IWMI
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Putting research knowledge into action

Water and climate security: The human impact of disrupted systems

The context

Rapid climate change is causing weather extremes in every region of the world. The global water cycle is now experiencing a structural change not seen since the last Ice Age, leaving human systems struggling to adapt and respond. Some events will have noticeable consequences in the short term, such as increased flooding from changing precipitation patterns. Others will be more long term, such as the desertification of cropland. All will have major implications for future human security.

Key messages

- Rapid climate changes are creating significant challenges for communities who are struggling to adapt and respond. Water security is central to climate security.
- A comprehensive vision of how climate change could impact human security can be seen through seven climate-fragility risks.
- Women and girls are disproportionally vulnerable to the impacts of climate change due to their roles in providing for domestic food, water and energy needs.
- Future investments in water security can blunt the impact of water-related disasters and crises. Eight action areas are presented that consider the highly integrated nature of the seven risks.

Breaking down water and climate security

We can view **climate security** as climatic stressors that amplify existing risks in society and influence the security of humans, ecosystems, economies, infrastructure and societies. In that sense, climate security is directly connected to **water security** defined as the ability of a population to safeguard sustainable access to adequate quantities of acceptable quality water.

If global warming reaches 2°C above pre-industrial levels, approximately 15% of the world's population will experience severe decreases in available water resources. Additionally, the number of people living under absolute water scarcity (<500 m^3 per capita per year) will increase by 40%. Degradation of both built and natural water storage is exacerbating the problem. It is estimated that since 1971 some 27,079 m^3 of water storage volume globally has been lost as a consequence of degradation of lakes, wetlands and soil, and sedimentation of reservoirs, as well as groundwater over-abstraction (McCartney et al. 2022).

Significant shifts in the water cycle will leave more people exposed to catastrophic events. Droughts, floods and extreme precipitation will take lives, both human and animal, while killing crops, reducing biodiversity and destroying infrastructure (IPCC 2021). This will unsettle global trading systems and cause prices of staples – such as maize, wheat and rice – to rise. Typical responses to these impacts such as substitution and diversification could also fail (Adams et al. 2021). And it is likely that changing weather patterns will heighten the spread of human diseases such as malaria (IPCC 2021). Interventions to enhance water availability may also enhance malaria risks and this needs to be considered in water resource planning and management (Lautze et al. 2016; Kibret et al. 2015).

Rainwater conservation in an underground tank near Chilhar, Tharparkar, Sindh, Pakistan (*photo*: Muhammad Usman Ghani/IWMI).

The impacts on individual security will reverberate within economies and social structures, fracturing societies and exacerbating community fragility, with a combination of "exposure to risks and insufficient coping capacity of the state, system, and/or communities to manage, absorb, and mitigate those risks" (OECD 2020). In short, climate change is a major risk multiplier at many levels from global system to individual household, challenging existing resource governance systems, further threatening human security and demanding of governments and societies major new forms of resilience building (IWMI 2020a).

Climate security manifested through water

To provide a more comprehensive vision of how climate change could impact human security, we use the seven climate-fragility risks identified in the G7-commissioned report *A New Climate for Peace: Taking Action on Climate and Fragility Risks* (Rüttinger et al. 2015).

The Ganges River near Kanpur, India (*photo*: Neil Palmer/IWMI).

Local resource competition: The increased intensity and frequency of heatwaves, heavy rain and drought will put further constraints on limited natural resources, specifically water and arable land. Drought and floods will become more frequent and severe while water quality will reduce due to salination and other forms of contamination. This will increase competition between user groups, such as farmers and pastoralists, and could lead to instability or even localized violent conflict (Borgomeo et al. 2021; Snorek et al. 2014).

Drinking water from an artesian water source that is installed in fish ponds in Nepal (*photo*: Nabin Baral/IWMI).

Livelihood insecurity and migration: Changing temperatures, water availability and water quality will deeply affect key income streams derived from natural resources by pastoralists, fishers and farmers. This will impact the world's poorest and may serve as the tipping point for outmigration or a resort to more precarious sources of income. Slower-onset climate impacts such as multi-year droughts, sea-level rise and coastal erosion could force 216 million people to migrate within their regions by 2050 (Clement et al. 2021). Climate-linked migration will put pressure on public services and physical infrastructure both in home and destination communities. This could lead to an increase in tensions between host communities and migrants. Political groups could leverage the impact of climate events to boost support, where alternative livelihoods are not easily available, possibly leading to a growth in conflict between communities (USAID 2021; King 2015).

