PERC Medley 2023: Cross-learning to improve disaster resilience globally

ZURICH

The Post Event Review Capability (PERC):

Relying on years of first-hand experience and extensive research working with and in communities, we have identified a number of lessons that can be used to prepare for any sort of disaster event in virtually any part of the world. Using our Post-Event Review Capability (PERC) methodology, winner of the "Outstanding achievement award" of the National Hurricane Center and the "Business Insurance Innovation Award" (both 2019), we are able to illustrate strikingly similar challenges faced by risk managers regardless of where they operate or the particular hazards they face.

PERC provides research and independent reviews of large flood events. It seeks to answer questions related to aspects of flood resilience, flood risk management and catastrophe intervention. It looks at what went well, as well as opportunities for improvement, and results in a set of recommendations for the future. Started in 2013 as part of the Zurich Flood Resilience Alliance, it has since conducted roughly two dozen post-event studies globally, expanding from floods to other climate-related hazards such as wildfires.
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Introduction / Foreword

This latest summary report of lessons learnt and recommendations is based on more than 20 PERC event reviews altogether. It focuses on the most recent disaster events that the Zurich Flood Resilience Alliance ("Alliance") and its partners have analyzed using the award-winning PERC methodology. It follows a series of previous PERC summaries, the latest one from 2020. In this review, the authors highlight the following learnings that are globally relevant:

First, the international community cannot just focus on the financial cost of natural hazard events but must remember the human impact they have. Large disaster events by definition leave behind a trail of devastation. This often includes a series of human and humanitarian tragedies that those encountering them first hand can hardly forget. Yet too often, events in the global south which cause big human tragedies but not so much a global economic impact seem to be forgotten quickly. In fact, the twin-cyclones Idai and Kenneth were termed the "forgotten disaster" (e.g. SRF, Caritas) already shortly after they had made landfall. Forgetting these catastrophes is frightening, considering that millions of people were then and continue to be in dire need of immediate humanitarian aid and longer-term support. Even more frightening were the moments when we authors realized how myopic views can be, depending on where somebody lives or works, and in which sectors. Idai alone had been, by far, the largest humanitarian disaster in 2019 when it happened. Yet in the annual catastrophe loss review published by the insurance industry, Idai was a mere footnote. Headlines are typically dominated by more costly events from the northern hemisphere.

Second, it has been surprising to learn how similar disaster risk challenges and risk reduction opportunities across very different contexts sometimes are. It is often thought that problems and potential solutions are unique to each event, or at least are linked to a large extent to the development stage of the affected area – e.g., that the developing countries need humanitarian support and can only learn from the global north, and in more developed context it is all about financing protection infrastructure and providing monetary support to overcome asset losses. But that is not what we have come across our studies; indeed, the commonalities in risk across development contexts has become obvious after hearing heartbreaking but very similar if not to say identical stories from affected people around the world. When visiting a camp of displaced people following initial response operations after Idai, we were told stories about the immediate situation when the flood waters came and washed away everything – shelter, belongings, people. One family was clinging to tree tops for an entire night; eventually some family members lost their strength, were swept away, and lost their lives. It was barely two years later that we heard the same story, recounted by town mayors, neighbors and in the media, in Germany. A family had to climb from the top windows of their house to the roof, and eventually, when even the roof wasn't high enough, had to swim towards higher trees and hold on for the night. Again, tragically, only part of the family survived, the other half drowning. How can it be that such tragedies are so similar across the world and across very different contexts, but still so frequent and far-reaching? These tragedies are simply not acceptable and this needs to be addressed through better early warning systems, a better separation of space to safely live in from hazardous areas, by stricter land use management and zoning laws, and by consistent enforcement of land use management and zoning laws.

Third, and linked to the second point, is the need to rethink how society approaches learning. One needs to be really open to learning from one another and from past events. If tragedies and issues are so similar across the globe, this calls for much more cross-learning to improve disaster resilience globally. We also need to be open to simple, low-tech solutions and more flexible, dynamic human and social attitude towards disaster risk management. Civil society organizations, particularly in the global south, have successfully implemented these softer solutions; they could potentially equally work in places like Germany. At the same time, established technological, financial and infrastructural protection approaches common in the global north could potentially be applied and financed in the global south.

Finally, and universally, we need to overcome the notion that unexpected big disasters are "unprecedented" and will "never happen again". If inspected closely enough, we typically find such events have happened in the past, and if anything, climate change will make such events in the future worse. It is critical to incorporate this understanding into our disaster risk thinking; incremental change based on the assumption that extreme events will never recur is insufficient to adequately manage disaster risk in the future.

Learning from Disasters

In a complex, interdependent and fast-paced society, there is often little time to look back and reflect on what has happened, and more importantly, why it has happened. However, learning why something has manifested in the way it has is fundamental to improving how we do things — learning allows us to recognize what worked well and what didn't and adapt our processes accordingly. Progress has been made when it comes to learning from disaster events, but more lessons still can be learnt.

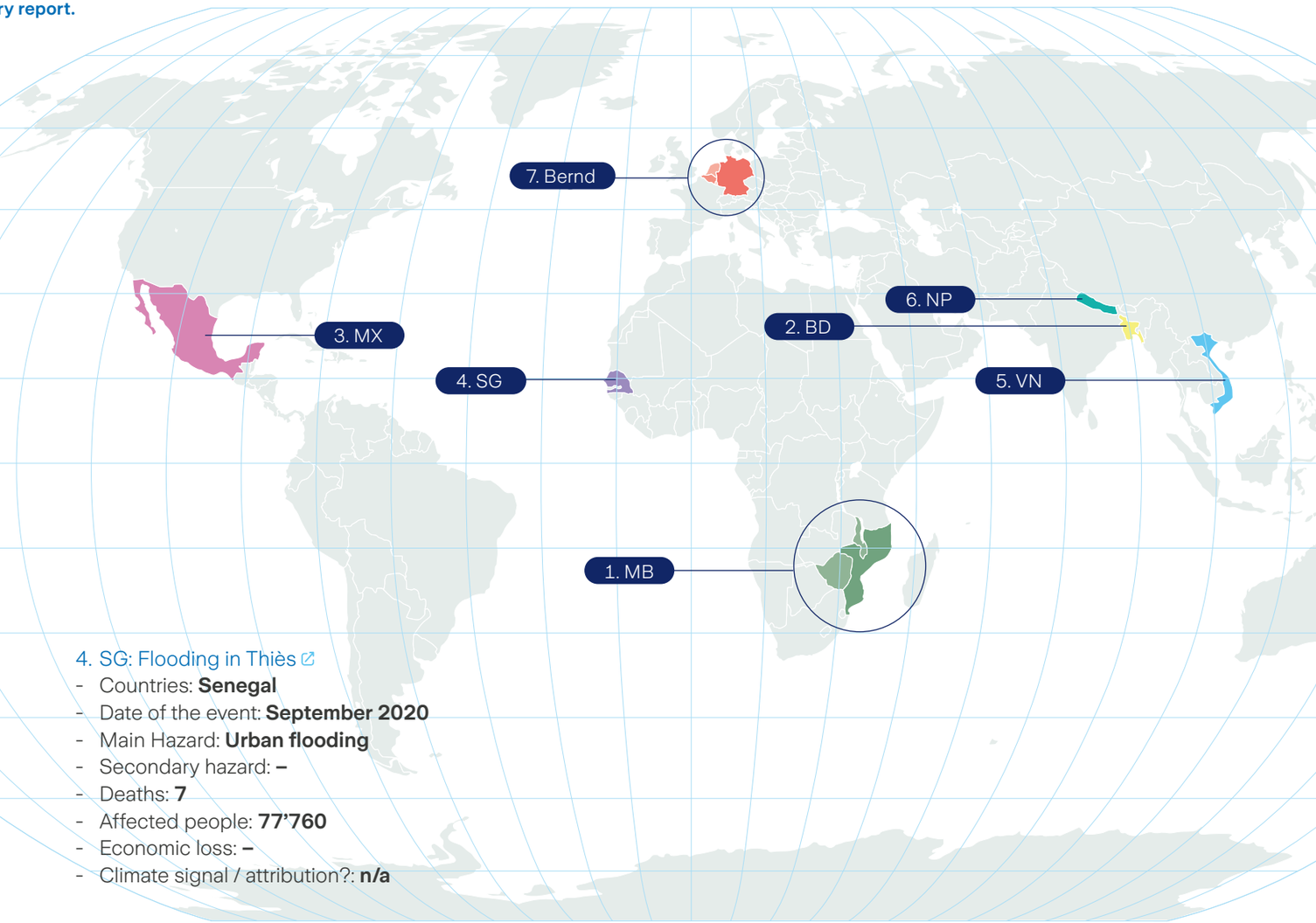
It is this gap, between the learning we need and the lessons available, that has led the Alliance to publish the PERC manual, outlining how and why we do these forensic analyses and how they can be used to identify and scale learning further. Disaster forensics is an important and emerging field precisely because of how it supports DRR experts and society at large to see beyond how things have been done, and realize the opportunities to do things better. Disaster forensics first emerged in 2011, when the Center for Disaster Management and Risk Reduction at the Karlsruhe Institute of Technology (CEDIM at KIT) deepened the field of disaster research into forensic disaster analysis (FDA). Building on this, in 2013, the Alliance began conducting Post-Event Research Capability (PERC) studies, further advancing and developing our own approach to forensic post-disaster resilience analysis. To date, close to two dozen PERC studies have been conducted on a variety of flood types including river floods, flash floods and tropical and winter storms that led to catastrophic flooding in both urban and rural settings and in global contexts ranging from least-developed to most-developed countries. A focus on floods remains important, as the hazard of flooding remains the most prevalent of natural hazards, and under a 2°C warming scenario flood exposure is set to be twice what it is today (Marsh McLennan, 2023). In addition, in 2018 the PERC methodology was expanded to include reviews of wildfire events, leading to a PERC wildfire summary report.

