



Knowledge Base

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CHAPTER 23

Valuing water

UN DESA

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Failure to properly recognize the full value of water, including its benefits and costs, is one of the root causes of water resources mismanagement and the political neglect of water issues.

A valuation of the benefits of water is essential in order to improve the decisions of governments, international organizations, the donor community and other stakeholders.

Valuation is a powerful instrument for making the public aware of water's many benefits. Without a doubt, it brings the less-visible benefits of water into the public arena.

Providing reliable information on the benefits of water development and water resources conservation will help to convince governments and stakeholders that water needs to be given priority in national policies. Having the right information will help to target investment, make real differences to economies and societies – and so help to eradicate poverty.

Water valuation is central to the water-related decisions of public and private agents. It can help water managers and stakeholders to choose between water supply and demand alternatives and to recognize the options that will improve welfare while simultaneously sustaining ecosystem services. Water valuation also helps water managers to design subsidies, public incentives and economic instruments that respond to current water challenges.

Water valuation is a tool that can be used to shape cooperative agreements to protect and share the benefits of water resources conservation.

More efforts need to be made to analyse the costs and benefits of water and to incorporate this analysis into decision-making. This helps in the move towards more integrated and holistic socio-economic approaches. Ways of looking at the valuation of water have been shifting from a rather limited focus on the economic benefits, to a more comprehensive focus that also takes into account social, cultural and non-market values. Valuation methods need to be chosen and adapted so that they respond better to policy questions and management needs.

23.1 Introducing the issues

Water is essential for human life. It is used in the production of food, the generation of energy and the manufacture of goods. It is vital to the economy and for preserving the structure and functioning of ecosystems and all the environmental services they provide (Box 23.1). The importance of these benefits makes the provision of water services crucially and intimately linked with development, both as an integral part of a strategy for socio-economic progress and as a precondition for holding on to the advances that have already been made.

However, decisions about how water is used and managed and about how scarce resources should be conserved are still being taken using only part of the information on its multiple benefits. The 'non-visible', external and indirect benefits (and costs) of using water are mostly ignored by end users when they decide how much water to use and what to use it for. This is often true of businesses when they make decisions about what to invest in and produce; of farmers when they decide what crops to grow; and of governments and institutions when they make decisions about priorities for water investment, management and allocation.

This lack of understanding of the multiple benefits of water results in water issues being given a low political

BOX 23.1

Categories of economic values

Direct use values: The direct uses of water resources for consumption include inputs to agriculture, manufacturing and domestic households. Non-consumption uses include hydroelectricity generation, recreation, navigation and cultural activities.

Indirect use values: The indirect environmental services provided by water include waste assimilation and the protection of habitats, biodiversity and hydrological functions.

Option values: These refer to the value of having the option to use water directly or indirectly in the future.

Non-use values: These include water's bequest value (passing on this natural resource to future generations) and the intrinsic value of water and water ecosystems, including biodiversity, the value people place simply on knowing that a wild river, for example, exists.

Source: UNSD (2007).

priority. It also causes fragmentation of resources and underinvestment, or overinvestment, in water infrastructure. Ultimately, this results in water being given a low priority in national development programmes and in strategies for reducing poverty. It also leads to inefficiencies in how water is used in the many areas of the economy where it is an essential production input.

Valuation, or 'valuing', is a process that judges the importance of water for human welfare. It refers to all the ways that can be used to identify, assess, measure and eventually assign a value to the importance that each benefit, and potential benefit, has for human welfare. Bringing this knowledge to the policy arena can improve water management in many significant ways. Valuations of the economic and social development benefits of water will push water management issues up the political agenda and will help decision-makers to make informed judgements about development opportunities and challenges. Valuation is also important because there are trade-offs to be considered when examining the various management options. Sometimes using available water for one purpose means forgoing the benefits that another use would bring. Valuation results in information that allows economic efficiency and political and social priorities to be addressed more transparently. It might also have a role in resolving water conflicts by indicating the potential shared benefits that come from cooperating to preserve critical water assets (such as transboundary river basins or common pool underground waters) rather than competing for their use.

23.1.1 Valuing the benefits of water so that it can be made a priority in the political agenda

Water is important for development. But if this is so, why do so many poor countries still lack water infrastructures, have difficulty benefiting from water's productive uses and suffer from poor access to basic sanitation and water supply services?

Part of the answer lies in the fact that most of the benefits obtained from (and the costs incurred by) investing in water and water management are external to the agencies and firms making the investments. Valuation shows that the benefits that countries derive from having water exceed the benefits obtained from the direct productive uses of water. In order to understand this, it is necessary to analyse how the overall productivity of all sectors is constrained by the availability and quality of water facilities (Kemp, 2005).

Better access to and more widespread availability of water expands the productive capacity of the economy by, for example, increasing the productivity of land or labour, and improving the quality of crops, energy and other products. Valuation also shows the

BOX 23.2

Valuing water's indirect benefits to support investment decisions

The Bhakra multipurpose dam system in northern India generated indirect benefits in two ways. First, the inter-industry links that were forged resulted in increases in the demand for inputs from other sectors. Second, the direct outputs of the dam led to higher levels of income, increased wages and generally higher levels of economic prosperity. For every rupee of direct benefit in terms of electricity generated, farms irrigated, water supplied, floods controlled and drought prevented, the indirect benefits amounted to an additional 0.9 rupee. The gains perceived by rural workers were also higher than the gains for other rural and urban households. This showed that one of the benefits of the project was that it led to a more equal distribution of income (Bhatia et al., 2007).

'The multiplier for the Sobradinho Dam in Brazil was estimated at between 2.0 and 2.4 depending on what assumptions are applied to the supply of labour and capital. This means that for every US\$1 invested, there was a total economic return of US\$2 to US\$2.4.'

Source: SIWI, WHO and NORAD (2005, p. 22).

important benefits that improved water infrastructures and services bring to production – having access to water is a cost-effective and safe way of reducing production costs. Farmers' incomes increase substantially when they shift from rain-fed to irrigated agriculture. Hydroelectricity provides energy for production and reduces reliance on expensive fossil fuels. Deliberation on the importance of these direct benefits has supported decisions to invest in multi-purpose infrastructures as an effective way of fostering productivity and saving costs in all the activities to which water contributes as a production input (Box 23.2).

