NeWater

IWRM AND ADAPTIVE MANAGEMENT

Synergy or Conflict?

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1 Background

„The concept of sustainable development is one of the most cited concepts of the present day“ (Braga, 2001) and has been defined as *development that meets the needs of the present without compromising the ability of future generations to meet their own needs* (Brundtland, 1987 cited in Jonker, 2002). In other words, sustainability can be considered as ‘the ability to maintain something undiminished over some time period’ (Lélé and Norgaard, 1996), or as an ‘ongoing endeavour… rather than a final state that implies the persistence of a system through time’ (Sneddon et al., 1996 as cited by Jewitt, 2002). In the past, however, a less sustainable approach has been used and natural resources have been exploited as if there is an infinite supply. With a world population that is nowadays much greater then in the past, regional and global changes are likely to occur, emphasising even more the importance for sustainable development.

In the case of water resources, the statement that ‘water is life’ can no longer be considered to be a cliché, rather a reality and fact (Kgarebe, 2002). Society depends on the benefits provided by fresh water and the ecosystem functions of catchments, which are essential to all life. However, there is widespread evidence of increasing degradation of river quality in many parts of the world (Everard and Powell, 2002). Generally the management of freshwater systems for human utility has also followed unsustainable routes causing degradation of those natural ecosystem functions that provide long-term life-support, economic opportunity and quality of life (Boon et al., 2000 cited in Everard and Powell, 2002).

Water is the origin of every form of life; it is a habitat, a means of production and transport, and a commodity. By its very nature, water creates networks: it is linked to other natural resources, but aquatic systems are themselves interconnected: environmental problems have repercussions from one end of a hydro-graphic basin to the other. Various groups and stakeholders use water for their needs. Water is also international, national, regional and local, with highly diverse temporal and spatial frames of reference. The complexity and interdependency of this network makes it difficult to implement adequate management measures. Thus, a river basin system comprises of many components, dimensions, scales and levels with interdependencies. Therefore, fragmented approaches to river basin management have often failed to lead to an optimal outcome, resulting in inefficient resource use, economic losses and environmental degradation (Lee and Dinar, 1995). This interdependence and complexity calls for integration (Jønch-Clausen and Fugl, 2001).

’The dominant driver for the development of more effective and efficient fresh water resources management over the last three centuries has been the rapid growth of the world’s population’ (Radif, 1999). The combination of this population growth with increasing economic activities has caused a continuous increase in demand for water as well as pollution of water and increased competition over limited water resources. The problems have become so complex and traditional sectoral and fragmented approaches based on single disciplines or sub-sectors have not been able to address this complexity and interdependency in water resources management (Odendaal, 2002).

It has been established by scholars that water resource problems are going to be even more complex in the future (Simonovic, 2000; Wurbs, 1998; Matondo, 2002). Factors such as: population growth, climate variability, regulatory requirements, project planning horizons, temporal and spatial scales, socio and environmental considerations, and trans-boundary considerations, all contribute to the complexity of water resources planning and management problems (Matondo, 2002). In line with the definition for systainable development, sustainable water resources systems could be defined as *those systems designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental and hydrological integrity* (Loucks, 2000).

There has been a worldwide movement towards integrated approaches which will provide solutions to the management of natural resources, representing a significant shift towards management focussed on the sustained use of these resources. In the case of water resources, this shift has found expression in the form of Integrated Water Resources Management (IWRM). The relationship between sustainable water management and Integrated Water Resources Management is that essentially sustainability is the goal, whereas IWRM is a strategy for pursuing this goal. In other words, *the main objective for effective IWRM is to find the right balance between protecting the water resource itself while meeting social and ecological needs and promoting economic development* (Odendaal, 2002). An interesting question that arises from the above statements is whether successful IWRM is commensurate with, or will necessarily lead to, sustainability?

Although the concept of IWRM seems very sensible and attractive and has been widely accepted as the appropriate framework to deal with complex water resources management issues, a deeper analysis reveals many problems, both in concept and implementation. There is as yet no overall agreement on the definition of the IWRM concept as well as on the fundamental issues like what aspects and dimensions should be integrated, how should they be integrated and by whom. It is not even clear whether such integration in a wider sense is possible (Biswas, 2004). The IWRM concept is generally struggling with two major weaknesses that cause most of its perceived failings these being the nature of the science which has informed its development as well as its ambiguous character in terms of current intellectual paradigms (Jeffrey and Geary, 2004). In addition, effective transfer of positive IWRM experiences across basins and frontiers has been restricted due to a lack of empirical knowledge regarding the characteristics of IWRM successes.

Besides these above described problems in concept and implementation, the principles of IWRM do not elaborate on water management under uncertainty, nor do they explicitly articulate adaptive capacity as a significant feature of water management strategies. Ecosystems, however, are often referred to as complex adaptive systems, which are highly variable, dynamic and self-organising. Adaptive management (AM) as a concept has been designed primarily to support managers in dealing with these highly connected systems. Where Odendaal (2002) states that sustainability is the goal and IWRM a strategy for pursuing this goal, Pahl-Wostl et al (2004) focus on IWRM as the goal and AM as a necessary management style in order to realise IWRM.

Like IWRM, the concept of AM has also been around for several decades. However, as of recently, relevant literature is raising the pertinent question why this concept has not been more widely adopted than it has been so far (Ohlson, 1999). The same author refers to one of the fathers of Adaptive Management, Carl Walters (1997), who noted that many AM initiatives have in the past either ‘vanished with no visible product’ of become ‘trapped in an apparently endless process of model development and refinement’. Some of the reasons for difficulty in implementing AM stem from issues related to regulatory and jurisdictional complexity, stakeholder impacts, and ecosystem considerations. However, other reasons could also be the inability of the scientific community to define what exactly is meant by AM and how it should be implemented (Ohlson, 1999).

The main aims of this paper are:

1. Review IWRM and AM as conceptual devices or abstract models, focusing in particular on:
    i. Their historical development;
    ii. Their anticipated benefits;
    iii. Challenges to implementation.

2. To investigate whether a combination of IWRM and AM would lead to enhanced and more sustainable water management regimes. IWRM and AM have both been facing difficulties in their transfer from theory into practice. An important question therefore is whether IWRM and AM would create synergy when combined or whether the barriers to both concepts individually will make a combination of them even more challenging to implement. In order to find the answers to these questions, the research ambitions of this paper are to seek more understanding on the definitions and descriptions of IWRM and AM and their consistency as well as the orthodox/ dominant models that are supporting both concepts. Also, the intellectual history of IWRM and AM will be investigated, the experiences and lessons learned that exist for implementation of both concepts, as well as the extent to which IWRM and AM are related and can contribute to one another.

2 Integrated Water Resources Management

2.1 Why IWRM?

Until the beginning of the 1980s water resources managers and policy makers have been managing and supplying water to people for their direct use, focusing solely on maximising the quantity of water available for this direct use. Water resources were developed on a single-purpose basis. As a response to the water problems and considering the limitations of this supply-driven approach, IWRM started to be advocated. This IWRM approach is seen as a holistic and integrated approach that considers economic, environmental, technical, social as well as cultural benefits/ issues, while ensuring the sustainability of water resources for future generations (Braga, 2001). This approach creates a clearer link between and better understanding of human and ecosystem requirements and the interactions between them (Wallace et al., 2003).

Many authors have acknowledged that the current 'water crisis' could also be termed 'crisis of Governance' as it is mainly related to problems in management and governance and goes beyond mere technical challenges (Keen, 2003). 'Improved performance of the water resources sector will depend on institutional reform rather than on additional technological improvements or more infrastructure' (Koudstaal *et al.*, 1992). Thus, the main challenges will be to establish correct policies, viable political institutions, workable financing arrangements, self-governing and self-supporting local systems, and a variety of other institutional arrangements that will help to mitigate this impending crisis (Grigg, 1999).

IWRM has been advocated as the most sustainable means to incorporate the multiple competing and conflicting uses of water resources ever since the first UNESCO International Conference on Water, which took place in 1977 at Mar del Plata. Different international organisations have been trying to promote IWRM all over the world and in recent years a number of conferences have been held with a focus on IWRM. The most influential of these have been the Dublin Conference (1992), the Second World Water Forum & Ministerial Conference held in the Hague (2000), the International Conference on Freshwater in Bonn (2001), and the World Summit on Sustainable Development in Johannesburg (2002).

IWRM is often referred to as the Dublin-Rio principle because it highlights an important principle developed during the Dublin Conference: *that fresh water is finite, vulnerable and that it is essential to sustain life, economic development and the environment*. The IWRM concept also stresses the fact that water reseources management should include a participatory approach which involves large groups of stakeholders (Jeffrey and Geary, 2004). However, many who 'discovered' the concept of IWRM were not aware that the 'new' concept was in fact not really new, but has been around for several decades. The concept has been promoted quite extensively since the beginning of the 1950s by international institutions such as the United Nations (Biswas, 2004).

Despite the popularity of the IWRM concept, it remains to be seen whether it is indeed possible for a single paradigm to encompass all countries and regions, each with very different physical, economic, social, cultural, and legal conditions (Biswas, 2004). The necessity to adapt the IWRM concept to suit different local contexts makes it very difficult to develop a generic and overall description of strategies and techniques (Jeffrey and Geary, 2004). However, the following set of IWRM principles have been identified that are at least to a certain extent characteristic by many national, regional and basin scale strategies (IWA/UNEP, 2002):

- IWRM should be applied at catchment level;

- It is critical to integrate water and environmental management;
- A systems approach should be followed;
- Full participation by all stakeholders, including workers and the community;
- Attention to the social dimensions;
- Capacity building;
- Availability of information and the capacity to use it to anticipate developments;
- Full-cost pricing complemented by targeted subsidies;
- Central government support through the creation and maintenance of an enabling environment;
- Adoption of the best existing technologies and practices;
- Reliable and sustained financing;
- Equitable allocation of water resources;
- The recognition of water as an economic good;
- Strengthening the role of women in water management.

2.2 The IWRM concept

Before the status of IWRM application can be discussed, an important and fundamental issue that should first be considered is what precisely is meant by this concept. The most often quoted definition of IWRM has been developed by the GWP; '*a process that 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-TAC, 2000). This definition given by the GWP appears to be all encompassing and impressive, but in practical terms, it gives very limited practical guidance to present and future water management practices (Biswas, 2004).

Biswas considers in his paper some fundamental questions in terms of the applicability of the definition in the real world and draws the conclusion that the definition of IWRM given by GWP is in fact difficult to implement, for all practical purposes, and internally inconsistent. However, the GWP definition of IWRM does recognise that management should be understood in its broadest sense while emphasizing that IWRM is a *process,* not a goal in itself. IWRM is a continuous process of balancing and making trade-offs between different goals and views in an informed way. This view seems to contradict the statement made by Pahl-Wostl et al (2004), where IWRM is described as the goal and AM as a necessary management style in order to realise IWRM. The GWP definition emphasizes that IWRM is all about coordination and integration leading to more holistic cross-sectoral water management (Jønch-Clausen and Fugl, 2001). In other words, the IWRM concept forces us to focus on the detail of our water use practices whilst keeping in mind the larger picture.

