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The United Nations World Water Assessment Programme

Scientific Paper

Investing in information, knowledge and monitoring

James Winpenny

United Nations World Water Assessment Programme (WWAP)

UNESCO
United Nations Educational, Scientific and Cultural Organization

World Water Assessment Programme

The United Nations World Water Development Report 3
Water in a Changing World

Coordinated by the World Water Assessment Programme, the *United Nations World Water Development Report 3: Water in a Changing World* is a joint effort of the 26 United Nations agencies and entities that make up UN-Water, working in partnership with governments, international organizations, non-governmental organizations and other stakeholders.

The United Nations' flagship report on water, the WWDR offers a comprehensive review of the state of the world's freshwater resources and provides decision-makers with the tools to implement sustainable use of our water. The WWDR3 represents a mechanism for monitoring changes in the resource and its management and tracking progress towards achieving international development targets. Published every three years since 2003, it offers best practices as well as in-depth theoretical analyses to help stimulate ideas and actions for better stewardship in the water sector.

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Sectors and topics to which water is cross-cutting or important will be covered in this series of side publications. Some examples of subjects discussed in this collection of reports include climate change, security, biodiversity, poverty alleviation and land use.

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Investing in Information, Knowledge and Monitoring

James Winpenny[1]

United Nations World Water Assessment Programme (WWAP)

Overview and abstract

Information about water is as essential to life as the water itself. It aids decision-making by converting uncertainty into risk, which is more manageable. It reduces ignorance and uncertainty, which are important ingredients of market failures. It enables a better choice of infrastructure to be made. It is also the basis of water democracy, giving citizens and users more control over their lives and making public institutions more accountable for their actions.

Despite this, this paper will argue that not enough information is produced. From a social viewpoint, insufficient resources are invested in the supply and dissemination of water information. From an economic perspective, water information is undersupplied, due essentially to its characteristic as a public good. This points to the important role of public agencies (and philanthropists) in rectifying this market failure. Globally, there is an important role for international action to supply public information goods and specifically to overcome the problem of 'underfunded regionalism'.

The generation of information for water management is an economic activity, and thus cannot be random or undirected. Economic principles can be used to help orient research towards socially valuable aims.

The benefits of providing greater information are illustrated in five areas:

- Information for water resource planning and use, for which there is evidence of a worldwide decline. The benefits of this for poor farmers are illustrated by the Mali Agrometeorological Project. Suggestions are made for improvements in data collection and the development of new indicators.
- In the realm of water governance, better information is needed for Integrated Water Resource Management (IWRM) and for monitoring progress towards the Millennium Development Goals (MDGs). Better data can be incorporated into cost-benefit studies to make the case for better sanitation.
- For the citizen: information enables public access to vital information for public health and safety, such as flooding. It also equips water users with data to empower them in dealings with authorities and service providers.

1 The author is a Director of Wychwood Economic Consulting Ltd, UK.

- For improved management of water services, better data is needed to monitor the state and performance of national water sectors and services and to create a level playing field between public and private operators.
- Turning to business and trade, further research on virtual water and water footprints would have an important influence on international trade policy, while the development of water sustainability indicators would assist private businesses and civil society watchdogs.

Finally, reference is made to the new System of Environmental-Economic Accounting for Water (SEEAW), promoted by UN agencies, which will provide a comprehensive framework for the inclusion of water information into national income accounts. The SEEAW will enable the state of water to be quantified and fed into conventional measures of national income and economic performance – the first and indispensable step to gaining the serious attention of national policy makers.

1. The production, consumption and benefits of information

Public bodies (national and international) and philanthropists[2] can support the production of information in several ways by:

- Creating an enabling intellectual climate through support for learning, research and free debate;
- Setting a legal[3] framework in which intellectual capital can be protected for a reasonable length of time;
- Subsidising research, data assembly and collection by independent agencies and private companies;
- Undertaking the work directly in publicly owned institutions.

This paper will argue that public bodies, philanthropists and the international community can and should do more to support the production of information relevant to water. This is needed because investment in water information provides a public good and can bolster private research that has wider spill-over benefits. Without more public support, there will be under-investment in information essential to the global public.

1.1. The benefits of information

The benefits of having more information may seem self-evident. However, this paper is not concerned with the philosophical and cultural value of pure knowledge. Instead, it deals with the narrower functional issue of producing information relevant to water use and management. Because generating applied information of this kind absorbs scarce resources it cannot be aimless – it must be oriented towards ends that society perceives as more important than others. Producing information itself competes with other priority areas of public concern, such as social welfare and new infrastructure.

Greater water information has the following potential benefits:

- Good information aids decision making. When better information exists, *ignorance and uncertainty* (e.g. about the state of water resources or the likelihood of an extreme event such as drought or flooding) can be converted into *risk* (the probability of an event multiplied by the size of its impact), which makes the problem much more tractable. Risk has been described as 'measurable uncertainty', and information provides the measure. Information shrinks the area of 'known unknowns' as well as 'unknown unknowns'. Information is a kind of insurance. It makes risk more manageable, and enables decision makers to target the right measures to deal with the problem concerned.
- Ignorance and uncertainty are major factors in *market failure*. We assume that private agents will respond to market opportunities (e.g. new water technologies) or incentives to change their behaviour (e.g. pollution charges, water markets) in a rational fashion. This will not happen if they lack vital information with a bearing on their decisions.
- Information enables better choice of infrastructure. The physical infrastructure of the water sector is very costly (e.g. navigation channels, hydropower schemes, irrigation schemes, flood protection, water supply, distribution and treatment, etc). These projects involve expensive studies, long planning procedures, extended implementation periods and major physical works. The availability of basic hydrological data (e.g. rainfall, river flows, groundwater levels, siltation rates) can reduce delays and enable more accurate specifications of projects. Better data may enable contingency measures to be reduced, bringing cost savings.
- Information is needed for *water democracy*. Citizens need to have access to good and user-friendly information about water relevant to their lives (e.g. the quality of drinking water, seasonal weather forecasts, the probability of drought and flood, the link between polluted water and disease). This is necessary for a properly informed debate between the major stakeholders about water policies or specific projects, and between customers and their providers.

2 This term is used for any individual or organization seeking to promote the welfare of others. It can include private, profit-seeking individuals and firms that choose in certain circumstances to follow not-for-profit behaviour.

3 Including fiscal, e.g. tax breaks for research.

1.2. When public intervention is needed

The above benefits are widely acknowledged, but why should *governments* intervene in producing information, rather than leaving this to the private sector or independent academics or researchers?

Information as a public good

The strongest case for public support of information gathering rests on the *public good* argument. Without public support, there would be under-investment in water information. *Public goods* are services provided to benefit the whole of society rather than specific individuals. Their benefits are enjoyed collectively and it is not feasible to charge beneficiaries directly through user fees. In economic terms a public good is both *non-excludable and non-rival*. Once it is provided, it is impossible to exclude any user from enjoying its benefits. This implies that a private provider would be unable to enforce payment from users the 'free rider' problem. Moreover, one person's use has no effect on the amount available for others. Thus there is no economic case for charging for it – using price to ration service quantity would be pointless and would result in sub-optimal use. The collection of hydrological and meteorological data, monitoring of water status, etc. are clearly public goods in the above terms.

