

## Which indicators for whose policies? Some challenges of global water monitoring

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### **Introduction: water as a global policy priority**

Water is a new priority for global policy and decision makers who are increasingly acknowledging the centrality of water in development and the focus that should therefore be placed on its effective management and sustainable use. This is reflected by extensive activity and global commitments in international fora.

At the United Nations, sustainable water management was included in the Millennium Development Goals (United Nations 2000) and a special session of the General Assembly was held in March 2010 to discuss water matters. The UN Secretary General has established a dedicated Advisory Board to help set and drive a high level water agenda. The concept of a right to water has been supported by the UN General Assembly after extensive international debate and there is a global movement to promote the ratification of the International Watercourses Convention.

In other global political structures such as the G8, Heads of State have been discussing water problems since 2002 and have committed themselves to programmes to address them (Government of Canada 2002). Water issues are also being brought into the international discussions about climate change because it is generally understood that water management will have to be an important element of adaptation efforts. This was highlighted during the Copenhagen Climate conference in December 2009 where most of the imagery used to illustrate the potential impacts of climate change was water-related (although water was not mentioned in the conference decisions).

Regional organisations such as the African Union have declared water to be a top priority (African Union 2008) and called for a focus on infrastructure and institutional development. Meanwhile, the OECD, a “rich world” organisation has launched programmes to consider the detailed technical challenges of financing and informing the management of water related activities. (OECD 2010)

Global business has also put water on its agenda. There is a CEO Water Mandate group, working under the auspices of the UN Global Compact, and an ongoing Water Initiative launched by the Davos-based World Economic Forum in 2009. Both are seeking ways in which the private sector can contribute to more sustainable water management while managing the growing risk posed by water to business activities.

However, the plethora of initiatives and the diversity of responses suggests that political and business leaders have difficulty in understanding this renewable natural resource. This is entirely reasonable since water is a complex renewable resource that defies easy characterisation. Although part of a global system,

freshwater resources in their liquid and solid phases are constrained by physical boundaries, have very local characteristics and cannot, for most purposes, be transported economically over large distances. While water is an input to or medium for many economic activities, it cannot simply be treated as a commodity, in part because of the wide range of economic and social uses (broadly defined) to which it is put, as well as the fact that it is part of the natural environment in its own right. It has most usefully been described as a “common pool resource” whose management must reflect the challenges inherent in this definition (Ostrom 2009).

Aside from their immediate concerns about ensuring adequate water supplies for their populations and economies, public policy makers are also aware of a range of water-related hazards, from floods to droughts, and the need to adopt a more systematic approach to water management in support of disaster risk reduction. Large businesses have identified the uncertain availability of water not just as a potential risk to their industrial operations but also to their supply chains. They also recognize that the impact of their activities on water resources, through waste water discharges as well as water abstractions, is likely to be more closely scrutinised and rigorously regulated in the future.

These concerns have been accentuated by a number of factors. It is predicted that, over the next few decades, the world’s water resources will be significantly impacted upon by global social drivers, including population growth as well as economic development. The changing diets of the world’s people are contributing to increased demands for water for agricultural purposes while increased industrial production associated with economic growth is imposing new demands and pressures upon the resource.

More generally, the threat of climate change has changed the perception that, while natural water cycles are variable, they are essentially stationary. There is now evidence to suggest that the parameters of water resource variability may be changing, making future availability and extremes more difficult to predict within defined levels of certainty. The impact on water resources of responses to climate change, such as the production of biofuels or the expansion of hydropower is also not always fully understood.

Given the combination of intensified pressures on the resource and growing uncertainty about its availability and behavior, it is also recognised that intelligent and innovative policy and management responses will be required at many levels to sustain both human activities and the environment as well as to address the needs of the poor communities that will bear the brunt of the impacts. This is the context in which interest in understanding water resources and their uses has grown and with it, a demand for policy relevant information to support policy development and decision-making to manage the resources and their impact on society.

It is this need that the UN’s World Water Assessment Programme (WWAP) has sought to address, together with its parent body UNWater, a consortium of international organisations whose mandate includes water issues. An Expert Group was established to support a review of the indicators with a particular focus on the data required to calculate them; this paper is based on the work of that Group.

### **What water resources indicators for policy makers?**

One consequence of the policy-makers’ interest in water as a constraint and a risk is a desire to monitor water resources and their management and use. But what do policy and decision makers want to know?

The amount of water available, its variability and reliability, is a key determinant of the viability of many human activities. One element of this is the extent and risk of extreme events, whether floods or drought. The quality of water is another dimension to be monitored since, in many applications, the availability of water for particular uses is determined as much by its quality as by the volume present.