In conducting PERCs, we explore the question of how hazard, exposure and vulnerability interact to form disaster risk. This question is more important than ever. Society often quickly jumps to conclusions that big disaster events are only due to the increasing frequency and severity of the hazard events themselves; indeed, often calling them "natural disasters", a term often used although there is nothing inherently natural about them, as is well-illustrated in the "no natural disasters" campaign. It is often overlooked that an increase in exposure (by building up assets in hazard-prone areas) and vulnerability (how society builds and acts in the face of natural hazards) are as much if not even more relevant drivers when it comes to understanding why risk is increasing. Marsh McLennan (2023) conclude that neither high-income nor low-income countries are currently managing current risk adequately nor do they account for future risk trajectories. This is not to say that climate change does not contribute to the problem. There is an entire new and growing field of attribution science focused on understanding how much climate change has been the driver of a particular disaster event, and many of the events for which we have conducted PERCs, including "Bernd" in Western Europe, have been exacerbated by climate change. But to focus on climate change alone misses a significant opportunity to address disaster risk.

When it comes to understanding why hazard events turn into humanitarian and economic disasters, common themes appear within the existing body of PERC analyses, with similar points of failures, successes, and capacities in anticipation of and response to natural hazard events across geographical, social, political and economic contexts. It is clear that any place on the globe can provide important, broadly applicable lessons regarding where and how resilience can be built. This has allowed us to compile lessons learnt and recommendations into a series of "PERC medleys" — short summaries of key findings over time, the first of which was published in 2016 (Keating et al., 2016) and updated throughout the years. This is the latest summary of our PERC findings, focusing on the most recent publications with a spot-light of events in lesser developed countries (Bangladesh, Malawi, Mozambique, Senegal, Zimbabwe), but also in emerging and more rapidly developing economies (Mexico, Vietnam) and Central Europe, where high development and asset density as well as population density lead to highly concentrated, massive losses, underestimated by current flood mapping. The aim of this publication is not only to provide the latest global key insights from disaster forensics, but also highlight the commonalities between the findings and recommendations irrespective of their development or economic context, and invite us all to learn more from each other and in all directions.

Flooding is expected to be a large driver of climate-induced population displacements, potentially affecting up to 630 million people by 2100 (Marsh McLennan 2023). Yet resettlement is a difficult topic in any context, whether it is about the limits of insurability and devaluation of high assets in richer economies, or the limits of livability of large population numbers in the south. Clearly, we should be doing everything we can to mitigate risk for these people where they are today, in the hopes of limiting the need for displacement. These large numbers simply mandate us to take different actions today and tackle the problem by learning from past events to escape our ever-repeating cycle of disasters.

Foundations of PERC studies for this summary report.



1. MB: Idai

- Countries: **Mozambique, Malawi, Zimbabwe**
- Date of the event: **Mar – Apr 2019**
- Main Hazard: **Cyclone (wind)**
- Secondary hazard: **flood**
- Deaths: **1300**
- Affected people: **3 million**
- Economic loss: **USD 2 bn**
- Climate signal / attribution?: **Yes**

2. BD: Amphan

- Countries: **Bangladesh (Faridpur)**
- Date of the event: **May 2020**
- Main Hazard: **Cyclone (wind)**
- Secondary hazard: **Flood, pandemic**
- Deaths: **135**
- Affected people: **2.4 million**
- Economic loss: **USD 38.33 m**
- Climate signal / attribution?: **Yes**

3. MX: Two cyclones

- Countries: **Mexico**
- Date of the event: **Oct-Nov 2020**
- Main Hazard: **Rainfall**
- Secondary hazard: **Landslides, pandemic**
- Deaths: **–**
- Affected people: **800’000**
- Economic loss: **–**
- Climate signal / attribution?: **n/a**

4. SG: Flooding in Thiès

- Countries: **Senegal**
- Date of the event: **September 2020**
- Main Hazard: **Urban flooding**
- Secondary hazard: **–**
- Deaths: **7**
- Affected people: **77’760**
- Economic loss: **–**
- Climate signal / attribution?: **n/a**

5. VN: Rapid typhoon sequence

- Countries: **Vietnam**
- Date of the event: **Oct 2020**
- Main Hazard: **Series of typhoons**
- Secondary hazard: **flood**
- Deaths: **243**
- Affected people: **1.5 million**
- Economic loss: **–**
- Climate signal / attribution?: **No – within regular variability**

6. NP: Terai flooding

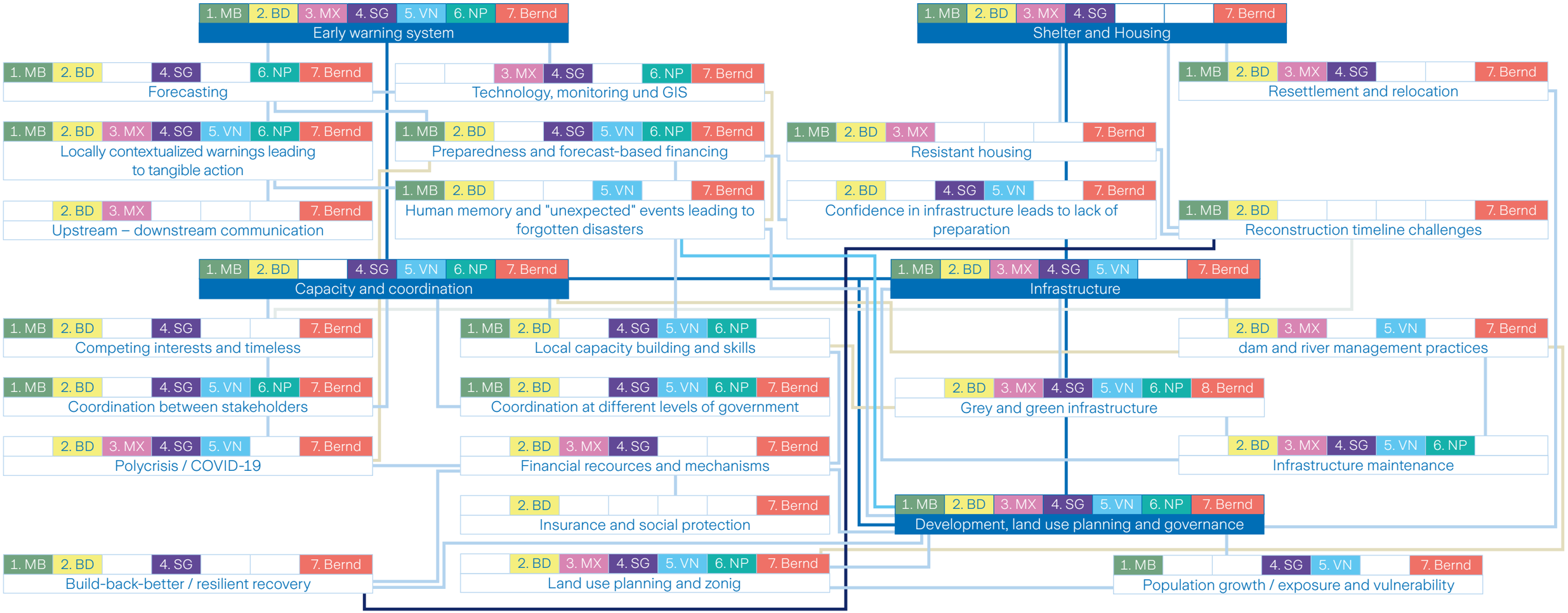
- Countries: **Nepal**
- Date of the event: **August 2017**
- Main Hazard: **Monsoon heavy rains**
- Secondary hazard: **flood**
- Deaths: **23**
- Affected people: **>150’000 households**
- Economic loss: **USD 585 m**
- Climate signal / attribution?: **n/a**

