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Bündnis Entwicklung Hilft

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Focus: Logistics and infrastructure

WorldRiskReport 2016

In cooperation with

Universität Stuttgart

www.WorldRiskReport.org

The print version of the WorldRiskReport has a volume enabling fast reading. The texts of the Report are supplemented by maps, diagrams and pictures to illustrate their content. More in-depth information, scientific details of the methodology applied and tables are available at www.WorldRiskReport.org. There, the 2011, 2012, 2013, 2014 and 2015 Reports can be downloaded, too.

The term "developing countries":

Finding the right word for the "poor countries" in Africa, Asia and Latin America is not unproblematic. On the one hand, different terms are used by the various global organizations (the UN, UN organizations, the World Bank) in this context. On the other hand, any expression one might use will be questionable. "Third world" is a term little appreciated by those countries attributed as such. "Developing countries" suggests that the countries in North America or Europe are developed and the countries in the other continents are underdeveloped. Of course we do not subscribe to such a simple view, but we have nevertheless opted to use the term developing countries (not in inverted commas) in this report. We hereby follow the practice of the United Nations.

1. Logistics, infrastructure and risk analysis

Dilapidated transport routes, unsafe power grids, buildings in a state of disrepair: During extreme natural events, a fragile infrastructure can have grave consequences for the local population, for whom it represents a direct threat. In addition, it delays the effective potential for those affected to help themselves and impedes humanitarian relief provided by the local authorities or from abroad. Usually, the challenges that relief agencies face are on the “last mile” of the logistics chain: Organizing transportation despite ruined roads or bridges, and ensuring fair distribution when, for example, there is a scarcity of water, food and shelter. With its focal topic, the WorldRiskReport 2016 shows the way in which logistics and infrastructure play a crucial role in determining whether an extreme natural event turns into a disaster.

Peter Mucke is Managing Director of Bündnis Entwicklung Hilft.

Saurpani, in the Nepalese District of Gorkha, was no longer accessible. There was no shelter in the village, and food supplies had run out. The road to Kathmandu, five hours away by car, was blocked by rocks and boulders (Fuller/Barry 2015). The last miles to the village were to be taken on foot, with a backpack for the barest necessities.

On 25 April 2015, the ground shook in Nepal with a force of 7.9 on the Richter Scale, and then again, with a force of 7.2, on 12 May. Out of Nepal's roughly 28 million inhabitants, more than eight million had to rely on humanitarian relief. Over 8,800 people died, and more than 22,000 were injured. Infrastructure was hit hard, too. More than 500,000 houses were completely destroyed by the earthquake, and over 250,000 were damaged. The Nepalese government estimates the costs of the damage at seven billion US dollars (UNDP 2016).

Especially the roads in the remote mountain regions were blocked by landslides and avalanches, telephone lines were destroyed, and power supply was cut off. The airport in Kathmandu was heavily overtaxed, while at the same time thousands were seeking to leave the country and hundreds wanted to enter to provide help.

As was the case in the two earthquakes in Nepal, susceptible infrastructure and poor logistical conditions often contribute to extreme natural events turning into humanitarian disasters.

Supply as a challenge

Wherever possible, supply channels to those affected should be self-organized while utilizing local resources. This approach is becoming more and more widespread, with

More and more reported disasters, ever greater damage?

Figure 1: Number of reported disasters and the amount of damages (Sources: EM-DAT, The OFDA/CRED International Disaster Database)

clear advantages when compared to aid that is "flown in" from abroad. In the context of internationally supported relief efforts, the distribution of vouchers and cash is also gaining in importance (see Article 2.3). These can be used to shop at local markets, meaning that local craftspeople receive business and the local economy is strengthened.

Nevertheless, where essential supplies such as food, drinking water or building materials are not available locally – because of widespread destruction, for example – humanitarian relief from the outside, organized along a logistics chain, remains necessary (see infographics on pages 40/41). Here, human logistics is a cross-cutting task that comprises both the material flow and information exchange relating to it. International humanitarian logistics has to provide the supplies and information needed in the required quantity on site and at the right time. In addition, quality and costs have to be considered.

If there is major destruction after an extreme natural event, or if a conflict is drawn out over a longer period, UN organizations and certain other international relief groups, including Welthungerhilfe, can draw on the six international UN Humanitarian Response Depots managed by the World Food Program (WFP). The location of these depots enables relief supplies to be dispatched to any region throughout the world within a matter of 24 to 48 hours (UNHRD 2016).

When supplying international relief, the biggest challenges are also faced along the last few miles. Gaining access to those hit by an earthquake, cyclone or flood presents humanitarian logistics with immense problems. This is where the close links between infrastructure and logistics become particularly apparent. Where roads are no longer passable, bridges have been destroyed and power supplies have collapsed, humanitarian logistics cannot make much progress either.

Critical infrastructure

Critical infrastructure is of particular relevance to crises and disasters. The Federal Office of Civil Protection and Disaster Assistance states that (BBK 2016): "Critical infrastructures are organizational and physical structures and facilities of such vital importance to a nation's society and economy that their failure or degradation would result in sustained supply shortages, significant disruption of public safety and security, or other dramatic consequences." The Federal Office distinguishes nine sectors:

+ **Energy:** electricity, gas, oil
+ **Information technology and telecommunication**
+ **Transport and traffic:** air transport, maritime transport, inland waterways transport, rail transport, road transport, logistics
+ **Health:** medical services, pharmaceuticals and vaccines, laboratories
+ **Water:** public water supply, public sewage disposal
+ **Food:** food industry, food trade
+ **Finance and insurance:** banks, stock exchanges, insurance companies, financial service providers
+ **State and administration:** government and public administration, parliament, judicial bodies, emergency/rescue services including civil protection
+ **Media and culture:** broadcasting (television and radio), print and electronic media, cultural property, structures of symbolic meaning.

Critical infrastructure makes societies vulnerable (see Chapter 2.1), whether through disasters, conflicts, accidents or terrorist attacks. Sometimes considerable interdependencies between the above-mentioned sectors can further exacerbate this, resulting in so-called domino effects: The breakdown of one sector can lead to disturbances and failures in other sectors and trigger a cascade of failures or

damage. Since the energy and service sectors have become more and more privatized and globalized, the private-sector economic interests and constraints this entails are leading to further risks. The lack of redundancies and emergency capacities, e.g. in power supplies or in information and telecommunication systems, warrant particular mention here.

On the other hand, the bulk of this critical infrastructure is required for providing functional logistics, including humanitarian logistics. For example, both information and communication as well as transport networks and functioning government structures are basic prerequisites for good support in a crisis or disaster situation.

Challenges worldwide

The risk of disasters remains high in 2016. From 1980 onwards, a significant increase was recorded in the number of reported disaster events worldwide. Estimated damage levels continue to reach new peaks (see Figure 1).

And while this trend has been on a downward trajectory since 2012, this could change at any time. The 2015 statistics are a stark reminder that there is still an urgent need for action despite this decline: The United Nations recorded 346 reported disasters, more than 22,000 deaths, almost 100 million affected persons and economic damage totaling approximately 66.5 billion US dollars (UNISDR/CRED 2016).

In addition to the acute disasters resulting from extreme natural events, relief organizations and the international community also need to address long-term disasters and crises that, as a rule, have political causes – for instance in Syria, Iraq, Sudan, Yemen and Afghanistan. The logistical problems they pose differ from those in acute disaster situations. In these cases, it is not the speed of the aid provision that counts, but rather the long-term nature of the supply, the need to solve access and security issues, and the assignment of changing political or military responsibilities.

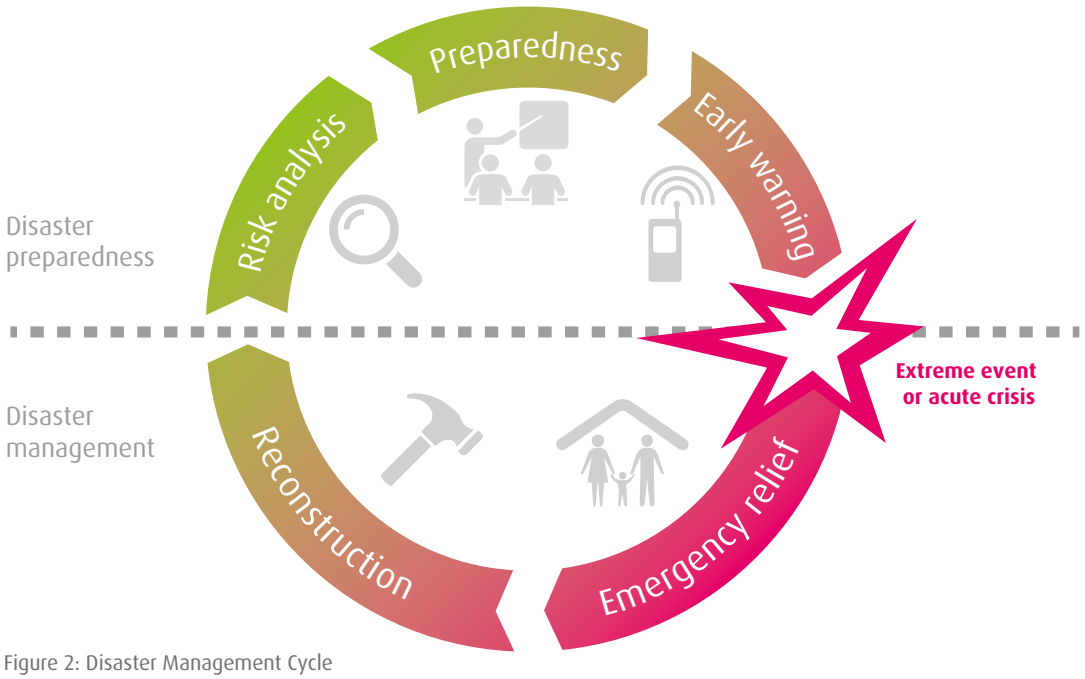


Figure 2: Disaster Management Cycle

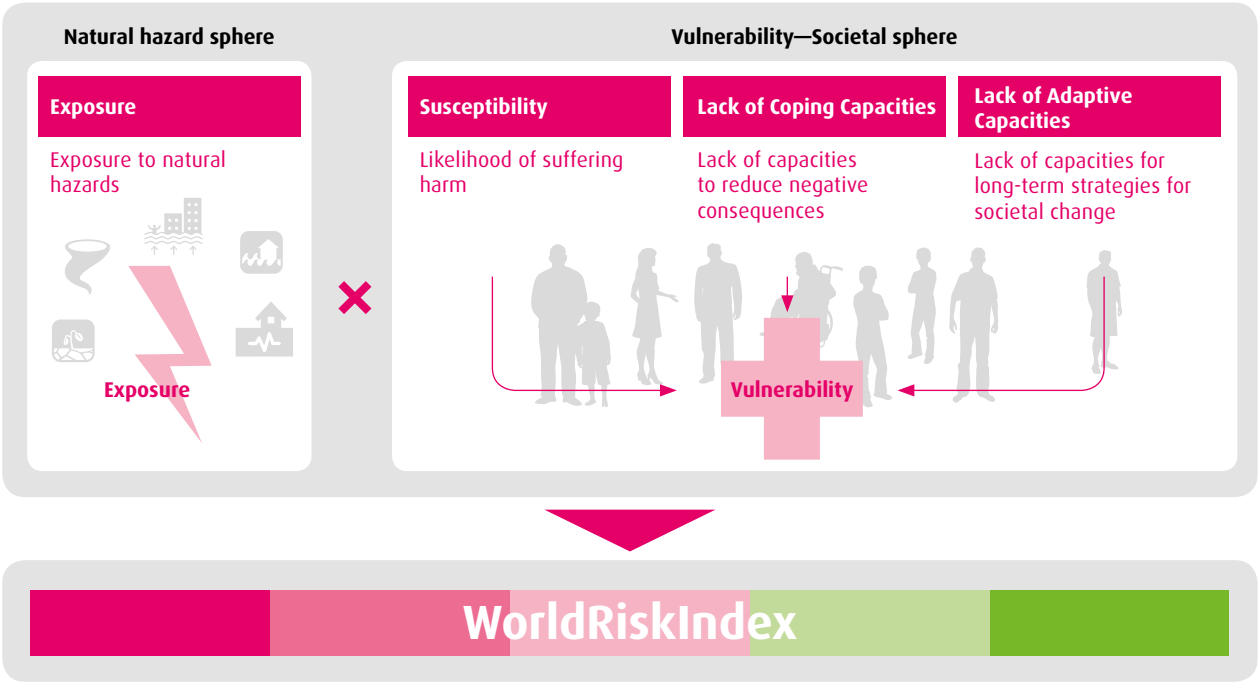


Figure 3: The WorldRiskIndex and its components

The unpredictable is daily routine ...

The future will also bring with it extreme natural events and other causes of disasters and acute crises. It is not enough to constantly improve disaster relief in the context of disaster management. Considerable efforts are also required as regards disaster preparedness (see Figure 2). Examples range from enforcing building regulations through strengthening local self-help schemes, to improving the reliability of critical infrastructure.

For some years now, the private sector has been increasingly involved in humanitarian logistics, and has sought greater cooperation with relief organizations. Private-sector involvement in combined efforts for disaster relief and disaster management include the initiatives "Get Airports Ready for Disaster" and HELP Logistics (see interviews at **www.worldriskreport.org**).

Relief organizations are now attaching growing importance to coordination in disaster situations (see Chapter 2.3). This is, for instance, implemented in the "Logistics Cluster" operated by the World Food Program. Care has to be taken in this context that the international relief organizations do not dominate. The local organizations must continue to hold the reins.

... and the future begins every day

While, especially with regard to the "last miles", analogue aids such as donkeys, elephants, or off-road motor-cycles continue to be indispensable, technological progress and the transition to the information and communication society are also clearly reflected in humanitarian logistics nowadays (see Article 2.2). Cellphones and SMS are used in the distribution of relief supplies, cash and vouchers are increasingly being transferred to cellphones as digital credits, while Big Data offers hitherto inconceivable tracking options, thereby ensuring more efficiency and transparency along the entire logistics chain.

The potential of drones in humanitarian logistics is a controversial issue among specialists (see interviews at **www.worldriskreport.org**). There is also widespread uncertainty regarding the potential influence of "The Internet of Things", "3D printing", and "virtual reality". However, there is no disputing the fact that the job profile of the humanitarian logistics specialist has changed significantly. "MacGyvers" muddling through from one improvisation to the next are no longer in demand. In their place there is a demand for professionally trained logistics managers.

Quantitative risk assessment

In 2016, too, the WorldRiskReport contains the WorldRiskIndex. Both infrastructure data and details of governments and authorities have been entered in the Index. Here, it is the case that as long as infrastructure is in an unsatisfactory condition and neither governments nor authorities can respond adequately as well as provide and coordinate the logistics needed, extreme natural events will have disastrous impacts. For when an extreme natural event occurs, the population will be more vulnerable than in a more favorable initial situation in terms of susceptibility and coping and adaptive capacities (Bündnis Entwicklung Hilft 2011).

In its risk assessment, the WorldRiskReport sets out from the basic assumption that the severity of the impacts that the forces of nature have on people is not the sole decisive factor, but that a society's level of development is just as important. It is on this basis that the WorldRiskIndex assesses the disaster risk for 171 countries worldwide (see Figure 3 and Chapter 3).

The WorldRiskIndex is intended to give answers to four key questions:

+ How likely is an extreme natural event, and will it affect people?
+ How vulnerable are people to natural hazards?
+ To what extent can societies cope with acute disasters?
+ Is a society taking preventive measures to face natural hazards to be reckoned with in the future?

