Chapter 12
Conclusions: The Future of Sustainable Water Management

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Abstract Ensuring sufficient unpolluted water for urban, agricultural, and industrial use is arguably the most important issue facing the world's communities. Countries such as Australia are currently unable to supply enough water to many areas in times of drought, and it is estimated that perhaps a billion people in the Asia-Pacific Region face the prospect of unsafe water at all times. This chapter and book take a new and skeptical look at some of the underlying factors that affect the management of this vital resource and the proposed solutions. Traditionally, water management policies and practices have dealt only with problems of water distribution to meet the ever-increasing demand, rather than better management of existing resources. The largely fragmented approach that results has contributed to the overexploitation of water resources. Nevertheless, in many parts of Australia, China, South Africa, Canada, the United States, Europe, Japan, and elsewhere, efforts are currently being made to better manage water distribution systems using proactive methods instead of simply reacting to supply and demand problems. Proactive management methods include new ways of accounting for water and methods for reducing losses, as well as benchmarking against international high performers. However, there are no across-the-board solutions since context matters and managers must therefore learn from local operating experience. The difficulties experienced by integrative efforts in this situation indicate that a significant part of the problem lies in the structures of governance in the water industry. Water management should be a regional, national, and international level concern, and it is in many places but generally at the level of policy rather than responsibility for infrastructure and pricing of water.

Keywords Demand • Integrated water management • Governance • Fragmentation • Policy

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12.1 Introduction

If we want to correctly determine the future of water management, we first need to understand the existing situation (Somlyody 1994; Gleick 2000; Steiner et al. 2000; Duda and El-Ashry 2000; GWP 2003). This understanding can be obtained through a series of propositions (this is a partial list only, intended to be instructive in the debate regarding the future of water management).

12.1.1 Propositions

- Fresh water is arguably the most important natural resource on Earth, yet it is currently squandered in vast quantities.
- While demand outpaces supply in some parts of the world, in almost all places, water is wasted in inappropriate applications and as a result of inadequate/non-existent/deteriorating infrastructure, especially drinking-quality water.
- The current situation is compounded by the pollution levels evident in many water supply systems and the increasing impact of climate change.
- As the volume and cleanliness of available water supplies decline in many countries, governments must effectively deal with this challenge. Reliable information on availability and use is one of the keys to shaping better policies that provide equal access to and sustainable use of increasingly problematic water resources. However, the need for better policy and governance structures is equally important, if not more so.
- The context of the water management problem matters. Local capacity to ensure effective management is a crucial variable, especially the ability to learn from operating experience (Garrick 2015).

These propositions should be evaluated in the context of a series of scenarios that must be addressed to successfully provide the best conceptual and practical approaches to dealing with the various problems in water demand and supply management.

12.1.2 Scenarios

- The amount of global water per capita is expected to fall to 5100 cubic meters per person by 2025, as the world's population grows from six billion to over eight billion (the Asia-Pacific Region in 1999 had only about 3690 m^3) (Hinrichsen n.d.).
- More than 2.8 billion people in more than 40 countries will face water stress or scarcity conditions by 2025 based on United Nations (UN) population projections (UNEP 2006).
- By 2050, the number of people and countries facing water stress or scarcity will increase, affecting 44 % (four billion) of the projected global population of over nine billion (UNEP 2006).

- Many of the affected people and their communities will be located in the Asia-Pacific Region. Also, despite important recent efforts, 2.4 billion people in this region are still without an acceptable means of sanitation (disposal of waste water), while at least one billion do not have access to clean water now.
- Relating these factors to what appears to be happening on a geophysical level, scientists specializing in climate change issues have attempted to forecast the effect of such changes on global water supplies up to approximately 2080. For example, predictions for Australia and a number of other countries indicate that there will be between 25 and 50 % less surface water in 2080, and a similar situation will exist in many parts of Africa and South Asia. However, water supplies will remain approximately the same in the remainder of Asia (Waldron 2007).
- The resulting complexities mean no permanent solutions may be possible, but there must be a strong effort to develop consistent and reliable diagnostic approaches to the water management problem (Garrick 2015).

If these predictions are accurate, the focus on water management will intensify, especially regarding how to better use the declining resource (Gleick 2000; Steiner et al. 2000; Duda and El Ashry 2000; GWP 2003; Waldron 2007; Garrick 2015). Water demand management rather than concentration on delivery (pipes) must become the foundation of managing water supply systems (Waldron 2007).