7. European weather system Bernd

- Countries: **Germany, Belgium, Netherlands, others**
- Date of the event: **July 2021**
- Main Hazard: **Large-scale low pressure (rain)**
- Secondary hazard: **Flooding in rapidly rising rivers (“flashy rivers”)**
- Deaths: **230**
- Affected people: **>200’000 households**
- Economic loss: **USD 40-50 bn**
- Climate signal / attribution?: **Yes, partially**

Key findings from the latest PERCs we analyzed

In this section, we draw together the key findings from the post event reviews that we have conducted and that were presented in Table 1 (see world map on page 5). While each event is unique and needs to be assessed in its particular context, we have identified surprisingly many common themes and underlying issues. We present them here issue by issue, or theme by theme, and have created a mindmap to outline how they hang together and in which and how many of the studied events they appear below.



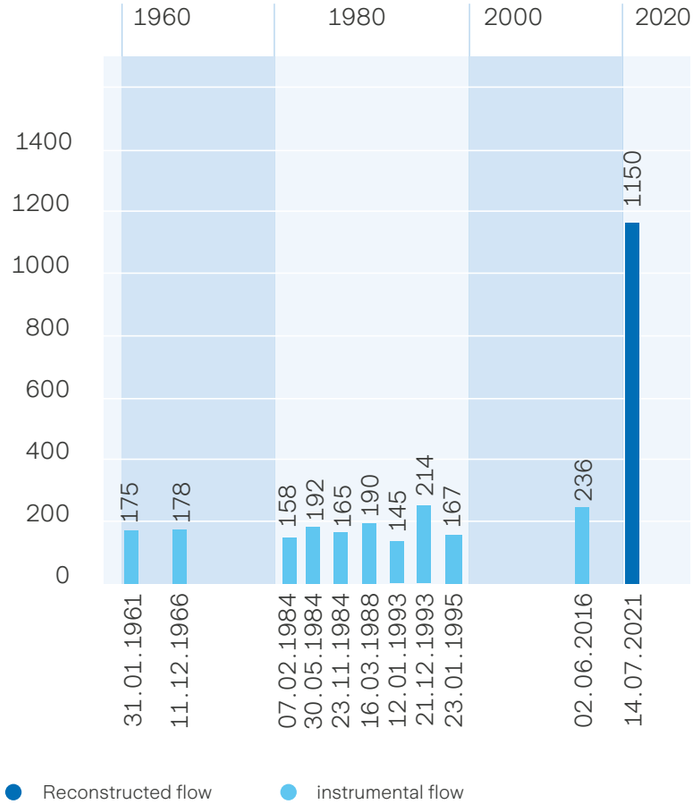
Forgotten disasters lead to disjoint learning

There is a discrepancy in how the international community perceives and communicates about disaster events; events with high asset loss draw significant attention while those with low assets loss, even if there is significant human loss, become something more like human-interest stories and quickly fade from the news cycle and general awareness. These 'forgotten disasters' are in part due to disjointed approaches or disjointed learning. Traditionally, humanitarian and financial impacts are not looked at jointly; the insurance and financial industries report on global losses with a focus on expensive, high-asset value losses in the North, whereas humanitarian disasters in the south do not make the news as much, or for as long, as the disasters with high economic impact. This leads to incomplete, fragmented learning at best, and potentially no learning at worst. As an example, cyclone Idai was by far the largest humanitarian disaster from a natural hazard in 2019, but quickly disappeared from global attention.

We also tend to 'forget' disasters when they aren't part of the historical records. Even the largest-impact disasters from the historic past tend not to be considered in risk management. Because they aren't part of the instrumental record, they don't make it into the hazard statistics that determine the protection levels. Not only does this leave communities unaware and unprepared for events experienced in the past, it means that when they eventually do recur, they are classified as "unprecedented" or "never seen before". This "unprecedented" label is then used to justify continuing to exclude them from consideration in risk management and the hazard statistics, perpetuating the problem. **This is particularly true for "Bernd", where almost everyone said that the scale of the event was unanticipated,** yet careful analysis clearly shows that, while not in the instrumental record, historic events in the past 200 years have reached the "Bernd 2021" and possibly higher water flows. A change in how (flood) event probabilities are calculated, and subsequently communicated[1] is required, and decisions about future flood protection needs to be based on more realistic, possible flood scenarios (see Figures 1A and 1B below) combining a longer-term historic record, the data record and climate change projections together.

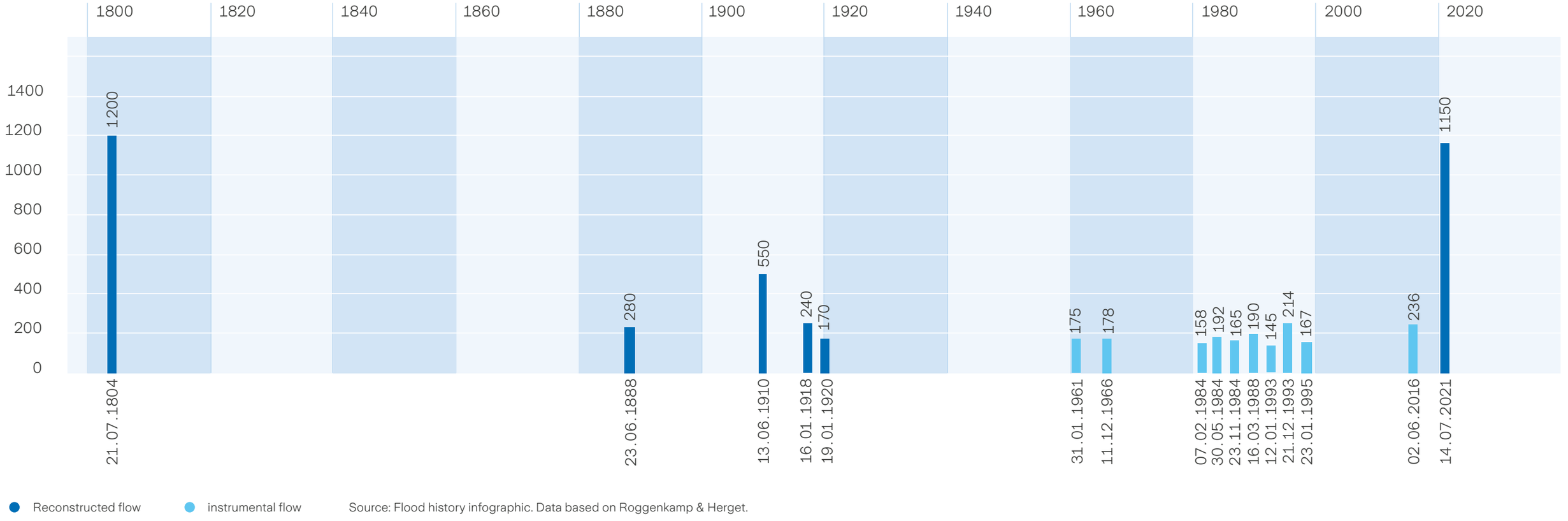
1 We repeat our recommendation from the last PERC summary report: We must continue to revise our language around event probabilities and timelines. A common and potentially devastating misunderstanding can be heard in the often-repeated statement: "Because there was a 1-in-100-year event five years ago, there will not be another of that size for another 95 years." What the statement '1-in-100 years' really means is that an event has a 1% chance of occurring each year. Experiencing back-to-back 100-year events is not unusual. It is inadequate to focus solely on precedented or at least statistically calculable 100-year events.