Some water uses require specific indicators. Hydropower generation does not consume water but requires water flows that can be varied over time, according to electricity demand while navigation requires flows to be maintained at reasonably constant levels. Flood control requires empty storage capacity in systems in which excess flows can be captured while drought mitigation requires that the amount of water in storage be maintained as high as possible. So indicators of storage capacity and actual storage are important but are most valuable when taken together with information about total flows. Ecosystems and ecosystem services, such as fish production are impacted by any uses that change “natural” flows or water quality and the state of aquatic ecosystems is a further, complex, dimension of water resources that must be monitored.

So, aside from a simple understanding of the resource endowments available to them and their limitations, policy and decision-makers may wish to understand other dimensions of water and its use and to assess when particular situations are becoming critical and where tradeoffs need to be made. They also need information to assist them in choosing appropriate management interventions and to monitor the effectiveness of such interventions, whether in terms of the reliability of water allocations, the quality of water abstracted from a particular source or the resilience of a society to extreme water related events.

This information is often required at different scales and can helpfully be provided in comparative form. For foreign policy purposes, an understanding of the division of water between countries is needed but will only be useful if it is accompanied by information about the extent to which the available water is used in each country. In assessing the potential impact of drought on a national economy, information about the availability of water at a national level may be adequate. In determining the sustainability or resilience of a particular production system, information about the specific local water resource on which it depends will be more important.

Policy and decision-makers also require processed information, which does not require detailed understanding by the user yet conveys a clear picture of a relevant dimension. Indicators are often proposed and designed as tools to meet this need.

So an indicator of storage capacity as a proportion of total flow would provide useful guidance of the extent to which a water system could be managed to produce hydropower, manage floods and navigation or mitigate drought. Trends in the extent of wetlands compared to an initial datum will provide evidence of the performance of environmental protection measures. Changes in an indicator of economic production associated with sectoral water abstractions can provide evidence of the success of policies to “delink” economic activity and environmental impact.

### **A focus on the data drought**

The design of indicators has attracted much attention and, when WWAP published the first World Water Development Report in 2003, it reported on more than 160 indicators that were proposed and calculated by a variety of organizations. It acknowledged that these would evolve over time but noted that a smaller set of high level indicators was required to support decision makers at national, regional and global level. To this end, in 2008, UN Water established a Task Force to propose a set of key indicators that should be monitored at global level. (UNWater 2010)

However, while the design of water indicators and water accounts has captured the attention of practitioners and academics (see, for example, Godfrey and Chalmers 2011), such systems will only be useful if data is available to calculate the indicators chosen or to populate the accounts. The challenge has been demonstrated by the experience of the compilers of the World Water Development Report. By the time the second World Water Development Report was produced in 2006, only 62 indicators were listed because there was no systematic process for updating the data in the interim. In the 2009 edition, 58 indicators were listed but only 30 had been updated. The situation has not improved and in the 2012 edition, it is expected that a similar number will be reported.

Policy formulation and decision making in the sector thus depend on what has been characterised as an “inverted pyramid”, with a great deal of analysis undertaken on the foundation of a limited and shrinking set of data points. This point was further emphasized at the 5th World Water Forum where, in all three sessions of the “Data For All” theme, there was a repeated message that “the challenges faced in the water sector are growing but the data available to provide the information to guide and monitor the responses is not; indeed in many regions, availability is decreasing”. (UN Stats 2010) At that meeting, it was also agreed that a collaborative programme of work needed to be initiated to address the challenges.

To address this situation and contribute to the work of the larger Task Force, an Expert Group was convened by the UN World Water Assessment Programme to review the provision of core indicators in the context of limited data availability. Recognising that the identification, production and use of water resource indicators involved many different actors and interests, a three stage consultation process was developed to engage their different perspectives.

A dialogue was held with key **users of water resource information** from different sectors, including government, business, financial institutions and non-governmental organisations working in the fields of poverty and environmental protection, to consider their indicator needs.

A subsequent dialogue was held with representatives from **communities of data providers and interpreters**, which focused on the availability of data to populate the key indicators proposed on a sustainable, ongoing basis as well as possible innovative sources of data. This included representatives from the leading global organisations responsible for different dimensions of water resource data monitoring, systems modellers, and representatives from water using sectors such as urban utilities and environmental managers as well as from the government statistics community.

Finally, representatives of indicator users were brought together together with data providers in a **synthesis session** to make recommendations on an approach to indicator production that would be

feasible, sustainable and meet the priority needs of key users. Where existing data streams were not adequate, specific proposals were sought to address the gaps.

