MAKING WATER A PART OF ECONOMIC DEVELOPMENT

The Economic Benefits of Improved Water Management and Services

A report commissioned by the Governments of Norway and Sweden as input to the Commission on Sustainable Development (CSD) and its 2004–2005 focus on water, sanitation and related issues.

SIWI

Contents

List of Tables

List of Figures

List of Boxes

Photo: Dr. Katrin Teubner

Note to the Reader

For the 13th meeting of the Commission on Sustainable Development (CSD–13) the Norwegian and Swedish Governments commissioned the Stockholm International Water Institute (SIWI) to produce the report entitled Making Water a Part of Economic Development: The Economic Benefits of Improved Water Management and Services. A collaborating partner for the report has been the World Health Organization (WHO).

In making its case, the report focuses on the economic benefits of actions that address the insufficient supply of water and sanitation services and inadequate water resources management. The report also brings to the forefront direct and indirect costs related to inaction, the costs of action and cost-benefit comparisons.

The authors of the report were Mr. Mark Sanctuary (Consultant) and Mr. Håkan Tropp (SIWI). The contributing author was Ms. Laurence Haller (WHO). The authors are indebted to the special input provided by Mr. Jamie Bartram and Mr. Robert Bos (WHO), Mr. Hans-Olav Ibrekk (The Norwegian Agency for Development Cooperation, Norad) and Mr. Anders Berntell (SIWI). Graphic and editorial services were provided by Ms. Stephanie Blenckner, Ms. Maria Stenström and Mr. David Trouba of SIWI.

SIWI graciously acknowledges the Norwegian and Swedish Governments' support for their financing of the report. The views expressed in this report are the responsibility of the authors and do not necessarily reflect the views of the Norwegian or Swedish Governments and WHO.

This report is a continuation of work prepared for CSD-12 by the Norwegian Government: S. Hansen and R. Bhatia (2004) Water and Poverty in a Macro-Economic Context. The report also draws upon a companion report for CSD-13 entitled Sanitation: The Compelling Case to Address the Crisis.

Five Important Messages

Photo: SIWI

Good business: that's what investing in improved water and sanitation and water resources management is for national economies and poor people. What's more, the greatest economic benefits of such investments will be felt in those countries with the greatest water challenges.

If followed, five urgent but realistic investment messages to public and private sector decision makers can help make water truly a part of economic development.

Message 1

Improved water supply and sanitation and water resources management boosts countries' economic growth and contributes greatly to poverty eradication.

- Among the world's poor countries, those with access to improved water and sanitation services experience greater economic growth. Poor countries with improved access to clean water and sanitation services enjoyed annual average growth of 3.7%. Poor countries with the same per capita income but without improved access had an average annual per capita GDP growth of only 0.1%.

Message 2

The economic benefits of improved water supply and – in particular – sanitation far outweigh the investment costs, surprisingly good news for Northern and Southern decision makers who often view investments as mere costs.

- Economic benefits ranging from USD 3 to USD 34 per USD 1 invested (depending on the region and technologies applied) would be gained in the health, individual and household, and agricultural and industrial sectors if the water and sanitation MDG targets are achieved. Furthermore, benefits of sanitation investments often are greater than those for water interventions.
- In aggregate, the total annual economic benefits of meeting the MDG on water supply and sanitation accrue to USD 84 billion.

Message 3

National economies are more resilient to rainfall variability, and economic growth is boosted when water storage capacity is improved.

- Decoupling an economy from rainfall variability promotes gains in GDP. In Kenya, which has a water dependent economy, the 1997–98 floods and the 1999–2000 drought provide a tantalising "what if". The floods cost the country at least USD 870 million, or 11% of GDP; the drought, at least USD 1,4 billion a year, or 16% of GDP. On average, the country experiences a flood that costs about 5.5% of GDP every 7 years and a drought that costs it about 8% of GDP every 5 years. This translates to a direct long-term fiscal liability of about 2.4% GDP per annum. This means that Kenya's GDP annually should grow at a rate of at least 5–6% in order to start reducing poverty. In 1996, a good year in Kenya, real GDP growth was 4.1%.
- Measures of improved water resources management have considerable economic gains – a USD 15–30 billion investment in improved water resources management in developing countries can have direct annual income returns in the range of USD 60 billion. Every USD 1 invested in watershed protection can save anywhere from USD 7.50 to nearly USD 200 in costs for new water treatment and filtration facilities.

Message 4

Investing in water is good business – improved water resources management and water supply and sanitation contributes significantly to increased production and productivity within economic sectors.

- Meeting the MDG on water supply and sanitation will gain 322 million working days per year, and the annual global value of adult working days gained as a result of less illness would be almost USD 750 million. The biggest

Photo: Mats Lannerstad

potential gain for increased productivity and production within both households and economic sectors is found in the total convenience time saving – water collection and sanitation access time saved due to improved access – it amounts to USD 64 billion.

- Providing reliable and sufficient water supplies is critical for business development and reduces investment risk. For example, a study in China points at the considerable gains that can be made by improved water quality. The industrial income lost due to water pollution amounted to USD 1.7 billion in 1992 alone. What is now becoming increasingly clear to many governments is that reliable access to water resources is a competitive advantage and attracts business opportunities.

Message 5

The overall public and private investment needs for improved water supply and sanitation and water resources management are considerable. However, at the country level, meeting such investment challenges is highly feasible and within the reach of most nations.

- Global estimates indicate that an additional annual investment of USD 11.3 billion is required to meet the MDG on water supply and sanitation. But, the total accrued economic benefits of reaching the MDG is USD 84 billion – a seven-fold return.
- Broken down into country cost estimates, it is clear that meeting such investment challenges by 2015 is doable. The annual per capita cost to meet the MDG on water supply and sanitation in Bangladesh, Cambodia, Ghana, Tanzania and Uganda ranges from USD 4 to USD 7 per capita annually.
- Meeting public and private investment challenges related to improved water resources management and infrastructure is feasible. For example, countries in Sub-Saharan Africa need to invest between USD 150 and USD 700 per capita to reach a level of water storage infrastructure equivalent to South Africa's. Spread out over the ten years between 2005 and 2015, these investments would amount to USD 15 to USD 70 per capita on an annual basis.

Improved water supply and sanitation and water resources management boosts countries' economic growth and contributes greatly to poverty eradication. The required financing for improved water supply and sanitation and water resources management is a sound public and private investment strategy that boosts economies and that allows individuals and households to explore new livelihood opportunities as well as businesses to increase productivity and production and venture into new markets.

The productivity and production capacity of people and economic sectors, such as agriculture and industry, depend on people's health and secure water availability. Investing in the health of people, ecosystems and more efficient water use are investments that not only provide immediate economic benefits but also safeguards future economic gains. For example, well-managed ecosystems provide "ecosystem goods" – such as fish and crops – and "services" – such as flood control and water purification. In Uganda alone, the use of inland water resources is worth almost USD 300 million a year in terms of forest catchment protection, erosion control and water purification services.

It is critical that the economic benefits of improved water supply and sanitation and water resources management are understood, clearly articulated and included in strategic macro-economic decision making. Investments in the water sector – sanitation in particular – must be acknowledged for the economic benefits they generate. Seen this way, the economic benefits outweigh costs considerably.

What are the required steps to action? This report highlights examples of economic benefits that derive from the implementation of the guiding principles or prerequisites to action, as set out by the United Nations Millennium Task Force on Water and Sanitation. The required action is not possible without strong leadership and commitment from government, civil society and business leaders and opinion makers. Leadership must set priorities and instigate the reforms necessary to improve institutional performance and attract investment. It is critical to convince decision makers that public and private investment in the water sector makes good economic sense and that improved water supply and sanitation and water resources management are acknowledged as critical for economic growth and poverty eradication. **Water and related services must be a part of the economic development business.**

1. Introduction

Improved water supply and sanitation and water resources management boosts countries' economic growth and contributes greatly to poverty eradication.

Resolving water related challenges requires that the costs for improved water supply and sanitation and water resources management be seen as sound public and private investments and key to a strategy that boosts economies, enables individuals and businesses to explore new income opportunities and provides them with a fair chance to prosper. Simply put, *water and related services must be made part of the economic development business.*

Water and economy are inextricably linked. A country's overall development strategy and macroeconomic policies – including fiscal, monetary and trade policies – directly and indirectly affect demand and investment in water-related activities. Perhaps the most obvious examples are reforms to trade and agriculture that affect terms-of-trade and production and cropping patterns and thus ultimately determine water resource use and allocation. This report makes a different case for the water and economy association: improved water supply and sanitation services and water resources management, including infrastructure, have critical direct and indirect impacts on a country's overall economic development and growth. Current macroeconomic policies and decision making can be made more efficient and equitable if the economic benefits of improved water resources management and water supply and sanitation are factored into the economic development equation.

Water and related services must be made part of the economic development business.

With the continuing importance of globalisation and economic reform, many developing countries are implementing fundamental changes in macroeconomic policies. Many macroeconomic reforms call for a greater reliance on market incentives, open trade, fiscal austerity and the phasing out of producer and consumer subsidies (input and product markets). Government measures to reduce budgets or preserve the status-quo also imply increased competition between and within sectors that rely heavily on public investments for the funding of new development projects. Given this, the overall economic, social and environmental benefits of investment choices and the benefits of alternative funding sources must be carefully addressed.

What factors determine overall economic development and growth? This report focuses on the economic benefits of action that address both the access to

Photo: Mats Lannerstad

Photo: Mats Lannerstad

water and sanitation services and inadequate water resources management, including infrastructure. It covers shorter and longer-term costs of inaction and benefits of action and cost-benefit evaluations. Cost-benefit analyses typically include short-term issues. In most analyses that are available, the long-term economic benefits are not considered. This suggests that many of the cost-benefit figures presented in this report are underestimated.

There is currently a high degree of awareness of the pressing social and environmental challenges the world is facing: 2 in every 10 people on earth lack access to safe water supply, and 4 in 10 lack access to basic sanitation service; 90% of the 5,000 people who die of diarrhoeal disease every day are under the age of 5[1]. Many women and girls spend hours (often 4 to 6 hours) every day fetching and ferrying water, which effectively precludes girls from obtaining an education.

There is also an awareness of increasing water demands and widespread cases of dwindling and mismanaged water resources and the inadequacy of water infrastructure. The additional water required to eliminate hunger and undernourishment of the world's population by 2025, is equivalent to all the water withdrawn and used today for agricultural, industrial and domestic purposes[2]. Degradation of freshwater ecosystems and land exacerbates the frequency and impact of droughts, floods and other natural hazards, particularly in ecologically fragile areas where the poor often live, and can intensify competition and the potential for conflict over access to shared water resources.

The water-related challenges and the urgency to resolve them have been confirmed and re-confirmed at the highest political levels. The Millennium Summit and the World Summit on Sustainable Development have made significant headway to identify water supply, sanitation and water resources management challenges and to build momentum for required actions.

Despite such strong political commitments and the strong demand for improvements from communities throughout developing regions, access to improved services remains low. The limited awareness of water's contribution to economic development is confirmed by its limited visibility in the Poverty Reduction Strategy Papers (PRSPs) and other development strategies. A recent study by ODI and WaterAid of the extent to which water supply and sanitation figures in PRSPs in Sub-Saharan Africa concluded that water supply and sanitation are inadequately reflected both in terms of the process of PRSP preparation and the content of emerging PRSPs. In total, 17 African PRSPs were examined and

of these, only Uganda prioritised water supply and sanitation[3]. A World Bank study examined 40 interim and full PRSPs. It found that environmental protection and natural resource management issues were weakly represented[4]. There are exceptions to this – a country like Mozambique gives prominence to these issues.

It is therefore urgent that decision makers within governments, private sector and civil society increase their awareness of water in all its uses as a critical macroeconomic "booster". Investments in improved water resources management and water supply and – in particular - sanitation are currently perceived as a mere cost by many decision makers in both the North and the South. In fact, and as illustrated in this report, the economic benefits outweigh costs considerably. Subsequently, water is good for business.

It is urgent that decision makers within governments, private sector and civil society increase their awareness of water in all its uses as a critical macroeconomic "booster".

1.1 Why the Urgency? Benefits for People, Environment and Business

Gains from improved water supply and sanitation and water resources management benefit poor people most. Water resources are critical to production processes, and worker health is critical for increased production and productivity. Targeting those who make the greatest economic gains will also achieve the highest marginal benefit of interventions. Interventions to reduce poverty and to bolster economic growth will be more effective if they explicitly include measures to improve people's health and livelihood systems as well as resilience of economies to rainfall variability. For example:

- The health of poor men and women are disproportionately affected by unsafe drinking water and poor sanitation services.
- Poor people's livelihood systems, rural areas in particular, are directly dependent on environment and natural resources. The sustainable development of rural economies thus becomes critical for long-term economic growth. More efficient and equitable management of common property resources like lakes, rivers, ground water and coastal areas translates directly into more food, income and time for the poor.
- Vulnerability is a critical dimension of poverty. Poor people are particularly at risk from environmental shocks and crises and are also those who are disproportionately affected by water services insufficiency. Natural disasters as well as rainfall variability – particularly for those in tropical and dry zones – or shifting agricultural zones affect developing countries and the poor who live there disproportionately.
- The performance of economic sectors – agriculture, industry and services – relies on water resources and water supply and sanitation services. The production capacity and productivity of economic sectors depend on people's health and reliable access to water.

Targeting those who make the greatest economic gains will also achieve the highest marginal benefit of interventions.

Sustainable and equitable conomic growth is vital to meeting the MDGs and the eradication of poverty. Box 1 provides some of the challenges and an overview of the number of people that will need to be served annually with water supply and sanitation to meet the MDGs. Meeting MDG 7 will bring the international community closer to meeting a number of other Millennium Development targets. In fact, it is difficult to imagine how progress can be made without first ensuring that poor households have safe, reliable water supply and adequate sanitation facilities. Water is clearly a key in the reduction of poverty in all its dimensions; income growth, promotion of health and gender equality, sanitation and water management, etc[5]. The achievement of the MDGs is challenged by the population growth that will continue to drive the increased demands for resources, including water and related services. The demographic change is affecting how water is used and managed. In real terms the urban population of developing countries is expected to nearly double between 2000 and 2030 from 2 billion to almost 4 billion. Between 2015 and 2020, the urban population in developing countries will exceed the rural population for the first time. Bigger cities will demand more water services; their inhabitants will aspire to different lifestyles[6].

The Millennium Development Goals are realistic, and concrete, but still go only half way towards ending absolute poverty. When they are achieved, poverty, inadequate supply of water and sanitation and poor water resources management will remain major issues.

Box 1
Target 10 and Poverty-Related Challenges[7]

Millennium Development Goal No. 7, Ensuring Environmental Sustainability, includes Target 10, to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. This challenge has four dimensions:

- More than one billion more people need access in order to keep pace with population growth and demographic change. In 10 to 15 years many more people will live in urban areas in developing countries, putting strain on these services.
- Existing coverage and service gaps must be closed; the sanitation gap being very large
- Existing and new services must be made sustainable;
- Service quality must be improved; often beyond what is already called "improved" in MDG criterion.

Target 10 translates into the following real challenges:

- The number of people served by water supply must increase by 1.3 billion between 2002 and 2015 and those served by sanitation by 1.9 billion;
- This means providing improved water services to an additional 100 million people annually, or 274,000 every day. A significant escalation of investments and reforms compared to the 1990s is required.
- For sanitation, services must be improved for an additional 145 million every year until 2015. In the 1990s, around 100 million gained access per year.

