLR criteria.

- **Water professionals need to integrate more**

Water professionals often tend to promote IWRM in a vacuum with the assumption that practitioners from different disciplines automatically adapt to the concept of IWRM. These practitioners, however, might be more accustomed to other integrated approaches. Water professionals should be open to such approaches whose underlying philosophy is very similar to that of IWRM, such as FLR and INRM.

- **Scale not well understood**

Spatial scale, which is central to each of the integrated approaches, was missing in the NAPA project profiles. In many cases, a project profile followed the principles of integration among land, water, and people, but the scale of the proposed intervention was not at the landscape, ecosystem functionality, or basin level. This indicates the need either to further clarify the importance of the broader scale, or to accept the fact that integrated approaches often need to be started at a small scale and gradually scaled up to the basin or landscape levels. The concept of considering the river basin as a network of Common Pool Resources as presented

by Oel *et al.* (2007) provides, again, interesting further consideration for operationalizing the different integrated approaches.

- **Little emphasis on institutions**

There was a strong lack of project profiles aiming at institutional strengthening or development. The problems related to institutional capacity have been identified as one of the key constraints on the success of IWRM (GWP-INBO 2009). This finding suggests the need for an intervention with regards to the NAPA project implementation: careful attention should be paid to institutions and their strengthening.

The issue of institutions also relates to various, competing integrated approaches. This applies to all institutional levels: from local to global, from universities to international organisations, and from governments to NGOs. The danger with these fragmented, and sometimes competing, approaches is the confusion created among different stakeholders.

6.4 SPECIAL CONSIDERATIONS FOR PRACTITIONERS

- **IWRM is a concept that has international policy support**

Even though big international conferences are sometimes criticized for too much talk with little actual outcome and even less action (Fomerand 2000, Barnett & Finnermore 1991, referred to in Haas 2002), in the author's opinion there is a function for these. Usually high-level representatives from the participating states sign the principles that are formulated in such events. This gives the entitlement for the implementing parties in the member countries to appeal to policymakers, which have at least in principle committed themselves to international resolutions. A pessimist would claim that signing a paper is far from implementation. Yet, without these universally signed principles, the means for the water professionals to influence the policy makers would be actually very little.

Yet, the wide distribution of IWRM can be credited to some extent to international policy processes. Although the usefulness of such big international events is questioned by some, and the outcomes of such events have been criticised as not being well followed-up, IWRM has benefited from such events. An example of this is the global spread of IWRM as the overarching water management strategy. Further, international processes have helped in bringing the concept of IWRM a step closer to practice: to the national level. This is exemplified by the relatively high proportion of NAPA project profiles aiming to adapt to climate change using integrated natural resources management approaches, including IWRM.

- **International organisations have a role to play but it comes with responsibility**

In extremely challenging situations where domestic security is an issue (e.g. the case of Lake Chad), international assistance can help advance IWRM if it focuses on capacity building and institutional strengthening. When the case study of Lake Chad was conducted eight years ago, the suggestion was that in such a challenging situation international support might be needed to ensure the functioning of the LCBC and implementing actions under its mandate. This conclusion was aligned with the recommendation of UNEP (2004), and confirmed by local expert as possibly having saved the LCBC (Tiega, 2010).

However, the international organisations, donors, and scientific community are often offering a “package” of IWRM. It is often forgotten that the countries that we understood as developing ones fall into various categories. Accordingly, these countries should follow the strategy of IWRM suitable for their circumstances rather than blindly try to implement the common framework. Yet, the fact that the international institutions are pushing forward the concept of IWRM is good since it forces the project implementers, such as consultancies, plan their project based on the concept of IWRM. A problem at the international level is the vast amount of often overlapping

organisations, declarations, and forums (e.g. Global Water Partnership, World Water Vision, World Water Forum), which all declare basically the same principles. This results in fatigue towards the very concept of IWRM and in worst cases apathy towards its implementation.

The role of international organisations as implementers of approaches such as IWRM is sometimes criticized as top-down - as opposed to bottom-up - driven. The latter emphasized the transfer of local ownership to national and local bodies all the way to the village level. Whereas in many cases such an approach is desired and will ensure the long-term sustainability of an intervention, there are cases where an external interlocutor, such as an international organisation, is needed (Article IV). In Chapter 6.2 the role of politics in IWRM was mentioned to play a big role. In such situations an external intervention can help to depoliticise the situation. Similarly, even though the big international organisations, such as those linked to the UN, are blamed for their ivory-tower type approaches, the fact that these organisations have a seat at the table in politically-driven international negotiations can in some cases advance IWRM more than transferring all the responsibility for IWRM to the “lowest appropriate levels”. The right amount of local versus international involvement and implementation is highly context-specific and should be taken into account when defining the IWRM area of influence and managing it.

International organisations and donors should take full responsibility for the outcomes of IWRM in initiatives they have funded. New plans should not be funded before it is understood why the previous ones have not been implemented or have failed. Plans should also be aligned with previous attempts, and not be undermined solely in order to promote a particular concept that the donor or international agency is interested in supporting. Externalities, such as the political instability of a country, should be taken into account in plans despite the fact that such issues are often diplomatically sensible.

- **There is a need to emphasize “IWRM-friendly” curriculum**

IWRM is taught in various institutions. It should be ensured that the curriculum for such studies includes topics that are relevant to IWRM and points out where the most weaknesses in its implementation are. Studies of diplomacy, negotiation, social anthropology, law, and history, among others, should be part of the curriculum aimed at training IWRM professionals.

- **There is a need to pay more attention to the “M” of IWRM**

Managing something as complex as IWRM is not an easy task. In the field of economics, management is a study field of its own. The private sector pays careful attention to people’s management skills from the junior to top levels. A number of institutes globally exist for the sole purpose of studying management and using that knowledge to train better business managers. The natural resources sector, including water, should better understand what “Management” in IWRM entails, and based on that understanding focus on developing such skills among the current and future generations of IWRM managers.