12.1.3 The Politics of Water Management

Water scarcity and pollution of existing resources are key issues in many regions. Traditionally, communities have dealt with these problems by focusing mostly on increasing the supply to meet the ever-increasing demand for freshwater from the domestic, agricultural, industrial, and service sectors of the economy. The largely fragmented approach traditionally applied to the management of existing water supplies has promoted conflicts and competition between users (there are predictions of "coming water wars" (Hinrichsen n.d.; Cooper 2013)), neglect of collection and distribution systems, and also contributed to the overexploitation of water resources. Many countries currently face the challenge of overcoming fragmented approaches and designing and implementing integrated water management mechanisms, particularly those that implement projects that transcend national boundaries and those within the major cities.

12.1.4 The Evolution of Water Management Practices

Despite current complications, efforts are being made to better manage water distribution systems using proactive, instead of only reactive, methods to solve problems. These proactive management methods include new ways to account for water and

methods for loss reduction such as new technologies in water pressure control systems, leakage detection, hydraulic data reporting systems, and benchmarking against international high performers. However, the difficulties experienced by participants in these integrative efforts indicate that a significant part of the problem lies in the structure of governance in the water industry. Many places clearly recognize that water management should be a regional, national, and international level concern, but generally they do so only at the policy level rather than in their actions and assignment of responsibility for infrastructure and water pricing.

For example, Australia has experienced policy confusion in the recent drought/wet cycle in Queensland, the ongoing Murray-Darling saga, and failed attempts to lessen or remove the stifling hold of local government on water management. These issues indicate that the politics of water management is one of the primary reasons for problems in the industry. Much of the wastage of water in Australia is a result of the continuation of the historical arrangements for management and delivery. These are carried out by state and local governments that have, in most cases, proven incapable of discharging this responsibility as a result of a "run-to-fail" approach to the maintenance of their collection and distribution infrastructure.

The short-term view adopted by most councilors and their staff as well as state government officials is of major concern for a type of infrastructure that is costly, requires long-term planning and financing, and is largely invisible. Councils tend to transfer income into general revenue and neglect water infrastructure for more visible infrastructure such as roads, even if capital-debt ratios and income from the water supply system allow effective management of existing infrastructure. In addition to this, state governments cannot agree on water allocation rights, solutions for common salinity problems, or the need to maintain environmental flows in the country's major river systems.

The solution to these problems related to the local control of water supplies often involves corporatization of water supply function within the local government. This removes the direct control of councilors and senior managers of council in favor of actual water industry expertise. Full privatization of the industry is another solution, but the few times this was done were not totally successful. Integrated water resources management (IWRM) is critical at the state level but still remains elusive in many respects (Garrick 2015).

12.2 Integrated Water Resources Management

The first issue regarding water demand management is the claim that water that occurs naturally almost everywhere should be available free of charge or at low cost regardless of any supply difficulties (Cooper 2004). This misconception gives rise to emotional and often highly politicized arguments when communities debate questions related to water use, charges, and the location of water supply services such as dams and storage reservoirs. Water has been traditionally viewed as a commodity with little economic value in most countries throughout the world. The value

of water and the costs involved in obtaining it rarely become an issue, even in times of relative scarcity. Therefore, individual and/or community water property rights have always been upheld over conservation needs, even to the detriment of in-stream environmental flows and diminished aquifer storage capacity in river watersheds. Meanwhile, saline intrusion or land subsidence have rarely been viewed as a reason to restrict usage although they may raise the cost of access.

The definition of water scarcity also remains open to debate. Basic economic theory defines scarcity as a point where the supplies of a commodity are lower than the total demand for its use. This definition conjures images for most of situations where freshwater is not available in sufficient quantity to meet the requirements without (unacceptable) radical changes in usage levels and changes in pricing policy. These changes could be designed to promote substitution of treated wastewater for freshwater in agriculture or industry and increase available potable water supplies, yet they are resisted (Kessler 1997).

The remaining concentrations of groundwater and surface water in many parts of the world compound the tendency to assume all water used by communities must be *potable* and cheap. The abundance of supply in some areas, and the use of potable water in industrial and agricultural processes in general, conjures up a favorable situation for all (Hinrichsen n.d.), and therefore, substitutes for potable water are not sought. But, while it is unlikely that many areas will face critical water shortages in the short to medium term, currently relied-upon water supplies are experiencing severe reductions in quality, as seen in Australia. This is economic scarcity (Cooper 2013). Thus, the recent appearance of a desire to address sustainability issues of access, supply, quality, and pricing, along with extensive research into practical solutions for particular supply and distribution problems, is a welcome indication of the recognition that there is a need to address water management problems in the Asia-Pacific Region (as outlined in this volume).

Water supplies in this situation are limited relative to demand at *the price that users wish to pay* (Kessler 1997). This means that some communities may face water shortages because the costs of developing new supplies cannot be funded. Addressing this problem will require basic changes in how community water supplies are perceived and allocated (Kessler 1997; Garrick 2015). A uniform, effective, and comprehensive legal framework covering ownership, supply, pricing, use of water, and disposal of wastewater is an important key to the effective management of these resources in this situation. The framework can be implemented through the development of policies favoring integrated water resources management (see Chap. 2 of this volume).

