WASP
WORLD ADAPTATION SCIENCE PROGRAMME

Science for Adaptation
Policy Brief

#5

The risk of cascading climate change shocks and stressors

About the WASP and Policy Briefs

- The Science for Adaptation Policy Brief Series is an initiative of the UN-led World Adaptation Science Programme (WASP). The briefs target researchers, policymakers and practitioners to help them successfully bridge the science-policy-action interface.
- WASP is led by the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Environment Programme (UNEP), the World Meteorological Organization (WMO), the Intergovernmental Panel on Climate Change (IPCC), the Green Climate Fund (GCF), the Global Environment Facility (GEF) and the United Nations University (UNU). WASP Secretariat is hosted at UNEP, Nairobi, Kenya. The current Chair of the WASP is Youssef Nassef, Director of Adaptation at the UNFCCC Secretariat in Bonn, Germany.
- WASP's mission is to ensure researchers, policymakers and practitioners have the scientific knowledge and capacity necessary to underpin effective climate adaptation policy and action.

Key messages

- **Cascading impacts of climate change amplify human vulnerabilities and risks, and further challenge the success of our sustainable development trajectories.** There are increasingly small windows of time in which to build back from each shock and stressor. Impacts are exacerbated for those most at risk (e.g., women, children, the elderly, and marginalized groups).
- **Responding to cascading risks and impacts requires transdisciplinary, cross-scale and cross-sector action. Collaborations are key to identifying the linkages in cascades and developing ways to build adaptive capacity and resilience.** Cascading risks with transboundary and multi-system impacts (e.g., food, health, migration, water), together with uncertainties about future manifestations, make risks harder to predict and act upon.
- **A focus on equity and justice is essential for effective responses in vulnerable developing countries.** The complexity of interconnected risks requires comprehensive governance responses, transdisciplinary collaboration and integration, and collective decision-making at multiple scales that focus on underlying social and political barriers (i.e., equity, marginalization, institutions).
- **There is insufficient financing to support communities to develop locally led resilience activities to respond to increasing cascading risks and impacts.**
- **COVID-19 stimulus packages that ensure a healthy environment and basic livelihoods, as well as access to jobs in the renewable energy industry, will help build adaptive capacity, resilience and reduce future risks.**

Introduction

Among the many challenges we face in achieving the Sustainable Development Goals, climate change stands out as the one most deeply rooted in anthropogenic activities that endanger human well-being. The complexity in assessing, dealing with, and containing climate risks has been investigated in the literature (Intergovernmental Panel on Climate Change 2014; Simpson *et al.* 2021; Adger, Brown and Surminski 2018). A particular challenge for dealing with climate

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change is that impacts can occur through a gradual increase in the interaction of multiple climate-related shocks (e.g., floods, landslides, droughts, forest fires, hurricanes), geological disasters (earthquakes, tsunamis, volcanic eruptions, and landslides), and non-climate related factors (e.g., social norms and culture, population growth, urbanization, livelihoods, water and food safety).

The increasing frequency, scale and magnitude of climate extremes portend a highly uncertain future, and the window for action in which to build back from each shock is progressively diminishing. In the past two years, the world has witnessed catastrophic climate events across the globe, including wildfires in Australia and the USA in 2019 and 2020, unprecedented heatwaves in the Pacific Northwest of the USA and Canada in June 2021, and heavy precipitation and floods in China, Germany and the Philippines in July and August 2021, alongside myriad meteorological hazards across the globe such as Hurricanes Grace and Ida in the Caribbean and the Gulf of Mexico.

The COVID-19 pandemic has aggravated the situation, specifically in terms of health, social, and economic factors: people who contracted COVID-19 may have long-term symptoms; others may become unemployed as a result of the pandemic; these people are more vulnerable to future stressors such as health crises, economic shocks, or climate disasters. For example, thousands of low-income migrant workers in Dhaka left for their village of origin (Ali and Amin 2020). This will most likely further limit their future access to economic opportunities and health care. Without a full recovery, it will not be possible for those most affected by the pandemic to regain the ability to confront consecutive, cascading shocks. Moreover, as neither COVID-19 nor climate change respect geographic boundaries, risks can be transported and amplified through connections across spatial domains and emerge in different combinations. This undermines the effectiveness and efficiency of thematically and geographically focused solutions, and demands greater attention towards systemic and transboundary risks (Benzie and Harris 2020).

Why do cascading shocks and stressors matter?