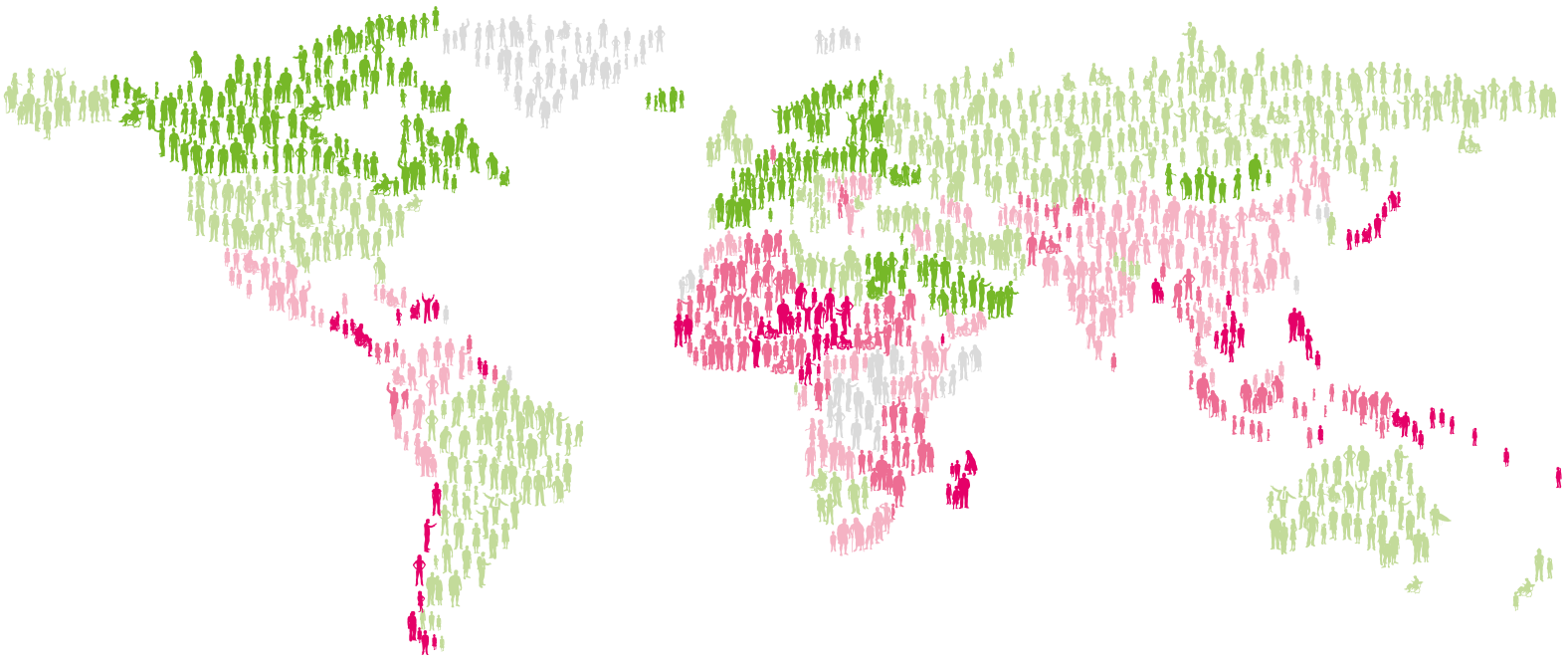
The representation through the Index and its four components provides answers to this and highlights both the problems and the fields of action very clearly. Nevertheless, it is also important to keep the limits of such a representation in mind. Just like any other index, the WorldRiskIndex can only consider indicators for which comprehensible, quantifiable data is available. For example, while direct neighborly help cannot be measured in a disaster event, it is nevertheless very important. It cannot be fed into the calculation of the WorldRiskIndex for lack of data. Furthermore, the quality of data between different countries may vary if data gathering is conducted only at the national level and not by an independent international institution.

This is why, in addition to the data section with its quantitative assessment, the WorldRiskReport always has a focus chapter with a qualitative approach that looks at the background and context – this year of the topic "logistics and infrastructure".

The concept of the WorldRiskReport

The basic concept of the WorldRiskReport has remained unchanged since 2011, when the first issue appeared.

"Whether it be an earthquake or a tsunami, a cyclone or floods, the risk of a natural event turning into a disaster always depends only partly on the force of the natural event itself. The living conditions of the people in the regions affected and the options available to respond quickly and to provide assistance are just as significant. Those who are prepared, who know what to do in the event of an extreme natural event, have a greater chance of survival. Countries that see natural hazards coming, that are preparing for the consequences of climate change and are providing the financial means required will be better prepared for the future. The WorldRiskReport should contribute to look at these links at a global level and draw future-oriented conclusions regarding assistance measures, policies and reporting". (Bündnis Entwicklung Hilft 2011)



Results at a glance

A disaster occurs when an extreme natural event hits a vulnerable population. The WorldRiskIndex 2016 shows that the global hotspots for a high disaster risk lie in Oceania, Southeast Asia, Central America, and the Southern Sahel. Thus countries like the Solomon Islands (ranked 6th), Papua-New Guinea (ranked 10th), and Guinea-Bissau (ranked 15th) are all very strongly exposed to natural hazards and, owing to their poor economic and social situations, particularly vulnerable. The example of Australia demonstrates how a low level of vulnerability can lower disaster risk. The country mitigates its exposure, which is mainly to drought, earthquakes and sea-level rise, and thus attains a ranking of 121st from 171 in the WorldRiskIndex. However, the example of Japan shows that a low level of vulnerability cannot fully compensate for extreme exposure. Despite its very low vulnerability, the country is in place 17 in the WorldRiskIndex because of its very high exposure, mainly to earthquakes and floods. In countries like Liberia (ranked 56th), Zambia (ranked 66th) and the Central African Republic (ranked 71st), the situation is the reverse of that in Japan. They are rather weakly exposed to natural hazards but very vulnerable. A total 13 of the 15 countries with the highest vulnerability are situated on the African continent (see Chapter 3). For these countries in particular, it is true that development helps. Highly developed countries with a low level of exposure do best in the risk assessment. Saudi Arabia (ranked 169th), Malta (ranked 170th) and Qatar (ranked 171st) have the lowest disaster risk.

WorldRiskIndex

Rank	Country	Risk (%)
1.	Vanuatu	36.28
2.	Tonga	29.33
3.	Philippines	26.70
4.	Guatemala	19.88
5.	Bangladesh	19.17
6.	Solomon Islands	19.14
7.	Brunei Darussalam	17.00
8.	Costa Rica	17.00
9.	Cambodia	16.58
10.	Papua New Guinea	16.43
11.	El Salvador	16.05
12.	Timor-Leste	15.69
13.	Mauritius	15.53
14.	Nicaragua	14.62
15.	Guinea-Bissau	13.56
.....	.....	.....
148.	Germany	2.95
.....	.....	.....
157.	Israel	2.30
158.	Egypt	2.29
159.	Singapore	2.27
160.	Finland	2.21
161.	Norway	2.19
162.	Sweden	2.12
163.	United Arab Emirates	1.97
164.	Kiribati	1.78
165.	Bahrain	1.69
166.	Iceland	1.52
167.	Grenada	1.42
168.	Barbados	1.32
169.	Saudi Arabia	1.14
170.	Malta	0.60
171.	Qatar	0.08

2. Focus: Logistics and infrastructure

When key infrastructure, such as transport networks or healthcare, is devastated by natural forces, the threat of a humanitarian disaster arises. In this case, a quick response is needed to ensure that people can provide themselves with the bare necessities. This is where information technology like the Internet or mobile phones as well as more recent technology such as drones or 3D printers, can support humanitarian logistics – that is, if they have not been impaired by a collapsed local power supply. But technology-based solutions aside, there still remains a host of challenges: examples include supporting self-help measures, coordinating the involved actors, making use of local resources, and the controversial issue of cooperations with the private sector and armed forces.

2.1 Infrastructure as a risk factor

Dr. Matthias Garschagen is Head of Section, "Vulnerability Assessment, Risk Management & Adaptive Planning", at UNU-EHS; **Dr. Michael Hagenlocher**, **Robert Sabelfeld** and **Yew Jin Lee** are members of this section.

Scientists and politicians increasingly recognize infrastructure as an important disaster risk factor. On the one hand, sufficient and crisis-proof provision of infrastructure is of key importance in coping with disasters. On the other, infrastructure itself can become a crucial driver of risk (Bach et al. 2013; Kadri et al. 2014). In an interconnected and technology-dependent world, infrastructure can contribute considerably to social susceptibility if it is not sufficiently crisis-proof. Its failure in the event of a natural hazard normally raises the human and economic damage potential and inhibits possibilities to cope with a disaster.

In the worst case, a failure of infrastructure can result in a (temporary) collapse of elementary processes and functions in social systems. Such infrastructure is therefore also referred to as critical infrastructure. This can comprise hard, technical elements such as power stations, power grids, transport routes, water infrastructure, or information and telecommunications technologies. But it also includes soft, institutional facilities for the management of technical elements, and the maintenance of governance, administration, security, and the rule of law.

Critical infrastructure is typically attributed to different sectors. For instance, Germany's Federal Office of Civil Protection and Disaster Assistance (BBK) is divided into nine sectors: Energy, Information Technology and Telecommunications, Health, Water, Food, Transport and Traffic, Finance and Insurance, Government and Administration, and Media and Culture (BBK 2016). The USA's Department for Homeland Security defines a total of 16 sectors (DHS 2016): Chemical Sector, Commercial Facilities, Communications, Critical Manufacturing, Dams, Defense Industrial Base, Emergency Services, Energy, Financial Services, Food and Agriculture, Government Facilities, Healthcare and Public Health, Information Technology, Nuclear Reactors, Materials and Waste, Transportation Systems, and Water and Wastewater Systems. Such differences illustrate that there are diverging conceptual classifications in the field of critical infrastructure.

This article discusses infrastructure as a risk factor in line with the four components of risk used in the WorldRiskIndex: exposure, susceptibility, lack of coping capacities, and lack of adaptive capacities. Special attention is given to the role of infrastructure in the logistics of relief measures in the event of a disaster.

Infrastructure and exposure to natural hazards

Critical infrastructure is often located in places with high exposure to natural hazards. For example, owing to their cooling water requirements, nuclear power stations are typically situated next to rivers or on coasts. Transport and logistics infrastructure is also particularly exposed in many places, which is of considerable importance to the disaster context. For instance, in many countries throughout the world, ports handle a major share of the medium- and long-term material requirements in reconstruction work following a disaster (Hellingrath et al. 2015), although they themselves are often affected by natural hazards such as cyclones, tsunamis or storm tides. But there are also growing efforts to prevent exposure of infrastructure, particularly at smaller scales. Hospitals and fire or police stations, for instance, are increasingly being located in places with particularly low level of exposure to floods and other natural hazards. In doing so, a dynamic perspective is needed to not only account for current hazard patterns but also for their future trends in the course of environmental and climate change.

Airports also play an important role in the logistics of emergency relief measures, for instance for food rations and other relief

Project example: Sierra Leone and Liberia

Developing and networking health infrastructure

The Ebola epidemic started in Guinea in December 2013 and quickly spread to the neighboring countries of Sierra Leone und Liberia. Within just a few months, WHO declared it a "Public Health Emergency of International Concern". In total, the epidemic claimed more than 11,300 lives (WHO 2016). Particularly in rural regions, caring for Ebola patients created considerable logistical and infrastructural challenges. In order to improve access to adequate healthcare in remote areas, Welthungerhilfe and Christoffel-Blindenmission (CBM) implemented projects in the field of health infrastructure.

In October 2014, Welthungerhilfe started the construction of four Ebola treatment centers in southeast Liberia. In the communities of Greenville City, Harper, Zwedru City, and Fishtown building land was selected by the regional authorities. A superstructure made of timber, a zinc roof, outer walls made of bamboo, and interior walls of waterproof tarpaulins were used for the construction of the centers in order to also protect the facilities against violent storms. The treatment centers, with a capacity of 60 beds each and distributed among two units, correspond to the WHO standards. Further aspects of the centers include a pharmacy, a laundry, a kitchen, washing and changing rooms, as well as recreational and visitors' rooms. The building measures provided paid work for hundreds of locals, including the manufacturing of 14,000 cement blocks.

In the building phase from October 2014 to January 2015, project personnel met with officers of international organizations and Liberian authorities to discuss technical solutions and necessary adjustments in the construction and design of the treatment centers. In order to maintain hygiene and disinfection, the plans for the sewerage system, the cleaning areas for ambulances, and the facilities for healed patients had to be modified several times. In addition, the delivery of the building material on time was complicated by heavy rainfall. Again and again, trucks got stuck in the mud of the soggy roads.

In January 2015, the treatment centers were transferred to the Ministry of Health and Social Welfare. They were subsequently handed over to health teams, also for the use of the buildings and equipment after the epidemic. Welthungerhilfe spent a total of roughly 1.5 million euro on the construction of the centers.

Sierra Leone was strongly affected by the Ebola epidemic as well. Since the government had to make considerable resources available for combating the virus, finance is now lacking for primary healthcare. This is why CBM commenced the construction of three eye health centers in the regions of Tonkolili, Kambia and Port Loko, in cooperation with its local partner, as part of its broader program to boost the national health system. In addition to treating the post-Ebola syndrome, one of the effects of which is eye diseases, the centers focus on primary healthcare in the field of eye health. Here, the project sets out from weaknesses in the health system that became apparent during the epidemic: a lack of medicines, insufficient technical equip-

Continued on page 16 →

→ Sierra Leone and Liberia, continued from page 15

ment, and not enough qualified health personnel able to successfully run the centers. The establishment of the centers is therefore complemented by the training of ophthalmological specialists.

The three new centers, which are linked to existing Primary Health Units, were built with cement, sand, iron and timber struts and fulfill the accessibility criteria. They consist of two treatment rooms, a reception area, and a storage room for keeping medicines in accordance with regulations. They have been equipped with the necessary basic equipment such as slit lamps and ophthalmoscopes.

Essential medicines like eye drops are kept in stock. Since they are frequently not available on the local market, CBM supports procurement. A list of the apparatus and medicines needed is handed in, whereupon they are delivered as single or bulk orders. To ensure the sustainability of the centers, 20 percent of the revenue from patient treatment will be used to finance and maintain medical infrastructure. When the project is concluded toward the end of 2019, regional authorities are to assume responsibility for the centers and their costs. They are already integrated in the training of specialist personnel and pay the latters' salaries.

CBM is also advising the Government of Sierra Leone on the development of a national eye health program. It is to be integrated in the existing Primary Healthcare System, which would enable short referral routes to other medical disciplines. CBM is providing 900,000 euro for the entire program.

At present, it cannot be assessed to what extent the projects are going to contribute to long-term improved access to medical infrastructure in the rural areas of Sierra Leone and Liberia, also with a view to possible future epidemics. This will only become clear over the coming years. Welthungerhilfe and CBM are going to support this process. One crucial aspect is that the impact of the Ebola outbreak as well as its causes are not forgotten so quickly.

***Simone Pott**, Welthungerhilfe, Head of Communication*
***Stephanie Schramm**, Christoffel-Blindenmission, Project Coordinator*

supplies. However, in the context of urbanization patterns, they are too frequently located in coastal, delta or river areas with a high risk of flooding and cyclones. In 2011, for example, flooding crippled Bangkok Airport, one of the key hubs of international passenger and freight transport, for several days. The airports in the metropolises of rich countries are also often characterized by a high exposure to hazards. For example, John F. Kennedy Airport in New York City, which lies only slightly above sea level, was paralyzed by Hurricane Sandy for two days in 2012. Several thousand flights had to be cancelled. At Amsterdam's Schiphol Airport, groundwater has to be pumped off in response to high tides since the runways and terminals would otherwise soon be flooded.