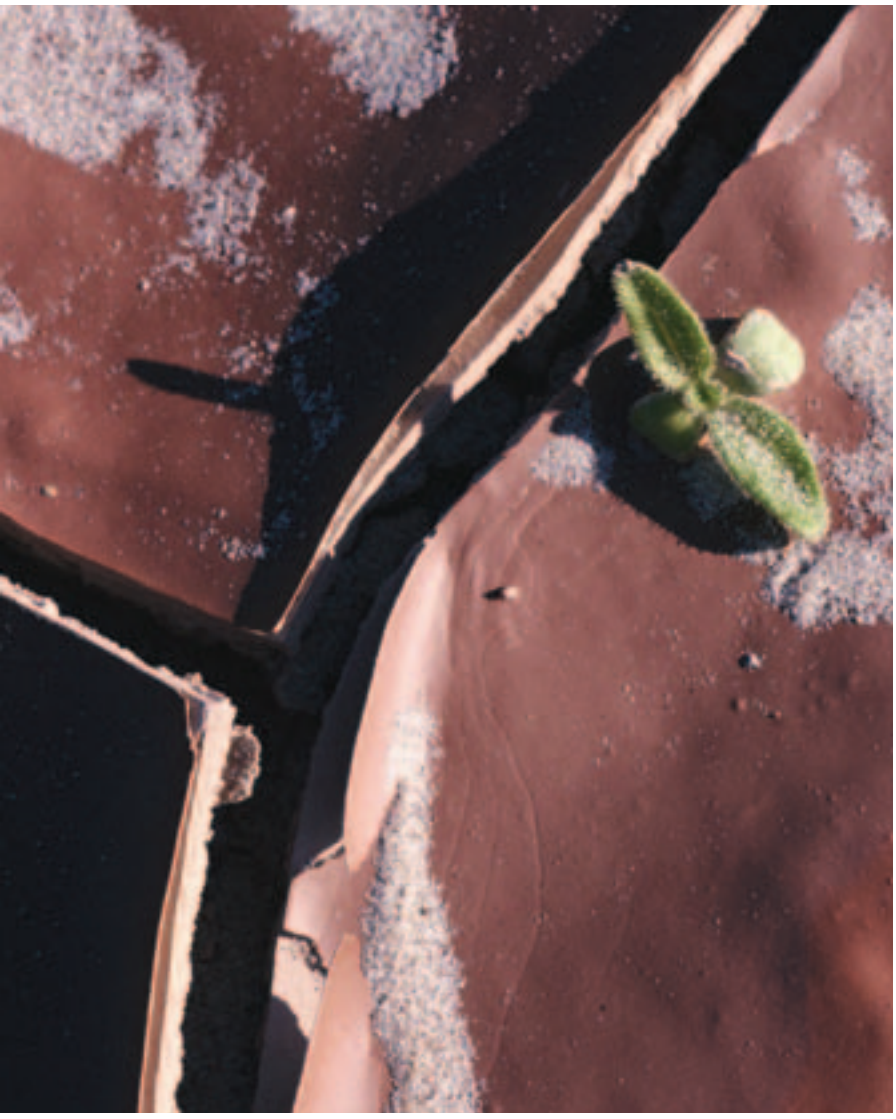

Photo: SIWI

The report is structured around costs and benefits of water-related action. Chapter 2 shows the huge immediate and long-term economic benefits of improved health by improved water supply and sanitation. It also provides snapshots of the critical roles water resources management and related infrastructure play in supporting economic development in economic sectors such as agriculture, fisheries, hydro-power and industry. The importance of sound water resources management and its contributions to the economy is also highlighted in relation to mitigating natural hazards and maintaining ecosystems. Chapter 3 presents cost estimates on what it would take to reach the MDG target on water and sanitation and to improve infrastructure for water resources management. Some of the multiple benefits from such investments are highlighted in the report. Chapter 4 applies cost-benefit evaluations. Water touches and affects so many issues that including every possible benefit and every possible cost in a cost-benefit analysis is neither possible, nor warranted. However, the advantage of this method is that it captures how powerful improved water supply and sanitation and water resources management is for economic growth and relieving poverty. Chapter 5 concludes the report and further elaborates on the **5 urgent messages** to decision makers.

2. Generating Economic Benefits with Improved Water Resources Management and Services

Photo: Dr. Katrin Teubner

Society's economic sectors, including agriculture, industry and services, rely on water resources and related services. Improved access to water services and improved management of water resources contribute substantially to economic growth through increasing business productivity and development. It also improves human health, productivity and dignity considerably.

There is a positive correlation between increased national income and the proportion of population with access to improved water supply. A 0.3% increase in investment in household access to safe water is associated with a 1% increase in GDP[8]. This report argues that improved water services and water resources management are an essential and necessary condition for economic development and growth. However, it is also clear that the interaction runs both ways. Economic growth itself can also drive increasing investments in improved water management and services. Thus, it can be argued that the interaction between improved

The interaction between improved water supply and sanitation and economic growth is mutually reinforcing and has the potential to start a "virtuous cycle" that improves the lives of poor people.

water supply and sanitation and economic growth is mutually reinforcing and has the potential to start a "virtuous cycle" that improves the lives of poor people.

The following section brings attention to water management and services interventions and benefits at different levels. At the individual/household level, enormous savings in time and increased livelihood opportunities for the poor are gained through improved access. Interventions also give sectoral and cross-sectoral economic benefits. At an aggregated level, the section looks at interventions of improving water resources management for agricultural and food production and industry and its role in economic growth and development. Furthermore, a selection of cross cutting themes is considered, such as multi-purpose water storage capacity, eco-system services and floods and droughts. Here, the section provides insight into the complex role water plays in supporting society, economic growth and our ecosystems.

2.1 Improved Access to Water Services and Basic Sanitation for Economic Development

Key Points

- The public and private investment needed to improve sanitation and water services contributes significantly to better health, economic growth and eradicating poverty. Increased productivity and production accrued at the individual/household level are augmented by economic, health and education gains.
- The economic benefits are immediate and long-term. Immediate benefits include averted health-related costs, and time savings associated with having water and sanitation facilities closer to home. Time saved due to less illness and closer access to facilities translates into higher productivity and higher school attendance. The total annual economic benefit of reaching the MDG on water and sanitation amounts to USD 84 billion.
- In China, the total welfare loss from the impact of water pollution on health alone is estimated to USD 13.4 billion for the late 1990s.

2.1.1 Immediate Benefits of Improved Human Health

The lack of access to safe water, basic sanitation and good hygiene practices is the third most significant risk factor for poor health in developing countries with high mortality rates[9]. Diarrhoeal disease, for example, is widely recognised as the principal result of inadequate water, sanitation and hygiene. 1.8 million people die every year from diarrhoeal disease; 90% of whom are children under the age of 5[10]. 133 million people suffer from high intensity intestinal helminth infections (Ascariasis, Trichuriasis, Hookworm disease) which often leads to severe consequenses such as cognitive impairment, massive dysentery, or anaemia.

Box 2
Dengue and Dengue Haemorrhagic Fever

Some 2.5 billion people – two fifths of the world's population – are now at risk from dengue. WHO currently estimates 50 million cases of Dengue infection and 19,000 deaths worldwide every year. Dengue in its haemorrhagic form is particularly deadly for children. The global prevalence of Dengue has grown dramatically in recent decades and the disease is now endemic in more than 100 countries in Africa, the Americas, the Eastern Mediterranean, South-east Asia and the Western Pacific. Southeast Asia and the Western Pacific are most seriously affected.

The mosquito vectors that transmit this virus breed in small water collections in and around the house, in particular in drinking water vessels. Improving the reliability of piped drinking water would remove the necessity to store water in or near their homes. These home water storage facilities are often designed without taking the dengue risks into consideration and have in some countries contributed to the exacerbation of the transmission. The direct costs of dengue varies from one year to the other in relation to the intensity of outbreaks, but the hidden costs to the health services are considerable: in some outbreak situations almost all the hospital beds are occupied by Dengue patients.

Source: WHO (2002b)

Box 3 Schistosomiasis

- An estimated 160 million people are infected with Schistosomiasis.
- The disease causes tens of thousands of deaths every year, mainly in sub-Saharan Africa.
- It is strongly related to unsanitary excreta disposal and absence of nearby sources of safe water.
- Basic sanitation reduces the disease by up to 77%.
- Man-made reservoirs and poorly designed irrigation schemes are main drivers of Schistosomiasis expansion and intensification

Source: WHO (2004)

Box 4 Trachoma

- 500 million people are at risk from Trachoma.
- 146 million are threatened by blindness.
- 6 million people are visually impaired by Trachoma.
- The disease is strongly related to lack of face washing, often due to absence of nearby sources of safe water.
- Improving access to safe water sources and better hygiene practices can reduce Trachoma morbidity by 27%.

Source: WHO (2004)

Box 5 What is a DALY?

The Disability Adjusted Life Year is a summary measure of population health, and one DALY represents one year of healthy life lost. The DALY is used to estimate the gap between the current health status of a population and an ideal situation where everyone in that population would live to old age in full health. For each ill health phenomenon, DALYs are calculated on a population scale as the sum of both years lost due to premature mortality and the healthy years lost due to disability.
Source: WHO (2002)

Sub-Sahara Africa is where better management of water resources and improving access to water and sanitation will have a particularly big impact. 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 suffering must also be added to this[11].

The benefits of preventive action provide another way to consider the immediate economic impacts of water quality and sanitation. Consider the cholera epidemic that swept Peru in 1991 that cost USD 1 billion to treat. It is estimated that USD 100 million – or a tenth of what was actually spent – could have prevented the epidemic. Adding to this the monetary expenses, the value of lost working days, and the lives lost, and the cost-benefit ratio of preventive investments in water and sanitation become astronomical[12].

Evidence shows that improved water supply and sanitation facilities and better hygiene behaviour will radically reduce population illness. Improved water supply can reduce diarrhoea morbidity by up to 25% if severe outcomes are included[13]. Improved sanitation reduces diarrhoea morbidity by 32%. Hygiene interventions including hygiene education and promotion of hand washing can reduce the number of diarrhoeal cases by up to 45%[14]. Additional improvements to drinking water quality at home, such as point-use of disinfection, are simple and cheap measures that make an immediate difference to the lives of those worst affected. These interventions can lead to a reduction of diarrhoea episodes of up to 39%.

Poor people in Africa spend at least a third of their incomes on the treatment of water-related diseases like malaria and diarrhoea.

Photo: Mats Lannerstad

Sub-Saharan Africa is a stark example of how water and sanitation has a very significant impact on the lives of poor people. Consider that in rural areas women spend up to 6 hours a day on water collection chores. People also spend considerable time in queuing for public toilets or finding a safe place to defecate. Again, this is productive time lost; time that could be spent on a host of more productive activities such as childcare and harvesting[15]. WHO estimate that time/convenience savings of USD 64 billion make up the lion share of the benefits of reaching the MDG water and sanitation target – the total benefits are estimated at USD 84 billion. WHO has provided a specific breakdown of the benefits of improving access to sanitation and clean water. These are presented in Chapter 4.

A World Bank review[16] provides convincing empirical evidence of the effectiveness of simple non "health sector" measures that bring health improvements in terms of preventing the loss of DALYs. Said otherwise – how much would it cost to avoid one year of healthy life lost. For various interventions, the review concluded with the following estimated costs per DALY saved:

- Hygiene behaviour change: USD 20 per DALY saved
- Water connections in rural areas: USD 35 per DALY saved
- Malaria control: USD 35–70 per DALY saved
- Improving indoor air quality with better stoves: USD 50–100 per DALY saved

The cost effectiveness of water and sanitation services with respect to other options is clear. If, as some like Jeffrey Sachs say, a DALY is worth at least USD 500 in low income countries, the effectiveness of these interventions is even more compelling. The investments required to realise these benefits are taken up again in Chapter 4 in a cost-benefit analysis.

2.1.2 Long-Term Benefits of Improved Education and Health

Investing in water management and services provides people with the chance to spend more time in school, more effectively.

Improving health through investments in water supply and sanitation services has several immediate benefits for the economy but also delivers important long-term economic growth benefits.

Human capital theory and endogenous growth theory suggest that there are substantial economic benefits of education. At the most basic level for example, a person without basic literacy and numeracy skills is not able to participate as effectively in political processes and higher levels of societal organisation. Investing in water management and services provides people with the chance to spend more time in school, more effectively. With less time ill and less time spent fetching water, children above all are able to devote more time to learning. Furthermore, better health strengthens cognitive abilities[17].

A study conducted on Jamaican school children aged 9–12 years shows that reducing the incidence of Trichuriasis, which is strongly related to inadequate sanitation, was followed by significant improvements in the results of tests of auditory short-term memory and of scanning and retrieval of long-term memory. The study also found that absenteeism was more frequent among infected children. Furthermore, there was a direct correlation between the intensity of the infection and the level of absenteeism[18]. Studies of school children in Tanzania[19] have established that water-related diseases from intestinal parasites such as Hookworm and Schistosomiasis are important impediments to child development and performance in school, and therefore also their productivity and chance to escape poverty.

Jamaica and Tanzania are not isolated examples where improved water supply and services would have an impact. According to UNICEF, millions of children around the world suffer from water related parasites that consume nutrients, aggravate malnutrition, retard children's physical development and result in poor school attendance and performance[20]. Schools themselves often have poor sanitary environments. They have no, or insufficient, water supply, sanitation and hand-washing facilities. If present, they are often not adapted to the needs of children, and are broken, dirty or unsafe. Under these conditions, schools become disease havens, with reinforcing negative impacts for the children, their families, the schools and overall development[21].

The China Council for International Cooperation on Environment and Development[22] estimates that 1.5% of all deaths in China, or 64,000 persons per year, can be attributed to water-related diseases. The highest costs of water pollution damage appear to come from IQ loss in children resulting from the ingestion of water and food contaminated with lead, mercury and other heavy metals. It is estimated that each year 7

Photo: Mats Lannerstad

million children are affected, losing on average 6.5 points on the IQ scale. The total welfare loss from the impact of water pollution on health alone is estimated to USD 13.4 billion for the late 1990s. This is equal to 1.3% of China's GDP[23].

High rates of disease also affect the level of parental investments in children. Societies with high rates of infant mortality (deaths under 1 year of age) and child mortality (deaths under 5 years of age) have higher rates of fertility, in part to compensate for the frequent deaths of children. Large numbers of children, in turn, reduce the ability of poor families to invest heavily in the health and education of each child[24].

A recent econometric study by Bloom and Sachs (1998) found that more than half of Africa's economic growth shortfall relative to high-growth countries of East Asia could be explained statistically by disease burden, demography and geography, rather than by more traditional macro-economic policy variables and political governance.

Widespread water-related disease and illness are also a concern with respect to investment at the macroeconomic level. Where the level of such disease is chronic, entire sectors of the economy (agriculture, mining, manufacturing and tourism, for example) suffer. High rates of disease and/or illness introduce a new source of business risk that deters investment[25].

The losses in productivity due to poor health and missed opportunities caused by lack of improved water management and services impede long-term growth. Jeffrey Sachs has demonstrated empirically the significance of water and sanitation mismanagement on health and education, and more generally on economic welfare and growth[26]. Sachs argues that across the world's poor countries, it is the countries with access to improved water and sanitation services that experience higher economic growth[27]. As an illustration, those poorest countries with per capita annual income below USD 750 in PPP-adjusted 1990 USD with safer access to clean water and sanitation services enjoyed annual average growth of 3.7%. Similarly poor countries (i.e. with the same per capita income) but without improved access had average annual per capita GDP growth of only 0.1%[28].

Sachs[29] provides an upper limit estimate of how many annual deaths due to diseases could be avoided if actions to eradicate water-related diseases throughout developing countries were realised. He estimates that the equivalent of 330 million DALYs could be averted by 2015[30]. Making the conservative assumption that each DALY is valued at one year of low-income country per capita income in 2015, i.e. USD 563, the direct economic savings would be USD 186 billion per year in 2015. Sachs argues that lost benefits would actually be much higher because this valuation is much more conservative than what is conventionally used and it does not take into account the missed economic growth opportunities.

The total welfare loss from the impact of water pollution on health alone is estimated to USD 13.4 billion for the late 1990s. This is equal to 1.3% of China's GDP.

Those poorest countries with safer access to clean water and sanitation services enjoyed annual average growth of 3.7%. Similarly poor countries without improved access had average annual per capita GDP growth of only 0.1%.

2.2 Water Resources Management for Economic Development

Photo: SIWI

2.2.1 Agricultural and Food Production

Key Points:

The public and private investments needed to improve water resources management make country economies more resilient to rainfall variability and maintain eco-system services. It boosts productivity in the sector and safeguards future profits of the agriculture and food sector (crop, fisheries and livestock) Poor countries in tropical and dry regions are especially susceptible to climate and rainfall variations. The incomes and expenditures of much of the population in developing countries depend on agricultural and food production.

- To even out seasonal and intra-seasonal access to water has great economic benefits. Consider the case of Kenya: If the country can decouple its economy from rainfall variability it can increase annual GDP growth with approximately 2.4 percent.
- Looking at fisheries – another food source – improved management of water and fish-habitats have clear economic impacts. For example, the economic loss of reduced annual catches of mangrove dependent fish species in the Indus delta amounts to more than USD20 million a year.

The management of water resources for growth and increased productivity in the agricultural and food sector faces two distinct challenges. On the one hand, sustainable agricultural growth will demand improving water use efficiency and matching water use with what regional water resources are able to provide. On the other hand, sustainable growth will demand protecting farmers, ranchers and fishers from rainfall variability and extreme events such as floods and droughts. Agriculture and food production is by far the largest user of water, particularly in developing countries[31]. For the 2.5 billion people living in low income countries, agriculture and food is the most important sector by employment but lags in terms of productivity, contributing only 23% of GDP[32]. Any poverty reduction strategy must therefore consider food production together with water resources management if it is to be effective.

For the 2.5 billion people living in low income countries, agriculture and food is the most important sector by employment but lags in terms of productivity, contributing only 23% of GDP.

Figure 2.1 provides a breakdown of the levels of water intensity of various foods. It shows that livestock are significantly more water intensive than grains, for example. Reducing the strain on the water systems will require a "matching" of what is farmed and what water resources can provide on a sustainable basis.

