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Focus: Floods

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Preface

Floods are among the most severe hazards of our time — with devastating consequences for people, infrastructure, and ecosystems. Climate change is exacerbating this threat: extreme weather events are on the rise, and vulnerable communities are bearing the brunt. Uncontrolled urbanization, industrial agriculture as a driver of soil degradation, and inadequate preventive measures further increase the vulnerability of many regions.

The escalating climate crisis demands a systematic approach that integrates diverse perspectives on prevention and sustainable development. The WorldRiskReport plays a crucial role in this regard: serving as an intersection between global research and local practice, it presents evidence-based solutions — from ecological retention areas to climate-adapted farming methods as well as participatory emergency plans. Its analyses demonstrate that preventive investments not only save lives but are also economically sound in the long term. Thus, every euro invested in flood protection, early warning systems, or resilient infrastructure can reduce emergency relief expenses significantly. Prevention saves lives and reduces costs.

But behind the data are human destinies. The story of Najeeb Ullah, his wife and their five children from Bostan, Pakistan illustrates the impact of such disasters — but also the path to recovery:

Najeeb Ullah, 45 years
Lives as a farm worker with his family in Bostan, Pakistan and was supported in his recovery after the flood disaster in 2022 by Deutsche Lepra- und Tuberkulosehilfe (DAHW) and its local partner WESS (Water, Environment and Sanitation Society).

"2022, the flood took ... simply everything. Our home, our belongings, our farmland, our livelihood, all just gone. The harvest, everything was destroyed. We had nothing to eat, nothing to sell. We were completely helpless. Everyone suffered. Families were torn apart; people were desperate. We were all defenseless, with no way to provide for ourselves.

Eventually we received support — just in time. We were given seeds, tools. I don't know what we would have done without them. It was a long journey, but we were finally able to gradually rebuild our livelihoods and return to farming. It's not just about the food; it's about our dignity, about being able to provide for our families ourselves. That gives us hope for the future. The support was tailored to our needs and is so important for rehabilitation after a disaster. It helps us not just to survive, but to truly recover and become resilient."

This testimony shows: Scientific findings must reach the places where they are needed. Sustainable assistance must empower those affected instead of creating dependencies. The WorldRiskReport contributes to scaling such solutions. To ensure that reactive crisis response can increasingly give way to preventive risk management. Our thanks go to all those involved in this important work.

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Further information

In-depth information, methodology and tables are available at **www.WorldRiskReport.org**.

All reports are available for download.

Bündnis Entwicklung Hilft is made up of the aid organizations Brot für die Welt, Christoffel-Blindenmission, DAHW Deutsche Lepra- und Tuberkulosehilfe, German Doctors, Kindernothilfe, medico international, Misereor, Oxfam, Plan International, Terre des Hommes, Welthungerhilfe. In contexts of crises and disasters, the member organizations provide both short-term relief and long-term support in order to overcome poverty and prevent new crises.

The Institute for International Law of Peace and Armed Conflict (IFHV) of the Ruhr University Bochum is one of the leading institutions in Europe for research and teaching on humanitarian crises. With a long tradition in the scientific analysis of international humanitarian law and human rights, the Institute today combines interdisciplinary research in the fields of law, social science, geoscience and public health.

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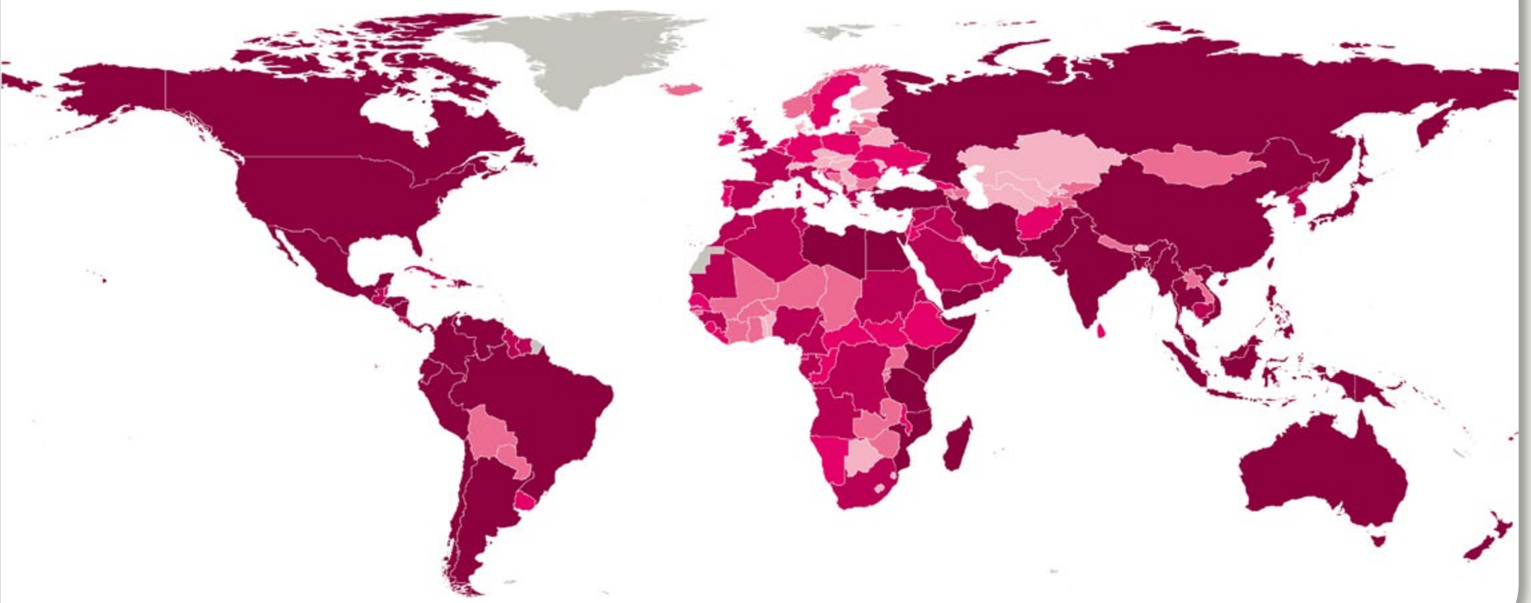

Figure 1: World map according to the WorldRiskIndex 2025

Key Findings

The **WorldRiskIndex 2025** indicates the disaster risk for 193 countries worldwide. Thus, covering all United Nations member states and over 99 percent of the global population:

- In 2025, risk hotspots remain concentrated in Asia and the Americas. At the same time, Africa continues to show the highest levels of vulnerability worldwide: almost 80 percent of the continent is classified as high- or very high risk-areas.
- The top 10 highest-risk countries show only minor changes: China re-enters the group, while Bangladesh drops to 11th place. Indonesia and India switch positions, with India now ranking second worldwide.
- The Philippines is once again at the top of the WorldRiskIndex this year: a country characterized by high geographic fragmentation and high exposure to weather-related extremes.
- Germany remains in the global midfield this year, sharing 95th place with the Democratic Republic of Congo.
- Global risk drivers include social inequality, structural vulnerability, and weak health systems. These reduce adaptability and resilience — even in wealthy countries, for example, through austerity measures in key societal sectors.
- The examples of China, Nigeria, and Afghanistan illustrate that data is often collected irregularly and published with delays. When current information is lacking, a country's risk profile appears to remain unchanged in a global comparison, thus skewing its ranking. When new data becomes available, there are often abrupt changes that are difficult to interpret, as it is unclear over what period they actually occurred.

Focus: Floods

- Floods are among the most frequent and devastating extreme natural events. Between 2000 and 2019, they affected over 1.6 billion people and caused economic damage of over 650 billion US-Dollars worldwide.
- There are three main types of floods: fluvial, pluvial, and coastal. This differentiation is important for developing targeted prevention strategies and assessing specific risks more accurately.

Figure 2:
Excerpt from the WorldRiskIndex 2025

Rank	Country	Risk
1.	Philippines	46.56
2.	India	40.73
3.	Indonesia	39.80
4.	Colombia	39.26
5.	Mexico	38.96
6.	Myanmar	36.91
7.	Mozambique	34.39
8.	Russian Federation	31.22
9.	China	30.62
10.	Pakistan	26.82
11.	Bangladesh	26.71
12.	Papua New Guinea	26.51
13.	Vietnam	25.92
14.	Peru	25.81
15.	Somalia	24.89
...		...
95.	Germany	4.28
...		...
179.	Maldives	1.04
179.	Malta	1.04
181.	North Macedonia	1.01
182.	Hungary	0.91
183.	Nauru	0.88
183.	Qatar	0.88
185.	Bahrain	0.87
186.	Belarus	0.72
187.	Liechtenstein	0.68
188.	Singapore	0.67
189.	São Tomé and Príncipe	0.61
190.	Luxembourg	0.57
191.	San Marino	0.35
192.	Andorra	0.29
193.	Monaco	0.18

+ The causes of flood disasters lie not only in natural processes, but also in man-made factors such as urbanization, climate change, and land use. Environmental degradation and unequal social structures increase susceptibility.

+ The increase in extreme weather events is overwhelming existing protection systems and calls for a rethink in flood risk management. Effective prevention is local, inclusive, and systematic, as demanded in the Sendai Framework (SFDRR). Successful flood prevention further relies on multidimensional approaches:

  + **Political:** The examples from Bangladesh, the Philippines, and Germany presented in the report demonstrate the impact of good governance, particularly through local networks and decentralized structures.

  + **Technological:** Satellites, AI, and participatory tools such as apps and mapping improve early warning systems. However, they are only effective if they are adapted locally, for example through participatory mapping or community apps. The report calls for more equitable access through cooperation and open access.

  + **Social:** Traditional knowledge plays an important role in disaster preparedness. In Indonesia, for example, local signs such as bird behavior help predict floods. Through community-based disaster risk management, this knowledge can complement modern approaches and strengthen resilience.

  + **Ecological:** Nature-based solutions are gaining importance. Renaturation, mangroves, or wetlands reduce flood risks and promote biodiversity. These approaches are more sustainable than technical protective structures, but require innovative strategies for land activation.

+ For the first time, the WorldRiskReport 2025 provides an exemplary analysis of a region with regard to the focus topic. Flood risks in the Philippines vary significantly from region to region and are influenced by geography, infrastructure, and spatial planning. This spatially differentiated analysis shows that local risk assessments are crucial for developing effective flood prevention measures and prioritizing adaptation investments.

+ The exposure analysis for flooding in the Philippines, tailored to the provincial level, shows pronounced flood hotspots in flat, densely populated lowland basins such as Cagayan or Pampanga. Laguna illustrates how spatial planning and retention areas reduce exposure.

Now with regional analysis on the focus topic → page 46/47

1 Floods and Disaster Preparedness

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Flood risks are increasing due to climate change and human interference with natural systems. Inadequate urbanization and destroyed ecosystems heighten vulnerability, especially in developing regions. Effective protection requires integrated approaches: high-precision forecasting systems, the renaturation of floodplains and mangroves as natural barriers as well as inclusive governance models. Combining technological innovations with ecosystem-based solutions and local knowledge integration is crucial. Only holistic strategies can sustainably reduce the growing threat.

Floods rank among the most frequent and devastating extreme natural events worldwide. Their force affects millions of people every year, destroying infrastructure and undermining both social and economic stability in the long term. Between 2000 and 2019, floods accounted for 44 percent of all disasters triggered by extreme natural events and affected more than 1.6 billion people (CRED / UNDRR 2020). During the same period, the economic losses exceeded 650 billion US-Dollars — a figure that underscores the systemic relevance of the issue.

This development cannot solely be attributed to natural processes. Rather, the increasing vulnerability to floods results from a complex interplay of climatic, ecological, and socio-economic factors. While climate change intensifies hydrological extremes, human interventions in natural systems increase the susceptibility of settlements and infrastructure. Marginalized groups are particularly affected, as they often lack fundamental protective measures.

Scientific analysis distinguishes between three main types of floods (Thieken et al. 2022). This differentiation is of central importance for the development of targeted prevention measures.

Fluvial floods occur when rivers and streams overflow, usually following heavy rainfall, particularly in monsoon regions such as South Asia or West Africa, or as a result of snowmelt. Examples include the recurring floods in Pakistan during the monsoon season and the 2024 floods in West and Central Africa, which extended from Liberia to Nigeria and across Mali, Niger, and Chad to Central Africa. The catastrophic flooding in Germany's Ahr Valley also falls under the category of fluvial floods.

Pluvial floods develop independently of water bodies when intense rainfall exceeds the soil's absorption capacity or overwhelms urban drainage systems. Pluvial flooding is expected to increase in the coming years (Kundzewicz / Pinskwar 2022). In cities such as Jakarta, Nairobi, or São Paulo, even short but intense rainfalls regularly lead to flooding, as sealed surfaces prevent natural water retention.

Coastal floods are caused by high tides, storm surges, or tsunamis and affect coastal regions. They can be exacerbated by rising sea levels and extreme weather events. Current NASA projections indicate that global sea levels could rise one to two meters by 2100 (IPCC 2023). This poses an existential threat, particularly to low-lying coastal areas and small island states such as the Maldives. At the same time, the destruction of natural coastal protection systems, such as mangrove forests or coral reefs, further increases vulnerability.

Drivers and interactions

The increasing frequency and severity of flood disasters can be attributed to several mutually reinforcing factors:

+ **Climate change**
  Climate change acts as a central catalyst for altered flooding patterns. The IPCC's Sixth Assessment Report (2023) documents how rising global temperatures lead to changes in precipitation patterns. In many regions, the

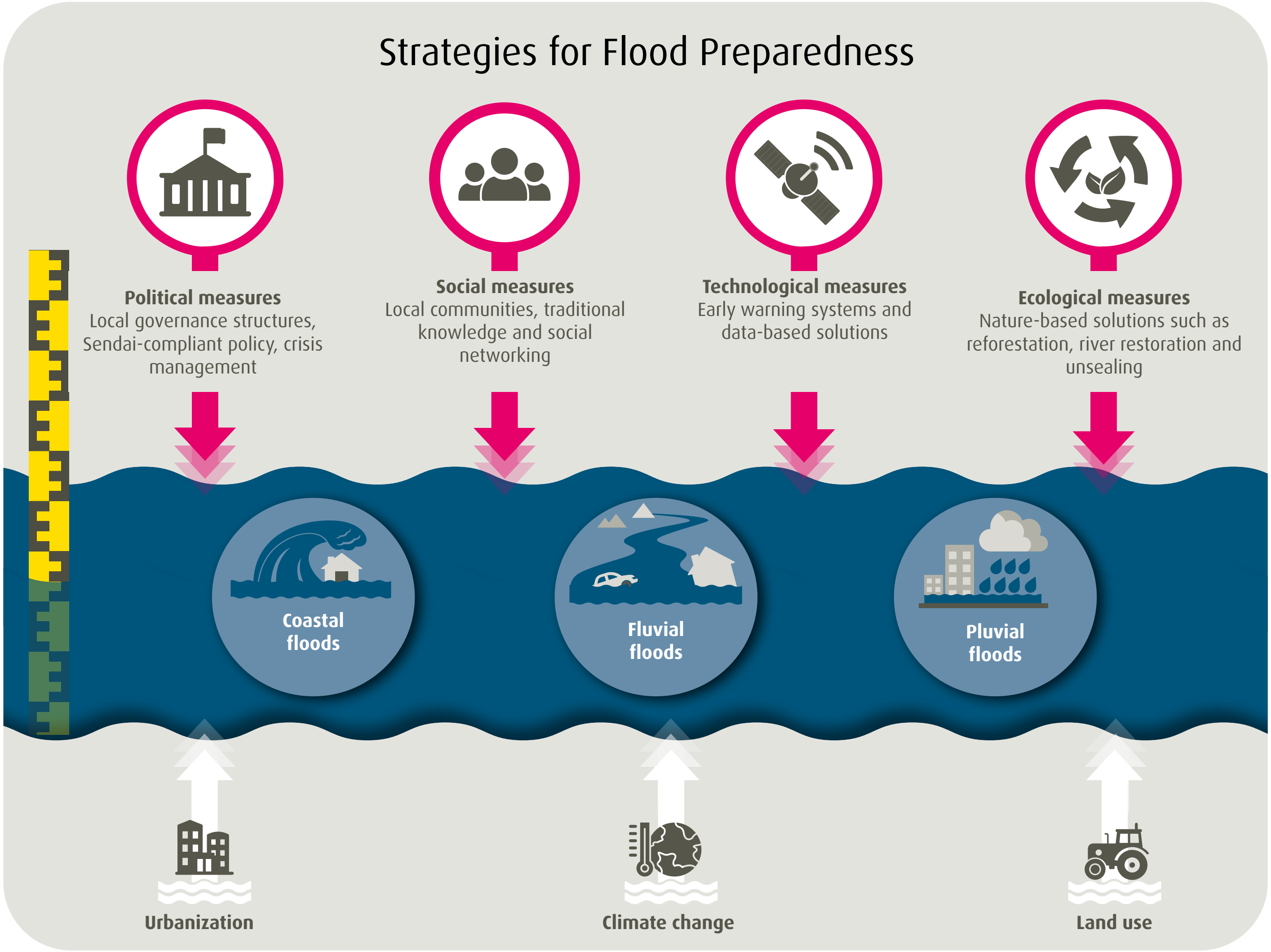


Figure 3: Driving factors such as urbanization and climate change cause different types of flooding, the consequences of which can be mitigated by various complementary prevention strategies.

intensity of heavy rainfall events and storms is increasing while drought periods are lengthening. At the same time, glacier melt is accelerating in mountainous regions such as the Himalayas and the Andes, resulting in increased runoff in river systems. Sea level rise further exacerbates the risk of coastal flooding, particularly in combination with storm surges. Regional models, as described in the IPCC AR6, support these assessments (IPCC 2023).

+ Urbanization

Rapid urbanization amplifies flood risks as expanding cities disrupt the natural water cycle through surface sealing and overburden outdated or inadequate drainage systems — such as during Hurricane Katrina in New Orleans (2005), the floods in Bangkok 2011, or in Manila caused by Typhoon Carina 2024. Particularly in older industrial cities or rapidly growing metropolises of the Global South, infrastructure is often dilapidated, incomplete, or not adapted to climate extremes. Fragmented responsibilities and insufficient investments further aggravate these problems. At the same time, the expansion of settlements into flood-prone areas — such as floodplains or coastal lowlands — increases vulnerability. By 2050, 5 billion people are projected to live in cities, including 1.4 billion in exposed coastal regions (UN-Habitat 2024).

+ **Changes in land use**

  Deforestation: Forests play an important role in water absorption and storage. The large-scale loss of forest ecosystems has profound impacts on the natural water balance. Due to their complex vegetation structure and humus-rich soil, forests act like sponges that absorb precipitation and release it slowly. Deforestation results in the loss of this buffering capacity, leading to faster surface runoff. Since 1990, an estimated 420 million hectares of forest have been lost due to conversion to other land uses. Although deforestation rates have declined over the past three decades, there is still no relief given the increased risk of wildfire due to climate change, rising pest infestations, and a growing demand for timber. The situation in tropical rainforest regions is particularly critical (FAO 2024).

  Agricultural practices: Modern agricultural methods have altered the hydrological characteristics of many cultivated landscapes. Monocultures, narrow crop rotations, intensive fertilization, and heavy use of pesticides can impair soil structure and stability and promote erosion. Intensive soil cultivation, the use of heavy machinery, and the omission of natural structural elements such as hedges and trees lead to soil compaction and reduce infiltration capacity. As a result, three key soil functions are disrupted: the soil's ability to absorb water and regulate surface runoff during heavy rainfall, its capacity to store water and ensure crop yields, and its function in groundwater filtration and recharge (BUND 2021).

  River straightening and regulation: In the past, many rivers have been straightened, embanked, and dammed to create space for settlements and agricultural land or to promote navigation and hydropower. Examples include the Yellow River in China, the Danube in Hungary, the Rhine in Germany, and the Mississippi in the United States. These interventions not only resulted in the loss of important floodplains but also changed the runoff behavior of the watercourses. The shortened river courses lead to faster flow velocities, which amplify flood waves and reduce their warning times. At the same time, there is a lack of natural retention areas in which floodwater could disperse (UBA 2011).

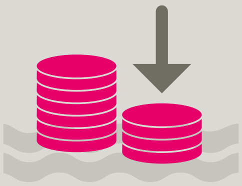
This differentiated approach demonstrates that flood risks do not arise from a single cause but are shaped by a complex interplay of various factors. The drivers often act in a synergetic manner and reinforce one another. For example, a heavy rainfall event may be manageable under ordinary conditions but can lead to a disaster when combined with sealed surfaces, altered river courses, and inadequate infrastructure. This highlights the necessity for integrated flood management approaches that take all relevant factors into account.

Prevention and preparedness approaches

Successful and innovative flood prevention and preparedness can be implemented at various levels. This year's WorldRiskReport emphasizes approaches at political, technical, social, and ecological levels, which are explored in greater depth through selected examples.

+ **Effective governance structures** are crucial to a community's ability to prepare for and respond to potential flooding. Successful models such as Bangladesh's state-coordinated, multi-tiered early warning system and the decentralization of disaster management in the Philippines demonstrate the effectiveness of governance reforms in the field of prevention. Article 2.1 uses the example of the flood disaster in Germany's Ahr Valley to illustrate how effective disaster governance can be supported by social networks and local knowledge.

+ **Technological innovations** are revolutionizing early risk detection and risk communication. Advancements in Earth Observation via satellites, improved hydrological models, and AI-supported forecasting systems now enable more precise and timely warnings. However, experience has shown that such technologies are only effective when adapted to local conditions and integrated into existing decision-making processes, such as the community-based warning apps in Nairobi or participatory mapping methods in Jakarta. Article 2.2 on “Earth Observation” concludes that global inequalities in access to technology should be reduced through cooperation and open-access initiatives.



89%
of people globally affected by flooding live in low- and middle-income countries.

Source: Rentschler et al. (2022)

+ **Social resilience and traditional knowledge** remain undervalued in disaster risk reduction. In many regions, local communities have developed proven strategies for adapting to hydrological extremes over generations. In Indonesia, for example, villagers use traditional indicator such as the behavior of certain bird species or changes in vegetation to predict monsoon floods. Article 2.3 (p. 26) explains how such practices, combined with modern approaches to Community-Based Disaster Risk Management (CBDRM) and anticipatory humanitarian aid, can significantly enhance the capacities of vulnerable groups. Key to this is the active participation of all societal groups, as well as the recognition of the complementarity and equality of different knowledge systems and sources in disaster risk management.

+ **Nature-based solutions (NBS)** are gaining importance as a sustainable alternative to technical protective measures. They harness natural processes to reduce flood risks while simultaneously promoting biodiversity — for example, through river restoration projects (such as along the Ganges in India), mangrove reforestation (in Indonesia or the Philippines), or wetland management (in the Sahel region or Ethiopia). Such initiatives enhance resilience to flooding and improve the quality of life. As outlined in Article 2.4, conventional land policy strategies are reaching their limits, meaning that innovative approaches to land activation are needed.