Valuation also highlights the importance of the intangible health benefits of improving basic sanitation and access to safe drinking water. Improved health means fewer lost working days – and increased productivity. The effects of better health can be seen in people living longer and having a better quality of life. Better services contribute to human development by allowing people to look and plan further into the future. They also enhance capacity so that people see the benefits of spending time acquiring an education, in the knowledge that they will have the better health conditions that will allow them to benefit from it into the future.

The World Health Organization believes that half the consequences of malnutrition are caused by

TABLE 23.1

Overall benefits of achieving the MDGs for water and sanitation

Types of benefit	Breakdown	Monetized benefits (in US\$)
Time saved by improving water and sanitation services	• 20 billion working days a year	US\$63 billion a year
Productivity savings	<ul style="list-style-type: none"> • 320 million productive days gained in the 15–59 age group • 272 million school attendance days a year • 1.5 billion healthy days for children under five 	US\$9.9 billion a year
Health-care savings		<ul style="list-style-type: none"> • US\$7 billion a year for health agencies • US\$340 million for individuals
Value of deaths averted, based on discounted future earnings		US\$3.6 billion a year
Total benefits		US\$84 billion a year

Sources: OECD (2010); Prüss-Üstün et al. (2008); Hutton and Haller (2004).

inadequate water, sanitation and hygiene. Providing access to safe drinking water in poor societies is one of the most effective labour-saving measures. For governments to consider just the financial value of health-care savings in their budget decisions, would be to overlook the importance of less visible, but in many cases more significant, economic values (Table 23.1). In poor countries, this is a concern because when the financial benefits are lower than the economic ones, the effort made to improve water services is usually less than what is required for economic development.

Information about the macroeconomic performance of poor countries – measured in gross domestic product (GDP), employment and productivity – has helped to confirm the vital correlation between water and economic development, and the potential that water development has to boost economic growth: Countries without improved water management and access to water and sanitation services, with per capita annual income below US\$750 grew on average at only 0.1% per year, which is equivalent to being trapped in the same level of income, while countries in the same range of income but with better access to water services grew at 3.7%, a rate that, if sustained in the long term, might guarantee their escape from poverty and help them converge to middle income economies (SIWI, WHO and NORAD, 2005).

BOX 23.3

Valuing the effects that water-related diseases have on productivity can improve investment targeting

In a study in 2008, the World Bank presented an estimate of the economic effects of mortality from malaria, pneumonia and acute lower respiratory illnesses in Ghana and Pakistan. The same study also looked at the prevalence of diarrhoea and malnutrition. A human capital approach was applied to quantify lost wages that resulted from environmental factors. The long-term direct and indirect costs in Ghana and Pakistan were estimated at 9.3% and 8.8%, of their respective GDPs. At least half of this impact is attributed to water-related environmental risks.

The 1991 cholera epidemic in Peru was treated at a cost of US\$1 billion, but could have been prevented by expending US\$100 million.

Source: Moss et al. (2003).

23.1.2 Valuing the benefits of water can support pro-poor strategies and better targeting

The benefits of water, when properly valued, show that projects aimed at improving access to basic sanitation and safe drinking water make economic sense. And what is more important, they show that they are effective in promoting equity, in stimulating gender fairness and in opening new windows of opportunity for the poor and for future generations. Valuing the many non-financial benefits of water is essential to enable societies to take advantage of development opportunities, to focus on poverty alleviation and to avoid unsustainable trends in water policy (Box 23.3 and Figure 23.1).

Valuation of the health benefits of investing in water and improving water management shows that providing basic water and sanitation services is essential to halt the poverty spiral of low income, low savings and low investment in human and physical capital. 'Poor people in Africa spend at least a third of their incomes on the treatment of water-related diseases like malaria and diarrhoea. ... The cost of the productive time lost due to these diseases as well as widespread human

BOX 23.4

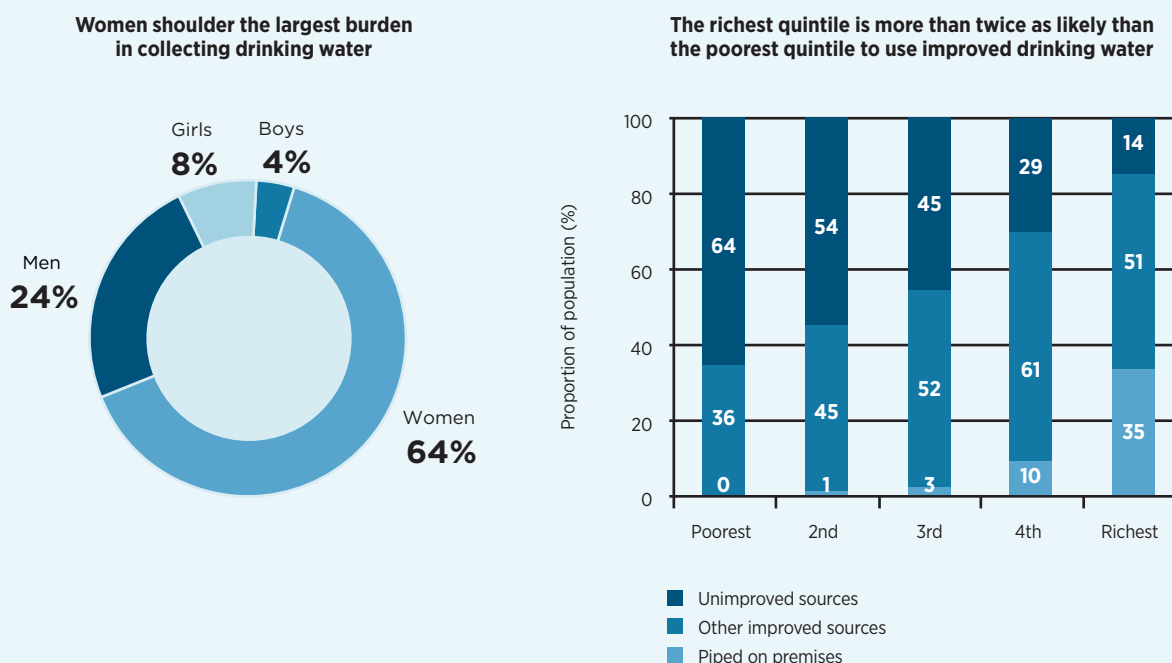
Valuing the benefits of water can define international priorities and target support at the poor

The Copenhagen Consensus sought to compare the costs and benefits of a broad range of development interventions in order to help define international priorities. It did this by evaluating benefit-cost ratios (BCRs) using standardized methodologies across a number of sectors. In 2008, Whittington et al. carried out an exercise on a range of low-cost water and sanitation sector interventions. Not all water and sanitation projects would pass a benefit-cost analysis, especially because of the substantial upfront capital investment required, which yields benefits over a long period. As a result, it is vital to evaluate the costs as well as the benefits of alternative investments, given that different service levels may yield comparable benefits at very different costs.