Food item	Water requirement m^3/kg (avg.)
Beef (grain fed)	15 or more
Lamb	10
Poultry	6
Cereals	0.4–3
Cirtus fruits	1
Palm oil	2
Pulses, roots and tubers	1

Figure 2.1 Water requirement equivalent of main food products
Source: SIWI and IWMI, 2004

Increases in the demand for food over the next 25 years will be met by increasing the yield from lands already under cultivatation. Irrigated land currently produces 40% of the world's food on 17% of the world's agricultural land. A broadening of irrigation and more effective rain fed agriculture will be necessary to meet the food demand. This will require significant investments in irrigation, water storage, water distribution and drainage, particularly if demand for water from other sectors is to be met[33].

2.2.1.1 Vulnerability to Rainfall Variability

Improving water management makes national economies more resilient to hydrological variability and is vitally important for sustainable economic growth and development. Though this is an issue that impacts all sectors, it is most acute in the agricultural and food sector that is highly susceptible to hydrological variability and associated landscape vulnerability. Though attention is typically focused on weather extremes, the simple fact is that without adequate water resources management, even regular, annual hydrological cycles threaten livelihoods and slow, or even stop, economic development[34].

The incomes and expenditures of much of the population in developing countries depend on agricultural production. Figure 2.2 is a dramatic example of how normal climate variability as well as events such as floods and droughts have an impact on economic growth. The entire Zimbabwean economy is closely tied to rainfall variability. Improved water resources management is critical to the stability and security that is required to enable economic development. There is ample evidence that irrigation, for example, has contributed significantly to poverty reduction. Across Asia, regions with high irrigation density consistently have significantly fewer households below the poverty line than areas relying on rain fed agriculture[35].

In Kenya, the 1997–98 floods and the 1999–2000 drought illustrate a vulnerable water dependent economy. The floods cost the country at least USD 870 million, or 11% of GDP. The two-year drought cost at least USD 1,4 billion a year, or 16% of GDP. Although the period between 1997 and 2000 was exceptional, floods and droughts occur frequently in Kenya. In fact droughts lasting at least 2 years have occurred four times over the last 22 years (about once every 5 years). Annual rainfall greater than 120% above the average has occurred three times in that period (about once every 7 years)[37].

The two-year drought in Kenya cost at least USD 1,4 billion a year, or 16% of GDP.

Assume for the sake of argument those 1-in-5-year droughts and 1-in-7-year floods are typically about 50% as severe as those that occurred between 1997 and 2000. That is, on average, the country experiences a flood that costs it about 5.5% of GDP every 7 years and a drought that costs it about 8% of GDP every 5 years. This translates to a direct long-term fiscal liability of about 2.4% GDP per annum, of which about a third of the annual economic losses are due to flood damages to infrastructure such as bridges and roads. The other two-thirds are due to lost production. This does not include the estimated annual loss of 0.4% GDP from water resource degradation. To consider this in context, in 1996, a good year in Kenya, real GDP growth was 4.1%. In 2000, it was –0.3%. What these national figures fail to capture,

In Kenya, there is a direct long-term fiscal liability of about 2.4% GDP per annum due to variability in rainfall.

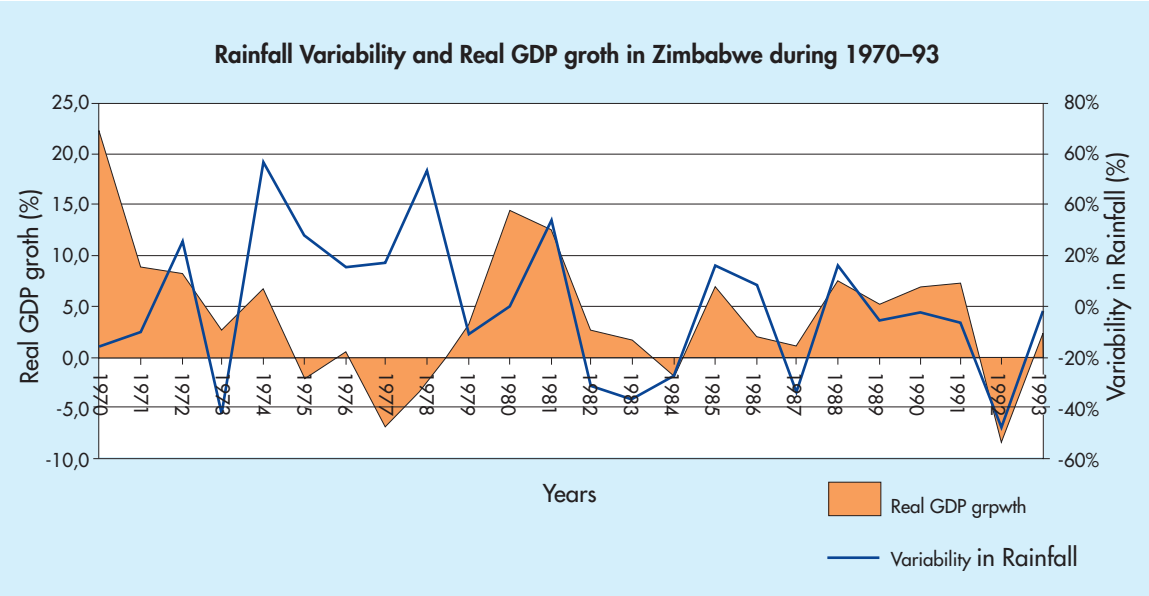

Figure 2.2 The dependency of the Zimbabwe economy on rainfall (1970 to 1990)[36]

however, is that the poor in particular bear the burden of these catastrophes.

Improved water management provides benefits to farmers' livelihood at one level; the competitiveness of agri-business in a globalising world is another level[38], and the structure and performance of national economies is a third level[39]. Section 2.2.3 – Water Storage and Hydropower Infrastructure discusses the benefits of water resources management and infrastructure development as a means to smooth seasonal and intra-seasonal water availability, thus reducing the economy's vulnerability to rainfall variability. Another measure to make the economy more resilient to rainfall variability is found in shifting trade strategies. Trade in food and other goods imply trade in water. The total amount of water that is used to produce a product is referred to as virtual water. The concept of virtual water is explained in box 6. Trade in virtual water can reduce consumptive water use in agriculture, as well as industry, provided that exporters achieve higher water productivity than importers.

Box 6 Virtual Water and Trade

Applying trade strategies based on virtual water can increase economies resilience to rainfall variability. Trade in food and other goods imply trade in water. The total amount of water that is used to produce a product is referred to as virtual water. Using this concept, international food trade has been analysed in terms of virtual water flows[40]. Simply put, the virtual water flow between two nations is equal to the volume of virtual water that results from product trade.

This concept provides insight on patterns of water consumption and serves to highlight areas of unsustainable water use. Moreover, it illustrates the gains from trade between high intensity and low-intensity water users. For example, in most cases, the major food exporters have highly productive rain fed agriculture, while most food importers rely on irrigation or low output rain fed systems[41]. Trade in virtual water can reduce consumptive water use in agriculture, as well as industry, provided that exporters achieve higher water productivity than importers.

Within the Organisation for Economic Co-operation and Development (OECD), farmers receive more than one third of their income from government subsidies, totalling over USD 300 billion every year, equaling the total GDP of Africa[42]. The liberalisation of trade in agriculture will continue to be a priority of future international negotiations. It is therefore important that the linkages between agricultural trade and water resources are identified and analysed to better understand the positive and negative impacts that trade liberalisation will have on the economy, taking into consideration the short and long term impacts on water resources.

Photo: Mats Lannerstad

2.2.1.2 *Fisheries*

For the people of Africa, Asia and Latin America, the fisheries of inland lakes, rivers and other freshwater ecosystems are an important source of food and income. Fish are also the principal source of animal protein for many. Over-fishing and degradation of the ecosystem through the mismanagement of water resources pose a threat to the livelihoods of hundreds of millions of people. Though the value of these fisheries is undeniable, the sustainable use and maintenance of them is overlooked in favour of short-term interests. The principal factor threatening inland fisheries is the loss of fish habitat and environmental degradation[43]. However over-fishing also poses a major threat.

The catch from inland fisheries totalled 7.7 million metric tonnes in 1997, or nearly 12% of all fish directly consumed by humans[44]. Based on production per se, most of the important inland fisheries countries are in Asia (5.8 million tonnes) and Africa (2.1 million tonnes). The annual catch in the lower Mekong alone is conservatively estimated at 1.6 to 1.8 million tonnes. It has a retail value of USD 1.4 billion and provides food security for 60 million people. The productivity and value of freshwater fisheries is highly dependent upon the quantity and quality of the water supply as well as access to markets. In Sub-Saharan Africa the larger floodplains of the inner delta of the Niger, the Sudd of the Nile, and the lake Chad basin, each yield up to 100,000 tonnes per year and generate USD 20–25 million in income in each area[45].

Photo: SIWI

Poorer households are more vulnerable to losses in fisheries and degradation of wetland resources, particularly because they are less able to deal with shocks such as health problems, drought and livestock death. Households in the village of Veun Sean of Cambodia depend on the Stung Treng wetland for their fish, water supply and transport. The total benefits of the wetland amount to USD 3,200 per household per year. Poorer households are most dependent on wetland resources for providing food security and income. They make on average 77% of their income from fisheries, compared to 56% for the less poor households[46].

The total benefits of the Stung Treng wetland in Cambodia amount to USD 3,200 per household per year.

Understanding the value of the natural ecosystem has led to greater attention being given to freshwater fisheries and ways through which its contribution to poverty alleviation and food security can be enhanced.

2.2.2 Industrial Development

Key Points

- The public and private investments needed to provide reliable water supplies mean more and better business development and reduced investment risk. Industrial areas that use water unsustainably are likely to direct more resources to ensure adequate access to water or are likely to suffer from intermittent water supply and/or poor water quality.
- The need for reliable access to water and pollution limitations is well recognised among businesses. Decision-makers within governments however must be made increasingly aware that improved water management and reliable access to water is good for local and national business and international trade.

Reliable and sufficient water supplies are critical for business development and reduced investment risk.

Industrial facilities use water for a variety of purposes such as cooling and transportation, producing steam or electricity, sanitation and as a critical component of a firm's output (such as paper products)[47]. For example, it takes 230,000 litres of water to produce one tonne of steel in the US[48]. High technology industries – increasingly important for many economies – also use enormous amounts of water. It takes, for example, over 8600 litres of water to produce a single 300 mm silicon wafer[49]. Similar to the food sector, the average virtual water content of industrial products varies significantly. The global average is 80 litres per USD. In the USA, it is nearly 100 litres per USD; in Germany and the Netherlands about 50 litres

The total industrial income lost in China as a result of water pollution in 1992 is estimated at USD 1.7 billion.

per USD. In Japan, Australia and Canada it is only 10–15 litres per USD. It is also quite low in China and India, or about 20–25 litres per USD[50].

China is currently facing serious water resources challenges, and water shortage is one of the biggest problems facing the economy[51]. The total industrial income lost in China as a result of water pollution in 1992 is estimated at USD 1.7 billion[52]. The Chinese case shows the implications of sound water resources management and its impact on economic growth. It is clear that water supply and its quality is a critical business risk issue.

It is clear that water supply and its quality is a critical business risk issue.

Many businesses in different regions are now increasingly aware of the need for improved water management and that reliable water access implies business opportunities. The Malaysian Industrial Development Authority (MIDA) is the government's principal agency for promoting and coordinating industrial development. It is marketing a reliable access to water as one key advantage of investing in the Malaysian economy[53].

Likewise, recent industrial development in Manila has led to a rapid increase in the demand for water. Water supply shortages have forced many businesses to dig their own wells. In fact, 80% of the industries rely on private wells as their main source, with only about 20% getting water from the Metro Manila Waterworks and Sewerage System. As a result, groundwater extraction is lowering the water table by 6–12 metres per year and salination and pollution threaten groundwater resources.

The unsustainable water withdrawals of groundwater pose a significant cost to businesses as they compete for a dwindling supply of poor quality water[54]. Consequently, there are huge economic gains that can be made through improved water resources management and through improved water storage capacity.

Photo: SIWI

2.2.3 Water Storage and Hydropower Infrastructure

Key Points

- The public and private investment needed to improve water storage capacity, both large and small-scale, and water resources management enhances countries' resilience to rainfall variability. Well-planned and efficiently managed water storage infrastructure is important for the provision of safe and secure water supply to households, agriculture and food production and for industry. Multipurpose dams can generate indirect economic benefits nearly as much as the direct economic benefits generated.
- Improved water storage capacity and water security is particularly required in climate zones characterised by big rainfall variation, such as low-income tropical countries. For example, Sub-Saharan Africa is subject to more climatic variability than most other countries, and at the same time has the least per capita water storage and buffer capacity to deal with climate and rainfall variability.
- The benefits of hydropower on economic growth and poverty alleviation are obvious. A comparison of Chinese counties with and without rural hydropower showed that the GDP of counties with completed primary electrification doubled with an annual growth rate of 15.3%, which was twice that of the national average. The annual average income per farmer increased 8.1% per year, which was 2.7% more than the national average.

As one Indian Finance Minister said, "Every one of my budgets was largely a gamble on rain". The development of a sound, well-planned stock of water infrastructure is a critical component of economic growth, water resources management and improved access to water and sanitation services. Dams and reservoirs, both large and small, provide services such as power generation, flood control and water supply to agricultural and domestic users. These facilities provide opportunities to improve livelihoods, increase incomes and reduce vulnerability. Water canals, drainage and irrigation, are also part of the infrastructure stock that water management and services rely on.

Water infrastructure provides water management services that even out the seasonal and inter-seasonal variations of water supply. This is particularly important in monsoon climates or other climate zones characterised by big rainfall variation, such as low-income tropical countries. For example, Sub-Saharan Africa is subject to more climatic variability than most other countries, and at the same time has the least per capita water storage and buffer capacity to deal with extreme natural events. Without adequate water control infrastructure, the economy is more susceptible to water-related shocks (as was highlighted Section 2.2.1.1 – Vulnerability to Rainfall Variability). In India, water infrastructure development has evened out the seasonal demand for labour, resulting in major gains for the poor. Furthermore, recent analyses in India have shown that irrigation infrastructure has a major impact on the returns to investments in education[55].

Sub-Saharan Africa is subject to more climatic variability than most other countries, and at the same time has the least per capita water storage and buffer capacity to deal with extreme natural events.

Water storage capacity per person is often cited as a proxy to water security and a measure of large and small-scale water infrastructure development. Figure 2.3 illustrates the disparity between different regions. Australia and Ethiopia have similar degrees of climate variability, but whereas Australia has over 4,700 cubic meters of water storage capacity per person, Ethiopia has 43 cubic meters[56]. Uganda and Kenya have similarly low levels of water storage. The breakdown of dams per geographical region shows that in Africa there is a large scope for water infrastructure development. Numbers from the International Commission on Large Dams shows that only 5% of the world's dams are located in Africa, whereas 33% are located in Asia. This does not however take into account local rain water harvesting technologies.

Photo: Mats Lannerstad

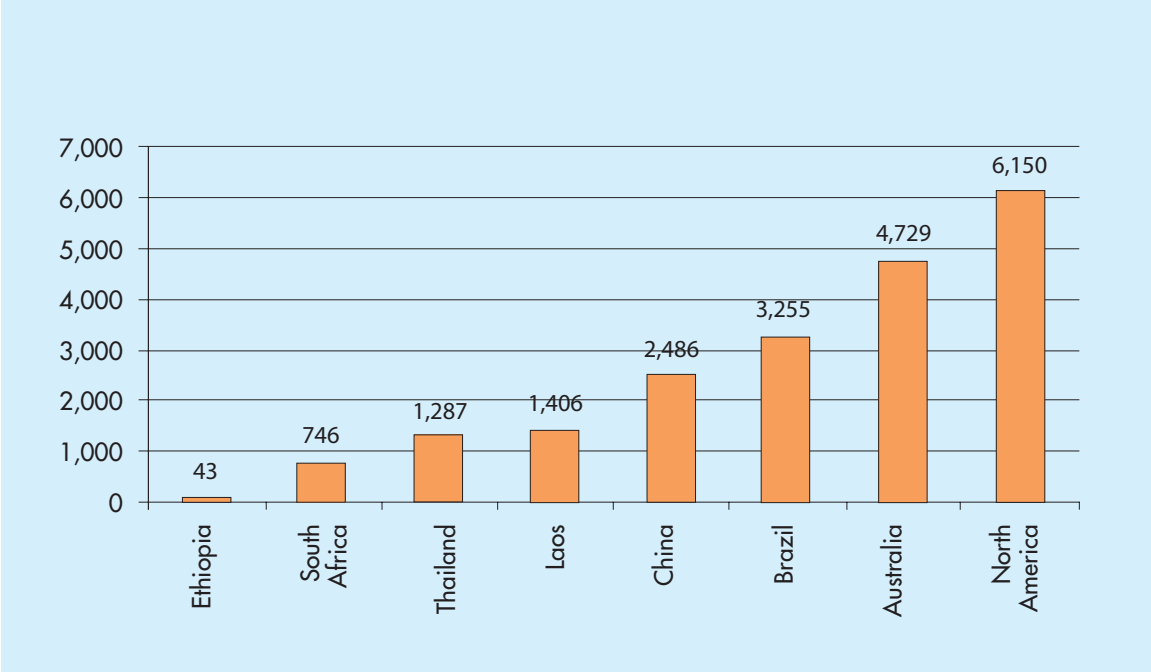

Figure 2.3 Africa's infrastructure gap: Water storage per person in cubic metres. Source Grey & Sadoff (2002)

The multiplier for the Sobradinho Dam in Brazil, was estimated from 2.0 to 2.4 depending on what assumptions are applied to the supply of labour and capital.

