Space for Water

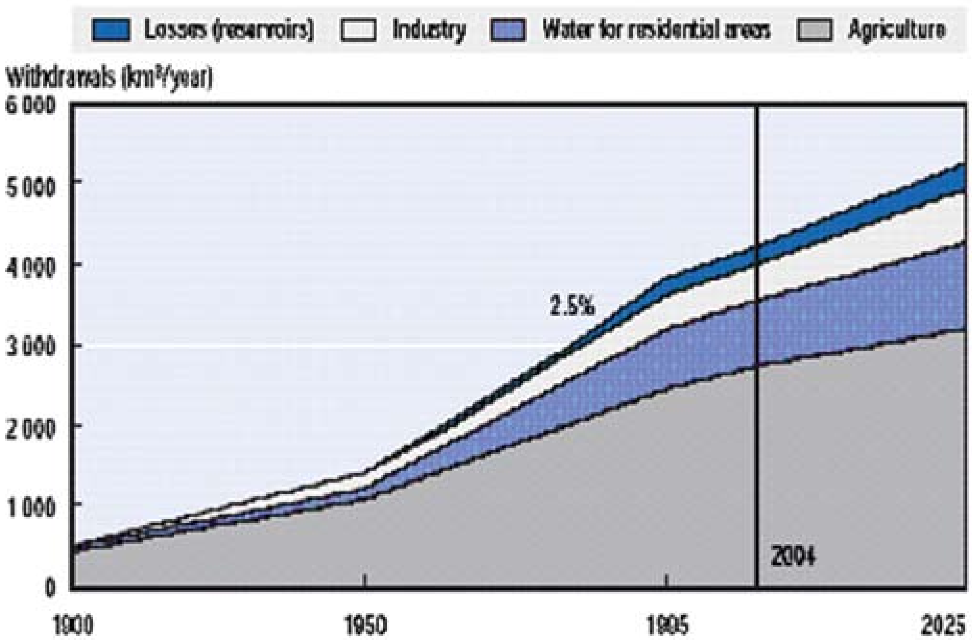
Claire Jolly and Barrie Stevens of the International Futures Programme look at how satellites can help us manage our water resources on Earth.

The management of the world's water resources is set to become one of the most important issues of the 21st century. In that context, a case study is being conducted within the framework of the OECD Forum on Space Economics. The objective is to explore the general capabilities of space technology to enhance water resource management, and see what space systems have generated so far in terms of socio-economic benefits and added-value in water management. The preliminary findings presented here are mainly based on existing literature and meetings with practitioners.

The state of the world's water has given rise to concern for decades now. A number of international bodies including the United Nations, the World Bank and the OECD have warned policy-makers for a number of years of the daunting consequences of failing to adequately manage water resources (see Figure 1). Global population is set to increase from slightly more than 6 billion in 2000 to over 8 billion in 2030.

The demand for fresh water and sanitation will grow in parallel, so that withdrawals are expected to increase substantially by 2025 with water withdrawals in developing countries increasing by 27% and by 11% in developed countries, thus putting even more pressure on current water management schemes, the search for new sources of water, on groundwater exploitation, etc. Economic growth and globalisation are expected to continue to grow apace, along with the population, thereby adding to the strains on water resources through increased demand but also increased pollution both of freshwater and coastal areas.

Figure 1–Global water withdrawal predictions



Sources: Shikomanov (1999) & FAO (2000) in OECD (2006),Infrastructure to 2030: Telecom, Land Transport, Water and Electricity, Paris.