The Whittington study (2008, p. 3) concluded by stating: 'the key to successful water and sanitation investments is to discover forms of service and payment mechanisms that will render the improvements worthwhile for those who must pay for them. In many cases, the conventional network technologies of water supply will fail this test and poor households need alternative, non-networked technologies'.

FIGURE 23.1

Access to water and potential gains in terms of gender, equity and education opportunities for children. Left panel, distribution of those who usually collect drinking water; right panel, proportion of the population using drinking water piped on premises, other improved drinking water source or an unimproved source, by wealth quintile, sub-Saharan Africa.



Note: For families without a drinking water source on the premises it is usually women who go to the source to collect drinking water. Surveys from 45 developing countries show that this is the case in almost two-thirds of households, while in almost a quarter of households, it is men who usually collect the water. In 12% of households, however, children carry the main responsibility for collecting water, with girls under 15 years of age being twice as likely to carry this responsibility as boys under the age of 15 years. The real burden on children is likely to be higher because, in many households the water collection burden is shared, and children – though not the main person responsible – often make several roundtrips carrying water.

Sources: WHO and UNICEF (2010).

suffering must also be added to this’ (SIWI, WHO and NORAD, 2005, p. 13).

People who do not have access to water from a safe facility that is located nearby pay a high opportunity cost for collecting the minimum amount they need to satisfy their basic needs. Although this cost is not measured in monetary terms, it is effectively paid in terms of lost time, lost school days and lost working days. Making water available to the poor is a means of freeing up human capital that can then be put to creating wealth. A valuation of these benefits justifies the collective provision of water because self-provision for household consumption is proportionally more expensive for the poor than for the rich and represents a heavier burden for women and children. But it is important to understand which interventions will bring

about the greatest benefits, based on levels of service and ability of poor households to pay.

Halting the poverty spiral is generally possible if income earning opportunities for the poor are increased. Improving water supply for productive uses, particularly for food production, would facilitate this (Box 23.5). Agriculture is still the main livelihood and the engine of growth for three-quarters of the world’s poor, who still predominantly live in rural areas. Strategies to reduce poverty need to focus on improving farmers’ incomes and building resilience in this sector. Valuing the impacts of higher yields and the effects of growing a greater variety of crops can help to bring about better poverty reduction strategies relating to the agricultural use of water. Knowledge of the value of higher incomes and the impact of lower food prices

BOX 23.5

Valuing the benefits of sanitation can foster government action and redouble the focus on sanitation

- 2008 was the International Year of Sanitation. This helped to put the neglected sanitation crisis onto the agendas of government leaders, the donor community, and civil society.
- The Sanitation and Water for All initiative aims to encourage donor governments and recipient countries' finance ministers to increase the efforts being made in the area of sanitation.
- Sustainable Sanitation: The Five-Year Drive to 2015 is an advocacy vehicle committed to keeping sanitation high on the political agenda, promoting national coordination and inspiring actors in the sanitation and health fields.

All these efforts are built, to a large extent, on the results of valuation analysis that show the links that sanitation and health have with economic development and environmental sustainability. The crucial information came from the work of the World Health Organization (WHO) (which highlights the important economic benefits of appropriate sanitation actions), and the UN-Water GLAAS analysis of existing drinking water and sanitation financing and its recommendations. Recommendation 1 says: 'Developing countries and external support agencies to demonstrate greater political commitment to sanitation and drinking water, given their central role in human and economic development.'

helps to measure those effects and target strategies appropriately.

23.1.3 Valuing the benefits of water can inform water management choices

Water valuation makes a real contribution by providing relevant information on the value of the different types of benefits and costs attached to the different courses of action open to water managers. Some of these courses of action complement other water and sanitation initiatives, while others are mutually exclusive (Table 23.2).

Each alternative considered on its own can be assessed as an individual project. Nevertheless this information, while useful, is not enough to make a decision. It requires comparing the value of its opportunity costs with the best available alternative. Dams, for example, are used to store water for drinking, irrigation, and

hydroelectricity generation as well as flood management. All these uses provide considerable benefits to society. However, dams have negative effects on the hydromorphological conditions of rivers by modifying aquatic habitats and influencing other valuable ecosystem services downstream. The impact of the value, or the cost, of losing these services must be considered when assessing the overall economic benefits of a dam. It is perhaps even more important to consider the alternative options for storing water, as was done in the case of New York when the city needed to plan a new water supply system (Box 6). Alternatives can include using natural infrastructure such as wetlands, soil or groundwater to store water. Each of these, along with other options, will provide co-benefits such as fisheries, water purification or flood mitigation. In the case of desalinated water, it may be more expensive to produce but its provision is more dependable. The cost of provision, however, needs to be compared with the full cost of using alternative sources of water. This comparison should include environmental costs that would not occur if the overuse of resources were prevented.

The relevant comparison of opportunity costs and benefits that are either obtained or foregone with each management option in the decision-making process are varied and context specific – for example, when considering how new infrastructure projects may (or may not) be more beneficial than demand-management options for ensuring water security. Demand management may be the most cost-effective way of increasing available water, but existing arrangements may make it financially unviable for water distribution managers. Managers will 'sell' fewer services, and so get a reduced income. With price caps on water services and no support from governments, this may affect the funding that is available for the operation, maintenance and replacement of infrastructures – and the viability of the services themselves.