Even though IWRM focuses on larger scale issues, Jonker (2002) suggests that we look at IWRM within the context of sutainable development. By integrating the concepts of sustainable development and IWRM it will become possible to look at practices (micro-level) within the context of IWRM (meso-level) and see how it impacts on sustainable development (macro-level). The general accepted definition of sustainable development given by Brundtland (1987), as described in the earlier section of this report, has been questioned by Jonker, who describes a number of difficulties that occur with such general definitions and suggests a more appropriate definition: '*sustainable development is the improvement of people's livelihoods without disrupting the natural cycles*'. Many of the difficulties regarding the definition of sustainable development are also applicable to the GWP definition of the

IWRM concept. This definition suggests managing things that cannot be managed, such as natural processes. However, we are capable of managing human activities (Jonker, 2002). Therefore, according to Jonker (2002), a more suitable definition of IWRM would be: '*managing people's activities in a manner that promotes sustainable development (improving livelihoods without disrupting the water cycle)*'.

The *balancing of goals and views of interdependent players* (Grigg, 1999) is an essential component which seperates 'integrated management' from other management practices. This continuous balancing of inputs of different players in water management is the core issue in integrated water management **(**Grigg, 1999). Besides the term IWRM, several other terms have been given to the basic concept of integrated water management, for example, 'Integrated Water Resources Planning and Management' (IWRPM), 'Integrated Catchment Management' (ICM) and 'Integrated Watershed Management' (IWM). Different authors have described these terms of which examples are given in Table 2.1.

The problem with the 'competing' paradigms of integrated water management is that they focus on different facets (or dimensions) of the process (Grigg, 1999). Grigg believes that the main benefit of using integrated water management as a paradigm is its focus on the blending of viewpoints, and he offers the following definition for IWRM: '*a framework for planning, organising and controlling water systems to balance all relevant views and goals of stakeholders'*, which includes two dimension of interdependence: balancing views and goals of stakeholders - social interdependence - in the context of managing water systems - ecological interdependence (Grigg, 1999).

The understanding and description of the concept 'integration' in relation to water resources management has changed over the years and represents the broadening scope of water resources management (Koudstaal et al., 1992). In their paper, these authors have identified the following main characteristics to 'integrated management' as:

- interaction between quantity;
- quality and biological aspects of both groundwater and surface water;
- sectoral coordination;
- environmental sustainability;
- institutional arrangements;
- public participation;
- implementation aspects, including financing and monitoring & control, play a decisive role in planning for water resources management, and;
- capacity building.

However, in the context of sustainable development, the meaning of the word 'integrated' clearly goes far beyond merely a coordination between water management agencies, an interaction between groundwater and surface water, or a planning approach which considers all possible strategies and impacts. Here Integrated Water Resources Management refers to the management of water resources as an *integral part of a nations' social and economic development* (Koudstaal et al., 1992).

Yet another definition of IWRM has been given by Thomas and Durham (2003) who describe the concept as *a sustainable approach to water management that recognises its multidimensional character – time, space, multidiscipline and stakeholders – and the necessity to address, embrace and relate these dimensions holistically so that sustainable solutions can be brought about.* Social, economic, environmental and technical dimensions should be taken into account in an integrated water resources management framework, which will help to initiate and ensure the participation of a large number of stakeholders in the decision-making processes and the development of a cyclic decision making process where feedback will be given at any point (Thomas and Durham, 2003). This description of a cyclic decision making process relates close to the (non-linear) learning cycle, described as one of the key tools for the AM approach.

It can be concluded that IWRM has never been clearly defined, nor has the question of how it can be implemented been fully addressed (Odendaal, 2002). Odendaal also raised other questions that need to be further investigated, such as:

- Is the GWP definition of IWRM suitable for both developed as well as developing countries?
- Is an unambiguous definition of IWRM not possible because IWRM is an evolving process?
- What has to be integrated and how is it best done?
- Can the broad principles of IWRM be made operational for practice, and if so, how?

Jønch-Clausen and Fugl (2001) state that IWRM has degenerated into a *buzz-word* that is used by many different people who, however, have a different understanding and give a different meaning to it. The fact that there is such ambiguity about the IWRM concept certainly does not help to bring together the different views and interests of the large group of stakeholders.

In addition, an analysis of recently published literature has shown that different authors have been considering different issues and dimensions that should be integrated in the IWRM process (Biswas, 2004). However, the analysis only refers to what should be integrated, but not on other equally fundamental questions like how can these issues be integrated? Who will do the integration and why? What processes will be used for integration? Will the integration produce the benefits that proponents claim? Biswas prepared a list including 35 sets of issues and dimensions identified by different authors to be integrated under IWRM. This immense set of issues and dimensions shows again the fact that there are many different views of the IWRM concept. It will be crucial to come to a more holistic view and understanding of the IWRM concept in order to reach an effective translation of IWRM into operational reality.

Source	Term	Definition/ description	Included Dimensions												
			Water	Other resources	Economic	Social	Ecological/ Environmental	Technical	Institutional	Time	Space	Multidiscipline/ Multisectoral	Operational	Strategic	Stakeholders
GWP-TAC, 2000	IWRM	Process promoting coordinated development & management of water, land and other resources, in order to maximize resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems	X	X	X	X	X			X					X
Grigg, 1999	IWRM	Framework for planning, organising & controlling water systems to balance all relevant views and goals of stakeholders	X	X		X	X								X
Koudstaal, Rijsberman, Savenije, 1992	IWRM	Framework for management of water resources as an integral part of a nations' social and economic development	X		X	X									
Thomas and Durham, 2003	IWRM	Sustainable approach to water management recognising its multidimensional character and the necessity to address, embrace and relate these dimensions holistically to find sustainable solutions	X		X	X	X	X		X	X	X			X
Newson, 2000; Ohlson, 1999	IWM	Process of planning & implementing water and other natural resources management strategies in watersheds with an emphasis on integrating the biophysical, socio-economic and institutional aspects	X	X	X	X	X		X		X				
Matondo, 2002	IWRPM	Through incorporation of socio human factors, economic issues and the ecological system and by linking more than one sectoral interest at both operational and strategic levels, societies will continue to benefit from utilization of water resources while maintaining the environment and the resource base to meet the needs of the future generations	X		X	X	X			X		X	X	X	

Matondo, 2002	ICM	To integrate, in a systems approach, all environmental, economic, and social issues, within the bounds of a river basin aimed at delivering the optimum possible mix of sustainable benefits for future generations and the communities in the area of concern, whilst protecting the natural resources which are used by the communities and minimising possible adverse social economic and environmental consequences	X	X	X	X	X			X	X				

Table 2.1: Definitions and descriptions of the IWRM concept

2.3 IWRM approach

IWRM is often confused with other approaches to water resources management and development, such as river basin management, water demand management and the ecosystems approach. Even though the IWRM concept is closely linked to these approaches, the main focus is different. The river basin management framework focuses on the use of the basin as the unit for water management, whereas IWRM has a much broader approach (Jønch-Clausen and Fugl, 2001). The authors give examples of issues that, although they may be approached at the river basin level, ultimately need to be addressed at the national level in the form of national policies and international relations. Similarly, water demand management and the ecosystems approach are critically important approaches to meet water resources management challenges. Each has much to contribute to IWRM, but they address only part of the complex issues of IWRM.

The dominant IWRM model as promoted by the GWP needs to be further investigated in order to find the needs for improvement and the potential contribution of other approaches, such as AM, to the IWRM approach. More recent information about the current state of the IWRM concept and its implementation as understood by the GWP can be found in the TAC Background Paper No 10 (GWP-TAC, 2004), which describes the ‘Why, What and How’ of the IWRM planning processes to provide guidance to countries in order to successfully implement IWRM.

The three pillars of IWRM as described in the GWP-TAC (2004) are:

- moving toward an *enabling environment* of appropriate policies, strategies and legislation for sustainable water resources development and management;
- putting in place the *institutional framework* through which the policies, strategies and legislation can be implemented;
- and setting up the *management instruments* required by these institutions to do their job.

These three pillars are illustrated in Figure 2.1 below. The GWP has also developed a toolbox for IWRM, which further elaborates on this framework and illustrates useful approaches through specific tools and good practices, as well as relevant references and case studies of IWRM experiences.

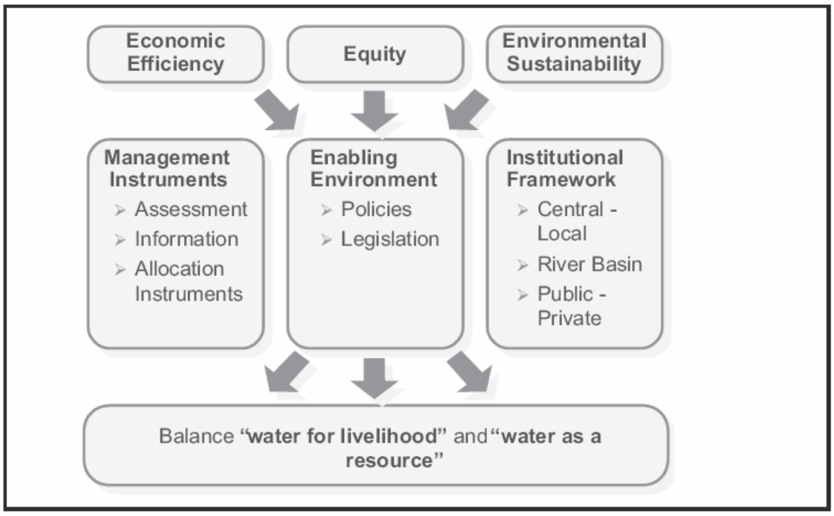


Figure 2.1: Three pillars of the IWRM concept

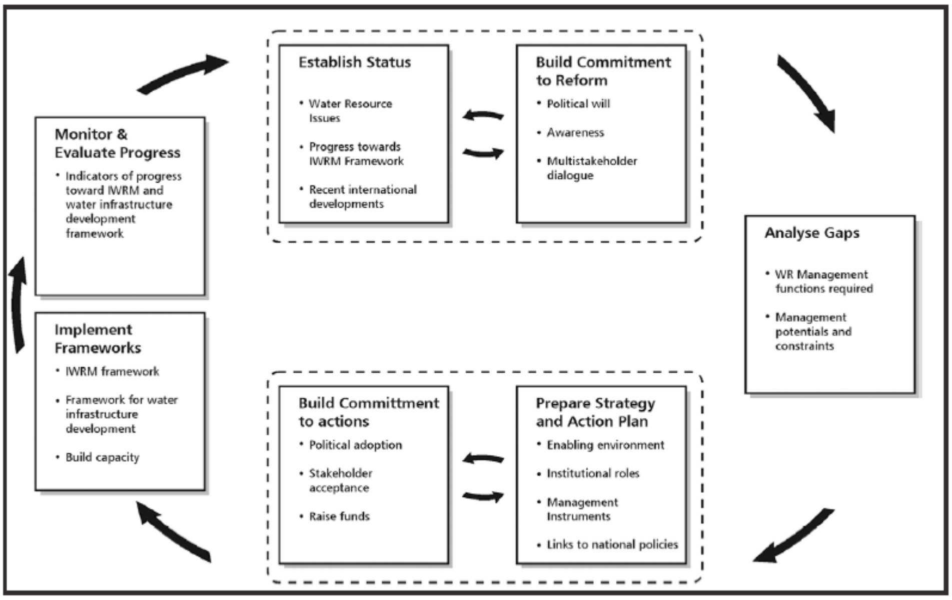
IWRM is a cyclical process and is illustrated in Figure 2.2, which is often referred to as the ‘Integrated Water Resources Management Cycle’. This cycle has been described in great detail and starts with the planning processes, continuing into implementation of the frameworks and actions plans and monitoring of progress. At any point in this cyclical process, feedback can be given or asked for based on which the past decisions can be monitored and evaluated and, when necessary, new revised decisions can be developed. Feedback loops in this process cycle are created through active stakeholder involvement and may result in certain phases and steps in the process having to be repeated. The cycle represents an ongoing learning and development process in which different countries can find themselves at different stages (GWP-TAC, 2000).