Development of hydropower capacity, in particular, is one strategy that will reduce economic dependence on fossil fuels and limit greenhouse gas emissions. The International Atomic and Energy Agency says the world will need almost 60% more energy in 2030 than in 2002, with economic growth in the developing world driving most of the increase. Thus, developing hydropower resources, particularly in the developing world, is absolutely necessary.

There are several economic benefits of electrical power in terms of economic growth and poverty alleviation. Energy services that allow for heating, cooking and illumination are not only a boon to the activities of daily life; they are also critical inputs to agriculture and the types of small-scale productive activities that are a significant component of rural and urban economies[57].

Dam projects are often a catalyst for economic growth and development and provide a host of benefits that are often indirect and more difficult to measure, but nonetheless significant. In the Punjab, India, a multipurpose dam (hydropower and irrigation) was found, in hindsight, to generate almost as much "indirect" value added via inter-industry linkages and consumption–induced effects, as "direct" value added through agricultural and electricity. The multiplier for the Sobradinho Dam in Brazil, was estimated from 2.0 to 2.4 depending on what assumptions are applied to the supply of labour and capital. This means that for every USD 1 invested there was a total economic return of USD 2 to USD 2.4. Traditional cost-analyses often do not, or are unable, to capture the multiplier effect of dam system developments[58].

The GDP of 335 counties in China with completed primary electrification doubled with an annual growth rate of 15.3%, which is twice that of the national average.

A comparison of levels of economic development was carried out in China comparing counties with and without rural hydropower[59]. From 1995 to 2000, the GDP of 335 counties with completed primary electrification doubled with an annual growth rate of 15.3%, which is twice that of the national average. The annual average income per farmer increased 8.1% per year, which is 2.7% more than the national average. In these communities about 30 million people changed their mode of living from marginalised farming to off-farm labourers in industry or the services sector.

The investment in water storage capacity, both large and small-scale, and water resources management enhances resilience to better cope with erratic rainfalls. Proper implementation of these installations provides opportunities for the poor as well as substantial benefits to broader society. Well-planned water storage infrastructure is critical for the provision of safe and secure water supply to households, agriculture and food production and for industry. Hydropower is a renewable source of energy for which there is still substantial development potential. The benefits of renewable electric power are clear not only for the economy but for sustainable development as well. Development of the water infrastructure stock, together with effective water management, provides a basis for economic stability, growth and poverty eradication strategies.

Photo: SIWI

2.3 Ecosystem Goods and Services

Key Points

- Immediate and future profits depend on public and private investment in improved water resources management to maintain ecosystem goods and services. The economic costs of environmental degradation have been estimated at 4% to 8% of GDP in many developing countries.
- Poor people in particular are directly dependent on ecosystem goods and services for their livelihood. In Uganda alone, the use of inland water resources is worth almost USD 300 million a year in terms of forest catchment protection, erosion control and water purification services. Work carried out in the Zambezi Basin in Southern Africa shows that natural wetlands have an annual net present value of more than USD 64 million.

Water and how it is managed contributes to the production and consumption of ecosystem services and goods – for example fish, fuel, timber, food crops, medicine and pasture. Typically, however, ecosystems are sidelined and are not maintained at a level that ensures continued productivity. The economic costs of environmental degradation have been estimated at 4% to 8% of gross domestic product in many developing countries[60]. On the benefit-side of the equation, ecosystems such as lakes, rivers, forests and wetlands generate important economic gains.

The economic costs of environmental degradation have been estimated at 4% to 8% of gross domestic product in many developing countries.

In Vientiane, the capital of Lao PDR, wetlands offer flood attenuation and wastewater treatment services valued at USD 2 million per year. It has been estimated that these ecosystem services constitute investment savings of more than USD 18 million in damage costs avoided and USD 1.5 million in the artificial technologies that would be required to fulfil the same functions[61].

The estimates in Table 2.1 are based on indirect aquatic ecosystems values. These include flood control, groundwater recharge, shoreline stabilisation and shore protection, nutrition cycling and retention, water purification, preservation of biodiversity, and recreation and tourism. The dollar values provide an indication of the "shadow price" of these resources i.e. the true economic price. For example, the total global value per hectare of lakes and rivers is estimated at USD 19,580.

The total global value per hectare of lakes and rivers is estimated at USD 19,580.

In Uganda alone, the use of inland water resources is worth almost USD 300 million a year in terms of forest catchment protection, erosion control and water purification services. Almost 1 million urban dwellers rely on natural wetlands for wastewater retention and purification services[62]. Work carried out in the Zambezi Basin in Southern Africa shows that natural wetlands have a net present value of more than USD 64 million. That is USD 16 million in terms of groundwater recharge, USD 45 million in terms of water purification

Photo: SIWI

Ecosystem types	Total value per hectare (USD per year)	Total global flow value (USD billion per year)
Tidal marsh/mangroves	6,075	375
Swamps/floodplains	9,990	1,648
Lakes/rivers	19,580	3,231
Total		5,254

Global and per hectare values of ecosystems have been calculated based on the estimation of the indirect values of the aquatic ecosystems in flood control, groundwater recharge, shoreline stabilization, and shore protection, nutrition cycling and retentions, water purification, preservation of biodiversity, and recreation and tourism.

Table 2.1 Value of aquatic ecosystem water services.
Source: Costanza et al., 1997.

In Uganda alone, the use of inland water resources is worth almost USD 300 million a year.

and treatment services and USD 3 million in reducing flood-related damage costs[63].

The improvement of water resources management has several productive benefits. The effect of water use related degradation of ecosystem services on overall productivity has so far been limited by bringing new lands under cultivation. However, cumulative global productivity loss due to land degradation has been roughly estimated at 12% of total productivity. This translates to an average annual rate of productivity loss of 0.4%[64]. Of course, this average value does not capture the wide deviation of productivity losses across regions, which ranges from near zero in China to at least 30% productivity loss in Pakistan[65].

Better water management and changed agricultural policy might have saved Uzbekistan and Kazakhstan from the catastrophic deterioration of the Aral Sea. The surface area of the sea has declined 50% since around 1960, due largely to unsustainable upstream water withdrawals for intensive irrigation. As the sea shrunk and salinized, biological productivity declined steeply. A 1979 study already concluded that aggregate damages within the Uzbek Republic, which has suffered the greatest harm, totalled USD 4 billion[66]. Fisheries, hunter and trappers and households incurred most of these losses[67]. Approximately 3.5 million people around the sea have suffered sfrom declining fisheries, loss of wetlands, health damages

from blowing salt and pesticides, and highly saline groundwater[68].

2.3.1 Floods, Droughts and the Economy

Key Points

- The public and private investment needed to improve water resources management also mitigate damage from natural disasters. Flooding alone cost the world economy USD 27.3 billion in 2002.
- Poor countries in particular can make the biggest economic gains to mitigate natural disasters. The flood control functions of wetlands can provide annual flood attenuation benefits of more than USD 1750 per hectare of wetland area.

The poor in low-income countries remain acutely vulnerable to exogenous shocks. Shocks such as natural disasters (floods, droughts) have significant adverse consequences on growth prospects in these countries, particularly in the agricultural communities that lack sufficient water resources management. Furthermore, providing access to water and sanitation services to these communities as well as better water resources management (better irrigation practices, protection of freshwater ecosystems) would be an enormous step towards lifting these groups out of poverty, reducing their vulnerability and promoting equitable growth in the longer term. Flooding alone cost the world economy USD 27.3 billion in 2002. Floods in Asia resulted in economic losses of approximately USD 6 billion and 3500 fatalities in 2002[69].

Between 1991 and 2000 over 665,000 people died in 2,557 natural disasters, of which 90% were water-related events. Ninety-seven percent of the victims were from developing countries[70]. Evidence of the broad economic impacts of droughts and floods is abundant:

- The drought in Zimbabwe in the early 1990s brought a 45% decline in agricultural production, an 11% decline in GDP and a 60% decline in stock markets;
- The 1997–98 El Nino floods in Kenya caused economic loss exceeding USD 1.7 billion; the 2000 floods in Mozambique led to a 23% reduction in GDP; the drought of 2000 in Brazil halved projected economic growth; in the 1998 El Niño, Peru suffered USD 2.6 billion in damages to public infrastructure, equivalent to 5% of GDP;
- Losses due to landslides in Venezuela in 1999 cost USD 10 billion, equivalent to 10% of GDP;
- In Honduras, Hurricane Mitch caused damages equivalent to 70% of GDP, with huge repair costs (10% of GDP) and an increase in poverty from 63% to 66%.

Photo: Mats Lannerstad

Flooding alone cost the world economy USD 27.3 billion in 2002. Floods in Asia resulted in economic losses of approximately USD 6 billion and 3500 fatalities.

Box 7 Water-Related Disasters and the Cost to the Global Economy

Economic losses from floods, droughts and climate variability are significant.

- El Niño floods (1997–98) caused an estimated economic loss exceeding 1.7 billion USD in Kenya and 2.6 billion USD in Peru.
- Mozambique suffered a 23% reduction in GDP following the floods in 2000.
- Between 1987 and 1997, 44% of all flood disasters affected Asia, claiming 228,000 lives (roughly 93% of all flood-related deaths worldwide). Economic losses for the region totalled USD 136 billion.
- There were 2,200 water-related disasters from 1990 to 2001.

Source: Hansen and Bhatia (2004)

Improved water resources management mitigates natural disasters and protects economic gains. The most important function of the Muthurajawela Marsh in Sri Lanka, for example, was found to be local flood control. According to IUCN it provided annual flood attenuation benefits of more than USD 5 million, or USD 1750 per hectare of wetland area.

Photo: SIWI

3. How Much would it Cost to Act?

Key Points

- The public and private investment needed for improved water supply and sanitation and water resources management is considerable. However, broken down to country-level cost estimates, it is clear that meeting such investment challenges is reachable.
- WHO estimates that halving the proportion of people without sustainable access to both improved water supply and improved sanitation (i.e. meeting the MDG target) would cost around USD 11.3 billion annually. The cost to meet the MDG on water supply and sanitation in Bangladesh, Cambodia, Ghana, Tanzania and Uganda is modest and ranges from approximately USD 4 to USD 7 per capita on an annual basis.
- The total estimated investment needs for 11 African countries to reach water security amounts to USD 200 billion. Within the next ten years, countries in Sub-Saharan Africa need to make annual investments between USD 15 to USD 70 per capita to reach a level of water storage infrastructure equivalent to South Africa's.

3.1 Improving Access to Water Supply and Sanitation

3.1.1 Global Level Cost Estimates

WHO has prepared estimates based on several different levels of service, reaching beyond the MDG targets[71]. They estimate that halving the proportion of people without sustainable access to both improved water supply and improved sanitation (i.e. meeting the MDG target) would cost around USD 11.3 billion annually. Access for all to improved water and sanitation services would cost around USD 22.6 billion per year. Another USD 2 billion would provide water treatment using chlorine and safe storage, taking the global cost to USD 24.6 billion. Access for all to regulated in-house piped water supply with quality monitoring and in-house sewerage connection with partial

Photo: SIWI

treatment of sewage would require a total investment of USD 136.5 billion per year. These cost estimates are taken up in Section 4 – Cost-benefit Analysis[72].

The World Bank estimated in 2003 that an additional investment of USD 15 billion per year is required to reach the Millennium target on water and sanitation. Other global financing costs range[73] from USD 30 billion to USD 102 billion for water supply, and from USD 24 billion to USD 42 billion for sanitation for the period 2001–15. There is no "absolute" cost figure, as much will depend upon the technologies adopted and country-specific preferences and conditions. Taking an average of the extremes would provide a conservative cost estimate of USD 68 billion for water and USD 33 billion for sanitation, or a total cost of USD 101 billion and an annual average of USD 6.7 billion (over 15 years).

Although these are considerable sums, the cost per capita is in fact moderate. The OECD calculates that meeting the MDG target for sanitation and water services in Ghana would cost on average USD 7.40 per person on an annual basis between 2006 and 2015[74]. These sums are targeted towards those where there is the most to gain, where the benefit is highest.

The OECD calculates that meeting the MDG target for sanitation and water services in Ghana would cost on average USD 7.40 per person on an annual basis between 2006 and 2015.

3.1.2 Country and Local Level Cost Estimates

Investment needs at the country level are able to reflect "how much would it cost" with a higher degree of accuracy. The Millennium Project Needs Assessment provides a snapshot of a few countries in terms of what is needed at the country level. Some of these figures are presented here. Table 3.1 presents a summary of some of the figures that have been prepared.

Total cost estimates in 2003 (millions of dollars)					
Period	**Bangladesh**	**Cambodia**	**Ghana**	**Tanzania**	**Uganda**
2006	689	50	133	160	63
2010	829	77	166	223	106
2015	1,178	151	263	545	336
2006–15					
Overall	8,719	882	1,797	2,764	1,467
Average per year	872	88	180	276	147
Average annual % of GDP, 2006–15	1.0	1.3	2.0	1.6	1.2
Per capita total cost estimates in 2003 (dollars)					
2006	4.4	3.3	6.0	4.1	2.2
2010	5.0	4.6	6.9	5.3	3.2
2015	6.5	8.2	10.0	11.9	8.6
2006–15 average per year	5.2	5.3	7.4	6.5	4.3

Table 3.1 Resource requirements for reaching MDG Water and Sanitation Target in five low-income countries, 2005–2015.
Source: UN Millennium Project (2004).

An estimated annual average of USD 5.20 per capita from 2004 to 2015 will be required to bring Bangladesh to the MDG target.

Tanzania, for example, is one of the poorest countries in the world, with an annual per capita income estimated at USD 257. Tanzania receives USD 27 in ODA per capita, of which an estimated USD 5 only goes towards the MDGs[76]. Forty-eight percent of the rural and 86% of the urban population had access to safe water in 2000. Likewise, 41% of the rural and 53% of the urban population had improved access to sanitation. In order for Tanzania to reach its MDG target for sanitation and water, it is estimated that per capita spending on these services will have to increase from USD 4.10 in 2006 to USD 11.90 in 2015. At the country level, this implies an average annual investment of USD 276 million[77]. The lack of domestic resources means that between a third and a sixth of this funding will have to come from outside Tanzania.

Cambodia is recovering from prolonged conflict where the foundations for human development and economic growth are being restored. Currently, 36% of the population is below the national poverty line. Water and sanitation are major challenges for Cambodia, especially in rural areas, where 30% have access to improved water services and 8% have access to improved sanitation. In Urban areas, the statistics are higher (but daunting nonetheless) at 58% and 53%, respectively. Cambodia is off track to meeting the MDG water and sanitation target. The investment needs stand at USD 3.30 per capita in 2006, increasing to USD 8.20 in 2015, or an average annual investment of USD 88 million over those 10 years. Approximately a quarter of the total financing will have to come from outside Cambodia[78].

In Bangladesh 50% of the population lived below the national poverty line in 2000. Access to improved sanitation, while increasing during the 1990s, remains low and substantial investments are still required. However, Bangladesh does have higher access to safe drinking water in both rural and urban areas and is on track for reaching the water MDG target. An estimated annual average of USD 5.20 per capita from 2004 to 2015 will be required to bring Bangladesh to the MDG target. Between a quarter and a sixth of this funding will have to come from outside Bangladesh[79]. National cost estimates require further refinement. For example, it has been shown that it is relatively more costly to develop urban sanitation systems than rural[80]. Any national cost estimate must also take into account the demographic trends indicating that in about 30 years there will be more people in urban than rural areas.

Further work is required to develop a more accurate understanding of both the global and local financial requirements to meeting the water supply and sanitation targets. One difficulty is the lack of knowledge in many developing countries on what can be rehabilitated and at what cost. The cost benefit analyses done by WHO among others is a significant step towards improving this lack of critical information.

Photo: Daniel Dahmén

3.2 Improving Water Resources Management and Water Infrastructure

What would it cost to improve water resources management? What would it cost to not only reduce the vulnerability of the economy to water-related shocks, but also to improve the sustainable use of water resources? The costs presented in this section provide an order of magnitude estimate at regional and local levels for improving water resources management and water infrastructure.