When assessing alternative courses of action, it is also important to consider that the market price cannot capture the full range of benefits that water brings to people and economies. Benefits and costs that affect peoples' welfare through, for example, water pollution and exhaustion, are often absent in the balance of costs and benefits that individuals and firms take into account when making decisions. For example, when judged on the basis of their own interest, using groundwater may be financially cost effective for farmers. But it can exhaust water supplies and transfer the

TABLE 23.2**Types of benefit attached to different water and sanitation interventions**

Investments options	Types of benefit
Providing access to safe water and sanitation	
<p>Providing access to safe water near the home</p> <ul style="list-style-type: none"> • Building water access point • Building and operating water treatment plants • Providing point-of-use water treatment methods <p>Providing access to sanitation and hygiene</p> <ul style="list-style-type: none"> • Building sanitation facilities • Promoting the adoption of hygienic practices <p>Wastewater collection and transport</p> <ul style="list-style-type: none"> • Collecting wastewater via sewerage networks • Collecting and transporting pit sludge outside the home 	<p>Health benefits</p> <ul style="list-style-type: none"> • Reduced incidence of waterborne diseases (e.g. diarrhoea) and of water-washed diseases <p>Non-health benefits/economic benefits</p> <ul style="list-style-type: none"> • Time saved for productive activities • Reduced coping costs <p>Economic benefits</p> <ul style="list-style-type: none"> • Increase in productivity • Use of urine and faeces as economic input • Impact on tourism from improved amenity <p>Other benefits</p> <ul style="list-style-type: none"> • Increases in overall cleanliness, dignity and pride • Increased school attendance, especially for girls
– downstream, in wastewater treatment for safe disposal	
<ul style="list-style-type: none"> • Building and operating wastewater treatment plants • Ensuring safe disposal of residual sludge • Relying on natural treatment processes 	<p>Health benefits</p> <ul style="list-style-type: none"> • Reduced incidence of waterborne diseases (e.g. diarrhoea) and of water-washed diseases • Benefits from improved recreational waters <p>Environmental benefits</p> <ul style="list-style-type: none"> • Reduced eutrophication <p>Economic benefits</p> <ul style="list-style-type: none"> • Reduced pre-treatment costs downstream (for drinking water and industrial purposes) • Protection of commercial fish stocks and aquaculture • Enhanced tourism activities • Increased water supply for irrigation • Saving of fertilizers through use of sludge <p>Other benefits</p> <ul style="list-style-type: none"> • Recreational benefits • Increased property values
– upstream, in managing the supply/demand balance sustainably	
<p>Protecting water resources</p> <ul style="list-style-type: none"> • Establishing catchment protection zones • Establishing voluntary agreements • Establishing regulations <p>Increasing and ensuring supply</p> <ul style="list-style-type: none"> • Building storage capacity • Building abstraction capacity • Developing alternative sources, such as aquifer recharge, desalination, re-use of treated effluent • Adopting drought management plans <p>Managing demand</p> <ul style="list-style-type: none"> • Reducing leakage (on the network and within customers' premises) • Introducing incentive pricing • Installing water-saving devices • Raising awareness and educating the public 	<p>Environmental benefits</p> <ul style="list-style-type: none"> • Reducing pressure on available resources (especially groundwater) and improving river flows • Economic impact on use of water for economic activities (agriculture, hydropower) <p>Economic benefits</p> <ul style="list-style-type: none"> • Reduction in water pre-treatment costs • Uninterrupted supply for production processes • Downsizing of facilities • Reduced need for desalination (energy savings) <p>Other benefits</p> <ul style="list-style-type: none"> • Increased quality of life due to reliable water supply • Indirect benefits (e.g. linked to recreational activities on dams)

Source: OECD (2011).

costs to other water users. Where short-term profits are higher than real economic costs, boom and bust outcomes result, and sustainable development may be undermined. There are many examples of much effort having been put into building water infrastructures that eventually became useless when water resources were exhausted.

The external costs incurred by the overuse and degradation of water resources often remain ignored until a crisis is reached – by which time the value of the infrastructure itself is usually reduced and is compromising the sustainability of services. If institutions governing water fail to properly manage its use, there is a danger of market incentives favouring short-term financial benefits at the expense of the integrity of the resource base and its long-term economic value. Worldwide evidence of the overexploitation of surface water and groundwater unveils this fact. It is expected that by 2025, 1.8 billion people will live in countries or regions with absolute water scarcity and two-thirds of the world population could be affected by water stress conditions (UNESCO–WWAP, 2006). In many places, society has been willing and able to go further with investment opportunities where the short-term financial returns for water users are transparently inferior to the economic benefits that will be available as a result of long-term sustainability.

23.1.4 Valuing non-market benefits can prevent critical ecosystem services from being neglected

Ecosystem services are the benefits, or services, that ecosystems bring to people. Drinking water, water

BOX 23.6

Balancing benefits and costs when assessing water management options: New filtration infrastructures versus water catchment protection in New York

‘Presented with a choice between provision of clean water through building a filtration plant or managing the watershed, New York City easily concluded that the latter was more cost effective. It was estimated that a filtration plant would cost between \$6 billion and \$8 billion to build. By contrast, watershed protection efforts, which would include not only the acquisition of critical watershed lands but also a variety of other programs designed to reduce contamination sources in the watershed, would cost only about \$1.5 billion.’

Source: Daily and Ellison (2003).

for food production and the generation of hydroelectricity are all ecosystem services – as are other often neglected services such as nutrient recycling, climate regulation, cultural and recreational benefits and flood mitigation. Most of the decisions that have to be taken are actually about maximizing one particular service, often at the expense of others. In this way, water decisions nearly always involve trade-offs. The objective should be to optimize the delivery of multiple inter-related ecosystem services. The purpose of effective valuation is two-fold. First, to identify and recognize what services are involved in the trade-off (even if they can't be valued). And second, to quantify values as much as possible in order to assist in calculating trade-offs.