7 CONCLUSIONS

In order to determine what happens between IWRM theory and practice, and what keeps the concept alive for decades, two case studies of IWRM on the ground and two case studies of IWRM at the international policy level were analyzed using a common framework. The case studies had been analysed in detail in the past and provide findings on IWRM on their own. Comparison of the various case studies - instead of studying them separately - was done in order to scale up the findings and thereby increase understanding of the underlying factors between theory and practice. The case studies were analysed using a different set of methods: literature review, field visits, Bayesian Causal Networks, comparative analysis and qualitative data analysis. Consolidated findings of the Summary section as well as the particular findings from the appended Articles are listed in Tables 4-6.

IWRM is understood as a management procedure that integrates the natural resources and society around a body of water. The framework used in analysing the case studies was developed for the purpose of systematically analysing IWRM. In this, IWRM is divided into three axes: nature, society – users, and society – institutions. Sustainable development can be considered as an outcome of the integration between the axes.

The case studies, Senegal River and Lake Chad fall in the so-called Sudano-Sahelian Zone, which is fragile due to unpredictable climatic patterns and weak socioeconomic development, among others. The analysis revealed that in both basins, there is a long history of IWRM planning. In both cases, however, implementation has not followed the same intensity. This is either due to contradictory or overlapping plans, or the

presence of external factors that have undermined or made their implementation impossible. Weak institutional settings, including disconnections between the institutions and the users as well as between institutions and nature, have played a key role. Based on the recent literature, the tendency towards more planning seems to continue. There is also some indication that large-scale projects that have already been tried in one basin with moderate (or even negative) results are on the planning boards of another one. This hints at a lack of learning from the past, or from each other. Finally, the involvement of international organisations in both basins has been strong.

One of the case studies representing international policy processes was purely IWRM-related, while the other one examined how IWRM is reflected in the international policy process driven by climate change, namely the National Adaptation Programme of Action (NAPA) process. Interestingly, the comparison of the two concluded that the NAPA process has been somewhat more successful in promoting integrated approaches in practice than international processes aiming solely at advancement of IWRM.

Comparative analysis of the case studies of theory and those of practice again revealed the well known fact that the water sector is not operating in a vacuum but is closely linked to other components and phenomena of the ecosystem as well as different institutional and user sectors of society. Some of these factors can be relatively easily taken into account in planning and management activities. Others are rather difficult to manage either because they are not even recognized as having influence on the water sector, or because the risks they pose involve large uncertainties.

I call these factors “IWRM externalities”. The challenge is to recognize who or what these in a specific water basin are, what risks they might pose to the integrated management of that basin, and how to control them. This includes either avoiding the influence of negative externalities or taking advantage of the positive ones.

I defined the confluence of the three components, theory, practice and externalities, as the “IWRM area of influence”. By this I want to emphasize the active nature of IWRM. Understanding of theories, practices, and externalities, as well as the way these three interact will give the management an understanding on what and who they should be managing, and what is beyond their direct control.

In addition to above-mentioned specific features of IWRM in West Africa, the analysis showed that win-win solutions are hard to find. Usually management options favour one group of people against other. The role of externalities in both of the study basins was strong, and should therefore be factored into any future development actions.

Analysis of the NAPA project profiles revealed that the terminology describing the different integrated approaches is often used vaguely. The differences and similarities between the concepts are not always clear to practitioners and terms are often used as “buzzwords” without necessarily understanding the key features of the different approaches. The notion of scale is a predominant feature in all the integrated approaches represented in this thesis. Yet, the analysis showed that this is the very feature that is the least well incorporated into practical proposals of integrated management of natural resources. There was indication that water professionals should integrate more with those representing terrestrial approaches, such as FLR and INRM. Finally, there was little emphasis on institutions or institutional capacity building in the NAPA project profiles, which can be seen as a serious shortcoming based on the findings from the practical IWRM case studies.

At the international and academic levels the gap between theory and practice of IWRM has

been widely discussed. The role of international organisations and conferences in IWRM dialogue can be seen as a positive factor in the sense that it has helped IWRM to become a truly global concept. Yet, international organisations that engage in the act of promoting, funding or implementing such concepts should take a real responsibility for local ownership and outcomes on the ground.

The methods used in the case studies provided an interesting learning experience of interdisciplinary. The methods needed to manage water in an integrated manner call for the skills of social scientists, legal experts, anthropologists, and diplomats, to mention just a few. The demanded set of skills is wide and requires individuals to adapt new methods and approaches that are not necessarily from their own domain. Another important finding relates to the use of models in IWRM and the type and availability of data in regions such as West Africa. The lack of data and their inhomogeneity call for the need to use models that can incorporate such input and related uncertainties.

There is a need to pay closer attention to the role of “Management” in IWRM. Instead of focusing solely on the bulky concept of “institutional strengthening”, perhaps more attention should be paid to the people that make up these institutions. High-profile institutes exist for management research and training of business leaders but these are mostly aimed at the private sector. The natural resources management sector might consider learning from the business world in this sense.

Since IWRM is the most useful at the strategic level, the thesis provides a set of high-level features of IWRM that people working at that level should concentrate on. In addition to the above-mentioned importance of i) externalities and the ii) area of influence, the analysis of IWRM case studies from the Sudano-Sahelian Zone and in international policy processes revealed two components of utmost importance when using the IWRM concept to achieve the desired end result, that is, water basins that are developed in a sustainable way. These are iii) the importance

of institutions, and iv) understanding that data are more about nouns than numbers.

In the author's opinion, IWRM is not a past paradigm. The fact that the concept has survived decades of scrutiny and is still being implemented globally, can be considered a strong proof of its viability as a strategy. IWRM has the same elements as the contemporary concept of sustainable development, which also is an overall, strategic approach, rather than a detailed, delivery-oriented technical set of guidance. IWRM could be seen as a subset of sustainable development adapted to the water resources management context. The attractiveness of IWRM might be in its intuitiveness and the fact that the basic concept is relatively simple, in which case there is no need to change the paradigm. Instead, careful attention should be paid to not overcomplicating the concept.