Available data suggest that countries in Sub-Saharan Africa might need to invest between USD 150 and USD 700 per capita to reach a level of water storage infrastructure equivalent to South Africa's[81]. Spread out over the ten years between 2005 and 2015, these investments would amount to USD 15 to USD 70 per capita.

Available data suggest that countries in Sub-Saharan Africa over the next ten years might need to invest between USD 150 and USD 700 per capita to reach a level of water storage infrastructure equivalent to South Africa's.

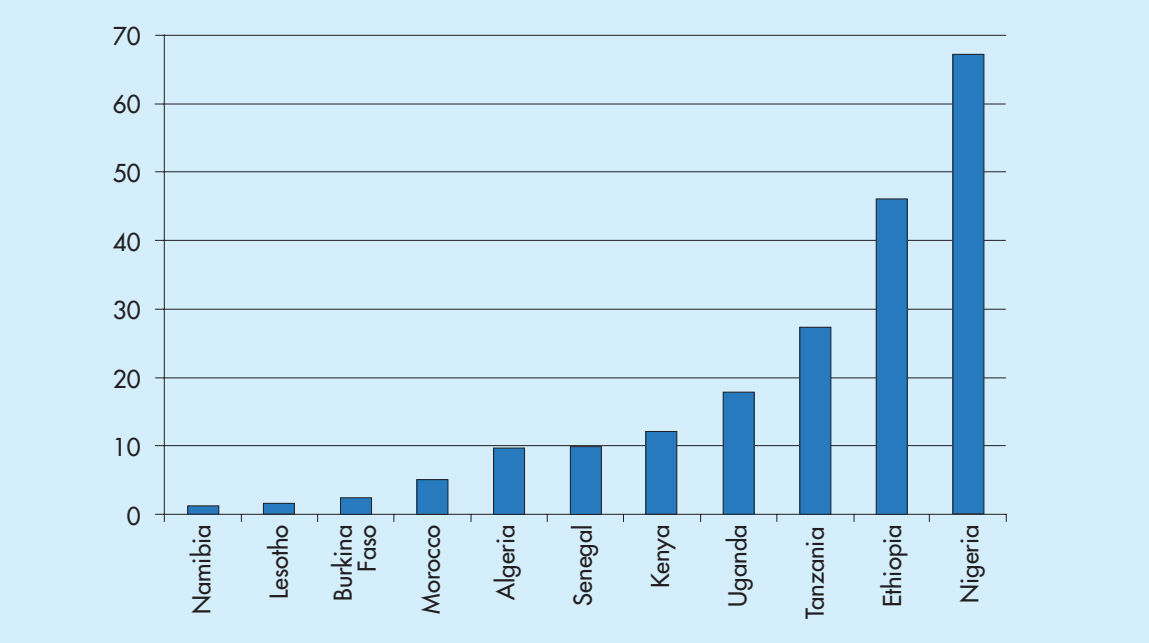

Figure 3.1 Water storage investments required in Africa. USD Billions. (source: Grey 2004 – World Water week Presentation)

Photo: Mats Lannerstad

An example from Gansu Province, China, showed that investment of a mere USD 12 per capita was sufficient in the specific case context to acquire upgraded water supplies and supplementary irrigation.

Figure 3.1 provides a World Bank estimated breakdown of the water storage investments that would be required in several African states. The costs are based on estimates of what level of water storage would be required in order to provide water security to the population. The total estimated investment need for the listed countries tops USD 200 billion. Nigeria, Ethiopia and Tanzania are the three countries where the required investments are highest.

The case of the Kenyan drought of 2000 illustrates the importance of such investment in water infrastructure and better water resources management. The manufacturing sector in Kenya was hit particularly hard from shortages of agricultural inputs, water supply for production and power supply. Real output in the manufacturing sector declined by 1.4% in 2000. Kenya requires investments of approximately USD 12 to 16 billion[82] in order to develop the same per capita water storage as South Africa – another country faced with a similar climate. The costs for improved water resources management and infrastructure depend on technologies applied. An example from the Gansu Province, China, using rainwater harvesting technologies showed that investment of a mere USD 12 per capita was sufficient in the specific case context to acquire upgraded water supplies and supplementary irrigation. The particular project benefited close to 200,000 households[83].

Photo: SIWI

However, simply building more water infrastructure is not the only strategy available to reduce water vulnerability. The World Bank has found that there are often sharply declining returns on water infrastructure investment[84]. They show that the cost of a cubic metre of water provided by the next scheme is often two to three times the cost of the current scheme. Thus, water conservation and demand management can result in significant savings by postponing the need to invest in new water supply infrastructure projects. Gauteng, in South Africa, provides a stark illustration. Growth in water demand must be met with a USD 1.5 billion investment on new wastewater treatment plants and a USD 2.7 billion investment on new water augmentation schemes. The potential annual financial savings of postponing the project is about 7% of the cost of that infrastructure. In other words, delaying these projects by a year would save approximately USD 300 million[85].

Morocco is another example of a country that lacks adequate water resources infrastructure. The government has spent USD 4 billion through 2005 to secure safe supplies of drinking water throughout the country. Efforts also include the upgrade of irrigation systems that could help stabilise the annual cereals harvest. The World Bank has indicated that the country could face a serious reduction in water availability unless improved water management techniques are introduced[86].

In developing local and national financing and adaptive strategies to climate shocks, the role of virtual water should also be taken into account. Alternatively, or as a supplementary measure, countries can strive to diversify economies and shift away from water-intensive agriculture and industries to reduce water scarcity as well as drastically reduce investment needs.

Photo: SIWI

4. Economic Cost-Benefit Analysis

Key Points

- Actions of improved water supply and sanitation imply significant economic gains. An additional annual investment of USD 11.3 billion is required to meet the MDG on water supply and sanitation. But compare this figure with the total annual accrued economic benefits – USD 84 billion – of reaching the MDG. It is more than a seven-fold return. The economic returns depend on region and technology choice and range between USD 3 and USD 34 for every USD 1 invested.
- The achievement of the MDG on water supply and sanitation will contribute 322 million working days globally, and the annual global value of adult working days gained as a result of less illness would be almost USD 750 million. The biggest potential gain for increased productivity and production within both households and economic sectors is found in terms of the total time saving: water collection and sanitation convenience amounts to USD 64 billion. The greatest proportion of time gain is from sanitation interventions, that is closer proximity of toilets or less waiting time for public facilities.
- Actions to improve water resources management bring considerable economic gains – a USD 15–30 billion investment in improved water resources management in developing countries can have direct annual income returns in the range of USD 60 billion. Every USD 1 invested in watershed protection can save anywhere from USD 7.50 to nearly USD 200 in costs for new water treatment and filtration facilities.

Evaluating the economic costs of interventions and the resulting benefits is critically important for effective resource allocation. While many criteria help determine where resources should be targeted, such as social and environmental considerations, a sound economic cost-benefit analysis is a vital and useful tool for decisions makers.

Poverty reduction strategies dominate the current development agenda. This report argues that investments in improved access to water and sanitation services are one of the most effective ways of promoting the equitable economic growth that is a prerequisite for poverty alleviation. However, the benefits and the costs of different interventions vary considerably depending on the type of technology selected. Informed and rational decision making requires sound economic evaluation of the various options available and appropriate to different contexts. This chapter presents some of the different approaches that have been taken using a cost-benefit approach ranging from reaching the MDG targets to universal coverage and from the global level to the local level.

It is important to note that the analyses presented here consider some, but not all, of the costs and

Photo: Mats Lannerstad

benefits that have been covered in the report thus far. It is simply not possible to include all of the factors in such an analysis. The costs of implementing and the benefits derived from flood or drought mitigation, maintenance of fisheries or wetlands, and long-term benefits accrued through improved health and education are difficult, maybe impossible, to price on a global level. The approach taken here is to consider those factors that are measurable; namely the direct benefits through savings in time, health care and so forth derived from a well-defined and costed set of interventions.

4.1 Water and Sanitation

WHO cost estimates are the most sophisticated currently available as they take into account existing levels of service and incremental improvements[87]. Their evaluation estimates the costs and benefits of a range of interventions including achieving the MDG target using basic technologies to providing universal access to in-house piped water and sewer connection. The costs of providing access to safe water and adequate sanitation will vary from relatively "expensive" when high standards are applied and sophisticated technology is used, to substantially "cheaper" when simple technology that demands low maintenance is used. In this analysis, "improved" water supply and sanitation refers to low technology improvements such as better access and protected water sources (e.g. stand post, borehole, protected spring or well or collected rainwater). "Improved" sanitation involves better access and safer disposal of excreta (e.g. septic tank, simple pit latrine or ventilated improved pit-latrine).

Costs of water improvement vary from USD 0.33 per person served per year in Africa for household water treatment using chlorine, to USD 12.75 for household water connection, including both hardware and software components. For sanitation the costs range from a cheap small pit latrine at USD 4.88 to a more expensive option with household sewer connection and partial treatment of wastewaters at USD 10.03 per year per person served[88]. The WHO report identifies a number of economic benefits associated with improved water supply and sanitation. These are provided in Table 4.1

BENEFICIARY	Direct economic benefits of avoiding diarrhoeal disease	Indirect economic benefits related to health improvement	Non-health benefits related to water and sanitation improvement
Health sector	• Less expenditure on treatment of diarrhoeal disease	• Value of less health workers falling sick with diarrhoea	• More carefully managed water environment and effect on vectors
Patients	• Less expenditure on treatment of diarrhoeal disease & related costs • Less expenditure on transport in seeking treatment • Less time loss due to treatment seeking	• Value of avoided days lost at work or at school • Value of avoided time loss of carer for sick babies • Value of loss of death avoided	• More carefully managed water environment and effect on vectors
Consumers			• Time savings related to water collection or accessing sanitary facilities • Labour-saving devices in household • Switch away from more expensive water sources • Property value rise • Leisure activities and non-use value
Agricultural and industrial sectors	• Less expenditure on treatment of employees with diarrhoeal disease	• Less productivity impact of workers being off sick	• Benefits to agriculture and industry of improved water supply – time-saving or income-generating technologies and land use changes

Table 4.1 Economic benefits arising from water and sanitation improvements.

Beyond reducing water-related diseases, providing better access to improved water and sanitation confers other diverse benefits, ranging from the easily identifiable and quantifiable (costs avoided, time saved) to the more intangible and difficult to measure (convenience, well-being, education, etc.). Actions to reach the MDG target on water supply and sanitation have considerable economic benefits and the benefits outweigh costs substantially[89]:

- The biggest potential gain for increased productivity and production within both households and economic sectors is found in the total convenience time saving – water collection and sanitation access time saved due to improved access – that amounts to USD 64 billion. For example, the relocation of a well or borehole to a site closer to user communities, the installation of piped water supply in house and closer access to latrines can save hours each day, translating into increased production and higher school attendance.
- Meeting the MDG target implies an annual health sector cost saving of USD 7 billion. An additional USD 340 million is saved due to avoidance of costs incurred by seeking treatment, including expenditures on care, drugs and transport and the opportunity costs of time spent on seeking care.
- Meeting the MDG target will gain 322 million working days and the annual global value of adult working days gained as a result of less illness would be almost USD 750 million. Another set of benefits related to reduced illness are the avoided "days lost" in terms of formal or informal employment, productive activities in the household or school attendance. The WHO analysis assumes that time spent ill represents an opportunity cost that is valued conservatively at a rate linked to minimum wage. The school attendance days gained reaches a staggering 270 million days. It implies enormous long-term

The annual global value of adult working days gained as a result of less illness would be almost USD 750 million.

benefits for economic development.

- Table 4.2 presents the total annual economic value for selected sub-regions and compares four levels of intervention. The total global economic benefits for reaching the MDG accrue to USD 84 billion. Access for all will accrue USD 263 billion in economic benefits. The economic benefits would be greater in regions where the number of unserved is high and where the diarrhoeal disease burden is significant. Table 4.2 shows that the African region will accrue the greatest absolute economic benefits at a cost-benefit ratio of 11.3.
- The results of this analysis point out that achieving the MDG target for both water supply and sanitation would bring substantial economic benefits. USD 1 invested would bring an economic return of between USD 3 and USD 34, depending on the level of intervention.

Photo: Mats Lannerstad

Region	Cost-benefit ratios and , Total economic benefits by intervention											
	Halving the proportion of people without access to both improved water supply and improved sanitation. Meeting the MDG Target.			Access for all to improved water and improved sanitation services			Access for all to improved water and sanitation services plus household water treatment at point of use			Access for all to regulated in-house piped water an sewerage connection		
Select countries within:	**Cost/Benefit**	**Annual Costs in USD millions**	**Annual Benefits in USD millions**	**Cost/Benefit**	**Annual Costs in USD millions**	**Annual Benefits in USD millions**	**Cost/Benefit**	**Annual Costs in USD millions**	**Annual Benefits in USD millions**	**Cost/Benefit**	**Annual Costs in USD millions**	**Annual Benefits in USD millions**
Africa	11.33	2021	22908	10.89	4043	44036	14.269	4360	62214	4.39	24729	108441
America	10.21	157	1607	10.59	315	3334	13.77	368	5074	3.88	2320	9007
Europe	3.40	71	242	6.55	143	934	5.82	266	1551	1.27	4206	5337
E. Mediterranean	34.95	100	3505	42.50	201	8523	61.47	250	15355	14.49	3275	47431
South East Asia	3.16	3628	11457	7.88	7257	57155	9.41	7704	72478	2.90	35074	101643
Western Pacific	3.36	3282	11013	6.63	6563	43487	7.89	6957	54885	1.93	28129	54426
Rest of the world		2046	33668		4087	105410		4744	132549		38782	229616
Total	7.50	11305	84400	11.63	22609	262879	13.96	24649	344106	4.07	136515	555901

Table 4.2 Cost-benefit ratios and total economic benefits for four interventions – all costs and all benefits included.

Note: The countries included in each region are those with the highest adult and child mortality rates.
A complete listing of each of the countries that are included in each of these categories is provided in Hutton & Haller (2004).
The region "Africa" includes both category E and category D African countries as identified by Hutton & Haller (2004).

The considerable economic benefits are confirmed by others. OECD[90] has prepared a cost-benefit analysis looking specifically at what is needed in order to meet the MDG sanitation target alone. The analysis provides figures in terms of net present value (NPV). With a discount rate of 5% and 10%, the NPV of the meeting the MDG sanitation target is USD 400 to USD 312 billion, respectively. The results confirm again that the benefits far outweigh the costs[91]. Similar economic benefits also appear if we look at local water supply and sanitation interventions, see box 8.

Universal improved access to water and sanitation services, including additional improvements such as point-of-use disinfection, would lead to an economic benefit ranging from USD 5 to USD 60 per dollar invested[92]. Choosing more advanced types of technologies such as provision of regulated in-house piped water and sewer connection would lead to massive overall gains, including an average global reduction of diarrhoeal episodes of around 70%[93]. But this type of intervention is also the most expensive; achieving universal access to in house piped water and sewer connection would cost every year more than USD 130 billion.

The burden of disease associated with lack of access to safe water supply, adequate sanitation and lack of hygiene is concentrated on children under five in developing countries. Accordingly, emphasis should be placed on interventions likely to yield an accelerated, affordable and sustainable health gain among this group. The present analysis points to household water treatment and safe storage as one option of particular potential as a good short-term approach to rapidly and efficiently reducing diarrhoea illness, assuming that this is followed with longer-term improvements to water and sanitation services. In terms of convenience time saved, improved sanitation has the biggest gain.

The NPV of the meeting the MDG sanitation target is USD 400 at 5 % level, to USD 312 billion, at 10 % level respectively.

Box 8
Net Present Value of Water Supply and Sanitation Interventions

Over the last two decades, India has implemented major investment programmes in rural water supply and sanitation. Karnataka was the site of a USD 200 million project that was completed in 2001, providing direct benefits to approximately 5.5 million people. The economic and social benefits were enormous. For one, it is the women who are in charge of providing water for home use, household cleanliness and sanitation. It was therefore the women whose quality of life benefited the most from the improved services. Ranges of different technologies were implemented, including pit latrines, and hand pumps/open wells or roof water harvesting schemes. Up to 50% of the households opted for private household systems. The NPV of the project is estimated at USD 85 million, and the economic internal rate of return is over 20%[94].

Senegal provides another example of the costs and the benefits that water services projects can bring. A World Bank project set out to improve water management and increase access to safe potable water and adequate and more affordable sanitation for the urban poor. USD 185 million went towards two water mains that tap groundwater resources through to its the distribution through over 80,000 social connections and 400 standpipes to the poorer residence of Dakar. USD 24 million went towards improving sanitation services, with approximately 13,000 new connections installed, sewerage treatment plants and drainage works. Overall, it is estimated that more than 1 million urban and peri-urban poor benefited from the project. The total cost was USD 290 million, the Economic Internal Rate of Return was 13.7 percent and the Net Present Value at 10% was USD 46.6 million[95].