Some of the non-market services provided by ecosystems can be relatively easily quantified and generate substantial values. Examples include the value of ecosystems such as wetlands in flood mitigation, and forests in sustaining drinking water quality. It is the growing recognition of these values that is motivating greater interest in the restoration of these services. Valuation has often shown that conserving ecosystems, or reversing their degradation, is not only a sustainable ecological alternative (very often with multiple benefits), but is also economically beneficial.

Valuation essentially provides evidence that economic benefits are relinquished when policy, management and investment cause avoidable environmental degradation. For producers of goods and services who use water directly, water prices and costs are the basic criteria for water-use decisions. But prices often do not reflect the real production costs or economic value of water. In particular, prices often do not reflect the decline in the natural capital stocks that support the production of all ecosystem services. Therefore, decisions taken on infrastructure investments are disconnected from what is efficient and sustainable for the economy and the environment as a whole.

Better awareness of the issues and more sharing of information on the economic benefits of maintaining or restoring natural capital is also important when trying to reach collective agreements and when trying to design financial incentives that align individual behaviour with the common good. Valuation and better communication of the costs and benefits are crucial for taking better individual and collective decisions on the use of water.

BOX 23.7

Valuing non-market ecosystem services in the European Union can inform decisions on environmental objectives in planning processes

In the European Water Framework Directive, valuing the costs and benefits provides the information required to assess whether the opportunity cost of improving water bodies – is disproportionate compared with the potential socio-economic and environmental benefits, and to then decide on the precise objectives and timing of measures to improve water status in the river basin management plans. It is widely accepted that in many water bodies there are more welfare gains to be obtained by improving the ecological status than by allowing their further degradation.

There are now a number of examples that demonstrate the benefits of environmental improvements and influence water planning and decision-making (Box 23.7).

23.1.5 Valuing to assess trade-offs in water allocation decisions

Water ecosystems have only a limited ability to continue to provide water services to the economy. So it is important for economic growth that water is used well and allocated to its various uses efficiently. Competition can be managed and degradation prevented by having sufficient accurate information about the economic, social and environmental value of water in its various uses. This will also help with re-allocating water so that it provides greater benefits to the economy and to society. There will be trade-offs to be considered too and decisions to be taken about which benefits to forgo when using water for one purpose instead of another.

In a world of scarcity, the valuation of water productivity in agriculture also needs to be considered. Information needed by governments so that they can assess whether water is being used for low-yield crops in water-scarce areas – and if so, determine alternative crops or uses that would make the greatest contribution to the economy. Such a valuation provides a database that farmers can use to make informed decisions about investing in improved infrastructure and crop varieties, and that governments can use to target their investment and to formulate incentives for improving efficiency in water use.

Legal frameworks and institutions need to be set up and better ways of allocating water need to be found. These need to be done using principles – such as equity and efficiency – that may be politically difficult to implement in practice. There is also a need to improve the mechanisms that deliver desired objectives to a range of diverse stakeholder interests (Box 23.8). If there are institutional arrangements that allow water to be allocated to where its use is most valuable, this may help in drawing up mutually beneficial allocation agreements. Establishing legal frameworks for decentralized water management is the type of institutional arrangement that has become important in many water scarce countries. These can be used to implement economic instruments such as water trading, licences and rights to use water. Water trading has developed in countries such as Australia, the United States, India, Chile and Spain (Box 23.9).

BOX 23.8

Stakeholder-oriented valuation can support allocation decisions water management in Tanzania

In the United Republic of Tanzania, some areas face severe water scarcity. Demand for water has been growing and there is conflict between the energy and irrigation sectors, between these sectors and conservationists, and between upstream and downstream users. In 2005, the government established a legal framework that decentralizes water management and increases stakeholder involvement by including local catchment area committees, river basin associations and water-users associations. A participatory approach to water valuation – through surveys, data collections and workshops to analyse data and results – was implemented to enable local stakeholders to engage in implementing IWRM.

Indicators for economic, social and environmental values were considered including crop water productivity in different zones, value across all water sectors, income from water-related production activities, food security (including the nutritional value of crops), access to drinking water, conflict over water, environmental base flows and environmental changes. The valuing process supported decisions to change to crops that use less water, to improve capacities to increase water productivity, to review existing water rights and the training of water-users associations, and to coordinate farmers' own marketing of agricultural products in order to increase income and improve stability.

Source: Hermans et al. (2006).

23.1.6 Valuing water can help to contain water conflicts and promote cooperation in preserving water resources

In the context of access to critical transboundary water resources, valuing can inform governments about the advantages of cooperation instead of competition or conflict. Working towards a common vision of the value of shared water resources is a powerful instrument for finding a way in which agreements in international disputes over water can be self-enforced.

Countries are more likely to cooperate when the net benefits of cooperating are perceived to be greater than those of non-cooperation – and this is even more

BOX 23.9

Valuation of scarcity in water markets

Values associated with water can be observed directly through market activity in arid regions where there is trading, where water is fully allocated and where irrigation is under pressure from municipal, industrial and, in some cases, environmental, demands. There are some basins where rights to use water are defined, enforced and tradable. Market prices in examples in the United States (in California's Central Valley, Colorado's South Platte basin and Nevada's Truckee River basin), and in Australia (in the Murray-Darling basin) confirm that the value of water use varies considerably and that it is driven by variations in market conditions and supply.

Data suggest that in many river basins, market transfers are happening in line with the agricultural value of water, but at a rate that's below the value of water to the domestic consumer or industrial user. Markets that don't have significant urban demand see prices that reflect the agricultural production value of water, which is calculated as the difference in the price of irrigated versus dry land. Where there is significant urban demand, prices are driven by this and shaped by the cost of transferring the water to urban use through conveyances and so forth.

Market values for permanent water rights acquisitions are roughly one order of magnitude greater than the prices for temporary allocations. From this it can be deduced that capitalization rates will be roughly on the order of magnitude expected given current costs of credit. The market value of water is intrinsically regional, or even local, because physical limitations constrain the scope of cost-effective trade. As a result, price observations from one context may have little relevance in another.

Source: Aylward et al. (2010).

likely when the sharing arrangement is perceived to be fair. The advantages of cooperation and collective action are easier to see when the benefits can be made visible to each one of the parties (Box 23.10).