Road and rail links, i.e. the primary overland logistic routes, are also widely exposed to natural hazards. In the course of land development and settlement, they were built mainly along easily accessible pathways and therefore often follow rivers, valleys, or coastlines with high exposure to flooding, landslides (also caused by earthquakes), avalanches, storm surges, cyclones, or tsunamis. Figure 4 shows the exposure of major transport infrastructure to four of the five natural hazards considered in the WorldRiskIndex (earthquakes, cyclones, floods, and sea-level rise). It demonstrates that small island states in the Caribbean and Oceania as well as countries with overlapping characteristics of long coastlines and a high earthquake or cyclone risk, especially in Asia and Latin America, feature a particularly high hazard exposure of their existing transport infrastructure.

But also other parts of the world are affected: In Europe alone, damage to roads and railroad lines caused by flooding is estimated to amount to 470 mil. US dollars – and rising (Forzieri et al. 2015). While the major share of damage to infrastructure has been recorded in high-income countries, relative damage measured against income levels is often higher in developing countries and emerging economies.

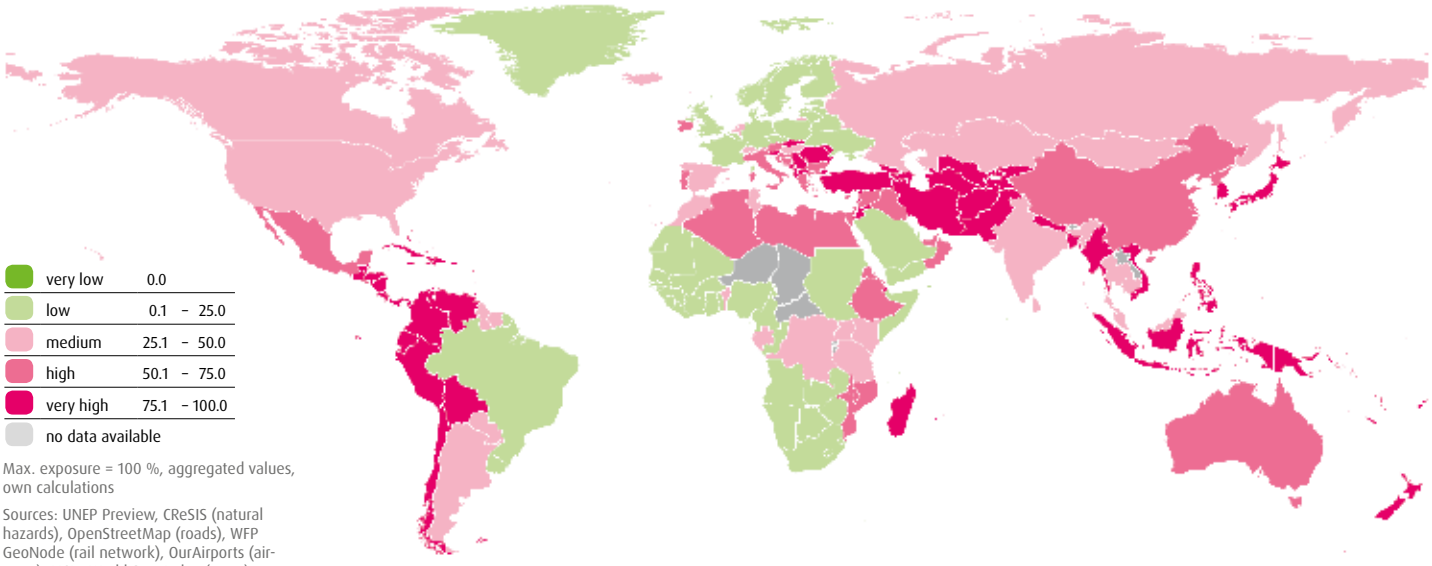


Figure 4: Share of transport infrastructure (roads, rail network, airports, ports) exposed to natural hazards

Infrastructure and susceptibility

Exposure of critical infrastructure to natural hazards can often not be prevented entirely, so that the susceptibility of infrastructure in terms of its constructional and functional fragility constitutes a further risk factor. Particularly in emerging economies and developing countries, infrastructure frequently is of insufficient quality (World Economic Forum 2015). One of the most discussed consequences of the devastating earthquake in Sichuan, China, in 2008 was the large number of dead schoolchildren among the victims. It was caused primarily by the damage or collapse of more than 12,000 school buildings (UNICEF 2009), which could largely be traced back to a lack of compliance with building standards. The susceptibility of transport infrastructure also plays a considerable role in the disaster context. For example, if they are structurally unsound, bridges, roads, railroads, or runways are at risk of suffering damage and becoming unusable when natural hazards like earthquakes, extreme heat or flooding occur. Based on the data of the "Global Competitiveness Report 2015-2016" (World Economic Forum 2015), Fig. 5 shows the quality of existing infrastructure (roads, railroads, ports, and airports) in international comparison. The information shown is based on an assessment by more than 14,000 experts from 144 nations who were interviewed between February and June 2015 (ibid.).

The illustration shows that especially in countries with a low to medium income level, the quality of existing transport infrastructure is very low. The analysis suggests that high investments are needed not only in developing additional infrastructure but also in improving existing infrastructure.

Furthermore, the functionality or stability of infrastructure in one sector may strongly depend on the susceptibility of infrastructure in other sectors (Bach et al. 2013). So-called cascade effects can mean that, for example, power supply failures caused by natural hazards can have far-reaching impacts on other disaster-relevant infrastructure such as transport or telecommunications links.

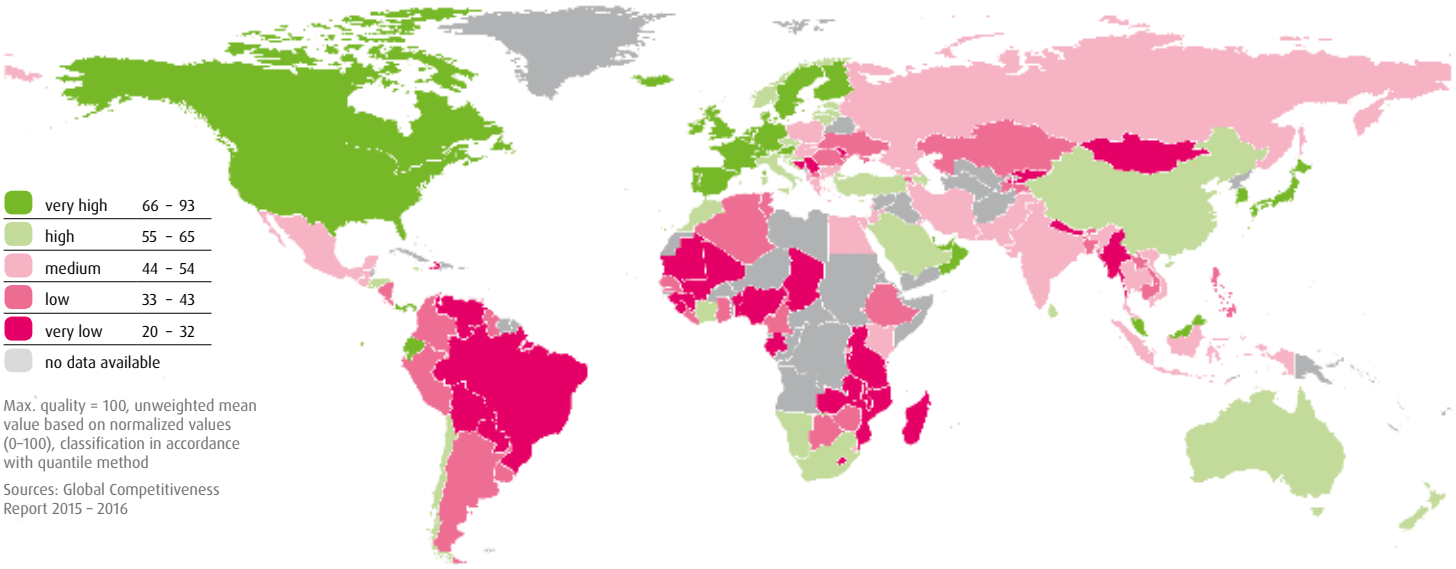


Figure 5: Quality of existing transport infrastructure (roads, railroads, airports, ports)

Infrastructure and coping capacities

Alongside the susceptibility of existing infrastructure, the insufficient provision of infrastructure, i.e. the absence of adequate infrastructure, makes for another significant factor of social vulnerability, especially with regards to the incapacity to cope with disaster situations. This applies in particular to transport infrastructure, which is needed in crisis logistics. In Africa, for example, there are only 65 kilometers of paved road per 100,000 inhabitants, compared to 832 kilometers in Europe or 552 kilometers in the Americas. In heavy rain, for instance, dirt roads soon become impassable, which inhibits regional relief measures and logistics in a crisis situation.

Fig. 6 provides a global comparison of the availability of transport infrastructure, measured as an aggregate of the extent of paved roads, the length of the railroad network, the number of airports, and container transshipment in ports, per 100,000 inhabitants. Countries with a low level of income show a particularly high deficit in transport infrastructure, whereas high-income countries usually feature a denser transport infrastructure.

According to World Bank estimates, additional investments of up to 1.5 trillion US dollars annually are necessary until the year 2020 in low- and medium-income countries to establish what the World Bank views as an adequate level of infrastructure. The greatest need for investment would be in the fields of electricity, water, and transport infrastructure (World Bank 2014). While these figures are not calculated specifically for a disaster situation, they do illustrate a massive lack in the quality and quantity of infrastructure in many parts of the world. However, the World Bank's focus on large-scale infrastructure projects has been criticized by numerous NGOs.

Poorly developed infrastructure limits the possibilities for redundancies, which are of key importance in crisis situations (Bach et al. 2013; Lenz 2009). For example, if a trunk road leading to an earthquake area has become impassable owing to a landslide, relief logistics need to be able to fall back on alternative routes or modes of transport

such as additional roads, railroad routes, or airlifts. On a smaller scale, this also includes, for example, the provision of additional access routes to hospitals and elderly homes, in order to be able to evacuate or supply the facilities in a disaster situation, e.g. during flooding, despite the main transport axes being inundated. However, in countries with poorly developed infrastructure, such options are limited. If the existing infrastructure is then also susceptible, as referred to above, a high vulnerability not only of the infrastructure system but of society as a whole is the result. This can also be observed with respect to power supply, where redundancies in production and distribution infrastructure (for example high-voltage power lines) are of considerable importance in coping with crises.

Infrastructure and adaptive capacities

Beyond a concrete disaster situation, sufficient, high-quality and properly accessible provision of infrastructure constitutes a significant factor in long-term risk preparedness. Global studies clearly emphasize the role of inadequate infrastructure as an obstacle to development and innovation (Calderón/ Servén 2014; World Bank 2014). It is usually remote and poorly connected areas that are affected by high levels of poverty and poor access to markets and social services. Spatial and institutional marginalization usually also coincide with a high vulnerability to natural hazards, and a lack of options for long-term risk reduction.

Regarding political decision-making processes of central or regional governments, it is often precisely these remote areas that are given little attention and are far down on the political agenda. This applies to the transfer and exchange of material goods as well as knowledge and experience in risk preparedness and response. These regions are therefore typically disadvantaged with

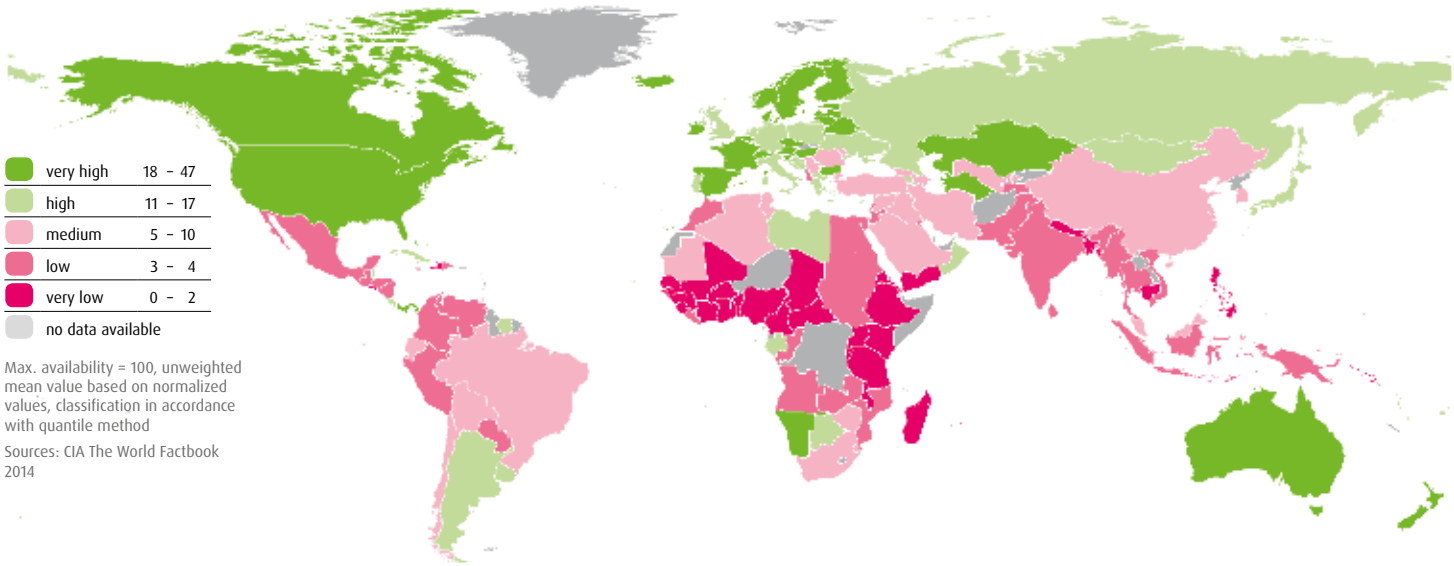
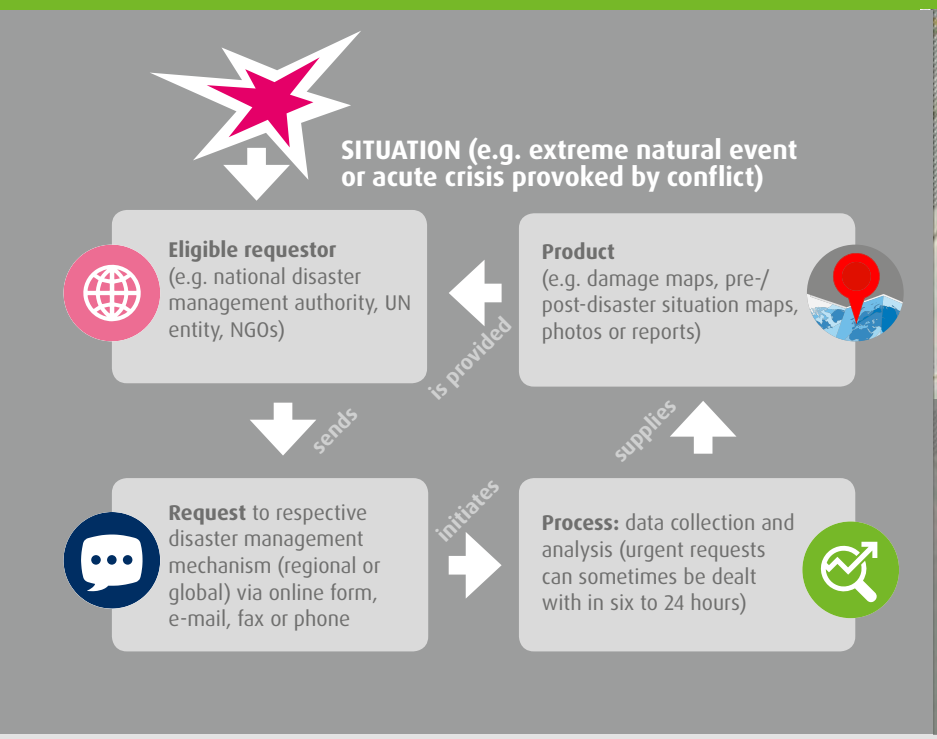
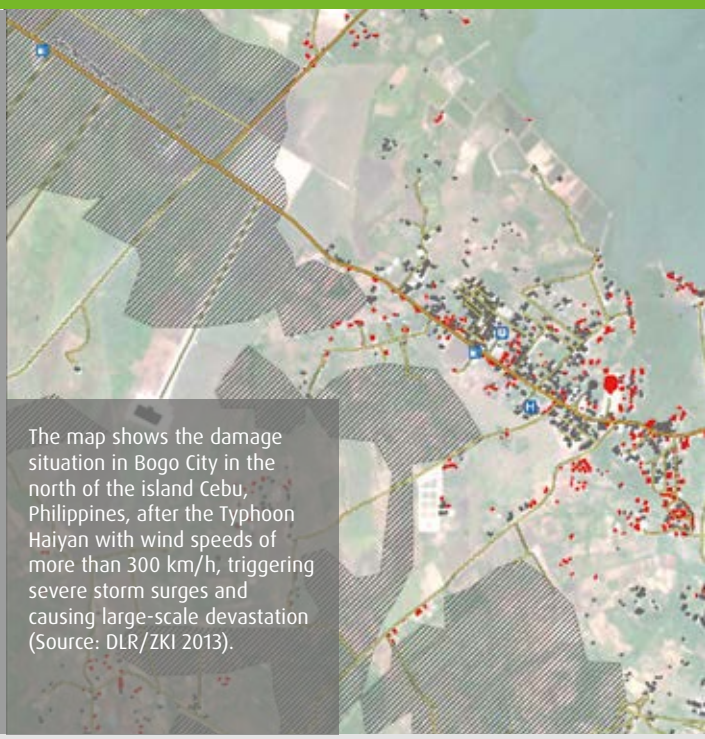


