Part I
Framing the context

1 Introduction

1.1 ORGANISING THE STRUGGLE TO GOVERN THE COMMONS

The recent worldwide push for broad-scale multi-level participatory processes to aid the adaptive management of socio-ecological systems has led to the emergence of important and rarely investigated actors – those who 'organise' the struggle to govern the commons.

In their 2003 *Science* article, entitled 'The struggle to govern the commons', Dietz, Ostrom and Stern (Dietz *et al*., 2003) described the creation of effective governance systems for the world's critical environmental problems as 'akin to a co-evolutionary race'. They suggested that adaptive and robust governance mechanisms to deal with these problems are most likely to succeed if the following strategies are pursued:

- The development of 'analytic deliberation' or well-structured dialogues between 'interested parties, officials and scientists';
- The 'nesting' of institutional arrangements to maintain complexity and redundancy;
- Employing 'institutional variety' or a mix of institutional types and different types of rules; and
- The promotion of 'designs that facilitate experimentation, learning, and change' (Dietz *et al*., 2003).

In recent years there has been a rapid increase in the number of attempts to promote governance mechanisms that fit some of these characteristics.

At a local level, hundreds of thousands of community stewardship groups have been established around the world since the beginning of the 1990s and these have supported marked improvements in environmental quality and maintenance of livelihoods (Pretty, 2003). Commonly, NGOs and governments provide funding support for facilitators and skills training for local people, to encourage ongoing self-governance (Pretty, 2003). This community group establishment has been coupled with an increasing realisation that such groups, researchers and other public and private actors should move away from 'treating the problems' to first asking what the problems or issues are and collectively structuring both them and visions for the future (Rosenhead and Mingers, 2001b; Adams *et al*., 2003; Libicki and Pfleeger, 2004).

Attempts are also being made to understand and address the broader-scale challenges of today's rapidly changing and interconnected world, such as climate change, ocean management, biodiversity, resource budgets (food, energy, water, nutrients, etc.) and the need to structure problems and governance mechanisms for their treatment. These attempts include growing efforts to establish and maintain inter-organisational networks to govern socio-ecological systems adaptively and to improve their resilience (Jackson and Stainsby, 2000; Adger *et al*., 2005; Fayesse, 2006). Multi-level participatory processes are also increasingly being organised to help overcome the scale mismatch issues, and to facilitate increased learning and changes in governance systems to meet the new challenges of today's increasingly interconnected world (Cumming *et al*., 2006).

The emergence of these governance structures means that we are again entering a phase in the evolution of common pool resource management, where increasingly important research questions must be addressed, in particular:

- Who is responsible for designing and implementing the structures of these new participatory systems, processes and networks?
- How are they organised?
- Who chooses or designs the methods that are used to aid decision making through these processes?
- Who chooses the participants to be included or the scope of issues to be addressed?
- Are these organising processes monitored by anyone?
- Do the organisers have the knowledge and legitimacy required to organise these processes effectively?
- To what extent could organisation be improved to obtain better participatory process and socio-ecological system outcomes?
- Just how important are the roles of these organisers in helping to meet the challenges linked to the world's critical environmental problems?

1.2 WATER: A KEYSTONE OF COMMONS GOVERNANCE

Water and its management is an integral part of almost all of these interwoven challenges, as it is a fundamental need for life. Neither we, nor the entirety of the world's diverse ecosystems, can survive without an adequate quantity and quality of water for our basic needs. Many of the aforementioned international-level networks and community groups are rapidly growing around specific centres of interest, including a variety of different aspects of water management. However, their capacity to effect on-the-ground action and improve human living standards appears minimal (Gleick *et al*., 2006), particularly for the almost 1 billion people who lack access to clean drinking water and the 2.6 billion who lack access to adequate forms of sanitation (UNDP, 2006).

General water 'scarcity' issues (Rijsberman, 2006) in many parts of the world and conflicts between competing water uses for potable water, sanitation, food production, industry, energy production and many other uses (social, recreational and spiritual), do not help the plight of these billions. Such drivers as population growth, climate change, technological innovations and past water management choices, including the construction of engineering structures and introduction of planning regulations, are to some extent all responsible for these issues that are linked to human behaviour. These drivers are also partially responsible for the increasing risk of damages and loss of life caused by 'natural' hazards, such as floods, droughts, storms, earthquakes and ecological shifts, such as algal blooms or fish kills (Kundzewicz and Takeuchi, 1999; Abramovitz, 2001).