Valuing provides key information that allows stakeholders to move towards cooperative agreements. It also enables the creation of benefits for all those involved in providing solutions. For example, valuing the benefits that water catchment protection can have in securing adequate supplies of quality water can open up solutions that were not envisaged. This can include cost saved by reducing the need for downstream treatment. Protecting watersheds also leads to a broad range of positive environmental effects on the quality of water in water bodies, in groundwater resources, in soil resources and the quality of water available for vegetation and for native flora and fauna.

23.1.7 Valuing water to design appropriate subsidies and targeted financing

Despite the substantial economic returns involved in providing water services to households, to industry and for food production, the basic water needs of people in many poor countries are still not being met. This is a result of a combination of the inability of individuals and business to pay and too few financial incentives to invest in the required facilities. These are key reasons why decisions should be taken to give water operators and community service providers better access to loans and well-targeted subsidies (Box 23.11).

BOX 23.10

Valuing benefits supports cooperation in international river basins

Benefit-sharing agreements exist for various international rivers, including the Danube, the Niger, the Okavango and many others. The Organization for the Development of the Senegal River was created in 1972. Disagreement about the competing rights of Mali, Senegal, Guinea and Mauritania was no impediment to the four countries reaching an agreement to share the benefits of various river projects. A common knowledge of the benefits was essential for building an institutional framework: 'the development of multi-purpose water resources infrastructure is expected to yield expanded opportunities for growth, reduced immigration and poverty, and improved health and livelihoods of the population while also preserving the environment' (World Bank, 2009, p. 12).

Valuation can help to identify when it is justifiable to charge water fees that are lower than full cost of recovering the investment.

Valuation can also give society crucial information that can be used to find practical solutions that ease the transition from the subsidized tariffs that are designed to stop poverty spirals, to a set of self-financed services that make water services financially sustainable.

In many poor countries, only a small portion of the benefits of water services can be funded entirely by the public or by private organizations. On purely financial grounds, providing water is not an attractive opportunity for private businesses. This can lead to poor maintenance and the deterioration of privately run water infrastructure and basic services. The consequence of this is a vicious downward spiral of underinvestment leading to poor service that undermines the ability to capture adequate revenue to operate, maintain and invest in systems (Figure 23.2).

BOX 23.11

Valuation can support the design of subsidies and targeted financing

There are economic benefits to be had from improving access to basic sanitation and safe drinking water. The benefits of irrigation have been estimated by the World Bank to yield average rates of return of 20%. However, financial problems and mismanagement can lead to the downfall of many irrigation systems. The prices of agricultural products have been falling and some investments are now less financially viable. There may be a need to stabilize the income of poor farmers who are subsisting below a certain income level and who are exposed to regular drought and crop insecurity.

Valuing the social and environmental consequences of abandoning financially unsustainable systems has found that there should be support for the implementation of financial packages and other capacity building programmes (such as record keeping and the collection of fees) by international donors. Donor resources that are already in place are being redesigned to help attract other resources and investment. They are also focusing in providing funding to bridge the gap between investment in infrastructure and income generation. This supports the development of local capital and financial markets including microcredit initiatives and local banks and is consistent with the aims of output-based aid.

Source: Grimm and Richter (2006).

Changes in the provision and management of water from being mostly self-collected to being a communally provided set of water provision services might mean that people have more time and better health. But they still won't have enough money to pay the financial cost of the services they get. In the first stage of this, even if the valuation exercise shows that the expected economic benefits are undeniable (particularly for the poor) people cannot afford to pay the full financial cost of the service. So in the absence of a collective action, they will continue without access to basic sanitation and safe water.

But improvements in water access might not be sustainable in the medium term if society and water institutions are not able to manage the transition from the initial stage (where the priority is to improve access to basic services) to an advanced stage where the financial sustainability of providing water needs to be ensured. New ways have to be found to transform the new opportunity of improved access to water into effective education, crop diversification or earning prospects for the poor.

Valuation is useful for determining what economic incentives are required to align individual behaviour with collective targets and objectives. For example, valuing less-visible non-market ecosystem services can provide clearer indications of the value of preserving or restoring ecosystems. Such valuation can be simpler than is often thought. For example, the loss of an ecosystem's ability to deliver clean water can be estimated from the point of view of the cost of rectifying the problem artificially (for example, the cost of artificial water treatment) or from the point of view of the economic cost of living the consequences of poor quality water (for example, a fall-off in productivity, higher health-care expenses, etc.). In many instances, the absence of an ecosystem service is already generating an economic, and often direct, financial cost. Identifying where benefits arise and costs are incurred helps to ascertain how costs can be transformed into incentives that will bring more efficient economic outcomes (Box 23.12).

23.1.8 Valuing can support decisions on what measures to take to improve water security

There are increasing demands on water and less-predictable rainfall patterns and water flows (including a higher frequency and intensity of extreme events such as floods and droughts). So better water security and more-resilient management options have an

increasingly higher value. Valuation approaches should factor in and provide information on the benefits, or risks, of increased or decreased water security. When done effectively, they should shed light on the costs and benefits of more resilient management options. The information that a valuation approach provides about the changing values of water in its various uses can be vital for implementing adaptive planning and management. It can also help to prevent inappropriate uncontrolled individual responses to risk and uncertainty.

Management that makes water supplies secure has a critical role in making the benefits of development more predictable. Poor and water-scarce societies that are now trying to establish systems to supply water and basic sanitation services are faced with the potential adverse effects of climate change (World Bank, 2010; Danilenko et al., 2010; Box 23.13).