Figure 1A –
Flood statistics using the instrumental record only, with "Bernd" floods from 14 July 2021 standing out as an exceptional event. For comparison, the flood from summer 2016 had been declared a "100-year flood", creating the misconception of Bernd being exceptional.



Source: Flood history infographic. Data based on Roggenkamp & Herget.

Figure 1B –
Full data record including historically reconstructed floods for 1804 and 1910, highlighting that similar floods as the “Bernd” flood have happened in the Ahr valley before.



Source: Flood history infographic. Data based on Roggenkamp & Herget.

Early Warning Systems (EWS)

EWS are a preparedness and disaster risk reduction instrument with huge potential. In every PERC, EWS have emerged as critical systems, yet always with some weaker element that limited maximum success. Yet where EWS are successful, loss of lives and movable assets are dramatically reduced, indicating significant potential for cost-effective scaling.

The desired end state of a successful EWS requires an end-to-end EWS that is capable of providing local, context-specific and actionable information which leads to the required action from the vulnerable population. Our mind-map shows the most important elements that need to come together to make the EWS work. This includes the ability to understand and then **forecast** the hazard(s) and the associated processes (also anticipating changes in process or frequency/severity under climate change, a potentially emerging weakness).

In Cyclone Idai (1.MB), regional capacities and global support enabled reasonable forecasting of the storm, **but early warning did not lead to early action.** Warnings disseminated to the local level were neither targeted nor specific enough to transmit an understanding of the severity of the imminent event; it was therefore difficult for recipients to interpret the forecast, and it remained unclear what actions recipients should take. Further effects of the storm, such a river flooding, flash flooding, and landslides were less well-forecast, or indeed completely unanticipated, and therefore created disproportionate impacts as people were surprised by sudden-onset, life-threatening conditions. Even in hindsight, many people said they would not have believed the severity of the cyclone and would not have taken appropriate safety measures, as they had expected Idai to be similar to previous events they had experienced, and the reality this time was much different and far worse.

In the **2020 flood events in Vietnam (5. VN)** there was good forecasting capability, but the potential for repeat flood wasn't clear to residents, and as a result households were surprised and unprepared for the rapid succession of multiple, back-to-back flood events. Breaks of just a few days between floods didn't allow households to restock food and water. Such repeat disasters trap people in a poverty cycle. Not only in Vietnam is it evident that vulnerability to disasters is driven by poverty – poorer households are often more exposed as well as more vulnerable. Disasters in turn exacerbate poverty, and recent increases in the repetition cycle of disasters push more and more households into extreme poverty, especially in urban areas.

For weather system Bernd across Europe (7.Bernd), we also saw a gap in the forecasting. While the rainfall event was forecast well, flood potential was forecast less well, especially in the smaller, 2nd and 3rd class rivers. .Local authorities along these smaller rivers didn't understand which rivers would reach which water level, when, and what the consequences might be. Warnings were technical in nature and not translated into a meaningful set of messages for the local responders and the general public. A seemingly calm and peaceful period since the end of the Cold War led to complacency and the dismantling of warning installations such as sirens, taking out an important element of the alarm mechanism. A lack of a risk culture and lack of understanding how big this flood would be led to wrong, or no, action. The end result was **enormously fatal consequences.**

In the Bangladesh Faridpur event (2.BD), flooding was a prolonged and recurring four-month event compared to more "normal" monsoon floods. This was further exacerbated by the extent of the flooding, which left almost 1/3 of the country underwater. Some communities flooded up to five times. Generally, Bangladesh has good forecasting and a strong EWS, but dissemination issues and the availability of tangible, actionable messages (as opposed to overly technical language) remain, particularly for those living in the most exposed areas on char islands and coastal and riverside communities. Accurate river level forecasting is also difficult, due

to lack of or late information arising from coordination gaps between India and Bangladesh. In 2020, this meant no clear communication how this event might be stronger than those before.

In Bangladesh, like many other less-developed countries, we identified a **lack of hazard and risk data,** often starting with poor access to data that exists but is not shared publicly, or not with those that need it the most. This is particularly true for vulnerable communities and their needs; vulnerable groups are consistently left out of planning, leading to poor coordination during emergency response, poor relief efforts, and poor recovery support. Even where protection was available, such as elevated homes and paddocks, the protection was insufficient as the water levels in the event were higher than in previous floods, up to 4-5 m deep, overwhelming the protection feature (see 3.3). There is a striking similarity with the event Bernd, where a lack of availability and access to risk-based data in Germany meant that highly vulnerable institutions such as nursing homes were located inside flood zones, were not particularly protected, and had not benefitted from priority emergency protocols, leading to a large number of fatalities in those institutions when they flooded.

While forecasting and emergency response has improved in recent years in many countries including Nepal, Vietnam, Mexico and Senegal, improvements are still urgently necessary.

In Senegal (4. SG), it was found that warning messages before the inundation of the city of Thiès were lacking precision and specificity, and lead time was insufficient to mobilize and evacuate citizens to safety. The reach of the EWS was not broad enough, leaving people unaware and unprepared. Forecasting still needs to be strengthened further to improve lead times to an extent where communities can take action. The accuracy of weather forecasts need to be strengthened and coupled with information on the likely impacts of an event.

Mexico (3. MX) has made progress in disaster risk management, implemented learnings, and flood response in Tabasco has improved since the big 2007 floods. Technical components of the EWS have improved, but gaps in the communication chain remain, including reaching the more remote communities, and including dams in the warning system, a critical gap in the 2020 floods. Involving the local population in weather and river monitoring helps them be engaged, more responsive, and better understand the risks they face, and complements official weather data with local information.

In Nepal (6. NP), significant advances in flood forecasting and weather prediction have been made, but there is a lack of operationalization of forecasts into preventative actions, which would have significantly reduced losses and damages.

In Mexico, Germany, and Bangladesh, we found issues in upstream-downstream communication. In Mexico populations downstream from the hydropower generation are susceptible to floods from both planned and unplanned water releases and if they are left unawares this increases consequences. Similarly, in Germany, the event unfolding in the Ahr valley left villages flooded in the upstream area where the flooding started, while the flood wave was still hours away from communities downstream and time would have been there to prepare. Yet, with very few exceptions in some smaller watersheds that had experienced this before, there was neither formal nor informal communication to outline what was about to happen, leaving each town on its own to realize how bad the flood would be as it was already too late to take corresponding action such as life saving evacuations. In Bangladesh, lack of communication with India regarding river flows making their way to Bangladesh means the Bangladesh EWS is heavily constrained with respect to how much advance notice they can provide for flood flows on the rivers flowing into the county from India. In all three of these, weak or absent communication puts assets and lives at risk.

Cascading infrastructure failure

Another recurring theme in almost every large disaster event is the overwhelming of critical infrastructure by the hazard process, typically leading to damage or destruction of the infrastructure and service interruption from that infrastructure. What follows are cascading failures of other critical services and impacts for the affected population. **In cyclone Idai,** wind damage took down communication and power lines – impacting radio, television, phone and mobile phone communication – abruptly cutting off the dissemination of warnings. This severely limited the ability to push communications and warnings out to communities regarding continued flood risk. There were successes, however, where avoided impacts on critical infrastructure prevented cascading failures – in particular, upgrades to the drainage system in the Mozambican city of Beira performed as designed during Idai, preventing what would have otherwise been significant flooding.

In many events like Faridpur or Bernd, critical services for citizens were impacted and unable to perform their functions. For example, health centers were flooded, compromising medical care heavily in the affected areas, not only for key life-saving functions such as treating injured patients, but sometimes also for seemingly simple and mundane tasks like refrigerating and distributing medication for the elderly and the chronically ill. Access to safe and functioning infrastructure was compromised for several months in many cases, leading not only to short-term but long-term issues for a wider population than just those immediately affected by the events.