Perhaps we need more voices calling out for simplicity and focus on the big picture in IWRM; just like the child finally dared to point out that the Emperor had no clothes on in the tale of Hans Christian Andersen.

ANNEX 1: FIELD VISITS AND LOCAL EXPERTISE

Material (mainly grey literature, such as reports from River/Lake Basin organisations and by international donors) has been collected during working and living in West Africa. These are listed in “References” and not specified in the table below.

Country/case	Institutions/experts consulted
Senegal River	<ul style="list-style-type: none"> • Mr. Mohamed Abdrabou, Directeur Technique, OMVS. Meeting and discussions in February-March 2001 • Dr. Madiodio Niasse, Head of IUCN’s West African Regional Water Programme. Personal communication in relation to the Senegal River and Lake Chad throughout the drafting of the thesis during the years 2002-2011
Lake Chad	<ul style="list-style-type: none"> • Dr. Anadou Tiega 2010. Secretariat General, The Ramsar Convention on Wetlands. Personal communication, 9 March 2010 • Dr. Niasse Madiodio, Head of IUCN’s West African Regional Water Programme
West Africa in general	<p>Living and working in Burkina Faso 2002-2003 during which informal discussions about IWRM in West Africa was carried out with:</p> <ul style="list-style-type: none"> • Ms. Birguy Lamizana-Diallo, IUCN • Dr. Madiodio Niasse, IUCN • Mr. Edouard Boungkougou, independent consultant <p>Comments acquired while working in the Niger Delta:</p> <ul style="list-style-type: none"> • Dr. Jonathan Amakiri, Shell Petroleum Development Company <p>Information acquired through email:</p> <ul style="list-style-type: none"> • Mr. Dam Mogbante, Coordinator Global Water Partnership, West Africa

REFERENCES

- Abel, R., 2004. Book and Journal Publishing. In: Encyclopedia of Library and Information Science. May 14, 2004, 1-9.
- Adekanye, 2008. Structural Adjustment, Democratization and Rising Ethnic Tensions in Africa. *Development and Change*, Volume 26 Issue 2, Pages 355 – 374.
- AfDB, 2000. Policy for Integrated Water Resources Management. Draft, February 2000. African Development Bank (AfDB).
- African Union, 2008. Decisions, declarations, tribute and resolution. Assembly of the African Union. 11th Ordinary Session, 30 June – 1 July 2008, Sharm El-Sheikh, Egypt
- AMCOW, 2010. An Indicative list of African Declarations in the Water sector. A quick reference guide. African Minister's Council on Water (AMCOW), Draft 22 November 2010 prepared for the 3rd Africa Water Week.
- AMCOW, 2011. African Minister's Council on Water (AMCOW) www.amcow.net. Accessed 27.5.2011
- ANEW 2010. Strategic Plan 2010-2014. African Civil Society Network on Water and Sanitation (ANEW).
- AWF, 2009. Pan African Water Sector Monitoring and Evaluation Assessment. African Water Facility (AWF),
- Ayibotele, N.B., Afouda, A., 2000. West African Water Vision. West African Technical Advisory Committee, Global Water Partnership.
- Ballo, A., 2004. Le système de la Dina. In M. Niassé, A. Iza, A. Garane, O. Varis (Editors), *Water Governance in West Africa: Legal and Institutional Aspects*. Proceedings of the IUCN workshop "Water Governance: Legal and Institutional Aspects of Natural Resources Management in West Africa", Ouagadougou, Burkina Faso, 25-27 September 2002. *IUCN – Droit et politique de l' environnement*, no 50. Pages 85-91.
- Batterbury S., 1998. The Sahel region; assessing progress twenty-five years after the great drought. *The Sahel - 25 years after the great drought. Assessing Progress - Setting a New Agenda*. Conference on 13.5.1998, Royal Geographical Society, London, UK.
- Barnett, M.N., Finnemore, M., 1991. The Politics, Power, and Pathologies of International Organizations. *International Organization* 53, no. 4 (1999): 699-732
- Bhat, A., 2004. Policy, politics, and water management in the Guadalquivir River Basin, Spain. *Water Resources Research*, Vol. 40, W08S07, doi: 10.1029/2003WR002726, 2004.
- BICF, 2001. Declaration of African Ministers responsible for Water Resources at the Bonn International Conference on Freshwater (BICF), 3 to 7 December, Germany.
- Biswas, A.K., 2004a. Integrated Water Resources Management: A Reassessment. *Water International*, Volume 29, Number 2, June 2004: 248–256.
- Biswas, A. K., 2004b. From Mar del Plata to Kyoto: a review of global water policy dialogues, *Global Environmental Change (Part A)*, 14, pp. 81–88.
- Bishop, J., Kapila, S., Hicks, F., Mitchell, P., Vorhies, F., 2008. *Building Biodiversity Business*. Shell International Limited and the International Union for Conservation of Nature: London, UK, and Gland, Switzerland. 164 pp.
- BJA, 2011. Bureau of Justice Assistance, Office of Justice Programs, U.S. Department of Justice. Available at: http://www.ojp.usdoj.gov/BJA/evaluation/glossary/glossary_m.htm. Accessed 24.2.2011.
- Boko, M.I., Niang, A., Nyong, C., Vogel, A., Githeko, M., Medany, B., Osman-Elasha, R., Tabo & P. Yanda, 2007. *Africa. Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Editors), Cambridge University Press, Cambridge UK, 433-467.
- Cambell, B.J.A., Sayer, J., Hagman, A., Stroud, L., Wollenberg, R.J., Thomas, and Frost, P., 2004. Operationalising the ecosystem approach – re-inventing research. *Forest Livelihood Briefs*, May 2004, Number 2.
- CIA, 2002. *The World Factbook*, Central Intelligence Agency (CIA), online version, available at <http://www.cia.gov/cia/publications/factbook/index.html> (accessed 31 October 2007).
- Cicin-Sain, B., Knecht, R.W. & Fisk, G.W., 1995. Growth capacity for integrated coastal management since UNCED: an international perspective. *Ocean Coastal Management*, 29(1-3): 93-123.