IWRM key elements, under which all water issues and relevant parties and their particular socioeconomic and environmental concerns can be brought together, are sustainability of water resources, water policy and integrated management, and management of the resource (Keen, 2003). However, another important element of the IWRM approach is the establishment of stakeholder participation through multi-disciplinary teams at various levels in order to understand and bring together different views and perspectives on water resources management (Radif, Adil Al, 1999).

In practice, achieving IWRM requires a systemic approach to water management. Systemic in the sense that the whole system needs to be taken into account including the relationship and dynamic interactions between human and natural systems, land and water systems, and key stakeholder agencies and groups (Keen, 2003). All these different elements and components within the system have a large degree of interconnectedness, which makes it so complex to translate the IWRM concept into practice. Many authors recognise this need for a more ‘holistic’, ‘integrated’, ‘systemic’ and ‘comprehensive’ approach to water management (cf. Biswas, 2001; Braga, 2001; GWP TAC, 2000; Hellstrom *et al.*, 2000; Jonch-Clausen & Fugl, 2001; Seppala, 2002; Keen, 2003).

A systemic approach can be described as *relating to the properties of the system as a whole, where none of the parts have the same properties in isolation* (Capra, 1997 cited in Everard and Powell, 2002). Thus, a systemic approach focuses on the overall dynamic system and aims at increasing the understanding about this system as well as developing strategic decision-making processes that affect the system as a whole. Since systems are operating at a different hierarchical and interconnected scales and levels, these systems can only effectively be managed in a systemic manner acknowledging their holistic nature and overall interconnectedness (Everard and Powell, 2002).

A detailed account of the contrasting philosophical concepts, problem conceptualisations and general methodologies of the hard systems and soft systems approach is presented by Walker (1996, cited in Ohlson, 1999). This author describes the hard systems approach as an approach that fosuses on problems with well-defined boundaries and simple linkages with other problems, including well-defined goals, alternatives and consequences. Through the soft systems approach, however, problems are considered as having: ambiguous boundaries and complex linkages with other problems; goals, alternatives and consequences which are not well-defined or well-understood; pervasive uncertainty which may not be quantifiable; and iterative management which involves conflict and negotiation among multiple stakeholders with divergent interests and values (Ohlson, 1999).



Establish Status and Overall Goals. The starting point of the IWRM process is the burning and urgent water resources issue seen in the national context. Chart the progress towards a management framework within which issues can be addressed and agreed and overall goals be achieved. Do international agreements with the neighbours present potentials/constraints? Pragmatism is key.

Build Commitment to Reform Process. The political will is a prerequisite and building or consolidating a multi-stakeholder dialogue comes high on the list of priority actions. The dialogue need to be based on knowledge about the subject matter and awareness raising is one of the tools to establish this knowledge and the participation of the broader population.

Analyse Gaps. Given the present policy and legislation, the institutional situation, the capabilities and the overall goals, gaps in the IWRM framework can be analysed in the light of the management functions required by the urgent issues.

Prepare Strategy and Action Plan. The strategy and action plan will map the road towards completion of the framework for water resources management and development and related infrastructural measures. A portfolio of actions will be among the outputs, which will be set in the perspective of other national and international planning processes.

Build Commitment to Actions. Adoption of the action plan at highest political levels is key to any progress and full stakeholder acceptance is essential for implementation. Committing finance is another prerequisite for taking planned actions to implementation on the ground.

Implement Frameworks. Taking plans into reality poses huge challenges. The enabling environment, the institutional roles and the management instruments have to be implemented. Changes have to be made in present structures and building of capacity and capability also taking into account infrastructure development need to take place.

Monitor and Evaluate Progress. Progress monitoring and evaluation of the process inputs and outcomes serve to adjust the course of action and motivate those driving the processes. Choosing proper descriptive indicators is essential to the value of the monitoring.

Figure 2.2:Integrated Water Resources Management Cycle (Taken from GWP-TAC, 2004)

2.4 Framework for prescription

Despite the fact that the IWRM concept seems very attractive and has a substantive intuitive influence, the concept remains mainly normative and prescriptive. *Despite its popularity IWRM remains a theory about, an argument for, and at best a set of principles for, a certain approach to water resources management* (Jeffrey and Geary, 2004). These authors also state that in practical reality, the IWRM concept has not structurally demonstrated its benefits to increase the sustainability of water resources management. „Hence, there is no recipe book, no laws, no formulae, no blueprint“ (Jeffrey and Geary, 2004). However, since IWRM should be considered a process and not so much a goal in itself, the question here is whether there should be such a thing as a recipe book, a law, a formulae or a blueprint for IWRM? Another question, which has been raised before, would be whether IWRM can be implemented in the same form globally or whether the concept should be translated and adapted to local circumstances? The AM approach could be suggested here in order to support IWRM as a way to create continuous feedback loops and a wider set of options in line with different local context and situations. However, this cyclical learning process including feedback loops has already been ascribed to the IWRM theory as described earlier in section 2.3.

’There is a need for the development of new metrics (things to classify or measure); techniques (ways of classifying or measuring); and analytical frameworks (perspectives on the utility of classes or measure)’ (Jeffrey and Geary, 2004). Unrealistic expectations and idealistic beliefs in the problem-solving capacities of IWRM should be avoided, especially when you take into acount the immense challenges the concept has been facing in the process of its transfer from theory into practice (Walther, 1987). Using and analysing three Canadian case studies, Walther concludes that the success and performance of IWRM, measured in terms of output such as formal decisions or plans, is primarily a function of the historical situation into which a project is placed, and only secondarily its professional design.

2.5 Benefits and challenges

„Empirical evidence of unambiguously demonstrated benefits of IWRM is either missing or very poorly reported“ (Jeffrey and Geary, 2004). The role of IWRM will vary depending on the development stage of the country. Developing countries, countries in transition and developed countries will have different ways of implementing the IWRM process and therefore will also derive different benefits. Developing countries will in particular see sustainable water resources management as an important element in tackling issues of poverty, hunger, health and environmental sustainability, whereas countries in transition may consider IWRM as a more rational approach to increase the effectiveness of the way they manage their resources thus assisting a continuous development of their economies. Developed countries may use the IWRM processes as a source for inspiration and chose to initiate and develop their own form and variety, such as the EU Water Framework Directive **(**GWP-TAC, 2000).

One of the main benefits of using IWRM as a paradigm is its focus on the blending of viewpoints (Grigg, 1999). In other words, *IWRM has adopted an holistic approach that considers the contributions of all users, planners, sciences and policy makers, thereby promoting increased communication between different public and private stakeholders groups as well as with the wider public* (Jeffrey and Geary, 2004).

In a sense, however, IWRM is not holistic since it considers water to be very important, if not the most important resource. Integrated management of only one resource is not possible because of the large amount of interconnections with other resources. However, if these resources were to be managed in an integrated and holistic manner, most countries would end up with large and unmanageable institutions, which is also undesirable and counterproductive. To avoid this, the aim should not be to integrate the management of these resources, but to create close collaboration, cooperation, and coordination between the existing institutions that are associated with the management of these resources (Biswas, 2004).

The soft systems nature of IWRM creates significant challenges which need to be met (Ohlson, 1999), such as: ambiguous boundaries and complex linkages; difficulties with objectives, alternatives and consequences; pervasive uncertainty; and, multiple stakeholder conflict. Geldof (1997) categorises these challenges into three categories:

1) *Complexity*: the more component parts we take into consideration and the more interactions we want to describe, the more information we need;

2) *Subjectivity*: the information we get is not always free of values, it can be biased, linked to interests, which makes it necessary to weigh things up against each other;

3) *Uncertainties:* the differences between the amount of information we need to perform our tasks and the information we actually have (Galbraith, 1973).

If we want to successfully implement IWRM, we have to make these three obstacles manageable.

Another major challenge for IWRM is to identify the essential elements for IWRM. Generic and rigid guidelines and prescriptions should be avoided since there are such large differences among countries. The identification of the essential elements for IWRM would help policy makers to have clear understanding of the issues that need to be focused on (GWP-TAC, 2000). Other critical challenges and issues that have been mentioned in this report are:

- awareness – and priority – at political level of water issues is still limited;
- institutions are rooted in a centralized culture with supply driven management and fragmented sub-sectoral approaches to water management;
- local governments lack capacity to manage pressures on water resources;
- inappropriate pricing structures and limited cost recovery result in inefficient operation and maintenance of water systems, as well as in misallocation and loss of water;
- investments in the water sector are low, and do not get sufficient attention in the national budgeting procedures;
- information and data to support sound management of water is generally lacking;
- inadequate economic, social and environmental criteria for the approval of policies, plans and projects.

IWRM is a political process and involves conflicts of interest that must be mediated (GWP-TAC, 2003). As mentioned before, effective water governance is of extreme importance for the successful implementation of IWRM plans. Awareness of the necessity to improve water governance has been raised through a series of dialogues on ‘Effective Water Governance’ and the lessons have been presented internationally at the 3rd World Water Forum in Kyoto (2003). In order to improve the effectiveness of water governance it will be crucial to (GWP TAC Background Papers No. 7, GWP, 2003):

- create an enabling environment which facilitates efficient private and public sector initiatives;
- create a coherent legal framework with a strong and autonomous regulatory regime;
- to have clear transactions between stakeholders in a climate of trust with shared responsibility for safeguarding water resources.

’Thus, a new framework is required for IWRM, a framework within which there may be a need for significant changes in existing interactions between politics, laws regulations, institutions, civil society, and the consumer-voter(GWP-TAC, 2003). The capacity to make these changes depends on changes in governance. Governance embraces the relationship between a society and its government and involves mediating behaviour via values, norms, and, where possible, through laws’ (GWP-TAC, 2003).