Climate change impacts may cascade across spatial, temporal and system scales. For example, cascading effects may occur due to the transmission of impacts across national or geographic boundaries whether through economic interconnections such as supply chains, or through social connections such as migration or forced displacement. Cascades could also lead to amplification of impacts. They are critical for gaining insight into the interconnections between the drivers and determinants of climate risks and their interactions. This helps to provide the evidence base for decision-making so that experts and country leaders can coordinate their efforts to further understand what makes a country vulnerable to cascading shocks and how a country can adequately respond to climate change. Distinguishing between vulnerabilities and responses helps identify adaptive options, including incremental or transformative actions (both reactive and proactive) (Wilbanks and Kates 2010).

Examining how climate change produces cascading stressors visible in specific events, and with implications over large areas, populations, and processes, can help bridge the knowledge gaps between disaster risk reduction and climate change adaptation. There is evidence to show how rapid- and slow-onset climate events lead to far-reaching effects that are amplified and generated through feedback loops and vicious cycles (Pescaroli and Alexander 2016). It is also evident that climate-related loss can lead to displacement and forced migration or relocation (McNamara *et al.* 2021).

To tackle these complex challenges, cross-sectoral and cross-disciplinary collaboration using emerging technologies – including information technology and biotechnology – may equip us to better alleviate exogenous pressure in harsher climate conditions.

Understanding, identifying and attributing cascading effects to specific climate shocks and stressors is a key element in mounting successful climate change litigation and advancing equitable policymaking.

Case studies of cascading shocks

Empirical examples (Boxes 1 and 2) suggest that climate change impacts propagate as cascades across physical and human systems, becoming increasingly severe (Lawrence, Blackett and Cradock-Henry 2020).

Box 1: Thailand 2011 floods and their effect on computer supply chains due the dependence on Thailand for key hard drive components

In 2011, Thailand experienced one of its most severe floods, affecting the country for 158 days and costing about $30 billion in economic losses. Intensified by a summer monsoon coupled with multiple tropical storms, flooding struck the Chao Phraya River, disrupting the country's manufacturing industry (Gale and Saunders 2013). Through a social network and content analysis of media documentation, Yeo and Comfort (2017) assess that while Thailand had systematically institutionalized disaster management plans, the country still experienced poor response coordination among institutional actors following the floods. The 2011 floods produced cascading shocks throughout the country and the global supply chain, emphasizing global interdependence and the pervasive impact of climate change. These cascading shocks were aggravated by structural and coordination issues, highlighting the relationship between climate change, systemic structures, multi-actor coordination, and cascading shocks.

Institutional actors such as non-profit organizations, private sector firms, and government organizations were all functionally prepared to manage the potential impact of a natural disaster, yet were unable to coordinate efforts, revealing fragile relationships between high-capacity organizations. Yeo and Comfort (2017) determine that while the Thai government established the necessary capacity to manage a natural disaster prior to the 2011 floods, lack of coordination between actors led to an ineffective initial response. Damien and Heinzlef (2018) argue that planning for natural disasters and capacity-building are not sufficient in the face of climate change as they do not emphasize the "dynamics of interdependence". In other words, there is a significant need for solid coordination between actors and geographical territories due to their interdependence.

Thailand experienced both indirect and direct damage in the aftermath of the 2011 floods (Haraguchi and Lall 2013). The flood's economic damage led to transboundary impacts on dependent economies. In 2012, the United Nations Office for Disaster Risk Reduction assessed that there was a 2.5 per cent decrease in the world's industrial production due to the floods (United Nations Office for Disaster Risk Reduction 2012). The floods affected seven industrial parks comprising 804 companies, caused up to 62 days of delays, and directly impacted Thailand's supply chain (Haraguchi and Lall 2013).

Haraguchi and Lall (2015) assessed that the flood drastically obstructed Thailand's electronics sector, especially since before the floods Thailand manufactured about 43 per cent of all hard disk drives globally. The floods made it almost impossible for Thailand to continue its normal level of production. This led to an increase in the international price of hard disk drives by 80–190 per cent (Haraguchi and Lall 2015). Abe (2014) argues that natural disasters such as the 2011 floods highlight the fragility of the global supply chain especially in the context of climate change.

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Box 2: Madagascar 2021 famine and drought and its effect on food security and potential migration with long-term implications for the next generation

In 2021, severe famine in Madagascar, following four consecutive years of drought, led to the almost total disappearance of food resources. This pushed communities "to the very edge of starvation" (UN News, 2021).