- CBD, 1995. Report of the second meeting of the conference of the parties to the Convention on Biological Diversity (CBD). Jakarta, 6-17 November 1995.
- Dasmann, R.F., Milton J.P. & Freeman, P.F., 1973. *Ecological Principles for Economic Development*. London, New York, Sydney and Toronto: John Wiley for IUCN and the Conservation Foundation, Washington DC.
- Douthwaite, B., Ekboir, J.M., Twomlow, S., Keatinge J.D.H., 2004. The Concept of Integrated Natural Resources Management (INRM) and its Implications for Developing Evaluation Methods. In: B. Shiferaw, H.G. Freeman, S.M. Swinton (Editors), *Natural Resources Management in Agriculture: Methods for Assessing Environmental Impacts*, CAB International.
- Earthmind, 2011. <http://wetcarbon.earthmind.net/projects/>. Accessed 27.5.2011
- EC, 2010. Introduction to the new EU Water Framework Directive, European Commission (EC). Available at: http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm. Accessed 20.1.2011
- ECOWAS, 2008. Rapport d'Activités Année 2007. Economic Community of Western African States (ECOWAS) Water Resources Coordination Unit, Ouagadougou, Burkina Faso.
- ECOWAS-SWAC/OECD, 2006. *Transboundary River Basins. Atlas on Regional Integration in West Africa, Land Series, August 2006*. Economic Community of West African States (ECOWAS) - Sahel and West Africa Club (SWAC)/Organisation for Economic Cooperation and Development (OECD).
- EIU, 2011. Political Instability Index: Vulnerability to social and political unrest, Economist Intelligence Unit Limited (EIU). Available at: http://viewswire.eiu.com/site_info.asp?info_name=EIUcontact. Accessed 17.1.2011
- Encyclopedia Columbia 2003. Encyclopedia Columbia (2003), <http://www.bartleby.com/65/i>. Accessed 31.10.2007
- Euroconsult/Institut National de Recherche pour la Conservation de la Nature, 1990. Profil de l'Environnement de la Vallée du Fleuve Sénégal, Arnheim, Euroconsult/Institut National de Recherche pour la Conservation de la Nature.
- FAO, 2009. Adaptive Water Management in the Lake Chad Basin. Addressing current challenges and adapting to future needs. Food and Agriculture Organisation of the United Nations, Seminar proceedings. World Water Week, Stockholm, August 16-22, 2009.
- Farace, D.J., Franzen, J., Schöpfel, J., Stock, C., Boekhorst, A.K., (2005). Access to Grey Content. An Analysis of Grey Literature based on Citation and Survey Data. Seventh International Conference on Grey Literature, Nancy, France, 5-6 December 2005.
- Fomerand, J., 2000. International Approaches to Development. The United Nations and Its Limits. *Seton Hall Journal of Diplomacy and International Relations*. Summer/Fall 2000, pp. 51-59.
- Foster, V., Briceño-Garmendia, C., 2010. Africa's Infrastructure. A Time for Transformation. The International Bank for Reconstruction and Development /The World Bank.
- Furber A. H., 1997. Fulani and Zarma tribes pushed into fights by Desertification?. ICE Case Studies, TED Conflict Studies. Available at: <http://www.american.edu/ted/ice/NIGER.html>. Accessed 31.7.2001.
- Garane, A., 2008. UN watercourses convention: applicability and relevance in West Africa. The Global Water Partnership-West Africa, Green Cross, the UNESCO Centre for Water Law, Policy and Science, and WWF.
- Gattei, S., 2009. Karl Popper's philosophy of science: rationality without foundations. Taylor & Francis e-Library, ISBN 0-203-88719-0, pp. 154.
- GWP, 2000. *Integrated Water Resources Management. Global Water Partnership (GWP) Technical Advisory Committee (TAC) Background Papers, No. 4*. Stockholm, Sweden.
- GWP, 2003. *Integrated Water Resources Management Toolbox, Version 2*, Global Water Partnership (GWP) Secretariat, Stockholm, Sweden.
- GWP, 2005. *Catalyzing Change: A handbook for developing integrated water resources management (IWRM) and water efficiency strategies*. Background paper no. 5. United Nations Department of Economic and Social Affairs. Commission on Sustainable Development. Thirteenth Session 11-22 April New York.
- GWP, 2007. *Managing Africa's Water Resources*. Global Water Partnership (GWP) support to IWRM planning: What have we learned? GWP Secretariat, Stockholm, Sweden.
- GWP, 2009. *Qu'est-ce que le PIWAG*. Global Water Partnership (GWP), Site du Partenariat Ouest Africain de l'Eau. Available at : <http://gwpa.org/spip.php?article30>. Accessed 25.1.2009.