One of the major elements for effective water governance is the interface between water and law as well as the many complex social aspects to water. These complex social aspects range from cultural and religious beliefs to the expectations of modern societies of water resources for recreation and aesthetic value **(**Wallace *et al.*, 2003).

In many countries, the principles that underly the IWRM concept have in many cases not been internalized into socio-economic development policies and systems of governance. It will be crucial to bring the people to the core of the decision-making processes through stakeholder participation and a decentralized way of water resources management and planning, most importantly at the basin level (Kasyap, 2004). The political will to increase the coordination among sectors in most countries is low, though generally some kind of structure for coordination exists. What is lacking in most situations is the capacity for implementation. Most coordinating bodies produce master plans, which end up gathering dust on shelves (Koudstaal et al., 1992). There is a serious lack of planning tools, management strategies, and human, institutional and systematic capacities to meet local demand for sustainable water services under climate variability and climate change regimes. Trans-boundary and regional water issues bring about additional complexity in developing appropriate national responses to water resources management (Kasyap, 2004). These implementation capacity issues are attracting increasing attention from authors, many of whom echo Gilbert White's observation that '*the problems of accurate analysis of intersectoral linkages and of achieving institutional reforms in the planning process, are formidable. It would be sanguine to expect early or easy solutions. Therefore, they deserve prompt, concerted attention'* (White, 1998).

Summarising, there are formidable barriers to organising integration in water. So given that taking a lead role in organising IWRM is in many ways a voluntary decision, the question arises 'why should an entity accept or create such a responsibility?' (Grigg, 1999). According to this author it is important to realise that more work is needed to explain and justify the IWRM approach. If we use terms that have a nice ring for academics and government people but are meaningless to citizens and politicians, we fall into a trap. Experts educate political leaders in the use of jargon on the public, who just get madder. Plain language needs to be used if the public is to participate (Grigg, 1999). In the case of combining IWRM with other approaches, such as AM, this remark should be taken even more seriously. It will be crucial to clearly explain and justify both approaches seperately as well as the reasons for combining them. Otherwise we might risk confusing water managers and the public even more by introducing yet another new concept or paradigm.

2.6 Lessons for successful implementation

Solutions to water problems depend on different factors (Biswas, 2004):

- water availability;
- water management processes;
- competence and capacities of managing institutions;
- prevailing socio-political conditions that dictate water planning/ development/ management processes and practices;
- appropriateness and implementation statuses of existing legal frameworks;
- availability of investment funds;
- social and environmental conditions of concerned countries;
- levels of available and usable technology; national/ regional/ international perceptions;
- modes of governance including issues like political differences, transparency, corruption, educational and development conditions;
- and status, quality and relevance of research conducted on national/ sub-national and local water problems.

It is therefore difficult to state general lesson that would be relevant to each and every case and context. However, many authors have identified different lessons which, according to their view, are important to a successful implementation of IWRM. We have gathered some of these in Table 2.2 below:

Author (Year)	Lessons/ proposals for facilitating succesful implementation of IWRM
Matondo (2002)	The highly integrative nature of air, land and water resources necessitates the need for multi-purpose IWRM; Both conventional and IWRM approaches for sustainable development have failed to deliver the end results due to a missing link: the institutional framework, that coordinates water resources planning and management responsibilities and activities at all levels of government; IWRM has failed to lead to sustainable water resources development especially in developing countries where environmental preservation has received less attention to communities who have to deal with the immediate realities of poverty; Stakeholder participation, which is the key factor in IWRM is also not possible in developing countries due to their usually fragmented institutional setup; institutional bottle necks occurring in implementation; lack of human resources; sectoral ministries opposing the concept; poor coordinated administrative bodies and/ or organizations in the water sector, etc.
Jewitt (2002)	Ecosystem is not regarded as a 'user', but as the base from which the resource is derived and upon which development is planned. A goal of IWRM should be to maintain, and whenever necessary, restore ecosystem health and biodiversity. Achieving the sustainable use of water resources and thus the maintenance of ecosystem services requires a rediscovery of the hydrological cycle and the water resources system.
Ohlson (1999)	Process of IWRM is often long, difficult and controversial. Improvement will require new approaches to planning and management, not just science. Many tools are currently available as aids to IWRM, but many of them have relatively narrow range of application. However, two approaches that integrate many tools and appear to be broadly applicable to IWRM are AM and decision analysis.
IWA and UNEP (2002)	6 obstacles have been identified for succesful implementation of IWRM: lack of understanding of and attention to the positive contribution that innovative work-place approaches can play in achieving IWRM objectives; potential complexity of the IWRM concept; need for reference projects; lack of adequate skills, expertise and awareness; lack of adequate and reliable data; gaps in available knowledge and technology; They advise a *phased and simplified approach* involving an AM approach, based on incremental gains, an initial focus on key issues of importance to all stakeholders, and responding to changes in information, understanding and circumstances. It does not imply that the vision of comprehensive IWRM be abandoned, rather that a step-wise approach towards the ultimate goal be used.
GWP-TAC (2000)	Start the IWRM process with the national context and urgent issues – to be pragmatic; Experience shows that implementation processes are facilitated by: strong political will, often motivated by a need to address burning and high profile issues; clear distribution of roles and responsibilities among the stakeholders; highly motivated drivers maintaining commitment throughout the process; exchange of knowledge and experience between countries at various stages of the process; setting clear milestones for the achievement; and, monitoring and evaluation of progress, performance and impact; Important is to realise that IWRM processes will differ from country to country, and there is no 'one size fits all'.
Keen (2003)	Information generated to manage the system by individual agencies needs to be widely shared so that planning, regulation, monitoring and infrastructure investments can occur systematically and systemically. Unfortunately, data sharing arrangements between water providers, water regulators and the public have yet to be established in most countries. This not only adversely affects service delivery, it undermines public accountability. It is important to create

	partnerships and institutional arrangements that facilitate information flows, which will provide a valuable impetus for integrated and sustainable water management.
Koudstaal, Rijsberman and Savenije (1992)	A major concern for water resources management is that most of the international attention is focused on global problems and much less on universal problems. Global problems refer to problems that affect a large part of the world and cannot be solved by any country individually. Universal problems consist of small-scale but globally widespread phenomena, which can be solved within a nation.
Thomas and Durham (2003)	The development and implementation of IWRM projects is complex and difficult because of the different disciplines that are involved. To make sure that the solutions proposed are sustainable in an economic, environment and socially acceptable way, it is necessary to: (1) develop solutions in context of IWRM where 'thinking globally' before 'acting locally'; (2) clearly understand the real water cycle and its relation with the urban area; (3) use methodology for decision-making process that integrate the complexity of the system to manage, and in particular the socio-technico-economic aspects; (4) integrate and communicate with all the stakeholders in decision-making process to avoid future problems.
Radif, Adil Al (1999)	A prerequisite to effective implementation is the provision of the required data which incorporate the assessment of water resources including the identification of potential sources of fresh water supplies, extent, dependability, and quality of water resources and of the human activities that affect those resources.
Jønch-Clausen and Fugl (2001)	Flawed demarcation of responsibilities between actors; inadequate coordination mechanisms; jurisdictional gaps or overlaps; the failure to match responsibilities, authority and capacities for action are major sources of difficulty in implementing IWRM. The agencies involved in water resources management have to be considered in their various geographical settings, taking into account the political structure of the country, the unity of the resource in a basin or aquifer and the existence and capacities of community organizations.
Rahaman, Varis and Kajander (2004)	The EU Water Framework Directive (WFD) has some clear mismatches compared with the guidelines that are the focus of the Dublin principles, Bonn Keys, Statements of the Second World Water Forum and in the WSSD Plan of Implementation, to make an effective water policy for IWRM. Q is whether the outcome of the international events regarding IWRM are not effective and efficient enough to influence EU policies for better water management? Or, whether there is a requirement for different principles of IWRM for developing countries and developed countries?
Everard *et al.* (2001)	Reactive and retrospective action, applied piecemeal as a form of 'sticking plaster' after damage has occurred, appears wholly inadequate to control the growing pressures of a population that places increasing demands on resources. There is a pressing need to move from a reactive and parochial approach to river management, towards a recognition of the dynamic and complex systems that catchments represent and upon which socio-economic benefits are based. There is an overwhelming need for a more far-sighted and appropriate framework for decision-making about human activities relating to river catchments.

Table 2.2: Lessons for successful implementation of IWRM

3 Adaptive Water Management

3.1 The nature of Adaptive Management

According to more traditional approaches to natural resource management social, economic and environmental factors and issues are assumed predictable. However, for certain reasons these factors might not always be predictable: (1) *variability in environmental, demographic, and other factors make ecosystem responses to management actions uncertain*; (2) *sampling and measurement errors make it difficult to precisely measure how ecosystems respond to management actions*; (3) *incomplete understanding and the complexity of ecosystems prevent accurate prediction of ecosystems responses to management actions* (Conroy, 2000; Constanza *et al.*, 1993; Prato, 2003).

According to many authors, the concept of Adaptive Management (AM) has been created in the 1970s at the International Institute for Applied Systems Analysis in Vienna, Austria. This concept has been developed to support the management of natural resources under uncertainty (Holling, 1978; Walters, 1986; Walters and Holling, 1990; Irwin and Wigley, 1993; Parma *et al.*, 1998; Prato, 2003; Ohlson, 1999). *Uncertainty refers to the situation in which the information that describes a problem under study is deficient* (Klir and Wierman, 1999). According to some authors, the concept of Adaptive Management found its origin in the decision analysis field. The decision analysis framework can support the analysis of complex natural resources management systems by emphasising the necessity to (Walters, 1986; Ohlson, 1999):

- explicitly state management objectives (that will inevitably be in conflict);
- design and evaluate creative alternatives;
- explicitly address uncertainty;
- incorporate stakeholder values.

'The AM concept has been widely advocated as the paradigm which natural resource managers should adopt, building on the recognition that ecosystems are complex systems, which are 'adaptive' or 'self organizing' and that management systems must be able to readjust to change or surprise in the system' (Gunderson and Holling, 2001). Holland (1992) states that systems are always undergoing changes and therefore never reach a *condition of equilibrium*. These systems are described as 'living systems' and have the following 4 characteristics: *a network structure in which several agents are active at a parallel level; several levels of organization and constantly engaged in modifying, revising and rearranging structures at different levels; anticipating future developments; many niches within the system, which can be filled by agents that have adapted to them* (Waldrop, 1993; Geldof, 1995).

Thus, the concept of AM has been designed primarily to deal with uncertainties recognising that it is impossible to foresee future key drivers and issues and the response of system to these drivers and issues (Holling, 1978; Walters, 1986; Lee, 1999). AM has been described as a *systematic approach to improving management and accommodating change by learning from the outcomes of management policies and practices* (Holling, 1978). The concept can support in increasing awareness of ecosystem functioning while creating the possibility for management to proceed even if there is a lack of sound scientific foundation for action, since the management interventions are developed carefully and there are monitoring programs that evaluate and monitor on a continuous basis the outcome of management actions (Holling, 1978).