Spillovers and externalities from private or sectional research

Information is a potentially valuable product: privately produced and protected, it can be beneficial to the holder, and private companies and individuals spend large sums obtaining such information, often with public support. However, unless they can protect this information for long enough to profit from it[4] (e.g. by means of a patent), private agents will be deterred from producing it. The risk of leakage of proprietary information can be a deterrent to research.[5] Sometimes, too, the research may entail spending beyond the scope of individual private companies, or may involve co-operation between different agents, which entails high *transaction costs*. All such market failures cause under-investment in information.

This matters where the production of information by private agencies has wider spillover benefits.[6] Research into more effective, cheaper and more accessible methods of treating HIV/AIDS, malaria and other diseases may be done by profit-seeking private companies, but there will also be great benefits to victims of these diseases, justifying national and international public interest.

Information as a merit good

This discussion has pointed to some reasons why the supply of information may fall below socially optimum levels. There are also factors affecting the demand for data which bias the result in the same direction. The major factor here is that information is a type of merit good. Merit goods and services are those that 'society' deems individuals should have, even if they are unwilling or unable to pay for them. People[7] may not realize the importance of information, that they need it and should have it, nor the benefits they can expect from receiving it.[8] Once they become better informed, they are likely to appreciate the benefits of information, and to demand more of it. But until they reach that point, the social value of information exceeds its private estimation.

Bringing vital information into the public domain

Some information is too important to leave solely to the private sector. For instance, although private insurance companies have their own major collections of hydrological data such as flooding and other extreme natural events, there is a strong public interest in creating information banks that are widely accessible, even if this means some duplication of private efforts.

1.3. When international action is justified

The previous section explained when national governments (or philanthropic agencies) need to intervene to protect the flow of information. A similar line of reasoning can justify international efforts to support, supplement or sometimes override national interests.

Global water information as an international public good

Climate change and the emergence of water scarcity and stress across many regions have elevated water from a local and national to a global concern,[9] where the effects of these changes occur at a global level. Although there is a wide measure of consensus about the broad nature of the likely impacts,[10] much research and data collection remains to be done on the phenomena, their incidence and how they can be mitigated. This is a pre-eminently appropriate topic for support on a global scale.

4 The rise of the Rothschild banking dynasty received a powerful fillip by Nathan Rothschild's possession of a temporary monopoly of vital information at the time of the Battle of Waterloo (1815). Due to the speed of his own messengers, he acquired news of the British victory some hours before anyone else, time that he used to manipulate the London Stock Exchange to generate a fortune! (Morton, 1961.)

5 A powerful case for strengthening intellectual property rights is made by Keith Maskus in *Solutions for the World's Biggest Problems: Costs and Benefits* (2007).

6 Analogously, research by governments for national strategic gain (e.g. space and polar exploration) may have wider spillover benefits, and the risk of premature leakage may deter research of this kind.

7 A similar argument could apply to governments, quite apart from those governments who are determined to keep their citizens in ignorance!

8 This recalls the 'Rumsfeld Principle', that there are known knowns, known unknowns, and unknown unknowns. It is impossible for people to have views or preferences on matters about which they are completely unaware.

9 Climate change and risk is a principal theme of the World Water Development Report 3 (2009).

10 Summarized in the Stern Review, pp 74-79.

External aid to rescue a postponable outlay

Research and data collection is a type of public expenditure that can easily be deferred from one year to the next. It is not urgent, vital or highly visible, and it is tempting for governments to postpone or reduce spending as an economy measure. Over time, this causes a cumulative drain of resources going into such programmes. (Similar considerations apply the maintenance of infrastructure, such as the upkeep and replacement of old water pipes and sewers). Many hydrological monitoring stations and systems have been deprived of resources, or have disappeared, faced with the more pressing claims of other public budgets. Given the need for complete data on a global scale, the collection and analysis of data have a strong claim on aid programmes.

Transboundary programmes

Research and monitoring programmes organized at an international or regional level are also liable to be deprived of resources since individual countries may reduce their contributions in the hope and expectation that others will continue with theirs. This is the 'free rider' factor.[11] A different factor may arise where waters are shared, hydrological information becomes a sensitive political matter and data may be manipulated for national political purposes.[12] International institutions and programmes may have a role in these cases. This topic is further discussed in section 3.4.

It was argued earlier that information can convert uncertainty into risk, which makes it more manageable by the decision maker. In certain cases it may even be possible to use information to convert risk into certainty (zero uncertainty). Clearly, such information has a high value to the decision-maker. The difference between a risky project and one with a certain outcome could imply big cost savings, e.g. through avoiding the need for fail-safe designs, precautionary project components, or insurance. The financial value of these savings is the potential value of generating the necessary information.

The cost-benefit framework commonly used to analyse projects or programmes provides a structure that indicates where further information would be most valuable (Box 1).

2. Information for water-resource planning and use

2.1. The impoverishment of hydrological data

A water information system requires the collection and storage of data on the hydrological cycle, of both a quantitative and qualitative nature. Information is also required on physical, socio-economic, demographic and consumption data from each of the major user sectors. Much data is routinely collected and disseminated by hydrological and meteorological offices.

Box 1 Estimating the value of more information

Estimating the 'base case' in cost-benefit analysis shows the Economic Rate of Return (ERR) with 'most likely' assumptions for key variables such as output, costs, completion date etc. Then, a *sensitivity analysis* can be undertaken in which the values for the key variables are changed, and the impact of these changes on the overall result is tracked (e.g. a 30% increase in costs might reduce the ERR from 15% to 10%. Sensitivity analysis, as its name suggests, indicates how sensitive the overall result is to changes in the level of particular variables.

The information from sensitivity analysis can be presented in a slightly different way to indicate where the search for more information (greater certainty) should concentrate.

The *switching value* of each variable is estimated by calculating the % change that would reduce the Economic Rate of Return to an unacceptable level.[1] If, for instance, a 10% reduction in the price of power sold by a hydroelectric project would reduce the ERR to the cut-off level of acceptability, whereas it would take a 60% increase in construction costs to do the same, we would conclude that the price of electricity is the more sensitive item for project viability, and concentrate our research and studies on the future market for electricity.

1 10%, where this is the opportunity cost of capital or the Government Test Discount Rate. At this level the Net Present Value of the project is zero.

1.4. Deciding what information to invest in

Pure research, or the quest for knowledge for knowledge's sake, cannot be constrained, without losing much in the process. However, the search for information to illuminate practical and applied problems needs to be channelled and focussed on social priorities. The production, gathering and analysis of information tends to be costly and time consuming, hence the importance of setting priorities.

