Brief for GSDR 2015

Managing water variability, from floods to droughts

Lead author: Vladimir Smakhtin (International Water Management Institute [IWMI])
*With contributions from Paul Pavelic, Giriraj Amarnath and Matthew McCartney (IWMI)**

Introduction

If people are prepared, they are much more resilient to natural disasters. Knowing the global hotspots of flood and drought risk, and quantifying the level of risk for individual locations, can ensure local inhabitants are as well equipped as possible to handle the worst climate-related events that come their way.

Droughts and floods cost lives

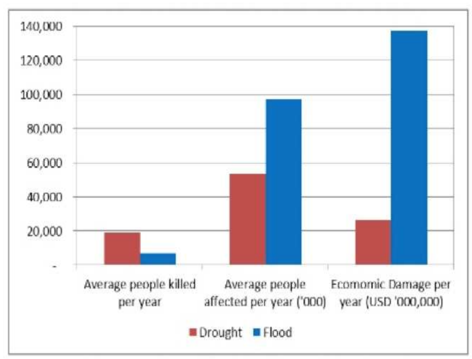
Water variability, manifested in floods and droughts, kills people, ruins crops, destroys livelihoods and damages economies. In many regions, the variability of water resources is projected to increase with climate change, raising the risk of disasters and outstripping the capacity of societies to adapt. This was recognized at the 2012 Rio+20 Conference, when member states committed to addressing water-related disasters.

The on-going discussions on Sustainable Development Goals (SDGs) support the need for early warning and disaster risk reduction systems; adaptation to climate change; strengthened resilience; adequate facilities and infrastructure; and appropriate policies. With water variability having an impact on the sustainability of development, improving how the resource is managed provides a means to achieving many of the envisioned SDGs. Methods for managing water variability are especially relevant to the SDGs for food security, water security, economic growth and action to address climate change, with an emphasis on basin-scale hydrological management techniques.

Greater resilience needed

In wet tropical regions, more intense rainfall is likely to increase flood risk; large floods could potentially surpass historical events in size and frequency. In contrast, many mid-latitude arid and semi-arid regions are likely to receive less rainfall, with droughts becoming more widespread, and longer than those observed since 1900.

Floods and droughts are the most economically and socially destructive of all natural disasters (Figure 1), accounting for about 90% of people affected by natural disasters, 95% of whom live in Asia. The global cost of natural disasters is close to USD 165 billion a year, more than all current aid flowing from developed to developing countries. By 2030, the damage from floods and droughts may exceed USD 450 billion, primarily from floods.



Average annual characteristics over 1980-2008

Figure 1: The effects of floods and droughts on people and economies. ***Source: EM-DAT, 2013***

Increasing people's resilience to disasters is important for achieving the SDGs. To protect against floods and droughts, we need to be creative about how we store water. Variability doesn't only result in negative outcomes, it has positive effects too. Floods are good for fisheries and floodplain agriculture, while droughts may kill pests.

For rivers to be healthy, the timing, frequency and range of high and low flows are important. The challenge for water managers is to alleviate negative aspects of variability while retaining those aspects that are essential for the health of ecosystems. Most importantly, to reduce people's vulnerability to

* The views and opinions expressed are the authors' and do not represent those of the Secretariat of the United Nations. Online publication or dissemination does not imply endorsement by the United Nations. Authors' can be reached at j.vanderbliek@cgiar.org.

climatic shocks and stresses, we need to holistically manage floods and droughts at the basin scale.

Identifying flood hotspots

The International Water Management Institute (IWMI) has developed a tool that uses near real-time satellite data to map flood inundation over time. Maps can be generated while flooding is taking place, enabling decision-makers to assess the progression of floodwaters and the severity of the situation, and to quantify the damage. The tool can also be used proactively to study flood vulnerability, areas prone to waterlogging, and the potential impact of flooding on critical agricultural production zones. The tool uses data captured by sensors that can operate day and night, and in almost any weather.

Flood risk products that take into account inundation extent, depth and duration can also be useful for determining flood insurance payouts. To enhance smallholder farmers' food and economic security via compensation for crop losses, insurance policies must include decision thresholds based on the frequency of extreme flooding. These thresholds can be derived from hybrid hydro-meteorological and satellite time-series data (Figure 2).

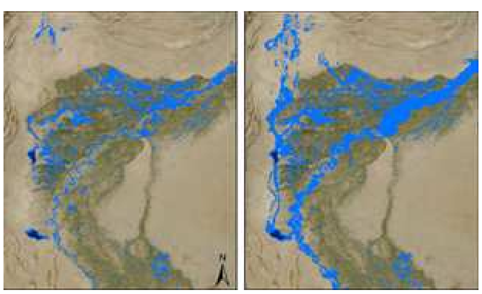


Figure 2: Satellite time series shows the maximum extent of flooding in Pakistan's Lower Indus in 2009 (left) and 2010 (right). ***Source: Giriraj et al., 2012***

Rethinking water storage

Water storage has a vital role to play in managing water variability, ensuring global food security and building resilience for adaptation to climate change. To meet the SDGs, countries with low per-capita water storage, especially those in sub-Saharan Africa, will have to invest in new water storage facilities.

Climate change and sustainable development needs necessitate a fundamental rethinking of the way water storage is planned and managed. This needs to be done from a basin perspective, to respond to the requirements of local communities, and meet both current and future water storage needs. Achieving this requires consideration of a variety of storage options and for those selected to be tailored for the specific context.