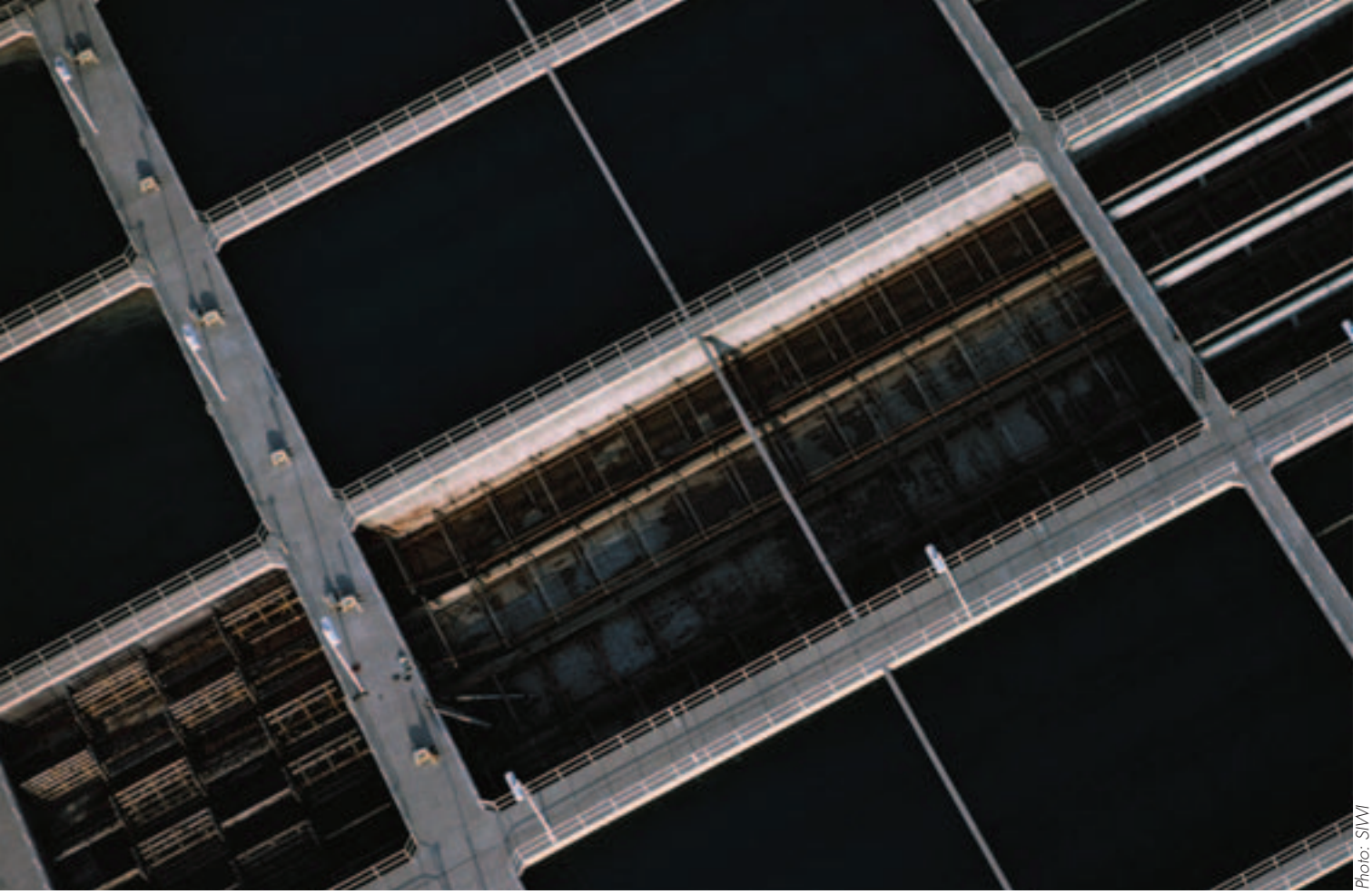

Photo: SIWI

4.2 Water Resources Management

An expert workshop convened by the United Nations on water economics and financing in 1998 concluded that "the economics of water resources rarely influence water policy, even in water-short regions. As a result, the principal asset of the water resource base remains highly undervalued and readily used without much concern for its value to others, the structural role of water in the economy and its in situ value as an environmental asset[96]".

This quotation indicates that decision makers typically need to enhance their awareness of the value and economic benefits of water resources and its management. Improved water resources management implies considerable costs, but these are significantly outweighed by the economic benefits. For example, in Portland, Oregon, Portland, Maine and Seattle, Washington it has been found that every USD 1 invested in watershed protection can save anywhere from USD 7.50 to nearly USD 200 in costs for new water treatment and filtration facilities. Through conserving upstream forests in the Catskills range, New York City hopes to have avoided investing an extra USD 4–6 billion on infrastructure to maintain the quality of urban water supplies[97].

Every USD 1 invested in watershed protection can save anywhere from USD 7.50 to nearly USD 200 in costs for new water treatment and filtration facilities.

Hansen and Bhatia (2004) venture to estimate that direct annual income lost due to land and water mismanagement in developing countries is in the magnitude of global foreign aid transfers (which currently stand at USD 60 to 70 billion). However, this estimate of the losses might even be low, since one runs into the challenge of setting a monetary price to things that are uncertain and intangible. At the same time, they argue that measures that could prevent such damages would cost no more than 25–50% of the annual losses. This means that a USD 15–30 billion investment in improved water resources management have direct economic returns in the range of USD 60 billion. For example, poor water resources development and management approaches in Kenya costs the country more than USD 48 million per year, about 0.6% of GDP[98]. There is however a need to also take into account that improved water resources management is beneficial for better health and economy. Box 9 points out that there are considerable health improvements and economic gains that can be made by improved management of water resources and related infra-structure.

Another example of the benefits of improved water resources management at the local level concerns a biological control program of water hyacinth. The project was undertaken in Southern Benin between 1991 and 1993[99]. According to estimates, water hya-

cinth at the peak of the infestation had reduced the yearly income of this population of about 200,000 by approximately USD 84 million. Lost revenues for men were mostly in fishing, while women experienced lost revenues in trade, primarily food crops and fishes. The reduction of water hyacinth cover through biological control was credited with an increase in income of USD 30.5 million per year. The total cost of the control program is estimated at a present value of USD 2.09 million. Assuming the benefits stay constant over the next 20 years, a most conservative assumption, the accumulated present value would be USD 260 million, yielding a respectable benefit cost ratio of 124:1[100].

Small changes in technology have the potential to provide massive productivity gains. There has been an upsurge in the adoption of water technologies for poor farmers such as low-cost bucket and drip lines, sustainable land management practices such as low or zero-till agriculture, supplemental irrigation, groundwater recharge and water harvesting systems. The evidence suggests that the promotion and adoption of these simple technologies has the potential to improve the livelihoods of the poorest farmers. Consider drip irrigation. The advantages of drip systems are that they minimise water losses and increase yields. Drip irrigation technology seeks to deliver the right quantity of water at the right time, increasing yields between 20% to 70%, while using less water than traditional methods[101]. A farmer in Nepal for example, buys a kit for about USD 13 a piece. The total net benefits, subtracting all costs except labour, obtained by each farm household were USD 210 per thousand square metres and the total NPV for 3 years (10% discounting rate) would be USD 570 per farmer[102].

Another example is the foot-operated "treadle pump", a device that uses bamboo or flexible pipe to pump water. The treadle pump is cheap and affordable, costs between USD 12–30, is easy to install, operate and maintain and has no fuel costs. The total NPV of a treadle pump to a farmer is approximately USD 900 to 1,900 (discounted at 10 and 5%, respectively). For the 1.5 million treadle pump users today, the total NPV then is USD 1.4 to 2.8 billion. If markets in Eastern India and the Nepal Terai are developed, the potential NPV amounts to USD 9–19 billion[103].

The drip irrigation and treadle pump are but two examples of the benefits of providing access to small-scale water technology to poor farmers. There are in fact a wide variety of technologies available. The direct total net benefits of promoting these technologies have been estimated to be USD 100–200 billion for the estimated 100 million farmers that could adopt these tools[104]. When including indirect benefits in the economy, with a multiplier of 3, the total net benefits (NPV) can increase to USD 300–600 billion.

The potential benefits of investment in water resources management is illustrated by a small-scale water resources development project in Bangladesh. The Asian Development Bank and the International Fund for Agricultural Development helped finance the USD 51 million project which focused on increasing agricultural production and farmer incomes. The Project includes several components including: development of infrastructure for flood control, drainage improvement, water conservation measures, introduction of integrated pest management, and mitigating measures to reduce loss of floodplain fisheries. The Project is spread over 37 districts of the western region of Bangladesh covering 164,735 ha. As a result of the project, some areas saw agricultural yield increased by 60%. The overall internal rate of return of the project is estimated at around 30%[105].

Though systematic empirical evidence on the benefits is scant, the statistics to be found on the subject present a convincing case that the potential benefits of investment in improved water resources management are real and considerable.

The direct total net benefits of promoting these technologies have been estimated to be USD 100–200 billion for the estimated 100 million farmers that could adopt these tools.

Box 9 Better Water Resources Management Benefits Health and Economy

Improved management of water resources would reduce the transmission of malaria and other vector-borne diseases. There are currently 396 million episodes of malaria every year, mostly in Sub-Saharan Africa. At the global scale 1.3 million people die of malaria every year. Children under the age of 5 account for 90% of these deaths. Intensified irrigation, dams and other water-related projects contribute importantly to this disease burden[106].

The economic gains to reduce malaria and other vector-borne diseases are considerable. For example, consider the effect of Malaria on Sub-Saharan Africa's economy. GDP would be up to 32% higher today if malaria had been eliminated 35 years ago. This would represent up to USD 100 billion added to Sub-Saharan Africa's current GDP of USD 300 billion. Malaria slows economic growth in Africa by up to 1.3% each year. This slowdown in economic growth is over and above the more readily observed short-run costs of the disease. The short-term benefits of malaria control, through for example more effective water management, have been estimated at between USD 3 billion and USD 12 billion per year for Sub-Saharan Africa[107].

4.3 Unproductive Costs – The Burden of Corruption

More than USD 1 trillion dollars (USD 1,000 billion) is paid in bribes each year worldwide in both rich and developing countries, according to estimates by the World Bank Institute (WBI).

Previous sections have demonstrated that improved management of water resources and improved water supply and sanitation implies considerable economic benefits. The importance of institutional quality and proper management of organisations thus implies considerable gains in terms of water resource and water services quality as well as effects on water productivity and production. Take corruption for example. Corruption undermines economic development and makes it harder to attain development targets. More than USD 1 trillion dollars (USD 1,000 billion) is paid in bribes each year worldwide in both rich and developing countries, according to estimates by the World Bank Institute (WBI). This is approximately equal to the combined GDP of all low-income countries. The estimation of global corruption costs does not take into account indirect costs in the form alternative uses of funds to improve, for example, water services provision, health and education.

A growing body of case studies indicate that corruption is a mounting problem within the water sector, costing the water sector millions of dollars every year. A study of the water supply and sanitation sector in a number of Indian cities indicated that:

- 41% of the customer respondents had made more than one small payment (median payment USD 0.45) in the past 6 months to falsify metre reading to lower bills;
- 30% of the customer respondents had made more than one small payment (median payment USD 1.90) in the past 6 months to expedite repair work:
- 12% of the customer respondents had made payment (median payment USD 22) to expedite new water and sanitation connections.

The study also indicated the frequency of side payments from contractors to public officials. In total, 50% of the public official respondents said that it takes place every time (17%) or that it was quite common (33%). The value of the kick-backs to public officials normally ranged from 6% to 11% of the contract value[108].

Aggregated empirical evidence is still insufficient to make generalisations on the magnitude of the problem and the extent to which it is blocking water development efforts. But it is clear that corruption and other types of improper management misdirect considerable financial resources that could have strengthened budgets and improved water, sanitation and other services. Consequently, the effective resolution of corruption and other mismanagement practices bolsters performance and effectiveness of both public and private sectors and contributes to a country's prospects for economic development and social stability.

Photo: SIWI

Photo: SIWI

5. Conclusions: Investing in Water is Good Business

The greatest economic benefits of improved water supply and sanitation and water resources management will be felt in those countries with the greatest water challenges.

Investing in improved water and sanitation and water resources management is good business for national economies and poor people. Poor people are disproportionately dependent on natural resources for their livelihood and hardest hit by low water and sanitation service access. Actions that target poor people have the highest marginal benefit.

Investing in the health of people, ecosystems and more efficient water use is an investment that not only provides immediate economic benefits, but it also safeguards future economic gains. It leads to more business, better adaptive capacities to climate variability and improved ecosystem services.

The overwhelming economic benefits of improved water supply and sanitation and water resources management provide a compelling case for decision makers to take immediate action to resolve water challenges. At the national and global levels there is considerable momentum towards making significant progress that will benefit poor people. The momentum should grow in light of the fact that the investments required are within reach for most countries.

The report concludes with **5 urgent investment messages** to decision makers in public and private sectors:

Investing in improved water and sanitation and water resources management is good business for national economies and poor people.

Message 1

Improved water supply and sanitation and water resources management boosts countries' economic growth and contributes greatly to poverty eradication.

Poor countries with improved access to clean water and sanitation services enjoyed annual average growth of 3.7%. Similarly poor countries (i.e. with the same per capita income) but without improved access had average annual per capita GDP growth of only 0.1%.

There is a causal relationship between access to water supply and higher income levels. Improved access to water and basic sanitation services in poor countries drives higher economic growth. Poor countries with improved access to clean water and sanitation services enjoyed annual average growth of 3.7%. Similarly poor countries (i.e. with the same per capita income) but without improved access had average annual per capita GDP growth of only 0.1%.

Lower GDP growth due to rainfall variability and extreme weather events, such as floods and droughts, is used as a proxy to illustrate the benefits. The Zimbabwean drought of the early 1990s resulted in a 45% decline in agricultural production, an 11% decline in GDP and a 60% decline in stock markets. Incomes and labour in developing countries rely heavily on agriculture, which thus make them more susceptible to rainfall variability. Also in the case of Zimbabwe, the fluctuations in GDP are positively correlated to rainfall variability.

As seen below in messages 2 and 3, the economic benefits of improved water supply and sanitation and water resources management are massive. Targeting poor people who have the most to gain implies providing the highest marginal benefit of interventions.

Message 2

The economic benefits of improved water supply and – in particular – sanitation far outweigh the investment costs, surprisingly good news for Northern and Southern decision makers who often view investments as mere costs.

The evaluation of health and socio-economic benefits of safe water and adequate sanitation results in a strong argument in support of further investments to improve access for poor people. Based on present WHO analysis, achieving the water and sanitation MDG target would definitely bring direct and indirect economic benefits to the health sector, individuals and households, and agricultural and industrial sectors, ranging from USD 3 to USD 34 per USD 1 invested, depending on the region.

To meet the MDG for water and sanitation implies total economic benefits of USD 84 billion. For example, the health-sector related costs avoided reach USD 7.3 billion per year, and the annual global value of adult working days gained as a result of less illness would be almost USD 750 million per year. The biggest potential gain is found in the total convenience time saving – water collection and sanitation access time saved due to improved access – it amounts to USD 64 billion. Improvement in sanitation, hygiene and water access contributes to improved health, generates savings for households and national health budgets and contributes to poor households' economies through reduced costs and losses of time. Saving time may enable productive activity and school attendance, especially for girls. Investment in water and sanitation — whether through development assistance at the national or community levels or by poor households themselves — makes sound economic policy. Estimates indicate that sanitation interventions often have a higher economic impact per dollar invested than water supply interventions, but it is the combination of improved water supply, sanitation and hygiene that has the biggest economic impact.

Based on the WHO figures, the OECD has prepared a cost benefit analysis looking specifically at what is needed in order to meet the MDG sanitation target alone. The analysis provides figures in terms of net present value (NPV). With a discount rate of 5% and 10%, the NPV of the meeting the MDG sanitation target is USD 400 to USD 312 billion respectively. The results confirm again that the benefits far outweigh the costs.

While economic cost-benefit comparisons attempt to make realistic assumptions about the economic value of potential savings, it is clear that social and environmental benefits are not fully reflected and that many of the accrued benefits are not immediate. For example, the economic growth benefits derived from improved education may not be realised until a decade later, once students have become part of the la-

bour force. Consequently, estimates of the economic benefits of investments in water supply and sanitation services are likely on the low side.