The need for data should be prioritized, based on the key water issues and what is required for assessing risks and damages. These needs should be clearly intelligible to policy makers, in order to attract political support and the allocation of sufficient resources. Where, as is common, data is supplied by a variety of different organisations, their systems should be compatible in terms of standards, quality assurance and electronic access and transfer. Cross-sectoral collaboration is essential for approaches based on Integrated Water Resources Management (IWRM), requiring the development of working relations and data exchanges on a routine basis

11 Analyzed in Barrett, 2006.

12 Nicol (2007) cites problems in the sharing of water-related data between Jordan and Israel.

between organisations often with differing working styles and cultures. Quality assurance is particularly important in transboundary use, where mutual confidence building and credibility are essential.[13]

There is evidence of a world-wide, general decline of hydrological observation networks in terms of spatial coverage and availability of long-term records. A telling example is provided by the United States Geological Survey, which reports that in the period from 1980 to 2004, 2,051 stream gauges with 30 or more years of stream flow record were discontinued. At the end of 2005, 7360 stations were active. While the overall number of stream flow stations did not change significantly, those stations with a long-term record were mostly affected by closure. If this were to be generalized, an important source of hydrological memory would be lost, along with long record information for studies on climate variability and change, and their impact on hydrology and water resources.

- the scope of networks as a result of changing national investment priorities or as a result of rationalization efforts of networks.[14]

The shortage of hydrological data and observations is compounded by a widespread reluctance to share and exchange hydrological data. This is due to national bureaucratic blockages, security concerns, political sensitivities about transboundary issues and a widespread failure to appreciate the value of global hydrological data and observations. Exchanging and sharing hydrological observations is also hampered by technical and logistical problems such as poor telecommunications between partner agencies.

What data is available is incomplete and uneven. In many countries there is insufficient sharing of data, and local authorities lack the capacity to fully carry out data monitoring, collection, analysis and storage. Data collection often lacks a comparable and adequate methodology.

Box 2 The Mali Agrometeorology Project

Following the severe droughts of the 1970s and the continuing risks posed to rural communities by rainfall variability, the Malian National Meteorological Department (DNM) launched a project in 1982, with external financial help, to provide climate information to rural people, especially farmers. This was the first project in Africa to supply climate-related advice directly to farmers, and to help them measure climate variables themselves, so that they could build climate information into their decision making.

In the words of one farmer:

> 'If I had to choose between agrometeorological information and fertilizer? Agrometeorological information! For without that, the fertilizer would be useless … of course, if you were offering a choice between irrigation or agrometeorological information, I would take the water.'

A number of factors contributed to the success of the project. The drought and famine of the 1970s was prominent in the minds of farmers and their political leaders. Long-term financial support was available from the Swiss Development Corporation together with technical support from the World Meteorological Office. The project's farmer-centred approach delivered services relevant to farmers' needs, while good communication channels between all parties and the use of radio (in all the major local languages) helped to disseminate information. Under the project farmers themselves collect much information about rainfall to feed into the information system.

The results of this long-term project indicate that the regular provision of agrometeorological information helps farmers to manage the risks entailed by increased climate variability. A framework is in place for gathering, analysing, processing and disseminating information in a form that farmers can use. The project is evidence that farmers can use the information to make better decisions leading to higher yields and incomes. They are enabled to take more risks by investing with greater confidence in new technologies that can raise incomes and yields further.

Source: Hellmuth et.al. *Climate Risk Management In Africa: Learning From Practice*. IRI, 2007

From a global perspective, the shortage of hydrological observations can be attributed to deficiencies in:

- the spatial coverage of hydrological variables;
- the observation frequencies, which is of critical importance for hydrological forecasting services, including flood forecasting; and

2.2. The benefits for farmers

The importance of hydrological data can be illustrated for West Africa, where since 1970 a decrease of 20 to 40% of rainfall amount for the core of the rainy season in July and August has been observed. The onset of the rainy season has become more variable (a greater *coefficient of variation*). Rainfall variability is clearly observed and reinforced in the discharge time series of many rivers in the sub-region. The decrease of discharge recorded for many of the river basins concerned varies from

13 Global Water Partnership *ToolBox for IWRM* www.gptoolbox.org

14 These themes are developed in WWAP, World Water Development Report 3, 2009.

Box 3. Indicators and data: current problems and future needs

(The author is indebted to Dr. Charles Vorosmarty of City College of New York/City University for material in this box)

- Scale: data sets are poorly harmonized between the disciplines involved in water assessment. Data sets based on administrative units are ill-co-ordinated with highly geospecific biogeophysical data sets such as climate and weather forcing, and runoff. Census data is blended with remote sensing information.
- Conceptual divides: WMO/UNICEF definitions of water supply and sanitation are viewed mainly from the engineering standpoint. Data on point-of-exit for water quality needs to be better inventoried and linked to household surveys of water-related disease, as well as public health statistics.
- Outdated and incomplete information, particularly for basic hydrography and water-use statistics. Data on water quality is particularly poor, especially in view of the potential demise of the GEMS/Water programme. Water engineering, irrigation, and water-use data sets have been difficult to assemble and interpret. An integrated global database is urgently needed. The result is that contemporaneous and interdisciplinary perspectives are still lacking.
- New capabilities are not fully exploited. Several emerging capabilities could provide continuous and updated information about water resources, such as remote sensing (e.g. Gravity Recovery and Climate Experiment, or GRACE, groundwater monitoring), data assimilation, and modelling. These technologies exist, but have yet to be assembled in a coherent manner. End-to-end tests are still necessary in the context of water resources.
- Different approaches are needed for specific kinds of water bodies. Surface sources (rivers, lakes, reservoirs) require different approaches and potentially different study variables, compared to groundwater and coastal resources.
- Indicators of water-conflict thresholds are required, addressing both human-to-human conflict (e.g. upstream/downstream) as well as human-to-nature (aquatic ecosystem) allocation issues and conflict.
- The next generation of indicators needs to address the emerging issues of concern. For example, the well-established Falkenmark indicators of water stress should be revisited from the standpoint of climate variability, intraseasonal low flows, and sub-national application. New indicators, including the level of development of the existing resource, could be contemplated.
- There is poor uptake of existing monitoring data sets, especially in the IWRM context. There is a notable lack of capabilities to adopt information sets. Decisionmakers have little drive to invest in routine data collection.
- Indicators to chart general ‘syndromes’ would be useful to help develop a broad understanding of water resource threats and thereby optimize policy interventions.

40% to 60%. A clear link has been demonstrated between the evolution of ocean surface temperature and the evolution of average annual rainfall in the Sahel region.[15]

Bringing the issue literally to the grassroots level, the Mali Agrometeorological project illustrates the practical benefits of climate information for farmers (Box 2).

2.3. Indicators, monitoring and databases

Some of the key issues for discussion and decision are presented in Box 3.

3. Information for water governance

3.1. Integrated Water Resource Management (IWRM)

IWRM is an organizing principle for providing good governance for all aspects of the water sector. It emphasises that good management of water involves the participation of decision makers outside as well as inside the water sector. IWRM embraces data collection, planning, policy making, resource management, the provision of water services, safeguarding the environment, biodiversity and other natural life dependent on water, and many other functions.[16]

In discussing the financial needs of the water ‘sector’, what tends to dominate are the cost of infrastructure for the management of the resource, and the provision of services from it. This distracts attention from the need to provide – and finance – the creation of the information base on which the whole sector depends.[17] As Section 1 argued, the postponability of much of this spending is its weakness, but countries lose from it at compound interest.