- GWP/AO, 2009a. Burkina Faso - Capitalisation du processus d'élaboration et de Mise en Œuvre du PAGIRE. GWP/AO, Ouagadougou, Burkina Faso.
- GWP/AO (Partenariat Ouest Africain de l'Eau), 2009b. Capitalisation du processus d'élaboration Du Plan d'Action de Gestion Intégrée des Ressources en Eau (PAGIRE) au Sénégal, GWP/AO, Ouagadougou, Burkina Faso.
- GWP-INBO, 2009. A Handbook for Integrated Water Resources Management in Basins. Global Water Partnership (GWP) - International Network of Basin Organisations (INBO), Elanders, Sweden, 2009. ISBN: 978-91-85321-72-8
- GWP, 2010. Water Security for Development: Insights from African Partnerships in Action. Global Water Partnership (GWP), Stockholm, Sweden
- GWP-PNE-Benin, 2010. Processus Planification GIRE au Bénin - Expériences acquises, résultats et leçons apprises, Global Water Partnership (GWP)- Partenariat National de l'Eau – Benin (PNE-Benin), Mars 2010.
- GreenFacts, 2011. Facts on Health and the Environment. Available at: <http://www.greenfacts.org/glossary/abc/common-pool-resource.htm>. Accessed 17.1.2011.
- Haas, P.M., 2002. UN conferences and constructivist governance of the environment. *Global Governance* (1): 73-91.
- Haddad, M., 2004. Politics and Water Management: a Palestinian Perspective. Water for life in the Middle East. 2nd Israeli-Palestinian-International Conference, Turkey 10-14 October 2004.
- HarperCollins Publishers, 2003. Collins English Dictionary – Complete and Unabridged. Available at: <http://www.thefreedictionary.com/Sahara>. Accessed 31.1.2011.
- Heinrigs, P., Perret, C., 2006. The ecologically vulnerable zone of Sahelian countries. Atlas of Regional Integration in West Africa, Environment Series, Economic Community of West African States (ECOWAS) - Sahel and West Africa Club (SWAC)/Organisation for Economic Cooperation and Development (OECD). ECOWAS-SWAC/OECD.
- Holdgate, M., 1999. The Green Web - A Union for World Conservation. Earthscan Publications Ltd, London. ISBN: 1 85383 595 1
- Homer-Dixon, T.F., 1999. Environment, Scarcity, and Violence. Princeton University Press, Princeton, NJ.
- ICWE, 1992. Dublin Statement. International Conference on Water and Environment (ICWE), Dublin, 29–31 December.
- International Congress on Cultivated Forests, 3rd-7th October, 2006. Bilbao, Spain. Session: Plantations and Water. http://www.waldbau.uni-freiburg.de/download/pdf/bilbao_pre_programme.pdf
- Ioris, A., 2008. The limits of integrated water resources management: a case study of Brazil's Paraíba do Sul River Basin. Sustainability: Science, Practice, & Policy. Fall/Winter 2008, Volume 4, Issue 2. Available at: <http://sspp.proquest.com/archives/vol4iss2/0803-007-ioris.pdf>. Accessed 26.1.2011.
- IPCC, 2007. Climate change 2007: Climate change impacts, adaptation and vulnerability. Summary for policymakers. A report of the Working Group II of the Intergovernmental Panel on Climate Change (IPCC). Fourth Assessment Report. 23 pp.
- IUCN, 2009. Water and Nature Initiative. Available at: http://www.iucn.org/about/work/programmes/water/wp_our_work/wp_our_work_initiatives/wp_our_work_wani/. Accessed 27.5.2011.
- IWMI, 2011. IWMI in West Africa. Available at: <http://westafrica.iwmi.org/iwmi-in-west-africa.aspx>. Accessed 27.5.2011.
- Jacques, G., Herron, C. (Editors), 2009. Final Report. 5th World Water Forum, Istanbul, Turkey 16-22 March, 2009.
- Jeffrey, P., Gearey, M., 2006. Integrated water resources management: lost on the road from ambition to realisation? *Water Science & Technology*, 53:1, pp 1–8.
- Jonch-Clausen, T. & Fugl, J., 2001. Firming up the Conceptual Basis of Integrated Water Resources Management. *Water Resources Development*, 17:4, pp. 501-510.
- Jones, T., Newborne, P., Phillips, B., 2006. Applying the principles of integrated water resource and river basin management – an introduction. A report to WWF-UK.
- Kedowide, F.-C., 2004. Stratégie endogène de la gestion de l'eau et des systèmes aquatiques dans le sud du Bénin. In M. Niasse, A. Iza, A. Garane, O. Varis (Editors), *Water Governance in West Africa: Legal and Institutional Aspects*. Proceedings of the IUCN workshop "Water Governance: Legal and Institutional Aspects of Natural Resources Management in West Africa", Ouagadougou, Burkina Faso, 25-27 September 2002. UICN – Droit et politique de l' environnement, no 50. Pages 79-84