Figure 6: Availability and development level of transport infrastructure (roads, railroads, airports, ports)

How satellite images improve support in case of disaster



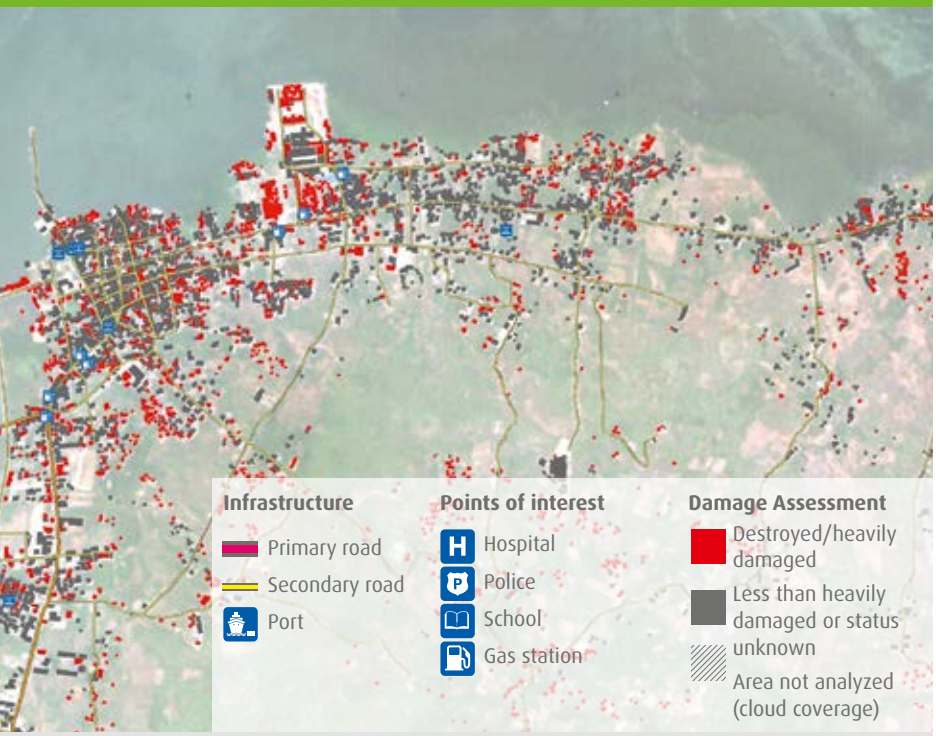


The map shows the damage situation in Bogo City in the north of the island Cebu, Philippines, after the Typhoon Haiyan with wind speeds of more than 300 km/h, triggering severe storm surges and causing large-scale devastation (Source: DLR/ZKI 2013).

When disasters strike, first responders need to understand new situations on the ground. They require timely, validated information that can be integrated into information products for efficient communication, situational understanding and ultimately for better decision-making. Space technologies provide synoptic, comprehensive, multi-temporal coverage of large areas in near-real time and at frequent intervals important for disaster monitoring and assessment. They are also essential when critical infrastructures are damaged to ensure that communication and location-based services are available. Within around one day, satellite-based reference maps can be delivered to provide updated knowledge on the territory and assets using data prior to the disaster. Within around three days information can be provided to create and enhance the situational awareness on the extent of the disaster, followed by additional information on impacts and damages, such as people affected, damage to buildings and critical infrastructure (see Philippines example map). The information products allow first responders to better allocate their logistics and resources in terms of where and when (areas of highest impacts, prioritization of actions) and how (coordination between first responders, planning accessibility and logistics).

Today, relevant regional and global mechanisms for satellite-based emergency mapping that are worthy of mention include the International Charter "Space and Major Disasters", the Copernicus Emergency Mapping Service, the Center for Satellite Based Crisis Information (ZKI) of the German Aerospace Center (DLR), the UNITAR Operational Satellite Applications Programme, Sentinel Asia and the SERVIR mechanism (see www.un-spider.org). UN-SPIDER provides further support with its mandate to "Ensure that all countries and international and regional organizations have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle". The International Working Group on Satellite-Based Emergency Mapping (IWG-SEM) is working on enhanced cooperation, communication and professional standards among the actors.

The basic principle behind all these mechanisms is that when a disaster strikes, mandated actors in disaster or crisis response may issue a request for activation by specifying their requirements. The respective mechanism then checks for compliance with their rules and initiates acquisition of satellite data, data processing, value-adding, product generation and dissemination to the eligible users. Meanwhile, operational service provision with defined products and quality standards is also in place. Product portfolios are expanding due to the requirements and feedback of the users. Delivery speeds and methods have improved significantly due to higher efficiencies of satellite data value-adding procedures, increase of satellites available and faster data reception and processing. The greater



abundance of open source tools and open data policies along with dedicated capacity-building efforts is enabling a larger community to use and analyze satellite data and to generate emergency mapping products. Collaborative mapping and crowd-sourcing activities further increase the quality and accessibility of emergency maps. Crowdsourced disaster response, until a few years ago informal and often haphazard, is now getting more organized, and is being embraced by official humanitarian organizations and integrated into relief operations. Fusion of satellite data with in-situ data and real-time hazard and impact modelling will in the future allow almost-real-time disaster consequence information and will significantly enhance knowledge of complex disaster situations and cascading effects, as with the Great Earthquake and Tsunami catastrophe of 2011 in Japan.

The successful use of space technologies and applications for disaster response needs to be extended to their implementation in disaster risk reduction. The Sendai Framework for Disaster Risk Reduction 2015-2030 adopted in March 2015, explicitly encourages the use of space-based information for disaster risk reduction. UNOOSA recently initiated the UNISPACE+50 processes to chart the future role of space for the 2030 Agenda for Sustainable Development, the Sendai Framework and the Paris Agreement on Climate Change in order to strengthen unified efforts at all levels and among all relevant stakeholders.

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regards to both the material and institutional factors of long-term adaptive capacities towards natural hazards, e.g. income levels, but also access to innovative technologies and know-how.

Conclusion

This analysis shows that an insufficient provision of infrastructure is a significant risk factor. This applies both to the prevention of and response to disaster situations and, already before them, to the creation of social vulnerability and hence damage potentials. Here, it has to be noted that infrastructure always needs to be understood as a multi-scale and multi-local network. For example, Bangkok Airport, which is of global significance, was affected by flooding in 2011 and was therefore of limited use in coping with the disaster. However, it was, in this case, possible to find other forms of transport for the relief supplies and material for disaster relief. In contrast, in the case of the earthquake in Nepal, the earthquake had not destroyed the most important national airports themselves. However, the only international airport (Kathmandu) did not dispose of the necessary capacities to process the large amounts of relief supplies. In addition, the road network was so heavily damaged that aid supplies and rescue material could not be sufficiently transported from the runway to the affected regions.

Moreover, the management of critical infrastructure is complicated by cascading effects that need to be identified and overcome. For example, the damage to a single runway or bridge caused by an earthquake can have a far-reaching regional impact on the provision of relief supplies. The term “critical infrastructure” is used to emphasize such bottlenecks and secondary effects, since individual infrastructure elements may be

of critical importance to the functioning of much larger systems.

Hence, different sectors of critical infrastructure are frequently mutually dependent, which further raises the systemic susceptibility to crises. Power supplies are of particular importance for maintaining health facilities or information and communication technologies, for instance. Nowadays, the latter are indispensable for the control of traffic flows e.g. at airports, on railroads, or in ports. A collapse of the power grid, as was the case when Hurricane Sandy hit New York City in 2012, can therefore pose significant problems for infrastructure and logistics, even if the transport infrastructure itself, i.e. roads or bridges, has not been destroyed in the disaster.

2.2 Opportunities and limits of information technologies in humanitarian logistics

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There is a wide range of areas in which information technologies can be applied in humanitarian logistics. This spectrum stretches from technologies that have been established for decades and are accessible worldwide, such as phones, to innovations in the more recent past. In Sub-Saharan Africa, for instance, mobile phones and SMS are being tested for relief supplies and single-board computers for the improved control of storage and transportation. Drones are used after acute disasters such as the earthquake in Nepal to identify damage. More recent technologies like Big Data and options for their application are also currently discussed by logisticians both at practical and scientific level. Big Data refers to mass data, i.e. large digital data volumes and their analysis and processing. Nowadays, such data is also generated for humanitarian logistics in real time, for instance in earthquake or flood disasters and in epidemics.

How can these technologies benefit humanitarian logistics or the people affected? There is no generally valid answer. Rather, relevant aspects differ according to the technology, region, type and extent of the disaster, and what purpose the technology is being applied for. The accessibility of information technologies crucially depends on the level of development and the location of a region. This, in turn, has an impact on the regional options for their application in humanitarian logistics. The following section, therefore, first deals with access to information technologies in order to then address the four examples from humanitarian logistics mentioned above and conclude with presenting a general assessment approach for the application of information technologies in humanitarian logistics.

Relevance and access

The development of, access to, and use of information technologies can be described quantitatively. Various coefficients (ITU 2015) document development towards an information society. Worldwide, the share of the population with Internet access grew from less than 20 percent in 2010 to more than 45 percent in 2015, and a further increase to 55 percent is estimated by 2020. However, Internet access is unevenly distributed across countries and regions. Whereas industrialized countries show a share of more than 80 percent, emerging economies and developing countries have

so far reached an access rate of 34 percent. In fact, only around ten out of 100 people enjoyed Internet access in 2015. There are huge differences in access rates to the broadband network, which is constantly being improved in terms of efficiency and speed. For example, in 2015, worldwide access to 3G broadband, through which dataflow is significantly faster than in the 2G network, was at 89 percent in urban regions and 29 percent in rural regions.

Innovations in information technologies such as Big Data require the existence of such high-performance information and communication networks, that they therefore can often not be put into practice in many developing countries and rural regions. Given the ever faster development cycles for new information technologies, there is a risk that developing countries and rural areas could be left behind, and that the innovations are not always available for humanitarian logistics in these areas either. Opportunities for effective use of information technologies and their networking open up mainly in those regions where networks are efficient, fast, stable, and available at a reasonable cost, and where the expertise to use them is available. Thus, a significant expansion of internet connectivity and access to information technologies also contributes to implementing the United Nations Sustainable Development Goals (SDGs), which were newly formulated in 2015. The issues that the 17 Goals refer to include poverty alleviation, food security, education, access to energy, infrastructure, and innovation (UNDP 2015). This was emphasized by the UN General Assembly towards the end of the World Summit on the Information Society in December 2015 (UN General Assembly 2016).

Already today, mobile phones enjoy an access rate of almost 100 percent. In 2015, statistically, 97 out of 100 people had ongoing mobile phone contracts (including prepaid contracts). Given the widespread distribution of mobile phones and continuously falling costs, this technology offers opportunities for humanitarian logistics in developing countries and emerging economies as well as, increasingly, rural regions (ITU 2015).

It is generally true that the application potential for a technology in humanitarian logistics depends on its effectiveness and efficiency. Both factors can differ significantly from region to region. The respective framework conditions offered by logistics, infrastructure, and technologies affect not only the particular implementation of humanitarian logistics but also the vulnerability or resilience of countries and regions.

In the following section, the examples of technologies applied in humanitarian logistics – mobile phones with SMS, single-board computers, drones and Big Data – will be presented in more detail. This highlights the diversity of these technologies, consisting of both established and new technologies, and differing respectively in terms of costs, access and necessary education levels.

The example of mobile phones with SMS

Given the limited and cost-intensive access of many emerging economies and developing countries to new technologies as well as additional aggravated conditions, application will tend to be oriented on simple, robust and cheap technologies. This applies in particular to the countries of Sub-Saharan Africa and their rural regions (Buatsi/Mbohwa 2014). One example of established and comparatively cheap technologies is the use of SMS in relief supplies. Instead of applying complex and expensive systems, mobile phones and applications are used in systems that are initiated by sending SMS. For example, SMS

for Life, a collaborative scheme between the United Nations and the pharmaceutical corporation Novartis, to replenish malaria medicine supplies in Tanzania, has been started. The project has meanwhile been extended to supplies of further medicines in several countries of Sub-Saharan Africa. Information on warehouse stocks is regularly dispatched from the regional warehouses via SMS and integrated into demand forecasts. A pilot project in Tanzania initially included 5,000 health facilities in 229 villages with 1.2 million inhabitants. Stock shortages of malaria medicines in the warehouse were significantly reduced from 79 percent to 26 percent. At the same time, the time replenishment supplies took to arrive at the warehouses was shortened from one-to-two months, to two days. For those suffering from malaria, and now also for tuberculosis and leprosy patients, this technology application means a clear improvement in the provision of medicines. The costs of the project amounted to 80 US dollars per health facility per year (Novartis 2016).

SMS and mobile phones find a wide variety of uses in humanitarian logistics beyond these examples, for example in the transfer of vouchers (eVouchers), in locating individuals or goods, or in training in the field of humanitarian logistics and technologies.

However, the use of mobile phones does also have its risks and limitations. For example, Oxfam has reported on a voucher project in Somalia for relief aid in the sanitation sector that failed owing to a combination of low acceptance rates among the users and long and cost-intensive logistics chains. Weaknesses include regional traders being integrated in the logistics chain at too late a stage, while also being insufficiently trained in handling the mobile vouchers. In addition, people in Somalia ordered vouchers via mobile phone but did not collect them later on. Thus the pilot project target had to be lowered from 50,000 to 5,000 deliveries. In the end, however, a mere 3,000 deliveries based on the voucher system actually materialized. (Abushaikha/Schumann-Bölsche 2016, O' Donnell 2015).

The example of single-board computers

Single-board computers also represent a comparatively simple, robust and cheap technology. Presently, the "Raspberry Pie", which was developed in the context of a non-profit initiative, is the most well-known type. The single board, which is the size of a credit card, contains all the essential elements and functions of a PC. The applicability of this technology in monitoring temperature and humidity in storage and during transport is currently being tested and discussed. By connecting it to output devices such as mobile phones or monitors, alerts for higher or lower deviations from set points can be issued as messages, colors or sounds. Thus comparatively simple and cost-effective solutions can help maintain the quality of medicines, vaccines and foodstuffs that have to be kept cool during transportation and storage.