3.2. Monitoring the Millennium Development Goals (MDGs)

Progress towards the UN’s Millennium Development Goals (MDGs) for water and sanitation is regularly assessed and reported on by the UN MDG Task Force and the WHO/UNICEF.[18] These high-level bodies rely heavily on data provided by national authorities, data which may be incomplete or misleading in some respects.

15 Further reference and discussion in World Water Development Report 3.

16 GWP *Toolbox.*

17 Rees, Winpenny and Hall, 2008.

18 WHO/UNICEF, *Meeting the MDG drinking water and sanitation target: the urban and rural challenge of the decade.* 2006.

Table 1 Cost-benefit ratios

		Intervention type				
WHO region	**Total pop (million)**	**1**	**2**	**3**	**4**	**5**
2 Sub-S Africa	481	11.5	12.54	11.71	15.02	4.84
5 Americas	93	10.01	10.21	10.59	13.77	3.88
11 Europe	223	6.03	3.40	6.55	5.82	1.27
13 SE Asia	1689	7.81	3.16	7.88	9.41	2.90
15 W Pacific	1488	5.24	3.36	6.63	7.89	1.93

Source: Hutton and Haller, 2004, Table 25

In poor districts, much of the initiative for developing water supply and sanitation rests with local groups that are not well linked into centralized databases. Many of the countries with the largest water and sanitation deficits have not had a recent census. Much information about safe water and sanitation (WatSan) is supplied by official service providers, whereas the MDG target groups lie overwhelmingly outside the scope of official public services.

Developments in satellite imagery are being exploited to monitor progress towards the MDGs and to better understand the needs of poor, informal settlements. The Cities Without Slums project of UN-HABITAT in Kisumu, Kenya, led by the local Municipal Council, developed and maintained a digital map of Kisumu based on a high-resolution satellite image. UN-HABITAT has an on-going programme to provide GIS capability to around 1000 cities, with the object of supporting pro-poor urban development programmes.

3.3. Cost-benefit approaches to water

The Stern Review on the Economics of Climate Change (Stern, 2007) demonstrates the power of economic cost-benefit analysis to influence the debate on climate change. Applied to water, there is mounting evidence on the economic costs of inaction in the form of the macro-economic costs of floods, drought, groundwater depletion, pollution and disease burden. This evidence should be marshalled into a powerful case for drastic action on behalf of global water.

Evidence is mounting that water-related risks pose big threats to macroeconomic performance. On a micro-scale, investments in water technologies can yield major returns to farmers. Providing safe water and sanitation facilities to poor communities can have huge benefits compared to their costs.

The level of water storage per head in developing regions, especially Africa, is much lower than in developed countries and this under-provision results in a disproportionate impact on the economy through both drought and flooding. In Kenya the 1997–8 floods and the 1999–2000 drought are estimated to have cost, respectively, 11% and 16% of GDP. In Zimbabwe there is a striking positive correlation between rainfall variation and real GDP growth over the period 1970–93.[19] Moreover, structures designed to manage droughts and flooding can sometimes be multi-purpose, providing the additional benefits of hydro-power, irrigation and transport.

A recent influential and widely quoted study (Hutton and Haller, 2004) estimates benefit-cost results for five types of WatSan intervention, in each of five WHO sub-regions. (The data relate to infectious diarrhoea, regarded as the 'marker' disease for WatSan and accounting for the largest part of the global death and disease burden from WaSH (Water, Sanitation and Hygiene) factors).

The interventions that are modelled are as follows:

1. MDG for water supply, with priority to those that already have improved sanitation
2. MDG for both water and sanitation
3. Access for all to improved water and sanitation
4. Universal disinfection of water at point of use on top of Intervention 3
5. Universal access to regulated piped water and sewage connections into homes.

While a high proportion of benefits arise from the time savings of water users (typically women and children), which can be contentious in societies with high unemployment or seasonality of work, the striking overall result from the WHO study is:

> '...in all regions and for all five interventions, the benefit-cost ratio is significantly greater than 1, recording values in developing regions of between 5 and 28 for intervention 1, between 3 and 34 for intervention 2, between 6 and 42 for intervention 3, and between 5 and 60 for intervention 4,' (Hutton and Haller, 2004).

19 Sanctuary and Tropp, 'Making water a part of economic development: the economic benefits of improved water management and services.' SIWI, (2005).

Box 4. Effectiveness of flood hazard mapping in Japan[1]

In March 2003, the Ministry of Land, Infrastructure and Transport in Japan developed a 'Flood Hazard Map Manual for technology transfer'. Using the manual, the Asian Disaster Reduction Centre (ADRC), in co-operation with Fuji Tokoha University, developed an exercise for 'Community Based Flood Hazard Mapping'. The exercise is a simple and cost-effective tool used to raise public awareness while fostering the active participation of the community. The tool was developed bearing in mind that in order to raise public awareness and to ensure smooth evacuation when a flood or another disaster is imminent, maps must be user-friendly and easily understandable for the community.

In the case of a flood, hazard maps need to include not only inundation areas and depth but also information such as evacuation centres and routes, disaster management centres, dangerous spots, communication channels and systems, evacuation criteria, tips for evacuation including emergency kits and other items needed in evacuation, and mechanisms and symptoms of hazards.

According to a survey recently conducted in Japan, among the residents who evacuated, those who had seen such hazard maps were 1.5 times greater in number, and they evacuated one hour earlier than their counterparts who had not seen a map. The results are shown in Figure 1. In case of an acute disaster such as a flash flood, this time difference could be a critical determinant in evacuation. The community must be provided with relevant information regarding hazard maps and how to use them. Most importantly, how effectively hazard maps are used depends on the level of community awareness. The members of the community must be taught how to understand potential disasters in their area from the map to be able to take appropriate countermeasures.

1 HR Wallingford (2007)

3.4. Transboundary water information and regional public goods.

This issue, which concerns the majority of African countries, is an example of the more general problem of 'underfunded regionalism' (Birdsall, 2006). It is argued that regional public goods are even more likely than international public goods to be underfunded, and therefore under-provided. This is for three main reasons:

- regional programmes and institutions involve co-operation between two or more neighbouring governments, often themselves poor, and which give transboundary issues a low priority compared with urgent national concerns. The problem is aggravated where neighbouring countries are at war with one another.[20]
- The attribution of benefits to the different partner countries is difficult, hence sharing costs is problematic and hampers setting realistic budgets and funding modalities.
- For such reasons, both donors and recipients of ODA may view regional public goods as less desirable objects than national programmes. Donors may also prefer supporting international, rather than regional, public goods out of self-interest, since they may perceive greater benefit accruing to themselves from actions of global concern. (Birdsall, 2006). The architecture of international aid, with its emphasis on national country programmes and country 'ownership' has also been blamed for the neglect of regional programmes. According to one estimate, only 3%-4% of ODA goes to regional public goods, though such programmes can give high returns.[21]

The relative neglect of regional public goods has in turn affected the supply of relevant information about them, which has fed back to further neglect, in a cumulative process. This matters because African water security will require the construction of regional and shared infrastructure on a large scale, entailing data collection and studies needing a greatly strengthened information base.