1.3 PROBLEM STATEMENT

Current water management and planning, including their associated decision making processes, are commonly characterised by interconnecting and complex problems that exhibit high levels of conflict and uncertainty. This results from overlapping legislative requirements, multiple decision makers and managers, competing interests, unequally distributed water resources and social and environmental impacts of their development, as well as uncertainties about the future in a more interconnected and rapidly changing world. In such contexts, the decision making process for the selection and implementation of water management strategies becomes a major challenge. 'Traditional' methods of water management and planning are usually insufficient (Gleick, 2000a), as are 'traditional' or 'objective' forms of risk assessment (Klinke and Renn, 2002). The pertinence of expert-created integrated water models designed to inform policy decisions, or quantitative risk analyses to determine levels of 'acceptability', has been more broadly questioned due to the unrepresentative nature of these experts' values-based decisions (Fischer, 2000; Rayner, 2007). In such water management and planning contexts, it is unusual that one institution possesses all of the relevant knowledge and is in control of all the resources required to implement its own decisions successfully. This means that water engineers and managers are increasingly obliged to work with other institutions, stakeholders, experts and the general public to create more acceptable models and plans and to implement management solutions (Loucks, 1998). Therefore, there is a widely recognised and increasing need for the development of improved approaches to aid inter-organisational decision making in the water sector, in order to ensure the sustainable and equitable development of water resources and their dependent societies and environments.

Decision-aiding for water management and planning has long focused on the building of models by experts, which can be used to inform managers' decisions. However, it is considered that in many current inter-organisational water management and planning contexts, decision-aiding through the use of such expert-created models is problematic: in particular, model transparency, scope of the problem treated, uncertainty related to model inputs and outputs, and expert legitimacy are just some of the aspects that can come under attack when this type of decision-aiding practice is pursued, particularly when stakeholders who may be adversely impacted are not involved in the decision process (Fischer, 2000; Rayner, 2007). To address such issues, 'participatory modelling' has been mooted as a potential solution. Participatory modelling is a process that allows a number of different points of view to be explicitly represented and collectively reflected upon by a group of stakeholders through a series of semi-structured decision cycles (Ferrand, 1997). The potential for participatory modelling to be used as a process for inter-organisational decision-aiding in the water sector remains under-evaluated and in need of further investigation.

Such inter-organisational decision-aiding processes for water planning and management are typically organised or 'co-engineered' by several agencies or actors, owing to their size and complexity, meaning that participatory processes are co-initiated, co-designed and co-implemented by a number of people. Co-engineering has also received scant attention in studies of participatory decision making and remains a large gap in current knowledge.

1.4 UNDERLYING HYPOTHESES

The initial hypothesis that guided this research project is that:

> *Situations exist where it is useful to use a participatory modelling approach to aid inter-organisational decision making for water planning and management.*

Linked to this hypothesis, it is assumed that:

The increasing complexity of water-related problems has contributed to the need for improved inter-organisational decision-aiding for water planning and management.

It is then further assumed that:

Participatory modelling processes used for inter-organisational decision-aiding in complex water management contexts are co-engineered.

This then leads to the central hypothesis of this research, that:

Co-engineering can critically impact on the participatory modelling processes and their outcomes.

1.5 BOOK AIM AND OBJECTIVES

To examine these hypotheses, the aim of this study is:

To investigate the impact of co-engineering of participatory modelling processes for inter-organisational decision-aiding in water planning and management.

To fulfil this aim and investigate the listed hypotheses, the book has the following objectives:

1. To critically review past and current water governance systems, their management priorities and strategies to examine whether water management has become increasingly complex.
2. To critically review decision-aiding theory and methods, including participatory modelling, and the way in which they could be used to improve water planning and management.
3. To develop a definition of, and critically review, the concept of co-engineering as it relates to the organisation of participatory modelling processes for water management. This is to allow the identification of priority gaps in knowledge that require further research.
4. To formulate an intervention research programme and evaluation protocol for investigating co-engineering of participatory modelling processes, for inter-organisational decision-aiding in water planning and management.
5. To outline the lessons learnt through individual and comparative intervention case analysis, so as to determine to what extent co-engineering can critically impact on participatory modelling processes and their outcomes.
6. To propose suggestions for future best practice, new perspectives and priority areas in need of further research in co-engineering participatory modelling processes for inter-organisational decision-aiding in water planning and management.