During the Expert Group's deliberations, it became clear that while there was agreement on the basic indicator categories, it would be difficult to reach consensus on a limited list of indicators because of the very different objectives of different "users". While some users focused on concerns of the main-stream water sector such as the capacity to provide water supply or generate power, others sought indicators to support social and environmental advocacy objectives or to guide corporate decisions in fields as disparate as food production and mining. This outcome was in line with the findings of other authors such as Scrivens and Iasiello (2010) who comment that "Indicators are invariably developed to inform and influence different societal, political, technical and institutional processes ... a composite indicator developed by an environmental Non Government Organisation (NGO) will probably have more success raising awareness among the general public, than as a widely-accepted information tool among government analysts".

However, it was confirmed that most users were interested in trends rather than "snapshots". It was also confirmed that very few of the proposed core indicators could currently be calculated in a reliable and repeatable manner to enable trends to be determined on a national or regional basis because of the limited extent of reliable and ongoing reporting of certain key "variables" or "data items". The key conclusion of the Expert Group was thus that the initial priority should be to identify a set of key "data items" and then to focus on the actions needed to produce them consistently and systematically in the future. The "data items" proposed are listed in Table 1.

While this conclusion addressed, in part, the original task of choosing key indicators, it also argued that a focus on the production of "data items" would achieve more than simply to facilitate the calculation of those indicators that are considered to be "core" by UNWater and the WWAP. It would also enable a wide range of other indicators to be generated that may be useful to other parties.

A key recommendation was thus that WWAP, as a neutral platform, should ensure that its output is sufficiently generic that it can be used to provide a range of indicators relevant to the many different interest groups that seek to track trends in water resources. A focus on the production of core "data items", in addition to the core indicators that WWAP itself uses, would achieve this purpose. The data items identified would have wide application in the indicator realm and some would themselves provide important information, for instance:-

- Trends in precipitation (including extremes of drought or excessive precipitation)
- Trends in water availability (TARWR<sup>1</sup>)
- Trends in species, wetland condition and water quality

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<sup>1</sup> Total Actual Renewable Water Resources

**Table 1 : Proposed Key Data Items****In the domain of water resource availability:**

- Total actual renewable water resources (TARWR) (30 year moving average)
- Storage
  - o Available man-made storage capacity
  - o actual long-term changes in
    - surface storage and
    - groundwater storage
- Long term average precipitation (30 yr moving average to match new TARWR)
  - o Indicators of variability
    - Frequency of specific extremes
    - Values of specific extremes

**In the domain of water quality and environment**

- Eutrophication of selected freshwater water bodies
- Nitrates and salinity in
  - o Groundwater
  - o Freshwater
- Freshwater species (subsector of living planet index by WWF)
- Extent and condition of selected wetlands

**In the domain of water use**

- Water use by sector (existing classifications)
  - o Agriculture
  - o Industry
  - o Domestic
  - o Energy

Once the identified “data items” are determined, they could also be combined with socio-economic data sets (such as population and livelihoods as well as national and regional GDP) to calculate a wide range of indicators. These would include standard items such as:-

- Freshwater availability as a proportion of precipitation (“conversion ratio”)
- Water availability per capita (water scarcity)
- GDP per unit water (“water productivity”)
- Employment per unit water (for economy, and for specific sectors)
- Available potential storage as a proportion of available water
- Water use as a proportion of available water (“water use intensity”)

This approach would be even more useful if both the socio-economic data was available on a river basin scale as well as according to national and sub-national administrative boundaries. It would also enable the production of “composite indicators” such as:-

- Trends in water quality in relation to trends in water use intensity
- Water productivity in agriculture in relation to rainfall variability
- Trends in water use intensity in relation to GDP

While WWAP would report on many of these data items in its regular assessments and select the most important indicators to support its key messages, this approach would enable the production of interactive data sets so that potential users could determine their own relationships between data items. This would greatly expand the usefulness and potential application of WWAP's information products.

### **Responding to the data constraints : approach and progress**

The effective monitoring of water and its use thus requires not just new accounting systems and conceptual indicators that are relevant in a wide range of physical, social and economic contexts but also the development of new data sources to inform these indicators. The challenges of data availability will also necessarily inform the choice of operational and policy indicators.