A UNICEF study suggested that when flood and drought zones overlap with areas of high poverty, children and families – disadvantaged and deprived of essential services and infrastructure – are likely to suffer most from climate change, are less likely to recover quickly, and will be generally more vulnerable to subsequent crises (the United Nations Children's Fund [UNICEF] 2015). Heslin *et al.* (2020) concluded that a country's ability and capacity to react to, and protect itself from, natural disasters largely depend "on the initial quantity of reserves held by the country, as well as the trade links from which to receive a shock and upon which to draw additional supply".

Madagascar's drought not only led to famine but produced lasting significant cascading shocks affecting the country's agricultural sector which, in turn, led to economic impacts. Huang *et al.* (2020) noted that when a country loses "cultivated land area" this has a significant impact on its agricultural sector which is only worsened by continuing climate change.

Continuous increases in food prices, coupled with a reduction in food availability in the markets, continue to negatively impact food security in the region. For several months, families have been living on raw red cactus fruits, wild leaves and locusts. An estimated 14,000 people are already in a catastrophic condition, which will double by October 2021. The World Food Programme has noted that Global Acute Malnutrition in children under-five in Madagascar is running at an alarming 16.5 per cent. The humanitarian crisis in Madagascar requires immediate and effective action to break the trajectory of impacts. Intensified efforts to help those in need are urgently required as the hunger crisis in Madagascar worsens in scale, location and across generations.

In Eastern Africa, the 2011 drought triggered a food crisis and children had to take hazardous jobs and expose themselves to violence, abuse and exploitation when outside their family setting (UNICEF 2015). They have little chance of continuing school, thereby undermining literacy and future opportunities. In addition, these children and families were more exposed to communicable diseases and there are very limited healthcare services for children near their households (UNICEF 2015). Furthermore, there is emerging evidence that drought disaster, may lead to mental health crises, developmental delays, and changes in children's genetic makeup (Marks *et al.* 2021; Bernstein 2018).

Annual agriculture production in Madagascar cannot always meet domestic demand. The country, therefore, relies on purchasing food from the global market. Benzie (2015) has assessed the vulnerabilities of developing countries that are heavily dependent on food imports: climate change-induced food supply changes exacerbate global food price fluctuations, and the effects may be passed on through trade and financial measures at different levels and locations (Benzie 2015).

The global food supply chain is interconnected (Heslin *et al.* 2020). Heslin *et al.* (2020) argue that the world's food supply chain is "vulnerable to climate change and associated extreme weather events", meaning that if a country, especially one such as the United States, were to suffer an extreme weather event, there would be significant impacts throughout the world. Concurrent extremes, such as heat stress and drought events, are likely to increase yield losses, causing grave challenges to food security and triggering market shocks (Toreti, Cronie and Zampieri 2019).

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Challenges and constraints in delivering an effective response

Extreme climate events, or slow-onset events, trigger chain reactions that can affect trade, finance, migration, psychology, geopolitics, disease and infrastructure. The ramifications can be escalated or diminished along the chain. Sometimes, this may lead to compounding risks at the end of a chain (Carter *et al.* 2021).

These cascading impacts can aggravate challenges to existing governmental and institutional systems, drain resources and restrict room for manoeuvre in the policy sphere and beyond. The lack of adequate consideration of climate impacts across sectors and domains, and the scarcity of robust evidence bases for adaptive actions, can lead to blind spots or unintended consequences in adaptation planning, with negative implications for the adaptive capacity of current governance regimes (Lawrence, Blackett and Cradock-Henry 2020). The absence of evidence of risk reduction is another obstacle to stimulating potential investments in climate adaptation. As the 2020 edition of the Adaptation Gap Report indicated, "while nations have advanced in planning, huge gaps remain in finance for developing countries and bringing adaptation projects to the stage where they bring real protection against climate impacts such as droughts, floods and sea-level rise." (United Nations Environment Programme 2021)

The poor quality of baseline environmental data, of institutional structures, and infrastructure further undermine the adaptive capacity of local communities to respond to diverse climate impacts. The inequitable gap in resources and data, as well as the knowledge and means to mount effective adaptive responses, have resulted in unintentional ignorance of looming climate events, their implications, and their cascade effects in the long run. Vulnerable groups, therefore, often lack the means to get advance notice of an extreme event, to plan and implement adaptation actions accordingly, and do not have the resources, or are not willing, to relocate unless forced to do so. For communities subject to climate shocks that cannot recover fully and in a timely manner, additional stressors at any level can worsen the situation. Such situations are likely to drive these communities into a downward spiral until a tipping point is reached.