4. Information for the citizen

Information about water is essential to decision making by governments, development banks, official aid agencies, and private sector investors. The general public is also a potentially important user of information, as well as being a major source of data. Where information is aimed at the general public it must be clearly relevant and in a user-friendly form. (Box 4 llustrates the importance of this simple message.)

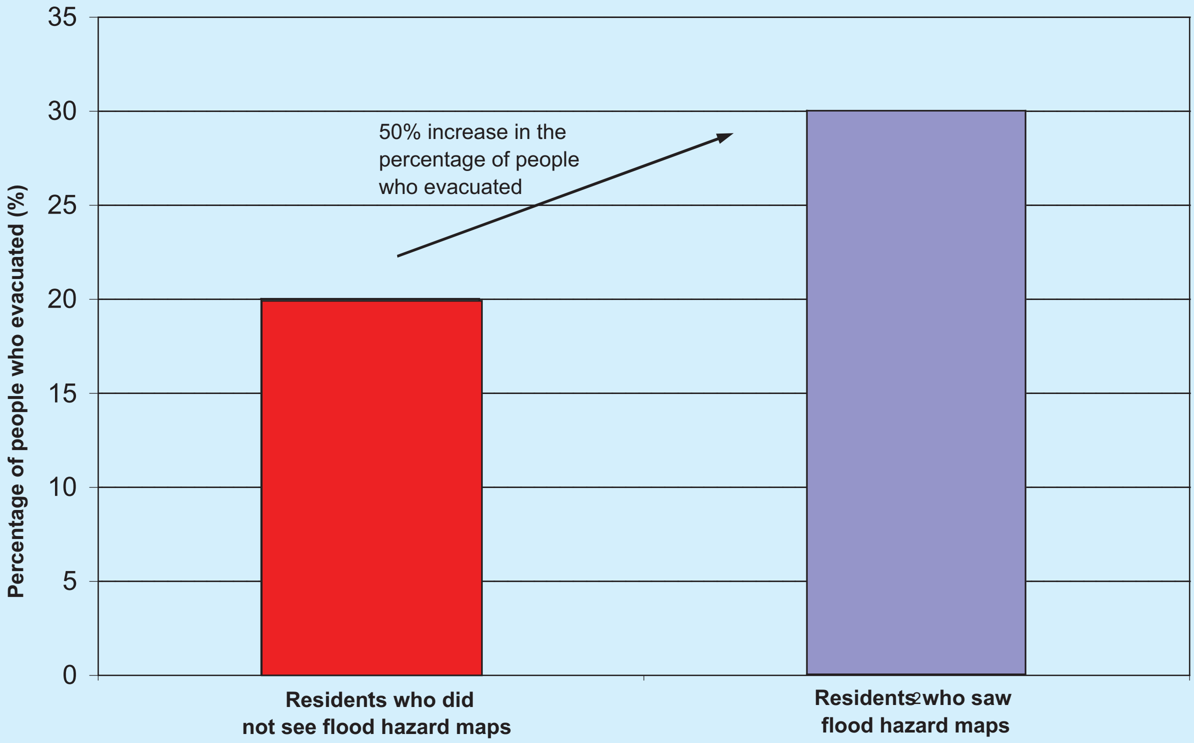
Relevant and user-friendly information about water is important to the success of decentralization of responsibilities for water services. It can also mobilize and empower public opinion concerning pollution and water quality. Pilot surveys carried out for The Access Initiative[22] showed that the general public rarely has easy access to useful information about the quality of drinking and surface water. Even when the quality of data is good, access to it is often very limited.

20 The control of the Desert Locust in Sahelian countries has been severely hampered by the decline in regional information and monitoring systems, due in part to civil unrest and armed conflict endemic in the border regions at risk in these countries.

21 Birdsall cites the Southern Africa Power Pool, the Baltic Sea clean up, the control of onchocerciasis in the Sahel, and the control of Chagas disease in Latin America.

22 World Resources Institute: www.accessinitiative.org

Figure 1 **The effectiveness of flood hazard mapping in Japan**



The situation regarding water quality is generally worse than that regarding air quality. A lack of information means that individuals and communities cannot protect themselves from polluted water, nor monitor the improvement of its quality. In Africa, RandWater is an exception: the company operates a website giving users updates on water issues, including areas where water should not be used for drinking without treatment, and where contact should be avoided because of microbiological health effects.[23]

5. Information for the management of water services

5.1. Monitoring performance and regulation

Information is a powerful driver of performance. Peer group comparisons provide both positive and negative incentives for performers. Motivated and high-achieving service providers know what they have to beat to excel, while poor performers are motivated to avoid being 'named and shamed'. Indicators also show national authorities, external financiers, etc. the strong and weak points of the sector.

There are many possible water indicators, and the choice between them depends ultimately on what they will be used for. World Water Development Report 2 (WWDR2)[24] listed over 60 indicators, categorized by challenge area (governance, settlements, water resources, ecosystems, health, etc). Focusing more narrowly on water resources and services, the broad choice is between

- General *macro and sectoral indicators*, useful to measure recent changes in the water/wastewater sector, its current status, and to make comparisons between countries.
- More *detailed performance indicators* used to assess service providers when judging their static efficiency, their progress over time, and how they compare with their peers (benchmarking). A number of the macro indicators are also relevant to the assessment of service providers, e.g. level of tariffs, affordability, consumption per head, etc. These indicators are basic for performance-based contracts between a public client and a service provider, as well as for use by credit-ratings agencies where the utility is raising finance through bonds or loans. The WSP is also using data of this type in producing *shadow ratings* for water service providers to enable them to compare themselves with their peers.

Macro and sectoral indicators

There is an optimal degree of detail and generality for these types of indicator. An indicator which is highly relevant to one particular situation, and which takes account of local factors, is unlikely to be widely available for other circumstances and therefore suffers as a comparator. The opposite is also true: the most widely available indices tend to

23 World Water Development Report 2, pp 77-79.

24 UN World Water Development Report 2, *Water, a shared responsibility*, 2005.

Box 5 Macro and sectoral indicators of household water services

- Water coverage:% of population (total, urban, rural) connected to a public water supply.
- Sewerage coverage: % of population (total, urban, rural) connected to public sewers.
- Wastewater treatment: % of wastewater collected that is regularly treated to an acceptable (defined) standard. Alternatively, % of the population whose wastewater is so treated.
- Volume and throughput: water production and estimated consumption, in litres per head per day.
- unaccounted-for-water, as a % of production. Alternatively, non-revenue water as % of production (which may include supplies to non-paying public purposes and institutions).
- Quality: % of drinking water supplied meeting (defined) quality standards
- Continuity: average uninterrupted water supply in hours per day
- Charges: average nominal combined water/wastewater tariff, Euros per m^3
- affordability: average monthly payments for water and wastewater services as a % of average household incomes

be crude, and need to be heavily qualified when used to make judgments about local cases. Indices need to be applied critically. Within countries, or in comparisons of similar institutions, more detailed indicators are appropriate. Box 5 lists macro and sectoral indicators that are commonly used for the household water services (typically urban).