Cascading failures of critical infrastructure become increasingly problematic the more dependent the population is on that infrastructure. That means that highly developed contexts and urban settings are typically more impacted than more rural or less developed settings. **During "Bernd," critical infrastructure was neither robust nor redundant,** causing massive cascading effects in communication and transportation infrastructure, increasing secondary losses and making first response enormously difficult.

In "Bernd", flood processes in 2nd and 3rd class rivers were not well understood, leading to unexpected humanitarian consequences and asset damage, especially as bridges acted as blockages and increased housing density slowed water further, increasing water heights. Bridges subsequently failed and contributed ot the cascading failure of infrastructure, often also because additional infrastructure such as water or sewage piping was tied to the bridges. Flood maps failed to keep people and infrastructure safe, and the intensity and rapidity of the water caused flood losses outside of flood insurance and civil protection expectations. Urgent action on land use planning and clear delineation of flood zones is necessary, especially in Germany as there are many other "Ahr valley" type middle mountain locations that could be subject to a similar flood disaster.

The disaster scenarios in many countries affected by "Bernd", in particular in Germany, were insufficient and did not capture the extent of this event, overwhelming the system. Equipment and organizational practice for disaster response were not fit for purpose for this event and required ad-hoc improvisation.

As a sub-theme of infrastructure, we see a reliance on protection from grey infrastructure, and consequently a "surprise" by its design limits, leading to failure and cascading consequences when an event surpasses the protection limit the grey infrastructure was designed for. The "levee effect" continues to be visible; in many localities people have full confidence in the protection infrastructure and therefore do not carry out any prevention or preparedness actions. In other locations, they don't even know they are being protected by infrastructure until it fails, or design thresholds are exceeded. This is a greater challenge in more developed contexts, where strong emphasis is put on protection infrastructure, and a heavy reliance on the statistic determination of the "design flood" is used to determine the threshold to build it to. However, it is also an aspect of flood 'protection' that we actively export to developing countries. Globally, we need a much greater awareness of design thresholds and more active planning and preparedness for the residual risk that remains.

Unsustainable River Management Practices

In many countries including Mexico, Vietnam, Germany, Bangladesh, and Nepal, river management practices and lack of process understanding are all key contributing factors to flooding consequences.

Many of our PERCs documented **unsustainable river management practices.** In Bangladesh and Vietnam, for example, we found that exploitation of natural resources in the form of sand mining is changing river flow and increasing downstream erosion. In Bangladesh, informal embankment construction, poorly coordinated dredging, and poor maintenance and operation of sluice gates is further impacting river flow and exacerbating problems with erosion and deposition. These issues all led to unintended flooding and consequences during events, and are resulting in river bank destabilization, and changes in river flow behavior, leading to unanticipated flooding consequences in the built environment.

In Mexico, river and dam management practices had an immediate influence on how the 2020 flood developed and these practices need to be improved. The discharge of water from a hydroelectric dam contributed to the flooding in the region and affected disproportionately a poorer, more indigenous, and more vulnerable population. Following the event, Dam Management Commissions were established to coordinate and manage dams better, including the installation of a monitoring and warning system for real-time water level adjustments to prevent flooding. However, further integration of grey **and green infrastructur**e is necessary, and Mexico has identified several opportunities for implementing them at river or community scale. Tabasco has made significant investments in grey flood protection infrastructure, but maintenance is equally important for the infrastructure to continue functioning properly.

There are community perceptions that the embankments or roads built along the border in India cause inundation **in Nepal** due to their obstruction of natural drainage. Many Indian communities share similar perceptions that 'Nepal sends flood'. How rivers are managed and dams operated to retain or release water needs to be improved, and cross-border cooperation between countries should be strengthened.

More recognition needs to be gained on the fact that it can only mitigate part of the risk and has a design limit after which the protection fails. The "levee effect" continues to be visible, and in some localities people have full confidence in the protection infrastructure and therefore do not carry out any prevention or preparedness actions – last not least in the event in Europe, where strong emphasis is put on protection infrastructure and a heavy reliance on the statistic determination of the "design flood", which however all too often can be surpassed in real events. Linking back to the earlier discussion on what flood levels are expected, **"Bernd"** as well as other events were characterized as never seen before, but only based on limited time-series of statistics from actual measurements. If historic data including chronicles and other sources are used, and the information used to increase the data record, it can clearly be established that most of the events have already happened in the past and are not unprecedented – even without climate change, making it all the more important to correctly project out into the future what realistic events could look like under a changed climate in 10, 25, or 50 years from now.

Climate change attribution and "future weather"

From various PERCs we see an urgent need to **Integrate (future) climate thinking into current planning,** and break climate projections down to the local level in a meaningful, practical way. The past track record of cyclones in southeastern Africa, but in particular cyclones Idai and Kenneth in 2019 and how they overlapped with existing food insecurity and crop-failure, are representative of a new normal rather than an exceptional extreme. Higher sea surface temperatures and existing and increasing sea level rise are contributing to increasing frequency and intensity or tropical storms, as well as shifting their occurrence spatially and temporally. We are increasingly seeing tropical storms with higher windspeeds, which strengthen faster (which shorten the time for warning and preparation), and are much wetter, resulting in more and more intense rain. At the same time, the cyclone range is extending further north and south. In the future, it is not out of the question that tropical cyclones could make landfall as far south as the capital of Mozambique, Maputo, a city that might be totally unprepared for for a storm like Cyclone Idai. For scenarios like this, society needs to anticipate better where the next "Idai" could happen, and what exacerbating aspects need to be considered in that scenario. As an example, climate change is impacting the livelihoods of small scale farmers. Their practices and their crops are ill adjusted to effects of climate change due to changed planting, seedling, harvesting seasons, more variability for rain, heat, drought, leading to underlying issues in farming technology, economic capacity, health etc., which all make them less prepared for extreme events. So, longer-term aspects are creating issues for rapid-onset disasters.

This is very similar in Central Europe. Climate change attribution for "Bernd" was difficult given the highly dynamic and relatively small-scale nature of the weather system, but overall attribution identified a clear trend that across the entire Central European region such events might become more frequent and intense. Correspondingly, authorities, disaster risk managers and the society at large needs to build resilience for these events, not just in the Ahr valley where Bernd has been so devastating, but in many similar, highly populated regions across the middle mountains with rivers that have a similar "flashy" nature and the potential to create highly devastating floods under similar weather conditions like "Bernd". Overall, climate scientists in the UK have suggested that slow-moving storms like Bernd might happen 14 times more frequently across the European continent by the end of the century (Kahraman et al., 2021).

Interestingly, despite nine tropical systems making landfall in short succession, a climate change attribution study interestingly found that the 2020 **Vietnam** flooding is **not** attributable to climate change but within the existing variability of rainfall, outlining the importance of improving the

regional DRR measures. However, the variability and the timing of the floods was unusual and exceeded the coping capacity of the population, and climate change is unlikely to make that better.

In Bangladesh, there is a strong dependence on the weather for livelihoods, especially in agriculture. Successful agricultural seasons can take place only in a narrow band – enough rain for some flooding, but too much is dangerous; and no rain at critical points when crops need to ripen and be harvested. With climate change, the variability is increasing, making events frequently go beyond that band.

Disaster response and recovery issues

Given the intensity and the size of the disasters analyzed and how this relates to the local and national contexts of emergency response and recovery institutions, the immediate phase following a disaster is often called the “chaos phase”. Despite immediate initial response mobilization, the disasters covered in the PERCs in Table 1 were often beyond the capacity scope of the impacted countries to respond alone, triggering international humanitarian response – even for **Bernd** in Central Europe, where the corresponding European Union support mechanism was triggered. An influx of external helpers coupled with the overwhelmed local capacities led to coordination issues, beginning with the immediate response — affecting search and rescue, and immediate basic food and sanitary needs alike. This often overlaps, however, with emergency solutions to address the destruction of critical communication and transportation infrastructure, in particular fragile roads and bridges damaged or lost to the flood. Lack of oversight and lack of priorities contributes to chaos further. We have seen this in as diverse disaster contexts as Bernd and Idai, outlining the importance of adequate disaster laws, the prepositioning of corresponding emergency response and recovery mechanism and personnel, and the need for training and cooperation in non-disaster times to improve coordination and communication when the real disaster situation is triggered.