1.6 SCOPE OF THE STUDY

The study will address the aim and objectives from the perspective of water governance at the international, Australian and European levels. An in-depth comparison of the co-engineering of two inter-organisational participatory modelling processes in the Australian and Bulgarian cultural and institutional contexts will be provided. Further examples of co-engineering practices being developed in other contexts, including Algeria, will also be outlined. The main focus of the book will therefore be based on the co-engineering of participatory processes for water management, which can be considered to be situated in the arenas of constitutional and collective choice (Ostrom, 1990), relative to the 'on-the-ground' socio-ecological process systems and day-to-day operational choices of water managers. The focus area is represented in Figure 1.1 as part of an idealised representation of the interconnected feedback systems.

Investigating the co-engineering of participatory processes for inter-organisational decision-aiding in water planning and management requires an understanding of previous theory and practice in a range of relevant academic disciplines. In this transdisciplinary book, a choice has been made to limit the range of literature and examples discussed to those that are relevant to on-the-ground practitioners and researchers, managers, consulting engineers and professional facilitators who are working towards the improvement of water planning and management. Disciplines with a focus on practice and action, such as water engineering, operational research or management science, regional planning and environmental policy, are therefore drawn upon to a greater extent than other academic disciplines with long theoretical and methodological histories, such as sociology, economics, anthropology or psychology.

Although elements of philosophical thought and theories of participation and democracy will be touched upon, this book is not directed towards advancing these bodies of knowledge. Other recent theses with bases in political, sociological and development theory develop these aspects of participation in water planning and management and are available to complement this enquiry (i.e. Barnaud, 2008; Ker Rault, 2008; Richard-Ferroudji, 2008). Similarly, this book is not an in-depth study into socio-ecological water processes, looking at water use behaviours, distribution, hydrological processes and so on; rather, it examines how coordinating decisions over the broader scale water governance aspects can be aided.

In other words, the research in this book stems from the observation that broad-scale participatory processes are becoming increasingly common in the water sector, and that practical, actionable knowledge of how better to organise them is needed. In particular, this work aims to highlight the practical need of water planners, policy makers, engineers, community workers and scientists for a greater understanding of how they could work

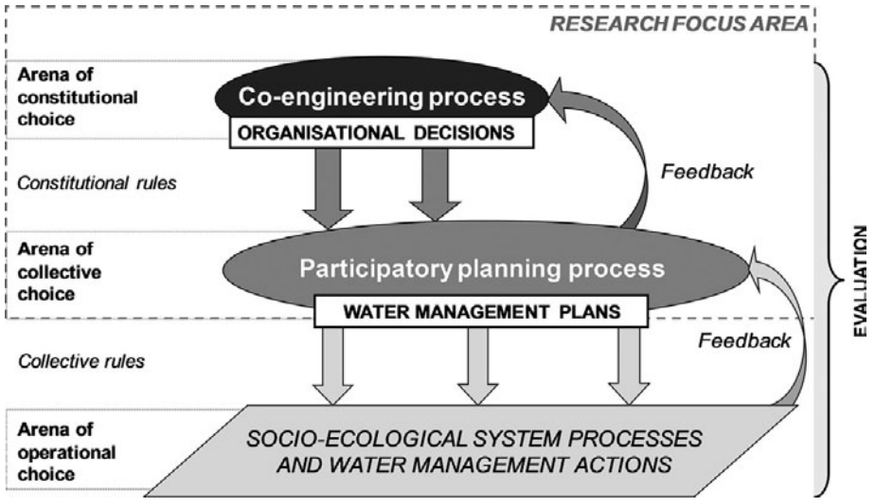

Figure 1.1 Linked systems definition of co-engineering processes for participatory water management relative to Ostrom's (1990) institutional analysis levels (left column).

with others using participatory modelling methodologies, so as to better manage the complex problems they face in today's world.

1.7 BOOK OVERVIEW

To achieve the aim and objectives, this book has been constructed with two principal parts. Part I, consisting of Chapters 1, 2, 3, 4 and 5, frames the context of the research work by presenting a critical review of literature to identify knowledge gaps and the development of research protocols which, when applied, could help to fill these gaps. Part II, consisting of Chapters 6, 7, 8, 9 and 10, then highlights the lessons learnt through research interventions and evaluation protocol application, as well as *ex-post* comparative analysis, extension, discussion, conclusions and areas of required future research. An outline of each of these parts is presented in more detail.