Additionally, while stressors can motivate and inspire enhanced collaboration between actors, the more severe an exogenous stressor acting upon the system, the more severe the internal competition for already scarce resources becomes. This may exacerbate the inequity and vulnerability of the system. To counter the pressure of cumulative exogenous stressors, a deep knowledge of the historical, cultural, economic, and political background of every specific context, coupled with evidence from climate and environmental sciences, as well as the best available technologies for estimating potential impacts and proposing possible responses, is vital.

Opportunities and next steps for adaptation

Given the complex nature and long-lasting, transformative effect of cascading risks, it is almost impossible to prevent damage. It, therefore, makes sense to focus on building adaptive capacity and resilience within countries and on a global scale.

In the context of cascading risks, capacity-building is key for building inherent resilience and reducing vulnerability. In line with the Cannikin Law, or Wooden Bucket Theory, in order to increase the capacity of the bucket (adaptive capacity), one should not increase the length of the longest plank, but rather, the length of the shortest plank, meaning that countries are only as strong as their weakest link when addressing cascading shocks. This means, in principle, that all-round development could be a good strategy for avoiding a very short plank in the bucket. Such an approach also helps reduce holistic vulnerabilities and lowers exposure to risk to the extent possible or contains the damage a risk can cause.

Intersectoral coordination and actions across levels are also important to ensure all stakeholders and sectors work together in an effective and efficient way (Street and Palutikof 2020). Through an analysis of 10 disastrous events, the 2021 UNU-EHS Interconnected Disaster Report confirms that a primary root cause of such events is the absence of ample coordination and communication between national and international actors leading to dangerous climate outcomes (O'Connor et al. 2021). This also helps to reduce internal friction within the system and boost the overall strength of the system at various levels in the face of multiple challenges. To identify and gauge climate impacts, predict future risks, develop policies and plans, coordinate actions across sectors and communities, and navigate transformative (instead of incremental) changes requires the engagement of all stakeholders through the whole process, and communication in a transparent, fair, and inclusive way. An integrated system could serve, therefore, as a solid basis for dealing with potential impacts.

As we gradually recover from the COVID-19 pandemic, a holistic approach in planning an appropriate, sustainable recovery is vital. COVID-19, which has overwhelmed global economic and political systems, highlights the need to address the systemic risks of climate change (van den Hurk *et al.* 2020). Government responses to COVID-19 should be linked to environmental sustainability and climate action (Botzen, Duijndam and van Beukering 2021). For example, in its policy

1. https://www.oecd.org/coronavirus/en/policy-responses

responses to COVID-19, the OECD[1] is applying systemic approaches with a focus on both short-term impacts and long-term consequences.

New technologies and their potential to improve adaptive capacity in response to climate change can be useful additions to existing tools used by communities and governments. For instance, early warning and forecast systems for adaptation are recommended to foster new behavioural adjustments to address resource decline and natural hazards (Sultan *et al.* 2021). The wider application of big data, 5G, and artificial intelligence may help assess global climate stressors, as well as non-climate drivers, and their interactions. This could be the next step for comprehensive and coherent policymaking, adaptation planning, implementation, and monitoring.

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Acknowledgements

Authors: Kathryn J. Bowen (University of Melbourne), Anand Patwardhan (University of Maryland), Ying Wang (UNEP, Nairobi) and Eva Bialobrzeski (University of Maryland).

Editors: Kaisa Uusimaa, Ying Wang, Charles Bartlett and Maarten Kappelle (UNEP, Nairobi).

Production: Maarten Kappelle, Kaisa Uusimaa, Ying Wang and Sofía Méndez Mora, WASP Secretariat, Science Division, UNEP, P.O. Box 30552, Nairobi, 00100, Kenya, Tel: +254-207624150, Email: secretariat@wasp-adaptation.org, Web: www.wasp-adaptation.org.

Design and Layout: UNON, Publishing Services Section, Nairobi.

Suggested Citation: Bowen, K. J. *et al.* (2022). The risk of cascading climate change shocks and stressors. Science for Adaptation Policy Brief 5. The World Adaptation Science Programme (WASP) Secretariat, UNEP, Nairobi.