Research issues yet to be examined and risks regarding the use of single-board computers include, among other things, networking concerns, the stability of energy supply and the need for more technology- and application-oriented training and further training, for example in Sub-Saharan Africa (Abushaikha/Schumann-Bölsche 2016, Schumann-Bölsche/Schön 2015).

The example of drones

For some years, the deployment of drones in humanitarian logistics has been discussed, planned, and put into practice. To emphasize the extent to which these applications differ from conventional military drone missions, these projects have been assigned titles such as "Drones for good" (UAE 2016). Some

How technologies are improving disaster management

Figure 7: Examples of the application of information technologies in the disaster management cycle (structure and contents: Prof. Dr. Dorit Schumann-Bölsche)

examples of drone deployment are already available, such as those seen in the aftermath of Typhoon Haiyan in the Philippines in 2013, and in the context of the two severe earthquakes in Nepal in 2015. As part of these deployments, cartographic material covering the affected disaster areas was compiled and compared with the initial situation. Information on the type and the extent of the disaster was available more quickly, and with a higher resolution than with satellite images. This information has proved to be valuable for humanitarian logistics since it provides both a good overview of the status of infrastructure and transportation routes as well as a first impression of the location and extent of expected demand or relief supplies. Furthermore, sensory measurements can be conducted, for example to establish contamination levels following chemical and reactor disasters.

In addition to their use in information technology, drones can also be employed as a means of transport in humanitarian logistics, both in acute and long-term disasters. Depending on its design, a drone can carry a payload of up to 500 grams, and some types can even manage several kilograms. Drones enable areas to be reached that offer only restricted access. For example, small amounts of relief supplies can be transported to areas in which there have been outbreaks of epidemics or that are otherwise hazardous (Meier 2015).

However, there is a long list of issues that need to be discussed, among them a lack of international standards, unanswered security and data protection questions, and the absence of a code of conduct. The security issue includes the question of how to protect the airspace over an affected region in a manner that drones do not endanger each other, that no other flying objects such as helicopters, airplanes, and other flying loadbearing vehicles are put at risk, and hence no further threat can arise to people through accidents. The effects of drones on humans have to be kept in mind. They may range from negative impacts such as being alarmed or being afraid of technology to positive effects. In Nepal, following the 2015 earthquake, there were reports of people perceiving the large number of drone deployments as a severe nuisance. In contrast, during the 2014/2015 Ebola epidemic, it was reported from West Africa that the images recorded by drones of no-go areas also generated an understanding of humanitarian relief and humanitarian logistics among people outside these areas, and that the informational role of the drones had left them with a positive impression (Jorio 2016, Meier 2015).

The example of Big Data

Big Data enables a real-time evaluation of large amounts of data. Traditional spreadsheets, statistics programs, and databases usually do not suffice for a high-speed capture, transfer, storage, analysis, and output of these data volumes in their full complexity. Big Data can cope with this. The technology is characterized by its four “Vs”: “Volume”, which represents its large data volume, “Variety” for the diversity of modalities and technologies from which the data originate, “Velocity” for the high speed, and “Value” for the high value and high concentration of the data. Big Data does not compete with the aforementioned technologies. Rather, it offers a further option for an interconnection at a high level of development. Data for Big Data are generated, for example, from mobile phones with geo-data, further sets of communications data from SMS

Project example: Nepal

Reconstruction of radio stations

When the two earthquakes in April and May 2015 left numerous local radio stations in Nepal damaged or inoperative through the collapse of power supplies, many people in remote villages lost their only source of news, announcements and offers of assistance. Immediately after the earthquakes, only six of the 150 radio stations in the area affected were still operational. Some of these stations initially broadcasted from tents after the earthquake.

This example shows that radio can play a key role in disaster situations – especially if it is the only medium available. For example, cyclone, heavy rainfall or flood alerts and information on relief missions can reach people most quickly by radio. Furthermore, if radio broadcasters have contacts in the villages and communication is still possible after a disaster, they support the coordination of relief activities by ensuring that the outside world is kept informed about the situation and the needs in regions that are difficult to access.

After the earthquakes in Nepal, Brot für die Welt and Misereor supported the restoration of functionality of the radio stations with 230,000 euros provided by the donations of Bündnis Entwicklung Hilft. These funds were allocated to AMARC, the World Association of Community Radio Broadcasters, which is cooperating with its partner in Nepal, the Association of Community Radio Broadcasters (ACORAB). More than 200 local radio stations are ACORAB members. The reach of these stations varies between just a few hundred meters in the village surroundings, to several hundred kilometers in the case of regional broadcasters.

In the acute phase, the functionality of 100 local radio stations was restored. Wherever necessary, a temporary shelter was built, power supply was re-installed, and damaged equipment in the studio and the transmitter sites was repaired or replaced. Also, radio reception equipment was brought to destroyed villages, and five mobile radio stations were set up for temporary operation. This was also done against the background that some landowners intended to cancel the lease agreements with radio stations because, for fear of further earthquakes in the future, they no longer wanted to have big antennae or radio masts standing on their land. At the same time, the restoration of power supplies, for example via generators or solar-powered systems, boosts capacities for immediately broadcasting after possible future disasters. The mobile radio stations, too, are both an acute relief measure and a contribution to disaster preparedness in the future.

In the second project phase, the radio broadcasters are being prepared for possible new disasters in the future. Local radio station personnel are being qualified in targeted reporting in the event of a disaster. Their training includes dialogs with the local population in a disaster event, the necessary information for refugees and relatives of missing persons, the encounter of traumatic stress as well as the monitoring of reconstruction and rehabilitation activities. Workshops are being run for local technicians to learn how to repair and maintain radio equipment.

Beyond its emergency relief efforts, AMARC is also providing long-term support to local radio broadcasters in creating a legal framework for independent radio operators, promoting freedom of expression, demanding the allocation of frequencies and encouraging the production of radio programs covering topics of relevance to citizens. Ultimately, the radio is also meant to contribute to social, political, and cultural development in Nepal, in addition to helping to support disaster management.

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Dr. Matthias Lanzendörfer*, Emergency Relief and Rehabilitation Advisor for Misereor*

messages, social networks, and satellites.

Since the 2010 earthquake in Haiti, Big Data has seen increasing use in humanitarian logistics. Following the earthquake, an outbreak of cholera occurred in Haiti. By gathering Big Data from Twitter, informally recorded cases on health cards via the Internet and further data sources, information on the extent of the outbreak was available almost in real time, and thus, unofficially, two weeks earlier than the official reports from government sources. Humanitarian relief and humanitarian logistics were able to respond more quickly, and it was easier to provide the relief supplies needed in the right quantities at the right places and hence save numerous human lives.

In the Global Pulse Project, for example, the United Nations is concentrating on the application potential of Big Data. Further advancements in the most recent humanitarian logistics missions incorporate data from drone deployments with Big Data, because information coming from the drones can only be used quickly with the large data volumes if it is integrated with other technologies, e.g. with planning systems in humanitarian logistics. Whereas drones represent technologies that can be deployed without further network access such as Internet or broadband, combining them with Big Data requires high-performance connectivity. Thus the lack of, or restricted, access to networks in developing countries can in turn be an obstacle. Big Data could also be generated from the global Logistics Cluster, for instance from reports and consignment-tracking geo-data and from social networks. It is conceivable for all this to be complemented by links almost in real-time with the standard cartographic material from the Logistics Cluster.

In this context, insufficient technical standards, a lack of IT specialists, and vague legal standards, especially with regard to data protection, can be referred to as examples of numerous risks and limits that Big Data bears. Establishing clarity regarding the technical and legal issues concerning the capture and transmission of communications data sets from mobile phones, which are just one source of Big Data, is already a very complicated issue (Meier 2015, Global Pulse 2016, Whipkey 2015).

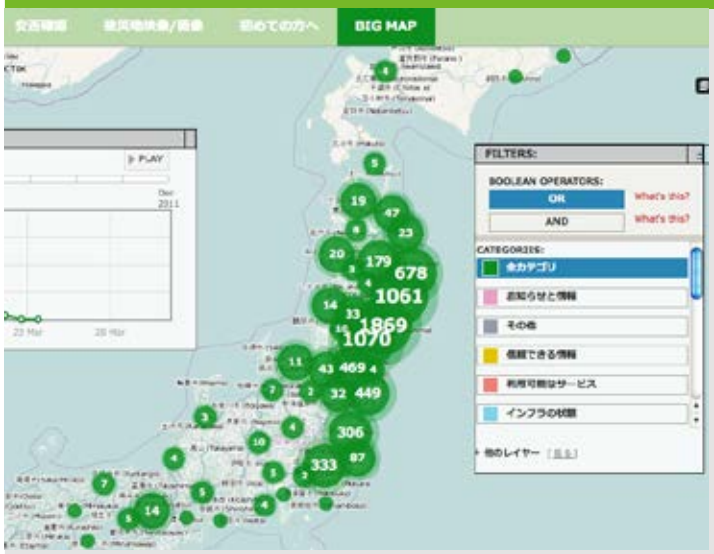
Selection and decision criteria

New technologies can enable what was hardly conceivable just a few years ago. For example, Big Data facilitates the evaluation of large volumes of data in almost real time. Not only are there a wide range of applications for drones, but they can also be extended in many aspects, such as more cameras, higher resolution, heavier payload, longer flying time. However, is it really so important to capture ever more information in an ever shorter time? Or should the emphasis be more on selecting suitable information at a reasonable cost? Despite all the enthusiasm that new information technologies can trigger, ultimately, it is the overall assessment that counts for humanitarian logistics and the people concerned.

In assessing the application of information technologies in humanitarian logistics, two target dimensions are relevant: the costs of logistics and logistics service quality. Thus, questions and solutions focus on the following aspects:

+ Can the use of information technologies improve service quality, e.g. through better service provision for the people affected thanks to a higher level of transparency and ability to act?

Social media in disasters



Both in day-to-day life and in crises, social networks form vital links between people. Using Twitter, Facebook and blogs, personal impressions are shared with the whole world or passed on to a closer circle of friends and acquaintances via chat-groups such as Skype, Whatsapp, or Snapchat. Following the earthquake in Haiti in 2010, social media also brought fundamental changes to communications in disaster situations. By now, Twitter and Facebook, joined recently by Instagram, have become some of the most important channels of communication between the population, national authorities, rescue forces, and international humanitarian organizations. At the same time, social media improve the self-organization of the affected population. Instead of passively waiting for help in the form of food, tents, or medical assistance, people can help one another and thus pool local resources. In this manner, the population's resilience is also strengthened as disaster relief gives way to long-term development.

Furthermore, it has become easier to generate information that qualifies as "shareable" in cases of disaster. With "Google Maps" or "Tableau", anyone can now easily compile and publish maps or visualizations that used to require the work of experts. Thus a new, yet quickly changing data landscape is emerging, in which a professionally designed product need not require expertise. However, much of this information, such as cartographic material, is provided by volunteers, and so the products are not subject to any controls and frequently do not meet professional standards.

There is also the issue that most of the information circulating in social media, such as Twitter or Facebook, does not offer the victims of disasters any practical help. For one thing, a large amount of the millions of shared pieces of information is limited to concern and comments. Furthermore, social networks may also be used by groups seeking to spread rumors that can be quickly distributed via social media but are difficult to recognize as such and debunk. From an operative perspective, these and other irrelevant or false messages are simply "random noise". The share of relevant and informative messages in social media is put at below 10 percent (Imran et. al 2013). However, these "gold nuggets" can in some cases express concrete needs and thus save lives.

In order to bundle and raise the share of practically relevant information, social networks and apps have been developed that are specially geared towards disaster situations. One example of a platform that structures relevant data following extreme events is "Ushahidi". Since the 2010 earthquake in Haiti, it has been in use in crises worldwide to gather local information – ranging from the addresses of open public pharmacies to food requirements – and make it accessible to the public. In addition, further applications have been developed to gather reports by people concerned about the local situation, to search for missing persons (Google Person Finder), or to find out whether friends and family are safe following a disaster (Facebook Safety Check).

Although social media is already intensively used in disaster relief, various critical issues apart from the aforementioned "random noise" do exist. For example, the possibility of sending a distress call creates the expectation of a response. Unanswered requests for shelter, medical assistance, or food lead to mistrust and frustration. Increasingly, data protection is becoming an important objective, especially if vulnerable groups such as children are involved. Ultimately, software and apps alone cannot be a substitute for direct communication and coordination. Technological development and process innovation have to go hand in hand in disaster management.

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+ Can the use of these technologies reduce the cost of logistics? If this is the case, the money could be spent for other humanitarian relief purposes.

Since the two dimensions are in conflict with one another in many decision-making situations, decisions on the use of technologies can neither be oriented solely on the goal of minimizing costs nor on that of maximizing service quality. In several cases, there is a (high) price to pay for a high efficiency of the technologies employed (Schumann-Bölsche/Schön 2015).

In comparison to other technologies, the use of a single-board computer is relatively cost-efficient. However, the positive impacts created by the sensory measurements and alert systems on logistics service are also at a comparatively low level. In contrast, the use of Big Data is cost-intensive to such an extent that it is unaffordable for some countries, regions, and organizations. But at the same time, the potential for humanitarian logistics is enormous. Moreover, it has been observed that a higher technological level and simultaneously lower degree of maturity of a given technology, for instance Big Data, also implies more risks and higher external demands on its use. Problematic legal and ethical issues, a lack of specialists, and limited or expensive access to networks are but a few of the challenges. Mobile phones and SMS use in humanitarian logistics are among the technologies bearing a medium level of service quality, cost and risks.

Taking these circumstances into consideration, an organization, whether it be an international or a national one, should first be guided by its own strategy and objective in applying a technology when choosing one for humanitarian logistics. Using kill criteria, it should first be assessed whether the application of a technology in humanitarian logistics has to be ruled out because of technical, ethical, or legal limitations. Using a technology may even carry the risk of an accident or a disaster, for example in the deployment of drones or in the event of Big Data being hacked. In addition, being dependent on certain technologies to an extent that failure of the technology or the network it is based on will result in an organization no longer being able to act, ought to be avoided. Some of the framework conditions are of a political nature and call for discussions and solutions at a political level. These include, for example, the cost-intensive development of broadband networks and reaching agreements on international standards that not only represent technical standards but also solve data protection problems (ITU 2015, Global Pulse 2016).

Given the diversity of decision criteria in humanitarian logistics, a scoring model seems expedient, considering both the costs and the wide range of service aspects such as speed, reliability, flexibility, stability, and adaptability. In addition, further assessments of the framework conditions can be taken up that have not already been covered by the kill criteria, for example with a view to power supply and educational levels, which play a key role in making use of information technologies. Not only does technical and physical access to technologies have to be provided, but people also require the knowledge to use them. In addition, it can be examined whether and in what way a technology can be applied solely at a central location or also in remote areas. To complement this, an assessment of the resulting economic or social potential of a region can be drawn up. By weighting the criteria and assigning point values, assessment comparisons can be made to guide organizations in their choice of technologies for humanitarian logistics. Here, the human being will continue to play an essential role (Merckens / Schneider 2013).

2.3 Coordination and conflicts of interest in humanitarian logistics

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Bruno Vandemeulebroecke is Emergency Relief Coordinator and Senior Procurement and Logistics Officer at Welthungerhilfe.

One specialty of humanitarian logistics is its fundamentally complex nature. It has to be understood as a process that is coordinated and designed by people for people. The actors involved often differ considerably – from government through civil society and private organizations to the affected population itself – and consequently, their interests can sometimes be at odds.