Photo credit: Bernd Engelien, Zurich Germany

For many events where external aid is necessary, such as **Nepal, Faridpur** or **Idai,** prioritizing and funding resilience-building and DRR should be integral part of both humanitarian response and development programming. Financing DRR should not just be for one-off "things" only, but also include continued use / operation / maintenance of the equipment. For example, in Mozambique, Malawi and Zimbabwe, protection and emergency equipment that was provided through development aid, but without an associated budget for maintenance, could often not be maintained or operated locally, rendering it useless. Almost every national government parking lot and many NGO offices had one or more pieces of slowly decaying equipment. Though a very specific example, this is indicative of how, in humanitarian and development work alike, the sector tends to not think systemically. More intentionally planning for humanitarian response that is funded to overlaps with and evolve into development and resilience work is needed to get us off the humanitarian disaster-response treadmill.

At the national level, DRR and DRM are primarily focused on response in most of the PERC countries included here. While all countries in Table 1 have implemented DRR and DRM policies and frameworks and have corresponding government institutions, most actions remain responsive and there is significant space to improve institutional capacity to act proactively. Most mandates are to be reactive, and most resources are kept at the national level, making dissemination and swift action at the local level difficult. Coordination remains an issue hindering progress.

For example, DRR in **Bangladesh** remains constrained by poor DRM funding and capacity, a lack of necessary data, and coordination challenges. From the Faridpur event, we learnt that Bangladesh's DRM system is mostly response focused and structured top-down, which limitis the effective distribution of funding and **limits** the capacity of local-level DRM actors to prepare and respond. Overall, DRM is underfunded, especially at the local (UDMC) level. Operationally, DRM is not as well coordinated as it could be, in particular between UDMCs and local Water Development Boards, although this coordination is supposed to be their mandate. Coordination challenges are, in part, due to a lack of capacity. While ample policies and DRM governance exist, especially at the local level, these local actors lack capacity and time, hampering the actual DRM work, especially ex-ante. Individual households, after a period of humanitarian support, are primarily left to recover on their own. Microfinance institutions (MFIs) offer a margin of flexibility for loan repayment or access to emergency loans, but often, MFIs stopped disbursing to flood victims as they utilized loans for more pressing daily needs and could not repay them. As an alternative, those in need of cash take out high-interest loans to rebuild homes, prepare their farm for cultivation, plinth raise their homes, restock and reconstruct sheds, etc.

In Senegal, it was found there is a need to improve the coordination between civil protection actors at local level and strengthen their knowledge and capacity in DRR beyond disaster response. Communities lack knowledge and capacity to translate weather forecast and hazard information into specific actions to stay safe. Households need to better know how to prepare for floods, what to do in case of floods, and how to manage post-flood. This should include community training programs and community task forces / disaster preparedness brigades.

While Vietnam has been very successful at reducing deaths from natural hazard events, with quite strong DRM policies in place, these are implemented separate from spatial, development or economic planning, and without full consultation of the local level. As a result, development is regularly creating new flood risk. This is coupled with a lack of capacity at provincial and communal level for DRM, which means this growing risk is poorly understood or tracked. If the country is to truly make progress on DRR and CCA, this gap needs to be urgently addressed.

Long-term DRR, ex-ante action to reduce risk, and building much broader community resilience is needed but hard to implement. Development program timelines are often short; disaster response and recovery timelines are typically even shorter and focused heavily of building back as quickly as possible, which almost always means 'as was', with pre-existing risks replicated in recovery. There is a lack of an integrated perspective where all stakeholders share a common interest and come together to jointly work on DRR. **These are all obstacles to overcome.**

For example, in Nepal there is still a stronger need to recognize the limitations of traditional disaster rescue and relief and to more actively incorporate preparedness and integration of DRR into development planning. **Local capacity in flood risk and emergency management need to be strengthened,** as these, alongside the necessary resources, are instrumental for successful DRM at the local level. Emergency equipment such as boats alongside financial resources to provide emergency funding for immediate needs are crucially needed at the local level.

On a positive note, we see how established coordination mechanisms and known ways of working help overcome challenges and reduce risk. In the area affected by Idai, there were strong pre-existing connections between those doing WASH programming and the critical health infrastructures. This helped contain post-event disease outbreak. Actors were also able to preposition resources based on early warnings, allowing them to be better prepared and act more swiftly once the event hit. Others can and should learn, even in areas where it would not typically be considered a risk. We saw critical health infrastructure overwhelmed and drinking water and wastewater services destroyed in the Ahr valley in Bernd, creating conditions where health issues due to contamination could suddenly turn into bigger problems. Indeed, temporary sanitary and wastewater processing had to be installed in the Ahr valley; they used technology which typically are used in development contexts and not domestically.

Land use management, zoning, and (re-) settlement

Policies need to be pursued, and opportunities exist, to rethink land-use with a basin-wide approach and to include “build back better” for flood resilient infrastructure and housing. In the last 70 years, there has been rapid population growth and urbanization in many of the PERC study areas, including Tabasco in Mexico. In these areas, rapid growth has contributed to irregular settlements, increases in human exposure to flooding, and increases in social vulnerability. Land-use management with regards to deforestation and agricultural development have led to changes in erosion and sedimentation patterns, leading to siltation of rivers; this, in turn, means less water is needed to cause channel overflow and flooding.

In Senegal, where the Thiès flood was mostly an urban flood, despite the existence of land-use, urban planning and construction standard tools, gaps remain how they are applied and enforced. As a result, authorities have been unable to mitigate rapid and uncontrolled urban growth. This places people but also large infrastructures into flood exposed locations. Flood mapping should be used more to inform where there is space for construction and where green space should be left for natural flood control. The uptake of green combined with grey infrastructure / nature-based solutions should be intensified and combined in urban planning for flood risk management. Resettlement in Senegal is also difficult. A debate about if, how, when and where to resettle communities in at-risk areas is intensifying. If resettlement is to take place, this raises the issue of identifying appropriate new sites where people can continue their livelihoods and maintain their social ties. Resettlement plans need to include local knowledge, use risk maps, and provide supportive measures including basic infrastructure and social support services.

In Vietnam, there is a high population exposure, meaning DRR measures are particularly relevant as the majority of the Vietnamese population lives on the coastal floodplain or in the Mekong Delta, exposing 70 % of the total population to flooding. **Development and urbanization is increasing flood risk.** Existing and new development is being built without

consideration for drainage at the city-scale. Because new construction, particularly roads, are built on fill with little consideration for drainage other than on-site, many new infrastructure features end up functioning as dams. Despite regulations to the contrary, natural drainage networks, flood channels and flood retention areas are often over paved. The impact on existing neighborhoods, as flood waters increasingly collect and/or back up into their communities, is significant. Many villages that previously experienced regular shallow flooding now experience flood waters of 1-2 meters during extreme events, as water backs up behind new transportation corridors, new levees, and new construction sites.

Resettlement is increasingly being considered as a last resort to solve the problem of how people already exposed to the hazard can be better protected from it in future. However, **resettlement is difficult,** politically charged and often found unacceptable to pre-plan. The question of how to support those who have lost not just homes but also land, or whose lands are clearly at far greater risk than previously known, remains unanswered. Where return to affected land is impossible because it is completely gone, resettlement is discussed at government / international expert level, but it is unclear how inclusive these discussions are and whether and how the affected population is involved. Too often, they are just given a “solution”, and almost as often that solution increases their vulnerability. Minimum criteria around resettlement should be satisfied, including the provisioning of critical infrastructure, the assurance that past livelihood activities can be sustained in the new place, that existing community and social structures will be maintained (rather than moving individual people / families and dividing communities that were previously mutually supportive), that distance between the new and old community location is limited as much as possible, and that an enabling environment is provided. The question of resettlement will be increasingly unavoidable in future, particularly as a climate change adaptation mechanism. Many things can be learnt where resettlement is not yet high on the agenda from those places where it is already reaching the point of being unavoidable to address.

Following cyclones Idai and Kenneth, communities around the most affected zones upstream of Beira in Mozambique, and communities on islands in the river in Nasanje in Malawi, are facing a situation where returning is not an option and resettlement has to be faced. **Permanent relocation** is also mentioned as part of Bangladesh's national recovery plan and considers the provision of livelihood options. However, in practice it has been difficult for community members who lost homes to find land unaffected by floods, find funding for reconstruction, and/or find livelihoods in new locations. On char islands, many households have already relocated several times, but it’s costly and every move makes them more vulnerable.