- Keskinen, M., 2010. Bringing back the common sense? Integrated approaches in water management: Lessons learnt from the Mekong. Dissertation for the degree of Doctor of Science in Technology. Aalto University, School of Science and Technology, Faculty of Engineering and Architecture, Department of Civil and Environmental Engineering.
- Koechlin, J., 1997. Ecological conditions and degradation factors in the Sahel. In: Raynaut/Stockholm Environment Institute: Societies and Nature in the Sahel, Routledge, New York, USA.
- Kombe, M.D., 2009. The Project for Water Transfer from Oubangui to Lake Chad. In: Adaptive Water Management in the Lake Chad Basin. Addressing current challenges and adapting to future needs. Seminar proceedings. World Water Week, Stockholm, August 16-22, 2009.
- Kurian, M., 2004. Institutional analysis of integrated water resources management in river basins - A methodology paper. International Water Management Institute Working Paper 79, Colombo, Sri Lanka.
- Laakso L., Launonen R., 1997. Building peace in Africa. Diversity of Distress – Diversity of Possibilities. KP Paino, Kokkola, Finland 1997, pp. 79.
- Lahtela, V., 2002. Integrated Water Resources Management in Western Africa-a framework for analysis. Licentiate Thesis, Helsinki University of Technology, Espoo.
- LCBC, 2000. Integrated River Basin Management. Challenges of the Lake Chad Basin. The Lake Chad Basin Commission (LCBC), Vision for 2025.
- LCBC, 2008. Strategic Action Programme for the Lake Chad Basin: Agreed by the LCBC Member States of Cameroon, Central African Republic, Chad, Niger, and Nigeria. Final SAP: 11 June 2008. Lake Chad Basin Commission (LCBC).
- Lemoalle, J., 2004. Lake Chad: a changing environment. In: J.C.J. Nihoul, P.O. Zavialov, P.P. Micklin, (Editors): Dying and Dead Seas. Climatic Versus Anthropogenic Causes. IV. Earth and Environmental Sciences – Vol. 36, NATO Science Series, Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 321-341.
- Lewins, A., Taylor, C., Gibbs, G., 2005. What is Qualitative Data Analysis (QDA)?. Online QDA, University of Huddersfield. Available at: <http://onlineqda.hud.ac.uk/index.php>. Accessed 26.1.2011.
- Marrakech Declaration, 1997. Available at: http://www.idhc.org/esp/documents/Agua/MARRAKECH_DECLARATION%5B1%5D.pdf. Accessed 13.2.2010.
- Meadows, D. 1999. Leverage Points: Places to Intervene in a System. The Sustainability Institute, Hartland VT, USA.
- Medema, W. & Jeffrey, P., 2007. Factors That Mediate Resources Management: Evidence from the Rheine Basin. International Conference on Adaptive and Integrated Water Management, Basel, Switzerland, 12-15 November 2007.
- Mehtonen, K., Keskinen, M., & Varis, O., 2008. The Mekong: IWRM and cooperation between different institutions. In: O. Varis, A. K. Biswas & C. Tortajada (Editors), Management of Transboundary Rivers and Lakes, Springer, Berlin/Heidelberg, pp. 207-224.
- Merrey, D.J., Drechsel, P., 2005. Integrating “livelihoods” into integrated water resources management: taking the integration paradigm to its logical next step for developing countries. *Reg Environ Change* (2005) 5:197-204.
- Merriam-Webster, Incorporated, 2011. Merriam-Webster Online Dictionary. Available at: <http://www.merriam-webster.com>. Accessed 26.1.2011.
- Ministry of Agriculture, hydraulics and fishing resources of Burkina Faso, 2003. Action plan for integrated water resources management in Burkina Faso (PAGIRE). March 2003
- Ministère de l’Energie, des Mines et de l’Eau – République du Mali, 2007. Plan d’Action National de Gestion Intégrée des Ressources en Eau (Ière Partie), Etat des lieux des Ressources en Eau et de leur cadre de Gestion. Rapport Final, Decembre 2007.
- Mirumachi, N. & Allan, J.A., 2007. Revisiting Transboundary Water Governance: Power, Conflict, Cooperation and the Political Economy. International Conference on Adaptive and Integrated Water Management, Basel, Switzerland, 12-15 November 2007.
- Molle, F., Renwick, M., 2005. Economics and politics and of water resources development: Uda Walawe Irrigation Project, Sri Lanka. Research Report 87. Colombo, Sri Lanka: International Water Management Institute (IWMI).
- Moss, T., 2010. Managing water beyond IWRM – from paradigm to pragmatism. Presentation to 1st Water Research Horizon Conference, Berlin, 13-14 July 2010.
- Mulrow, C.D., 1994. Systematic Reviews: Rationale for systematic reviews. *British Medical Journal* 309: 597-9.
- Musa, I.K., Bila, M., Mana, B., Mahaman, C., 2008. Saving Lake Chad. Proceedings of Sirte Roundtable (LCBC and ICID), 17 December, 2008, Libya.

- Mylopoulos, Y., Kokokytha, E., Vagiona, D., Kampragou, E., Eleftheriadou, E., 2008. Hydrodiplomacy in practice: transboundary water management in northern Greece. *Global NEST Journal*, Vol 10, No 3, pp 287-294, 2008.
- National Board of Waters, 1974. Summary Report of the Integrated Water Resources Development Plan for the lower parts of the Kymi River. Helsinki: National Board of Waters, Finland.
- Niang, I., 2007. Institutional framework in relation to climate change in West and Central Africa. *Climate Change Adaptation in Africa Programme*.
- Odame-Ababio, K., 2005. Putting Integrated Water Resources Management into Practice – Ghana's Experience. In: B. Swallow, N. Okono, M. Achouri, L. Tennyson, L., 2005 (Editors), *Preparing for the next generation of watershed management programmes and projects Africa*. Proceedings of the African Regional Workshop, Nairobi, Kenya, 8-10 October 2003. Food and Agriculture Organization of the United Nations, Rome 2005.
- Oel, van B.R., Krol, M.S., Hoekstra, A.Y., 2007. A river basin as a common pool resource: a case study for the Jaguaribe basin in Brazil. *Value of Water Research Report Series no. 24*, UNESCO-IHE, University of Twente, Delft University of Technology.
- OMVS, 2000. Programme d'Optimisation de la Gestion des Reservoirs. Organisation de la Mise en Valeur du Fleuve Sénégal (OMVS), Dakar, Sénégal.
- OMVS, 2007. Analyse Diagnostique Environnementale Transfrontalière du Bassin du Fleuve Sénégal. Synthèse Régionale. Rapport final. Organisation pour la mise en valeur du fleuve Senegal (OMVS).
- OMVS, 2008. Plan d'Action Stratégique. De Gestion des Problèmes Environnementaux Prioritaires du Bassin du Fleuve Sénégal. Version finale. Organisation pour la mise en valeur du fleuve Senegal (OMVS).
- Ostrom, E., 1990. *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press, Cambridge, MA.
- Ostrom, E., 2000. The Danger of Self-Evident Truths. *Political Science and Politics*, Vol. 33, No. 1 (Mar., 2000), pp. 33-44.
- Pearl, J., 1988. *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference*. Morgan-Kaufmann, San Mateo, CA, p. 552.
- Pegasys, 2010. Draft AMCOW workplan January 2011-December 2013.
- Pernetta, J.C. & Elder, D.L., 1993. Cross-sectoral integrated and coastal area planning (CICAP): guidelines and principles for coastal area development. A marine conservation and development report. Gland, Switzerland, IUCN in collaboration with World Wide Fund for Nature, p. 63.
- Pickvance, C., 2001. Four varieties of comparative analysis, *Journal of Housing and the Built Environment*, 16, 2001, pp 7-28. School of Social Policy, Sociology and Social Research, University of Kent, Canterbury, Kent, UK.
- PNUD-OMVS, 1974. Programme intégré de développement du bassin du Sénégal. 12 volumes, Programme des Nations Unies pour le développement (PNUD)- Organisation pour la mise en valeur du fleuve Senegal (OMVS), Norbert Beyrard, Paris 1974.
- Raadgever, G.T. and Mostert, E., 2005. Transboundary River Basin Management – State-of-the-art review on transboundary regimes and information management in the context of adaptive management. Deliverable 1.3.1 of the NeWater project, RBA Centre, TU Delft (online) http://www.usf.uni-osnabrueck.de/projects/newater/downloads/newater_wp10.pdf. Accessed 26.1.2011.
- Rahaman, M.M. & Varis, O., 2005. Integrated Water Resources Management: evolution, prospects and future challenges. *Sustainability: Science, Practice & Policy*, 1(1), pp. 1–8.
- Rahaman, M.M. & Varis, O., 2008. Mexico World Water Forum's Ministerial Declaration 2006: A dramatic policy shift? *International Journal of Water Resources Development*, 24(1), pp. 179-198.
- Rahaman, M.M., 2009. *Integrated Water Resources Management: Constraints and opportunities with a focus on the Ganges and the Brahmaputra river basins*. Dissertation for the degree of Doctor of Science in Technology. Helsinki University of Technology, Faculty of Engineering and Architecture, Department of Civil and Environmental Engineering.
- Revenge, C.S. Murray, J. Abramovitz, and A. Hammond, 1998. *Watersheds of the World: Ecological Value and Vulnerability*. Washington, DC: World Resources Institute.
- SADC, 2005. *Regional Strategic Action Plan on Integrated Water Resources Development and Management - Annotated Strategic Plan 2005 – 2010*. Southern African Development Community (SADC), SADC House, Government Enclave, Gaborone, Botswana.