1.7.1 Part I: Framing the context

To introduce further the general context of this study, following Chapter 1's introduction of the water problem context and outline of the scope of the book, Chapter 2 reviews a range of current governance systems, issues and priorities for water planning and management internationally and in Europe and Australia, to provide sufficient background on the water governance contexts of the two intervention research case studies and other co-engineering examples in Part II. A brief review of the lessons learnt from failed management approaches is provided, to identify the need for alternative approaches. Reflecting on these reviews, a number of future needs and opportunities are highlighted, including the *need to develop and implement improved methods of aiding decision making in water planning and management*, in particular for inter-organisational decision-aiding.

Chapter 3 outlines the concept of decision-aiding and its use in relation to the water sector. A critical review of the literature discusses the origins and evolution of decision-aiding practices with a specific focus on theory and management practice from engineering, operational research and management science, and environmental and public policy literature, as well as decision-aiding and its relevance to the inter-organisational water management and planning. How decision-aiding models can be put into practice in this context is then examined. Participatory structure design is also examined, and a comparison of participatory modelling methods is made. An example of integrated participatory modelling for inter-organisational decision-aiding in water planning and management is proposed. The choice or design of different methods for use in such methodologies based on contextual needs and constraints is highlighted as a knowledge gap, as well as what happens when a number of analysts and decision makers are required to co-engineer the participatory modelling processes.

Chapter 4 fills these gaps by critically reviewing a number of current approaches designed to aid the choice, mixture or creation of methods in participatory interventions and determine the remaining gaps in knowledge. The large gap in the understanding of the co-engineering of participatory modelling processes for decision-aiding is then analysed. A definition of the co-engineering process is given, followed by a critical interdisciplinary review of literature to gain insights on the concept. A research agenda on the co-engineering of participatory processes is then outlined, including the need for an

appropriate research approach and evaluation protocol to aid the comparative assessment and learning on inter-organisational decision-aiding in the water sector.

Based on these needs, Chapter 5 presents the research protocols to be used as part of a 'participatory intervention research process' for *investigating co-engineering of participatory modelling processes for inter-organisational decision-aiding in water planning and management*. The principal objects of interest within this process, the 'co-engineering process' and the internal 'participatory modelling process', are delimited and the choice of setting these research boundaries is discussed. An adaptation of the Tsoukiàs' (2007) decision-aiding process model to the inter-organisational context is proposed for use as the base for constructing participatory modelling methodologies. An outline of the kind of evaluation protocol and methods that could be used to monitor and develop further insights on the co-engineering of participatory modelling processes for inter-organisational decision-aiding for water planning and management then follows. Finally, the validation and legitimisation of research insights obtained through an intervention research approach are outlined.

1.7.2 Part II: Learning through intervention

Drawing on the research needs and theoretical framework identified in Part I, Part II presents a selection of intervention cases. Two in-depth case studies from the water sector, which focus on estuary management in Australia and flood and drought risk management in Bulgaria, are then described. The results of the evaluation procedures are reported and an outline is given of a range of lessons learnt. The discussion is further extended by examining co-engineering practices in other recent cases, including for agricultural water management in Algeria.

Commencing Part II, Chapter 6 outlines the practical intervention cases used to create actionable knowledge through interventions of co-engineering participatory modelling processes for inter-organisational decision-aiding in water planning and management. Information is provided on the case selection and a brief background to the cases, including data sources and interpretation schemes. An overview of the lessons learnt from the pilot intervention case carried out in Montpellier, France, that were used to inform the next two interventions in Australia and Bulgaria is also provided. Elements outlined include some adaptations to the evaluation protocol and learning about whether participatory modelling processes for decision-aiding require simulation models.

Chapter 7 presents the Australian intervention case based on the adaptation of a participatory modelling methodology to a 'participatory values-based risk management approach', which was used for collective decision-aiding in the creation of the Lower Hawkesbury Estuary Management Plan in New South Wales (NSW), Australia. This process, driven by local government, and using the Australian and New Zealand Risk Management Standard (AS/NZS 4630:2004), included three interactive stakeholder workshops with a range of stakeholders from state and local governments, the water and sanitation authority, local industries, community associations and residents. Evaluation results demonstrate that the process was efficient from a time and budgetary perspective and has a number of other potential benefits, including broad agency support, which are outlined, together with some lessons learnt and questions arising in need of future research.