Performance indicators for service providers

All the above indicators are also relevant for specific utilities or service providers to measure their performance in their service areas. However, general indicators need to be supplemented by more specific performance measures. Depending on the precise purpose of these, there needs to be a compromise between detail and comprehensiveness on the one hand – which limits comparability – and the selective use of more general indicators on the other – which is of lesser value to individual utilities.

As an example of the latter, the key indicators used by the World Bank in a recent comparative exercise involving 246 water utilities in 51 countries are: unaccounted-for-water, staffing ratio, working ratio, collection period, service coverage, affordability and continuity of service.[25] But at a more detailed, country-specific level, the World Bank's Benchmarking Water and Sanitation Utilities Project provides a network of linked websites containing values of cost and performance indicators for utilities in a particular region or country. The World Bank's Benchmarking Start-up Kit contains over 30 indicators, many of which have several measures for the same item. Several major projects for the selection and promulgation of water indicators, including the above, are being sponsored by the World Bank/ WSP, OECD , EU and other agencies. The Water Operator Partnership has a role in benchmarking African water utilities.

Where performance indicators are used as a policy tool by regulators, or in performance contracts between governments and service providers, experience shows that indicators need to be tried and amended for several years before they can be accepted as robust. Box 6 contains other, more detailed, indicators frequently used by regulators, ratings agencies and others:

5.2. Creating a level playing field for owners and operators

More information on all aspects of existing water, sanitation and sewerage systems is essential for their sustainability, irrespective of whether the assets are in public or private ownership or operation. This is even more important where a change of ownership or operator is being contemplated.

Most water and wastewater systems are run as public services by government or municipal authorities, para-statal bodies or utilities. Many of these perform badly, have bloated payrolls, insufficient revenues, high losses of water and weak contacts with their consumers.[26] In these circumstances, data collection and monitoring tends to be weak, feedback from consumers is poor, and knowledge about the state of their installations and networks (much of which is underground) is deficient. Many utilities, in short, don't know enough about the state of their assets, their operations or their customer base.

This is serious enough in normal circumstances, since it complicates routine operation and maintenance, leak prevention, planning extensions, preparing for tariff changes, etc. It is particularly serious where some type of Private Sector Participation (PSP) is being prepared, since the private partner is being required to bid on the basis of imperfect information

25 World Bank, *A Water Scorecard*. Note no 242 of the Private Sector and Infrastructure Network, April 2002.

26 The World Bank has completed detailed research on the performance of 836 state-owned water and sanitation enterprises, and 141 water and sanitation utilities with private sector participation in 71 developing and transition countries over a decade or more of operation. The results of the full study are summarised in the PPIAF *Gridlines*, May 2008.

Box 6 Indicators used to assess performance of water service providers

- rate of new service connections in '000 per year.
- number of faults reported and/or dealt with. The denominator can be either a unit of time (day, year), the size of the network (km of water or sewer pipes) or the number of consumers.
- staffing ratio, in employees per 1000 customers (or per 1000 connections). An alternative measure is water produced per employee.
- extent of metering, as % of water supplied, or % of connections, subject to individual household metering. Alternatively, metered water volume as a % of total water supplied.
- working ratio: total annual operational expenses, excluding depreciation and debt service, as a ratio of total annual pretax collections from billings and subsidies.
- billing efficiency, revenues collected as a % of payments theoretically due. The reciprocal concept is accounts receivable as a share of annual revenues, in months of sales.
- Operating costs per m^3 of water supplied or wastewater treated. Alternatively, total costs per m^3 unit, including capital charges

about the state and extent of assets, the financial situation of the system, and the customer base. In the event of a miscalculation, the company has to live with the consequences for the duration of the contract – frequently 20 years or more in the case of a concession.

Although the so-called *asymmetry of information* is often invoked as a factor in favour of the private bidder in such situations, the reality is often the opposite. The public authority's grasp of the reality, though imperfect as noted above, is likely to be superior to that of the private bidder. By the time the latter has a better grasp of the situation, the new pipes will be in the ground, costs will literally be sunk, and the public client will have a bargaining advantage. There are numerous examples of the failure of water PSP contracts due to poor information about the condition of assets, finances, customer base, etc, the latest being the management contract in Dar es Salaam, which terminated in 2004. In fact, the majority of high profile concession failures in recent years has resulted, in greater or lesser part, from information deficiencies at the time of contract.

International agencies (EBRD in Sofia, IFC in Manila, etc.) have successfully supported public bodies preparing PSP water contracts with help in creating the necessary information base, as well as advice on contractual forms and procedures, and actual negotiation. The information base is made freely available to all bidders in 'data rooms' This kind of information is also useful for subsequent regulators or adjudicators, and also for public-public negotiation such as the preparation of performance contracts between Ministries and public service providers.

5.3. Transparency and accountability

Full disclosure of all relevant information about operations, finances, procurement and contract decisions is vital if service providers are to be fully accountable to customers, citizens and tax payers. Inefficiency and, worse, corruption, flourish in the darkness of ignorance:

Enhancing transparency in water services would release large sums for their proper intended purposes.[27]

An unacceptable level of leakage of existing resources brings into question current processes and, perhaps, the wisdom of increasing resource flows to the sector. Much of the funding available in ministries, local governments, utilities and village administrations is being used by public office for private gain.[28]

6. Information for business and trade

6.1. Water footprints, virtual water and trade

The concept of *virtual water* – the water embodied in (or impacted by) the goods and services entering international trade – has enlivened the debate about water policy since it was introduced into the literature in 1993.[29] More recently the empirical application of the concept has been given focus by research on *water footprints* of specific products and national trade patterns. The precise implications of these concepts for national and international trade policy, and for consumption patterns within countries, are still unclear and controversial: further research and policy analysis is still required.

It has long been common for water-scarce countries to supplement their water resources by importing goods (usually food) that embody water. Thus people may have access to the benefits of water without

27 Plummer & Cross point out that if 30% (a hypothetical figure) of the flow of finance for African watsan MDGs is being diverted, this would lose CAN $20 billion from the effort over a decade. This indicates the size of potential gains from investing in data and analysis that might lead to reducing this problem. The 2008 *Global Corruption Report* by Transparency International is on the topic of corruption in the water sector.

28 Plummer and Cross, WSP, 2006.

29 Prof Tony Allan (author) was the 2008 Stockholm Water Laureate.

having access to water itself. Conversely, some water-scarce countries aggravate their situation by exporting goods (e.g. irrigated farm products) or services (e.g. golf holidays) embodying a large element of water. A country's water endowment is not an absolute constraint, and can be managed by adjustments to exports and imports containing 'water intensive' goods and services. But by the same logic, countries and companies based in them may unwittingly add to water scarcities in supplying countries by importing goods and services that are water-intensive.

There is growing awareness of the impact of lifestyle and consumption choices on water use, and the pressures this creates in many countries. These pressures can be transmitted abroad through trade and investment. The question 'how much water do people drink?' is less relevant than the question 'how much water do people eat?'. According to one estimate, people in more affluent countries 'eat' 3,000 litres of water per day. It is estimated that the production of a kilogram of wheat takes 800–4,000 litres of water, a kilo of beef 2,000–16,000 litres, and a kilo of cotton 2,000–8,700 litres.[30]

The water footprint of a nation is the volume of water needed for the production of the goods and services consumed by its inhabitants.

