# 7 Managing Water Variability: Floods and Droughts

# Managing Water Variability: Floods and Droughts

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*If people are prepared, they are much more resilient to natural disasters. This means knowing the global hotspots and quantifying the risk of disasters.*

**Water variability manifests itself in floods and droughts whereby people die, crops are lost, livelihoods destroyed and economies damaged.**

In many of the world's regions, the variability of water resources is projected to increase with climate change, increasing the risk of disasters and outstripping the capacity of societies to adapt.

The variability in water availability impacts the sustainability of development. The ongoing SDG discussions support the need for early warning and disaster risk reduction systems, adaptation to climate change, strengthened resilience, adequate facilities and infrastructure and appropriate policies.

The types of solutions for managing water variability are especially relevant to the SDGs of food security, water security, economic growth and action to address climate change.

## COMMUNITY RESILIENCE NEEDED FOR INCREASING RISK OF FLOODS AND DROUGHTS

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

Floods and droughts are the most economically and socially destructive of all natural disasters (Figure 6), accounting for about 90% of people affected by all natural disasters, 95% of whom are in Asia. Global economic damage from 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, most of it from floods.

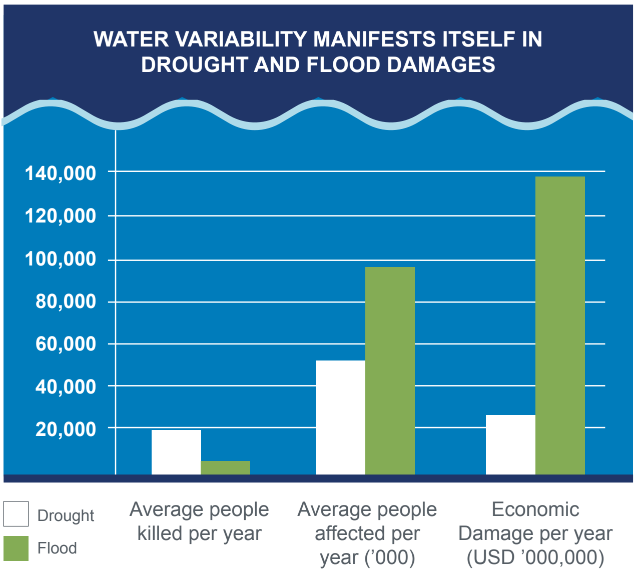
The evidence points towards an increase in the number of climate-related disasters, which is likely to outstrip the capacity of societies to adapt and exacerbate inequalities, with poor and vulnerable communities bearing a disproportionate share of the impact.

Increasing people's resilience to such disasters is important for achieving SDGs. If people are prepared and able to respond in a coordinated way, they are much more resilient to natural disasters. Part of this preparedness is knowing the global hotspots and quantifying the extent and risk of disasters.

To protect against floods and to provide for dry times, we need to manage variability by being creative about water storage; although, variability has positive effects too. For example, 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 management challenge is to alleviate negative aspects of variability while retaining those aspects that are essential for the health of ecosystems.

Most importantly, to reduce vulnerability and increase people's resilience to climatic shocks and stresses, we need to holistically manage floods and droughts at the basin scale.

***FIGURE 6.*** **Floods and droughts are the most economically and socially destructive of all natural disasters.**




**Source:** *EMDAT (2013)*

## IDENTIFYING FLOOD HOTSPOTS AND QUANTIFYING THE TIMING, EXTENT AND RISK

As the proposed SDGs assert, to alleviate flood damage it is important to understand changes over time with flooding.

IWMI has developed a tool that uses near real-time satellite data to map flood inundation over time. Maps can be generated during a flood, allowing 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 impact on critical agricultural production zones. In contrast to similar systems that have been developed to date, this tool uses data captured by sensors that can operate day and night and in almost any weather.

In Sudan's Gash Basin IWMI is trialing a prototype flood forecasting tool—the first of its kind in the region—to deliver flood information directly to farmers via mobile phone SMS technology.

Flood risk products that take into account inundation extent, depth and duration can also be useful for determining flood insurance payouts.

## CASE STUDY: Mapping Flood Extent in Near Real Time in Pakistan

Himalayan rivers have flooded more frequently and disastrously in the past 20–30 years, in part due to climate change, and also because of increasing population and economic growth in flood-prone areas. In 2010 and 2011, Pakistan was affected by major floods caused by heavy rainfall during the monsoon period. Land-use change has disturbed the river systems, leading to more severe floods. More than 2500 people died, 27 million people were affected, 17 million acres (~6.9 million hectares) of Pakistan's most fertile crop land was submerged, 200,000 livestock died and massive amounts of grain and animal fodder were washed away. The economic losses were estimated to be USD 7.4 billion.

A time series of flood maps (Figure 7) is useful for identifying changes in flood cycles over time at a regional scale. Maps of flood vulnerability and the long-term flood cycle (Figure 8) can be used to assess flood-risk zones.