At present, this information flow is weak, particularly at the national and regional level on which WWAP focuses. This situation reflects a number of problems. At its simplest, data collection systems are deteriorating due to underfunding, particularly, although not exclusively, in poor countries, which face many more immediate challenges. Global information repositories work on shoestring budgets and depend on national reporting, which is often of doubtful quality. They do not have the resources to verify the data or to help countries to improve its production. While huge volumes of potentially relevant data are routinely collected by remote sensing and related mechanisms, this is often not processed to provide management and policy relevant information due to technical challenges and the costs involved.

There are further barriers. In some countries, water resource data is seen as a commercial product to be paid for, not shared; in others, particularly those with shared river, it is considered to be a matter of national security, access to which must be restricted. On the vital dimension of water use, some corporate users are unwilling to share data about their performance because of concerns about legal liability; weak public management institutions often fail to collect and report data on a systematic basis even where it is available; this is aggravated by the absence of a formal framework for data collection and reporting. As a result, information about actual water use, which is fundamental to any assessment of progress or problems in water resource management, is also very limited.

It was therefore suggested by the Expert Group that a dedicated programme for the production of key "data items" should be established. The approach proposed was informed by the progress that has been made in the field of domestic water services by the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. When global Millennium Development Goal targets were set, first for water supply and later for sanitation, the sub-sector confronted similar problems to that now faced in water resources. Available data about access to services, their quality and reliability depended on national reporting which was notoriously unreliable and of little value for programme design and monitoring.

The response, led by WHO and UNICEF was to start a Joint Monitoring Programme which focused on developing new sources of data, in this instance, by cooperating with existing systems of national household surveys, usually undertaken by national statistical services. The data provided transformed the understanding of the challenges and contributed significantly to the design of effective programmes to address them. The approach taken by the EG was as follows:-

- Areas in which data deficiencies seriously impede the production of key indicators were identified;
- Potential approaches to improve data availability, either by resort to traditional methods or through the application of innovative methods were considered;
- Target areas in which substantial progress could be made in the short term with relatively limited resources were chosen;
- In the selected target areas, outline proposals for programmes of work to deliver global sets of data items were prepared with indicative costings;
- Potential institutional partners were identified.

Areas of focus that were identified included:

- Resource availability (TARWR)  
The establishment of a system to produce an annual estimate of total available renewable water resources by country and major river basins, using the best available data and agreed methodologies to “patch” the record from remote observations where direct observation is not possible.
- Remote sensing index of water quality  
The initiation of a project to interpret data about water quality, specifically the extent of eutrophication, using remote sensing data to enable global, regional and national trends to be determined to complement existing data which focuses on known “hotspots”.
- Wetland status and environmental services  
Remote sensing data is also proposed to be used for the systematic ongoing monitoring of the extent of wetlands whose reduction is in many places a good indicator of the state of environmental protection.
- Resource use  
Because of the importance of improved water use data to populate key indicators such as water use efficiency, a project has been proposed to support countries to collect and report data on water use within a common and consistent framework; this would include the promotion of partnerships to encourage key water users such as urban water utilities and manufacturing industry, which already collect a great deal of data, to make it available on a regular basis.
- Trends and variability in precipitation  
Precipitation is the best signal of climate input into the hydrological system. A moving 30yr average of precipitation will need to be developed in order to complement the resource availability data item. It is proposed that this be coupled with an assessment of trends in rainfall variability.

Some progress has already been made with the first item, the development of a systematic approach to the generation of TARWR. In partnership with Professor Charles Vorosmarty of the CUNY, a new set of TARWR has been computed using available observational data sets so that it can be replicated on a regular, ideally annual, basis. It has been demonstrated to produce results comparable with the “stationary” estimates that are the basis of currently reported values for TARWR and could, if systematically generated, be used to monitor trends in water availability so that, for the first time, core indicators such as TARWR per capita would reflect trends in water availability as well as population changes.

If successfully implemented, the proposed programme will help WWAP to fulfil its mandate and ensure that it can report on whether and how changes in water resources endowments affect countries and regions, whether the efficiency of water use for national socioeconomic development is improving and whether degradation of the water environment has been slowed.

## Conclusions

This background is relevant to the statistical community which will come under increasing pressure from policy makers to help address the technical challenges of generating and translating data into policy useful information. A key issue that will immediately be confronted in many areas is the relative paucity of water sector data which aggravates the challenge of developing tools that can adequately address the variability of resource inputs. Compounding this, much of the water that is used is not monitored, since it is taken from natural systems (rather than controlled technical systems), and its quantities and qualities often need to be estimated.

The message that must be delivered to policy makers is that, if they do indeed believe that water and its management are of growing importance and that their monitoring is therefore a priority, more intellectual, institutional, infrastructural and of course financial resources, will need to be devoted to the task.

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