Women helping to get fish out from boats at Volta Lake, Ghana (*photo*: Nana Kofi Acquah/IWMI).

Extreme weather events and disasters: Between 2001 and 2018, water-related disasters (floods, storms, landslides and droughts) caused over 300,000 fatalities and approximately USD 1.7 trillion in economic damages (Lee et al. 2020; CRED and UNDRR 2020). The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) notes that climate change will contribute to increasing the occurrence of "some extreme events unprecedented in the observational record." And in extreme heat, under extraordinarily dry conditions, fire weather seasons will lengthen and intensify (IPCC 2021).

Volatile food prices and provision: Weather extremes will affect the timing and amount of food that is produced as heat and water scarcity impact crop yields. Rising food prices, unstable power production and water scarcity can lead to social protest and political conflict. Already, 75% of the world's crops are grown in water-stressed areas (WWF 2021). In places such as the Middle East and North Africa (MENA) region, reliance on food imports will grow even further as water scarcity and warmer temperatures reduce crop yields, populations continue to grow and consumption habits change. Thus, agricultural water management needs to be designed within a wider systems approach (Uhlenbrook et al. 2022).

Transboundary water management: Worldwide, 153 countries share 286 river basins and 592 aquifers (UN-Water 2019). Rivers are especially important as 25% of the world's food is produced

Children bathing and playing around in a canal near Gujarat, India (*photo*: Hamish John Appleby/IWMI).

on cropland irrigated by river water (WWF 2021). Management of international rivers in some regions will grow more complex as changes to glacial and snow melt, as well as more intense but unpredictable rainfall, affect flow regimes downstream. Transboundary waters can be a source of cooperation, but as demand grows and climate change impacts system volatility and predictability, cooperative management and prevention of conflict will become harder.

Sea-level rise and coastal degradation: Global mean sea level will continue to rise for centuries, even if some climate targets are met. Extreme sea level events, which used to occur once per century, are projected to become annual events (IPCC 2021). By 2050, more than 800 million people living in over 570 low-lying coastal cities will face a projected rise of at least 0.5 meters, which threatens their viability. This in turn could lead to social and livelihood disruption, displacement and long-term migration (C40 Cities 2021). Saltwater intrusion affects water quality and quantity for coastal cities, river deltas and small island developing nations (UN-Water 2019; WWF 2021).

Unintended effects of climate policies: Societies have developed a variety of strategies to build resilience in the face of water scarcity, but these may also increase vulnerability

A farmer pumping groundwater for irrigation near Cairo, Egpyt (*photo*: Hamish John Appleby/IWMI).

(IPCC 2021). This becomes a form of "maladaptation" where increased demand from one sector as an adaptation measure will draw limited resources away from other uses (Saghir et al. 2020; UNESCO and UN-Water 2020; IPCC 2021). This can include over-abstraction of groundwater to compensate for more irregular rainfall. Failing to adjust adequately or appropriately to the situation may not only negatively impact the environment but could have adverse effects on social systems. Adaptation investments therefore need to work to mitigate both the environmental and social impacts they may contribute to.

Women, water and climate security

Women and girls are disproportionally vulnerable to the impacts of climate change due to their often-assigned roles in providing for domestic food, water and energy needs. This can deepen and exacerbate existing gender inequalities (Smith et al. 2021; Harper and Vinke 2020).

Impacts of climate change on women

Water security: Women and children frequently supply water for household drinking and agricultural needs. This takes considerable time and energy, particularly when water is scarce, reducing time for other activities including education and recreation, deepening gender inequalities and affecting child development. The increased frequency and intensity of water disasters can be especially dangerous for women and children who are almost 14 times more likely to die as they are less likely to receive early warnings or have the resources to escape in time (UNESCO and UN-Water 2020).

Food security: With less food available in households, unequal food distribution amongst family members can occur, affecting nutritional outcomes for women and children. These food hierarchies can result in women and children taking in fewer calories, and other nutrients, affecting their nutrition (White et al. 2021). This can have long-term intergenerational implications.