Conclusion

Considering these multidimensional challenges, effective flood management requires decisive action that relies on holistic, inclusive, and locally led approaches. Reducing the risks and impacts of floods demands a systematic and holistic approach, as outlined in the Sendai Framework for Disaster Risk Reduction (SFDRR). In the context of flooding, this entails investing in a better understanding of flood risks, strengthening disaster risk reduction in relation to floods and integrating it into national and local development strategies and plans; enhancing flood prevention and investing in infrastructure and other measures that increase resilience to floods; improving flood coping capacities; and designing the reconstruction in a way that can reduce future flood risks (UNDRR 2015). A key to the success of preventive measures is cross-border cooperation, knowledge transfer, and collaboration between the Global North and South.

Regulating Chaos?
The International Legal Framework for Disasters

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Already in 2007, the Intergovernmental Panel on Climate Change (IPCC) identified some environmental impacts where adaption would be the only response to climate change (IPCC 2007). The concept of adaption can be traced back to the 1992 UN Framework Convention on Climate Change. The 2015 Paris Agreement (PA) also enshrines it as a general goal to adapt and strengthen resilience by reducing vulnerabilities (Art. 7), requiring "adjusting to the actual or expected effects of climate change and their impact" (Douka 2020, 39). These measures are particularly challenging as they cross-cut multiple policy sectors in their integration and enforcement (Douka 2020). Here, the PA provides little guidance, as it lacks concrete goals or obligations how to adapt — a general point of criticism of the PA (also Douka 2020).

As a new field of law, international disaster law is emerging. On December 6, 2024, the UN initiated negotiations for the Treaty on the Protection of Persons in the Event of Disasters to be concluded by the end of 2027 (United Nations 2024). They are based on draft articles (United Nations 2016) that address the role of external assistance and enshrine humanitarian principles and individual human rights. Human Rights instruments protecting health (Art. 14 International Covenant on Social and Cultural Rights) and life (Art. 6 International Covenant on Civil and Political Rights) can be interpreted to require protective action, also found by the European Court of Human Rights (e.g., Kolyadenko and Others v Russia (2013); Budayeva and Others v Russia (2014); see also Sommario 2018). Other instruments like the Water Convention (UNECE 1992) and the Watercourses Convention (United Nations 1997) require cross-border cooperation for flood protection. Soft law like the Sendai Framework for Disaster Risk Deduction 2015–2030 provides a non-binding framework for international cooperation.

As a regional example, the European Union's directive on the assessment and management of flood risks (Floods Directive; 2007/60/EC) establishes a binding framework to assess and manage flood risks. It complements a 2006 directive's (2000/60/EC) environmental angle with a disaster management approach (Reinhardt 2008, 446). The Floods Directive requires risk assessments, hazard and risk maps, and risk management plans that contain nationally determined objectives and measures, all to be reviewed and updated every six years. Critics again point to the lack of substantive regulations and ambition (Reinhardt 2008; Douka 2020), since the concrete objectives and measures are finally determined by states themselves.

The fragmented and spotty legal framework largely leaves disaster responses and their details to states. This flexibility is needed to accommodate socio-ecological differences between and within states (Verschuuren 2012), which is why a uniform framework would struggle to adequately address specificities. On the other hand, recent events, such as the 2024 floods in Spain, demonstrate the risks of relying on state initiative: despite its obligations, Spain failed to issue its flood risk management plans in time (European Commission 2024).

2 Focus: Floods

2.1 Formal and Informal Structures in Disaster (Risk) Governance

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The Sendai Framework for Disaster Risk Reduction (SFDRR) emphasizes the need for stronger involvement of local structures. Using the example of the flood disaster in the German Ahr Valley, a case study demonstrates how informal networks enabled effective crisis management while formal structures were not yet operational. The case study thus confirms findings from other disaster contexts, such as earthquakes in Central America and the flood disaster in Malawi. Research on the Ahr Valley illustrates that effective disaster governance is supported by social networks and local knowledge. Future approaches should include raising awareness among professional actors, strengthening resilience, and targeted financial support for local structures in order to sustainably improve disaster preparedness.

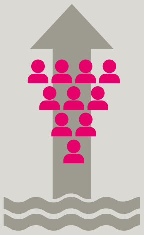
Especially in the first hours and days, a disaster is rarely managed by professional civil protection personnel alone (Helsloot / Ruitenberg 2004; Lorenz et al. 2018). "It is not unusual that survivors also become the first responders and do so for days or weeks until help arrives. They pull people from debris, tend to injuries, call for help, comfort the traumatized, and assist police, fire, emergency, and volunteer managers. They also lead recovery groups, write grant proposals, and feed and house incoming volunteers while rebuilding their own homes and businesses" (Phillips 2020).

For more than a hundred years, disaster research has documented how local communities cope with disasters within very different socio-cultural contexts. These range from explosions in Canada (Prince 1920), landslides in the United States (Gray 2023), earthquakes in Peru and Mexico (Oliver-Smith 1999), and hurricanes in the Caribbean (Schrauf / Victoria Rodríguez 2024), to earthquakes in India (Simpson 2013), and flood events in Malawi (Šakić Trogrlić et al. 2018). It can therefore be assumed that these forms of coping are a constant that is independent of specific socio-cultural conditions, but rather occurs in almost every disaster. In many cases, including the German example of the Ahr Valley, which will be examined in more detail later, these local structures prove so effective that they can be considered a part of disaster governance.

Global disaster governance, the Sendai Framework for Disaster Risk Reduction, and its implementation in Germany

In line with the empirical evidence of disaster research, the Sendai Framework for Disaster Risk Reduction (SFDRR) (2015–2030), which aims to drastically reduce the global impact of disasters, assigns a central role in disaster risk reduction to local actors and local knowledge (UNDRR 2015). Disasters first and foremost affect the local level, in terms of both immediate and long-term consequences as well as in their management, meaning effective disaster risk reduction must start there and be considered in conjunction with national and regional strategies (UNDRR 2015). UN member states are called upon to implement appropriate measures to achieve these goals. Despite the intensifying global challenges, several states have made significant progress in the area of disaster risk management and in strengthening local structures. The Philippines, for example, are highlighted as a particularly successful case (UNDRR 2023).

2050



1 billion people

could be affected by sea level rise by 2050, according to projections.

Source: IPCC (2023)

In its national evaluation of the implementation of the SFDRR (BMI 2023), the German government also emphasizes that the country experienced disasters of an unprecedented scale during the reporting period, such as the 2021 flood and extreme rainfall disaster in western Germany. It broadly acknowledges that disaster preparedness must adopt locally specific approaches and strengthen and integrate the relevant actors, and emphasizes that disaster management as a formal system in Germany is already firmly anchored at the local level. When an extreme natural event such as a flood occurs that threatens people or property, the responsibility initially lies with the municipal level together with the mostly voluntary fire departments as part of general emergency response. If these structures cannot cope, responsibility for disaster management passes to the districts or independent cities as the next higher administrative level by declaring a state of disaster.

In the practice of disaster response, next to formal governance structures, informal and often less visible structures and practices exist “that happen outside the gaze of the formalized governance arrangements but underlie and affect such arrangements and practices” (Hilhorst et al. 2020). The flexibility and informality required for the effective functioning of formal governance structures in their current form — which are understood as rather loosely defined procedures and practices that allow for a flexible and adaptive handling of formally codified structures such as laws (Dittmer et al. 2024; Dittmer / Lorenz 2021a) — make the strengthening of local structures, as called for in the SFDRR, and their integration into comprehensive disaster risk management highly demanding, since formal disaster governance structures intersect with informal practices that necessarily deviate from that formal structure.

The following example of the response to the 2021 flood and extreme rainfall disaster in the German municipality of Mayschoß in the Ahr Valley illustrates how local coping with disaster works at the intersection of formal and informal disaster governance.

The 2021 flood and extreme rainfall disaster in Western Germany

Between July 13 and 15, 2021, exceptionally heavy rainfall due to climate change led to severe flooding and flash floods in several Western European countries. The German federal states of Rhineland-Palatinate and North Rhine-Westphalia were particularly affected, with a total of 189 fatalities (Thieken et al. 2023). The total economic damage amounted to 40.5 billion Euros (German Federal Government 2023).

On the night of July 14 to 15, 2021, Mayschoß, a village in the Ahr valley with around 800 inhabitants, was struck by several flood waves, some reaching up to nine meters in height. Six people lost their lives, and due to the destruction of the transportation infrastructure, the village was cut off from the outside world for several days (Dittmer / Lorenz 2024). The inhabitants of Mayschoß quickly realized that they would initially have to manage the situation on their own. A police officer trained in staff work formed a local informal crisis unit — although this was not formally intended in disaster management — which consisted of individuals who knew one another, had lived in the village for generations and held central positions with management tasks, such as in the volunteer fire department, the municipal administration or the local winegrowers’ cooperative, or were at least well known in the community but not trained in staff work.

In addition to restoring local transportation routes, distributing food and electricity, providing medical care, and managing waste disposal, the informal crisis team focused on informing the affected population about the relief measures and the overall situation. This was achieved through daily meetings held in an undamaged church building located on higher ground, as well as through a courier service run by a local youth group that distributed flyers and informational material (Schmitz 2022). When the first units of professional disaster response forces arrived in Mayschoß a week later, it became apparent that the expectations of the local crisis team and those of the external professionals did not align. While the professional forces assumed they were entering a location still in the immediate response phase with no structures in place, the residents of Mayschoß had already organized a functioning disaster response using their own resources. By integrating a variety of local actors, local knowledge, and spontaneous volunteers who had already arrived, coupled with distributed experience in disaster management, this informal structure clearly outperformed the external formal structures, so that after some initial hesitation, the professional emergency responders also integrated and subordinated themselves seamlessly — thus effectively reversing the formal governance structures according to which disaster response would typically be under the control of the professional forces (Dittmer / Lorenz 2024).

From response to prevention

The success of local disaster response in Mayschoß was based on everyday social networks and community resilience, which were determined by the village's specific spatial structure and historical continuities: The residents who decided to set up the local crisis team had already established strong mutual trust before the disaster and were thus able to rely on the local social networks. They had in-depth local knowledge of geographical features (e.g., topography, roads, infrastructure) and social institutions and rituals (e.g., winegrowing cooperatives, neighborhoods). They were familiar with the local dialect and knew who held specific skills and expertise. At the same time, they were trained in various areas due to their professions — some of them worked in fields relevant to disaster response, such as police or project management, and were able to integrate the relevant knowledge even without formal responsibility.

Although Mayschoß initially represents a singular case of local disaster response, existing research clearly demonstrates that informal governance structures are active in every disaster and organize or support local response efforts (Dynes 1970; Quarantelli / Dynes 1977; Carlton et al. 2022). Due to varying conditions and persistent power asymmetries and the reservations of professional disaster relief workers towards local and informal structures within the Global North (Lorenz et al. 2018) and, even more so, in the postcolonial dynamics of Western disaster relief in contexts of the Global South (Dittmer / Lorenz 2021b; Hilhorst 2018; Roth 2015), the recognition of informal governance structures and their integration into disaster assistance is slow in practice. Informal and local approaches to disaster management thus remain underutilized, or interventions by professional disaster relief workers may even undermine existing local coping mechanisms. The international humanitarian disaster relief following the 2010 earthquake in Haiti led to further catastrophic consequences for those affected, as local forms of community organization were unknown. For example, food distribution was based on Western ideas of the nuclear family, which forced the Haitian population to adapt their established social structures, ultimately weakening them in the long term (Schuller 2016). The 2015 flood disaster in Malawi showed that even approaches that explicitly attempt to adopt a local perspective (community-based flood risk management) fail and do not adequately incorporate local flood management practices. Reasons cited include the lack of financial security and the attitudes of external actors who prioritize a scientific approach over local expertise and only involve local actors superficially (Šakić Trogrlić et al. 2018; Šakić Trogrlić et al. 2019; Šakić Trogrlić et al. 2022).

In light of the SFDRR, the question arises as to whether and how these local structures can be more effectively promoted and supported if, on the one hand, they invariably emerge in some form during disasters and are central to coping with them, but, on the other hand, are not institutionalized due to their informality — and therefore cannot be addressed proactively and preventively.

There are several approaches to strengthening disaster preparedness at the intersection of

151 %

above the pre-industrial level: CO_2 concentration in the atmosphere in 2023 — a record high. A high CO_2 concentration leads to more frequent and more intense extreme weather events such as heatwaves, droughts, and heavy rainfall.

Source: WMO 2024

professional and informal disaster governance in the sense of the SFDRR:

+ Raising awareness within professionalized disaster governance structures of local contexts, as demanded in the context of the localization debate (Roepstorff 2020). This particularly concerns the fact that the standardized operational culture of international humanitarian actors often disregards the context, namely, local socio-economic, political, and cultural structures and thus perpetuates asymmetries between the Global North and the Global South (e.g., Dittmer / Lorenz 2021b). This includes paying greater attention to the importance of social networks, mutual trust, local knowledge and know-how in coping with disasters within the context of the Global North — a perspective that has so far been adopted almost exclusively for countries of the Global South (Atanga 2020; Charles / Fievre 2021).

+ Recognizing the added value of diverse sources of knowledge. The case of Mayschoß illustrates the importance of different forms of knowledge regarding both the widespread voluntary commitment in Germany and the professionalized world of work, in which management responsibilities are required in many occupational fields. Even though the qualitative differences between informal and formal governance structures are greater in the aforementioned examples in countries of the Global South, the value of incorporating multiple forms of knowledge has also been demonstrated there (Šakić Trogrlić et al. 2018).

+ Strengthening overall societal resilience and civil society actors who can provide crucial resources during disasters. This includes strengthening volunteer engagement in disaster response, but also civil society engagement in general, as well as raising awareness among the population about local risks and hazards and disaster preparedness options at the community, household, and individual level. The integration of local structures into national disaster preparedness and governance has also been politically promoted in recent years in countries such as Nepal, India, and Bangladesh (Paudel et al. 2024).

+ Financial support for local actors, particularly for the communication of local risks and formal disaster management plans, to enable better cooperation with informal structures. In Germany, examples include the federal government's siren installation program or public training initiatives as part of first aid courses with self-protection components (EHSH). In the global context, the UN initiative “Early Warnings for All” offers relevant points of reference, for example when it calls for the integration of locally existing communication channels as primary warning mechanisms, which should be embedded within the respective national warning governance.

+ Emphasis on shared objectives. Problems in cooperation arise not least due to competition between professional and informal disaster governance structures, but also between different professional organizations. Emphasizing and reaffirming shared goals in disaster preparedness and response can therefore help to reduce competition and improve collaboration.

The 2021 flood disaster in Germany’s Ahr Valley impressively demonstrated that effective disaster management does not rely solely on formal disaster response structures, but is significantly sustained by informal practices, local networks, and community-based resilience. Findings from the case study of Mayschoß, as well as research on flood disasters in Malawi or the earthquake in Haiti, highlight the need to integrate such informal structures more strongly into existing disaster governance, thereby implementing a central goal of the SFDRR. Through targeted support for local actors, the recognition of social capital, and improved coordination between formal and informal structures, disaster preparedness can be strengthened in a sustainable way. Implementing the principles of the SFDRR offers the opportunity to learn from past experiences and to develop resilient, anticipatory, and locally anchored strategies to better cope with future risks.

2.2 Technological Innovations for Flood Risk Management

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Technological innovations including Earth Observation (EO) have revolutionized flood risk management, offering new opportunities to enhance flood early warning and prediction, monitoring, and response. The amount of free and open available geospatial datasets is continuously increasing in the "golden age of remote sensing," describing a period of significant advancements and increased data availability in the field. But which data is the right one to use when it comes to disaster risk management? Each dataset has its opportunities and challenges and offers to focus on specific details during a flood event.

Forecasting floods can prevent hazards from becoming disasters. Information on Preparedness, Early Warning and Forecasting for floods are often based on hydrological models analyzing rain and gauging stations. But, maintaining meteorological stations is costly regarding time and resources compared to the use of e.g. satellite imagery. The GEOGloWS-ECMWF Streamflow Forecasting Model, for example, provides global 15-day ensemble streamflow forecasts and over 40 years of historical data, supporting flood risk monitoring and water resource management. The integration into Malawi's Community-Based Flood Early Warning System has significantly enhanced flood preparedness and response. By combining telemetry data from 21 river stations with GEOGloWS forecasts, the system extended warning reaches from a few hours to up to 15 days. This advancement enabled timely alerts during events like Cyclone Ana in January 2022, facilitating early actions that mitigated flood impacts on vulnerable communities (Wara et al. 2022).

During a flood, timely and high-resolution data is crucial. Optical and microwave (SAR) remote sensing support emergency mapping, preferably SAR since it works independent of daylight and weather conditions. Key factors include spatial resolution (image detail) and temporal resolution (frequency of data capture). In major flood events, services like the International Charter or Copernicus Emergency Management Service (EMS) can be activated to rapidly provide satellite data for disaster response. During the Floods in Emilia-Romagna in Italy in May 2023, the EMS provided detailed flood extent maps within hours of activation and supported municipal authorities such as the Italian Civil Protection Department to prioritize evacuations, allocate emergency shelters, and assess infrastructure damage across multiple towns (EMSR, 2023). At the local level, this data supports emergency services, local governments, and civil protection authorities in coordinating evacuations, assessing damage, and planning recovery efforts with timely, location-specific insights. Very high-resolution data, such as imagery by Digital Global with 0.6 m or Pléiades with 0.5 m spatial resolution was analyzed for detailed mapping of the affected infrastructure and housing.

Humanitarian action plays a key role during and after a flood disaster. In November 2024, severe flooding impacted northern Cameroon. The EMS provided flood delineation maps based on remote sensing that identified flooded areas of around 148,678.8 ha (EMSR 2024). This information aided local authorities in coordinating emergency response efforts and resource allocation through humanitarian organizations, including the Cameroon Red Cross Society (CRCS), which participated actively in relief operations; the International Federation of Red Cross and Red Crescent Societies (IFRC), which launched an emergency appeal to support flood victims and facilitate international assistance and funding; as well as the World Food Programme (WFP),

142 disasters
triggered by flooding were recorded in 2024, making them the second most common cause of disasters after storms.

Source: CRED (2024)

which focused on the needs of children and vulnerable populations and provided food assistance (IFRC 2024). Both examples show the importance of information derived from geospatial data to guide emergency response during and after a flood event.

In the response, rehabilitation, and recovery phase — as well as in prevention and mitigation efforts — EO-based models and, in particular, geospatial analysis using Geographic Information Systems (GIS), play a critical role. These tools enable the identification and quantification of affected areas and help assess populations, infrastructure, and agricultural zones at risk, thereby informing targeted and effective disaster risk management (Tellman et al. 2021; Rogers et al. 2025).

In addition to the wide range of technological possibilities that facilitate taking action remotely, involving communities during all phases of the disaster not only enhances the accuracy and timeliness of data but also empowers local populations to actively contribute to disaster preparedness and response. Participatory action for flood monitoring involves engaging local communities in the process of data collection, interpretation, and decision-making, which fosters a collaborative approach to flood risk management. This approach is particularly effective in areas where traditional monitoring systems may be lacking or difficult to implement due to geographic or infrastructural constraints. By utilizing local knowledge and observation, participatory action enables a more context-specific understanding of flood risks and vulnerabilities, which can lead to more effective, tailored

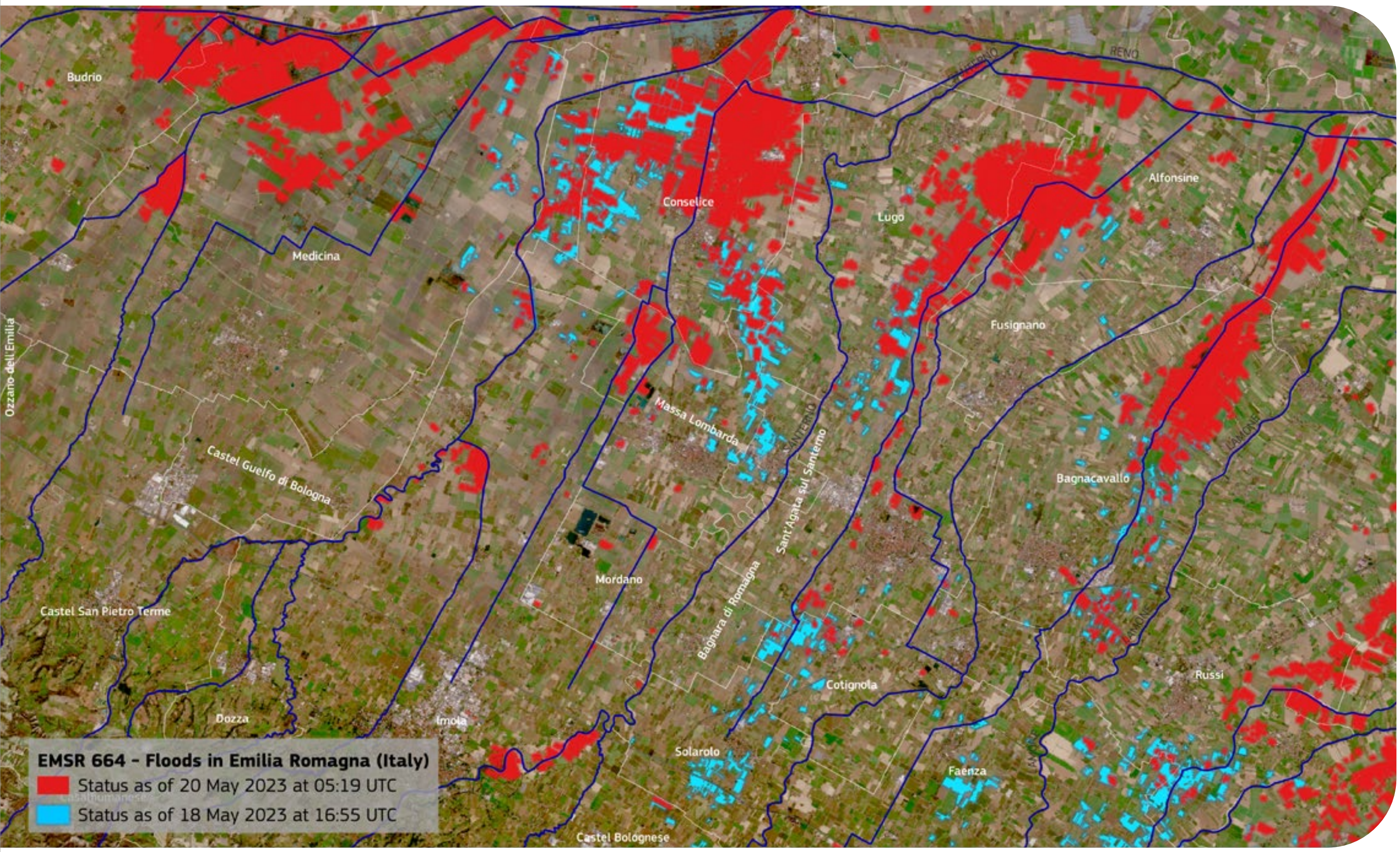

Figure 4: Copernicus satellite data from May 18 and May 20, 2023 delineate the flooded areas in Emilia-Romagna..

interventions. Participatory Mapping is one tool that can be embedded from a technological perspective. Integrating communities for data collection and geospatial reference data before, during, and after a flood event can vastly improve flood mapping products. During an activation, the so-called project manager is also in continuous communication with local agencies to provide the right products but also to have local knowledge on where additional monitoring needs to take place and which information needs to be mapped.