Chapter 8 presents the intervention – 'Living with Floods and Droughts' – in the Upper Iskar Basin in Bulgaria to be used for building collective capacity in flood and drought risk management. This year-long process, driven by a number of researchers and regional stakeholders, included two phases of interviews and 15 workshops organised into series for six groups of paid stakeholders from national-level policy makers and experts to municipal-level Government representatives and citizens from around the region. The process was co-engineered to include qualitative participatory modelling activities on: stating expectations, modelling systems and actors, eliciting visions and values using cognitive mapping and causal modelling techniques; developing management options and strategies, framing and assessing strategies using option cards and multi-criteria analysis; and robustness testing of scenarios, risk response project planning and process evaluation. The co-engineering of this participatory modelling process is presented and discussed along with a range of participatory modelling process evaluation results, lessons learnt and areas of interest for further research.

Following the descriptions and results of the case studies presented in Chapters 7 and 8, Chapter 9 presents a comparative discussion of the two case studies, with a focus on: context effects; participatory modelling methodologies; the co-engineering team processes and effect of divergent objectives and leadership; participatory process ethics; and participant evaluation results. It then looks at the validation of the models and protocols used through the intervention research methodology, including an inter-organisational decision-aiding model, a participatory structure model, the evaluation protocol and the legitimisation of the intervention research findings. The discussion is also enriched with further examples of co-engineering practices from other participatory processes around the world, including cases from: the Dhünn Basin in Germany, on ecological river restoration; the Mitidja Plain in Algeria, on understanding and managing agricultural water use behaviours; and

Tarawa in the Republic of Kiribati, on water and sanitation development. Suggestions are then made for future best practice in the use of participatory modelling for inter-organisational decision-aiding in the water sector.

Chapter 10 gives final conclusions relating to the extent to which *co-engineering can critically impact on the participatory modelling processes and their outcomes* and the other research hypotheses. The key contributions of the research are summarised and related to the book aim and objectives. Finally, a range of priority areas and questions that require further research is outlined.

1.7.3 Book overview

The structure and flow diagram of the book is presented in Figure 1.2. The solid arrows represent direct linkages in the book structure, and the dashed arrows represent conceptual or indirect linkages.