Caretaker burden: Increased precipitation, reduced water quality and rising temperatures may increase the prevalence of infectious diseases, increasing the care-giving burden on women and girls, in particular. This will limit the time they have to generate income and attend school, which, in combination with rising medical costs, can heighten risks of impoverishment, thereby establishing potential spirals of decline in household health.

Physical security: As water scarcity and travel times to access water increase, women and girls may become targets of violence. Rates of domestic and sexual violence typically rise after disasters (UNESCO and UN-Water 2020; Gevers et al. 2020; Gender-Based Violence Area of Responsibility Helpdesk 2021).

Mobility and vulnerability: Known as "trapped" populations, women may be left behind and unable to participate in outmigration due to lack of resources or freedom. This can expose them to new layers of physical and institutional risk (Harper and Vinke 2020). Women are also more vulnerable to climate shocks because their access to revenue-generating opportunities, markets, financial services and social safety nets can be more constrained than men's. For example, women often lack the deeds or titles to the land they farm, so they may be unable to apply for loans in the absence of male household members.

Building resilience through water

Future investments in water security will help to blunt the impact of water-related disasters and crises, preventing communities from further fragility. Interventions will need to consider the highly integrated nature of the seven risks identified above, so mitigation efforts will need to adopt a systems perspective and be aware of contextual complexity. Management structures and governance institutions will need to be responsive and ready to adapt, identifying and scaling solutions as they emerge.

More coordinated planning along the humanitarian-development-peacebuilding spectrum will include crisis response mechanisms and long-term investment strategies that are strategically and inclusively designed to build resilience, prevent conflict and promote social cohesion. For these investments to be effective in the long term, governance capacities require strengthening, so key institutions can monitor risks, mitigate impacts and respond to crises.

A woman watering plants in India (*photo*: Hamish John Appleby/IWMI).

Action areas

Invest in water and climate resilience to save on disaster responses: Only 5% of global climate finance – roughly USD 30 billion/year – is currently allocated for adapting to climate change (Mason et al. 2020). Investments in climate resilience can help achieve effective poverty reduction and social equity. Adaptation lessens future vulnerability while fostering current gains. Dollar for dollar, climate adaptation delivers higher returns than traditional financial investments at between two and 10 times the original cost. A USD 1.8 trillion investment in five areas – early-warning systems, climate-resilient infrastructure, improved dryland agricultural crop production, global mangrove protection and water security – could generate USD 7.1 trillion in total net benefits by 2050 (Saghir et al. 2020). In 2020, losses from disasters exceeded USD 244 billion globally, which already surpassed the average of the 21st century and is only likely to increase as disasters worsen under climate change (Gevorgyan 2021). We need to reconsider the balance of investments in disaster response versus long-term resilience in a way that will protect vulnerable populations far into the future.

Prioritize adaptation in infrastructure services: Each year, disruptions to physical infrastructure – up to 70% of which can be caused by natural hazards – cost households and firms in low- and middle-income countries between USD 391 and USD 647 billion dollars (Hallegatte et al. 2019). We need to take steps to adequately update and adapt water supply and sanitation services, energy production, flood protection, water storage and irrigation schemes ahead of climate impacts. This will be crucial so that communities can more effectively absorb shocks, respond to crises, and continue to adapt and scale over time as new climate trends evolve. Strategies need to consider demographic change, including population growth and human mobility, which will shift the concentration and increase the demand for resources. Infrastructure promoting alternative water sources will become more critical in the context of growing scarcity. For every dollar of investment made now, communities will see four dollars in benefit (Hallegatte et al. 2019).

Scale-up use of non-conventional water technologies: We need to make further investments in non-conventional water technologies such as wastewater treatment, water reuse and desalination. Globally, informal and unsafe wastewater use in agriculture is taking place on 29.3 Mha as estimated by IWMI (Thebo et al. 2017). We need to support the trajectory to safe reuse which is so far only happening on about 1 Mha worldwide (Drechsel et al. 2022a). Water stress is a reason not only to improve current wastewater management, but to develop better water reuse programs, which will increase water quantity and quality. For example, in Morocco, better groundwater management through wastewater reuse, seawater desalination and the replenishment of aquifers can restore groundwater deficits (Saghir et al. 2020). Though expensive, desalination is a useful method for ensuring water security for coastal communities in water-insecure countries which can afford to do so. Another opportunity, studied by IWMI in Spain, Mexico, and Iran, is wastewater-freshwater swaps between urban and rural areas (Drechsel et al. 2022b).