In other words, the AM process should include the design and implementation of management programs that offer the possibility to experiment with and compare selected policies and practices. This comparison takes place through evaluation of alternative hypotheses about the system (Holling, 1978; Walters, 1986; Lee, 1999). Lee (1993) emphasises the usefulness of this approach by stating: 'if human understanding of nature is imperfect, then human interactions with nature should be experimental'. Although Holling (1978) is of the opinion that the AM concept will support management to proceed even if there is a lack of sound scientific foundation for action, other authors contradict this by suggesting that AM *requires major investment in research, monitoring, and modelling to test alternative hypotheses about sustainable use and management of the natural resources* (Smith and Walters, 1981; Hilborn *et al.*, 1995; Walters and Green, 1997; Prato, 2003).

'In theory, AM recapitulates the promise that Francis Bacon articulated four centuries ago: to control nature one must understand her.' However, in this case it is crucial to not only understand the natural world, but the system as a whole, in particular the influence of humans activities on this system. Thus the AM process that consists of experiments is supposed to influence and affect human behaviour towards the system and in general on *how people live their lives* (Lee, 1999). AM could be described as *a strategy of reacting to a variety of signals and information that are constantly being monitored and fed back into a formal system of response* (Stakhiv, 1998). In this light AM could be seen as a management process that is both anticipatory as well as adaptive (Kay, 1997). Hypothesis and assumptions are developed based on a thorough understanding of the system as a way to anticipate to possibilities and uncertainties that could have an impact on this system. These hypothesis and assumptions are translated into plans and actions which are evaluated and monitored in order to test their affect on the system. Based on these results, the hypothesis and assumptions will be adapted with the objective to improve the overall management framework. The idea is that this process is repeated to guarentee continuous improvement.

To conclude this section, we would like to quote a statement made by Egler who says that 'Ecosystems are not only more complex than we think, they are more complex than we can think' (Egler, quoted by Haney and Power, 1996). Through this statement, Egler seems to agree on the one hand with the fact that the emphasis should be on uncertainties rather than on the idea that everything can be predicted and underastood. But he also indicates that ecosystems are so complex that we might never be able even imagine the degree of this complexity. One could ask what should we be adapting to if it is impossible and too complex for us to foresee changes to come?'

3.2 The concept of AM

As mentioned before the IWRM concept has not been paying attention to the the flexibility and adaptive potential of a system. Flexibility is defined as *the potential of a system for structural change*. Adaptability refers to *the potential of a system to adapt to changes in external boundary conditions*. In other words, adaptibility implies a certain responsiveness of the system. On a theoretical level, learning is considered a crucial element of AM. While developing and analysing new policies, learning should be taken as the key objective (Walters, 1986; Lee, 1993). However, there are very few examples recorded where learning has indeed been taken as the objective for policy development and evaluation (McDaniels and Gregory, 2004).

According to some authors, the origin of the AM concept lies with the adaptive control theory. This theory is designed to *enable decision makers to learn from experiences, operations and research, and management science* (McLain and Lee, 1996). The AM theory can be split up in two streams, that of passive AM and of active AM. Passive AM *formulates predictive models of ecosystem responses to management actions, bases management decisions on model predictions, and uses monitoring data to revise model parameters* (Walters and Hilborn, 1978). This form of AM is non-experimental which makes it rather simple and inexpensive to implement. However, Hurlbert (1984) and Wilhere (2002) are of the opinion that this form of AM lacks statistical validity and does not provide reliable information for decision making. Through time, the AM concept has slowly evolved from this passive form into an active form of AM, whereby experimentation is a key element for the development and evaluation of management decisions and actions (Halbert, 1993). These experiments and the outcome of their implementation form the basis to determine whether a particular management action has achieved a desired outcome. 'Since experiments incorporate replication and randomization of management actions, active AM yields reliable information about how management actions influence socioeconomic and ecological conditions' (Lee, 1993).

Similar to the IWRM concept, the AM concept has been around for several decades. Although the origin of the concept comes mostly from an ecological perspective, in its development, it has drawn mostly from theories and methods coming from the social sciences fields, such as social learning (Holling, 1978). These theories are still evolving and have not at all reached a state of perfection. This causes the AM concept also to be unclear. Many people and disciplines tend to have a differing description for and understanding of the concept (Goodin, 1996; Pahl-Wostl, 2002). Social learning has been developed based on the view that in order to change social behaviour and conditions, the following elements should be in place:

- critical self-reflection;
- development of participatory, multi-scale, democratic processes;
- reflexive capabilities of individuals and societies;
- capacity of social movements to shape the political and economic boundary conditions towards improvement of the current situation.

Social learning with respect to sustainable development is based on the participatory processes of social change and societal transformations (Minsch et al., 1998). Similar to the IWRM concept, participatory approaches are considered crucial in the AM process.

Social learning has been defined as *building knowledge within groups, organizations, or societies*. Since the last decade, social learning has also been used in reference to learning about the interconnections and links between human, environmental and technical dimensions within a complex system (Gunderson *et al.*, 1995). This clearly shows another overlap or similarity with the IWRM concept. As discussed before, learning through AM means gathering information and understanding about uncertainties within complex systems through the use of experiments. 'Policies can be treated as experiments, trying different policy actions in informative contexts, creating experimental designs with controls where possible, avoiding costly failures, monitoring and evaluating outcomes, and selecting a basis for judging what has been learned' (Holling, 1978; Walters, 1986; McDaniels and Gregory, 2004).

Therefore, AM could be described as *a systematic approach to improving management and accommodating change by learning from the outcomes of management policies and practices* (Holling et al., 1978; Walters, 1986). Gleick (2003) has described AM as a process that involves *learning to manage by managing to learn*. It clearly includes the following steps:

- development of management experiments;
- gathering information for and increase understanding of uncertainties;
- development of continuous monitoring procedures and space for adjustments.

Through social learning, frequent data gaps are avoided. However, AM takes place in the context of complex political processes where organisations cooperate and function based on established rules and clear defined roles and responsibilities. Negotiation and planning which includes structured stakeholder participation processes are methods for decision making that are crucial to *policy-oriented* learning (Lee, 1993). Another concept that is described in connection to AM is *value-focused thinking* which is *crucial for directly involving stakeholders in structuring a decision process* and is based on the idea that values always underly decisions. Therefore, it is important to understand and identify the values that motivate the decisions of a wide range of stakeholders involved in the decision making process. These different values can be translated into a *structured set of objectives* which can support the development of more attractive and sustainable alternatives and the comparison and evaluation of these alternatives (Keeney, 1992).

The concept of AM would increase the understanding of the interplay between different components and dimensions of IWRM as well as improve the coordination between different policy fields (Geldof, 1995). It is important for the implementation of AM to have a clear vision or model of the system (Walters 1986). As AM is about uncertainties and learning, the objective for AM should be the learning itself and not so much the development of tools that can help to support this learning process. Rather, AM is meant to treat policies as experiments through which the human behaviour towards ecosysems would be changed and improved (Lee, 1999).

3.3 Review of current AM approaches

So far, there has been very little interplay and interaction between the scientific community and the organisations that are involved in the management of ecosystems. Besides this lack of cooperation and learning between *science* and *management*, the focus has in the past also always been on more short-term and fragmented management policies (Walters and Holling, 1990). The AM approach stems from the recognition *that natural systems and the interactions between people and ecosystems are unpredictable* (Gunderson *et al.* 1995). It recognizes the need for management actions to proceed even if our understanding of a system and the effects of management on a system is incomplete (Johnson 1999). Therefore, adaptive policies are designed to test hypotheses about system response to human interventions (Lee 1993). In other words *management actions are taken not only to manage, but also explicitly to learn about the processes governing the system* (Shea *et al.* 1998).

'In the case of large river ecosystems it is important to manage them at larger spatial scales and longer time frames with an emphasis on balancing multiple management objectives and views in a collaborative decision making framework that embraces uncertainty' (Prato, 2003). The enormous complexity of ecosystems asks for a holistic approach which recognises and confronts uncertainties (Clark, 2002). The ability to learn and adapt in the AM framework increases the capacity to innovate and find policies and practices that enhance resilience and sustainability (Magnuszewski *et al.*, 2004).

This AM process, also sometimes called Adaptive Environmental Assessment and Management (AEAM), offers a framework to integrate research, policy and local practice. AM increases the adaptive capacity of river basins through a cyclic learning process that encompasses policy formulation, implementation and evaluation as well as the modification of conceptualisations based on the outcome of the policy evaluation (Holling 1978, Walters 1986, Gunderson et al 1995, Gunderson and Holling 2002). From both institutional and ecosystem management perspective, *continuous and deliberate learning emerges as a result of this experience-knowledge-action cycle*. This learning cycle suggests that *purposeful action derived from experience-based knowledge will itself result in new knowledge* (Checkland and Scholes, 1990). Many researchers have emphasized the importance of stakeholder involvement throughout this process for improving the quality and perception of decisions made at each step (Dovers and Mobbs, 1997; Shindler and Cheek, 1999).

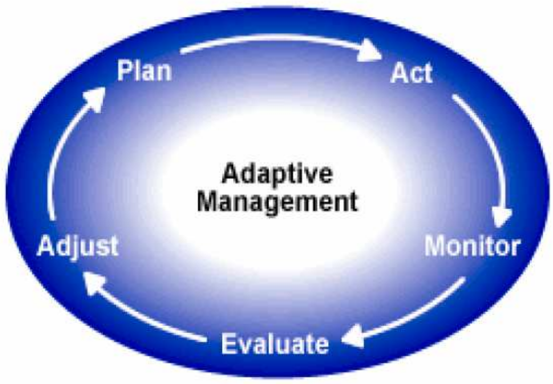


Figure 3.1: Adaptive Management Cycle (Taken from National Oceanic and Atmospheric Administration Coastal Services Center)

This learning cycle of AM (Figure 3.1 above) includes the following sequence of steps, which are continually repeated (Levine, 2004; Johnson, 1999; Parma et al., 1998; Walters, 1997):

1) establish a stakeholder adaptive management team;
2) define the problem(s) to be addressed;
3) establish goals and objectives;
4) specify a conceptual model that expresses the collective understanding of how the system in question functions, highlighting key uncertainties and acknowledging factors that are outside of the system;
5) develop hypotheses about the effects of different management actions that address the uncertainties;
6) design management experiments/interventions to test hypotheses while meeting management goals;
7) design a monitoring plan to measure the impact(s) of management interventions;
8) implement management interventions;
9) monitor;
10) evaluate the impacts in terms of management goals and hypotheses;
11) reassess and adjust the problem statement, goals, conceptual model, interventions, and monitoring plan.