Investments in water supply and sanitation are perceived as having lower returns than in other sectors (for example, on roads or energy). Over the years it has become clear that raising the profile of sanitation and hygiene is difficult in part due to the fact that it is a subject shrouded in cultural taboo. In industrialised nations and amongst those in positions of power, this plays out as a reluctance to discuss the looming, ever present sanitary crisis. Lacking the facts, many people have assumed other development issues dwarf the sanitation crisis – there is a lack of public awareness and support for sanitation as a core development concern. Another part of the story is also that technical specialists, civil society actors and others have largely not been able to make a compelling case to decision makers concerning the economic and social benefits of access to water supply and sanitation services.

Message 3

National economies are more resilient to rainfall variability, and economic growth is boosted when water storage capacity is improved.

In many countries there is great scope for continued development of water resources management for large and small-scale water infrastructure to meet food requirements, mitigate natural hazards and promote energy and industry development. The difference in water storage per capita, a measure of water security, clearly demonstrates the need for investment and thus also the unexploited development potential through creating resilience to rainfall variability. For example, Australia and Ethiopia have similar degrees of climate variability, but whereas Australia has over 4,700 cubic meters of water storage capacity per person, Ethiopia has 43 cubic meters. It has also been suggested that annual income lost due to land and water mismanagement stands at around USD 60 to 70 billion a year when preventive, corrective and rehabilitative measures that could prevent such damages would cost no more than 25–50% of the annual losses.

Improved water resource management and water storage capacity makes the economy more resilient to external shocks, such as rainfall variability, and thus provide a stable and sustainable base for increased food and industrial productivity and production to maintain economic growth and development. The case of Kenya illustrates that frequent floods and droughts take a heavy toll on the economy, impeding poverty eradication efforts. These floods and droughts translate to a direct long-term fiscal liability of about 2.4% Kenya's GDP per annum. This implies that GDP would have to grow at an annual rate of at least 5–6% in order to start reducing poverty. In 1996, a good year in Kenya, real GDP growth was 4.1%.

Structural shifts away from water-intensive agriculture and industries could decrease economic vulnerability to water shocks. Equally and sometimes even more important is the shifts towards sectors where the country or a community has a comparative advantage in terms of water use efficiency. Relying on trade in virtual water to meet a country's power supply and food needs could drastically reduce unsustainable water use. Furthermore, it could also mitigate the need for diverting national resources as well as foreign direct investment and aid towards costly water supply projects to support water intensive activity in areas that do not have the necessary water resources.

Investments in water supply and sanitation are perceived as having lower returns than in other sectors (for example, on roads or energy).

Message 4

Investing in water is good business – improved water resources management and water supply and sanitation contributes significantly to increased production and productivity within economic sectors.

The need for reliable access to water and related services is well recognised among businesses. Often less obvious, but equally important to business development, is the role water and related services play in health, employment and economic development. Some of the economic benefits that arise from improved water supply and sanitation include less expenditure on treatment of employees with diarrhoeal disease; increased productivity due to less workers

Photo: SIWI

Improved water resources management throughout production and consumption cycles is good business practice.

are off sick and; and benefits to industry and agriculture of time-saving. It has, for example, been calculated meeting the MDG on water supply and sanitation will gain 322 million working days, and the annual global value of adult working days gained as a result of less illness would be almost USD 750 million. The biggest potential gain for both economic sectors and households is found in the total convenience time saving – water collection and sanitation access time saved due to improved access – it amounts to USD 64 billion. Studies in Africa indicate that households value their time spent collecting water at around the average wage rate for unskilled labour.

Improved water resources management throughout production and consumption cycles is good business practice. Providing reliable and sufficient water supplies is critical for business development and reduces investment risk. For example, a study in China points at the considerable gains that can be made by improved water quality. The industrial income lost due to water pollution amounted in 1992 to USD 1.7 billion. What is now becoming increasingly clear to many governments is to use reliable access to water resources as a competitive advantage to attract business opportunities. For example, the Malaysian Industrial Development Authority is marketing reliable access to water as a key advantage of investing in the Malaysian economy.

The annual per capita cost to meet the MDG on water supply and sanitation in Bangladesh, Cambodia, Ghana, Tanzania and Uganda ranges from approximately USD 4 to USD 7 per capita on an annual basis.

Message 5

The overall public and private investment needs for improved water supply and sanitation and water resources management are considerable. However, at the country level, meeting such investment challenges is highly feasible and within the reach of most nations.

What would it cost to reach the MDG on water supply and sanitation? WHO estimates that halving the proportion of people without sustainable access to both improved water supply and improved sanitation (i.e. meeting the MDG target) would cost around USD 11.3 billion annually. Access for all to improved water and sanitation services would cost around USD 22.6 billion per year. The World Bank estimated in 2003 that an additional investment of USD 15 billion per year to reach the Millennium target on water and sanitation. There is no "absolute" cost figure, as much will depend upon the technologies adopted and country-specific preferences and conditions. This is of course a considerable global investment challenge that must be met. But broken down into country cost estimates to reach the MDG on water supply and sanitation it is clear that meeting such investment challenges by 2015 is highly feasible. The annual per capita cost to meet the MDG on water supply and sanitation in Bangladesh, Cambodia, Ghana, Tanzania and Uganda ranges from approximately USD 4 to USD 7 per capita on an annual basis.

What would it cost to improve water resources management and infrastructure? Estimations suggest that there is a need for considerable investments to improve water resources management and expand country water storage capacity. The total estimated investment needs for 11 African countries tops USD 200 billion. Countries in Sub-Saharan Africa need to invest between USD 150 and USD 700 per capita to reach a level of water storage infrastructure equivalent to South Africa's. Spread out over the ten years between 2005 and 2015, these investments would amount to USD 15 to USD 70 per capita on an annual basis. The costs for improved water resources management and infrastructure depend on the technologies applied.

It is clear that investing in water is good for business and poverty eradication. The aggregated investment requirements to improve water supply and sanitation and water resources management are challenging and will by no means be easy, particularly in those poor countries plagued by social and political conflicts. But broken down into country estimates it is clear that it takes fairly moderate financing to reach the MDG on water and sanitation.

But how can such improvements be realised? What are the next steps that are required? In the following section, it is proposed that the "call to action" outlined by the United Nations Millennium Project Task Force on Water and Sanitation provides a platform for advancing investments to make lasting improvements.

5.1 What are the Ways Forward?

The water-related challenges and the urgency to resolve them have been confirmed and re-confirmed at the highest political levels. The Millennium Summit and the World Summit on Sustainable Development have made significant headway in identifying the water challenges, and to build momentum for desperately required actions. Currently, there is a high degree of awareness of the water-related social and environmental challenges. Resolving these challenges boosts countries' GDP and reduces poverty. The required actions will not only meet MDG target 10 on water supply and sanitation, but also help meeting other MDGs and the Johannesburg Plan of Implementation commitments.

It is critical that the economic benefits of improved water supply and sanitation and water resources management are understood, clearly articulated and included in national strategic macro-economic decision making. Investments in the water sector – sanitation in particular – must be acknowledged for the economic benefits they generate – the economic benefits outweigh costs considerably.

What are the required steps to action? The United Nations Millennium Project Task Force on Water and Sanitation cites five critical guiding principles or prerequisites to action that must be fulfilled to achieve not only the MDGs but also beyond. These prerequisites provide a starting point for the development of national and local action strategies that target case specific challenges and priorities. Drawing on the material used in this report it is clear that the economic benefits of implementing these prerequisites are highly effective in terms of economic development and growth. Below are proposed ways forward and snapshots of economic benefits that can derive from their implementation.

Prerequisite 1

There must be a deliberate commitment by donors to increase and refocus their development assistance and to target sufficient aid to the poorest low-income countries.

- **Example of economic benefit:** Aid interventions must to a greater extent focus on improved water supply and sanitation and water resources management. As has been shown interventions have considerable impacts that are going far beyond immediate project benefits. Just consider again that for every USD 1 invested in water supply and sanitation the direct and indirect benefits range from USD 3 to USD 34 depending on the region and level of intervention.

Prerequisite 2

There must be a deliberate commitment by governments of middle-income countries that do not depend on aid to reallocate their resources so that they target funding to their unserved poor.

- **Example of economic benefit:** The targeting of improved and extended water supply, sanitation and water resources management constitutes a pro-poor investment strategy. Consider the cholera epidemic that swept Peru in 1991 that cost USD 1 billion to treat and that hit the poorest the hardest. It is estimated that USD 100 million – or a tenth of what was actually spent – could have prevented the epidemic in the first place. Add to this the monetary expenses, the value of lost working days, and the lives lost, and the cost-benefit ratio of preventive investments in water and sanitation become astronomical.

It is critical that the economic benefits of improved water supply and sanitation and water resources management are understood, clearly articulated and included in national strategic macro-economic decision making.

Photo: SIWI

Photo: SIWI

Prerequisite 3

There must be deliberate activities to create support and ownership for water supply and sanitation initiatives among both women and men in poor communities.

- **Example of economic benefit:** Community ownership and participation are required for successful interventions. Over the last two decades, India has implemented major investment programmes in rural water supply and sanitation. Karnataka was the site of a USD 200 million project that was completed in 2001, providing direct benefits to approximately 5.5 million people. The economic and social benefits were enormous. For one, it is the women who are in charge of providing water for home use, household cleanliness and sanitation. It was therefore the women whose quality of life benefited the most from the improved services. Ranges of different technologies were implemented, including pit latrines, hand pumps/open wells or roof water harvesting schemes. Up to 50% of the households opted for private household systems. The NPV of the project is estimated at USD 85 million, and the economic internal rate of return is over 20%.

It is paramount that decision makers are aware that investment in the water sector is highly effective and that improved water supply and sanitation and water resources management is a part of the economic development business.

Prerequisite 4

There must be a deliberate recognition that basic sanitation in particular requires an approach that centres on community mobilisation and actions that support and encourage that mobilisation.

- **Example of economic benefit:** Community involvement and ownership is key for successful interventions. Estimates indicate that sanitation interventions often have a higher economic impact per dollar invested than water supply interventions. An OECD cost benefit analysis looking specifically at what is needed in order to meet the MDG sanitation target concluded: with a discount rate of 5% and 10%, the NPV of the meeting the MDG sanitation target is USD 400 to USD 312 billion, respectively. The results confirm again that the benefits far outweigh the costs.

Prerequisite 5

There must be a deliberate planning and investment in sound water resources management and infrastructure.

- **Example of economic benefit:** Interventions of improved water management and infrastructure must target poor sections of society. Targeting those with lowest capacities and levels of access to water for various productive uses is sound investment strategy. For example, interventions of providing access to small-scale water technology to poor farmers have huge economic benefits. The direct total net benefits of promoting these technologies have been estimated to be USD 100–200 billion for the estimated 100 million farmers that could adopt these tools. When including indirect benefits in the economy, with a multiplier of 3, the total net benefits can increase to USD 300–600 billion.

The fulfilment of these prerequisites to action is not possible without strong leadership and commitment from government, civil society and business leaders and opinion makers. Leadership sets priorities and instigates the reforms necessary to improve institutional performance and attracts investment. Where strong leadership and commitment have been accompanied by social marketing, significant progress has been made not only in access to water supply, but also to sanitation. It is paramount that decision makers are aware that investment in the water sector is highly effective and that improved water supply and sanitation and water resources management is a part of the economic development business.

Equitable economic growth is absolutely necessary for poverty reduction. Investment in the expansion of water supply and sanitation and water resources management, as discussed in this report, targets resources towards the disadvantaged and provides the infrastructure that is a basic prerequisite to economic participation. Equitable economic growth will not be possible unless water issues are taken on board. Even though there remain many challenges to increased public and private investments in water supply and sanitation and water resources management, the obstacles pale in comparison to the economic and social difference that such investments will make to poor people and to the entire economy.

Notes

1. WHO (2002)
2. SIWI et al. (2005)
3. Slaymaker & Newborne (2004)
4. Bojö & Reddy (2002)
5. For more information on the contribution of improved water resources management and access to water supply and sanitation to the MDGs see: UN Task Force on Water and Sanitation (2005) and WHO/UNICEF JMP (2004).
6. WWDR (2003)
7. Based on Hansen and Bhatia (2004)
8. World Bank (1994) figures 1 and 1.2.
9. WHO (2002)
10. WHO (2004)
11. Moss et al (2003)
12. Moss et al (2003)
13. Severe outcomes refer to more severe diseases such as cholera.
14. Bartram et al (2005)
15. Moss et al (2003)
16. Lvovsky (2001)
17. Michaelowa (2000)
18. WHO Technical Report Series No. 912 (2002)
19. Bhargava (1997)
20. UNICEF Press release; New York, 10 March 2003
21. www.irc.nl School sanitation
22. Warford and Yining (2002)
23. Hansen and Bhatia (2004)
24. Becker (1991)
25. Hansen and Bhatia (2004)
26. Sachs (2001)
27. Sachs argues convincingly that this health indicator is closely related to access to safe water and sanitation.
28. In this study, low infant mortality rates fall between 50 and 100 deaths per 1000 live births whereas high infant mortality is defined as greater than 150 deaths per 1000 live births. Data ranges between the period from 1965 to 1994.
29. Sachs (2001)
30. This estimate is based on comparison with a business as usual baseline.
31. Worldwide, agriculture uses 69% of water, compared with 23% by industry and only 8% by households. In contrast, agriculture's share of GDP in 2001 was only 5% globally, while industry's share was 31% and that of services 64%. In developing countries, however, the water proportion used by agriculture is very much higher, e.g. 97% in Pakistan, 93% in India, 87% in China, 86% in Egypt, and 76% in Indonesia, to list a few of the most populated developing countries.
32. World Bank, World Development Report (2003) tables 1.3.
33. Hansen and Bhatia (2004)
34. The issue of extreme events are taken up in Section 2.3.1.
35. Thakur, et al. (2000); Garcia, et al (2000); Hossain, et al (2000) among others.
36. Grey and Sadoff (2002)
37. World Bank, Water Resources Memorandum, Towards a water secure Kenya, (2004)
38. In developing countries, 80% of export earnings come from the agricultural sector
39. Securing food sources is seen by many as a precursor to development of a more advanced economy.
40. For a discussion on the virtual water concept see: Allan (1993) and Hoekstra & Hung (2002).
41. Presently, cereal trade reduces annual global crop water depletion by 6% and irrigation depletion by 11%. Estimates that take into account trends in virtual water trade forecast 19 percent less irrigation use in 2025 than those that do not include trade. Fraiture, et al (2004).
42. The value of total agricultural support in OECD countries is more than five times higher than total spending on overseas development assistance and twice the value of agricultural exports from developing countries.
43. FAO (1999a)
44. FAO (1999b)
45. Mekong River Commission (2001)
46. Press Release WHO/28 (2000)
47. Wang and Lall (1999)
48. According to the US Environmental protection agency.
49. Faruqui, N. (2003). These highly pure silicon wafers are used to fabricate microchips.
50. Chapagain and Hoekstra (2004)
51. People's daily. March, 2004
52. Hansen & Bhatia (2004)
53. http://www.mida.gov.my/beta/
54. www.idrc.ca/ policy brief on "Manila's Water Supply: Getting Water to Work" (1998)
55. World Bank (2004b)
56. World Bank (2004b)
57. www.unesco.org/water
58. Hansen & Bhatia (2004)
59. Chinese Ministry of Water Resources (2003)
60. World Bank (2000)
61. Emerton, L., et al. (2004)
62. NEMA, 1999
63. Turpie, J., et al (1999)
64. see Crosson (1995) and World Development Report (2003)
65. Hansen and Bhatia (2004)
66. Calculating the Ruble to US$ exchange rate is assumed at 1.33 RUB per US$ in 1979. The exchange rate at the time was fixed and is not adjusted for PPP.
67. Desiccation of the Aral Sea: A Water Management Disaster in the Soviet Union, www.ciesin.org/docs/006-238/006-238.html.
68. World Bank (2003b)
69. Munci Re (2002) Most of these economic losses occured in the developed countries of Europe as a result of the 2002 floods.
70. WWDR (2003)
71. Hutton and Haller (2004)
72. See Table 4.2
73. See the UN MDG Task Force 7 report, page 103.
74. OECD (2004)
75. These costs consider rural and urban differences in capital and operating costs for water and sanitation provision. They also consider the cost of rural and urban wastewater treatment and hygiene education.
76. World Bank (2003c).
77. UN Millennium Project (2004)
78. ibid.
79. Ibid.
80. See, for example, the UN MDG Task Force 7 report, pp. 88-90.
81. Grey (2004b)
82. Republic of Kenya (1998)
83. Gould, J. 1999.
84. 1993 World Bank Policy Paper on Water Resources Management
85. International Rivers Network http://www.irn.org/programs/lesotho/ws.report/ws5.incrsup.shtml
86. Enterprise Ireland - http://www.enterprise-ireland.com/Contact/MarketDev/Morocco.htm
87. Evans (2004)
88. Hutton and Haller (2004)
89. Hutton and Haller (2004)
90. Evans (2004)
91. Rijsberman (2004)
92. Hutton and Haller (2004)
93. ibid.
94. World Bank (2001)
95. World Bank (2004a) Note that the cost per capita in this case runs to about US$ 290, however the levels of service and the range of services here far exceed the scope of the cost estimates presented in chapter 3.
96. UNDESA, 1998
97. Emerton, L., et al (2004)
98. Mogata et al (2001)
99. It consisted of the release of three natural enemies that feed exclusively on water hyacinth that had clogged local waterways.
100. De Groot, et al (2003)
101. Water savings are reported to be around 60% over flood irrigation for example, see Shah and Keller (2002).
102. Rijsberman (2004)
103. Rijsberman (2004)
104. Assuming a NPV discount rate of 10 and 5 percent, respectively, see Rijsberman (2004)
105. Asian Development Bank (2004b)
106. WHO (2004)
107. WHO, Harvard University, London School of Hygiene and Tropical Medicine – Press Release WHO/28 (2000)
108. Davis (2004)

Bibliography

Allan, J.A. 1993. "Fortunately there are Substitutes for water Otherwise our Hydro-political Futures would be Impossible." In Priorities for water Resources Allocation and Management. London, United Kingdom: ODA: 13-26.