Humanitarian logistics – more important than ever

Difficulties in providing relief for the people in Nepal in the aftermath of the earthquake in April 2015, which cut off many villages in remote areas from the outside world for several days, very clearly demonstrated the importance and acuteness of humanitarian logistics. At the same time, this example shows the problems and obstacles confronting humanitarian logistics. These need not always be physical barriers, for instance in the form of damaged bridges or destroyed roads, but frequently, they are of a political, economic, and social nature, too. Roads may also be blocked by local actors seeking to benefit from relief supplies themselves, the approval of import or transit permits may be slowed down, or these may be refused altogether in order to protect local markets. For political reasons, conflict parties in particular may deny access to the target group in order to demonstrate their own power and put pressure on their opponents. The danger of losing control or power also represents a possible political reason not to let relief organizations or supplies into the country, especially in the case of authoritarian regimes.

All in all, experience gained in disaster relief clearly shows that it is not only the efforts of the affected country itself that play an important role in human logistics but also the different political interests of neighboring or involved countries. Therefore, landlocked countries in particular are to a considerable degree dependent on the support of surrounding states, for example when it comes to importing relief supplies and corresponding flyover rights that have to be granted for relief supplies.

Even though every humanitarian relief situation is unique, there are certain activities that always proceed in a similar manner. As soon as a disaster sets in, logisticians in relief organizations activate their logistics chain. In next to no time, large amounts of relief supplies have to be procured, corresponding transport and storage capacities need to be organized at short notice, and the basis for a safe distribution of relief supplies according to needs has to be created at the local level. This requires relief organizations to mobilize personnel and prepare pre-stocked relief items and response kits for shipping. The logisticians connect through their network in order to optimize the use and load factor of aircraft, trucks, and storage areas by joint chartering and cost sharing.

The same networks share information on the status of the areas affected, access conditions, and entry and import conditions for emergency staff and supplies. At the same time, first needs assessments are performed at the local level. Often, relief supplies are sent to the areas affected even before the exact demand has been assessed. In rare cases, this can mean that not all of the supplies will be needed by the time they arrive. However, this risk is consciously taken into account since waiting for the results of the needs assessment would lead to delays in the logistics chain and would thus ultimately jeopardize the health and lives of the population affected.

From big to small

Humanitarian relief is also first and foremost a national objective. As a rule, international actors should only become involved following an official request for support by the

respective government. In practice, it has often been revealed that developing countries in particular do not have sufficient capacities of their own to cope with a humanitarian emergency. Therefore, also on account of their specialist and technical expertise, many international relief organizations operate throughout the world in humanitarian emergencies. Thus logistics and infrastructure in humanitarian aid evoke above all what people have seen in news broadcasts – big warehouses, aircraft, or long convoys of trucks bearing the logos of the United Nations or well-known relief organizations dispatching large quantities of relief supplies to conflict and disaster areas.

It should be noted, however, that a major share of humanitarian logistics is carried out at the local level, by local actors frequently cooperating with big international relief organizations. In the media, this local support is largely "invisible". Especially in small disasters that are often regionally limited, local actors such as church communities or local civil society organizations perform humanitarian logistics, and the relief supplies that are needed are also procured locally. The local procurement of relief supplies has a number of advantages. For one thing, there are savings on transport costs, and relief supplies are often more quickly available. Secondly, local procurement stimulates local markets, whereas importing larger quantities from abroad can throw them out of balance. In cases in which a government does not allow international relief organizations to enter a country for political or economic reasons, the availability of local logistics chains and the work of the local relief organizations is even more important.

Over the last few years, there has also been a marked tendency among international relief organizations to procure more and more of the required goods locally. In the mid-1990s, a mere 13 per cent of food was purchased locally or regionally, while by 2009, this figure had already risen to more than 50 percent (Barret et al. 2011). At the same time, greater efforts are being made to enhance responsiveness at national and local levels. This is accomplished through cooperating with local relief organizations as well as local authorities in making preparations for future emergencies. From a logistics perspective, this includes mapping critical infrastructure such as airports, ports, and storage capacities as well as power and water supply. In exposed areas, logistics specialists can thus assess and localize the capacities, strengths, and weaknesses of local infrastructure. The results are discussed with local authorities, and corresponding contingency plans are developed.

Coordinating humanitarian logistics at local level

Government, private, and civil society humanitarian actors have to coordinate their relief activities well, and attune them to one another. Otherwise there will be a danger that, following a disaster, certain regions are oversupplied while others in turn receive hardly any or no relief supplies. In addition, an uncoordinated approach can lead to an overstretch in infrastructure capacities. In the case of the earthquake in Nepal, for instance, the volume of goods arriving at Kathmandu airport equaled that of an entire year in normal circumstances.

Further negative impacts from a lack of coordination in humanitarian logistics include possible price hikes, both in transport and warehousing, and in procuring relief supplies. In the event of a humanitarian relief situation, additional vehicles and storage facilities are hired by the humanitarian actors. Warehouses that are only half-loaded often cost as much as they would at full utilization, but they lead more quickly to a corresponding scarcity on the market and, accordingly, prices increase. The same applies when there is an acutely high demand for certain relief supplies whose

Project example: The Philippines

Invisible infrastructure: Local networking crucial

In 2013, Typhoon Haiyan devastated vast stretches of the Philippine islands of Samar, Leyte and the Visaya archipelago to a hitherto unknown extent. In the immediate aftermath, Kindernothilfe sprang into action in the community of Salcedo in Samar, together with its partner AMURT. The project centered on the repair of 60 houses and the construction of 116 new ones in two of the community's villages, Jagnaya and Asgad, where nearly all homes had been destroyed or made uninhabitable. A major share of these buildings were made of light material such as bamboo or coconut wood and corrugated iron. Incorporating sturdier timber, stone, concrete and metal struts, the new houses were to be more solid and meet the relatively high construction standards of the Philippine government so that they could also withstand severe future weather. However, construction involved considerable logistical and planning challenges.

Many infrastructural components required for reconstruction were destroyed in Salcedo. For example, clearing activities in the wake of the typhoon had to be carried out in the absence of a functioning power supply and communications network. It therefore took some time to establish the extent of the damage and local needs. Keeping in touch with colleagues in Germany also turned out to be a challenge since the coordinators had to leave the disaster region to send e-mails or use phones, which sometimes required travelling for several hours. In East Samar, the road is the main means of transportation. Until clearing work was finished, many roads were covered with debris and could only be driven on at certain points. After the typhoon, it took relief workers between 16 and 48 hours to obtain new tools or generators.

Major construction work on houses, schools, and kindergartens therefore only commenced six months after the disaster. Since the road structure in the region had been renewed before the typhoon and had not been damaged by the storm, there were no longer major problems with road traffic after clear-up. This was not the case with transport vehicles. Initially, trucks for hire to carry material were hard to come by, and they were correspondingly expensive. Once project personnel had succeeded in procuring three trucks for the project, transportation worked more reliably, and costs fell. However, some of the construction sites were situated on the surrounding islands, and powered catamarans were needed to access them. But since boats were scarce and those available only had a low cargo capacity, carrying materials across water continued to be tedious and expensive.

During the entire construction phase, there was above all a shortage of sturdy timber, since it was in high demand throughout Samar. Moreover, other building materials such as gravel or sand were procured in unpackaged bulk volumes and stored centrally to cut costs. This led to new challenges in distribution. A comprehensive logistics plan for building material ensured that the project personnel could keep track of supply volumes and stay within the budget limits.

The local authorities proved to be very forthcoming, and so the partners in Salcedo could soon start with reconstruction and repairs. Not only did the municipalities provide direct assistance such as storage areas and excavators, but they sped up communication both with locals and with government authorities. This made it much easier to acquire land

Continued on page 34 →

→ Country example country: The Philippines, Continued from page 33

for house construction, to issue land titles, or to obtain approval for construction or logging.

Reconstruction has almost completely changed the structure of the villages of Jagnaya and Asgad. The mayor and the local community declared the high-risk sites "no-build zones" unfit for future housing construction. Building land more protected against the wind was made available for 70 percent of the houses by the community. However, it required a considerable development effort before building could commence. In addition to the resettlement program and the new power and sewage infrastructure, reconstruction offered a chance to review plans for a new village center around a newly formed marketplace that now links the existing settlements with the buildings of the housing project.

Reconstruction of the buildings was carried out by a team of local engineers and a local workforce. This had many positive side effects. The people concerned were involved in reconstruction, could earn incomes, and received additional vocational qualifications through the building projects that could be of help to them in the future.

The cost of the project totaled 950,000 euros. All in all, 176 families benefitted from the building and repair of houses, including more than 400 children. The materials accounted for 69 percent of the costs, and wages for a further 27 percent. A mere 4 percent of the finances was spent on transportation and site management.

The house construction initiative on Samar shows that centrally managing a project of such dimensions and implementing it with a largely inexperienced workforce can succeed. Work without professional building service providers is intensive but is also much more cost-effective. This cost efficiency created new financial scope for the relatively expensive but stable new buildings. A strong local framework and networking are crucial elements in achieving such a result. The acceptance of the project and support for reconstruction requires good contacts with the local community. At the same time, links with the local, regional and national authorities and politicians are immensely important in overcoming political or administrative hurdles with the aid of local advocates.

***Ludwig Grunewald**, Kindernothilfe, Editor*

production cannot be ensured quickly enough by the market. Having supplies in stock can be a way of preventing price hikes. With large depots at strategic locations such as Dubai, Malaysia, Panama, Spain, und Ghana, relief organizations have options to keep a selection of relief supplies in stock. Through close cooperation between the organizations, the depot stocks can be mobilized in a matter of hours, and a timely supply to a disaster region can be ensured in 24 to 48 hours (UNHRD 2016).

One of the measures to improve coordination in humanitarian logistics is a special global Logistics Cluster. The Cluster operates through and for the members of the humanitarian community and their respective logistics departments. In the event of a disaster, international and national organizations work together in the Cluster and coordinate their activities with the authorities in the region affected after its activation by the UN Emergency Relief Coordinator. The chief functions of the Logistics Cluster are (Logistics Cluster 2016):

+ Information management, e.g. regarding infrastructure, customs procedures, and legal provisions.

+ Coordination of logistical support through information exchange on planned relief measures. The aim here is to avoid overlapping and supply gaps.

+ If humanitarian demand for logistical capacities (transport vehicles, storage rooms, etc.) cannot be met locally, the logistics cluster organizes external provision. This may include, for example, organizing an airlift or a convoy of trucks.

Cooperation with private sector and military actors – curse or blessing?

Cooperation with the private sector is playing an increasingly important role in humanitarian logistics. Cooperating can be beneficial to all

parties. One example of this is the program "Get Airports Ready for Disaster", which is being run by DHL/Deutsche Post in collaboration with UN-OCHA and UNDP. In addition to international corporations, local enterprises such as transport companies, owners of large warehouses, or producers of certain goods often assume a key role.

From the perspective of the relief organizations, it is above all the professionalism of the private service providers that speaks for such cooperation. It can usually help relief organizations save time, and above all money, since the provision of the required infrastructure, such as transport vehicles, as well as the provision and standby availability of personnel and resources for a disaster situation is very expensive. Relief organizations can also learn from the knowledge and experience of private service providers for future disaster situations. At the same time, humanitarian actors cooperating with private service providers face the challenge of making the most efficient use of this cooperation without becoming dependent on certain private sector actors. Here, the private sector is also actively promoting the development of the humanitarian market, for instance by developing transportable health stations and water purification plants.

Another important actor often considered in humanitarian relief situations is the armed forces – both the national armed forces of the country affected and foreign forces. Owing to their function proper (national defense) and their resulting independent structure, the armed forces dispose a wide range of logistics infrastructure (trucks, helicopters, ships, etc.) in most cases. Therefore, military capacities have made a crucial contribution in supporting humanitarian actors facing logistical challenges in many humanitarian crises that they could not have overcome on their own given their limited logistics resources.

However, cooperation between humanitarian actors and the military also raises questions and creates risks. Humanitarian organizations commit themselves to complying with humanitarian principles – with neutrality assuming special significance in the case of the military. But in many instances, the military cannot implement such a neutral form of humanitarian aid, especially if it is simultaneously one of the conflict parties. Here, even a photo published in social media showing humanitarian actors cooperating with armed forces that is accessible to all (conflict) parties can represent a risk. Consequently, civil society actors are forced all the more to choose between the principle of neutrality on the one hand and a potentially greater scope of their humanitarian efforts through cooperating with armed forces on the other.

Cash transfers as an alternative supply tool?

Transporting relief supplies to the target group represents both a significant cost factor and a key challenge in humanitarian logistics. For this reason, looking for more efficient and less complex alternatives to provide supplies for the target group is an important task. The local procurement of relief supplies is one way to cut the costs and reduce the complexity of humanitarian logistics chains. At the same time, the significance of the pure distribution of relief supplies in kind is steadily declining. Instead, cash transfers in the form of cash payments or vouchers as an alternative or supplement to in-kind distribution are increasingly being introduced. The beneficiaries either receive cash payments that they can use to buy goods, or vouchers that they can redeem at cooperating merchants.

One basic precondition for cash transfers is a functioning market. Only if local markets are intact and capable of providing enough goods – without the threat of drastic price hikes – should the distribution of money or vouchers be given preference over the direct

handing out of relief supplies. The advantages of these methods are obvious. Cash transfers strengthen the beneficiaries' self-responsibility and freedom of choice in comparison to in-kind distributions and prevent them from receiving goods they do not want or need. Even though cash transfer systems have only been in use for a couple of years, experience gathered by the relief organizations so far shows that they are often more cost-effective than the direct distribution of relief goods because significant components of humanitarian logistics, such as the procurement of commodities or transport, are not required. In addition, dependence of the humanitarian actors on producers, merchants, and transport service providers is reduced.

At the same time, other logistical steps are required for the implementation of such programs, such as the monitoring of supply chains and the price development of relevant goods, so that if any doubts arise, one can switch back to the direct distribution of goods. Also, the necessary infrastructure has to be in place so that the target group can be reached with the money or the vouchers – either via direct payments in cash or via electronic systems (for instance transfer via SMS, see Article 2.2).

Globally, both the number and the volume of cash transfer programs have risen significantly over the last few years. In the World Food Program (WFP) alone, the sum of expenditure on these programs rose from ten million to more than 830 million US dollars from 2009 to 2013, and today, it accounts for more than 17 percent of WFP activities (WFP 2014). But even if cash transfer programs are becoming increasingly important in humanitarian relief, this does not render humanitarian logistics superfluous. Rather, its field of activities has been changed or expanded. Also, there will be many disasters in the future in which essential goods have to be provided directly by relief organizations. Thus in-kind and cash transfer programs do not represent opposites in humanitarian relief but are instruments for different situations that complement one another.

Current challenges in humanitarian logistics

One of the most important tasks in the coming years will be, above all, the further strengthening of local capacities – both with regard to disaster preparedness and in terms of logistics in humanitarian relief. International actors should be less present than humanitarian actors themselves but ought to shift their focus to strengthening local actors. This is also one of the central findings of the World Humanitarian Summit (UN General Secretary 2016). To achieve this, more attention should be paid by the media and international organizations to the stronger local and regional entrenchment of humanitarian logistics. So far, cooperation with local civil society partners has been overly neglected – a state of affairs to which international relief organizations have contributed by focusing too much on their own visibility in the context of relief activities in the hope of improving their fundraising prospects.

The increasing number of disasters brought about by extreme natural events and violent conflict, particularly when they occur in parallel, for example in the Central African Republic, has also resulted in changes in logistical demands. In addition to destroyed or damaged infrastructure, the political or security-related barriers constitute a growing challenge. Not only are humanitarian transport vehicles and storage rooms a worthwhile target for thieves (given the relief supplies they are used to carry or store) but roadblocks can also be set up, and humanitarian relief workers themselves can become the target of attacks and kidnappings. In addition to the issue of target group accessibility, the aspect of the safety of an organization's own personnel and relief supplies is becoming more and more important and is driving up this cost factor.