As a result of this cyclical learning process, the focus is on *response and scenario building based on the monitoring of carefully defined indicators of system state and behaviour rather than on long-term prediction from first principles or past statistics and information* (Clark and Gardiner, 1994). It could be said that an AM framework depends on expertise and information while creating increased understanding and awareness as well as visualisation and recognition of possible implications (Newson, 2000).

3.4 An analytical framework

Principally, it has always been avoided to develop generic procedures for the AM process. Especially since flexibility and adaptibility are importants aspects of the AM approach and these could be jeopardised by developing rigid generic procedures. AM was not meant to be a prescriptive approach (Holling, 1978). Despite this initial stanza, a more generic process has developed though the years. The overview of this process (Figure 3.2 below) offers a good visualisation of the AM approach. It summarises the generic process, major principles and primary tools of AM (Ohlson, 1999).

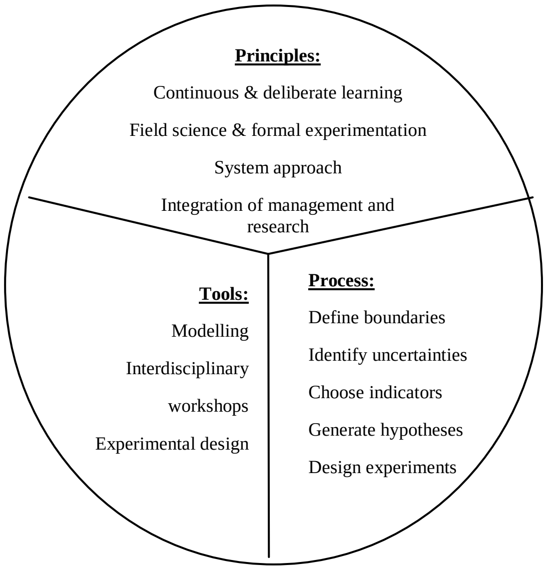


Figure 3.2: generic process, major principles and primary tools for AM

The AM framework can be considered a ‘soft system approach’ as it is an open, participatory and recursive process, which is used both for policy formulation and indicators selection instead of top-down control. It is a form of systems analysis, which includes and performs many feedbacks between sectors, instead of narrow technical analysis, while using conceptual qualitative modelling instead of formal quantitative modelling. There are however some drawbacks with this soft approach that it is not easily reportable or demonstrable to auditing authorities. Another problem may arise when a team working on indicators feels the soft systems approach is not rigorous or professional enough (because it does not provide quantitative results) (Bell and Morse, 1999). It should be taken into account however, that even though AM is regarded a soft systems approach, regarding more recent development, initial and also more recent approaches to AM pursued by some ecologists rely still heavily on the idea to be able to design experiments to test different hypotheses that are derived from a clear understanding of ecosystem function.

3.5 Benefits and challenges

Integration across sectors and different levels of the system helps to avoid fragmented management and misunderstandings. When information about system responses to interventions is avalaible, the management system will be able to adapt and respond more effectively to unforeseen changes (Clayton & Radcliff, 1996; Jackson, 2000). As pointed out by Holling in the 1970s, the result of non-adaptive management is that the whole system, over time, can become less resilient and more vulnerable to disturbances and change (Holling, 1978). An important question here, however, is whether AM has in fact in practice proved to have a positive impact on the resilience and adaptive capacity of systems? But also whether AM is an appropriate tool for an adaptive system?

Advantages of AM include (McLain and Lee, 1996; Wondolleck and Yaffee, 2000): (a) increasing the pace and frequency at which policy makers and resource managers acquire knowledge about ecological relationships; (b) aiding management decisions through the use of iterative hypothesis testing; (c) enhancing information flows among policy makers; (d) creating shared understanding among scientist, policy makers, and managers. However, evidence from three case studies of AM indicates these advantages have not always been achieved (McLain and Lee, 1996).

According to McDaniels and Gregory (2004), the following advantages could be achieved when learning is treated as an objective throughout the AM decision making process:

(1) *Stakeholder advantages*: explicit attention to 'what matters' from different viewpoints; acknowledgement that information base is limited and uncertain and could be improved; provides a way forward for difficult one-time choices with limited information;
(2) *Organisational advantages*: helps create an organisational routine and measurable outcome for learning; fosters creation of a learning plan; facilitates double loop learning;
(3) *Decision process advantages*: converts one-time decisions to repeated decisions with opportunities for learning and adjustment; fosters creation of a performance measure for learning; fosters creation of alternatives to achieve learning objective; fosters explicit consideration of tradeoffs between learning and other objectives.

Despite the appeal and attractiveness of the AM concept, however, there is widespread agreement among researchers that several obstacles have obstructed the successful implementation and limited its effectiveness as a management approach (Levine, 2004). In a rather negative assessment of the AM concept, Walters (1997) ascribed the limited success stories regarding the implementation of AM to the following factors:

(1) focus on perfecting models rather than field testing them;
(2) expense and risk of undertaking large scale experiments;
(3) fear among research and management organizations that adaptive management may undermine their credibility; and
(4) fundamental conflicts among diverse stakeholders about ecological values.

Other obstacles include: high costs of information gathering and monitoring; resistance from managers who fear increased transparency; political risk due to the uncertainty of future benefits; difficulty in acquiring stable funding; and fear of failure (Lee 1993). Through an analysis of implementation of the AM framework in the Florida Everglades, Gunderson (1999) concluded that three major barriers for its successful implementation are: inflexibility in social systems, little resilience in ecological systems, and technical challenges associated with experiment design.

Other practitioners also identify a considerable number of barriers while attempting to implement AM. Social and institutional challenges include high costs and limited availability of funding, a mismatch between the lengthiness of the AM process and short funding cycles, agency and stakeholder impatience with the slow pace of AM, a lack of leadership for monitoring and coordinating efforts, and risk aversion among agency personnel and stakeholders. Technical challenges encountered include a limited understanding of how to apply AM and difficulties in translating results from site-level projects to an understanding of the river system (Levine, 2004). However, one of the major challenges posed by AM is that *it requires learning to occur at spatial and temporal scales relevant to the defined management task* (Lee, 1993; Gunderson et al., 1995).

In order to match "science" and "management", it is crucial to integrate field research with on-going efforts to formulate policy and improve practices and methods at different scales and levels. System management is usually misdirected due to inadequate understanding of the system and its possible changes and uncertainties. 'This raises the challenge to control even as we explore, to manage as we learn and to counterpose management actions and research in a cycle such that they reinforce one another in a progressive series that spirals upward to greater resilience. The challenge requires that different factors evolve and complement one another across the whole basin' (Sendzimir et al., 2004).

All these challenges and barriers which have been described above represent the reasons why the AM concept has not been successfully translated from theory into practice. Carl Walters (1997), one of the fathers of AM, notes that out of the 25 major planning exercises for AM that he has participated in, only 2 could be considered well-planned. Other initiatives have either *vanished with no visible product* or become *trapped in an apparently endless process of model development and refinement*. In general, most of the reasons for difficulty in implementing AM can be related to regulatory and jurisdictional complexity; stakeholder impacts; and ecosystem considerations. However, there are a number of other difficulties related to how AM is implemented that have contributed to its failure to achieve widespread adoption and its rather modest success when adopted (Ohlson, 1999), which include (Walters, 1997; Rogers, 1998; Halbert, 1993):

- failure to define what is meant by AM and how it will be implemented;
- an absence of strategic thinking about the end-points of scientific inquiry;
- tendency for AM processes to evolve into continuous and costly modelling exercises;
- over-reliance on a passive AM approach;
- belief that effective experiments are excessively expensive and/or ecologically risky (even when baseline options cannot be said to be low-cost or low-risk);
- fear on the part of individuals in management agencies that acknowledging uncertainty will compromise public confidence in the agency;
- failure of scientists to understand management priorities and to recognise the need to provide information that can be directly used by managers in decision making;
- tendency of scientists with self interests to overstate their capability to measure complex functional relationship through experimentation;
- lack of emphasis or attention to the processes required for shared understanding or shared decision making among diverse stakeholders.

The recent literature also suggests that institutional challenges may be the key barriers to the implementation of AM, and/or that AM may in fact be a tool for enhancing institutional effectiveness. For example, Lee (1993) discusses institutional conditions for success in applying an AM approach. He highlights the social dynamics and institutional rigidities that complicate the AM approach.

Information is expensive and a major issue related to AM is *how to get information cheaply and with as few organizational and procedural hassles as possible*. Learning is information-intensive and requires active stakeholder participation (Margoluis and Salafsky 1998). The level of cooperation that is required in order to gather necessary information for the AM process shows that many different stakeholders need to maintain a commitment to the learning process. However, it should be kept in mind that it is possible that some stakeholders might resist participation because of the cost and risks involved (Lee, 1999).

Policy makers need to be more attuned to innovations in technologies related to their respective sectors. The best of the tested and practical new forecasting procedures, better simulation models, and improved data monitoring systems, etc. must be introduced into water resources analysis and decision making. Technology advances are more effective in better-managed water resources systems. The largest hindrances to effective water management in virtually all countries are the outmoded economic and institutional policies that shape public and private decisions, development strategies and resource use patterns (IPCC, 1997; Stakhiv, 1998).

3.6 Lessons for successful implementation

Despite the many challenges for AM, modest successes are being reported in practice, and a growing number of government agencies are initiating AM programs as key part of their overall management strategy. Despite the wide ranging interpretations of AM, and despite the limited success in implementing a comprehensive active AM approach at the scale of large ecosystems, these initiatives confirm that, in principle at least, AM is widely regarded as a useful tool for resource managers. Also in the case of the AM approach, many authors have identified different lessons which, according to their view, are important to a successful implementation of AM. We have gathered some of the most interesting lessons in Table 3.1 below):

Author (Year)	**Lessons for facilitating succesful implementation of AM**
Frederiksen et al. (1993)	Sound adaptive water management relies on functioning institutions that are designed to accommodate changes and new information, not only in meteorology and hydrology, but the more rapidly shifting changes in the socioeconomic structure, demographics, technology and public preferences regarding strategies for sustainable development. Without this institutional base, water resources cannot be sustainably developed or managed; Few developing countries have adequate national water policy statements, national water plans, legislative and regulatory frameworks, or mechanisms for intersectoral coordination. Building this institutional capacity further is the key to water management and adaptation.
Lee (1993)	Effects of management actions involving major ecosystem changes are easier to detect than actions involving minor changes; Keeping a management action relatively simple facilitates measuring the relationships between the action (cause) and ecosystem responses to that action (effect). However, even under the best of circumstances it is difficult to establish actual cause and effect relationships in large, complex systems. Managers should expect surprising responses to management actions. Surprises are common when uncertainty is high and provide an opportunity to learn about ecosystems; The political consequences of exposing management actions that fail to achieve desired outcomes may be unacceptable.
Levine (2004)	*Long-term, stable source of funding* is imperative, which includes funding for all steps of the process (baseline data collection, planning, modelling, implementation, and long-term monitoring); *Long-term institutional commitment* to a new approach is essential for learning, feedback and ecological improvements. This will require the support of stakeholders, staff, and agency directors. Gaining the confidence of stakeholders appears to be especially important for smooth progress and functional working relationships. A fundamental tension in stakeholder-driven AM is that increasing stakeholder participation tends to lengthen the process (requiring multiple iterations of each step), but with more stakeholders, there may be greater pressure for the pace to proceed more rapidly; *Leadership and more structured coordination* are required in order to promote learning. Lack of leadership is particularly significant in cases with multiple people working on different projects on a single river or in cases where multiple similar rivers are all testing different hypotheses. Without a distinct person responsible for oversight and coordination of AM, knowledge gained in one location may fail to be integrated into projects and efforts at other locations. In short, this lack of coordination may translate into the loss of information gained at considerable cost; *Training* is needed for those expected to implement AM, because it has multiple and often ambiguous definitions, resource managers may not understand what AM is and how they can actually apply it.
Lee (1993) and Wilhere (2002)	A mandate is required to take action in the face of uncertainty; preservation of pristine environments is no longer an option; human intervention is not capable of producing desired outcomes in predictable ways; sufficient institutional stability is required in order to measure long term outcomes; possibility to formulate hypotheses should be available; theory, models, and field methods should be available to estimate and infer ecosystem scale behaviour; decision makers need to view management actions as experiments and uncertainty about outcomes as potential hazards; it is important that the organizational culture encourages learning from experience, and the culture places value on having reliable information; resources should be adequate to measure ecosystem-scale behaviour; decision makers should care about improving outcomes over biological time scales.