The research documents in great detail the water requirements of components in national production, consumption and trade of many countries. The claim is made that 'major water exporters in the world are the USA, Canada, Australia, Brazil and Argentina. The big water importers are Japan, Italy, the UK and Germany …. the African continent… is a net exporter of water to the other continents, particularly to Europe.'

This would be of little concern if the water embodied in traded goods and services were fully valued, priced at its opportunity cost, including supply, depletion, and environmental costs. If that were true, countries would be adequately compensated for their 'exported' water, and would pay fully for their 'imported' water. But this is patently not

Box 7 Green water in international crop trade

Most global crop production is rain-fed. *Green water* refers to soil moisture from rainfall, accessed directly by plants. Green water represents the largest share of the virtual water flows in international trade in agricultural commodities. In general, exports flow from countries rich in green water towards those reliant on *blue water* (irrigation). According to new research, green water is by far the largest share (about three-quarters) of virtual water embodied in maize, soybean and wheat exports from the USA, Canada, Australia and Argentina during the period 2000–2004.

In countries with ample water, the use of green water in crop production has a low opportunity cost, fewer negative externalities (e.g. diversion of river flows, risks to health from stagnant water, etc.) and is therefore likely to be more sustainable. For these crops, international trade is likely to improve water security in importing countries without harming it in exporting countries.

Source: 'Strategic importance of green water in international crop trade' by M.M.Aldaya, A.Y.Hoekstra and J.A.Allan. UNESCO-IHE. March 2008

The growth of a social 'middle class in China, India, Brazil, Russia and other emerging markets is creating a growing market for foodstuffs such as milk, bread, eggs, chicken and beef which are water-intensive compared to the more exiguous diets they replace.[31] Likewise in the services sector, tourism and sports recreation are leaving a major water footprint in the host societies.

Trade is a result of the interaction of changing consumption patterns and shifts in the location of production. The latter reflects decisions on international outsourcing, investment flows, country export strategies, and other processes. The upshot of these forces is the water 'footprint' of economic activity, which has received greater definition from research on the Water Footprints of Nations (Chapagain & Hoekstra, 2004).

the usual case, least of all for the production and processing of agricultural products. Increased international trade in water-intensive goods and services, where water is a hidden or distorted cost, risks aggravating the water status of exporting countries where these are short of water and where it has a high opportunity cost.

The 'cost' of virtual water embodied in traded goods and services is its *opportunity cost* – its value in the best alternative use. Where this water is scarce, or where there are potential alterative uses for it, this opportunity cost is significant. Conversely, where water is ample, and there are no feasible alternative uses for it, its opportunity cost can be zero, or close to it. New research on the *green water* content of internal crop trade throws light on this point, with important trade policy implications (Box 7).

6.2. Sustainability indicators and diagnostic tools

Private companies operating on a major scale, especially multinationals, are becoming highly aware

30 World Economic Forum, *Managing our future water needs for agriculture, industry, human health and the environment*. Discussion Document for Davos meeting, 2008.

31 *Financial Times Magazine*. Jan 26/27, 2008.

Box 8 The Global Water Tool

The Tool is a user-friendly method for companies and other organizations to map their water use and assess risks that might affect their global operations and supply chains. It provides information about the presence of company sites in water-scarce areas, numbers of employees in countries lacking improved water and sanitation, and the number of suppliers in water-scarce areas now and what that number is likely to be in 2025.

The Tool compares the company's water uses with data on the availability of water and sanitation on a country and watershed basis. It allows calculation of water consumption and efficiency and establishes water risks within the company's portfolio. It creates key Global Water Risk indicators, inventories, performance metrics and geographic mapping, and enables effective communication with stakeholders on company water issues.

Source and further information: www.wbcsd.org.

of their water footprints and are taking steps to quantify, justify and minimize these. Their motives are various – to minimize risk through their reliance on water that is becoming more scarce, to prevent bad feeling with water-scarce communities amongst which they operate, to respond to shareholder and NGO pressures, and to economize on an input that may become more costly in future. Banks and other financial institutions that deal with companies exposed to water risk have similar concerns, at one remove.[32]

Firms are increasingly mapping their *water sustainability* – the content, use, impacts, etc. of the whole supply/value chain of production, including their materials and components, power and energy sources, consumption and use, waste disposal and recovery, etc. Some firms are developing the concept of 'water balances' as a business tool. The Global Water Tool developed by the World Business Council on Sustainable Development is attracting attention (Box 8).

A number of sustainability indicators are now available, e.g. the (Brazilian) Banco Real's BOVESPA sustainability index., the Dow Jones Sustainability Index, the FTSE4Good, the CERES guidelines on reporting social and environmental performance, the GEMI Water Sustainability Tool, etc. Amongst this plethora of indices, the production of an authoritative, best-practice water sustainability indicator would be a valuable service.[33]

7. A comprehensive national accounting framework for water

Water is an important element in the economy of all countries. It is a vital input to economic activities, it contributes to the good health and well-being of the population, it is crucial to natural habitats and the environment, etc. However, like other environmental goods and services, it has proven difficult to fully capture the impact of water on economic status, growth and performance, as these are conventionally measured and recorded in national income accounts.

There are various reasons for this, but the fundamental factor is that water is not valued – or *fully* valued – as an economic good in monetary terms that can be collated alongside other economic services. Hence its contribution to national income accounts is undervalued or ignored. A country's economic dependence on water is not fully appreciated, and situations where its water *capital* is run down or debauched[34] are not signalled in time (Box 9).

Box 9 Saudi Arabia's use of non-renewable aquifers

In the 1980s the Saudi Government promoted national food self-sufficiency using non-renewable groundwater, encouraged by large subsidies to new farmers. By the early 1990s the policy had become so successful that the Saudi desert had become the world's sixth-largest exporter of wheat. During this period the overall irrigated surface area increased by almost a million hectares. In subsequent years the high cost of subsidies bore heavily on a Saudi budget that was coming under pressure from other sources, and by the end of 1996, 76% of the newly irrigated land was abandoned.

It has been estimated that, between 1980 and 1999, 300 billion m^3 of water (equivalent to six years' flow of the Nile into Egypt) was used in the Saudi programme, two-thirds of which was from non-renewable sources. Even after wheat production declined in the mid-1990s, water consumption remained high due to the growth of other water-intensive crops and livestock products, much of which was exported. Exports of *virtual water*, much of it non-renewable, between 1997 and 2006, have been estimated as 37.5 billion m^3. On plausible estimates of the size of the remaining water reserves and the current rates of extraction, Saudi Arabia's aquifers may be effectively exhausted in one or two decades.

Source: Elie Elhadj, 'Saudi Arabia's agricultural project: from dust to dust'. *The Middle East Review of International Affairs.* 12/2, June 2008.