Opportunities and challenges of the use of technologies for different flood types

Fluvial floods primarily affect areas adjacent to rivers, making targeted monitoring in these zones essential. Geospatial technologies and risk models that incorporate elevation data, river dynamics, soil characteristics, drainage systems, and housing structures are vital for identifying vulnerable populations, infrastructure, and flood-prone areas (Thacker et al. 2020). During the 2018 flood event in Kerala, India, geospatial analysis helped monitor riverine flooding caused by intense monsoon rains by integrating elevation models and hydrological data to identify affected areas along major rivers and enabled targeted emergency response and assessment of infrastructure and population exposure (Samanta et al. 2018). Remote sensing enhances this by capturing the duration and intensity of flooding within floodplains, which helps to understand the evolving nature of flood events. Prolonged surface water presence can exacerbate disaster impacts, including the outbreak of waterborne diseases (Semenza 2020). However, the temporal resolution of satellite sensors plays a critical role — flash floods may go undetected if satellite overpasses miss the brief window of inundation.

Pluvial floods, often impacting urban areas, present a particular challenge due to the complexity of urban environments. Optical remote sensing is frequently hindered by cloud cover or smoke, while SAR can be difficult to interpret in urban settings because of layover effects, shadowing from tall buildings, and complex backscatter signals from diverse surfaces (Ling et al. 2023). Early warning systems for pluvial floods demand integrated modeling approaches that incorporate secondary data on drainage infrastructure and storage capacity, alongside hydrological and meteorological models. One commonly used tool is the Hydrologic Engineering Center's River Analysis System (HEC-RAS), which simulates flood behavior using inputs such as digital elevation models, rainfall, and flow discharge data — though such detailed datasets may not be available for all regions. In urban Jakarta, Indonesia, pluvial flood risk has been modeled by incorporating drainage network data, rainfall intensity, and land use with hydrological tools like HEC-RAS (Pratiwi 2020), while EO data supported the mapping of water accumulation on streets and infrastructure impacts (Ramdani 2024).

Coastal flooding is often associated with storm events, making meteorological data essential to issue early warnings. In the context of long-term sea level rise, climate models also play a crucial role in assessing future coastal flood risks. Satellite altimetry missions provide critical data on sea-level changes that enhance coastal flood forecasting. Additionally, satellites can contribute to monitoring inundation patterns and coastal erosion. Wind and wave conditions, which influence cyclone intensity and subsequent flooding, are tracked using scatterometers. During Cyclone Amphan in 2020, SAR data was used to assess flood extent along the Bay of Bengal, while scatterometer data provided insight into wind field strength and direction (Mondal et al. 2024). Integrating such data into coastal flood models along with digital elevation models helped identify low-lying, flood-prone zones and guided emergency response planning in affected areas.

Challenges in access and application of flood monitoring technologies: from the global to local level

Availability of and accessibility to data is crucial to provide information for early warning and strengthening community resilience. However, despite significant advancements in EO technologies, access and application of these in flood monitoring remain highly uneven across

6.9
trillion
US-Dollars in damages have been caused globally by disasters resulting from extreme natural events since 1980. Around 67 % of these damages were uninsured.

Source: Munich Re (2025b)

1.81 billion

people worldwide live in areas exposed to significant flood risk.

Source: Rentschler et al. (2022)

*Further analysis of the digital divide is available in the WorldRiskReport 2022, which addresses digitalization as its main theme.

the globe. High-income countries benefit from state-of-the-art satellite data, AI-driven predictive models, and Digital Twin simulations, enabling accurate flood forecasting and early warning systems. In contrast, low- and middle-income countries often face challenges, such as limited access to real-time data due to inadequate infrastructure, and a lack of technical expertise to utilize these tools effectively. While free EO based platforms and services like the EMS have improved accessibility and data processing, interpretation and integration into local disaster management frameworks remain hurdles, especially for regions with weak digital infrastructures. Aditionally, the high cost of high-resolution satellite imagery hinders independence from external technical support and lead to gaps in political implementation. Equal access to data and infrastructure is therefore essential. Processing big data requires capacities to run complex flood models. Especially, when running cloud-based analysis, the speed in which results are produced also depends on the internet connection. These describe crucial time periods during a disaster for the relevant authorities. During activations of the International Charter or the EMS, data is mainly provided for download directly after an overflight pass. It allows fast processing but only if the infrastructure is available and accessible. Identified project managers with their teams support the activating institution 24/7. But here, the digital divide* starts to play a role, allowing access and ownership to tools and data simply because infrastructure circumstances define it. It may lead to top-down implementation of tools and methods in line with the concept of techno-colonialism. Those who support emergency mapping activities also need to have experience in processing respective datasets and understand the purpose. Risk communication is a crucial determinant ensuring effective disaster response and recovery. It is vital that there is a clear and consistent flow of information from emergency mappers to decision-makers during and after a disaster. To facilitate proper interpretation of data, decision-makers must be familiar with the language and format used in maps, ensuring they can accurately understand the information presented. Additionally, communication is needed to specify data needs and highlighted elements on a map, enabling informed decision-making and timely actions to mitigate the impact of the disaster. While models need indicators that can be quantified, qualitative indicators such as risk perception might be disregarded. At the same time, information on indicators is missing in certain areas, which makes it impossible to transfer a working model or approach. Here, the integration of community-based data with remote sensing can help bridge the gap between local needs and institutional flood management strategies, ultimately strengthening flood resilience. However, in this case, capacity building mechanisms, data collector training, but also access to technologies such as smartphones is necessary. Moreover, barriers with regard to language or culture need to be considered. Another question is the right to monitor certain areas. For example, indigenous communities living in remote areas have eventually developed coping mechanisms and do not want to be “identified” with flood maps and get further attention.

Despite the availability and possibilities to apply different tools and methods for flood monitoring, there is no guideline thus far for the operational use to assist flood disaster response at the global level (Schumann, 2024). Challenges such as data accessibility, processing complexity, and integration with local decision-making frameworks remain barriers to fully leveraging available and future technologies. Addressing these disparities requires global cooperation, investment in capacity-building, and open-access initiatives to ensure that advanced flood monitoring technologies are not just available but effectively utilized where they are needed. Balancing these opportunities and challenges is key to building more resilient and adaptive flood risk management strategies.

2.3 Flood Risk Is Local: Why Solutions Must Be Too

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Floods are the most frequent hydro-meteorological hazard in Sub-Saharan Africa, with severe impacts on livelihoods and food security. This article explores how Indigenous Knowledge Systems (IKS) and community-based flood monitoring support Anticipatory Action in South Sudan, Madagascar, and Kenya. It highlights how indigenous forecasting indicators, participatory river gauges, and tailored risk communication enhance early warning and anticipatory action. It also examines challenges, such as the erosion of traditional knowledge and sustaining community-led systems. Blending IKS with scientific forecasts offers a culturally grounded and adaptive path to inclusive flood resilience.

Since 1975, floods have been the most frequent hydro-meteorological hazard in Sub-Saharan Africa, seeing cascading impacts including displacement, disease outbreaks and adverse acute food security outcomes. Local knowledge and scientific flood Early Warning Systems (EWS) used by communities have been demonstrated to be effective at mitigating flood risks, enhancing food security, reducing injuries and fatalities, and establishing longer-term flood management plans, thus contributing to resilience (Ringo et al. 2024).

Floods result from a complex interaction of climate, hydrology, and water management practices, the latter of which are challenging to account for in forecasting models. Many rivers, including major rivers such as the White Nile remain without monitoring systems, limiting the ability of global models to forecast potential floods to facilitate timely anticipatory humanitarian action (AHA; e.g. Clare Programme, n.d.). This is where community engagement and traditional knowledge can support. Through understanding community-based forecasting and monitoring approaches, we can work to blend different knowledges to ensure that we use all available information to act ahead of floods and minimize their impacts.

This article highlights community engagement, monitoring and the use of indigenous knowledge systems (IKS) to support AHA as part of Welthungerhilfe's (WHH) Anticipatory Humanitarian Action Facility (WAHAFA) program in South Sudan, Madagascar, and Kenya. We share primary data on IKS for flooding collected in 2024 from Kenya and in 2025 from South Sudan, alongside secondary data to place these insights within the wider IKS for AHA discourse. This provides insights into how IKS and community monitoring can work with scientific forecasts and discusses the challenges and advantages of such blended approaches.

Indigenous knowledge for flood resilience in one of the world's largest wetlands, South Sudan

The Nile Basin is one of the world's largest river basins, covering eleven countries, providing an important source of fresh water and supporting livelihoods. Comprising three main rivers, the White Nile, the Blue Nile, and the Nile, the system is largely without gauges, highly complex, and flows across international borders, which makes it challenging to monitor and forecast floods (University of Reading 2023). In the Sudd, South Sudan, the White Nile passes through one of the world's largest wetlands, characterized by a vast network of smaller rivers, floodplains, and marshes. The Sudd floods every year, with the seasonal extent of floods determined by in-country rainfall and inflows from upper reaches of the Nile. Floodwater and waterlogged soils often remain for some time as the clay-rich marshy soils restrict the ability of water to drain away (Stephens and Levi 2024). Since 2010, the upper part of the basin has been experiencing a multi-year period of above normal rainfall, seeing water levels within upstream Lake

Victoria reach record highs (WFP 2021). This has driven an expansion of the Sudd wetlands, with more widespread and protracted floods, challenging IKS and coping strategies relating to flood management.

In South Sudan's flood-prone areas, indigenous forecasting reflects generations of local knowledge. Communities use environmental and biological indicators like unusually hot Februarys or river bats migrating inland in April or May to anticipate floods in July or August. These signs offer practical early warnings, especially where formal meteorological systems are lacking (Easton-Calabria 2024). With several months of lead time indicating an increased flood risk, this effectively functions as a seasonal forecast enabling communities to prepare and implement disaster risk reduction measures in advance.

Focus group discussions with the flood-prone community of Panyijar, Unity State, guided by WHH South Sudan and local partner Hope Agency For Relief And Development, reveal that the mass emergence of red ants along riverbanks is interpreted as a sign that floodwater will rise within 10 to 15 days. "When the red ants surface from ground in large numbers along the riverbanks, we know that flood will come in about two weeks," said a community elder (FGD 2025). This shorter lead time allows for more immediate anticipatory actions, as the flood is forecasted with greater timeline precision. Likewise, a distinct nocturnal bird call, which community members identify as "Here it comes, here it comes," alerts them to an impending flood within three days. Bird call changes after water starts receding signal the end of flooding. Similarly, when soil 20 to 30 meters from the river begins to dampen, it is seen as a reliable sign that floods may occur within 3 to 4 days (FGD 2025).

Indigenous knowledge guides coping strategies, including building raised huts to protect food and valuables from rising waters and the construction and rehabilitation of dykes. These dykes are built collectively around the community, following a participatory approach where each household is responsible for maintaining sections of the dyke near their home. However, quality varies — wealthier families build stronger parts, while food-insecure households often struggle to contribute. As one community elder stated during a focus group discussion: "On an empty stomach, we cannot do much about floods. We cannot prepare ourselves when we are hungry" (Fawwad 2025). Most rely on clay-rich mud and grass for dyke construction, as sandbags and wooden reinforcements are too costly. Recurring floods and burrowing animals like snakes and crocodiles weaken the structures, requiring constant repairs and creating another ongoing burden for resource-limited households.

Stakeholders from government bodies and humanitarian organizations acknowledge the value of indigenous methods. The Chairperson of the Relief and Rehabilitation Commission emphasized the importance of institutionalizing anticipatory actions building on traditional triggers. "Our local government always takes ownership of the products provided by NGOs, ensuring that anticipatory actions remain sustainable" (Lual 2025). He further highlighted: "By linking our traditional indicators with modern forecasts, we build an early warning system that truly protects our community." Similarly, officials from the Ministry of Agriculture noted the potential of community observations in informing crop choices and guiding local agricultural calendar adaptations as flood cycles shift due to climate change (Uchala 2025).

However, the integration of indigenous forecasting with modern scientific data is not without its challenges. Community insights point to a gradual erosion in the intergenerational transfer of IKS. Whereas elders and community chiefs continue to rely on IKS indicators passed down through years of lived experience, younger generations are increasingly skeptical. Communities have observed mismatches between signals and actual floods, highlighting the need for a blended approach that combines IKS with scientific data and technology.

Indigenous forecasting and coping strategies in South Sudan showcase a resilient, deeply rooted knowledge system. While these practices have long helped communities manage annual floods, climate change and rising socio-economic pressures are challenging their reliability. To strengthen early warning systems and anticipatory measures, a cooperative and hybrid approach is needed — one that combines indigenous knowledge with scientific methods and prioritizes collaboration with communities.This ensures culturally grounded, adaptive, and inclusive flood resilience in an era of rapid change.

45.8 million

internal displacements were caused by disasters resulting from extreme natural events in 2024, the highest number of displacements within a single year since records began in 2008.

Source: IDMC (2025)

Community flood monitoring: Opportunities and challenges, Madagascar

Madagascar is another country without countrywide river gauge coverage. A 2023 review noted the Direction Général de la Météorologie (DGM) identified a lack of surface observation networks, alongside financial and technical constraints, as limitations in predicting riverine floods (Deutscher Wetterdienst, 2023). International models, such as the

Global Flood Awareness System (GloFAS) and the Google Flood Hub do not have countrywide coverage to enable timely observations and flood forecasting. With these aspects in mind, as part of their Anticipatory Action Plan (AAP) development, WHH Madagascar plans to utilize a network of community-administered river gauges to support identification of river flood risks, alongside longer-term seasonal forecasts.

The river gauges are located in Atsimo Atsinanana, Atsimo Andrefana and Anosy, southern Madagascar. Working with communities, simple community-monitored flood gauges with three levels (green, yellow, and red) were installed upstream of flood-prone areas. When water levels reach the yellow thresholds, coupled with rainfall forecasts, this indicates a possible flood event, signaling need for anticipatory actions. Daily monitoring is planned during the November-to-April rainy season. While this system is yet to be fully tested, it is one proactive way of using community knowledge in siting the gauges and identifying the thresholds.

19.1 million

internal displacements in 2024 were triggered by floods — only storms caused more displacements.

Source: IDMC (2025)

Initiatives like the network of community-administered river gauges in Madagascar offers several advantages. On a pragmatic level, community-based and local solutions address gaps in the monitoring and forecasting infrastructure, oftentimes in a cost-effective way. In Nepal, a similar network of community-administered gauges together with simple EWS between upstream and downstream communities complements the high-tech river level monitoring stations installed by the national Department of Hydrology and Meteorology (Budimir / Uprety, 2020). In both cases, the placement of measurement stations is based on local knowledge, which both increases effectiveness and strengthens the sense of responsibility and acceptance within the community, especially when approaches such as anticipatory humanitarian aid are newly introduced to the communities (Schneider 2024). However, challenges of community-administered river gauges remain, especially their long-term sustainability. Since they rely on local volunteers or community members for maintenance and data collection, there is a risk of inconsistent monitoring due to turnover, competing priorities, or lack of incentives. Additionally, data reliability and integration into official EWSs can be an issue if measurements are not standardized or if communication channels between communities and national agencies are weak.

Forecast, warning, action. Risk communication and inclusive messaging, Kenya

The arid and semi-arid lands of northern Kenya face significant flood risks during the March-May and October-December rainy seasons. Recurrent floods destroy homes and assets, drive displacement, and contribute to worsening acute food security outcomes. Forecasts are available at seasonal and sub-seasonal scales from national and international sources such as the Intergovernmental Authority on Development (IGAD Climate Prediction and Applications Centre (ICPAC), with forecasts for the global climate driver El Niño useful in anticipating enhanced flood risk sometimes months in advance.

However, forecasts alone are not enough — communities must understand and act on early warnings to mitigate impacts. An important step is the communication of flood risks adapted to local contexts. WHH Kenya, the Pastoralist Community Initiative and Development Assistance (PACIDA) and other stakeholders carried out a simulation exercise in 2024 to test the readiness and effectiveness of their AAP for floods — including the early warning messages that will be disseminated when a flood is forecast (Burakowski 2024a).

As part of the development of early warning methods for communities, the participants used the participatory approach of Community Profiling to jointly create a comprehensive profile of the different population groups with the community. This led to a better understanding of the needs, interests, and communication habits of the various groups, enabling targeted and effective risk communication. Messages were customized for groups including women and persons with disabilities, addressing diverse needs based on gender, age, and their economic situation (CDAC Network 2012). Participants created communication plans outlining target audiences; message content and actions; languages, formats (verbal, written, visual); timing (e.g., after prayers); communication channels (e.g., radio, WhatsApp, community leaders); and responsible parties (Burakowski 2024b).

101.4 millimeter
above the 1993 level was the global average sea level in 2023 — a new record. Since 1880, sea levels have risen by 21–24 cm worldwide. The rise is accelerating steadily.

Source: Lindsey (2023)

Following "community profiling," community members reviewed and refined warning messages, confirming key assumptions. For example, men preferred radio warnings in local languages like Borana and Turkana, best received in the evening when families gather, which then could further be spread via traditional meetings held between men in the late evening.

Tailoring warnings to gender roles made them more effective. In one community, men were responsible for moving livestock, so messages focused on safe grazing areas. Women managed children and belongings, so their alerts included evacuation sites and advice on protecting important documents. Overall, the community preferred messages with clear timelines and specific instructions. They emphasized conflict-sensitive messaging, as evacuations may lead to tensions with host communities over scarce resources. According to the community, government-led peace meetings could ease conflicts. Using traditional knowledge to confirm forecast messages was valued by community members but interviewees also described challenges. For instance, traditional forecasters are believed to have the expertise to predict droughts by interpreting signs from goat intestines. However, this practice becomes challenging in the aftermath of livestock losses, as individuals may be less willing to sacrifice a goat for such rituals. (Burakowski 2024b).

The example of co-developing early warning messages with communities in Isiolo, Kenya showcases how tailored early warning messages are crucial to ensuring that everyone receives, understands, and acts on vital information in times of crisis. By considering factors such as language, gender roles, cultural dynamics, and preferred communication channels, these messages become more actionable and effective, ensuring that messages do not reinforce existing patterns of marginalization or exclude certain groups. It shapes who gets heard, whose knowledge is valued, and who benefits most from risk communication efforts. Deliberately including diverse voices, for example of women (Budimir et al. 2023), or people with disabilities (Batchelor et al. 2021), using multiple communication channels, and considering power relations from the start, fosters an enabling environment that supports continuous dialogue and inclusive participation in flood risk communication and early warning. A well-adapted warning system not only enhances preparedness but also minimizes risks, discourages risky behavior, fosters community trust, and prevents conflicts that may arise during evacuations. Ultimately, tailoring early warning messages enhances disaster response by enabling communities to take timely and informed action to protect lives and livelihoods.

Recommendations and conclusion

Flooding remains one of the key hazards across Sub-Saharan Africa, and while forecasting capabilities have notably improved, there is still progress to be made to ensure more precise and actionable early warning. Community-based IKS play a crucial role in filling critical gaps, especially when global models cannot adequately capture local influences such as small tributaries, irrigation channels, dams, or levees.

At the same time, the realities of climate change, displacement, and shifting environmental patterns are posing new challenges to the reliability and continuity of indigenous and local knowledge. Yet, this knowledge can also act as a powerful early indicator, highlighting changes in environmental patterns that may not yet be captured by scientific models.

To ensure early warning systems are equitable and effective, it is vital that risk communication does not reinforce existing inequalities. This includes meaningful community profiling, inclusive simulation exercises, and the integration of local knowledge to foster trust and increase the relevance and uptake of early warning messages.

Indonesia

Effective Early Warning for Floods in Jakarta

WorldRiskIndex Rank 3

Risk very high	39.80
Exposure very high	39.89
Vulnerability very high	39.71

Country profile

Jakarta, home to over ten million residents, is among the largest metropolitan regions worldwide. Due to its geographic conditions, the city is particularly vulnerable to flooding; approximately 40 percent of its territory lies below sea level, and it is intersected by thirteen rivers that frequently overflow during the rainy season (Jakarta Government 2020). Rapid urbanization, characterized by dense construction and the sealing of natural surfaces, has further exacerbated these risks by severely limiting the infiltration capacity of rainwater (BPBD Jakarta 2020).

One of the most devastating floods occurred on January 1, 2020, when 380 liters of rainfall per square meter were recorded within a few hours. For comparison, the average precipitation during the entire month of January typically amounts to 300 liters (Climate-Data 2024). The extreme rainfall led to widespread flooding, resulting in 48 fatalities and the displacement of over 19,000 residents (BNPB 2020). Entire districts were submerged, schools were destroyed, and significant power outages severely disrupted daily life. Particularly affected were low-income neighborhoods, where inadequate infrastructure left inhabitants highly exposed to the devastating impact of the floodwaters.

Project context and activities

Since 2015, Plan Indonesia, in cooperation with Plan Australia, the Australian government, and the Yayasan Kausa Resiliensi Indonesia (YKRI), has been implementing

Key Figures Indonesia

283,487,931
Inhabitants
Worldbank (2024b)

27 %
Proportion of the population exposed to high flood risk
Rentschler et al. (2022)

516,000
Internal displacements due to disasters caused by extreme natural events
IDMC (2025)

320,000 km^2
Tree cover loss since 2000
Global Forest Watch (2025a)

a community-based flood preparedness initiative (Plan Indonesia 2020). Central to the project is the "Rescue Ball" early warning system, a locally developed, mechanical device constructed from plastic pipes, loudspeakers, cables, and tennis balls. When floodwaters reach a critical level, the ball rises with the water, mechanically activating an acoustic alarm. The initial version of the system depended on the public electricity grid, which often failed during flood events (Plan Indonesia 2020). Subsequent improvements led to a version powered by a motorcycle battery, ensuring independence from the electrical grid. A weatherproof casing was added to protect sensitive components from moisture and physical damage, and visual warning signals were incorporated to complement the acoustic alerts (Plan Indonesia 2020).

The improved system was installed in 2019 in two particularly flood-prone areas: Kelurahan Klender and Kelurahan Pinangsia, districts that face severe flooding annually. From the outset, community members were actively involved in the project. Local youth not only participated in the system's installation but also received training in its maintenance and operation. Their engagement ensures the system's ongoing functionality through regular inspections and repairs. Youth participation forms a core component of Plan International's strategic approach. In this context, it plays a crucial role in fostering technological skills, encouraging innovation, and promoting the transfer of disaster preparedness knowledge within communities and across generations. Moreover, by equipping young people with practical skills, the project contributes to social inclusion, education, and the development of sustainable structures. The active involvement of the community further strengthens the system, as local knowledge identifies the most vulnerable sites and informs ongoing improvements. This participatory approach enhances risk awareness and empowers communities to independently adapt their protective measures to evolving circumstances (Plan Indonesia 2020).

The Rescue Ball's effectiveness has received international recognition. In 2022, it was selected as a global finalist for the SAFE STEPS D-Tech Award, an esteemed prize awarded by the Prudence Foundation in Asia for innovations in disaster preparedness (SAFE STEPS D-Tech 2024). Additionally, students from a vocational school in Depok further refined the design, leading to its installation in 21 additional flood-prone locations across Jakarta and Depok. This expansion was substantially supported by the Indonesian Red Cross with funding from the Zurich Flood Resilience Program. .

Results and impacts

The introduction of the Rescue Ball early warning system has significantly strengthened flood preparedness in the affected communities. During the catastrophic flood on January 1, 2020, the system in Klender was triggered at 3 a.m., providing residents with several hours to evacuate — in stark contrast to other districts where residents were caught unprepared. The timely warning helped to considerably reduce the risk of severe injuries and fatalities. A similar outcome was observed during another flood event on January 24, 2020 in Pinangsia, where the early warning system again enabled residents to evacuate safely.