In the past there has been considerable emphasis on large-scale infrastructure but other options need to be considered that incorporate the beneficial aspects of natural wetlands, soil moisture, groundwater aquifers, ponds, small tanks and reservoirs (Figure 3). The effectiveness of each option varies and none is likely to be a solution on its own. However, broadly speaking, the deeper and/or larger the storage, the more reliable the water supply it provides; and the more 'natural' it is, the less complex and less costly it is to develop and access.

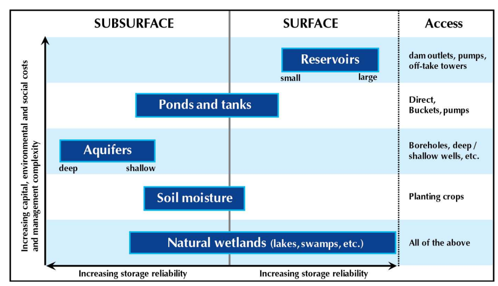


Figure 3: A wide range of water storage options exists. ***Source: IWMI Water Policy Brief 31***

IWMI has developed a diagnostic tool, based on biophysical and demographic indicators, which can be used to rapidly evaluate the need for storage and the technical performance of different storage options, under different climate scenarios.

When IWMI scientists applied the tool to assess water-storage needs in sub-Saharan Africa, they found the greatest need existed in the Sahel, the Horn of Africa and southern Africa, with more localized hot spots in southern Angola, Rwanda, Burundi, Uganda, Malawi and Mozambique. In Ethiopia and Ghana, the greatest need did not coincide with areas having the least rainfall, but with those having the highest population density.

Managing water at basin scale

If floods and droughts are managed at the basin scale, monsoon water can be stored underground in upstream areas and used for irrigation in the dry season while maintaining the supply-demand balance downstream. This approach would offer protection from flooding impacts. As well as having the necessary physical conditions, storing water underground and recovering it later on a basin scale requires effective policies, institutional arrangements and incentives that are socio-economically sustainable, and recognize the rights of the relevant stakeholders.

Harvesting floods for later use

In Thailand's Chao Phraya basin, major catastrophic flooding events occur regularly. Yet, basin aquifers upstream of the flood-affected areas have become depleted by over-extraction. Harvesting floodwater, storing it in aquifers upstream of the flood-prone areas, and using groundwater to grow crops in the dry season is technically viable. This would also reduce the magnitude of flooding of downstream industries and urban centers.

About 28% of the coastal discharge –equivalent to the third largest storage in the basin – could be harvested in one year out of four, on average, without affecting existing major storages, or the riparian and coastal environments. The system has the potential to recover its investment within 14 years, while generating USD 250 million annually in export earnings and boosting the livelihoods of some of the country's poorest people.

Appropriate approach for Asia

The approach could be used in similar basins in Thailand and other parts of Asia. For example, an analysis of the Ganges basin revealed that around 40% of it has biophysical and socio-economic characteristics well suited to such an approach.

References[1]

Giriraj, A.; Ameer, M.; Aggarwal, P.; Smakhtin, V. 2012. Detecting spatio-temporal changes in the extent of seasonal and annual flooding in South Asia using multi-resolution satellite data. In: *Earth resources and environmental remote sensing/GIS applications III: Proceedings of the International Society for Optics and Photonics (SPIE), Vol. 8538, Amsterdam, Netherlands, July 1-6, 2012*, eds., Civco, D.L.; Ehlers, M.; Habib, S.; Maltese, A.; Messinger, D.; Michel, U.; Nikolakopoulos, K.G.; Schulz, K. Bellingham, WA, USA: International Society for Optics and Photonics (SPIE). 11p.

EM-DAT 2013. D. Guha-Sapir, R. Below, Ph. Hoyois - EM-DAT: International Disaster Database – www.emdat.be – Université Catholique de Louvain – Brussels – Belgium.

IWMI Water Policy Brief 31. *Flexible Water Storage Options and Adaptation to Climate Change.* Colombo, Sri Lanka: International Water Management Institute (IWMI).

McCartney, M.**;** Smakhtin, V. 2010. *Water storage in an era of climate change: Addressing the challenge of increasing rainfall variability. Blue Paper*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 14p.

McCartney, M.; Cai, X.; Smakhtin, V. 2013a. *Evaluating the flow regulating functions of natural ecosystems in the Zambezi River Basin*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 59p. (IWMI Research Report 148).

McCartney, M.; Rebelo, L-M.; Xenarios, S.; Smakhtin, V. 2013b. *Agricultural water storage in an era of climate change: Assessing need and effectiveness in Africa*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 37p. (IWMI Research Report 152).

Pavelic, P.; Srisuk, K.; Saraphirom, P.; Nadee, S.; Pholkern, K.; Chusanathas, S.; Munyou, S.; Tangsutthinon, T.; Intarasut, T.; Smakhtin, V. 2012. Balancing-out floods and droughts: Opportunities to utilize floodwater harvesting and groundwater storage for agricultural development in Thailand. *Journal of Hydrology* 470-471: 55-64.

[1] A version of this whole text was published in: van der Bliek, J.; McCornick, M.; Clarke, J. (Eds.). 2014. On target for people and planet: setting and achieving water-related sustainable development goals. Colombo, Sri Lanka: International Water Management Institute (IWMI). 52p. doi: 10.5337/2014.226