Events taking place as part of polycrises

Many of the events we analyzed for this summary have happened in the period of 2020 and 2021 during the Covid-19 pandemic. The context of such a **polycrisis lead to severe livelihoods, evacuation and sheltering issues** in many cases, such as the Bangladesh event, where the cyclone during the pandemic led to increased economic and social devastation, leaving the already vulnerable more vulnerable and creating a new layer of vulnerability, all affected by the flooding from cyclone Amphan. The Covid-19 response had already used up available resources, making preparation and response for the cyclone complicated. Usual pre-monsoon disaster risk management planning events had been cancelled due to Covid-19. Due to the pandemic, relocation and sheltering was not centrally coordinated. Lack of COVID-safe shelters (i.e. enough space in shelters to maintain distance) and/or household decisions not to evacuate because of COVID health risks meant WASH safe practices both for Covid and flooding were impacted, as households were more exposed to contaminated water sources. And, because Covid-19 impact on livelihoods had forced many city laborers back to their original home communities just before the storm, more people were impacted and in need of shelter, food and clean water. Disaster preparedness needs to include improvements in multi-hazard / polycrisis preparedness and consider “what if” scenarios when a rapid-onset natural hazard event takes place on top of longer-term or other natural hazard events.

In Mexico, the pandemic had a significant effect on managing the disaster, but during the COVID-19 pandemic, the flood shelters were well managed to support general physical and mental health in parallel with COVID-19 precautions / strict sanitation protocols, providing vaccination opportunities as well as medical consultations. Aid distribution was not centrally organized to avoid mass gatherings, but rather was handed out house-to-house.

The polycrisis situation described above for Bangladesh and Mexico, interestingly, is quite unlike how the Bernd flood unfolded in Central Europe in the summer of 2021. While Bernd also took place during the pandemic, the severe effects of the floods and the overwhelming of the entire response and recovery system meant that essentially all pandemic protocols were put out of effect for the duration of the flood crisis in the flood-affected areas. Exceptions included a special vaccination campaign in the flooded areas, but the authorities felt that physical distancing and other health protocols could not be upheld for the clean-up operations and the emergency sheltering. Where possible, individual emergency sheltering in hotels and empty homes was offered over mass sheltering. This seemingly did not create a big health impact, perhaps in part because the event was during the summer when infection rates were lower, but the exact effects are unknown to our current knowledge.

Building back better / a resilient recovery

As shown by small and patchy examples, building back better can be done, but there are many obstacles to overcome before it really will be mainstreamed. A year on from the cyclones Idai and Kenneth, tens of thousands of households have been rebuilt by their residents, but many with the same materials and techniques that contributed to loss of homes. Rural homes in Malawi, Zimbabwe and Mozambique are typically made from mud brick with thatch or sheet-metal roofs and have limited resistance to strong winds and floodwaters. In Malawi, one of the NGOs interviewed discussed the successes they have had improving the technical capacity of households and communities to build more resiliently. Even working with just the traditional mud and thatch, by strengthening foundations, carefully selecting soil for bricks, and altering the roof shape to better protect the walls, homes can be made significantly more resistant. However, the projects were small, the results not widely disseminated, and even these improvements may be beyond the financial capacity of some householders. Access to and the affordability of materials needed to build more resiliently, like fired bricks and sheet metal, is a barrier for many households. Also, the resilient reconstruction process is often slow in terms of being approved, financed and/or implemented, another barrier, leading to reconstruction as-was as well as people remaining in temporary shelters including tents. Some critical infrastructure such as boreholes and other WASH interventions, when installed under the control of development programs, however, are learning from Idai and (re)construct to above Idai flood levels.

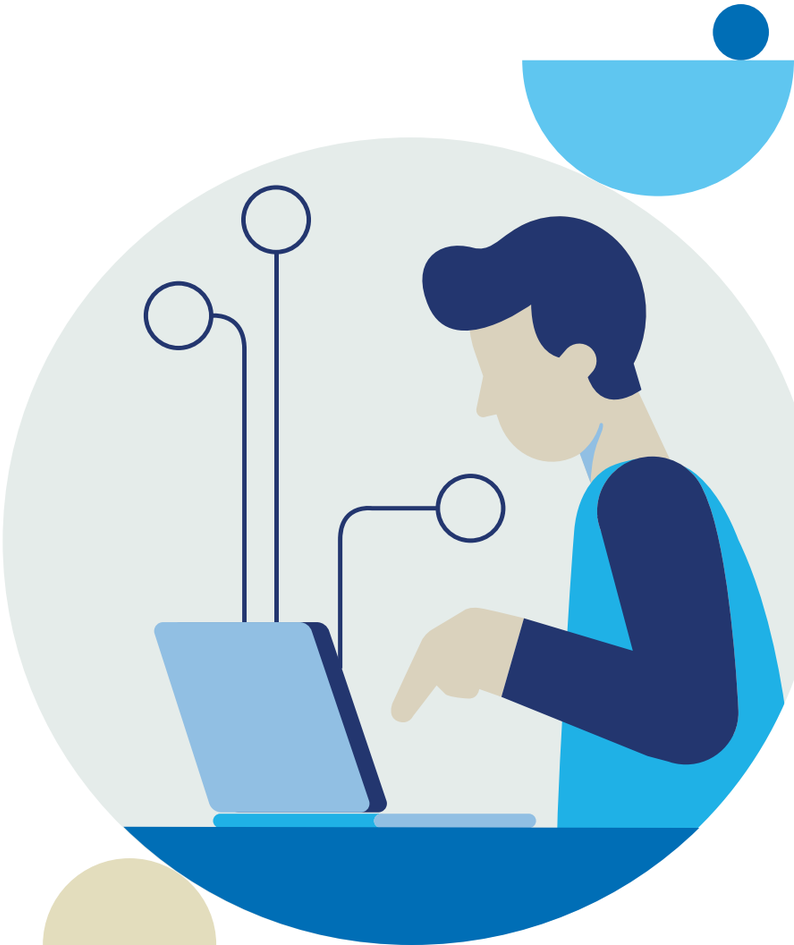
Across Europe following "Bernd", the researchers found and also heard from citizens and local authorities alike that reconstruction was slow, uncoordinated and unable to incorporate a resilient recovery. Coupled with coordination challenges amongst different actors and the ensuing timeline challenges of aligning when different decisions should be made and actions be carried out are **challenges around competing interests:** For Idai, food security, economic downturns, agricultural demands and pressure on natural resources are important factors to keep in mind when addressing DRR, especially in longer-term planning. These are strongly competing interests that make it harder for the case that DRR is a good and sensible economic investment to be heard. Similarly in **PERC Bernd,** different stakeholders with different interests work along so many different timelines that it is really difficult if not impossible to align them and prepare a recovery approach that is synchronized and can be based on the bigger picture rather than individual processes that don't align. This, however, is a requirement to recover in a more resilient but also more efficient way.

Reconstruction for large disaster events cannot be coordinated and implemented on a reasonable time scale unless it is pre-planned. Due to the differing timelines and priorities of those rebuilding, it is almost impossible to provide a comprehensive reconstruction concept or "master plan" with an ambitious forward look at communal or district level. This misses a significant opportunity to include sustainability and modern technology and is not forward looking.

Build back better is mentioned in **Bangladesh** in the recovery plan as part of the reparation of damaged infrastructure – homes will be brought back to prior condition or "improved". In practice, the design for locally adapted flood resistant homes is described, but it is unclear who would fund and build them.

In Mexico, build back better relates mostly to improved construction of housing; researching alternative housing models is necessary. Indigenous knowledge seems to have been partially lost, as in the past alternative housing models such as using houses on platforms (tapancos) or stilts (palafitos) have been common. The government is now promoting housing programs with these approaches in mind.

In addition to the policies and practices for building back better, financing instruments are also required. In Mexico, with **FOPREDEN, the fund for disaster prevention,** there was a good mechanism is in place to provide economic resources for risk prevention, including risk identification and reduction as well as the promotion of a culture of prevention and self-protection. However, flood risk management in Tabasco specifically has focused mostly on hard infrastructure work along the main rivers, which was carried out with a specific design limit in mind, and the infrastructure was since not adequately maintained. People also feel a false sense of security due to these protection structures and feel the "levee effect". Currently, due to political conditions, it is unclear if and how funds like FOPREDEN in Mexico can continue.