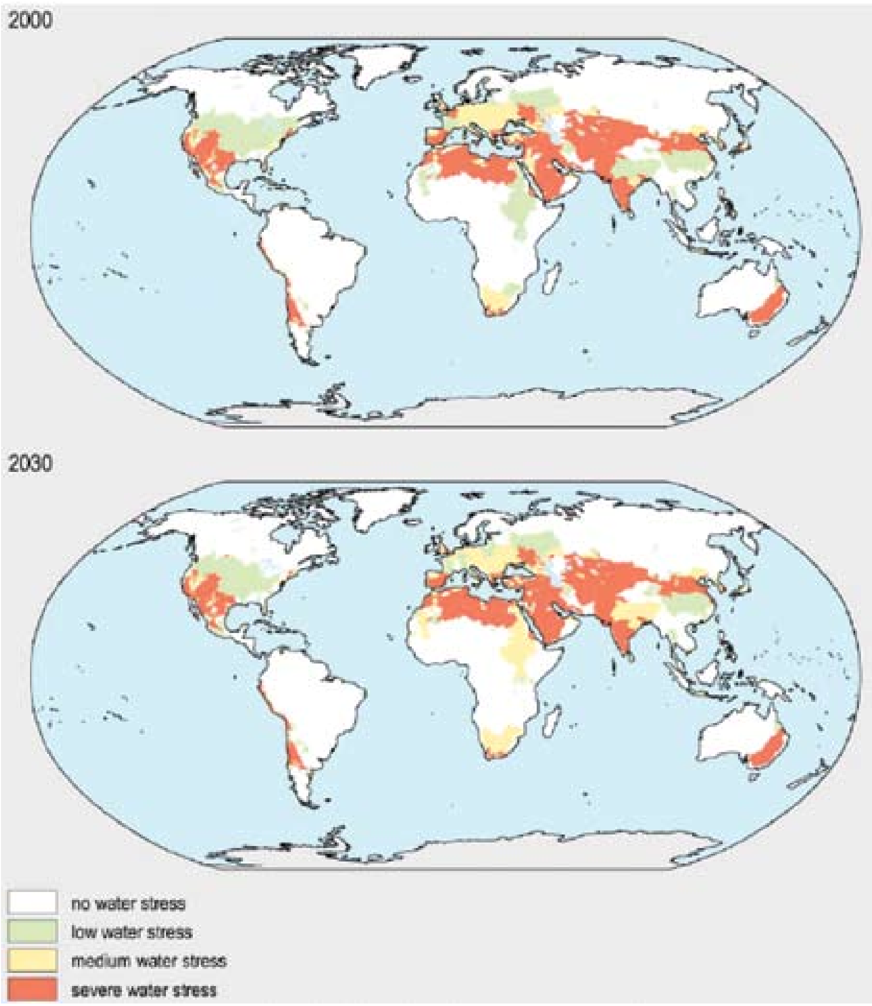
The effects of these developments are largely unpredictable. What are probably even more unpredictable are the effects of climate change.

Extreme weather events, droughts, inland and coastal flooding, hurricanes, etc. are expected to increase significantly in the coming years (see Figure 2). The costs in human lives and damage to economic assets and the environment could be huge. As an example, hurricane Katrina cost insurers around USD 50 billion, but the total economic damage it inflicted could be as high as USD 200 billion. As globalisation progresses, large scale natural disasters in a given country could have huge economic repercussions in the neighbouring countries, but also with worldwide commercial partners.

Given such risk-laden long-term prospects, it is absolutely crucial to take action to adapt to and mitigate the effects. This will involve a range of different measures – some policy, some regulatory, some technical, etc. Within that range of instruments, space-based tools could have an important role to play.

A variety of satellites and ground systems are already in place which are making, and will continue to make, a vital contribution.

Figure 2 – Water stress by major water basins in 2000 and 2030



Note: White: no water stress (annual average water withdrawals is less than 10% of annual average water available in the water basin). Green: low water stress (10-20%). Yellow: medium water stress (20-40%). Red: severe water stress (>40%). Source: OECD (2006), Working Party on Global and Structural Policies, Revised environmental baseline for the OECD environmental outlook to 2030, 20-21 November 2006, 24 October 2006, ENV/EPOC/GSP(2006)23

These range from meteorological satellites to Earth observation satellites tasked with the monitoring and measurement of specific Earth parameters, such as the bio-optical properties of oceans or water vapour. Space has become an increasingly important source of information, thanks to the global view it provides, and as many ground-based monitoring systems have continued to deteriorate in recent years. Data from meteorological satellites participate increasingly in operational water management, and key scientific discoveries have been made thanks to space-based data. For example, the Franco-American mission Topex / Poseidon has shown that oceans have been rising over the past decade using space altimetry, and has provided unexpected information for monitoring oceanic phenomena such as variations in ocean circulations such as the El Niño 1997-1998 event. A growing range of scientists and operational users are pressingly requesting even more data.