- Sawyer, A., 2004. Violent conflicts and governance challenges in Western Africa: the case of the Mano River basin area. *The Journal of Modern African Studies*, 42:3:437-463 Cambridge University Press
- Schöpfel, J., Farance, D., J., 2010. Grey Literature. In M. J. Bates & M. N. Maack (Eds.), *Encyclopedia of Library and Information Sciences*, Third Edition, pp. 2029-2039. CRC Press.
- Sivakumar, M.V.K., Wallace, J.S., 1991. Soil water balance in the Sudano-Sahelian zone. *Proceedings of the Niamey Workshop*, February 1991. IAHS Publ. no. 199, 1991.
- Snellen, W.B., Schrevel, A., 2004. IWRM: for sustainable use of water 50 years of international experience with the concept of integrated water management. Background document to the FAO/Netherlands Conference on Water for Food and Ecosystems. Ministry of Agriculture, Nature and Food Quality, The Netherlands.
- Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program, 2000. Natural resource management institution building in the decentralizing context of West Africa: the SANREM CRSP approach. Institutional Development Theme Session of the International Farming Systems Association (IFSA) Symposium, Santiago, Chile.
- TEEB, 2009. *The Economics of Ecosystems and Biodiversity (TEEB) for National and International Policy Makers – Summary: Responding to the Value of Nature*.
- TEEB, 2010. *The Economics of Ecosystems and Biodiversity (TEEB) Report for Business – Executive Summary 2010*.
- Tiega, A., 2010. Secretariat General, The Ramsar Convention on Wetlands. Personal communication, 9 March 2010.
- Tortajada, C., 2001. Conference Report: International Conference on Freshwater. Bonn, Germany 3-7 December 2001. Available at: <http://www.thirdworldcentre.org/freshwater.PDF>. Accessed: 3.3.2010.
- Traore, S., 2004. Le cas du Delta et de la Vallée du Sénégal. In M. Niasse, A. Iza, A. Garane, O. Varis (Editors), *Water Governance in West Africa: Legal and Institutional Aspects*. Proceedings of the IUCN workshop "Water Governance: Legal and Institutional Aspects of Natural Resources Management in West Africa", Ouagadougou, Burkina Faso, 25-27 September 2002. UICN – Droit et politique de l' environnement, no 50. Pages 93-99
- Twomlow, S., Love, D. & Walker, S., 2008. The nexus between INRM and IWRM. *Physics and Chemistry of the Earth, Parts A/B/C Volume 33, Issues 8-13*, 2008, pp: 89-898.
- UN, 1977. Report of the United Nations (UN) Water Conference, Mar del Plata, 14-25 March 1977.
- UNCED, 1992. Agenda 21, Chapter 18: Protection Of The Quality And Supply Of Freshwater Resources: Application of Integrated Approaches To The Development, Management And Use Of Water Resources. The United Nations Conference on Environment and Development (UNCED). Available at: <http://habitat.igc.org/agenda21/a21-18.htm>. Accessed 28.1.2011.
- UNDP, 2009. Human Development Report 2009: Overcoming barriers: human mobility and development,. The United Nations Development Programme (UNDP), New York, United States.
- UNDESA, 2002. Johannesburg Plan of Implementation. United Nations Department of Economic and Social Affairs (UNDESA). Available at: http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl.pdf. Accessed 1.3.2010.
- UNECA, 2000. *The Africa Water Vision for 2025: Equitable and Sustainable Use of Water for Socio-Economic Development*. United Nations Economic Commission for Africa (UNECA).
- UNECA, 2006. *The Africa Water Vision for 2025: Equitable and Sustainable Use of Water for Socio-Economic Development*. United Nations Economic Commission for Africa (UNECA).
- UNEP, 2004. Fortnam, M.P. and Oguntola, J.A. (eds), *Lake Chad Basin, GIWA Regional assessment 43*, University of Kalmar, Kalmar, Sweden.
- UNEP, 2007. Roadmaps for water management in West Africa. UNEP-DHI Centre for Water and Environment. Horsholm, Denmark.
- UNEP, 2010. Improving water governance and management in Western Africa. United Nations Environmental Programme (UNEP). Available at: http://www.unep.org/Themes/freshwater/PDF/Factsheet_WesternAfrica.pdf. Accessed 20.1.2011.
- UNESCO, 2009a. Facing the challenges. The United Nations World Water Development Report 3. Case studies volume. United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris, France and Earthscan London, the UK.