The success of this intervention lies in its simplicity, affordability, and adaptability. While conventional early warning systems often rely on complex and costly technologies requiring extensive maintenance, the Rescue Ball employs easily accessible, locally sourced materials. This enables communities, particularly youth groups, to construct, repair, and expand the system independently, representing a decisive advantage over expensive, externally managed solutions.

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Bangladesh

Community-based Strategies for Coping with River Erosion

WorldRiskIndex Rank 11

Risk very high	26.71
Exposure very high	16.57
Vulnerability very high	43.07

Country profile

Bangladesh, situated in the delta of the Ganges and Brahmaputra rivers, is one of the regions with the highest rainfall globally. Due to its low-lying location and dense river network, the country is frequently affected by floods and river erosion. The coastal regions are also threatened by rising sea levels and frequent cyclones. In 2019, around 2,860 hectares of land were lost due to land erosion in river basins (CEGIS 2019). At the same time, the intensity of monsoon rains is expected to increase further in the coming decades due to climate change (Bhattacharjee et al. 2023), which will exacerbate the already precarious flood situation. The impact is drastic: the most recent severe floods in 2024 hit eleven districts in the north and south-east of the country, displacing more than 500,000 people and claiming 71 lives. In total, around 5.8 million people were affected. This data illustrates the threat that flooding and river erosion pose to the people of Bangladesh.

Project context and activities

Since mid-2020, CBM has been working on disability-inclusive disaster risk reduction in the Kurigram district in the north of the country in collaboration with its national partner Centre for Disability in Development (CDD). The region is not only one of the poorest in the country, but is also particularly affected by regular flooding and land erosion due to its close proximity to the Dharla, Teesta and Brahmaputra rivers.

Key Figures Bangladesh

173,562,364
Inhabitants
Worldbank (2024a)

57.5 %
Proportion of the population exposed to high flood risk
Rentschler et al. (2022)

2,402,000
Internal displacements due to disasters caused by extreme natural events
IDMC (2025)

2,620 km²
Tree cover loss since 2000
Global Forest Watch (2025b)

The Chars — river islands created by sedimentation — are particularly affected. Although fertile, the increasing risk of flooding and erosion poses an existential threat to these islands. Many inhabitants have already been displaced several times by river erosion, which has led to a considerable loss of income and a deterioration in living conditions. With a poverty rate of 44 percent, Char residents are well above the national average (Concern Worldwide 2021). The remote location also makes access to health and educational services and humanitarian aid more difficult (Hossain 2021)

Against this backdrop, the joint CBM and CDD project aims in particular to systematically strengthen community-based disaster prevention measures, utilize local knowledge and traditional solutions in a targeted manner, and actively integrate the needs of people with disabilities and other vulnerable groups into all measures.

Results and impact

The project focuses primarily on strengthening the Ward Disaster Management Committees (WDMCs). In many communities in Bangladesh, these local working groups play a central role in the implementation of disaster prevention measures and act as first responders in the event of a crisis. However, they often do not have the necessary financial and technical resources to fulfil their tasks effectively.

Targeted training (including on first aid) and the provision of equipment such as life jackets, flashlights, and first aid kits have significantly improved the ability of these groups to act when disaster strikes. Community-based flood simulations and the development of detailed action plans have made significant progress in preparing for disaster situations. At the same time, a comprehensive database of particularly vulnerable households has been set up and is regularly updated.

In addition to these measures at community level, the project also promotes individual adaptation of livelihoods. The aim is to increase household income and to diversify income sources. Vulnerable households receive support for goat and sheep rearing, keeping chickens and ducks, or setting up small businesses. Traditional adaptation strategies such as raising houses and stables and improving the storage of supplies are systematically promoted, even if they cannot eliminate the fundamental risk of river erosion (Tod / Morshed 2021). Another important component of the project was the establishment and support of self-help groups (SHGs) for people with disabilities and the strengthening of their knowledge for better individual disaster preparedness. At the same time, the self-help groups also implement advocacy activities to strengthen their rights.

One particular success was the introduction of barrier-free infrastructure on two river islands, which was achieved in close cooperation with the local government. This activity was met with great acceptance among the Char population and generated interest among other organizations to implement similar projects. In addition, inclusive feedback and reporting mechanisms were established that allow for a continuous evaluation of the envisaged project impact and provide the affected communities with the opportunity to get involved in the project (Wiegers et al. 2022).

During the severe flooding in the summer of 2024, the system proved its worth: the members of the WDMCs immediately disseminated flood warnings by handheld microphone and actively participated in evacuation measures. At the same time, the CDD successfully advocated for the inclusion of people with disabilities and other particularly vulnerable groups in the emergency response.

Improving weather forecasts remains a key challenge for the future, as existing systems are often too imprecise (Rahman et al. 2021). However, the experiences of the project clearly show that the combination of modern approaches and traditional knowledge is crucial to sustainably strengthen the resilience of the most vulnerable population groups.

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2.4 Flood Risk Reduction through Nature-Based Solutions on Private Land

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Nature-based solutions (NBS) use natural processes to mitigate climate risks such as flooding or drought while promoting biodiversity. However, implementation of NBS is still at an early stage. One of the main challenges is their high demand for land, much of which is privately owned. To activate these areas for NBS, land policy is essential. This article outlines key challenges for land policy in relation to NBS. Those include insufficient evidence of effectiveness and efficiency, the strong location-specific nature of these measures, and their significant land requirements.

Nature-based solutions are becoming increasingly relevant in science and practice as a strategy to address heavy rainfall and river flooding (Hartmann et al. 2019; Schanze 2017). The European Commission defines them as measures that utilize natural processes to sustainably manage societal challenges such as climate change, flooding, or soil erosion (European Commission 2015). Unlike purely technical solutions such as dikes or dams, NBS are multifunctional: they not only mitigate climate risks but also promote biodiversity, improve quality of life, and support sustainable resource use.

Complementing traditional technical protection measures, NBS include a wide range of measures, from urban green spaces and reforestation to river restoration projects (Thaler et al. 2025). Their common principle is to retain water where it falls before it comes to the drain — through local infiltration, delayed runoff, or temporary storage. Large-scale projects such as the Waal river expansion near Nijmegen in the Netherlands and the restoration of the Emscher river in the Ruhrgebiet in Germany showcase this.

Measures are often small in scale and can be implemented in both urban and rural areas (Thaler et al. 2023). NBS can reduce flood and heavy rainfall events by naturally storing, infiltrating, or redirecting water. In cities, the removal of impervious surfaces — such as parking lots or private gardens — can contribute. Green roofs and facades also help slow or reduce runoff. However, individual measures are often insufficient; their effectiveness only emerges through interconnected implementation.

In rural areas, NBS also show their impact: vegetated buffer strips along agricultural fields prevent soil erosion and filter pollutants from surface runoff. Restored floodplains retain water in the landscape and reduce downstream flooding. In Styria, Austria, vegetated embankments aligned with contour lines slow water runoff and simultaneously mitigate drought, soil loss, and erosion. In the Euskirchen district near Bonn, Germany, reed grass is cultivated to stabilize the water balance — with the goal of regional use.

In urban areas, green roofs store rainwater, relieving sewer systems while also cooling buildings. Swales along roads channel water for local infiltration. Flood-resilient forests with deep-rooted tree species and stable soil structures improve water retention. Unsealed surfaces with permeable materials reduce runoff and contribute to cooling effects during summer. In Euskirchen, so-called micro-forests are being developed to combine climate resilience with water retention.

NBS thus not only contribute to flood protection but also promote biodiversity, improve urban climates, and support long-term climate adaptation. Due to their relatively low costs and multifunctional benefits, they can address multiple climate risks simultaneously (Ferreira et al. 2022). This makes them especially attractive in resource-constrained areas, for instance through buffer strips or alternative cultivation methods involving water-intensive plants.

However, NBS do not represent a clearly defined category of interventions. Whether a measure qualifies as nature-based depends on its objective and implementation. Not every green roof or reforestation effort automatically constitutes an NBS — it must address a specific problem. Therefore, each case must be assessed to ensure it meets the criteria.

A key feature of NBS is that individual measures are often insufficient. Only when applied extensively across relevant natural spaces — such as river basins — do they become effective (Potočki et al., 2022). This requires broad implementation, often on private land. Unlike traditional infrastructure, NBS cannot be limited to public areas. This poses specific challenges in terms of both effectiveness and feasibility on private properties.

Challenge 1: Demonstrating effectiveness and efficiency

To unlock the full potential of NBS, robust evidence of their impact is needed — not only regarding climate risks, but also biodiversity and quality of life. Planning and implementation require a systematic analysis of their impact mechanisms. Yet the small-scale and often hard-to-measure effects of NBS make modelling difficult.

This is partly due to limitations in available data and models, and partly because their multiple effects are hard to quantify within existing frameworks. A comprehensive assessment of NBS effectiveness also involves normative and qualitative elements. How, for instance, should the tourism value of a river expansion be weighed against biodiversity gains? This requires evaluation approaches that integrate both qualitative and quantitative indicators. Traditional efficiency measures — such as cost-benefit ratios — often fall short, which is why "cost-effectiveness" is more appropriate.

The lack of evidence is not only a methodological issue but also a political and engineering challenge. Public initiatives require legitimacy, which is difficult to establish without demonstrable impact (Needham et al. 2018). From an engineering standpoint, reliable modelling is essential for planning and design.

While NBS intuitively make sense, trust in them hinges on solid evidence. Improved data and practice-oriented modelling are thus crucial for widespread adoption.

Challenge 2: Location-Dependence and a Lack of Generalizability

The effectiveness of NBS is highly location-specific (Raška et al. 2019). Climate, soil type, topography, and socio-economic conditions greatly influence their efficiency. Measures needed in one region cannot be easily transferred elsewhere.

For example, a stormwater management system in urban areas may yield different results than in rural regions with differing hydrological conditions. The effectiveness of a retention measure or land use change depends on its position within a catchment. Reed cultivation to enhance water balance is effective only if implemented in the right location. General claims of benefits are insufficient; locally validated data is necessary to identify suitable sites.

However, data at the required spatial resolution is often lacking. Pilot projects and field studies can help fill this gap. At the same time, context-dependence limits broader generalization — creating tension between local relevance and scalability.

Challenge 3: Implementation on Private Land

The widespread impact of NBS requires its application on private land (Potočki et al. 2022). However, this is precisely where a key hurdle lies — be it due to property rights, a lack of incentives, or an unsuitable legal framework.

+ **Nature-based solutions need more space:** NBS often require more space than technical alternatives, particularly when small-scale measures must work collectively. This makes them land-intensive. NBS generally complement rather than replace conventional measures. A dike, for instance, is far more space-efficient than reforestation or river expansion for water retention. However, a dike is a monofunctional structure,

325 billion

US-Dollars in damage caused by floods worldwide from 2020 to 2024. The most expensive flood disaster occurred in Central Europe in July 2021 with 59 billion US-Dollars in damage caused by flash floods in the Ahr valley and neighboring regions.

Source: Munich Re (2025a)

while NBS are multifunctional. However, not all interventions entail restrictions on land use. While river renaturation consumes land, other measures, such as façade greening or hillside management, can be easily integrated when implemented across the slope rather than along the slope. Projects like micro-forests or reed cultivation demonstrate how NBS can complement existing uses.

+ Focus on public land is insufficient

Investments have largely focused on public property. Especially in water management, authorities prefer using publicly owned land to avoid planning and procedural hurdles. Ownership simplifies implementation, avoids lengthy negotiations or compensation claims, and allows for flexible, nature-based use — such as converting farmland into riparian forests or wetlands.

Land acquisition and land consolidation are established strategies but quickly reach their limits due to the high land demand (Albrecht / Hartmann 2021). These approaches are deeply rooted in institutional practices, especially in Germany, but leave much of the NBS potential untapped. This threatens both scalability and acceptance.

+ Land policy strategies are necessary

While public land is relatively easy to use, mobilizing private land requires different land policy approaches (Raška et al. 2022).

Land policy generally offers three strategies to mobilize private land for NBS:

1. sovereign strategies, such as expropriation or preemption rights, are legally complex and only justifiable with clear objectives — which is difficult given the often hard-to-prove impacts of NBS.

2. Market-based strategies offer incentives such as subsidies or certificates. However, legitimacy, feasibility, and coordination among funding entities remain challenges.

3. Voluntary approaches rely on cooperation, land swaps, or usage agreements. They are less efficient but require a deep understanding of landowners.

A successful land policy will likely require a mix of all three strategies (Hartmann, 2011). Yet experience is lacking. The European project *LAND4CLIMATE* is currently investigating how different strategies can be effectively applied to NBS.

Final note

Nature-based solutions are a promising component in managing heavy rainfall and flooding, especially as extreme events become more frequent. They build on earlier concepts such as natural or decentralized stormwater management and natural water retention measures (NWRM), which use landscape features like wetlands, soil infiltration, or floodplain restoration. Also related is the Dutch "Room for the River" program of the 1990s, which emphasized designated flood zones over technical flood defenses. From environmental economics, Payments for Environmental Services (PES) have long been discussed, particularly in the Global South. These approaches can be considered forerunners of NBS.

Yet their potential comes with challenges: difficulties in proving their impact, location dependence, high land requirements, and limited feasibility on private property. Developing appropriate land strategies and funding instruments will be critical to enable widespread and effective deployment of NBS. Both research and practice must work to close this gap.

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Bündnis Entwicklung Hilft

Challenges and Opportunities of Nature-based Solutions in the Global South

Nature-based solutions (NBS) offer a promising approach to reducing flood risks while simultaneously creating ecological and social benefits. While the article by Thomas Hartmann focuses on the Global North, projects in the Global South demonstrate that NBS must be developed and implemented under different conditions. The challenges and opportunities differ significantly from those in Europe or North America.

A key problem is the often inadequate regulation of land use and property rights. In countries such as Bangladesh, Mozambique, or the Philippines, many people live in informal settlements along riverbanks and coastlines. These are highly prone to flooding, and there is a lack of legal frameworks or formal property rights, which makes the planning and long-term securing of NBS more difficult.

In addition, there is often a lack of financial resources and technical expertise to implement renaturation projects or urban green spaces. While projects such as *Room for the River* in the Netherlands receive government funding in Europe, such programs are rare in Sub-Saharan Africa or Southeast Asia. Unstable political conditions further complicate long-term planning.

Climate change is an additional factor: in Mozambique, cyclones Idai (2019) and Freddy (2023) caused massive flooding and destroyed many areas designated for renaturation. Repeated reconstruction efforts tie up resources that would be needed for NBS projects.

Nevertheless, there are inspiring approaches in the Global South

→ In Bangladesh, the "Floating Gardens" project protects rice and vegetable cultivation in flood-prone regions. Here, floating beds are built from natural materials that remain productive even during heavy rainfall and high water levels. This form of agriculture is not only climate-resilient but also improves food security in rural communities.

→ In Kenya, the *Green Belt Movement* led by Wangari Maathai spurred massive reforestation. Planting millions of trees not only reduced flooding but also prevented soil erosion and secured local incomes through sustainable timber use.

→ In the Philippines, mangroves are being reforested to protect the coastline. They serve as natural barriers that break storm surges, can reduce the impact of tsunamis, and provide habitat for numerous fish species, thereby supporting the livelihoods of local fishing communities.

Compared to the Global North, NBS in the Global South must be more closely adapted to local conditions. Challenges related to land rights, financial resources, and political stability require flexible and participatory implementation. Successful projects demonstrate that NBS can work even under difficult conditions if they take traditional knowledge and local needs into consideration.


সেনবাগ সরকারি পাইলট উচ্চ বিদ্যালয়
নির্মাণে: শিক্ষা প্রকৌশল অধিদপ্তর (EED)

3 The WorldRiskIndex 2025

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Extreme natural events such as floods, storms, droughts, and earthquakes affect the daily lives of a large part of the world's population. The WorldRiskIndex 2025 indicates the disaster risk for 193 countries worldwide and highlights the extent to which this risk depends on exposure to natural hazards as well as on societal vulnerability — that is, on susceptibility, coping, and adaptive capacities. The results continue to identify the global risk hotspots in Asia and the Americas. At the same time, Africa exhibits the highest vulnerability worldwide: almost 80 percent of the continent is classified as high- or very high-risk areas. Climate change exacerbates this situation. It not only increases the frequency and intensity of extreme weather events, but also adds complexity to regional risk profiles. As a result, new hazards are emerging even in regions that were previously less affected, making the targeted development of societal capacities essential. This year's focus on local flood and inundation risks underscores the urgent need for climate-resilient adaptation measures, especially in vulnerable areas. The WorldRiskIndex thus provides a robust basis for assessing latent disaster risks and developing sustainable strategies for risk reduction.

In the context of anthropogenic climate change, the year 2024 marks a significant turning point: for the first time, the global average temperature exceeded the threshold of the Paris Climate Agreement for eleven consecutive months (Copernicus Climate Change Service 2025). After record temperatures in 2023, a permanent overshooting of the climate target is coming ever closer. The consequences have been apparent for some time: globally, the frequency, intensity, and duration of extreme weather events such as heat waves, droughts, and floods are increasing, as recent extreme events confirm.

In 2024, cyclones such as Hurricane Beryl and Typhoon Shanshan caused severe damage and led to significant loss of life in Southeast Asia and North America. Meanwhile, between July and September, approximately 4.5 million people in ten countries across West and Central Africa were affected by severe flooding. Extreme natural events also became more frequent in the first quarter of 2025: tropical hurricanes with wind speeds of up to 195 kilometers per hour and subsequent floods severely affected Mozambique and Malawi, while eastern Australia received a month's worth of rainfall in just two days. At the same time, prolonged droughts are steadily increasing in South America, Africa, and the Mediterranean. Climate change intensifies these extreme events through rising temperatures, which alter atmospheric water distribution. This leads to both heavy rainfall and pronounced dry spells, resulting in drinking water shortages and crop failures (Chen et al. 2025; Hoover / Smith 2025).

At the same time, conflicts and wars are intensifying worldwide, further increasing disaster risks in the affected areas. They significantly weaken the resilience of local populations and hinder humanitarian action. In Sudan, the ongoing civil war threatens to become the greatest humanitarian crisis of our time. More than 30 million people — around two-thirds of the population — are in urgent need of assistance. In South Sudan, an escalation of local violence is also looming, with severe humanitarian consequences. In Gaza, millions of people are suffering from acute shortages of water, food, and medical care — a catastrophic famine cannot be ruled out. Meanwhile, Russia's ongoing war of aggression against Ukraine is claiming lives every day and causing widespread destruction. The consequences of this conflict extend far beyond the region, as it is significantly disrupting global food security of staples such as grain, thereby affecting the disaster risks of many countries.

The Concept

The WorldRiskIndex represents a synthesis of various research approaches to hazard, exposure, and vulnerability, whose interactions are considered central to the emergence of disaster risks (Wisner et al. 2004). The index builds on the work of Bogardi / Birkmann (2004), Cardona (1999), Birkmann (2006), and Cardona / Carreno (2011) and integrates more recent discussions on coping and adaptive strategies (Davies 1993; Lavell et al. 2012). In contrast to earlier approaches (Cardona 2005; Peduzzi et al. 2009), which primarily focus on hazard, exposure, and damage, the WorldRiskIndex takes a broader spectrum of factors into account (see info box). Fundamental to the model is the recognition that disaster risks not only depend on the occurrence, intensity, and duration of extreme natural events, but also on social, political, and economic factors.

This understanding leads to the assumption that every society can take precautions for effective disaster prevention in line with its capabilities. The goal is to mitigate the impacts of extreme natural events. Societies can reduce their vulnerability through targeted measures — for example, by reducing social inequalities or expanding civil infrastructure. Coping capacities can be strengthened through investments in the health system or effective warning systems. In the medium to long term, education, research, and especially economic capacity in particular contribute to enhancing the adaptability of societies. However, if these areas are neglected, resilience not only declines — instead, a vicious cycle emerges in which acute vulnerability hinders or even reverses medium- and long-term development processes.

A key aspect of the WorldRiskIndex is its relative nature: it indicates the disaster risk of all 193 United Nations member states in comparison to each other. Therefore, a country's result depends not only on internal developments, but also on global developments. A country may improve, yet its index score remains unchanged if other states achieve similar or greater progress. The significance of the index thus lies less in the isolated assessment of individual countries and more in the global comparison. To facilitate visualization, the values are divided into five classes — from very low to very high.*

For the current edition of the report, the vulnerability sphere has been comprehensively updated. In addition to incorporating the most recent data, large portions of the dataset for trend analyses have been revised to integrate revisions of previous information from global data sources such as the World Bank and the International Monetary Fund.**

* A detailed description of the methodology can be found in the WorldRiskReport 2022, 39 ff., and at WorldRiskReport.org.

** Both datasets are available on the WorldRiskReport website as well as on the UNOCHA HDx platform.

The Results

The WorldRiskIndex has demonstrated for years that global disaster risks are distributed very unequally and are closely linked to poverty and inequality. This often results from interactions between structural vulnerability and the impacts of extreme natural events. Countries whose risk profiles are characterized by climate-sensitive exposure and high to very high vulnerability are particularly at risk. In the future, they must expect more frequent and intense natural events, which, in the long term, can undermine their protective, coping, and adaptive capacities and reduce societal resilience. At the same time, conflicts such as the Russian war of aggression against Ukraine or the war in Syria demonstrate that even countries with low exposure can temporarily exhibit higher vulnerability — for example, due to supply shortages or humanitarian strains.

Extensive revisions of the vulnerability indicators have led to significant shifts in the country rankings compared to the previous year. This is because many indicators could not be updated due to the Covid-19 pandemic and ongoing conflicts and wars. This particularly affected indicators whose collection is heavily dependent on access to vulnerable population groups or which are based on estimates derived from secondary data. Delays in data provision cause relative distortions in country comparisons, which are further exacerbated by widely varying regional causes.

The shifts observed can be attributed to two developments: first, the revisions have allowed countries whose data collection was impaired by crises over a longer period to catch up — leading to a normalization of previous outliers, particularly at the top and bottom of the ranking. Second, the indicators for price stability and government investments — despite their scientific relevance and sound collection — are particularly sensitive to global crises such as the pandemic. Combined with the associated uncertainties, this area exerts an amplified influence on the overall ranking, which must be considered more specifically in the future.

The ten countries with the highest risk this year are the Philippines, India, Indonesia, Colombia, Mexico, Myanmar, Mozambique, Russia, China, and, once again, Pakistan. The ten most vulnerable countries remain primarily located in Africa: the Central African Republic, Somalia, Chad, South Sudan, the Democratic Republic of the Congo, Yemen, Niger, Ethiopia, Sudan, and Mozambique. Compared to last year, Nigeria and Afghanistan have moved out of this group. The examples of China, Nigeria, and Afghanistan illustrate the importance of up-to-date indicators for realistic risk assessment. Delays in data collection and provision can result in countries becoming statistical artifacts — without current data, their status remains unchanged in global comparisons, which affects their ranking. Conversely, highly up-to-date data can also lead to distortions, as demonstrated by the example of China over the past three years: due to the timely provision of data showing positive developments in reducing vulnerabilities and building adaptive capacities — which clearly deviated from the global trend — China appeared as an outlier and recorded significant improvements in the global ranking. This picture is slowly coming into perspective as data collection in other regions gradually normalizes.