Collective decisions on measures that will increase water security and facilitate the financial resources to do so cannot be properly informed without a proper valuation of the benefits and costs. Valuation can

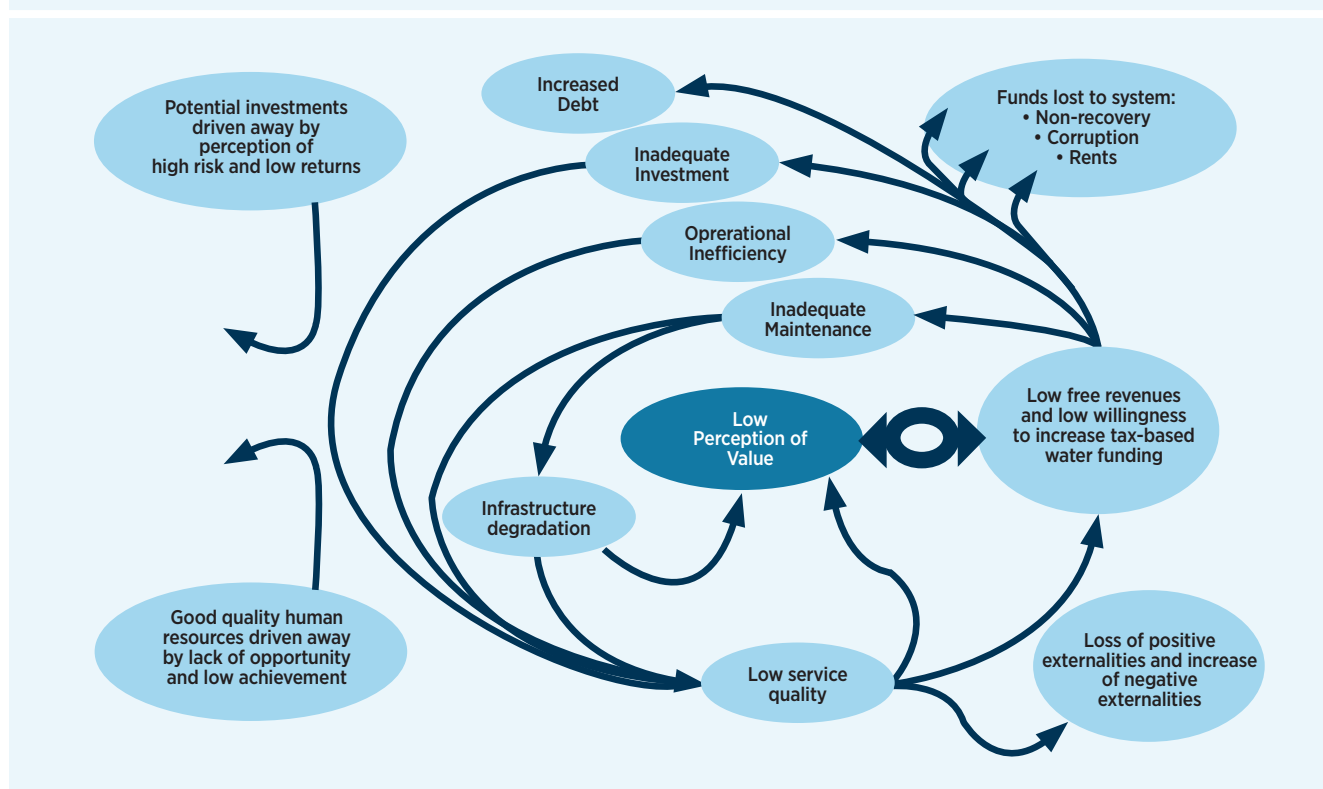
improve the accuracy of the information that private and public agents use to take better-informed decisions with full knowledge of the costs involved. Water storage schemes and infrastructure, water conservation programmes and improvements in efficiency are all examples of the kinds of measure that are already considered beneficial, but which are even more valuable in a climate stress context. Other measures, which need only be considered in the face of uncertainty, may include the diversification of water sources (such as desalination and non-conventional sources), the upgrading of storm water systems, the reversal of coastal developments to reduce exposure, the recovery of floodplains for flood protection and the recovery of aquifers for buffering security stocks.

Valuing can provide valuable information on the capital and maintenance cost of these various options. And it can also give an insight into the benefits and opportunity costs involved in water security and other ecosystems services.

Economic incentives can have a role in enhancing adaptive capacities. When water supply and quality

FIGURE 23.2

The vicious spiral of low funding



Source: Adapted from Moss et al. (2003, fig. 4, p. 13) by J. M. Moss.

vary unpredictably over time and from location to location, stakeholders and water users might be more efficient than public authorities in finding the most cost-effective and appropriate answers. For example, valuation can support water trading and the design

BOX 23.12

Valuing compensation payments for environmental services in China

China's ecological compensation mechanisms are a modern variant of traditional government payments to providers of ecological services. The government transfers money and compensates land owners (or land users) for specific actions that produce environmental benefits. There are various applications of the eco-compensation approach. These include compensation paid to residents living near water sources or reservoirs to migrate to other areas, subsidies paid to sewage treatment plants, compensation to support the forestry sector in upstream areas and payments to farmers to compensate for lost production caused by reducing the use of fertilizers and pesticides.

At the central government level, China has developed and implemented some of the largest public payment schemes for ecosystem conservation in the world. These schemes include the Sloping Land Conversion Program (SLCP), the Natural Forest Protection Project (NFPP), and the Forest Ecosystem Compensation Fund (FECF). The SLCP (also called the 'Grain for Green' program) was initiated in 1999 to restore natural ecosystems and mitigate the adverse impacts of farming in previously forested areas or marginal land. Farming these lands resulted in flooding, the sedimentation of reservoirs, and dust storms. Farmers who enrol in the scheme receive payments for seeds, seedlings, and management expenses. It is one of the largest public transfer schemes in the world, reaching some 30 million farms spread over 7 million hectares (ha) of cropland. It disburses around US\$8 billion per year. The FECF programme targets the management of privately owned forests. It compensates land owners for the ecosystem services provided by their land and for the land and resource use restrictions that are subject to when they participate in the programme. The scheme currently covers 26 million ha in 11 provinces, and costs the government about RMB 2 billion (\$253 million) annually – of which about 70% goes to farmers, who are paid an average of US\$9 per hectare. Local governments are encouraged to provide additional funds. In December 2004, the FECF was extended to the entire country. It covers key state-owned non-commercial forests, as well as woodlands in areas that are at risk from desertification and soil erosion.

Source: Jian (2009).

and implementation of a weather-based insurance scheme that may provide incentives to invest in water saving and make water allocation and reallocation decisions acceptable, and adaptable. Such a scheme may be contingent on changes in water supply and the stabilization of income and economic output.