12.2.1 Governance

Governance of water resources "refers to the range of political, social, economic, and administrative systems that are in place to regulate the development and management of water resources and provision of water services at different levels of society" (GWP 2003). The following issues are important:

- Reliability of information about water resources.
- Level and equitability of access to water.
- Effectiveness of the enabling environment for sustainable water resources management (Garrick 2015). The considerations here include (1) poor enforcement of regulations, (2) problems in the coordination and integration of government agencies, and (3) as a result, weakly integrated water resources management.
- Poor private sector involvement through lack of incentives and integrative policies.
- Participation problems for many stakeholders. Participation is limited to government entities and international organizations, in other words, upward integration, not downward.
- Poor knowledge and understanding of the values and benefits of water, including water pricing, rights, and management technologies (Waldron 2007; Cooper 2013).

The ability to achieve effective system governance is one of the most important yet most complex challenges of integrated water resources management (Conagua 2006). It requires the involvement of all stakeholders in a way that allows them to identify and implement the best possible solutions to water issues that will benefit the majority. Moreover, policy modification is time-consuming, and dealing with many governments requires an understanding of government dynamics, as well as effective persuasion and negotiation skills. Examples of appropriate local governance include neighborhood cooperatives for infrastructure development, local waste recycling schemes, integrated transport plans developed together with user groups, and regional initiatives of state agencies, industrial groups, and residents to control watershed deforestation. At the international level, governance has been viewed primarily as intergovernmental, but it must now involve various nongovernmental organizations (NGOs) and other participants such as businesses. The influence of the important global mass media also interacts with all of these (Conagua 2006).

12.3 The Future of IWRM

Integrated water resources management (IWRM) is “a process that promotes the coordinated development and management of water, land, and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (GWP-SEATAC 2003). It is a political process and involves mediation of conflicting interests (Kataoka 2002; Cooper 2013). The three pillars of IWRM include management instruments, enabling environments, and an effective institutional framework.

In summary, analysis and understanding of IWRM begin by defining a spatial locus within which the critical components interact with and among each other. The most appropriate future locus of analysis and action will be the watershed or

catchment area, because it is a naturally defined and discrete unit of the Earth's surface. More concretely, it is a naturally defined territorial unit surface drainage system and as such is a clearly identifiable ecological unit for interface management between biophysical and human systems (Mitchell 1990).

12.3.1 A Watershed Approach

The concept of integrated water management has been evolving over the past half-century (Duda and El-Ashry 2000). During the 1930s, comprehensive water management projects like that in the Tennessee Valley initiated this evolution (Lundqvist et al. 1985). Mitchell (1990) and the Tennessee Valley Authority (1989) showed that integrated land and water resources management policies are necessary. However, even though many academic publications have addressed this subject, it is difficult to achieve in practice. Although we might see trade-offs among economic sectors, full consideration is often not given to issues such as the needs of environmental flows in a river as distinct from its water load, for example.

Failure to achieve integrated management has been attributed to the strength of government ministries responsible for other sectors that oppose the concept, as well as institutional bottlenecks in implementation (Garrick 2015). Somlyody (1994) showed that community-by-community and sector-by-sector approaches that remain the norm are fast becoming a serious international issue. Experience reveals that many water conflicts stem from the implementation of supply-side projects only and that this contributes significantly to the decline of important ecosystems around the world (Duda and El-Ashry 2000).

Therefore, the largely fragmented approach that has traditionally been applied has allowed conflicts and competition and led to the overexploitation of scarce water resources. Many countries are currently challenged by overcoming fragmented subsector approaches and designing and implementing integrated mechanisms, particularly the implementation of projects that transcend subsectors and discrete areas of local government.

The watershed approach to IWRM refers to the formulation and implementation of courses of action involving, as much as possible of the natural and human resources within the confines of such a unit, taking into account the social, political, economic, and institutional factors operating in order to achieve specific objectives. The concept of water resources management within a water catchment area, with a focus on the integration of land- and water-related issues, has been applied in a range of countries including India, Australia, China, and Japan. In India, for example, national water policy mandates that water resources planning be undertaken for a complete hydrological unit, such as drainage watershed or sub-watershed. In Indonesia, institutions for water resources management have been established for some catchments (watersheds), although these have yet to become fully functional (ESCAP 2000).