Apart from the top group, the results largely reflect the long-term trends prior to the pandemic. However, they clearly demonstrate that the recovery and stabilization of societal capacities continues to progress unevenly for various reasons. These include disparities in the reduction of economic inequality as well as in the health sector — for example, in immunization rates — between the Global South and the Global North. One example is Tunisia, whose risk score in the area of vulnerability and lack of adaptive capacities has decreased by 2.24 points compared to the previous year, while the revision of the trend dataset only shows minor changes in its long-term development.

Germany has a low overall disaster risk but shows weaknesses in essential areas such as adaptive and coping capacities. The Covid-19 pandemic revealed structural deficits in the health sector — ranging from staff shortages in medical facilities and bottlenecks in hospital infrastructure to the slow and, in some cases, inefficient allocation of public funds. There are also long-term risks in research, development, and investment capacity. Germany is currently still benefiting from its low vulnerability but should take early countermeasures if its coping and adaptive capacities deteriorate in order to maintain its current level. This illustrates that even in highly developed countries such as Germany, functional weaknesses in crucial societal areas can undermine resilience in the long term.

Overall, the most significant global risk drivers lie in structural vulnerability, social inequality, and insufficient medical capacities. When these factors cross critical thresholds, adaptive capacities decline immediately — impacting resilience, vulnerability, and coping ability. Humanitarian assistance can help break this cycle, open up development prospects, and promote stability. However, more affluent countries are not immune to such dynamics either: budget cuts in key societal sectors — for example, as part of fiscal consolidation — can weaken resilience in the long term.

The Structure of the WorldRiskIndex

Exposure

Number and share of the population regarding

- Intensity Levels: Strong, Severe, Extreme
- Earthquakes
- Tsunamis

WorldRiskIndex =

Vulnerability

is composed of

Susceptibility

Socio-Economic Development

+ Life expectancy at birth
+ Life expectancy at age 70

+ Mean years of schooling
+ School life expectancy from primary to tertiary education

+ Gross national income per capita (USD PPP)
+ Gross national savings per capita (USD PPP)

+ Net volume of official development assistance received per capita (USD PPP)
+ Net volume of personal remittances received per capita (USD PPP)

Societal Disparities

+ Income gini coefficient
+ Income top-bottom decile ratio

+ Young age dependency
+ Old age dependency

+ Gender disparity in adolescent fertility
+ Gender disparity of mean years of schooling
+ Gender disparity of school life expectancy from primary to tertiary education
+ Gender disparity of labor force participation

Socio-Economic Deprivation

+ Lack of access to at least basic drinking water services (percent)
+ Lack of access to at least basic sanitation services (percent)

+ Fixed broadband subscriptions per 1,000 persons
+ Mobile cellular subscriptions per 1,000 persons

+ Lack of access to electricity (percent)
+ Lack of access to clean cooking fuels (percent)

+ Prevalence of undernourishment
+ Average dietary energy supply adequacy

Vulnerable Populations due to Violence, Conflicts and Disasters

+ Refugees, asylum seekers, returned refugees and other displaced (total and percent)
+ Internally displaced persons due to natural disasters (total and percent)
+ Internally displaced persons due to violence and conflict (total and percent)

Vulnerable Populations due to Diseases and Epidemics

+ Prevalence of HIV and AIDS
+ Prevalence of tuberculosis and respiratory diseases
+ Prevalence of neglegted tropical diseases and malaria
+ Prevalence of other infectious diseases

* These dimensions are not currently considered due to insufficient availability of indicators.

The unweighted geometric mean is used to aggregate the indicator values at all levels of the WorldRiskIndex.

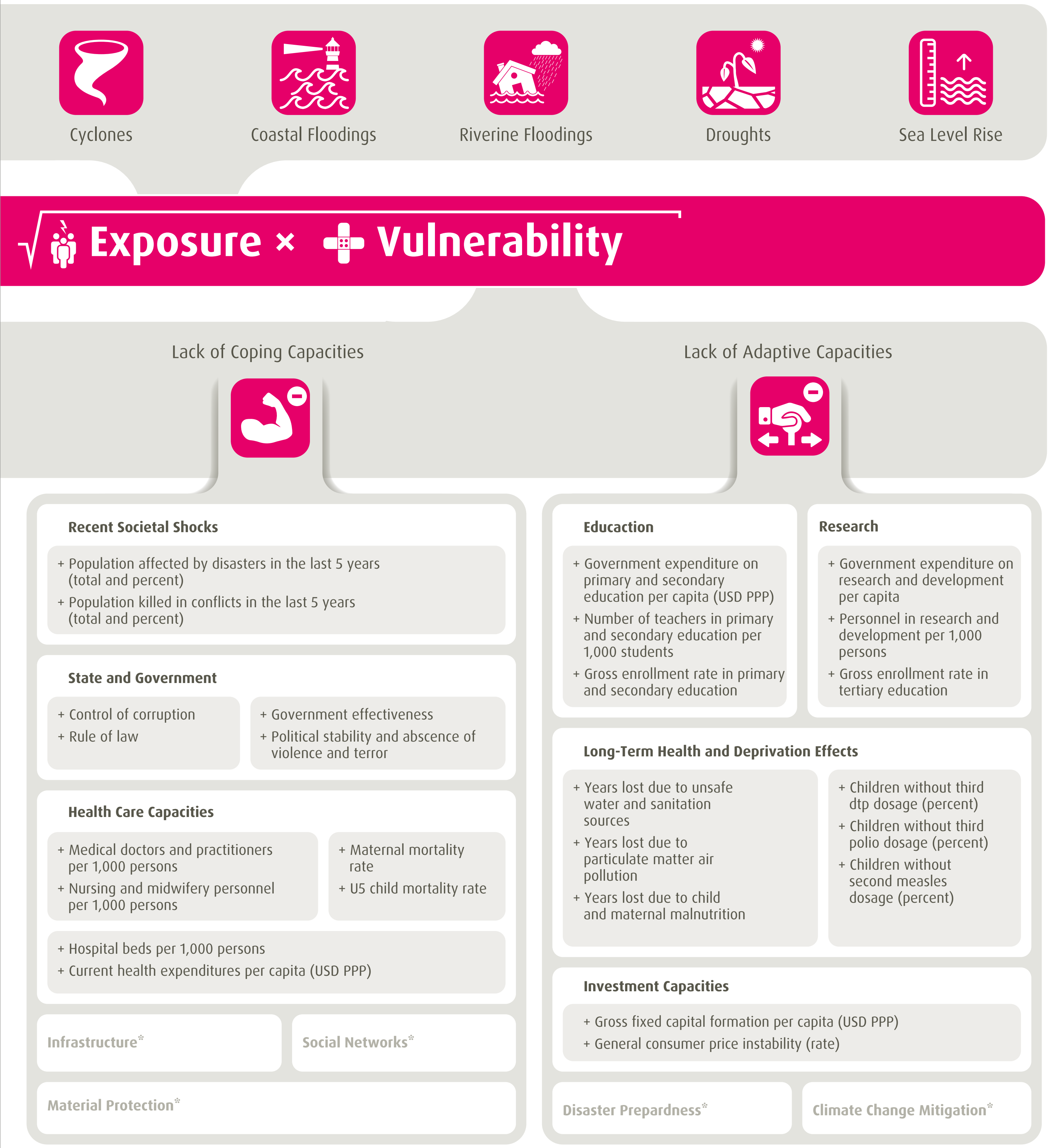


Figure 6: The Structure of the WorldRiskIndex

Opportunities and Limitations

The results of the WorldRiskIndex have raised awareness of the importance of societal capacities in disaster preparedness in recent years. The index provides guidance for the prevention of humanitarian crises and supports decisions regarding the allocation and prioritization of resources. Condensing complex relationships into comparable values facilitates communication and interpretation of the results, but carries the risk of overlooking nuanced aspects such as culturally embedded coping strategies or informal social safety nets. Therefore, users should not view instruments such as the WorldRiskIndex as purely technical tools, but should understand their conceptual and methodological foundations in order to interpret findings correctly (Garschagen et al. 2021).

Global index models inevitably have gaps: for areas such as infrastructure, social networks, or material security, data are often available only regionally or not at all. Additionally, many global indicators exhibit significant time lags between collection, processing, and publication, which prompted this year's revision. On the one hand, this is because in times of crisis, resources for data collection are often tied up elsewhere; on the other hand, many data sources do not cover smaller countries in the required depth or quality. Moreover, conflicts are not included in the model, as their drivers fundamentally differ from those of natural extreme events (see the special analysis on conflict exposure, WorldRiskReport 2024). Quantitative models must therefore always be supplemented by qualitative information and local knowledge to avoid misrepresenting complex realities.

Despite these limitations, the WorldRiskIndex is gaining scientific significance. It is increasingly being used to analyze latent risks and to bridge the gap between research and practice (Shitangsu et al. 2025; Ciribuco et al. 2025). At the same time, it is fostering the development of new instruments for assessing recovery processes after disasters (Borre et al. 2025). This demonstrates that methodological improvements facilitate its integration into planning and strategy processes, while aspects such as epidemiological exposure remain unresolved.

Nevertheless, one structural result remains constant despite methodological improvements: the WorldRiskIndex — like all global index models — is highly dependent on data that is globally comparable, up-to-date, and reliable. This data usually originates from international sources that is collected under the coordination of established organizations such as UN institutions, the World Bank, or major aid organizations. While this is a key strength of the model, it is also an increasing weakness.

The Indicators of the WorldRiskIndex

Risk is the interaction of the two spheres of exposure and vulnerability. It arises only where the two spheres meet. In this respect, risks only occur where populations without sufficient resilience, coping, or adaptive capacities live in regions where hazards from extreme natural events or negative impacts of climate change exist.

Exposure is the extent to which populations in hazard-prone areas are exposed to and burdened by the impacts of extreme natural events or the negative consequences of climate change. Thus, exposure consists of the aspects of hazard, which include the frequency and intensity of earthquakes, tsunamis, coastal and river flooding, cyclones, droughts, and sea level rise in an area (hazard zone), and population (hazard object).

Vulnerability is the predisposition of populations to be vulnerable to damage from extreme natural events or negative impacts of climate change. As a sphere of economic, political, social, and environmental factors, vulnerability depicts the capacities and dispositions of people, households, and societies and indicates how easily and to what extent they can be destabilized, damaged, or even destroyed by extreme events. It consists of the three dimensions of susceptibility, lack of coping capacities, and lack of adaptive capacities, which are subdivided into further categories.

Susceptibility refers to structural characteristics and general conditions of societies that increase the overall likelihood of populations suffering damage from extreme natural events and entering a state of disaster. In this respect, susceptibility indicates the extent of resilience and resources of a population to mitigate the immediate consequences of extreme events.

Coping capacities refer to the abilities and measures of societies to counter adverse impacts of natural events or climate change through direct action and available resources in the form of formally or informally organized activities and measures, as well as to reduce damage in the immediate aftermath of an event and initiate recovery. Within the model of the WorldRiskIndex, the deficits in these capacities are included, which is why they are referred to as a lack of coping capacities.

Adaptive capacities, in contrast to coping capacities, refer to long-term processes and strategies to achieve anticipatory changes in societal structures and systems to counteract, mitigate, or prevent future negative impacts. Analogous to the lack of coping capacities, the lack of adaptive capacities is included in the WorldRiskIndex.

Global Data Under Pressure – The Silent Crisis of Humanitarian Responsibility

Index-based models such as the WorldRiskIndex require internationally comparable, regularly updated, and methodologically reliable data. This publicly available information forms the backbone of robust analyses of societal risks and vulnerabilities. A prerequisite is that only indicators collected worldwide, transparently documented, and provided by trustworthy institutions — such as the World Bank, the United Nations, the WHO, or research networks — are included. These are not merely technical resources, but essential instruments of evidence-based humanitarian responsibility. The necessary standardization of this data inevitably entails certain limitations, but it enables a globally comparable picture of the situation.

The previously stable ecosystem of global humanitarian data is increasingly under pressure. Political priorities are shifting, budgets are being cut, and key actors are withdrawing — including USAID, but also European states such as the United Kingdom, France, the Netherlands, Belgium, and possibly Germany — thereby not only jeopardizing long-term sustainability, but also calling into question the continuation of essential data collection.

Figure 6 illustrates the development of official development assistance (ODA) from the five largest OECD donor countries — USA, Germany, France, the United Kingdom, and Japan — over the period from 2018 to 2024. It is supplemented by scenarios for 2025 based on current budgetary developments and parliamentary plans. The graphic highlights the growing tension between international responsibility and national priorities: a substantial decline in ODA funding is foreseeable, marking a historic turning point after years of growth. The dynamics depicted highlight the increasing erosion of international solidarity, with potentially far-reaching consequences for global risk analysis, prevention, and the strategic direction of humanitarian action.

Fragile states, conflict-prone regions, and smaller countries — whose risks and needs have already been underrepresented in the past — are particularly affected. If these gaps are not actively addressed, there is a risk of a gradual but profound decline in data quality and availability, with potentially serious consequences for early warning systems and risk analysis. A warning sign was the sudden suspension of the Famine Early Warning Systems Network (FEWS NET) — a central pillar of anticipatory humanitarian assistance in food crises. Its discontinuation would have meant far more than the loss of a platform — it would have symbolized the collapse of a long-established, closely interlinked humanitarian data ecosystem that had provided a reliable basis for anticipatory action for years. The restriction or abandonment of such programs leaves a structural gap — with impacts far beyond the humanitarian sector.

This development is not merely a technical or financial problem but marks a normative crisis for humanitarian principles. The loss of independent data collection opens the door to political instrumentalization and undermines impartiality — a central principle of humanitarian work (Worley 2025). Cascading effects are already becoming apparent: without valid data, it is impossible to maintain early warning systems, make evidence-based decisions, or allocate resources according to need. Particularly concerning is the growing risk that marginalized population groups — especially in unstable contexts — are increasingly disappearing from the analytical focus. This not only jeopardizes the effectiveness of evidence-based crisis prevention but contradicts the commitment to leave no one behind.

Moreover, cuts in development funding in the areas of nutrition, health, water and sanitation, and agricultural development measurably exacerbate wasting, stunting, and micronutrient deficiencies (Osendarp et al. 2025). The consequences are long-term: they systematically weaken the institutional capacities and specialized structures that are essential for maintaining support services. As a result, programs are discontinued, entire regions are no longer covered, and central data streams are interrupted.

When the data base dwindles, it is precisely those most in need of protection and assistance who disappear — a humanitarian blind spot with far-reaching consequences. This leads to a clear appeal to the international community: the collection, safeguarding, and further development of humanitarian data must be understood as global responsibilities, coordinated in a binding manner, and financed sustainably. Data must not become a pawn of political cycles — it forms the basis for strategic foresight, evidence-based decision-making processes, and people-centered planning.

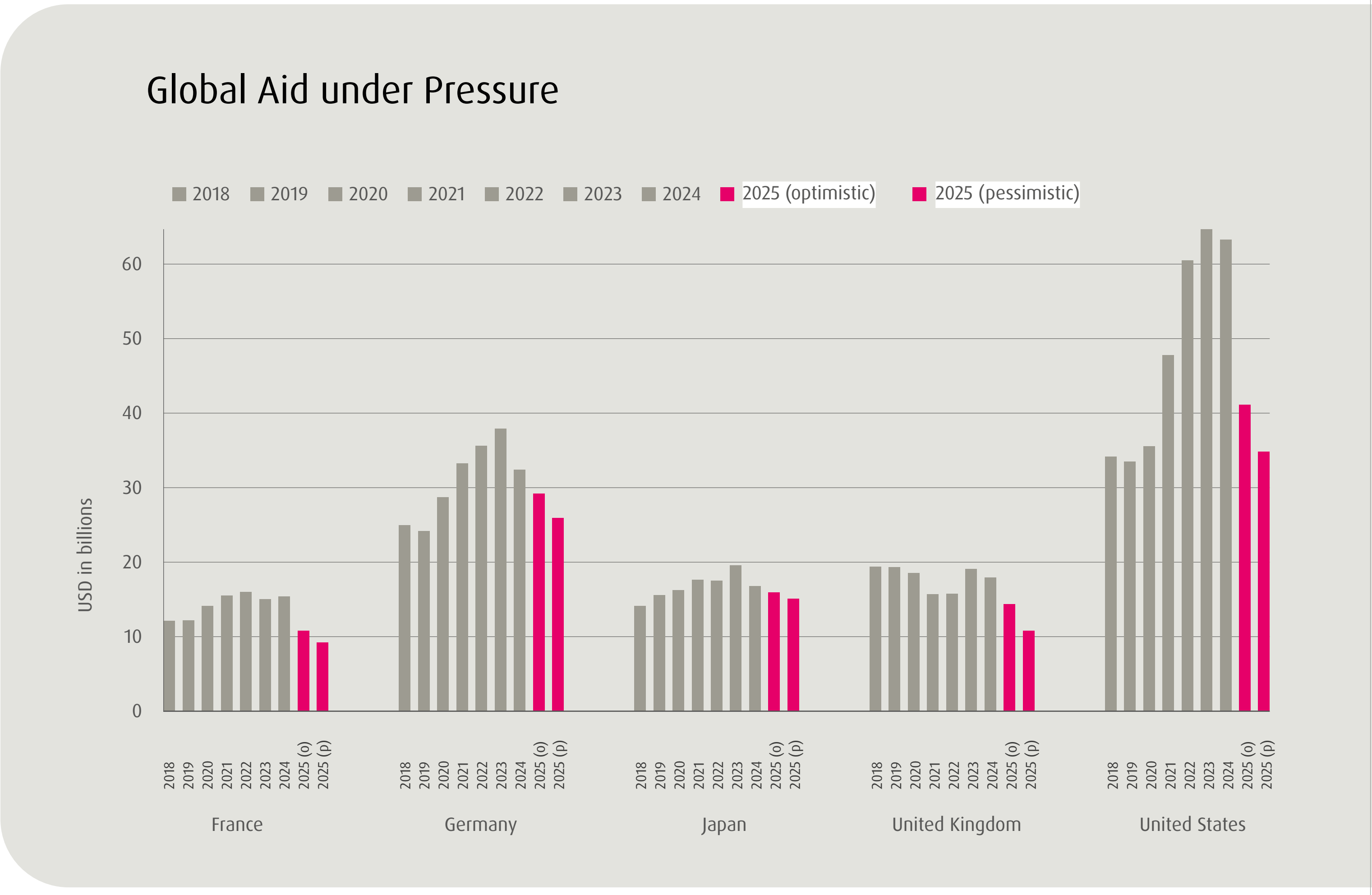
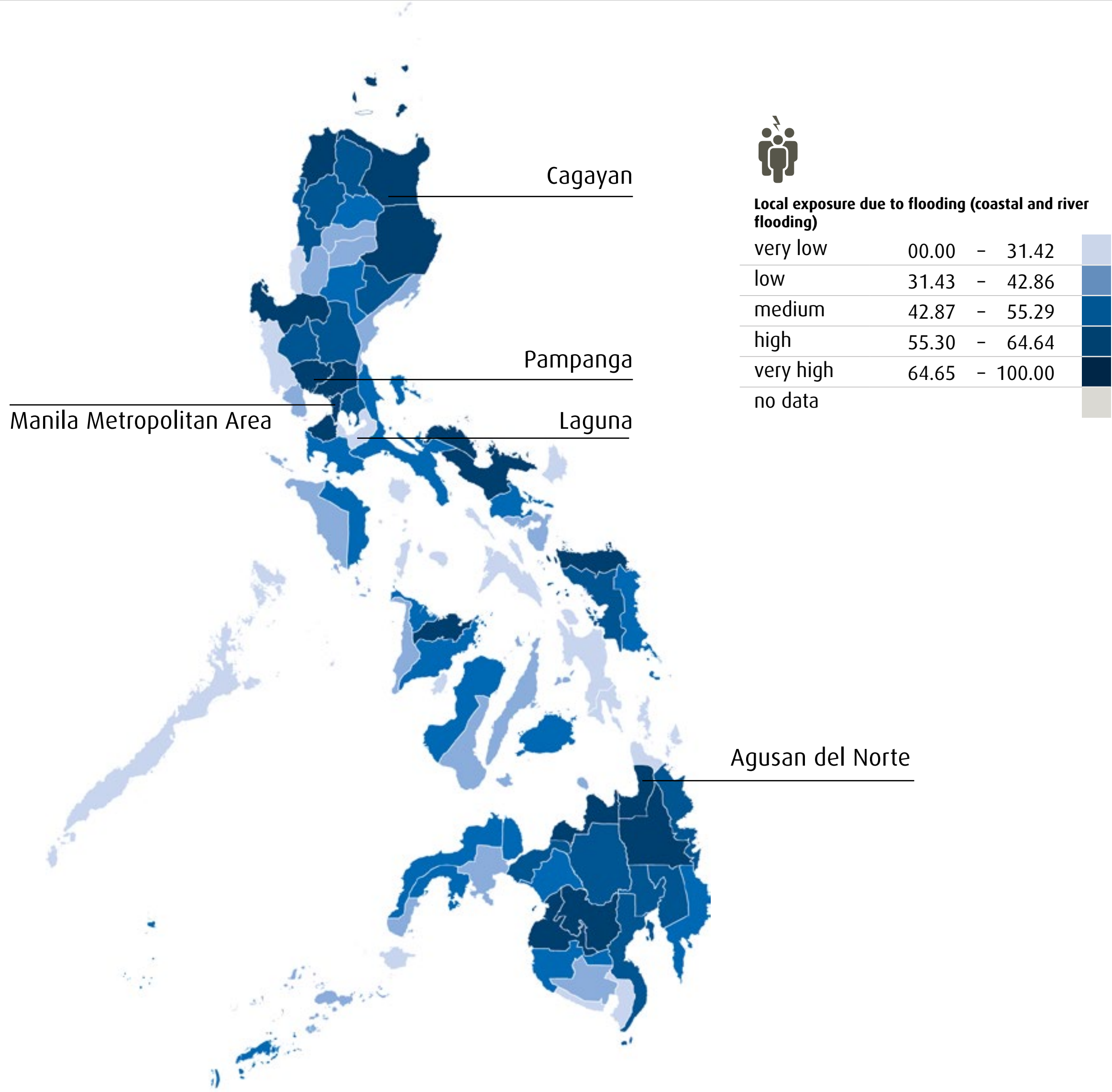


Figure 6: After years of growing development budgets, a turning point is imminent: in the five largest donor countries, 2025 is likely to see a partly significant decline in public funding for development cooperation — a signal of the increasing pressure of national priorities on global responsibility. Data source: OECD, own scenarios.



Local Exposure Analysis: Philippines Focus on Flooding

The risk profile of the Philippines is characterized by a variety of natural hazards, with river and coastal flooding playing a particularly central role. The map shows how strongly the individual provinces are exposed in direct comparison to one another, i.e., the extent to which the population there is potentially exposed to and affected by flooding.

Based on the methodology of the WorldRiskIndex, a locally adapted exposure analysis was developed for the Philippines. The aim was to determine the average expected number of people exposed per year — differentiated by five intensity levels for river and coastal flooding. The result is a relative, color-coded comparison of the provinces, revealing local hotspots of exposure.

The findings clearly show: Exposure is particularly high in regions with flat topography, high population density, or inadequate drainage infrastructure — such as Cagayan, Pampanga, or Agusan del Norte. Other provinces like Laguna or Metro Manila demonstrate how urban planning, sewer systems, and retention areas can effectively reduce risk.