But how are policy makers to decide on what level of financial, R&D and other resources to put into space systems with a view to improving water resource management, and where to focus their efforts? The conventional approach to such questions is cost-benefit analysis. Numerous attempts have been made to measure the benefits of space-based systems more generally, but it has proven very difficult, if not impossible, to do so in a way that generates satisfactory results for the purpose of investment in decision making.

The difficulties apply equally to specific attempts to quantify the use of space in the field of water resources management, although several socio-economic benefits have been identified, especially in terms of cost avoidance (see Table 1). It is generally expected that as the number of systems increases, more relevant data will become available, overcoming some of the technical limitations of today's systems (e.g. having a satellite scan the same location repeatedly almost in real time). But this will come at a cost, not only from the space-based systems, but also from the need to develop the overall information architecture (i.e. integration of diverse in-situ and remote sensed data, models, speedy communications).

The lack of accurately quantifiable benefits from the deployment of space-based systems, coupled with the sheer unpredictability of many future events and their outcomes, clearly complicates major investment decisions. In light of this, it can be argued that policy makers need to explore new additional pathways to reaching decisions. One such alternative is a risk management approach. The risks to human life and economic assets stemming from the effects of population growth, economic growth, globalisation and climate change on water resources are very substantial, and difficult to predict, and by the time they have happened, they may well be irreversible. In such circumstances, it makes eminently

Table 1 –General benefits of using satellites for flood management

Better forecast with avoided costs of damages	Weather forecast combined with hydrological models permit more advanced flood and flash flood forecasts and warnings. Hence, - Reducing casualties and injuries (as well as consequences on public health), - Reducing economic damages (properties damages and economic activities) as well as environmental damages (especially for what concerned forest fires).
Improvement of operational efficiency	The response during the flood can be well targeted, satellite data providing the basis for extent mapping and real time monitoring, damage to infrastructure, meteorological assessments, evaluation of secondary disasters, resulting on other costs savings: - Reducing prevention costs (prevention plan elaboration, flood protection investments, forest maintenance), - Reducing anticipation costs (flood forecasting services, fire alert systems), - Reducing crisis management costs (rescue activities, fire fighting, recovery).
Reconstruction	Satellites' use speed the reconstruction efforts and loss assessments (insurance).

good sense to take action to better understand the risks, reduce uncertainty, reduce vulnerability to hazards, strengthen prevention, and improve the basis for mitigating the effects. In other words, to tackle the challenges facing the world's water resources through a kind of "insurance package" approach.

The question for policy making then becomes, what level of premiums are we willing to pay? There would be understandable reluctance to pay excessive premiums. But are investments in a space infrastructure that would help meet such objectives excessive? This would not seem to be the case. Comparing Earth Observation and meteorological infrastructure with terrestrial infrastructures (roads, water, telecommunications, national statistical offices), and bearing in mind the magnitude of potential losses in human life and economic assets, suggests that the overall cost of setting up such a system is not unduly high, nor are the rates of annual investment to maintain and expand the space infrastructure.

With the current orientations of several OECD and non-OECD countries in giving more importance to climate change policies, the need for adequate Earth observations will be more necessary then ever. Although extremely difficult to assess as shown by the case study's findings, the socio-economic benefits induced or derived from space-based infrastructure do exist in many cases (e.g. key scientific advances, saved lives, economic activity derived from known water quality), and more research needs to be conducted on this topic notably in the larger context of debates surrounding environmental valuation methodologies. In any case, the space infrastructure needs to be considered as a strategic asset in an infrastructure portfolio approach, where decision-makers need to consider their options for improved risk management.

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