32 UNEP Finance Initiative, *Financing water: risks and opportunities*, 2006.

33 This will be one conclusion of the World Water Development Report 3.

34 Through over-exploitation or contamination of groundwater or water courses.

Box 10 Information presented in the 'System of Environmental-Economic Accounting for Water,' (SEEAW)

The SEEAW includes as part of its standard presentation the following information:

(a) stocks and flows of water resources within the environment

(b) pressures of the economy on the environment in terms of water abstraction and emissions added to wastewater and released to the environment or removed from wastewater

(c) the supply of water and the use of water as input in the production process and by households

(d) the reuse of water within the economy

(e) the costs of collection, purification, distribution and treatment of water, as well as the service charges paid by the users

(f) the financing of these costs, that is, who is paying for the water supply and sanitation services

(g) the payments of permits for access to abstract water or to use it as sink for discharge of wastewater

(h) the hydraulic stock in place, as well as investments in hydraulic infrastructure during the accounting period

Source: UN Statistics Division, 2008

The incorporation of hydrological data into national income accounts will give economic policy makers signals of problems such as those above. Leading issues such as growing water scarcity will receive a more robust framework in which options can be considered. Discussions of water footprints and virtual water will be conducted in a context familiar to the economic policy maker, using a common vocabulary and units. The development of the System of Environmental-Economic Accounting for Water (SEEAW) is for these reasons a major step forward in getting water the attention it needs in national agendas.

7.1. The System of Environmental-Economic Accounting for Water (SEEAW)

SEEAW provides a conceptual framework for organizing hydrological and economic information in a coherent and consistent manner. It is an elaboration of the handbook *Integrated Environmental and Economic Accounting 2003* of the United Nations, which describes the interaction between the economy and the environment. Both this document and the SEEAW use the basic framework of the 1993 System of National Accounts, which is the international standard.

SEEAW permits a consistent analysis of the contribution of water to the economy and the impact of the economy on water resources. Because it covers all important environmental-economic interactions, it is ideal for capturing cross-sectional issues such as IWRM, as well as a range of other relevant features (Box 10).

SEEAW could throw light on a number of matters of interest to policy makers, such as allocating water resources efficiently, improving the efficiency of water use in different sectors, and the costs to water users with and without proposed new investment. Intelligent use of the System should give a powerful boost to IWRM. The System provides information on the pattern of water use compared to its availability, changes in its stock, and details on abstraction and returns by industry. It provides a standardized information system which harmonizes data from different sources, is accepted by the stakeholders, and can be used to create indicators. The information it provides is transparent, readily available to the public, and can also be used for international comparisons.

The effort and cost entailed in building up a SEEAW should not be underestimated, and would need regular updating to retain its value. However, it is probable that these costs would be amply repaid through the creation of a more relevant policy environment.

Water professionals often complain that theirs is a neglected 'Cinderella' sector. The adoption of SEEAW could give them their rightful place at the high table.

8. Conclusion

If water is essential to life, then information about it is equally vital. This paper has given examples from a variety of angles as to why more information, and better use of it, would bring great benefits to society – which justifies public and international support. These examples include: information enabling the citizen to access vital information for public health and safety, such as flooding; meteorological information needed for the survival of farmers in the Sahel; data for monitoring progress towards the MDGs; the use of data and analysis to make the case for better sanitation; information to monitor the state and performance of national water sectors and services; data to create a level playing field between public and private operators; research on virtual water and water footprints with a potential bearing on international trade policy; and the development of water sustainability indicators for use in private businesses and by civil-society watchdogs.

The generation of information is itself a type of economic activity, and the notions of cost-effectiveness and 'results-effectiveness' are relevant. Because much of the information discussed here is a public good, it deserves public support. Where it is an international public good, there is likewise a case for international public (or philanthropic) support.

If water problems and challenges are to receive the relevant policies they deserve, the assimilation of water data into conventional national accounts is necessary. The appearance of the new System of Environmental-Economic Accounting for Water (SEEAW) is a milestone, which will add coherence, proportion and economic respectability to many of the issues discussed in this paper.

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World Water Assessment Programme side publications, March 2009

During the consultation process for the third edition of the World Water Development Report, a general consensus emerged as to the need to make the forthcoming report more concise, while highlighting major future challenges associated with water availability in terms of quantity and quality.

This series of side publications has been developed to ensure that all issues and debates that might not benefit from sufficient coverage within the report would find space for publication.

The 17 side publications released on the occasion of the World Water Forum in Istanbul in March, 2009, in conjunction with *World Water Development Report 3: Water in a Changing World*, represent the first of what will become an ongoing series of scientific papers, insight reports and dialogue papers that will continue to provide more in-depth or focused information on water–related topics and issues.

Insights

IWRM Implementation in Basins, Sub-Basins and Aquifers: State of the Art Review
by Keith Kennedy, Slobodan Simonovic, Alberto Tejada-Guibert, Miguel de França Doria and José Luis Martin for UNESCO-IHP

Institutional Capacity Development in Transboundary Water Management
by Ruth Vollmer, Reza Ardakanian, Matt Hare, Jan Leentvaar, Charlotte van der Schaaf and Lars Wirkus for UNW-DPC

Global Trends in Water-Related Disasters: An Insight for Policymakers
by Yoganath Adikari and Junichi Yoshitani at the Public Works Research Institute, Tsukuba, Japan, for the International Center for Water Hazard and Risk Management (ICHARM), under the auspices of UNESCO.

Inland Waterborne Transport: Connecting Countries
by Sobhanlal Bonnerjee, Anne Cann,Harald Koethe, David Lammie, Geerinck Lieven, Jasna Muskatirovic, Benjamin Ndala, Gernot Pauli and Ian White for PIANC/ICIWaRM

Building a 2nd Generation of New World Water Scenarios
by Joseph Alcamo and Gilberto Gallopin

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by Marie-Joëlle Fluet, International Secretariat for Water; Luc Vescovi, Ouranos, and Amadou Idrissa Bokoye, Environment Canada

Updating the International Water Events Database
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Scientific Papers

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A Multi-Model Experiment to Assess and Cope with Climate Change Impacts on the Châteauguay Watershed in Southern Quebec
by Luc Vescovi, Ouranos; Ralf Ludwig, Department of Geography, University of Munich; Jean-François Cyr, Richard Turcotte and Louis-Guillaume Fortin, Centre d'Expertise Hydrique du Québec; Diane Chaumont, Ouranos; Marco Braun and Wolfram Mauser, Department of Geography, University of Munich

Water and Climate Change in Quebec
by Luc Vescovi, Ouranos; Pierre Baril, Ministry of Transport, Québec; Claude Desjarlais ; André Musy; and René Roy, Hydro-Québec. All authors are members of the Ouranos Consortium

Investing in Information, Knowledge and Monitoring
by Jim Winpenny for the WWAP Secretariat

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by Maite Martinez Aldaya, Twente Water Centre, University of Twente and Manuel Ramon Llamas, Department of Geodynamics, Complutense University of Madrid, Spain

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World Water Assessment Programme
Villa La Colombella
Localita di Colombella Alta
06 180 Colombella (PG) – Italy

World Water Assessment Programme (WWAP)
UNESCO - Division of Water Sciences
1, rue Miollis
75015 Paris - France

Fax : +33.(0)1.45.68.58.11
E-mail address: wwap@unesco.org

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