This special analysis highlights how regional detailed analyses complement the national findings of the WorldRiskIndex in a meaningful way — and provide an important foundation for adaptive strategies in particularly at-risk areas.

Data source: IFHV's own calculation based on GFDDR, JRC and WorldPop.

Philippines
WorldRiskIndex Rank 1

Risk very high	46.56
Exposure very high	39.99
Vulnerability very high	54.20

Philippines: The WordlRiskIndex and Local Exposure

The WorldRiskIndex 2025 provides a global perspective on disaster risk by linking exposure to natural hazards with societal vulnerability. However, its application at the local level faces methodological limitations, such as the availability of small-scale data. This is also true for to the Philippines — a country characterized by high geographic fragmentation and high exposure to weather-related extremes.

This year's focus topic therefore provides an exemplary analysis of the exposure of Philippine provinces, with an emphasis on river and coastal flooding. Building on the methodology of the WorldRiskIndex, but adapted to local conditions, population and hazard data with a 1-kilometer grid resolution were used; five intensity levels up to 2.5 meters of flood depth were defined, and both absolute and relative exposure values were calculated. Aggregation was performed across coastal and river floods, followed by normalization according to Weller (2022). The result is a relative ranking of the provinces. The analysis provides a locally adapted exposure assessment that enables more precise insights into the spatial distribution of flood risk across the Philippines. The underlying map visualizes these results and shows the regions where the combined exposure to river and coastal flooding is particularly high.

Rank	Province	Exposure
1.	Cagayan	88.10
2.	Agusan del Norte	87.51
3.	Pangasinan	85.19
4.	Pampanga	83.49
5.	Maguindanao	82.94
6.	Metropolitan Manila	81.12
7.	Camarines Sur	75.77
8.	Misamis Oriental	73.66
9.	Camarines Norte	72.69
10.	Isabela	71.23
...		...
72.	Romblon	23.88
73.	Masbate	22.08
74.	Catanduanes	21.07
75.	Surigao del Norte	17.93
76.	Guimaras	16.84
77.	Dinagat Islands	15.84
78.	Sarangani	0.41
79.	Batanes	0.17
80.	Laguna	0.02
81.	Marinduque	0.01

At the top of the ranking are the regions of Cagayan, Agusan del Norte, Pangasinan, Pampanga, and Maguindanao, grouped here as a single methodological unit. They share a location in lowland basins with flat topography, where water drains slowly and often remains standing for days. In wide, shallow river systems — such as the Cagayan, Agusan, Agno, Sinocalan and Pampanga Rivers — precipitation accumulates rapidly; typhoons regularly cause prolonged flooding as a result. Cagayan and Agusan del Norte are particularly vulnerable due to the combination of long main rivers, dense tributary systems, and extensive coastlines. At the other end of the spectrum are Marinduque, Laguna, Batanes, and Sarangani. These regions lack large river systems; small catchment areas and natural drainage reduce flood risks despite their proximity to the coast.

A comparison of the flood-prone metropolitan region of Manila (ranked 6th) with the neighboring province of Laguna illustrates the impact of geography and infrastructure on exposure. Manila is located in a low-lying, densely populated river plain, crossed by the Pasig River and covered by a heavily regulated canal network. The high degree of soil sealing (impervious surfaces) promotes urban flash flooding during heavy rainfall. In contrast, Laguna benefits from hilly terrain and the buffering effect of Laguna de Bay, the country's largest inland lake. It acts as a natural retention area that absorbs excess water and releases it slowly. In addition, despite growing urbanization, Laguna has larger unsealed rural areas with better infiltration capacity. Lower-lying communities such as Bay, Biñan, and Los Baños remain exposed but usually experience slower, more manageable flooding.

The example of Laguna shows how targeted spatial planning, adapted building regulations, and sustainable infrastructure measures can effectively reduce exposure. The local perspective complements the WorldRiskIndex with decision-relevant details: only spatially differentiated analyses allow for the development and prioritization of tailored adaptation strategies.

4 Requirements and Recommendations

Bündnis Entwicklung Hilft
and
Institut für Friedenssicherungsrecht und Humanitäres Völkerrecht

The current challenges in flood risk management require a fundamental rethinking of disaster preparation. Extreme weather events are not only increasing in frequency, but are also increasingly exceeding the capacities of existing protection systems. At the same time, practical examples from various regions of the world show that successful coping strategies are based on the interplay of several factors: technological innovation, local capacity for action, and ecological resilience. A critical success factor lies in overcoming the previous fragmentation between different approaches. Flood protection can no longer be regarded as an isolated technical task, but must be understood as a societal challenge that equally encompasses spatial planning, ecosystem management, and social cohesion. The growing complexity of risk scenarios calls for integrated solutions that systematically link different knowledge systems and levels of action. Particular importance is attached to the interface between modern technologies and local coping capacities. While digital tools offer new possibilities for early warning and damage limitation, their effectiveness remains limited if they are not embedded in local decision-making structures. Likewise, although nature-based solutions show promising potential, they often fail due to implementation barriers and insufficient political anchoring. The greatest challenge lies in connecting these different elements into a coherent framework for action — a framework that links scientific knowledge with practical applicability, reconciles global standards with local adaptability, and combines short-term protection with long-term resilience. It is precisely at this point that the following strategic recommendations set in, pointing out concrete ways to overcome these systemic challenges.

Strengthening Local and International Governance Structures

+ The implementation of a binding framework for the integration of informal networks into formal disaster management systems requires concrete measures at multiple levels. Municipal administrations should, through legal regulations, be obliged to establish institutionalized cooperation mechanisms with local actors, which define clear allocations of competences, resource distribution, and decision-making processes. In parallel, capacity-building measures are essential that both strengthen the technical abilities of local actors and promote the acceptance of informal structures among authorities.

+ The establishment of regional competence centers for participatory risk management represents an innovative approach to systematically document local knowledge and integrate it into decision-making processes. These centers should function as permanent interfaces between authorities, science, and civil society and, in addition to knowledge management, also take over the coordination of prevention measures. Permanent financing by the federal and state governments is indispensable for this.

+ Communities of states such as the EU should introduce binding minimum standards for flood preparedness that combine three central elements: technical requirements for nature-based solutions, mandatory participation procedures, and transparent reporting. Compliance should be monitored by an independent body, which also recommends regular adjustments and differentiated sanction mechanisms.

- International and regional regulatory frameworks should contain clear, verifiable adaptation obligations in order to ensure reliable flood preparedness. Soft-law principles are no longer sufficient in view of increasing extreme weather events. Existing obligations such as flood risk management plans should be monitored more strictly, and sanctions considered in cases of non-compliance.

Techonlogical Innovation and Digital Transformation

- A transnational data infrastructure with barrier-free, real-time access to satellite data as well as jointly usable analysis platforms should be developed together with hybrid warning systems that combine artificial intelligence and local knowledge sources. Through this combination, early warning times can be significantly improved and the data situation, particularly in regions with insufficient monitoring, can be strengthened. Training programs and standardized protocols ensure that technical data can be prepared and used in a comprehensible way.

- It must be ensured that all systems are based on open data standards and use international interfaces in order to enable cross-border exchange. In this way, smaller and less well-resourced municipalities can also benefit from the same information flows and strengthen their resilience in a targeted manner.

Systemic implementation of nature-based solutions

- The development of a nationwide system of nature-based flood protection measures requires innovative governance approaches. A three-tiered model consisting of regulatory requirements (e.g., unsealing quotas), economic incentives (tax relief, eco-points systems), and voluntary cooperation models (land pools, cooperatives) could be pioneering in this respect. Pilot regions should be scientifically supported in order to develop scalable models. The creation of a standardized evaluation framework for nature-based solutions is decisive for their political acceptance. This must quantify not only hydrological parameters but also socio-economic and ecological indicators, and integrate qualitative assessment methods for effects that are difficult to measure (e.g., quality of life). Long-term studies in reference areas are indispensable for this purpose. The package of measures particularly includes unsealing, greening, and water retention in settlement and open areas.

Transformation of international cooperation

- International cooperation should be based on binding partnerships with local organizations. This includes a fixed quota for direct fund allocation, simplified accounting procedures, decision-making bodies with equal representation, and the promotion of joint research programs as well as South-South cooperation.

Integration of local and indigenous knowledge in risk communication and early warning

- Local and indigenous knowledge (IKS) closes gaps in global forecasting models and supports anticipatory action. Early warning systems are more effective when they are adapted to local realities and designed jointly with those affected. This includes comprehensible, culturally relevant risk communication as well as the simultaneous development of local capacities to interpret warnings and respond appropriately.

Sponge city — urban water retention as a holistic resilience strategy

- The sponge city is an example of an integrated solution strategy that combines ecological, social, technical, and political perspectives of flood risk management and thereby implements central approaches of the WorldRiskReport in practice.

- Cities and municipalities should increasingly adopt the sponge city principle in order

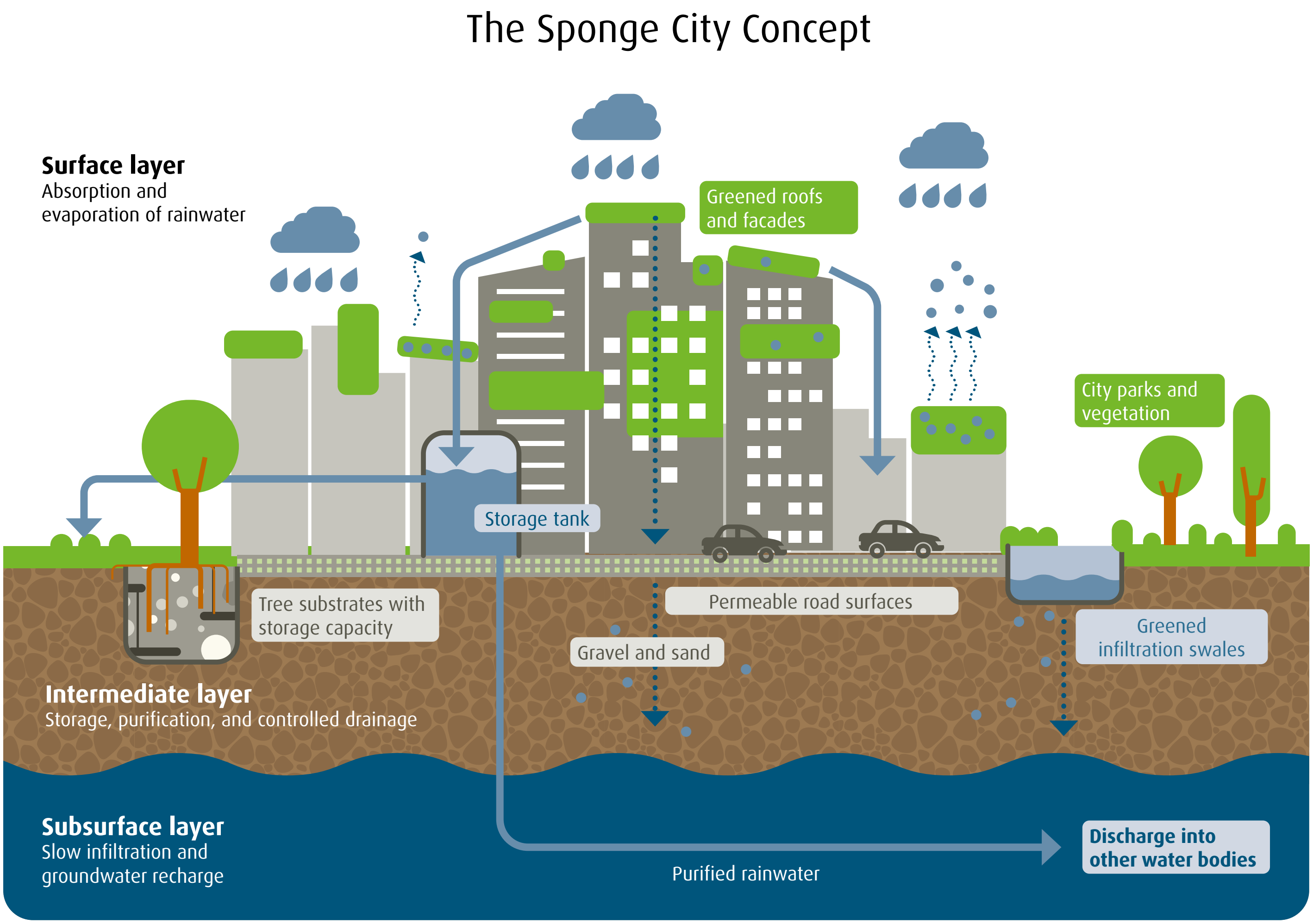


Figure 7: The sponge city reduces the risk of flooding through storage, evaporation, and controlled infiltration of rainwater. Its layered system enables holistic water management that uses rainwater as a resource instead of discharging it as waste. Source: Ali et al. (2024)

to mitigate heavy rainfall events, reduce heat islands, and promote groundwater recharge. Central measures are unsealed surfaces, green roofs, infiltration basins, retention areas, and open watercourses.

+ These nature-based solutions simultaneously contribute to biodiversity, improve air quality, and create recreational spaces.

+ In order to fully exploit the potential, a binding integration of the sponge city concept into spatial planning, building regulations, and funding programs is necessary. Municipalities should be supported technically and financially by the federal and state governments. Effectiveness increases when measures are planned in a participatory manner and local conditions are taken into account. International examples show that sponge city elements can be applied not only in metropolises but also in medium-sized and small towns.

WorldRiskIndex 2025 Overview

Classification	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of Coping Capacities	Lack of Adaptive Capacities
very low	0.00 – 1.84	0.00 – 0.17	0.00 – 9.90	0.00 – 7.17	0.00 – 3.47	0.00 – 25.28
low	1.85 – 3.20	0.18 – 0.56	9.91 – 15.87	7.18 – 11.85	3.48 – 10.01	25.29 – 37.47
medium	3.21 – 5.87	0.57 – 1.76	15.88 – 24.43	11.86 – 19.31	10.02 – 12.64	37.48 – 48.04
high	5.88 – 12.88	1.77 – 7.78	24.44 – 33.01	19.32 – 34.16	12.65 – 39.05	48.05 – 59.00
very high	12.89 – 100.00	7.79 – 100.00	33.02 – 100.00	34.17 – 100.00	39.06 – 100.00	59.01 – 100.00

Beginning in 2022, the WorldRiskIndex and its components will use fixed thresholds for classifying countries to allow for medium- and long-term trend analysis. These threshold values for the WorldRiskIndex and each dimension have been calculated as the median of the quintiles from the results of the last 20 years.

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of Coping Capacities	Lack of Adaptive Capacities
1.	Philippines	46.56	39.99	54.20	50.10	58.54	54.30
2.	India	40.73	35.99	46.10	34.56	54.08	52.43
3.	Indonesia	39.80	39.89	39.71	24.80	51.27	49.24
4.	Colombia	39.26	31.54	48.86	47.85	50.87	47.91
5.	Mexico	38.96	50.08	30.31	44.39	12.53	50.07
6.	Myanmar	36.91	22.43	60.74	55.42	64.47	62.72
7.	Mozambique	34.39	18.10	65.33	65.91	63.33	66.79
8.	Russian Federation	31.22	28.35	34.38	26.49	39.99	38.36
9.	China	30.62	64.59	14.52	8.96	11.44	29.85
10.	Pakistan	26.82	13.11	54.85	40.52	63.30	64.34
11.	Bangladesh	26.71	16.57	43.07	27.09	59.29	49.73
12.	Papua New Guinea	26.51	18.84	37.29	57.52	13.36	67.46
13.	Vietnam	25.92	26.73	25.14	24.42	13.00	50.05
14.	Peru	25.81	16.65	40.02	28.12	48.69	46.83
15.	Somalia	24.89	8.55	72.45	68.89	81.04	68.13
16.	Yemen	24.83	9.12	67.59	59.67	72.95	70.93
17.	Japan	24.81	43.67	14.09	13.44	6.99	29.80
18.	Ecuador	24.14	14.57	39.98	27.02	47.78	49.50
19.	Madagascar	23.68	18.38	30.51	25.96	15.28	71.62
20.	Nicaragua	23.60	18.71	29.76	35.86	14.07	52.26
21.	United States of America	23.09	39.59	13.47	9.89	7.57	32.64
22.	Venezuela (Bolivarian Republic of)	22.12	19.52	25.06	18.43	14.91	57.26
23.	Australia	21.90	31.21	15.37	8.31	14.67	29.78
24.	Thailand	20.03	14.32	28.03	12.35	49.29	36.18
25.	Canada	19.88	25.89	15.26	12.66	8.03	34.97
26.	Egypt	18.91	10.74	33.30	15.80	45.76	51.05
27.	Panama	18.25	15.89	20.95	19.49	11.06	42.63
28.	Honduras	17.78	8.82	35.85	52.48	14.79	59.36
29.	Iran (Islamic Republic of)	16.30	12.49	21.28	20.42	57.17	8.25
30.	Tanzania (United Republic of)	16.11	5.49	47.29	32.80	55.23	58.39
31.	Argentina	15.72	11.54	21.42	18.70	10.76	48.81
32.	Libya (Libyan Arab Jamahiriya)	15.69	4.94	49.81	40.77	62.66	48.37
33.	New Zealand	15.20	17.99	12.85	8.79	6.69	36.06
34.	Solomon Islands	15.04	9.62	23.50	18.28	12.72	55.83
35.	Turkey	14.62	8.90	24.01	16.04	54.07	15.95
36.	El Salvador	14.41	7.30	28.43	45.69	11.73	42.88
37.	Malaysia	14.28	8.64	23.61	16.46	20.53	38.95
38.	Chile	14.27	12.86	15.84	10.43	9.74	39.12
39.	Brazil	13.80	6.37	29.90	44.48	12.25	49.06

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of Coping Capacities	Lack of Adaptive Capacities
40.	Kenya	13.72	3.27	57.53	58.49	56.38	57.73
41.	Dominican Republic	13.47	7.05	25.72	27.65	12.73	48.35
42.	Syrian Arab Republic	12.65	2.53	63.24	51.54	74.84	65.56
43.	North Korea	11.70	7.22	18.97	8.17	12.74	65.56
44.	Vanuatu	11.67	5.80	23.50	19.02	12.73	53.62
45.	Guatemala	11.36	4.29	30.06	32.45	14.82	56.49
46.	Italy	11.34	8.69	14.80	11.96	8.33	32.52
47.	Costa Rica	11.32	9.89	12.95	16.10	11.22	12.02
48.	Cameroon	11.19	2.08	60.20	56.26	61.61	62.93
49.	South Korea	11.01	9.96	12.17	8.72	8.00	25.84
50.	Angola	10.83	2.37	49.49	33.73	52.16	68.91
51.	Morocco	10.55	7.63	14.59	21.14	12.65	11.61
52.	Sudan	10.41	1.65	65.69	59.29	64.66	73.93
53.	Spain	10.17	7.77	13.32	8.48	8.12	34.30
54.	Haiti	10.06	2.78	36.40	44.50	15.09	71.81
55.	Djibouti	10.03	4.25	23.69	17.64	14.64	51.48
56.	Democratic Republic of Congo	9.68	1.37	68.41	67.14	67.92	70.21
57.	Saudi Arabia	9.67	5.25	17.81	9.35	19.06	31.71
58.	South Africa	9.50	3.13	28.81	37.05	11.74	54.96
59.	Algeria	9.25	2.62	32.68	15.59	47.72	46.91
60.	Nigeria	9.19	1.32	63.99	56.86	64.34	71.63
61.	Iraq	9.06	2.91	28.18	29.16	13.24	57.96
61.	Mauritania	9.06	1.72	47.68	37.66	55.70	51.67
63.	Greece	9.02	8.25	9.87	11.37	8.55	9.88
64.	Cambodia	8.14	2.47	26.81	29.87	13.97	46.19
65.	Oman	7.84	6.68	9.20	16.59	4.79	9.80
66.	France	7.75	2.70	22.27	9.97	33.29	33.29
67.	Tunisia	7.67	2.88	20.45	17.68	11.18	43.28
68.	Belize	7.31	2.50	21.40	15.91	12.71	48.45
69.	Timor-Leste	7.25	2.93	17.94	8.33	12.63	54.90
70.	Guinea	6.92	1.47	32.58	31.83	14.99	72.48
70.	Cuba	6.92	4.57	10.47	13.06	7.49	11.74
72.	Fiji	6.87	2.79	16.94	20.98	11.72	19.76
73.	Guyana	6.40	2.63	15.57	17.63	11.89	17.99
74.	Suriname	6.21	1.78	21.70	15.80	11.58	55.86
75.	Gabon	6.18	1.50	25.43	27.59	11.86	50.28
76.	United Kingdom	6.14	2.58	14.62	10.64	7.93	37.00
77.	Eritrea	6.03	2.30	15.79	18.31	3.71	57.99
78.	United Arab Emirates	5.97	3.77	9.44	6.44	4.22	30.97
79.	Albania	5.91	2.29	15.25	9.06	10.16	38.54
80.	Namibia	5.86	1.32	26.05	30.78	10.15	56.57
81.	Belgium	5.80	1.84	18.27	7.43	28.12	29.21
82.	Uruguay	5.21	1.54	17.64	15.42	8.81	40.38
83.	Sierra Leone	4.96	1.09	22.57	14.08	13.02	62.75
84.	Poland	4.92	1.73	13.98	8.40	7.87	41.34
85.	Croatia	4.89	1.57	15.25	10.69	9.48	34.97
86.	Ethiopia	4.87	0.36	66.01	61.91	66.94	69.41
86.	Senegal	4.87	1.05	22.62	17.45	12.28	54.00
86.	Sri Lanka	4.87	1.60	14.83	18.75	12.37	14.07
89.	Portugal	4.76	3.07	7.37	13.37	2.19	13.66
90.	Bahamas	4.44	1.51	13.07	11.37	5.04	38.97
91.	Gambia	4.43	0.67	29.24	31.41	12.78	62.30