The extent to which some of these measures need to be taken depends on how individuals and governments value the increased security they provide. It also depends on how they value the benefits that have to be foregone in each case. A higher aversion to uncertain events means a higher risk premium – that is to say, the more people fear exposure to extreme events, and the more likely these events are seen to be, the more people will be willing to pay for insurance. Valuing the private willingness to pay to increase security is an important step in judging the extent to which available measures would be financially viable.

Valuing provides reliable evidence of the potential damage and reduction in welfare that may result from leaving risk responses to spontaneous individual answers instead of implementing collective and more comprehensive anticipatory responses to water variability and climate change. Leaving risk response to individual efforts to defend and maintain production

BOX 23.13

Valuing the economic losses of droughts and the effects of climate change can make the case for political action

In Kenya, droughts occur on average once every seven years. Their economic cost (as was the case on the 1999–2000 drought) was equivalent to one-sixth of the gross domestic product (GDP). This figure suggests that if the country could decouple its economy from rainfall variability, its annual economic growth could increase by 3.5% (SIWI and WHO, 2005).

Nicholas Stern's review, *The Economics of Climate Change* found that climate change had a significant impact on economic output. In a baseline climate-change scenario, the review estimated that climate change would be responsible for a 2.5% loss in GDP in India and South East Asia by 2100, and would cause a 1.9% loss in GDP in Africa and the Middle East over the same period.

Source: Stern (2007).

activities could lead to the extension or intensification of existing vulnerabilities. Spontaneous answers from people, businesses, and farmers in rural communities depend on their perception of value and risk, the options available to them and their individual economic incentives. The lack of a planned and coordinated response to increased scarcity and risk will favour individual answers that do not necessarily produce the best or most sustainable outcomes. For example, they may add more pressure to cultivate marginal land or adopt unsustainable cultivation practices because erratic rainfall has made yields drop. All of these possibilities could reinforce water scarcity and land degradation and endanger the biodiversity of both wild and domestic species. They might also increase vulnerability and jeopardize the ability to respond to climate and other risks later on.

Showing the difference between the financial and economic costs and benefits of alternative actions is a useful way of underlining the importance of a planned, anticipatory and coordinated response to water management challenges. Collective actions instead of spontaneous individual responses are required as well as implementing risk management options instead of coping with the consequences of extreme events and adapting to negative

trends. Valuation may play a critical role in showing the advantages of cooperation, leading to better responses and higher security, instead of individual actions.

23.2 Challenges for Valuing water

Many valuation methods already exist and, have been tested in a variety of situations and contexts that are relevant for policy decisions. Water valuation methods vary according to how they obtain information about the importance that people give to water benefits.

In spite of its relevance to policy and in spite of the growing number of successful examples, valuation is still controversial. Among the issues most commonly discussed are: the usefulness of the various valuation approaches for any specific decision problem; the robustness of the results provided by valuation exercises; the comparability of costs and benefits when both are obtained from different sources, at different geographical scales and with different valuation methods (UNSD, 2007 and Chapter 8).

Water valuation is still challenging because data is often not available and is expensive to collect and because assumptions sometimes need to be made to overcome the absence of relevant information. Water

TABLE 23.3

Valuation techniques for water

Valuation techniques	Comments
1. Water as an intermediate input to production: agriculture, manufacturing Residual value Change in net income Production function approach Mathematical programming models Sales and rentals of water rights Hedonic pricing Demand functions from water utility sales	Techniques provide average or marginal value of water based on observed market behaviour.
2. Water as a final consumer good Sales and rentals of water rights Demand functions from water utility sales Mathematical programming models Alternative cost Contingent valuation	All techniques except contingent valuation provide average or marginal value of water based on observed market behaviour. Contingent valuation measures total economic value based on hypothetical purchases.
3. Environmental services of water: waste assimilation Costs of actions to prevent damage Benefits from damage averted	Both techniques provide information on average or marginal values

Source: UNSD (2007, table 8.1, p. 120).

benefits are usually site-specific and cannot be easily transferred from context to context. Methods and assumptions are not standardized and uncertainty in the numerical results obtained may be quite high. Valuation methods have been developed in response to these limitations and the results are validated by extensive scientific research. However, the assumptions, the numerical results, and the limitations on how valuation results can be used to assess policy options, are still difficult to communicate to stakeholders.

Decision-making contexts have favoured valuation methods and results that are less controversial in that they do not involve sensitive value judgments and are easier to communicate to stakeholders (Table 23.3). These are methods where, in the main, results are initially obtained from directly observed behaviour in existing markets – rather than from laboratory tests or chosen experiments in implicit markets and artificially created decision environments. They are also methods that can make the best possible use of the information that is already contained in existing market prices to derive the value of other water benefits. Examples of contexts where these methods have been used are welfare measures such as averted costs (for example measures to value the costs that were avoided when clean, safe drinking was obtained); averted damage (methods to value the flood mitigation services provided by the environment); the residual value (methods to show how crop yields and farmers' incomes increased when irrigation was made possible); and avoided treatment cost (from the water purification services provided by the natural water course instead of by manufactured systems). These methods provide useful information about three important categories of water benefits: water as an intermediate input to produce other goods, water as a final consumer good and the environmental services of water.

Considering values and specially value perspectives is of great importance in implementing measures – especially measures related to adapting to climate change because these will necessarily mean a change to the status quo. Managing participatory decision-making is becoming increasingly important. In practice, valuation and the consideration of value perspectives are fundamental when balancing trade-offs. They also support decision-making processes where compromises need to be reached between different stakeholders – especially when managing water demands and allocation decisions (Hermans et al., 2006).

There is a need to develop valuation frameworks that can be used in information gathering and policy-making. The links between ecosystems and human well-being are complex. A basic conceptual framework has been developed by the Millennium Ecosystem Assessment that provides a logical structure for the analysis and valuation of ecosystem services (Millennium Ecosystem Assessment, 2005). Including information on the value of water in water accounting frameworks would be an important step forward. The UN Statistics SEEAW framework (System of Environmental-Economic Accounts for Water) provides such an integrated information system to study the interactions between the environment and the economy (UNSD, 2007). It can provide the basis for progress, specifically because it covers the stocks and flows associated with water. There is also a need for further adaptation of valuation methods so that they can better respond to policy questions and management needs.



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