Asian Development Bank (2000) "Project Completion Report on the Dalian Water Supply Project in the People's Republic of China" PRC: PRC 25013.

Asian Development Bank (2004) "Project Completion Report on the Manila South Water Distribution Project in the Philippines" PCR: PHI:24109.

Asian Development Bank (2004b) "Project Completion Report on the small scale water resources sector project in Bangladesh" PCR: BAN 25312.

Bartram, J., K. Lewis, R. Lenton and A. Wright (2005): The Millennium Project: Focusing on improved water and sanitation for health. Lancet 2005; 810-12.

Becker, Gary S. (1991) A Treatise on the Family. Cambridge, MA: Harvard University Press.

Bhargava, Alok, (1997) "Editor's introduction: Analysis of data on health," Journal of Econometrics, Elsevier, vol. 77(1), pages 1-4, 3.

Bloom, D. and J. Sachs (1998): Geography, Demography and Economic Growth in Africa, Brookings Papers on Economic Activity 2, Washington, DC. Brookings Institution.

Bojö, J. & Reddy (2002) Poverty Reduction Strategies and the Environment World Bank Environmental Economics Series Paper no. 86.

Chapagain, A.K., and A.Y. Hoekstra (2004) "Water Footprints of Nations." Value of Water Research Report Series No. 16, UNESCO-IHE, Delft.

Chinese Ministry of Water Resources (2003): Country Report of the People's Republic of China – From the Hague 2nd World Water Forum 2000 to the Kyoto 3rd World Water Forum 2003. Beijing, March 2003.

Granit, J., Grey, D., Sadoff, C., Alemu, S., (2003) "Cooperative Development in the Zambezi River Basin, Constraints and Opportunities", World Bank Brief, Washington DC.

Cosgrove, W. and Rijsberman, F.-R. (2000) World Water Vision: Making Water Everybody's Business. London, UK, World Water Council and Earthscan Publications Ltd.

Costanza, R.; d'Arge, R.; de Groot, R.; Farber, S.; Grasso, M.; Hannon, B.; Limburg, K.; Naeem, S.; O'Neill, R.; Paruelo, J.; Raskin, R.; Sutton, P., van den Belt, M. (1997). 'The value of the world's ecosystem services and natural capital'. Nature, Vol. 387, pp. 253–60.

Crosson, P. 1995. Soil erosion and its on-farm productivity consequences: what do we know? Discussion paper 95-29. Resources for the Future, Washington, DC.

Davis, J. (2004) "Corruption in Public Service Delivery: Experience from South Asia's Water and Sanitation Sector", World Development Report, Vol. 32, No. 1 pp. 53-71.

De Groote, H., , O., Attignon, S., Djessou, R., Neuenschwander, P. (2003) "Economic impact of biological control of water hyacinth in Southern Benin" Ecological Economics, Volume 45, Issue 1, April 2003, Pages 105-117.

Emerton, L., Bos, E. (2004) Value: Counting Ecosystems as Water Infrastructure, IUCN, Gland, Switzerland and Cambridge, UK.

Evans, Barbara (2004): "Whatever Happened to Sanitation? – Practical steps to achieving a core Development Goal", MDG Task Force background paper.

Evans, Barbara; Hutton, Guy and Haller, Laurence (2004): "Closing the Sanitation Gap – the Case for Better Public Funding of Sanitation and Hygiene." Background paper to OECD Round Table on Sustainable Development.

FAO (Food and Agriculture Organization of the United Nations). 1999a. Review of the State of World Fishery Resources: Inland Fisheries. FAO Inland Water Resources and Aquaculture Service, Fishery Resources Division, FAO Fisheries Circular No. 942. Rome, Italy: FAO.

FAO (Food and Agriculture Organization of the United Nations). 1999b. The State of World Fisheries and Aquaculture 1998. Rome, Italy: FAO Fisheries Department.

FAO Fisheries Circular No. 942, Rev. 1 Review of the state of world fishery resources: inland fisheries and agriculture organization of the United Nations, Rome, 2003

Faruqui, N. (2003). "Balancing between the eternal yesterday and the eternal tomorrow" Economic globalization, water and equity. International Development Research Centre, Ottawa, Canada.

Fraiture, C. de, X. Cai, U. Amarasinghe, M. Rosegrant and D. Molden. (2004). "Does Cereal Trade Save Water? The Impact of Virtual Water Trade on Global Water Use." Comprehensive Assessment Research Report No. 4. International Water Management Institute, Colombo

Frans & Soussan (2003) Water in Asian PRSPs. Asian Development Bank Water and Poverty Initiative, ADB Manila.

Garcia, Y.T., A.G.Garcia, M. Oo, and M. Hossain. (2000). Income Distribution and Poverty in Irrigated and Rainfed Ecosystems: The Myanmar Case. Economic and Political Weekly, December 30, 4670- 4676.

Gould, J. (1999): Contributions Relating to Rainwater Harvesting, Contribution to the World Commission on Dams, Thematic Review IV.3:Assessment of Water Supply Options.

Grey, D. (2004b). "The World Bank and Water Resources: Management and Development." Presentation at World Bank Water Week 2004.

Grey, D. And C. W. Sadoff (2002): Water resources and poverty in Africa: Essential economic and political responses. Presented by the World Bank to the African Regional ministerial Conference on Water (ARMCOW).

Hansen, Stein & Bhatia, Ramesh (2004): "Water and Poverty in a Macro-Economic Context". Norwegian Ministry of the Environment.

Hoekstra, A.Y. and P.Q. Hung (2002) "Virtual Water Trade: A Quantifcation of Virtual Water Flows Between Nations in Relation to International Crop Trade." Value of Water Research Report Series No 11. IHE, Delft.

Homedes, Nuria (2000), "The disability-adjusted life year (DALY) definition, measurement and potential use" HCO.

Hossain, M., B. Sen, and H.Z. Rahman (2000). Growth and Distribution of Rural Income in Bangladesh; Analysis Based on Panel Survey Data. Economic and Political Weekly, December 30: 4630-4637.

Hutton, Guy & Haller, Laurence (2004): "Evaluation of the Costs and Benefits of Water and Sanitation Improvements at the Global Level" World Health Organisation, Geneva, Switzerland.

IUCN (2000). Vision for Water and Nature. A World Strategy for Conservation and Sustainable Management of Water Resources in the 21st Century – Compilation of All Project Documents. Cambridge.

IUCN (The World Conservation Union) (2002). Johannesburg Programme of Action. A document prepared for the World Summit on Sustainable Development (WSSD), 28 August–4 September, Johannesburg.

Jønch-Clausen, Torkil (2004) "…Integrated Water Resources Management (IWRM) and Water Efficiency Plans by 2005 – Why, What and How" Global Water Partnership, Elanders Infologistics, Sweden.

Kaufmann, D. & Krayy, A.,(2003) "Causality which way? Evidence for the world in brief" WBI, 2003.

Lipton, M., J. Litchfield and J-M Faures. (2003) The effects of irrigation on poverty: a framework for analysis. Water Policy 5(2003): 413-427.

Lvovsky (2001) "Health and Environment" Environment Strategy Papers No.1, The International Bank for Reconstruction and Development/The World Bank, Washington, DC.

Mehta, Meera & Knapp, Andreas (2004): "The challenge of financing sanitation for meeting the millennium development goals", Water and Sanitation Program, Africa.

Mekong River Commission (2001) "Programme for fisheries management and development cooperation" Annual Report 2000/2001.

Michaelowa, Katherina (2000): "Returns to Education in Low-Income Countries: Evidence for Africa" presented to the Committee on Developing Countries of the German Economic Association.

Millennium Project and Swedish Water House Policy Brief (2004) "Investing in the Future, Water's role in Achieving the Millennium Development Goals"

Mogata, et al. (2001) Economic aspects of community involvement in sustainable forest management in Eastern and Southern Africa. Nairobi, Kenya: IUCN.

Mogata, H., S. Gichere, R. Davis and R. Hirji. (2002): Impacts and costs of climate variability and water resources degradation in Kenya. Draft Report.

Moss, J., G. Wolff, G. Gladden and E. Guttierez (2003): "Valuing water for better governance – How to promote dialogue to balance social, environmental, and economic values?" Sponsored by the CEO Panel Business and Industry.

Munich Re (2002) "Topics, Annual Review: Natural Catastrophes 2002"

NEMA, 1999, Uganda Biodiversity: Economic Assessment, National Environment Management Authority, Kampala.

Nigam and Ghosh 1994; Briscoe and Garn 1994. New York. paper drawn from WSCC 2000; WWC 2000; WHO/UNICEF JMP 2000;

OECD–DAC (Organization for Economic Co-Operation and Development–Development Assistance Committee). (2004). "Aid for Water Supply and Sanitation." Report from the International Water Academy Seminar "Water for the Poorest" at World Water Week, August 19, Stockholm.

PricewaterhouseCoopers. (2001). Water: A World Financial Issue – a Major Challenge for Sustainable Development in the 21st Century. Sustainable Development Series. Paris.

Report of the World Panel on Financing Water Infrastructure (2003): "Financing Water For All". World Water Council, 3rd World Water Forum and the Global Water Partnership.

Republic of Kenya, (1998), The Aftercare Study on the National Water Master Plan. Nippon Koei Co., Ltd, Tokyo, Japan.

Rijsberman, Frank (2004): "The Water Challenge". The Copenhagen Consensus Challenge Paper.

Roy, Jessica L., Crow, Ben and Swallow, Brent (2005) "Getting access to adequate water: community organizing, women and social change in Western Kenya" International workshop on 'African Water Laws: Plural Legislative Frameworks for Rural Water Management in Africa. Johannesburg, South Africa

Sachs, J. D. (2001): Macroeconomics and health: Investing in health for economic development. Report of the Commission on Macroeconomics and Health prepared for WHO.

Saleth, Maria & Dinar, Ariel (1999): "Water Challenge and Institutional Response: A Coss-Country Perspective" Institute of Economic Growth, India.

Shah, T, M. Alam, M. D. Kumar, R.K. Nagar and M. Singh. (2000). Pedaling Out of Poverty: Socioeconomic Impact of a Manual Irrigation Technology in South Asia. IWMI Research Report 45. International Water Management Institute, Colombo.

Shah, T. and J. Keller. (2002). "Micro-irrigation and the Poor:Livelihood Potential of Low-cost Drip and Sprinkler Irrigation in India and Nepal', in: H. Sally and C. Abernethy, eds. Private irrigation in sub-saharan Africa. FAO/IWMI., IWMI, Colombo, p.165-183.

Slaymaker & Newborne (2004) Implementation of water supply and sanitation programmes under PRSPs ODI, London.

STEA, (2003), Lao PDR Biodiversity: Economic Assessment, Science, Technology and Environment Agency, Vientiane.

Stockholm International Water Institute et al., Let it Reign: The new water paradigm for global food security, (2005).

SIWI and the International Water Management Institute (2004): " Water – More nutrition per drop – Towards sustainable food production and consumption patterns in a rapidly changing world."

Thakur, J., M.L. Bose, M. Hossain, and A. Jinaiah (2000). Rural Income Distribution and Poverty in Bihar; Insights from Village Studies. Economic and Political Weekly, December 30 :4657-4663.

Panayotou, T. and Zhang Zheng (2000). The Cost of Environmental Damage in China: Preliminary Assessment and Valuation Framework, (Bethesda, MD: Aileen International Press for the China Council for International Cooperation on Environment and Development).

Turpie, J., Smith, B., Emerton, L. and J. Barnes, (1999), Economic Valuation of the Zambezi Basin Wetlands, IUCN -The World Conservation Union Regional Office for Southern Africa, Harare

UN MDG Task force 7 "Water and Sanitation Task Force Report for the Millennium Project. Health, Dignity and Development: what will it take?" (2005).

UN Millennium Project (2004). "Millennium Development Goals Needs Assessments for Ghana, Tanzania, and Uganda, Background paper"

UNDESA (United Nations Department of Economic and Social Affairs) (1998). Expert Group Meeting Report of Working Group 3: Economic and Financing Issues. UN, New York.

UNICEF (2002). "Financing the International Goals for Water and Sanitation." Unpublished

United Nations Development Programme, United Nations Environment Programme, World Bank and the World Resources Insitutute, (2000) "World Resources 2000–2001 – People and Ecosystems, the fraying web of life". Wang, Hua & Lall, Somik (1999), Valuing Water for Chinese Industries: A Marginal Productivity Assessment" Development Research Group, The World Bank.

Warford, J.J. and Li Yining (2002) "Economics of the environment in China" A publication of the China Council. Aileen International Press, Md., USA

World Bank (1993) "Policy Paper on Water Resources Management" Washington, DC.

World Bank (1994): World Development Report 1994 – Infrastructure for Development, Washington D.C.

World Bank (2001) "Second Karnataka rural water supply and sanitation project – India" Project Appraisal Document Report No: 23204-IN

World Bank (2003): World Development Report 2003: Sustainable Development in a Dynamic World, Washington D.C.

World Bank (2003a): Water – A priority for responsible growth and poverty reduction – An agenda for investment and policy change. Washington D.C.

World Bank (2003b): Water Resources Sector Strategy – Strategic directions for World Bank engagement. Washington D.C.

World Bank (2003c). World Development Indicators 2003. World Bank, Washington D.C

World Bank (2004a) "Water Sector Project: Republic of Senegal" Implementation Completion Report No. 30800.

World Bank (2004b) Water Resource Sector Strategy, Strategic Directions for World Bank Engagement" Washington, DC.

World Bank, (2004) "Water Resources Memorandum, Towards a water secure Kenya."

World Bank. (2000): Making Sustainable Commitments. An Environment Strategy for the World Bank. Washington D.C.

World Commission on Dams (2000) "Dams and development, A New Framework for Decision-Making", Earthscan Publications, UK.

World Health Organisation (2002) "The world health report 2002 - Reducing Risks, Promoting Healthy Life" Geneva, Switzerland.

World Health Organisation (2002b) Fact sheet N°117 Revised April 2002

World Health Organisation (2004) "Water, Sanitation and Hygiene Links to Health: Facts and figures"

World Health Organisation and United Nations Children's Fund Joint Monitoring Programme (2004): "Meeting the MDG drinking-water and sanitation target: A mid-term assessment of progress"Geneva, Switzerland.

World Health Organisation, Harvard University, London School of Hygiene and Tropical Medicine – Press Release WHO/28 (2000)

World Health Organisation (2002) "Prevention and control of Schistosomiasis and Soil-transmitted Helminthiasis" WHO Technical Report Series No. 912, Geneva.

World Meteorological Organization (WMO). 1997. Comprehensive Assessment of the Freshwater Resources of the World. Geneva: WMO.

WWDR (2003) - THE UN WORLD WATER DEVELOPMENT REPORT Water for People, Water for Life. UNESCO.

Making Water a Part of Economic Development:

The Economic Benefits of Improved Water Management and Services

Better access to clean water, sanitation services and water management creates tremendous opportunity for the poor and is a progressive strategy for economic growth. This report articulates the close link between water and the economy and makes the case that investing in water management and services is absolutely essential for the eradication of poverty and is a necessary condition for enabling sustained economic growth.

The poor gain directly from improved access to basic water and sanitation services through improved health, averted health care costs and time saved. Good management of water resources brings more certainty and efficiency in productivity across economic sectors and contributes to the health of the ecosystem. Taken together, these interventions lead to immediate and long-term economic, social and environmental benefits that make a difference to lives of billions of people.

This report was commissioned by the Governments of Norway and Sweden and prepared by the Stockholm International Water Institute in collaboration with the World Health Organization and the Norwegian Agency for Development Cooperation.

SIWI

Stockholm International Water Institute, SIWI
Hantverkargatan 5, se-112 21 Stockholm, Sweden • Phone +46 8 522 139 60 • Fax +46 8 522 139 61
siwi@siwi.org • www.siwi.org

Design: Quadrata