Sendzimir et al. (2004)	How can we increase the adaptive capacity as we manage to lower vulnerability such that our management approaches become more adaptive? It may mean short-term excursions into lowered resilience to cross to another, less vulnerable and more resilient stability domain.
IPCC's Working Group III report (1996c)	A decision process should be sequential. It should be able to respond to new information with mid course corrections and to include the option value of alternative courses of action. The challenge today is to identify short-term strategies in the face of long-term uncertainty. The question is not what is the best course over the next 100 years, but rather, what is the best course for the next few years, knowing that a prudent strategy will allow time to learn and change course.
Pahl-Wostl *et al.* (2004)	Management for efficiency and equity, but also for increasing uncertainty will have to be, in many ways, an inherently local activity where courses of action and the incentives to undertake them are contingent on specific local hydrological, economic, technical and social conditions.
Pahl-Wostl (2005)	New information must be available and/ or consciously collected (e.g. indicators of performance of management regimes and of change that may lead to desirable or undesirable effects). The actors in the management system must be able to process this information and draw meaningful conclusions from it. Management must have the ability to implement change based on processing new information.
Walters, Goruk, and Radford (1993); Walters and Green (1997)	AM is likely to be costly and slow in many situations, so those involved in stewardship need to think through whether the scientific approach is worthwhile in specific cases. It is important to spell out how much difference in management might result if adaptive learning proceeds as envisioned).
McConnaha and Paquet (1996)	AM is most feasible and most likely to be successful when the number of regulatory bodies is relatively small, the number of interest groups is small and the impacts on them are not severe, and the risk of driving any species to extinction is low.
Lee (1999) and Walters (1997)	AM is difficult to initiate and to sustain and is unlikely to be considered affordable in many instances. There is reason to think that this *mode of learning* is important, possibly essential, in the search for a durable and sustainable relationship between humans and the natural world. The need is not so much better ammunition for rational debate but creative thinking about how to make AM and social learning an irresistible opportunity, rather than a threat to various established interests.
Walters and Hilborn (1978); Walters and Holling (1990)	Some stakeholders are likely to view experimental management as too time consuming, complex, and costly and more ecologically and economically risky than passive AM, trial and error, and deferred action.
Walters and Green (1997)	It is often difficult to make the transition from model development to experimentation.
Smith (1997)	AM is likely to give misleading results when relevant variables are either ignored or not held constant.
Peterman and Peters (1998)	DA is particularly effective during the planning stage of an active AM process because it can compare the expected performance of alternative experimental designs. It can provide a strategic framework for AM that helps to establish an AM program that is focused on delivering information that will be useful in future decision making. This joint implementation of AM and DA will help to avoid: lack of support from management due to failure to demonstrate how AM will address management priorities; (2) waste of resources in conducting studies that do not provide useful information for management.
LeMoigne et al. (1994)	Experience in many of the most vulnerable developing countries of the world suggests that establishing sound institutional frameworks and water management reforms is a necessary condition that can provide the basis for systematic AM.

Table 3.1: Lessons for successful implementation of AM

4 Relationship between IWRM and AM

’There are clearly a number of significant problems in realising the promise of IWRM’ (Jeffrey and Geary, 2004). AM is facing many challenges, with only a few modest successes that have been reported in practice. As mentioned, the main objective of this report is to investigate whether a combination of the IWRM and the AM concepts would lead to enhanced and more sustainable water management regimes. Since IWRM as well as AM have been facing a large number of difficulties in their transfer from theory into practice, it is important to look at the question whether IWRM and AM would indeed create synergy when combined together or whether the barriers and challenges to both concepts will make a combination of them even more complex for successful implementation? We have attempted to simplify and visualise this question as shown in the figure 4.1 below:

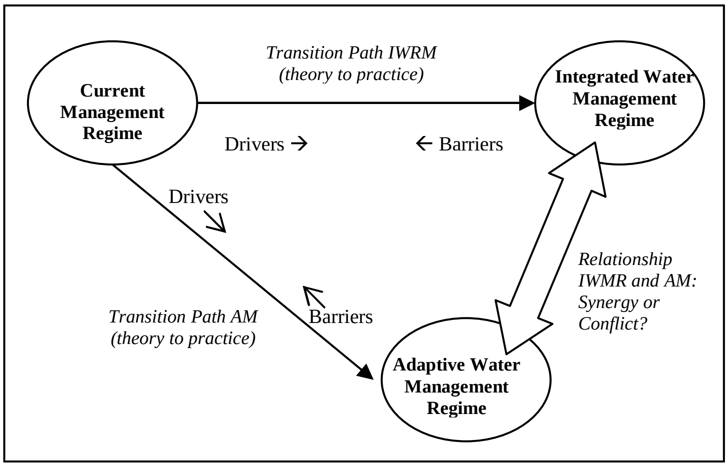


Figure 4.1: Relationship between AM and IWRM

This comparative analysis between IWRM and AM included: a historical analysis of the scientific concepts underpinning IWRM and AM; an exploration of the current approaches of IWRM and AM; as well as the transfer of their theories and principles into practice. This comparative analysis has enabled us to identify and better understand the relationship (overlaps and gaps) between both concepts. This final section will focus and attempt to elaborate further on the relationship between the IWRM and AM concepts.

4.1 Drivers to IWRM and AM

4.1.1 Systemic approach

The ’Adaptive Integrated Water Resources Management’ is synonymous with ’Sustainable Water Management’. Yet, there are distinct challenges associated with exactly how to operationalise these terms’ (Eisenhuth *et al.*, 2004). Usually sustainability is linked to a clear understanding of the dynamics going on in natural systems. However, it is much more crucial to have understanding about the interconnectedness and links between the different elements of the human and natural system.

Ecosystems, such as river basin systems, have been described by Gunderson and Holling (2001) as complex systems, which are *adaptive* or *self-organising* and the management of these systems should therefore be able to readjust to change or surprise within the system. The IWRM framework has been developed as an approach to address the need for a more holistic, integrated, comprehensive approach to water management, whereby the whole system is taken into account including the relationships and dynamic interactions between human and natural systems, land and water systems, and key stakeholder agencies and groups. IWRM is a challenging soft systems problem (Ohlson, 1999). Therefore, in practice it requires a systemic approach.

As stated before, a systemic approach can be described as *relating to the properties of the system as a whole* (Everard and Powell, 2002), where *none of the parts have the same properties in isolation, so that when a system is dismantled it loses all or some of its original attributes* (Capra, 1997).

'Thus, attempts to manage the three interrelated and overlapping biophysical, socio-economic and institutional systems must address key issues such as reconciling conflicting objectives, managing watersheds as complete ecosystems, and facilitating meaningful stakeholder participation. Moreover, coping with inherent uncertainty and pervasive complexity is an overriding challenge' (Ohlson, 1999). Ohlson describes and summarises the potential contribution (significant, some, no/ limited) of the AM approach to the soft systems challenges of IWRM (see Table 4.1). He concludes that AM offers an overall approach and set of tools that may help to address some, but not all, of the intractable characteristics of IWRM.

Soft Systems Characteristic	**AM**
Ambiguous Boundaries/ Complex linkages	
Cross-boundary impacts	No/limited
Cross- boundary influences	No/limited
Cross-disciplinary scope	Some
Difficulty with objectives, alternatives and consequences	
Unclear objectives	Some
Complicated alternatives	Some
Inherent conflict	No/limited
Data overload	Significant
Pervasive uncertainty	
Uncertain ecosystem relationships	Significant
Uncertain socio-economic relationships	No/limited
Evolving institutional and legislative bounds	No/limited
Multiple stakeholder conflict	
Gridlock over facts and values	Significant
Potential for escalation of conflict	No/limited
Lack of transparency in decision making	Some

Table 4.1: Soft system characteristics for AM

As can be concluded from the above table, limitations of AM for resolving the soft systems nature of IWRM problems include: (1) cross-boundary impacts and influences remain fundamental issues not directly addressed by AM (need for reform of institutional systems); (2) the potential for escalation of conflict stems from deeply rooted values and vested interests. These will be only indirectly affected by AM and suggest a need for an assessment of the tools and techniques of facilitation, mediation, bargaining and negotiation (Ohlson, 1999).

4.1.2 Cyclical decision processes

Both the IWRM as well as the AM framework are described as cyclical management decision processes. The steps which have been described for the IWRM and the AM processes in sections 2.3 and 3.3 have been compared and combined into one process (see Table 4.2), which integrates the two processes into one framework for Adaptive Integrated Water Resources Management (AIWRM).