What we can learn from each other

From across the past disaster events that we have studied in detailed and assessed for commonalities in the previous chapters, we have identified several key themes:

- **Early warning systems are brilliant when they work, but they need to be further strengthened, everywhere;**
- **Society is still too often surprised and overwhelmed by large, unexpected, yet not unrealistic events;**
- **Unsustainable river management practices that exacerbate flooding need to be overcome;**
- **There is an overreliance of grey infrastructure, the hard thresholds of which brings the risk of cascading failures. Engineers and decision-makers need to retain an awareness of and plan for this residual risk;**
- **The international community needs to broaden the focus of DRM systems beyond response and build DRM capacity at all levels, but particularly local;**
- **Dealing with disasters in isolation is a luxury, society needs to be better prepared to respond to polycrises;**
- **Flood risk is being exacerbated by climate change, so we need to learn quickly and plan for the future events we know we'll experience.**

While there is no one-size-fits-all approach to solving these common issues, society must better learn from each other and make progress in establishing new, future-adapted solutions, and establish trust in them.

There are a number of ideas to keep in mind as we approach this. The first is the concept of resilience in all its richness and diversity of elements, as opposed to a "risk-based" model only. The Alliance defines (climate hazard disaster / flood) resilience as **"The ability of a system, community, or society to pursue its social, ecological, and economic development and growth objectives, while managing its (climate hazard disaster, flood) risk over time in a mutually reinforcing way."**

This highlights that risk management and development are interrelated and cannot be addressed in isolation. The Alliance does this with a resilience framework based on the 5C-4R concept — the five capitals of the Sustainable Livelihoods Framework (5C) and the four properties of a resilient system (4R). This framework illustrates the richness of aspects of resilience to consider when implementing flood resilience solutions.

This framework highlights that countries and flood risk management practices that are more heavily rooted in grey infrastructure engineering to provide flood protection can and should couple their successful engineering practices with non-structural, human and social capital elements. Strengthening human and social capital will help overcome design limits, human assumptions, and maintenance challenges of ageing and expensive infrastructure.

The Alliance 5C-4R resilience approach has been successfully implemented in over 400 communities around the world, mostly in the global south but also in the UK, Germany, Jordan, and the United States, and has helped enhance early warning, monitoring and preparedness capacities at the local level through human and social capital. Interestingly, this is a focus area that we find less pronounced in our Central and Western Europe PERC. Particularly following the event "Bernd", we noticed a culture of risk management and self-responsibility of citizens and local communities was lacking, with a higher reliance on infrastructure and procedures provided by higher levels of government. The affected countries in Central Europe could benefit more from a culture of risk management and self-responsibility and more creative solutions rather than just rely on government, and there is much they can learn from the global south regarding how to best do this.

Good hazard and risk awareness can be – besides infrastructure – also very powerful. One of the things we see in contexts with less available financing and capacity, is a greater reliance on community structures and adaptive capacities. Where this is coupled with strong early warning systems, training for communities and individuals regarding how they can help themselves, and targeted softer support for community preparedness, response and recovery, outcomes can be as good or better than in more developed contexts where people are often too reliant on floodplain mapping, protection infrastructure, and emergency services. Resilience is a combination of both strong, healthy, flexible built and natural environments and connected, networked, informed, transparent and equitable human and social systems. The latter is often a fraction of the cost of the former, yet we consistently overlook it. In our PERCs, we have documented numerous small, inexpensive ways communities can build their resilience by building human and social capital, particularly risk awareness and learning about and regularly practicing corresponding behaviors, such as subscribing to, understanding, and heeding targeted early warnings.

Around the world, early warning is improving in coverage and reliability, but at the same time human fatalities and avoidable asset losses are still too numerous. In all of the events summarized in this medley, the natural hazard events were forecast, often with growing accuracy for days in advance. Yet, as we have seen, as weather and flood regimes shift, and in particular as smaller river systems showing more frequent, more intense and more damaging "flashy" flood types, new river monitoring technologies using open-source software, standard, easy-to-repair tech components, and ensuring they are embedded in overall monitoring networks run by or on behalf of official authorities, could close an important data and monitoring gap. This has the potential to be as effective in developing as developed contexts, as more localized data is a data gap globally. Indeed, recognizing this gap, the Alliance has developed some novel, low-cost solutions, often rooted in community engagement and participation, and successfully rolled then out in many countries and projects (e.g. see Practical Action's and the Red Cross Red Crescent Climate Center's work here ↗). Technologies and approaches like this could benefit data-scarce regions or river systems globally.

Only occasionally do we have the opportunity to deal with a disaster in isolation. More often, disasters are layered on top of other challenges or even other disaster events. This has been demonstrated by the recent COVID pandemic that compounded the flood events analyzed in this report, but includes also political or economic crises, or other natural hazard events. Society needs to get better at scenario planning for polycrises. One way we can do this is to look back at how we dealt with other crises that arose during COVID – every community and country on the globe has lessons they can draw, even if was just balancing COVID with day to day needs and demands.

As we consider polycrises, however, we also need to consider the intersection of hazard, exposure, and vulnerability, which together form risk. This means, in simple terms, that vulnerable people and assets need to better be kept out of harms way, or outside hazard zones. Land use planning and development needs to make much better use of past extreme events, current risk maps, and future climate change projections. Society cannot afford, anywhere in the world, to build new risk into new development. This is particularly true in post-disaster contexts; if approaches of building back better are not incorporated, that society is (re-) building for failure. Both local extreme events and extreme events seen elsewhere in the world need to be better considered. These are not unimaginable; rather, they are the new design standard that should be met or exceeded. Our body of PERCs contain many examples of places where ‘unprecedented’ events happened 5 or 10 years prior in areas within 200 km, or indeed in the same location. We have also documented cases of ‘1 in 500 year’ events happening every 7 years, or every year. Learning from these is far cheaper than responding to and recovering from them the same way every time.

One important aspect of planning for disasters is doing it early, setting it up for a well-coordinated, pre-planned situation where recovery can be organized and executed swiftly and incorporate aspects of resilience – a resilient recovery (which we use here as a further evolution of the approach of “building back better”). Disaster events are often less disastrous if at least the possibility of such an event is considered in advance, and what actions could be taken in that eventuality. We know that society can’t plan for everything, but we can broaden our thinking, do more thought-experiments and scenario planning, and build out broader and stronger networks. Where, in our PERC studies, we have seen this done, outcomes are more resilient, and some impacts are avoided.

In particular in “Bernd”, we have identified a number of challenges why a resilient recovery does not happen unless it is pre-planned, but we have seen it in some of the other analyzed events, too. The key take away is to not reconstruct without an overarching flood protection plan finalized and transparently published, drawing on learning from the disaster event. There needs to be an honest discussion and decision-making process on how to reconstruct in a truly transformative and more imaginative way. Many questions need to be answered as part of an integrated recovery and reconstruction plan before reconstruction itself can begin - this is particularly true for critical infrastructures to avoid cascading effects in the future. To allow for such pre-planning of disaster recovery and reconstruction to happen, one might need to look as high as the national disaster law, which may need modification to allow this to be done ahead of a disaster, and special timelines, disaster recovery zones, and disaster recovery delegates put in place for coordinated, encompassing and timely decision making.

“Later this year, the Alliance will launch a global report on resilient recovery, with case studies based on the PERCs in Mexico, Senegal, and Nepal.”

Most importantly, efforts to enhance flood (and other hazard) resilience should not be concentrated (and potentially overdesigned) only in areas impacted by the events that we have analyzed. There is virtually nowhere on the globe that doesn’t experience at least one of the gaps outlined in this paper. Explore whether there are gaps, consider how they behave based on the physical processes and couple that with the human element, and then explore how you can strengthen the resulting human-physical system. This is critical in averting future, large hazard events from turning into humanitarian disasters. And, related to this, it is paramount to continue learning from events both in your location, in neighboring locations, and in similar environments globally, summarizing and generalizing the key lessons, and ensuring that those are not exclusively kept to those affected by the most recent disasters, but share it widely. This may feel like an unrealistic time demand, but the potential payback in terms of losses avoided and staff time saved will more than pay for the effort.

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