In addition, it would be desirable for the work "behind the scenes" in humanitarian logistics to become more clearly visible. Long convoys of trucks supplying disaster regions are just a very small portion of what humanitarian logistics really is about, and what it achieves. Making preparations for future disasters, by continuously monitoring price developments of goods related to logistics, and continuously improving value chains as well as the standby availability of goods, equipment, and personnel are important measures that occur in the background but are also indispensable when it comes to ensuring a quick response in a disaster situation. Like a fire extinguisher that has to work at the flick of a switch in the event of fire and therefore requires ongoing maintenance and checks, humanitarian logistics is an ongoing process that also takes place when there is no existing humanitarian relief situation. There is a danger of such invisible but indispensable tasks being increasingly neglected as a result of the growing need for finance.

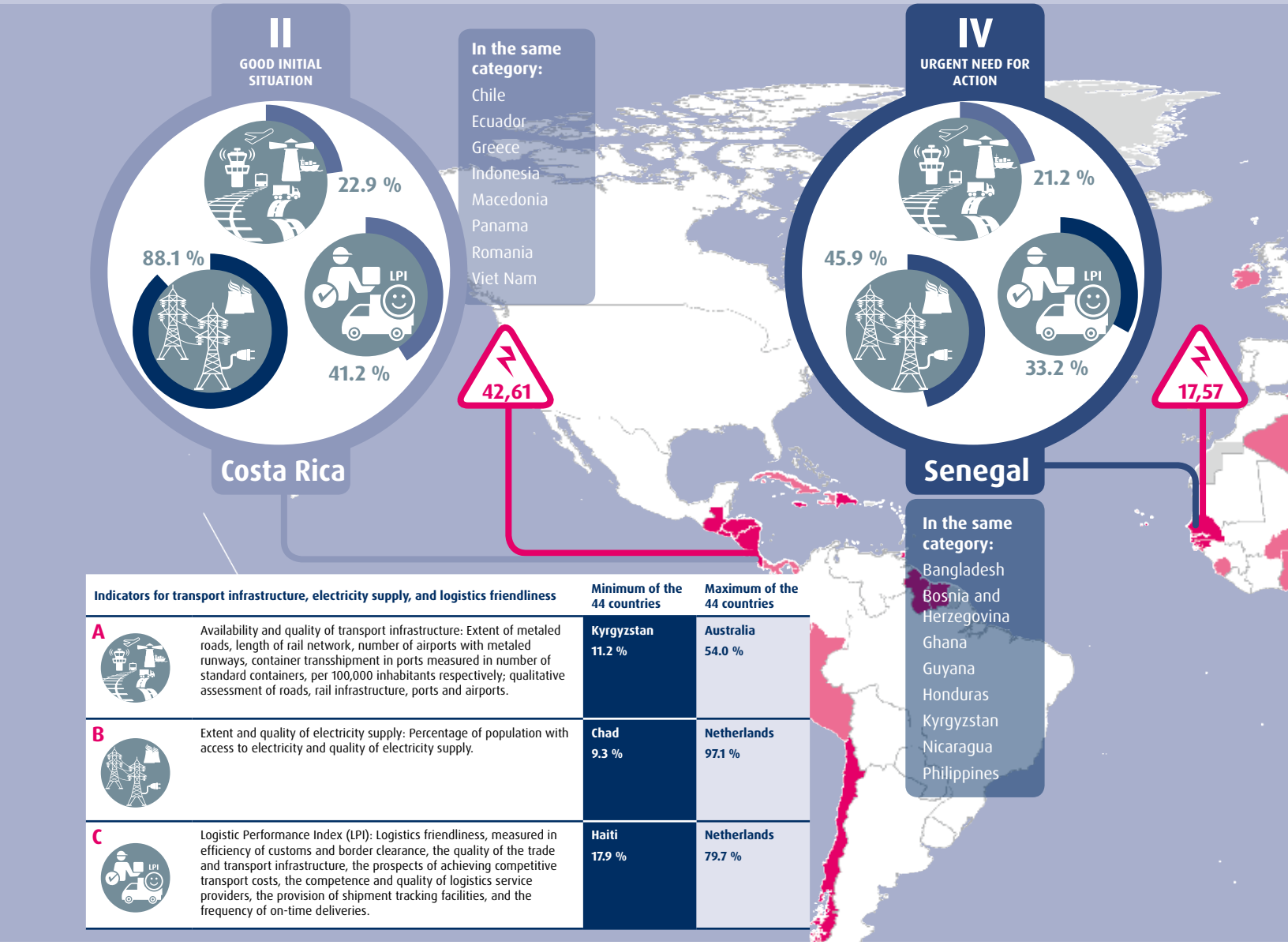
Owing to its supportive role for the other clusters and sectors, humanitarian logistics is not always visible for the beneficiaries of humanitarian aid but remains in the background in most cases and creates the foundations for further humanitarian aid measures. It is therefore important that the target group at the local level is not forgotten in all discussions about faster and more efficient logistics. Even though humanitarian logistics tends to act as a service provider for the other humanitarian sectors, the question has to be raised as to how the special needs of particularly vulnerable groups can be better integrated. Here, humanitarian logistics can support the individual humanitarian sectors and promote innovation. The specific needs of the local population must always be given top priority, and must not be soft-pedaled when it comes to issues like the employment of drones or smartphone apps.

Bündnis Entwicklung Hilft

Logistics and infrastructure: Need for action in exposed countries

Intact infrastructure and functioning logistical processes contribute to preventing a disaster following an extreme natural event. This Map of the World shows the current state of logistics and infrastructure for 44 of the 68 countries that are highly or very highly exposed according to the WorldRiskIndex. It demonstrates for each of these countries what action has to be taken in the two areas to achieve better disaster preparedness. No sufficient data is available for the other 24 highly or very highly exposed countries – which in itself presents a problem because it significantly complicates disaster preparedness.

Three indicators were used to establish the need for action: One from the area of logistics and two from that of infrastructure. In the first area, a country's "logistics friendliness" (see legend) was considered, and in the second the transport infrastructure and electricity supply (see legend). No sufficient global database is available for other infrastructure areas. The five categories of the need for action result from calculating a mean value on the basis of five classes per indicator (compiled using the quantile method). One country was chosen as an example from each of the five categories. The respective indicator values of the countries are represented in the circle. For example, there is a very urgent need for action in Myanmar. This country, which is highly exposed to cyclones and floods, lacks a (stable) transport infrastructure. Freight transport can therefore easily collapse in the wake of an extreme natural event. The loadable electricity supply is poor on an international scale. In terms of "logistics friendliness", the country is in the second-worst class. Japan is at the other end of the scale. This high-tech country is very highly exposed to natural hazards such as earthquakes and floods. However, thanks to its top values for all three indicators, it has very good prospects of mitigating a disaster resulting from such events.



Indicators for transport infrastructure, electricity supply, and logistics friendliness		Minimum of the 44 countries	Maximum of the 44 countries
A	Availability and quality of transport infrastructure: Extent of metaled roads, length of rail network, number of airports with metaled runways, container transshipment in ports measured in number of standard containers, per 100,000 inhabitants respectively; qualitative assessment of roads, rail infrastructure, ports and airports.	Kyrgyzstan 11.2 %	Australia 54.0 %
B	Extent and quality of electricity supply: Percentage of population with access to electricity and quality of electricity supply.	Chad 9.3 %	Netherlands 97.1 %
C	Logistic Performance Index (LPI): Logistics friendliness, measured in efficiency of customs and border clearance, the quality of the trade and transport infrastructure, the prospects of achieving competitive transport costs, the competence and quality of logistics service providers, the provision of shipment tracking facilities, and the frequency of on-time deliveries.	Haiti 17.9 %	Netherlands 79.7 %

Data for indicators (latest respective version) provided by: CIA World Factbook/Global Competitiveness Report (A); The World Bank (B, C); Exposure according to

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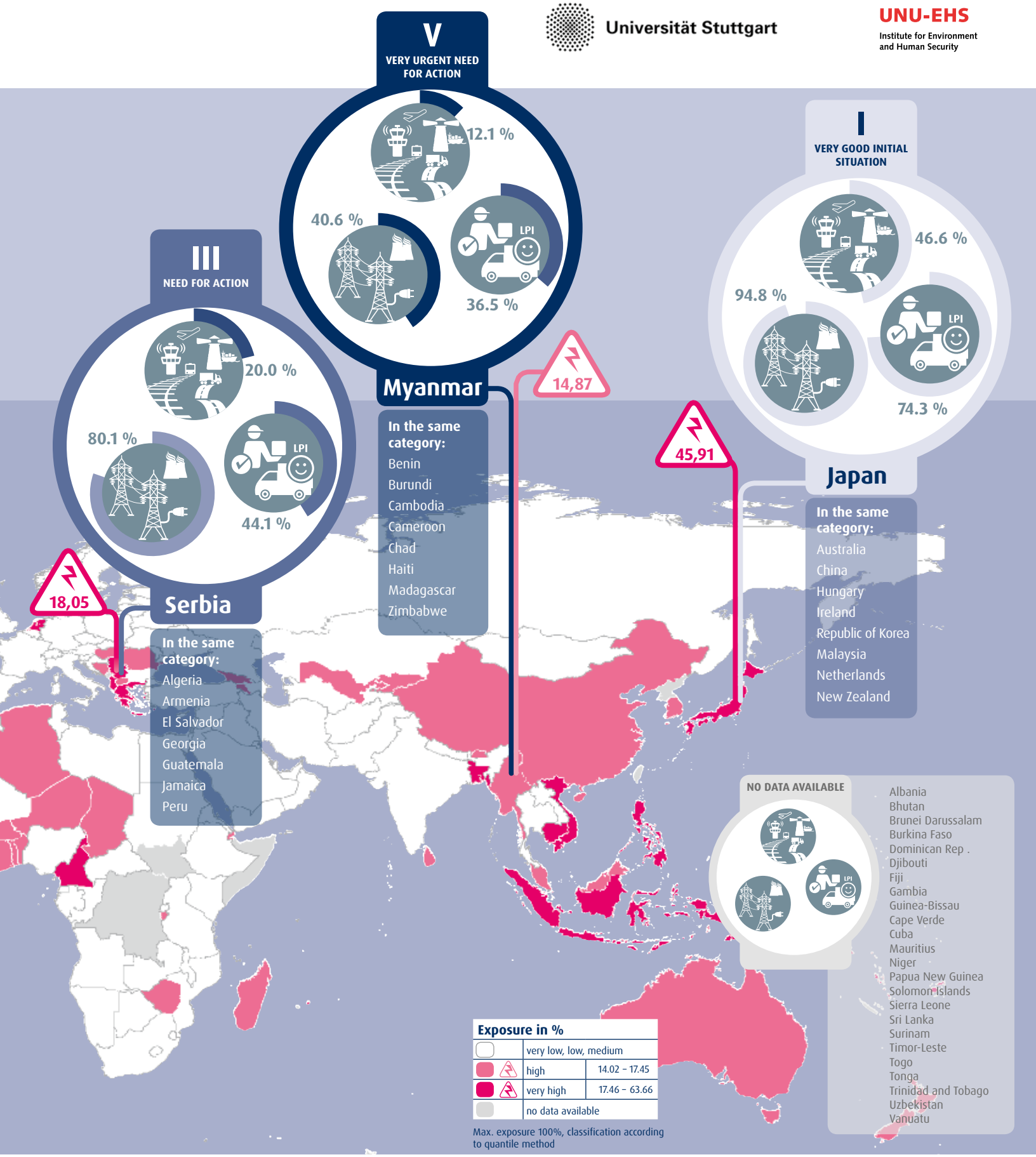
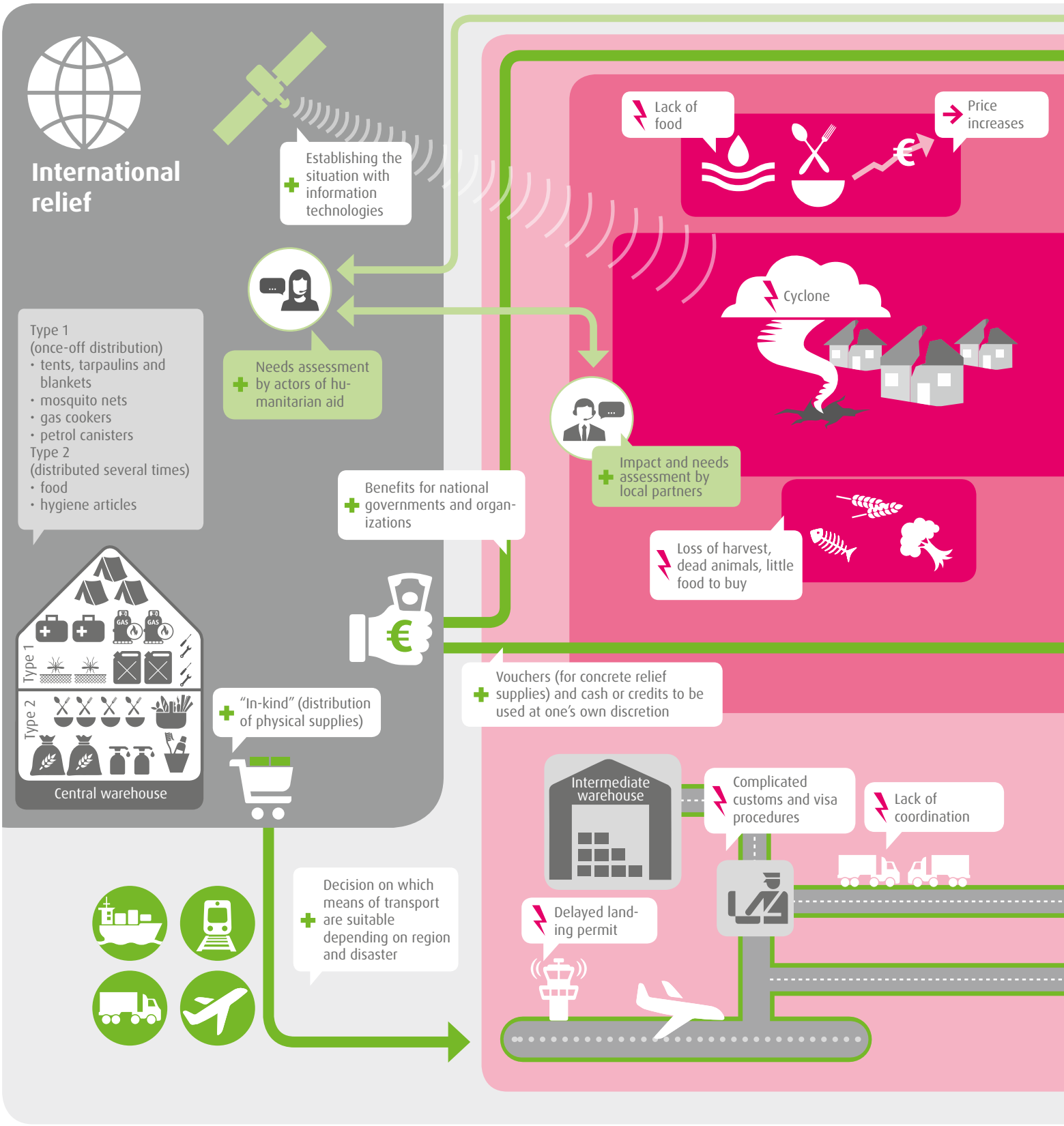
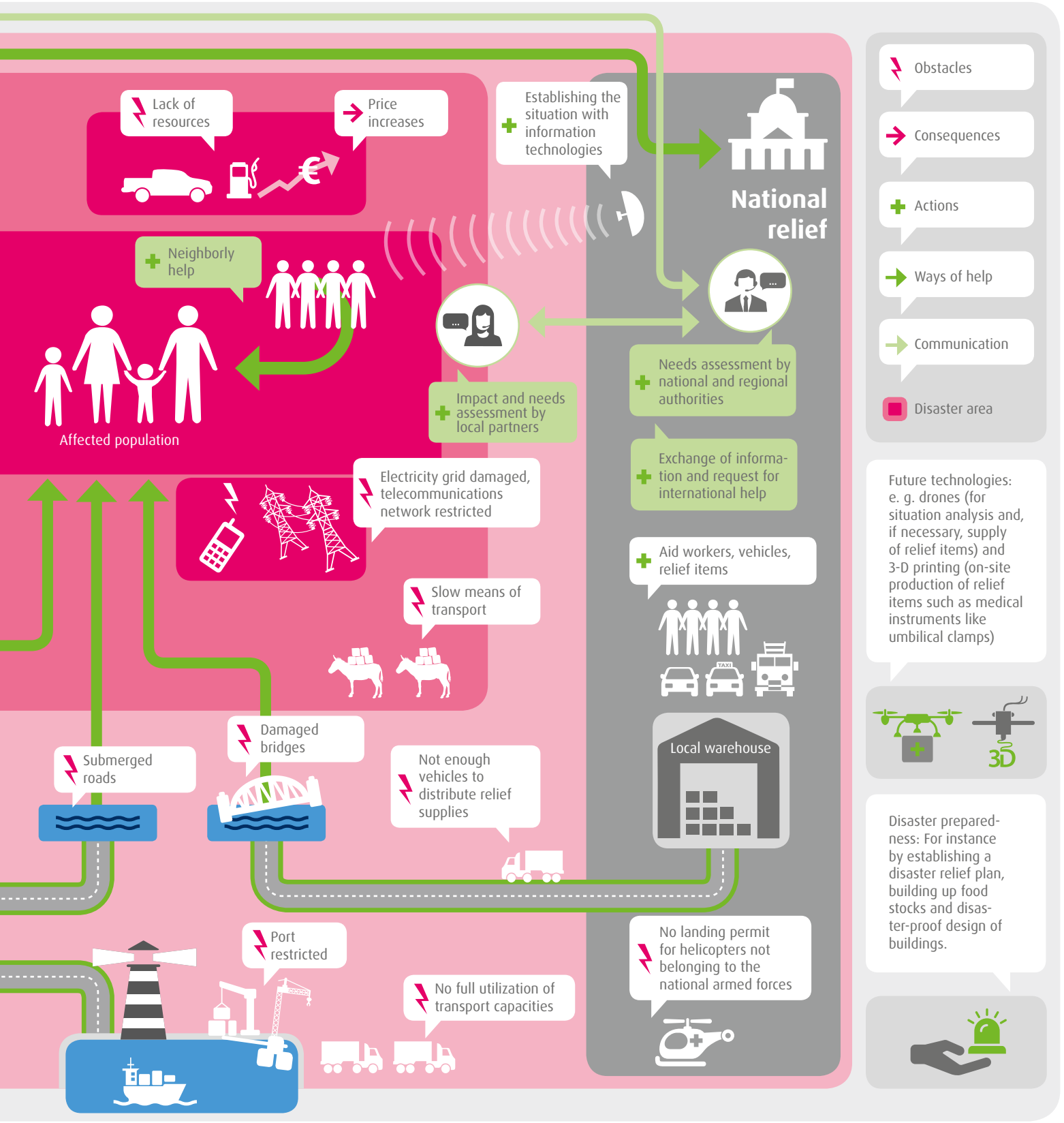