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of Coping Capacities	Lack of Adaptive Capacities
92.	Ukraine	4.34	0.48	39.24	27.95	43.75	49.40
93.	Netherlands	4.33	2.20	8.53	5.41	3.45	33.27
94.	Lebanon	4.29	0.38	48.38	30.59	58.53	63.23
95.	Congo (Republic of)	4.28	0.57	32.16	35.29	14.57	64.71
95.	Germany	4.28	1.99	9.19	6.38	3.55	34.22
97.	South Sudan	4.17	0.25	69.62	69.00	66.23	73.84
97.	Micronesia (Federated States of)	4.17	1.12	15.54	12.93	5.73	50.68
99.	Jamaica	3.97	1.10	14.35	11.05	5.98	44.71
100.	Georgia	3.80	0.73	19.82	19.92	10.32	37.90
100.	Antigua and Barbuda	3.80	1.20	12.02	18.08	2.57	37.35
102.	Afghanistan	3.70	0.25	54.81	32.13	73.62	69.61
103.	Israel	3.69	0.88	15.48	11.92	9.57	32.52
104.	Tonga	3.67	1.33	10.10	7.55	11.57	11.81
105.	Liberia	3.64	0.54	24.52	33.94	6.64	65.45
106.	Mauritius	3.48	0.73	16.55	11.65	9.90	39.28
107.	Central African Republic	3.41	0.16	72.71	74.55	66.25	77.83
108.	Malawi	3.38	0.35	32.63	34.65	14.90	67.30
108.	Sweden	3.38	1.05	10.90	7.01	6.81	27.16
110.	Romania	3.36	0.86	13.15	10.86	3.60	58.12
110.	Equatorial Guinea	3.36	0.71	15.88	9.47	8.59	49.27
110.	Cyprus	3.36	1.02	11.09	8.93	4.56	33.45
113.	Ireland	3.25	1.45	7.28	8.68	1.87	23.76
114.	Jordan	3.21	0.57	18.12	14.34	9.48	43.76
115.	Ghana	3.19	0.34	29.84	39.03	11.48	59.32
116.	Latvia	3.18	0.79	12.84	9.06	7.63	30.62
117.	Guinea-Bissau	3.15	0.67	14.84	13.98	3.67	63.75
118.	Bolivia (Plurinational State of)	3.13	0.35	27.91	27.83	13.62	57.35
119.	Samoa	3.10	0.81	11.88	12.97	2.55	50.70
120.	Burundi	3.04	0.16	57.76	45.88	60.46	69.46
121.	Trinidad and Tobago	3.03	0.49	18.74	14.77	11.30	39.42
122.	Lao People’s Democratic Republic	3.00	0.38	23.63	16.10	13.57	60.42
123.	Norway	2.95	1.06	8.20	4.47	4.80	25.68
124.	Zambia	2.94	0.28	30.84	34.40	13.17	64.73
125.	Chad	2.91	0.12	70.70	67.25	70.07	75.01
126.	Tajikistan	2.90	0.23	36.56	22.01	45.42	48.89
127.	Barbados	2.89	0.48	17.40	13.86	8.77	43.32
128.	Montenegro	2.86	0.83	9.87	9.17	2.45	42.81
129.	Uganda	2.81	0.23	34.32	47.49	13.84	61.51
130.	Kiribati	2.80	0.69	11.40	9.75	2.86	53.10
131.	Dominica	2.73	0.79	9.42	7.56	2.46	44.89
132.	Kyrgyzstan	2.72	0.22	33.68	15.53	47.73	51.55
132.	Saint Vincent and the Grenadines	2.72	0.43	17.25	19.65	9.90	26.40
134.	Comoros	2.69	0.33	21.91	12.60	14.13	59.08
135.	Seychelles	2.68	1.03	6.96	4.40	2.21	34.64
136.	Rwanda	2.66	0.16	44.18	33.19	46.56	55.82
137.	Nepal	2.60	0.25	27.01	27.07	13.39	54.36
138.	Saint Lucia	2.53	0.46	13.93	6.98	9.57	40.45
139.	Marshall Islands	2.52	0.50	12.75	8.28	5.27	47.50
140.	Bosnia and Herzegovina	2.49	0.34	18.17	11.02	11.58	46.98
141.	Kuwait	2.42	1.05	5.56	4.53	2.55	14.90
142.	Azerbaijan	2.40	0.23	25.03	26.73	12.95	45.28
143.	Zimbabwe	2.38	0.20	28.23	24.62	13.34	68.52

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of Coping Capacities	Lack of Adaptive Capacities
144.	Iceland	2.34	0.55	9.94	7.94	6.45	19.17
145.	Lithuania	2.32	0.64	8.41	8.90	2.09	31.97
146.	Mali	2.24	0.08	62.53	58.61	64.25	64.92
146.	Saint Kitts and Nevis	2.24	0.53	9.43	10.56	2.50	31.73
148.	Bulgaria	2.23	0.30	16.59	12.18	9.04	41.47
149.	Slovenia	2.22	0.31	15.86	12.96	8.98	34.31
150.	Niger	2.17	0.07	67.28	65.23	66.06	70.67
150.	Palau	2.17	0.36	13.04	6.72	9.89	33.35
152.	Burkina Faso	2.04	0.07	59.22	61.52	58.01	58.19
153.	Grenada	2.02	0.31	13.15	11.55	4.94	39.82
154.	Mongolia	1.96	0.21	18.35	12.69	11.29	43.16
155.	Armenia	1.91	0.23	15.85	9.21	42.50	10.18
156.	Paraguay	1.88	0.14	25.18	25.86	12.06	51.17
157.	Côte d'Ivoire	1.86	0.13	26.62	24.16	12.54	62.28
158.	Estonia	1.84	0.43	7.84	6.93	2.00	34.81
159.	Eswatini	1.76	0.14	22.23	17.59	11.16	55.93
160.	Serbia	1.75	0.17	18.09	14.55	9.89	41.16
161.	Kazakhstan	1.73	0.25	11.99	14.64	10.24	11.49
162.	Benin	1.62	0.09	29.15	31.61	13.25	59.16
163.	Finland	1.60	0.49	5.20	6.82	0.86	23.95
164.	Tuvalu	1.47	0.15	14.38	7.90	10.39	36.19
165.	Togo	1.45	0.07	30.18	33.60	13.63	60.05
166.	Uzbekistan	1.42	0.18	11.19	10.02	10.82	12.92
167.	Lesotho	1.41	0.07	28.31	30.48	11.78	63.21
168.	Austria	1.31	0.17	10.09	9.70	3.36	31.54
168.	Brunei Darussalam	1.31	0.33	5.20	9.62	2.17	6.73
170.	Moldova (Republic of)	1.28	0.10	16.37	9.99	9.33	47.08
171.	Turkmenistan	1.27	0.17	9.43	9.31	3.14	28.73
172.	Botswana	1.25	0.09	17.43	20.34	5.40	48.24
173.	Switzerland	1.23	0.16	9.47	6.42	5.12	25.85
174.	Czech Republic	1.17	0.10	13.75	9.60	7.54	35.92
175.	Cape Verde	1.16	0.07	19.29	15.08	10.54	45.19
176.	Slovakia	1.11	0.10	12.41	11.61	4.37	37.66
176.	Bhutan	1.11	0.10	12.40	8.18	8.86	26.28
178.	Denmark	1.07	0.18	6.32	5.73	1.54	28.54
179.	Maldives	1.04	0.15	7.21	5.90	2.07	30.73
179.	Malta	1.04	0.11	9.82	9.86	9.93	9.66
181.	North Macedonia	1.01	0.10	10.12	8.48	2.58	47.42
182.	Hungary	0.91	0.11	7.61	8.81	4.97	10.05
183.	Nauru	0.88	0.15	5.19	3.37	2.31	17.98
183.	Qatar	0.88	0.11	7.12	8.08	2.73	16.35
185.	Bahrain	0.87	0.14	5.45	7.13	2.66	8.55
186.	Belarus	0.72	0.05	10.44	10.14	2.95	38.02
187.	Liechtenstein	0.68	0.09	5.07	6.63	0.98	20.08
188.	Singapore	0.67	0.15	2.99	3.92	0.86	7.94
189.	Sao Tome and Principe	0.61	0.02	18.86	9.76	12.99	52.92
190.	Luxembourg	0.57	0.06	5.48	5.35	3.09	9.98
191.	San Marino	0.35	0.03	4.08	3.06	1.30	17.08
192.	Andorra	0.29	0.02	4.07	3.08	1.80	12.17
193.	Monaco	0.18	0.02	1.55	1.75	0.42	5.05

WorldRiskIndex 2024, Countries in Alphabetical Order

Country	WRI	Rank
Afghanistan	3,70	102.
Albania	5,91	79.
Algeria	9,25	59.
Andorra	0,29	192.
Angola	10,83	50.
Antigua and Barbuda	3,80	100.
Argentina	15,72	31.
Armenia	1,91	155.
Australia	21,90	23.
Austria	1,31	168.
Azerbaijan	2,40	142.
Bahamas	4,44	90.
Bahrain	0,87	185.
Bangladesh	26,71	11.
Barbados	2,89	127.
Belarus	0,72	186.
Belgium	5,80	81.
Belize	7,31	68.
Benin	1,62	162.
Bhutan	1,11	176.
Bolivia (Plurinational State of)	3,13	118.
Bosnia and Herzegovina	2,49	140.
Botswana	1,25	172.
Brazil	13,80	39.
Brunei Darussalam	1,31	168.
Bulgaria	2,23	148.
Burkina Faso	2,04	152.
Burundi	3,04	120.
Cambodia	8,14	64.
Cameroon	11,19	48.
Canada	19,88	25.
Cape Verde	1,16	175.
Central African Republic	3,41	107.
Chad	2,91	125.
Chile	14,27	38.
China	30,62	9.
Colombia	39,26	4.
Comoros	2,69	134.
Congo (Republic of)	4,28	95.
Costa Rica	11,32	47.
Côte d’Ivoire	1,86	157.
Croatia	4,89	85.
Cuba	6,92	70.
Cyprus	3,36	110.
Czech Republic	1,17	174.
Democratic Republic of Congo	9,68	56.
Denmark	1,07	178.
Djibouti	10,03	55.
Dominica	2,73	131.
Dominican Republic	13,47	41.
Ecuador	24,14	18.
Egypt	18,91	26.

Country	WRI	Rank
El Salvador	14,41	36.
Equatorial Guinea	3,36	110.
Eritrea	6,03	77.
Estonia	1,84	158.
Eswatini	1,76	159.
Ethiopia	4,87	86.
Fiji	6,87	72.
Finland	1,60	163.
France	7,75	66.
Gabon	6,18	75.
Gambia	4,43	91.
Georgia	3,80	100.
Germany	4,28	95.
Ghana	3,19	115.
Greece	9,02	63.
Grenada	2,02	153.
Guatemala	11,36	45.
Guinea	6,92	70.
Guinea-Bissau	3,15	117.
Guyana	6,40	73.
Haiti	10,06	54.
Honduras	17,78	28.
Hungary	0,91	182.
Iceland	2,34	144.
India	40,73	2.
Indonesia	39,80	3.
Iran (Islamic Republic of)	16,30	29.
Iraq	9,06	61.
Ireland	3,25	113.
Israel	3,69	103.
Italy	11,34	46.
Jamaica	3,97	99.
Japan	24,81	17.
Jordan	3,21	114.
Kazakhstan	1,73	161.
Kenya	13,72	40.
Kiribati	2,80	130.
Kuwait	2,42	141.
Kyrgyzstan	2,72	132.
Lao People’s Democratic Republic	3,00	122.
Latvia	3,18	116.
Lebanon	4,29	94.
Lesotho	1,41	167.
Liberia	3,64	105.
Libya (Libyan Arab Jamahiriya)	15,69	32.
Liechtenstein	0,68	187.
Lithuania	2,32	145.
Luxembourg	0,57	190.
Madagascar	23,68	19.
Malawi	3,38	108.
Malaysia	14,28	37.
Maldives	1,04	179.

Country		WRI	Rank
Mali		2,24	146.
Malta		1,04	179.
Marshall Islands		2,52	139.
Mauritania		9,06	61.
Mauritius		3,48	106.
Mexico		38,96	5.
Micronesia (Federated States of)		4,17	97.
Moldova (Republic of)		1,28	170.
Monaco		0,18	193.
Mongolia		1,96	154.
Montenegro		2,86	128.
Morocco		10,55	51.
Mozambique		34,39	7.
Myanmar		36,91	6.
Namibia		5,86	80.
Nauru		0,88	183.
Nepal		2,60	137.
Netherlands		4,33	93.
New Zealand		15,20	33.
Nicaragua		23,60	20.
Niger		2,17	150.
Nigeria		9,19	60.
North Korea		11,70	43.
North Macedonia		1,01	181.
Norway		2,95	123.
Oman		7,84	65.
Pakistan		26,82	10.
Palau		2,17	150.
Panama		18,25	27.
Papua New Guinea		26,51	12.
Paraguay		1,88	156.
Peru		25,81	14.
Philippines		46,56	1.
Poland		4,92	84.
Portugal		4,76	89.
Qatar		0,88	183.
Romania		3,36	110.
Russian Federation		31,22	8.
Rwanda		2,66	136.
Saint Kitts and Nevis		2,24	146.
Saint Lucia		2,53	138.
Saint Vincent and the Grenadines		2,72	132.
Samoa		3,10	119.
San Marino		0,35	191.
Sao Tome and Principe		0,61	189.
Saudi Arabia		9,67	57.
Senegal		4,87	86.
Serbia		1,75	160.
Seychelles		2,68	135.
Sierra Leone		4,96	83.
Singapore		0,67	188.
Slovakia		1,11	176.

Country		WRI	Rank
Slovenia		2,22	149.
Solomon Islands		15,04	34.
Somalia		24,89	15.
South Africa		9,50	58.
South Korea (Republic of Korea)		11,01	49.
South Sudan		4,17	97.
Spain		10,17	53.
Sri Lanka		4,87	86.
Sudan		10,41	52.
Suriname		6,21	74.
Sweden		3,38	108.
Switzerland		1,23	173.
Syrian Arab Republic		12,65	42.
Tajikistan		2,90	126.
Tanzania (United Republic of)		16,11	30.
Thailand		20,03	24.
Timor-Leste		7,25	69.
Togo		1,45	165.
Tonga		3,67	104.
Trinidad and Tobago		3,03	121.
Tunisia		7,67	67.
Turkey		14,62	35.
Turkmenistan		1,27	171.
Tuvalu		1,47	164.
Uganda		2,81	129.
Ukraine		4,34	92.
United Arab Emirates		5,97	78.
United Kingdom		6,14	76.
United States of America		23,09	21.
Uruguay		5,21	82.
Uzbekistan		1,42	166.
Vanuatu		11,67	44.
Venezuela (Bolivarian Republic of)		22,12	22.
Vietnam		25,92	13.
Yemen		24,83	16.
Zambia		2,94	124.
Zimbabwe		2,38	143.

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Diversity

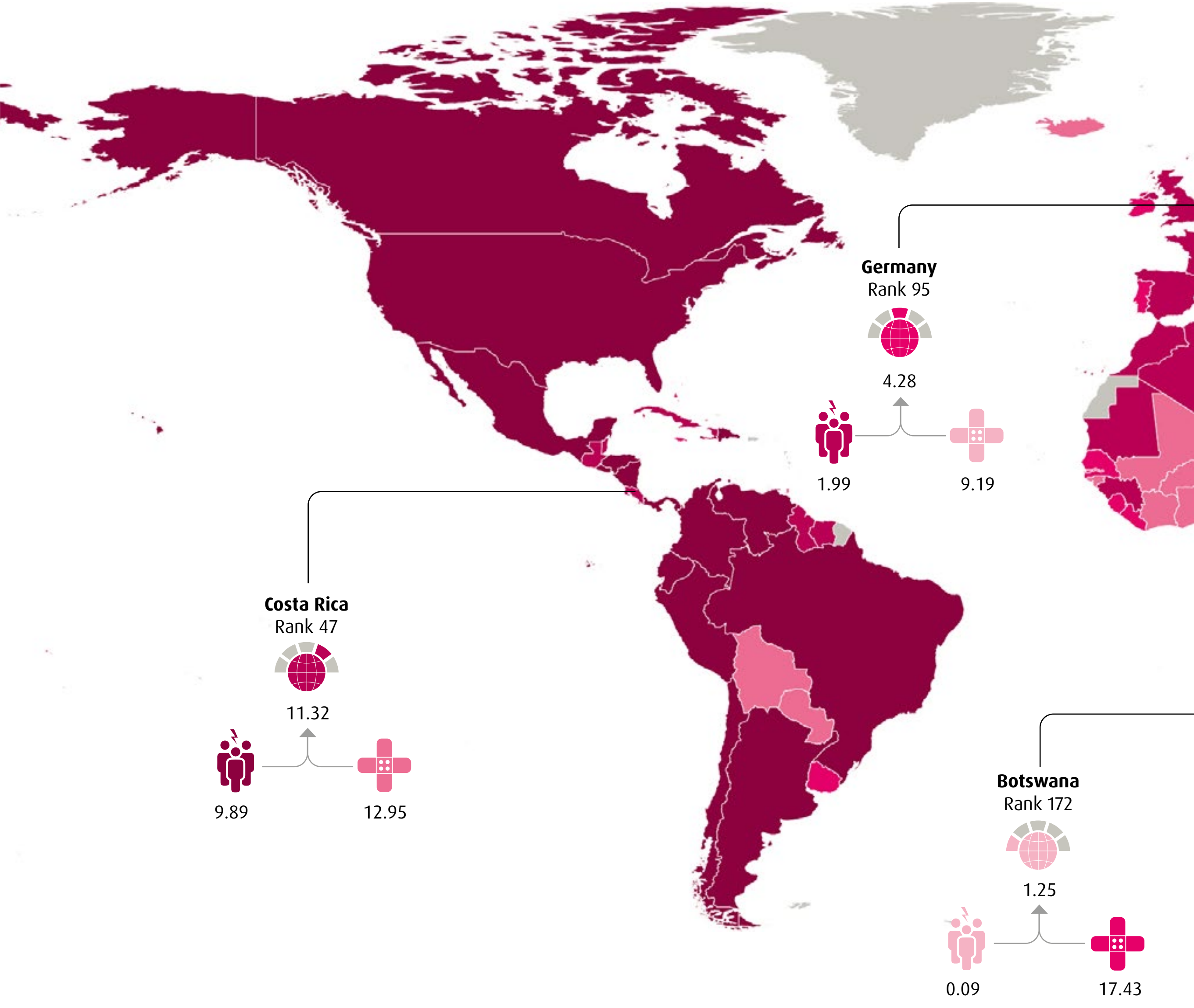
Multiple Crises

All WorldRiskReports are available to download at www.WorldRiskReport.org

Bündnis Entwicklung Hilft

Gemeinsam für Menschen in Not

WorldR



WorldRiskIndex

very low	0.00	–	1.84
low	1.85	–	3.20
medium	3.21	–	5.87
high	5.88	–	12.88
very high	12.89	–	100.00
no data			

Exposure

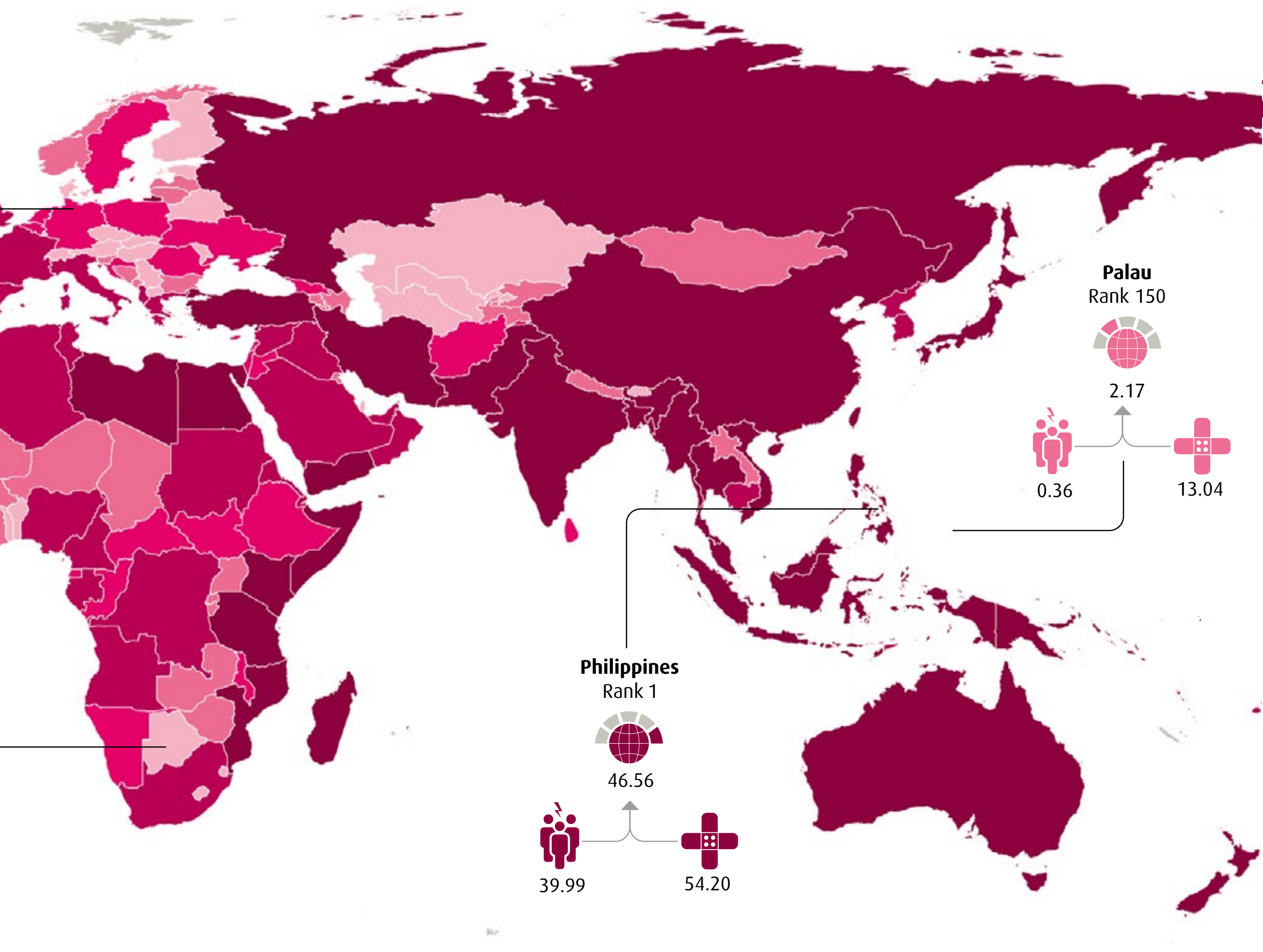
very low	0.00	–	0.17
low	0.18	–	0.56
medium	0.57	–	1.76
high	1.77	–	7.78
very high	7.79	–	100.00
no data			

Vulnerability

very low	0.00	–	9.90
low	9.91	–	15.87
medium	15.88	–	24.43
high	24.44	–	33.01
very high	33.02	–	100.00
no data			

Beginning in 2022, the WorldRiskIndex and its components will use fixed thresholds for classifying countries to allow for medium- and long-term trend analysis. These threshold values t
kIndex model is always based on unweighted geometric mean values.
Data sources: IFHV's own calculation based on CReSIS, EMDAT FAO, GFDRR, IHME, IDMC, JRC, IMF, ILO, UCDP, UNESCO, UNHCR, UNDRR, WHO, Worldbank, WorldPop, WID; detailed informatio

RiskIndex 2025



The 10 countries with the highest risk

1.	Philippines	46.56
2.	India	40.73
3.	Indonesia	39.80
4.	Colombia	39.26
5.	Mexico	38.96
6.	Myanmar	36.91
7.	Mozambique	34.39
8.	Russian Federation	31.22
9.	China	30.62
10.	Pakistan	26.82

The 10 countries with highest exposure

1.	China	64.59
2.	Mexico	50.08
3.	Japan	43.67
4.	Philippines	39.99
5.	Indonesia	39.89
6.	United States of America	39.59
7.	India	35.99
8.	Colombia	31.54
9.	Australia	31.21
10.	Russian Federation	28.35

The 10 countries with highest vulnerability

1.	Central African Republic	72.71
2.	Somalia	72.45
3.	Chad	70.70
4.	South Sudan	69.62
5.	Democratic Republic of Congo	68.41
6.	Yemen	67.59
7.	Niger	67.28
8.	Ethiopia	66.01
9.	Sudan	65.69
10.	Mozambique	65.33

for the WorldRiskIndex and each dimension were calculated as the median of the quintiles form the results of the last 20 years. The aggregation of values across all levels of the WorldRis-

n at www.WorldRiskReport.org.