IWRM (GWP, 2000)	**AM (Levine, 2004)**
	(i) Establish Stakeholder AM team
(1) Establish status (water resources issues seen in national context)	(ii) Problem identification
(2) Establish overall goals	(iii) Establish goals and (learning) objectives
(3) Build commitment to reform Process (political will, awareness, multistakeholder dialogue)	
(4) Analyse gaps (WRM functions required and management potentials and constraints)	(iv) Specify conceptual model of the system (expressing collective understanding of systems functioning including uncertainties and external factors)
(5) Prepare strategy and action plan	(v) Develop hypotheses
	(vi) Design management experiments (interventions) for testing hypotheses
	(vii) Design monitoring plan for measuring impacts of experiments
(6) Build commitment to actions	
(7) Implement frameworks	(viii) Implement management interventions
(8) Monitor	(ix) Monitor
(9) Evaluate progress	(x) Evaluate impacts in terms of management goals and hypotheses
	(xi) Reasses and adjust problem statement, goals, conceptual model, interventions and monitoring plan

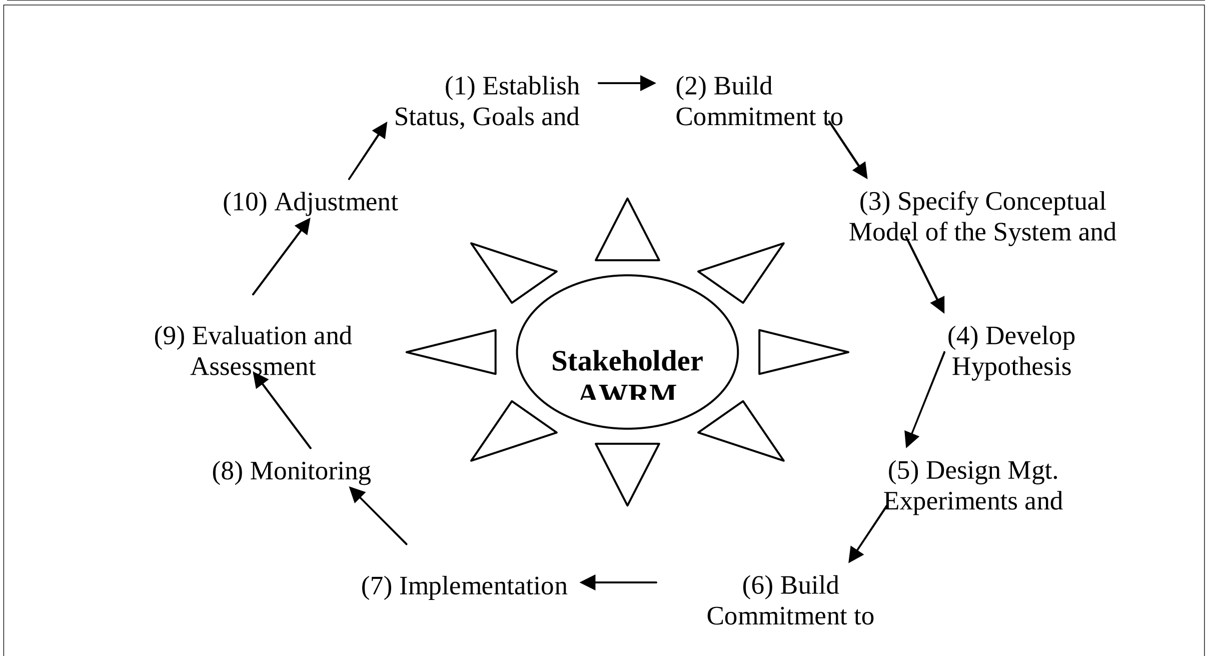


Figure 4.2: Comparision of IWRM and AM processes and combined cycle

However, the question still remains whether integration of both concepts is desirable and will indeed create synergy. It is still not clear whether the barriers and challenges to both concepts will make a combination of them even more complex for successful implementation.

4.1.3 Stakeholder involvement and learning

The most critically important element of the IWRM framework is the integration of various sectoral views and interests in the development and implementation of this framework, while building on and providing consistency with current government policies and national or sectoral development plans and budgets. This integration of different dimensions and aspects within the system requires the participation of a large number of stakeholders in the decision making processes. In other words, IWRM, being a holistic approach, needs to consider contributions and perspectives of all users, planners, sciences and policy makers, thereby promoting increased communication between different public and private stakeholder groups as well as with the wider public (Jeffrey and Geary, 2004).

’Although IWRM reflects this post-modernist inspired agenda through its emphasis on contextual relevance, wider participation in planning and decision making, and responsive and reflexive practice, it remains rooted, by and large, in a *predict and prepare* paradigm. It is therefore, more akin in practice to the contingency planning approaches of the 1960sand 70s than to the AM frameworks promoted during the 1990s’ (Jeffrey and Geary, 2004).

Stakeholder involment has been described as an important aspect of the AM framework as well. In the case of IWRM, the AM approach can contribute to the overall stakeholder involvement proces. According to Ohlson (1999) the AM approach offers a path to learning. With respect to the soft systems nature and challenges of IWRM, it may help to: (1) simplify the problem(s) by focusing on key uncertainties; (2) improve quality of information over time and hence the understanding of ecosystem function; (3) break multi-stakeholder gridlock over controversial facts and assumptions by committing to a program of structures learning and continual adjustment.

’A post-modern perspective, such as IWRM, raises the spectres of conditional and particular knowledge (i.e. knowledge as a funtion of experience and thereby neither absolute or general). Such uncertainty is an unwelcome guest where bad decisions can lead to serious consequences’ (Jeffrey and Geary, 2004). Eventhough the AM approach is said to contribute to improved quality of information and understanding of the systems functioning, the question remains whether AM can indeed support the learning through its experiments? When we experiment and learn from the testing of hypotheses that have been formulated today, how do we know for sure if this problem will at all be relevant for the future? This question is emphasised by the earlier mentioned statement made by Egler: *’Ecosystems are not only more complex than we think, they are more complex than we can think’* (Egler, quoted by Haney and Power, 1996). If we cannot predict issues arising in the future, we will somehow always continue to react to them after they have arisen without us being prepared. You cannot really stop that, even by experimentation. In fact you are just improving your management system based on very recent information/ feedback, but no matter how recent the feedback is, its already information from the past. You are still running behind the facts with the only difference is that you try to improve the management system on a more continuous basis. So it is in fact somehow still a predict and prepare paradigm.

4.2 Barriers to IWRM and AM

Analysing the sections on IWRM and AM, it can be concluded that both IWRM as well as AM face many barriers and challenges to their succesful transfer from theory into practice. We have developed a table in which we have attempted to compare the most crucial barriers which have been described for each concept. This gives a clearer picture that IWRM and AM are facing quite similar challenges.

IWRM	AM
'Crisis of Governance': Effective water governance is crucial for the implementation of IWRM plans. Problems in management and governance go beyond mere technical challenges, in the case of IWRM, institutional reform is needed: correct policies, viable political institutions, workable financing arrangements, self-governing and self-supporting local systems, etc. Institutions are rooted in a centralised structure with fragmented sub-sectoral approaches to water management and often local institutions lack the capacity. Awareness and priority at political level of water issues is in many cases limited. Also information and data to support sound management of water is generally lacking.	***Institutional challenges:*** It is said that institutional challenges may be the key barriers to implementation of AM, and/ or that AM may be a tool for enhancing institutional effectiveness. Social dynamics and institutional rigidities may complicate the implementation of the AM approach. Learning is information intensive and requires active participation of many stakeholders, that need to maintain a commitment to the learning process throughout. Sound adaptive water management relies on functioning institutions that are designed to accommodate changes and new information. This institutional base is crucial for sustainable water resources management and development. Also long-term source of funding is crucial for the AM approach, which should include all steps of the process.
Generic and prescriptive framework: The necessity to adapt the IWRM concept to suit different local contexts which doesn't allow for a generic and overall description of strategies and techniques. In practical reality, the IWRM concept has not structurally demonstrated its benefits to increase the sustainability of water resources management. Empirical evidence is either missing or poorly reported. It will be important to identify the essential elements for IWRM, while avoiding rigid prescriptions and allowing for vast differences among countries.	***Analytical framework:*** It is a form of systems analysis which includes and performs many feedbacks between sectors, instead of narrow technical analysis, while using conceptual qualitative modelling instead of formal quantitative modelling. The drawback of this soft approach is that it is not easily reportable or demonstrable because it does not provide quantitative results. Also the AM approach has emerged into a more generic process, which could jeopardise the intended flexibility of the approach. It is important here to identify short-term strategies in the face of long-term uncertainty.
Ambiguous definition: The most used definition of IWRM by the GWP gives very limited practical guidance to present and future water management practices. It is difficult to implement and internally inconsistent. Besides the GWP definition there are several other definitions that all differ from each other in one or more facets or dimensions.	***Ambiguous definition:*** A reason for failure to achieve widespread adoptation and a rather modest success when adopted is the failure to define what is meant exactly by AM and how it should be implemented. The AM concept has multiple and often ambiguous definitions. Resource managers may not understand what AM is and how they can apply it in practical reality.
Soft system approach: IWRM is a soft system approach taking into account the whole system including relationships and dynamic interactions between human and natural systems, land and water systems, and key stakeholder agencies and groups. This interconnectedness on different scales and levels	***Experimental and learning approach:*** Stakeholders may view experimental management as too time consuming, complex, costly and more ecologically and economically risky. They may be unwilling to accept experiments without knowing the consequences. AM is considered difficult to initiate and

makes it very complex to translate the IWRM concept into practice. Through the soft systems approach, problems are having ambiguous boundaries and complex linkages with other problems; goals, alternatives and consequences that are not well-defined or understood; pervasive uncertainty which may not be quantifiable; and iterative management which involves conflict and negotiation among multiple stakeholders with divergent interests and values. In a way, however, IWRM is not holistic since it considers water as the most important resource.	sustain and unlikely to be affordable in many instances. AM is likely to be costly and slow in many situations, so those involved in stewardship should consider thoroughly whether this approach is worthwhile in all cases. New information must be available and collected and the actors in the management system should be able to process this information and draw meaningfull conclusions from it in order implement change based on these conclusions.

Table 4.2:The major barriers for implementation of the IWRM and the AM concepts

4.3 IWRM and AM: synergy or conflict?

To summarise shortly, strategic policy in the water sector has developed from supply oriented, through demand oriented to integrated approaches over the past decades. Although IWRM as an abstract model has been widely accepted as the appropriate framework to deal with complex water resources management issues, its principles have not been elaborating on management under uncertainty, nor did they specifically articulate adaptive capacity as a significant feature of water management strategies. AM, as a concept, has been designed to support managers in dealing with uncertainties. In relation to the water sector, AM is considered an approach that could improve the conceptual and methodological base and promote realisation of the goals of IWRM. The aim of this report has been to investigate whether the coupling of IWRM and AM has indeed the potential to lead to enhanced and more sustainable water management regimes.

We have tackled this objective by reviewing the drivers for both concepts as well as the issues that have challenged their successful implementation. Our findings describe and show that there are indeed common drivers for IWRM and AM. The similarity and overlap in drivers also suggest how on a conceptual level, both concepts could complement each other. Also the issues associated with the limited success experienced by practitioners in implementation of both concepts show a large overlap. This could mean that the implementation of a combination of IWRM and AM would not guarentee enhanced success compared to the implementation of IWRM alone. On a theoretical level, AM appears to facilitate the IWRM process, but the conditions for successful implementation of AM ask for a lot of institutional capacity and flexibility. And these preconditions for succesfull AM seem to be exactly the challenges that IWRM has been struggling with.

However, in order to draw serious conclusions whether or not a combination of IWRM and AM would create synergy and increase the sustainability of water resources management, it still needs to be further investigated how IWRM in practical terms can lead to more sustainable development, as well as how AM practice could lead to improved practical implementation of IWRM. This cannot be assumed but needs to be tested in the context of specific cases.

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