Invest in nature-based adaptation: Nature-based adaptation – including land restoration, reforestation, wetland rejuvenation and mangrove cultivation – can help improve water management in a changing system. Wetland restoration can in some places improve flood management and groundwater recharge especially when incorporated into gray infrastructure "sponge cities" (Ortinez et al. 2018), more able to absorb extreme flows. For small island developing states, planting and cultivating mangrove forests has successfully prevented some coastal erosion (Saghir et al. 2020). Nature-based adaptation projects may also have the dual benefit of creating employment opportunities while improving water quality and quantity (Lieuw-Kie-Song and Pérez-Cirera 2020).

Develop and deploy early warning systems and response strategies: Innovative technologies such as flood- and drought-early warning systems will prepare communities, water and agriculture service providers, and governments to anticipate, adapt and respond to extreme events. For example,

the MENAdrought project, led by the International Water Management Institute (IWMI), has developed a map-based monitoring system using an enhanced Composite Drought Index (eCDI) which captures multiple indicators and can detect drought early in both irrigated and rain-fed farming systems (IWMI 2021b, 2021c, 2021d). Financial remediation tools, such as insurance, are a growing pillar of strategies for protection and adaptation to natural hazards. Multi-peril Crop Insurance (MPCI), which can include both flood and drought insurance for agricultural losses, incentivizes farmers to engage and invest in risk mitigation measures while reducing the pressure that crop losses can place on the public (Amarnath et al. 2021).

Empower local populations with technology and knowledge: For adaptation and resilience efforts to be truly effective, however, they need community-level action and leadership to be scaled for long-term application and focus explicitly on reducing poverty. To accomplish this, financing needs to be made increasingly available to poor and rural communities, climate information needs to be more accessible and locally available, and the training and hardware for technological solutions must be distributed more widely (Mfitumukiza et al. 2020). Empowering smallholder farmers with the knowledge and access to implement adaptation measures will ensure greater community resilience, and also provide for a better quality of life. These measures can include access to solar-powered, micro-irrigation systems which can increase farm incomes by five to 10 times while reducing water usage by up to 90%, and phone apps which provide information specific to a farmer's plot and crop including geo-specific weather data (WMO 2020; IWMI 2020b, 2021a).

Ensure resilience building efforts are inclusive and transformative: The climate emergency is also a poverty emergency. If we do not act fast, an additional 35–122 million people could be in extreme poverty by 2030. In October 2021, the World Food Programme stated that drought and possible famine in Madagascar could be the first to be caused directly by climate change (UN 2021). A recent study shows that the droughts of Madagascar have exacerbated existing fragility, especially poverty (Harrington et al. 2021). Resilience building must include poverty reduction and involve women and minorities in creating a more collaborative governance model (Mfitumukiza et al. 2020). More equitably distributed benefits through more inclusive interventions can help promote social cohesion at different levels, build trust, promote collaboration and counter fragility.

Prioritize cooperation and environmental peacebuilding: Cooperation through holistic adaptation efforts can build networks of experts, civilians and politicians at the local, national and regional levels, who can upon a rich combination of local indigenous and technical scientific knowledge to allow more coherence and sustainability in adapting to climate change. Working together to address climate risks can mitigate grievances and conflict, reduce fragility, promote stability and foster peacebuilding.

Conclusion

Climate change will pose security risks for all of humanity. The need for international cooperation has never been greater. From floods and droughts, to increased forest

A farmer picking grapes at the Abu Kishik Farm in Mafraq, Jordan (*photo*: Seersa Abaza/IWMI).

A man adjusting a newly introduced modern sprinkler system on a farm near Cairo, Egypt (*photo*: Hamish John Appleby/IWMI).

fires and sea-level rise, changes in water systems will pose threats to everyone's well-being. Preserving water quality and availability by investing in water infrastructure, nature-based solutions, early warning and non-conventional water technologies can support future water security and promote social cohesion.

Water security is central to climate security – and both lie at the heart of human security. As the water systems supporting our societies, economies and ecosystems begin to reach dangerous levels of disruption, we must respond with actions that are coherent and coordinated, rooted in achieving key United Nations Sustainable Development Goal (SDG) targets on poverty, food and water security, and that build long-term climate resilience.

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