***FIGURE 7.*** **The maximum inundation extent in the lower Indus.**

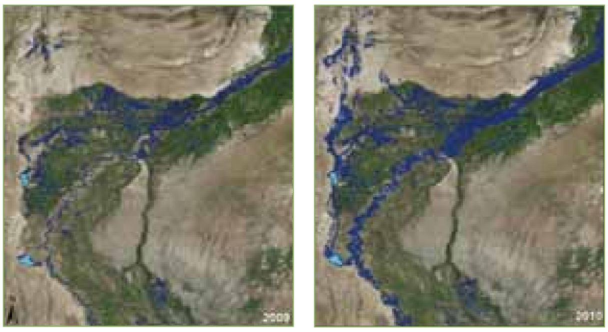
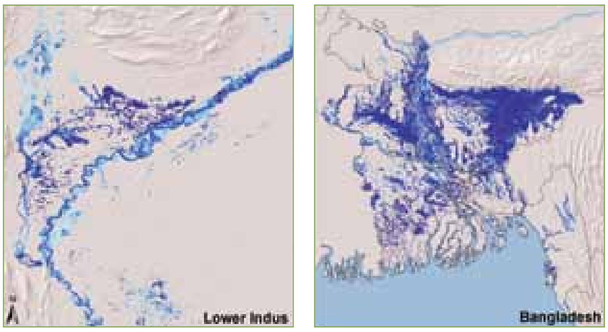



***FIGURE 8.*** **Flood risk areas for the period 2000–2011. Dark blue areas are more frequently flooded.**




**Source:** *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: Civco DL, Ehlers M, Habib S, Maltese A, Messinger D, Michel U, Nikolakopoulos KG, Schulz K (eds.) Earth resources and environmental remote sensing/GIS applications III: Proceedings of the International Society for Optics and Photonics (SPIE), Vol. 8538, Amsterdam, Netherland, 1-6 July 2012. Bellingham, WA, USA: International Society for Optics and Photonics (SPIE) 11p.*

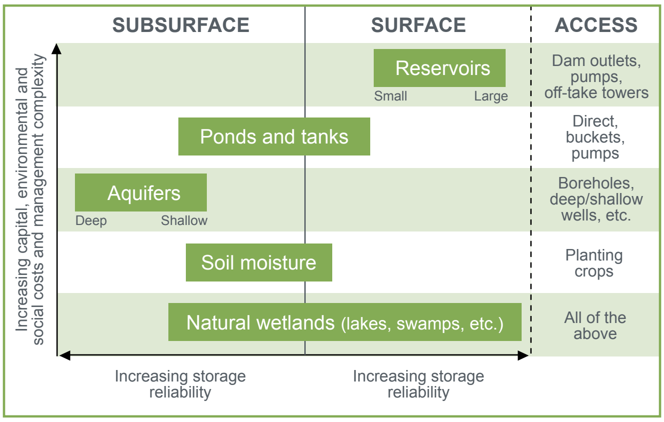
## RETHINKING WATER STORAGE

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 SDGs, countries with low per capita water storage, especially those in sub-Saharan Africa (SSA), will have to invest in new water storage.

Climate change and sustainable development needs will require a fundamental rethinking of the way water storage is planned and managed. This needs to be done from a basin perspective, be responsive to the needs at the local community levels and meet both current and future water storage needs. A variety of storage options need to be considered and tailored for the specific context.

The emphasis has previously been on large-scale infrastructure, but other options need to be considered that incorporate the beneficial aspects of such features as natural wetlands, soil moisture, groundwater aquifers, ponds, small tanks and reservoirs (Figure 9). The effectiveness of each option varies, and neither is likely to be a solution on its own but, broadly, the deeper and/or larger the storage, the more reliable the water supply that can be provided; and the more 'natural' it is, the less complex and less costly it is to develop and access.

***FIGURE 9.*** **Having a range of storage types across a basin will increase resilience to climate change.**




**Source:** *IWMI Water Policy Brief 31, Flexible Water Storage Options and Adaptation to Climate Change*

**How Much Water Storage Does sub-Saharan Africa Need for Agriculture?**

All of the possible agricultural water storage options are used throughout SSA. While there have been systematic efforts in both the development of larger dams and programs on smaller scale storage options, much of the existing capacity has developed in an 'organic' manner, through private, community and local initiatives. In some cases, reservoirs have silted up, wells have gone dry and people have contracted malaria from mosquitoes breeding around storage structures.

The greatest need for storage is in the Sahelian zone, 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 is in areas with the highest population density rather than the areas with the least rainfall.

## MANAGING FLOODS AND DROUGHTS AT THE 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 also offer protection from flooding impacts.

Storing water underground and recovering it later on a basin scale requires the necessary physical conditions as well as effective policies, institutional arrangements and incentives that are robust, socioeconomically sustainable and recognize the rights of the relevant stakeholders.

**CASE STUDY: Harvesting Floodwater in Thailand's Chao Phraya Basin**

In Thailand's Chao Phraya Basin, major catastrophic flooding events are regular and episodic. Yet basin aquifers upstream of the flood-affected areas have become depleted by over-abstraction. Harvesting floodwater, storing it in aquifers upstream of the flood-prone areas and using groundwater to grow cash crops in the dry season is technically viable. This would also reduce the magnitude of flooding of high value assets downstream, such as industries and urban centers.

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

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

*Climate change and sustainable development needs will require a fundamental rethinking of the way water storage is planned and managed.*