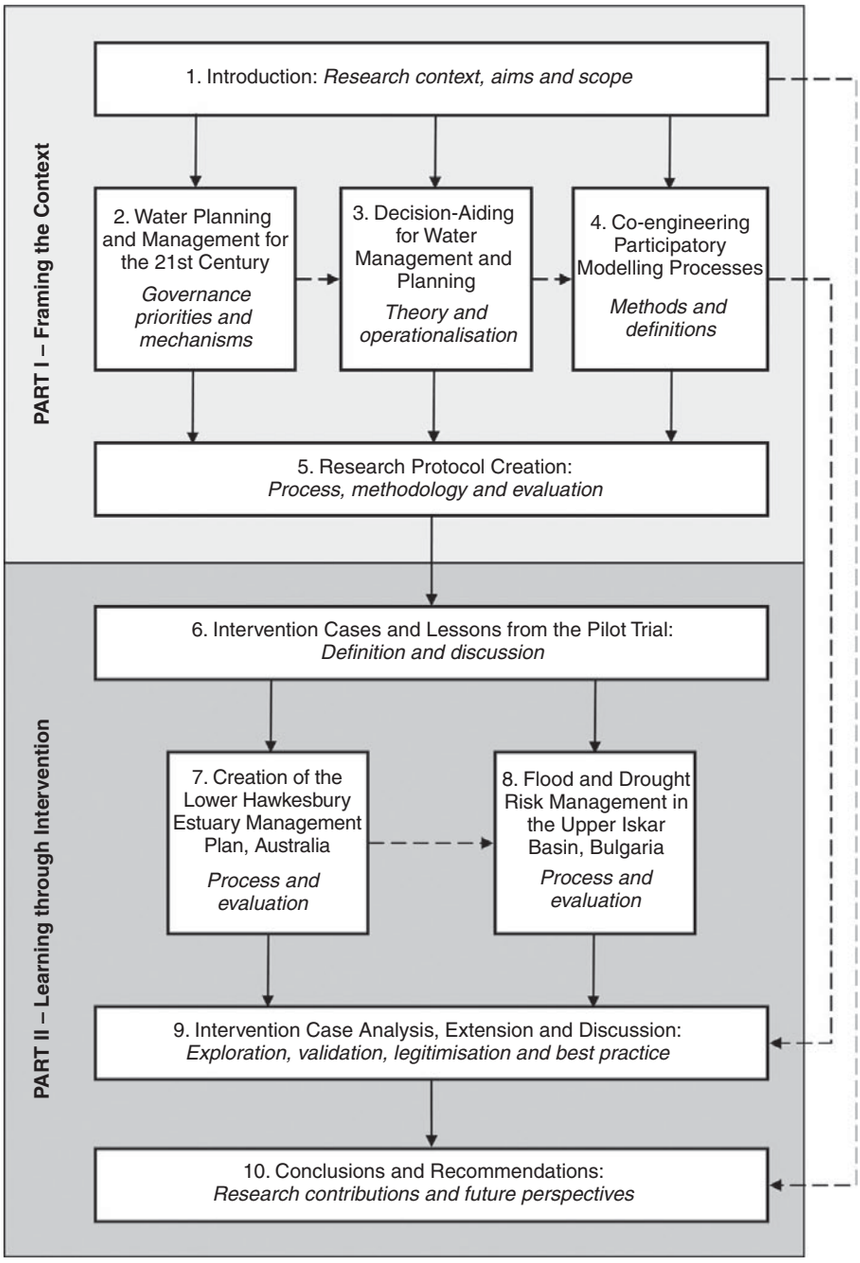

Figure 1.2 Book flow diagram summary.

2 Water planning and management for the twenty-first century

> *The world is heading for a water crisis that is unprecedented in human history; water development and management will change more in the next 20 years than in the past 2000 years.*
>
> ASIT BISWAS *Kyoto World Water Forum (2003)*

This chapter aims to outline the current context of water management, through the critical review and comparison of Australian, European and International water governance systems, and the challenges that remain for the future, as well as to provide a brief review of management approaches that could be considered as history's mistakes and from which we have much to learn. The purpose of this review is to propose responses to a number of larger questions, including:

- What are the principal challenges facing water planners and managers in the twenty-first century?
- What governance mechanisms are currently being put in place for managing these challenges and do they appear adequate?
- What can we learn from history that may help us to manage today's and tomorrow's water issues better?

2.1 CURRENT GOVERNANCE SYSTEMS FOR WATER PLANNING AND MANAGEMENT

Systems for water planning and governance vary widely around the world. The priorities of the water governance systems are closely linked to the main concerns and resources of their surrounding political systems and differ significantly, depending on the scale of management being addressed, its location and its hydrological and socio-economic context. This section will highlight just three examples and give a brief comparison of such systems, including their main challenges and management priorities: water governance at the Australian national level; the European Union's supra-national level; and an international level.

2.1.1 International frameworks and priorities

> *Access to water for life is a basic human need and a fundamental human right.*
>
> Human Development Report 2006 (UNDP, 2006)

As innocuous and reasonable as this statement in the 2006 Human Development report may seem, finding unanimous support for it from national ministers in international forums is just one of a significant number of challenges with which governance of water issues on an international scale must cope (Gleick *et al*., 2004). Despite water and sanitation recently being acknowledged explicitly as a fundamental right and prerequisite for the realisation of all other human rights in the United Nations General Comment No. 15 (United Nations, 2002) and specifically in a legally enforceable resolution adopted by the General Assembly of the United Nations (United Nations, 2010), opponents of acknowledging water rights do so potentially to avoid it being considered by international lawyers as part of 'customary international law', in order to shirk legal, financial and moral responsibilities (Gleick *et al*., 2004).

Legislating that water is a 'human right' and is not just considered as a 'need' is seen by many in the global community as a key step in highlighting how essential water is for the full enjoyment of life and all other human rights, and to incite increased action to uphold this right for the almost 1 billion people who currently lack access to clean and safe drinking water and the 2.6 billion who lack access to adequate forms of sanitation (UNDP, 2006). The direct results of the current lack of water and sanitation include the deaths of between 14 000 and 30 000 people per day, the majority of whom are children and the elderly (Gleick, 2000b), and daily disease-related problems for the equivalent of about half those living in the developing world (United Nations, 1997). Clearly, considering these statistics, efforts to improve water management on a worldwide scale have a long way to go, despite concerted efforts to address these kinds of issues for almost half a century.