- UNESCO, 2009b. IWRM guidelines at river basin level. United Nations Educational, Scientific and Cultural Organization (UNESCO). Available at: <http://www.unesco.org/water>. Accessed 20.1.2010.
- UNFCCC, 2009a. The NAPA project database. United Nations Framework Convention on Climate Change (UNFCCC). Available at: http://unfccc.int/cooperation_support/least_developed_countries_portal/napa_project_database/items/4583.php. Accessed 1.12.2009.
- UNFCCC, 2009b. Copenhagen Accord. United Nations Framework Convention on Climate Change (UNFCCC), Copenhagen, 2009.
- UN-Water/Africa, 2006. African Water Development Report 2006. Economic Commission for Africa, Addis Abeba, Ethiopia
- UN-Water & GWP, 2007. UN-Water and Global Water Partnership (GWP) Roadmapping for Advancing Integrated Water Resources Management (IWRM) Processes. Based on the Copenhagen Initiative on Water and Development prepared jointly by UN-Water and the Global Water Partnership.
- UN-Water, 2008. Status Report on Integrated Water Resources Management and Water Efficiency Plans. Report Prepared for the 16th session of the Commission on Sustainable Development – May 2008.
- UN/WWAP, 2003. 1st UN World Water Development Report: Water for People, Water for Life. United Nations/World Water Assessment Programme. UNESCO (United Nations Educational, Scientific and Cultural Organization) and Berghahn Books. Paris, New York and Oxford.
- Uusitalo, H., 1991. Tiede, tutkimus ja tutkielma. Johdatus tutkielman maailmaan. WSOY, Juva, Finland 121 p. (In Finnish).
- Varis, O., 1998. A belief network approach to optimization and parameter estimation: application to resource and environmental management. *Artificial Intelligence*, 101, pp. 135-163.
- Varis, O., 2004. Basin organization models: the case of the Mekong River. In M. Niassé, A. Iza, A. Garane, O. Varis (Editors), *Water Governance in West Africa: Legal and Institutional Aspects*. Proceedings of the IUCN workshop "Water Governance: Legal and Institutional Aspects of Natural Resources Management in West Africa", Ouagadougou, Burkina Faso, 25-27 September 2002. IUCN – Droit et politique de l' environnement, no 50. pp 223-238.
- Varis, O., Kumm, M., Keskinen, M., Makkonen, K., Sarkkula, J. & Koponen, J., 2006. Integrated Water Resources Management on the Tonle Sap Lake, Cambodia, *Water Science and Technology: Water Supply*, 6(5), pp. 51-58
- Walk, K., 1998. How to Write a Comparative Analysis. Writing Center at Harvard University. Available at: <http://www.fas.harvard.edu/~wricntr/documents/CompAnalysis.html>. Accessed 25.2.2011
- Walther, P., 1987. Against idealistic beliefs in the problem-solving capacities of integrated resources management. *Environmental Management*, 11 (4), pp. 439-446.
- Webster, J., Watson, R.T., 2002. Analyzing the past to prepare for the future: Writing a literature review. *MIS Quarterly*; Jun 2002; 26,2; ABI/INFORM Global, pg. R13.
- Wenger, R., Sommer, R., Wymann von Dach, S., 2005. Forest Landscape Restoration. *Focus No 2/05*.
- World Bank, The, 2009. Implementation completion and results report – Reversal of Land and Water Degradation Trends in the Lake Chad Basin Ecosystem Project. Report No: ICR00001168. June 17, 2009
- World Water Forum, 2006. 16-22 March. 2006. Mexico City, Mexico. Session FT5.10: The role of forests in water-related natural disaster risk management.
- WSSD, 2002. World Summit on Sustainable Development (WSSD) Plan of Implementation. Available at: http://www.johannesburgsummit.org/html/documents/summit_docs/2309_planfinal.htm. Accessed 12.12.2010.
- Yillia, P., Bashir, D., Donkor, E., 2004. Partnership approach in capacity building for IWRM – WANET initiative. In: Harvey, P. (Ed), *Towards the Millennium Development Goals - Actions for water and environmental sanitation: Proceedings of the 29th WEDC Conference, Abuja, Nigeria, 2003*, 408 pp.
- Yu, W. H., 2008. Benefit Sharing in International Rivers: Findings from the Senegal River Basin, the Columbia River Basin, and the Lesotho Highlands Water Project. Report no. 46456 Africa Region Water Resources Unit Working Paper 1. The World Bank, Africa Region Sustainable Development Department.

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IN SEARCH OF INTEGRATION

Analyzing the gap between theory and practice of Integrated Water Resources Management with case studies from West Africa and international policy processes

Virpi Stucki

Dissertation for the degree of Doctor of Science in Technology

Integrated Water Resources Management (IWRM) is one example of integrated approaches to natural resources management that has been widely promoted during the past decades. In this thesis, IWRM is understood as a strategic management procedure that integrates the natural resources and society (users and institutions) around a body of water. Numerous international conferences and meetings have promoted IWRM as a key approach to water management and subsequently a way to sustainable development. Yet, practical implementation of IWRM on the ground has had uneven success.

The overall objectives of the thesis were to increase understanding of the high-level, strategic issues that hinder or enable the translation of IWRM from policy into practice and based on that, to distil special considerations of IWRM in Senegal River and Lake Chad, for integrated approaches, and among practitioners. This was done by examining the gap between theory and practice of IWRM with the help of case studies representing IWRM in practice (Senegal River, Lake Chad), and IWRM in theory (IWRM in international policy, climate change adaptation policies as a driver for integration). A framework was developed and used in order to systematically analyze the appearance and implementation of IWRM in the four case studies. The methods used in examining the case studies varied from a literature review and field visits, to Bayesian Causal Networks, comparative analysis and qualitative data analysis.

The thesis concluded with four high-level, strategic issues that hinder or enable the translation of IWRM from policy into practice. These include i) the importance of recognizing externalities, ii) defining and understanding the “IWRM area of influence” (the confluence between theory, practice and externalities), iii) the key role of institutions and especially management and communication aspects, and the fact that iv) understanding, analyzing and managing the above is more about nouns than numbers.



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