The rationale for insisting on a watershed base for future IWRM can be summarized:

- The watershed is a functional unit of water assessment established by physical relationships (Steiner et al. 2000).
- The watershed approach is able to evaluate the biophysical linkages of up- and downstream activities, as part of the hydrological cycle.
- The watershed approach is holistic, which means that the many facets of resource development can be included.
- Water collection and other land-use activities often result in a chain of environmental impacts that can best be examined within this context.
- The watershed approach has a strong economic as well as environmental logic. Many of the externalities involved with agricultural, industrial, and residential management practices are internalized when the watershed is managed as a unit.
- The watershed provides a framework for analyzing the effects of community interactions with the environment. Therefore, the environmental impacts within the watershed can operate as a feedback loop for changes in local social systems and
- The watershed provides a context by which integration relevant to IWRM within the natural and human systems can be better understood. The integration of various sector views and interests relevant to IWRM, thus, becomes more tractable in the watershed context.

Another view of the future of IWRM in the watershed context considers the interaction of resources, population, institutions, and technology. At the core of interactions among the components is governance, as noted above. Governance viewed in this light is the hub that balances and harmonizes the interactions. Therefore, it ensures that the demands of the population are being met without endangering the sustainability of the resources, because technologies, policies, and organizational arrangements are applied and appropriately designed to meet the goals of water resources management.

Watershed organization of water resources can take many forms depending on the size of a watershed, the goals of management, the political requirements of a country, and the existing capabilities of resource management. In Southeast Asia, for example, the river watershed organizations have many different models such as committees, commissions, authorities, tribunals, corporations, foundations, and councils. The future use of such a water resources management framework must focus on understanding the level of participation of different actors, sectors, and organizations, and the manner by which efforts and resources are coordinated and harmonized through the councils and other parts of the governance mechanism. Recent discussions of experiences worldwide have confirmed the need for holistic, transdisciplinary, integrated, and participatory approaches.

12.3.2 The Messages in This Book

Many important points are made in this book about what is required to achieve effective water management in the future, and for this summary, I have chosen a few of the most important. Kato et al. (Chap. 2) note that participatory approaches that feature the broad inclusion of local stakeholders have become a basic requirement in any design for future water resources management. However, actual implementation of an effective form of management plan remains one of today's most difficult challenges. The authors argue that the problem exists because "hard-path" water resources management is the preferred course of action (for fixing infrastructure). However, the future requires a soft-path, adaptive management system that considers all aspects of the integration of resource management (Garrick 2015).

For Setiawan et al. (Chap. 3), environmental assessment is one of the main keys for the design of a local framework of integrated water resources management. They correctly point out that in the future we must deal with land use and climate changes as integral parts of our approach to water resources management and not only concentrate on the technical aspects of water collection, cleaning, and distribution. For them and Budiasa and Hisaaki (Chap. 5), the best way to do this is to involve all stakeholders equally, including local people, in acquiring data, in undertaking strengths, weaknesses, opportunities, and threats (SWOT) analyses, and in making decisions. However, this process will be useful and successful only if it has appropriate financial and legal support.

Somewhat similar messages are given by Budiasa et al. in Chap. 7, Li and Nakajima in Chap. 8, and Han and Qian in Chap. 10. The additional points made are critical. The key issues are not so much about the water, but about the institutional legal water regulatory arrangements, pollution control, and chosen approaches to water resources allocation and management. The implementation of integrated management action plans is as important as seeking new sources of water to achieve the most optimal multifunctionality and effectiveness in water management.

12.4 Conclusions and the Future

Experience demonstrates that technological developments or changes in the infrastructure of the water industry do not succeed without effective policy, institutional, and legal structures to support them (Cooper 2013). Our use of water resources is closely linked with that of all other resources. All must be managed together for biodiversity preservation and community participation area by area, because opportunity costs, social institutions, and environmental requirements are different on a country-by-country basis. The approach of integrated water management was developed to provide a solution to this, but results have been disappointing, since not all economic activities, land use considerations, biodiversity needs, and political debates have become integrated with the water security issue. However, as this

discussion has shown, a more comprehensive approach is now developing at both the national and local levels. This approach may achieve a more strategic implementation of policy reforms, better technical programs for integrated water and wastewater management, and the introduction of projects supportive of a collaborative response to actual or potential water crises that is required around the world.

The responsible use of water requires ensuring the amount withdrawn from a source does not exceed the environment's capacity to renew that quantity or the environment's needs itself, that the resource is equitably and efficiently collected and distributed (shared), and that there are dispute mechanisms available to adjudicate transboundary, overuse, and intergenerational use issues (Kessler 1997). Experience also demonstrates that no technological or infrastructure investments to achieve better collection and distribution will succeed without effective local policy, institutional, and legal structures. Also, domestic water policies and actions must go hand in hand with international policies and relationships as globalization proceeds (Duda and El-Ashry 2000). Effectively addressing the aspects of water supply and demand, land use, ecosystem health, and socioeconomic development in a more coherent and linked framework will facilitate the needed transition to a new development paradigm. We need integrated and holistic policies that will allow steady improvement in water quality and availability standards, without destroying the biological diversity on which our economies and lives rest.

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