The acknowledged need for a concerted international effort to address water issues effectively commenced in the years following the establishment of the United Nations after the

Second World War. It started with the creation of a number of water-related scientific and political international associations and the UNESCO-run 'International Hydrological Decade' from 1965–1974 (Varady, 2004). This initiative was then developed into the International Hydrological Programme (UNESCO-IHP), which has played an important role in international water initiatives ever since, including aiding the publication of the first *World Water Balance and Assessment of Water Resources of the Earth* in 1978 (Varady, 2004). During this time, the rise in worldwide social and environmental movements (for example, The 'Club of Rome') and calls for citizen participation in decision making corresponded with a range of United Nations 'mega-conferences' to address such issues (see Biswas (2004) for details). One of these conferences in 1977 was the United Nations Water Conference in Argentina, the first high-level political meeting of its type, where the 'Mar del Plata Action Plan' for water development and resources was drafted (Gleick *et al*., 2006).

Even by today's standards, the plan is considered a remarkable and insightful political declaration that considered water in a holistic and comprehensive manner (Biswas, 2004). The opening statement of the conference gives an image of the objectives of the meeting:

> *It is hoped that the Water Conference would mark the beginning of a new era in the history of water development in the world and that it would engender a new spirit of dedication to the betterment of all peoples; a new sense of awareness of the urgency and importance of water problems; a new climate for better appreciation of these problems; higher levels of flow of funds through the channels of international assistance to the course of development; and, in general, a firmer commitment on the parts of all concerned to establish a real breakthrough so that our planet will be a better place to live in.*
>
> (Mageed (1978), in Biswas (2004)).

Although a small number of issues that were neglected, including international transboundary water management issues and the financial aspects of how the action plan could be successfully implemented (Gleick, 2000b), the plan outlined a number of important principles and recommendations ranging across the areas of: evaluation and assessment; water use and efficiency for development and sectorial needs; environment, health and fighting pollution; politics, planning, management and institutional aspects; teaching, education and research; natural disasters; and regional and international cooperation (United Nations, 1982). These included making the first explicit declaration of the human right to water:

> *All peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in qualities and quantities and of a quality equal to their basic needs.*
>
> United Nations (1977)

The period after this conference saw water issues slipping largely off the world stage again until the 1992 International Conference on Water and the Environment in Dublin, Ireland (with the notable exception of on-ground work to implement actions from the Mar del Plata Action Plan through the 'International Drinking Water Supply & Sanitation Decade from 1981–1990' (WWAP, 2007)). The Dublin conference was prepared as a precursor to the Earth Summit in Rio de Janeiro, Brazil, which was to be held four months later, although the Dublin conference was predominantly an expert meeting with no inter-governmental committee, unlike the Mar del Plata conference. This omission meant that the recommendations, now known as the 'Dublin Principles', were not allowed to be officially considered at the UN Earth Summit where the Section 18 on water of Agenda 21 (United Nations, 1992) was drafted (Biswas, 2004). Despite this hurdle, as many of the experts were present at both the expert meeting and the Earth Summit drafting sessions, the information was still partially taken into account (Daniell, 2008; personal communication).

The recommendations of the Dublin conference have since been accepted into the common-knowledge sphere of many water professionals and policy makers. The Dublin Principles are (ICWE, 1992):

1. *Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment*;
2. *Water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels*;
3. *Women play a central role in the provision, management and safeguarding of water; and*
4. *Water has an economic value in all its competing uses and should be recognised as a common good.*

Some water experts argue that these principles, and those of Section 18 in Agenda 21, are not a large improvement on the original Mar del Plata Action Plan, especially the economic recommendation, which moves away from the carefully defined recommendation of adopting *'appropriate pricing policies with a view to encourage efficient water use, and finance operation cost with due regard to social objectives'*, and omits the issues of equity and poverty (Biswas, 2004). However, a number of other authors have been more vocal in their support of the principles, in particular of Principle No. 2, on the need for a participatory approach to water development and management (FAO, 2000; Rahaman *et al*., 2004), as it is a base element of the 'Integrated Water Resources Paradigm', which is heavily promoted on an international scale (Ker Rault, 2008).