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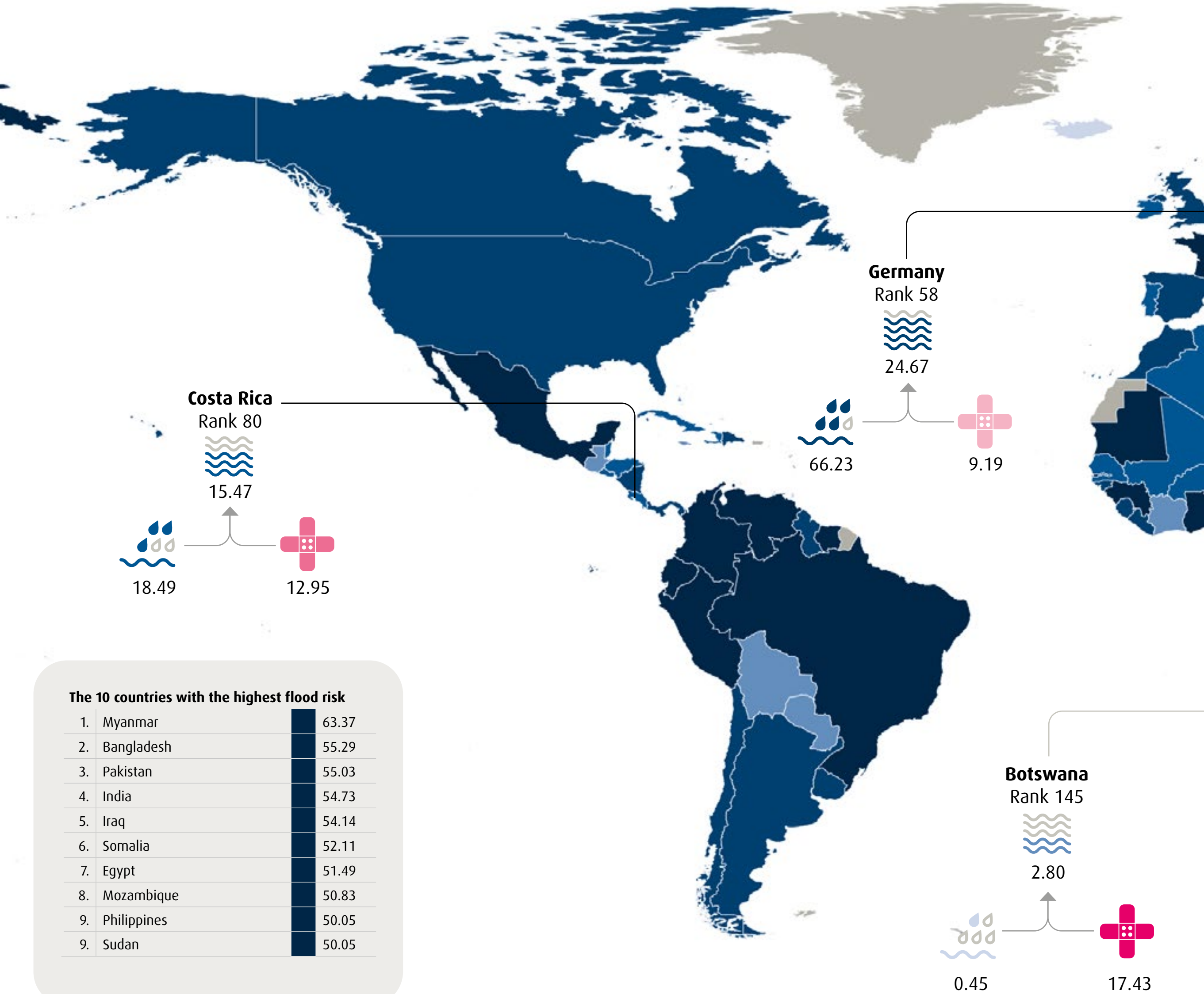

The 10 countries with the highest flood risk

1.	Myanmar	63.37
2.	Bangladesh	55.29
3.	Pakistan	55.03
4.	India	54.73
5.	Iraq	54.14
6.	Somalia	52.11
7.	Egypt	51.49
8.	Mozambique	50.83
9.	Philippines	50.05
9.	Sudan	50.05

Flood risk

very low	0.00	–	0.41
low	2.42	–	4.23
medium	4.24	–	15.81
high	15.82	–	31.61
very high	31.62	–	100.00
no data			

Flood exposure

very low	0.00	–	0.48
low	0.49	–	0.66
medium	0.67	–	19.47
high	19.48	–	40.96
very high	40.97	–	100.00
no data			

Vulnerability

very low	0.00	–	9.90
low	9.91	–	15.87
medium	15.88	–	24.43
high	24.44	–	33.01
very high	33.02	–	100.00
no data			

Data source: Own calculations by IFHV based on FAO, GFDRR, IHME, IDMC, JRC, IMF, ILO, UCDP, UNESCO, UNHCR, UNDRR, WHO, Worldbank, WorldPop, WID.

p of Flood Risk

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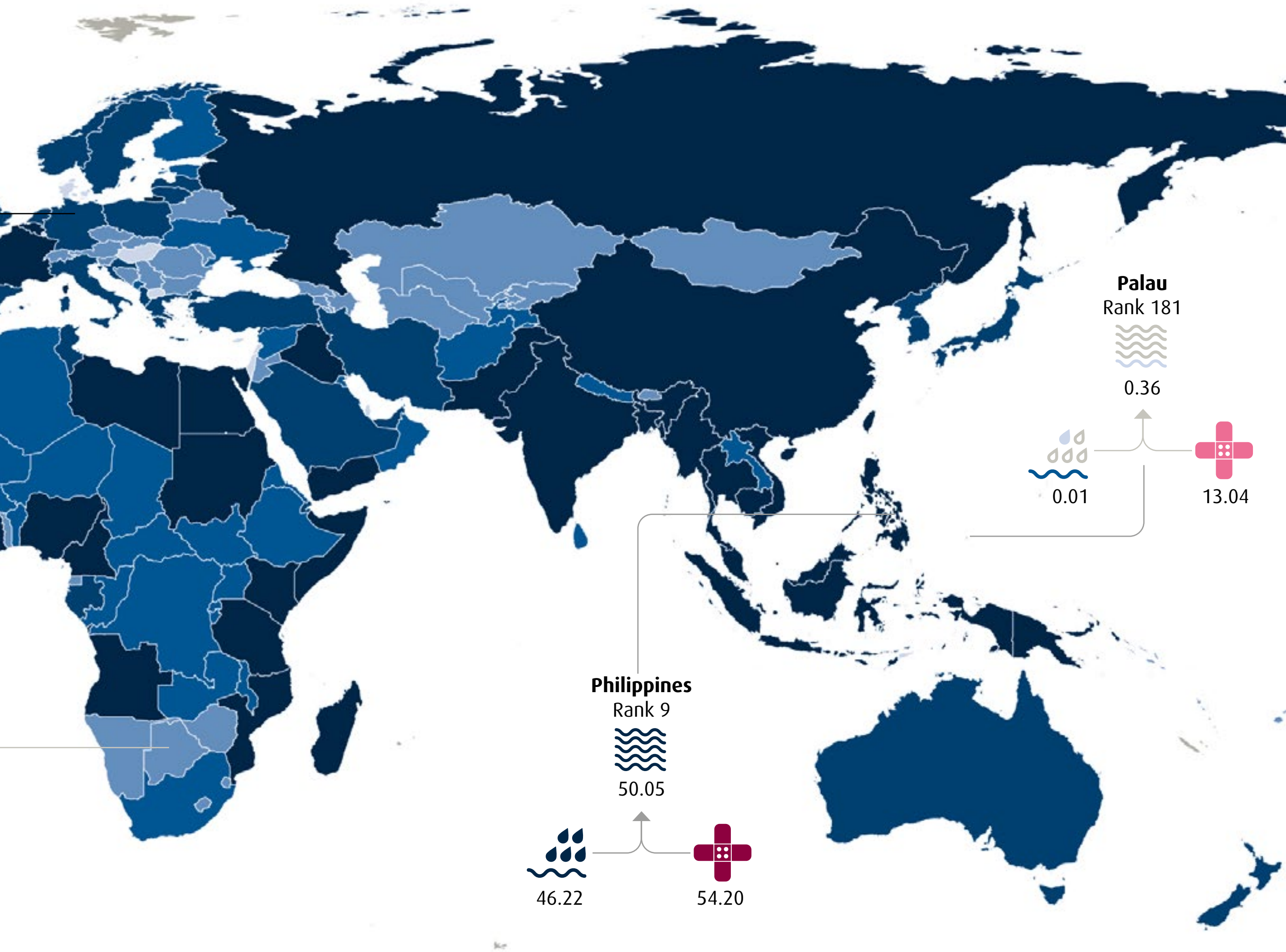
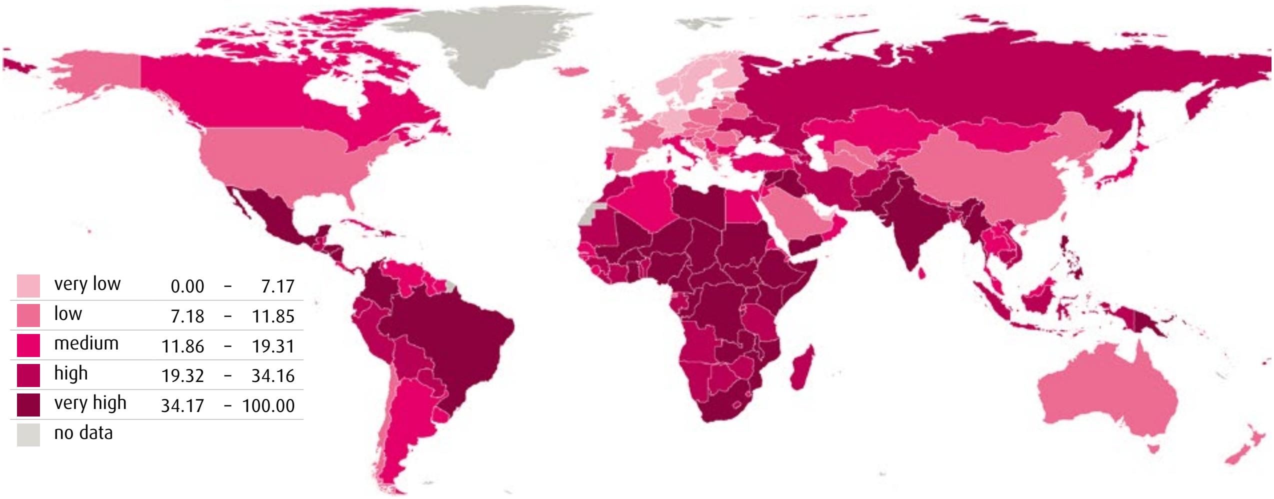


In addition to geophysical hazards, floods — caused by heavy rainfall, river flooding, or storm surges — represent a central risk for millions of people worldwide. The presented world map shows flood risk based on an adapted calculation approach of the exposure sphere of the WorldRiskIndex. Unlike the classical exposure calculation, only river and coastal floods were considered here to provide a targeted picture of this specific threat type. Particularly high values are found in South and Southeast Asia, such as in Myanmar, Vietnam, and the Philippines, where high population density, exposed locations, and intense monsoon cycles converge. Strong risks are also evident in parts of West and Central Africa as well as in Latin America (e.g., Colombia, Brazil). Noticeable is the high exposure in countries with large river systems like China, India, or Nigeria. Compared to the classical exposure of the WorldRiskIndex, both overlaps and significant differences can be observed. For example, Bolivia shows an above-average flood risk, even though it has a low risk in the WorldRiskIndex ranking. These deviations highlight the importance of differentiated risk assessments. The map underscores the necessity of targeted early warning and adaptation strategies in dealing with floods — especially in regions where socio-economic conditions further increase the risk. The complete dataset is available at WorldRiskReport.org.

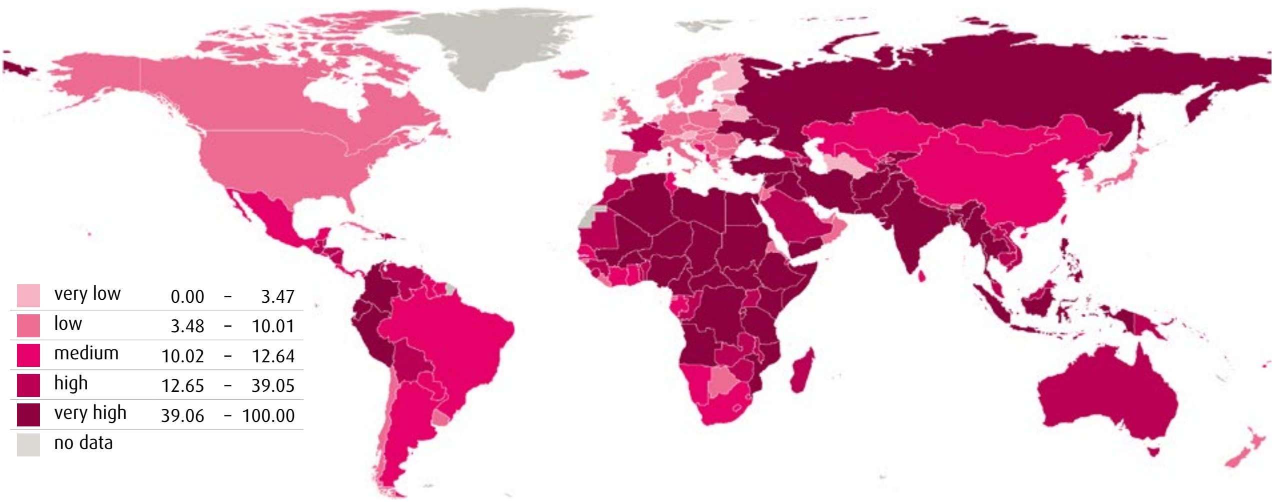
Susceptibility

Dependent on the level of socio-economic development, social disparities, deprivations, and vulnerable population groups



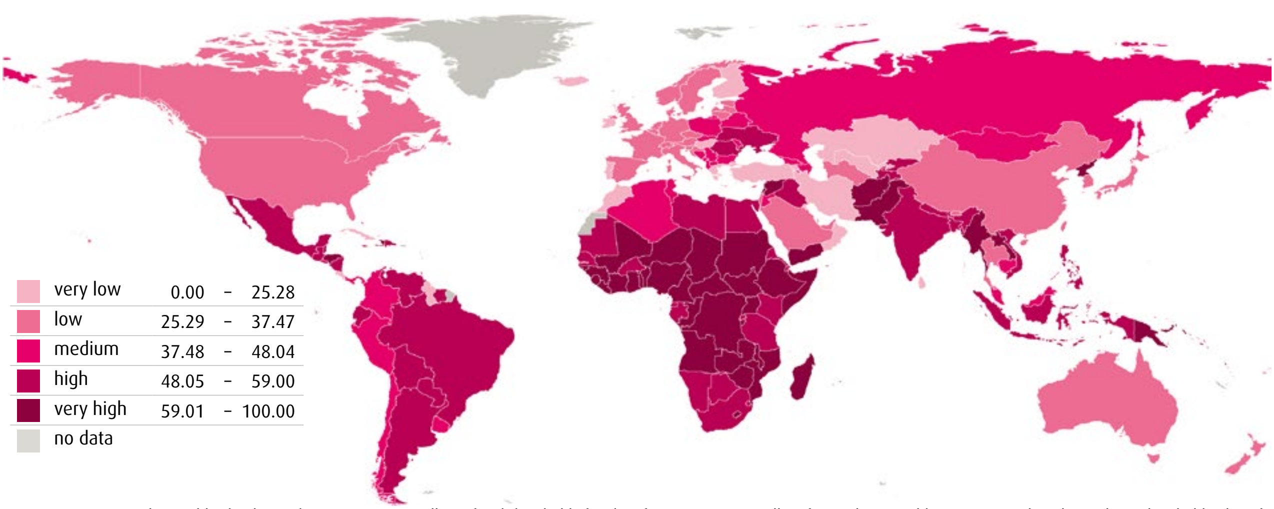
Lack of Coping Capacities

Dependent on social shocks, political stability and the rule of law, health care capacities, infrastructure, and material protection



Lack of Adaptive Capacities

Related to developments in education and research, reduction of disparities, investments, disaster prevention, and climate protection



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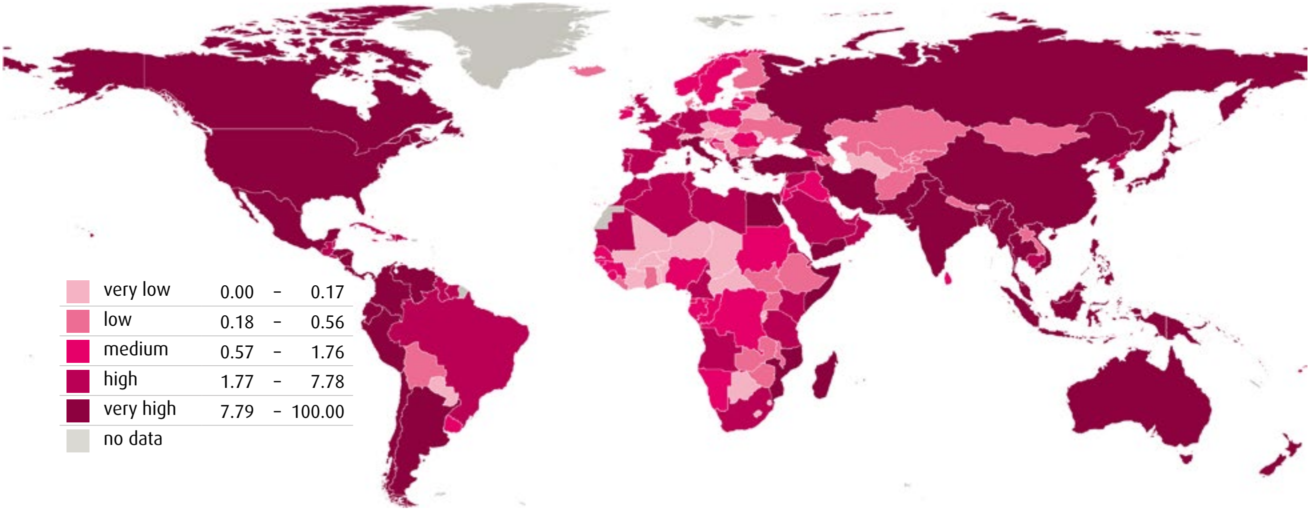
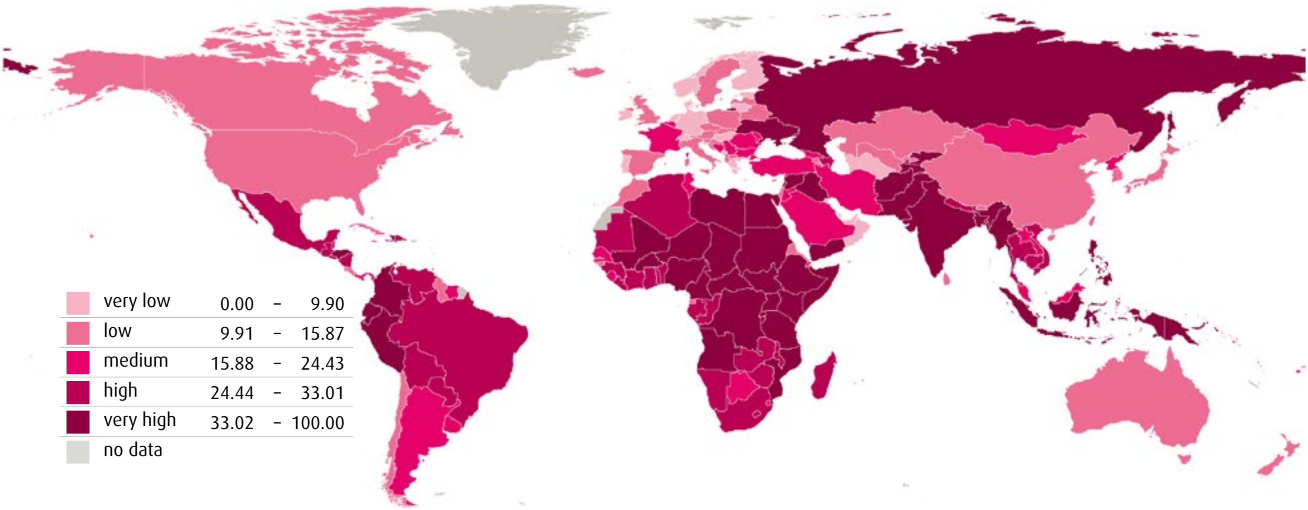
Exposure

Sphere of exposure to earthquakes, tsunamis, coastal flooding, riverine flooding, cyclone, droughts, and sea level rise



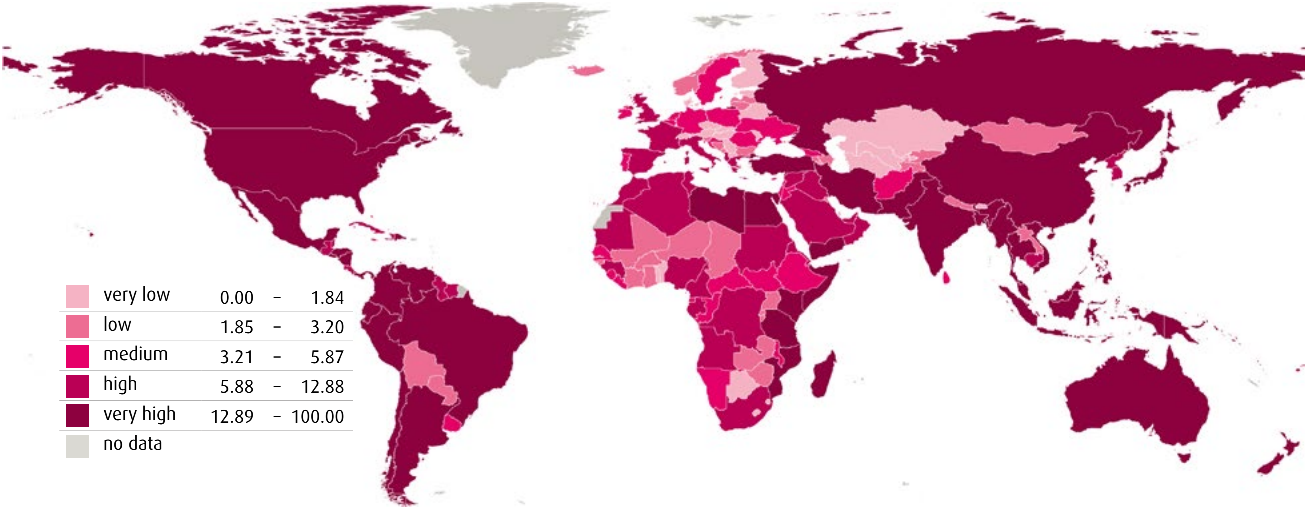
Vulnerability

Sphere of societal vulnerability consisting of susceptibility, lack of coping capacities, and lack of adaptive capacities



WorldRiskIndex

Geometric mean of exposure and vulnerability



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ww.WorldRiskReport.org.

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