WorldRiskIndex 2016. For calculating method and data base, see www.WorldRiskReport.org

Bündnis Entwicklung Hilft

Humanitarian logistics to the last mile




Lack of resources
Price increases
Establishing the situation with information technologies
National relief
Neighborly help
Affected population
Impact and needs assessment by local partners
Needs assessment by national and regional authorities
Exchange of information and request for international help
Electricity grid damaged, telecommunications network restricted
Aid workers, vehicles, relief items
Slow means of transport
Damaged bridges
Submerged roads
Not enough vehicles to distribute relief supplies
Local warehouse
Port restricted
No full utilization of transport capacities
No landing permit for helicopters not belonging to the national armed forces
Obstacles
Consequences
Actions
Ways of help
Communication
Disaster area
Future technologies: e. g. drones (for situation analysis and, if necessary, supply of relief items) and 3-D printing (on-site production of relief items such as medical instruments like umbilical clamps)
3D
Disaster preparedness: For instance by establishing a disaster relief plan, building up food stocks and disaster-proof design of buildings.

3. The WorldRiskIndex 2016

Nature cannot be controlled. Humans can only influence to a limited degree whether, and with what intensity, natural events are to occur. But they can take precautions to help prevent a natural event from becoming a disaster. It is this vulnerability of a society that forms the basis for the WorldRiskIndex, which calculates the disaster risk for 171 countries by multiplying vulnerability with exposure to natural hazards (cyclones, droughts, earthquakes, floods, and sea-level rise). This risk is especially high wherever natural events hit vulnerable societies. While a low level of vulnerability is not a guaranteed protection against disasters, it can reduce the risk.

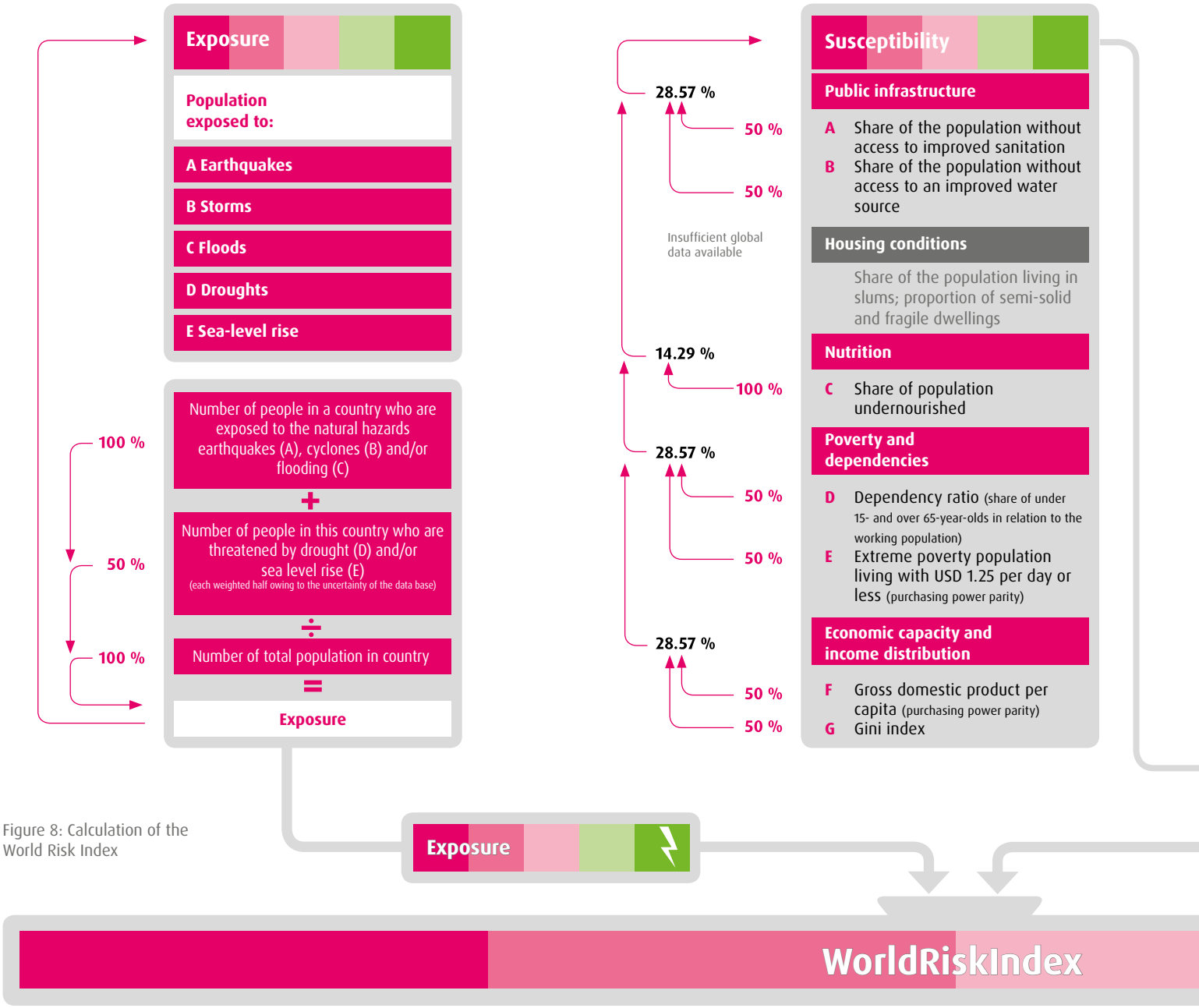


Figure 8: Calculation of the World Risk Index

The concept

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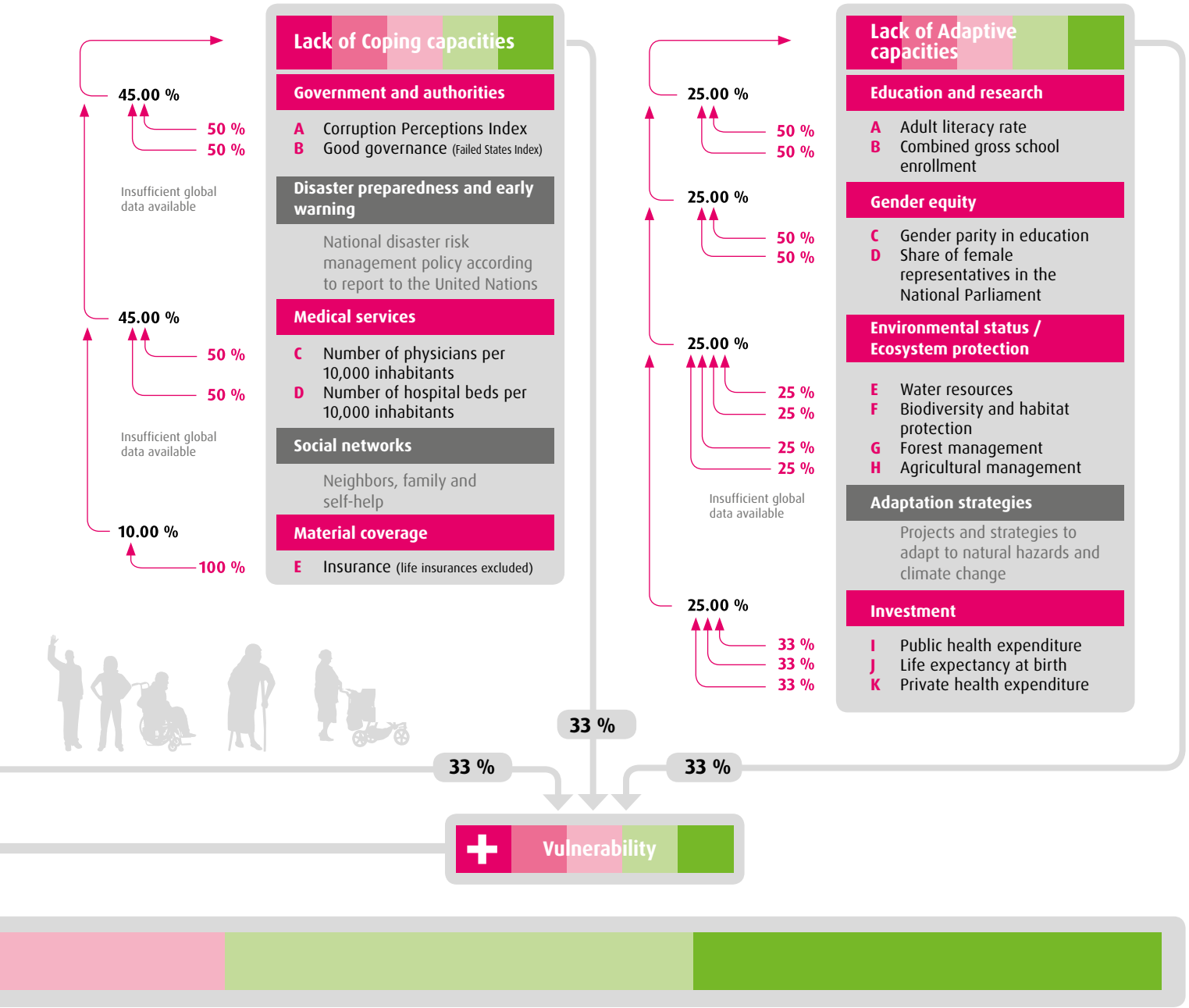
The WorldRiskIndex is calculated with 28 individual indicators and rates the disaster risk for 171 countries owing to five natural hazards: Earthquakes, cyclones, floods, droughts, and sea-level rise. The disaster risk refers to a combination of potentially prone areas or countries and the social, economic and ecological conditions within the respective countries. The WorldRiskIndex does not state when and with what probability the next disaster will occur as a result of extreme natural events but highlights the risk of becoming a victim of disaster. The force and duration of a natural event are not always the main reasons for a disaster, rather social structures and political framework conditions often play a superordinate role (Bündnis Entwicklung Hilft 2011).

The WorldRiskIndex consists of four components: Exposure (to natural hazards), susceptibility, coping capacities and adaptive



capacities. The Index as a whole is calculated from 28 indicators using data that is globally available and accessible to the public (Birkmann et al. 2011, Welle/ Birkmann 2015b).The assignment of the specific indicators to the four components and their weightings is described in the modular structure of the Index above on this page. The result is dimensionless index values for each component that are divided into five classes (quantile method) and represented as maps based on Geographic Information Systems (GIS). This enables a comparison of the 171 countries, and the results can be represented in the media and discussed with decision-makers and experts.

The four components and their combination in the WorldRiskIndex are explained as follows:

→ **Exposure** means that an entity (population, built-up area, infrastructure component, environmental area) is exposed to one or

more natural hazards (earthquakes, cyclones, droughts, floods, and sea level rise).

→ **Susceptibility** is understood as the likelihood of suffering harm in the event of a natural hazard process. Thus, susceptibility describes structural characteristics and framework conditions of a society.

Coping and **coping capacities** comprise various abilities of societies and exposed elements to minimize negative impacts of natural hazards and climate change through direct action and the resources available. Coping capacities encompass measures and abilities that are immediately available to reduce harm and damages in the occurrence of an event. The opposite value, i.e. the **lack of coping capacities,** which results from the value 1 minus the coping capacities, was used for the calculation of the WorldRiskIndex.

→ **Adaptation,** unlike coping, is understood as a long-term process that also includes structural changes (Lavell et al. 2012; Birkmann et al. 2010) as well as measures and strategies dealing with and attempting to address the negative impacts of natural hazards and climate change in the long run. Analogous to the copying capacities, the **lack of adaptive capacities** is included in the WorldRiskIndex.

→ **Vulnerability** comprises the components of susceptibility, lack of coping capacities and lack of adaptive capacities (Bündnis Entwicklung Hilft 2011) and relates to social, physical, economic and environmental factors, which make people or systems vulnerable to the impacts of natural hazards and the adverse effects of climate change or other transformation processes. Moreover, the term vulnerability also covers the abilities and capacities of people or systems to cope with and adapt to the negative impacts of natural hazards. So in a comprehensive sense, the term relates to the vulnerability of societies.

The → **WorldRiskIndex** is calculated by multiplying exposure with vulnerability, since risk is understood as the interaction between exposure and vulnerability. A detailed description of the concept, the indicators used and the method to calculate the WorldRiskIndex is given in the WorldRiskReport 2011, in Welle and Birkmann (2015b), and at www.WorldRiskReport.org.

The WorldRiskIndex 2015 calculates the risk for 171 countries from 28 indicators, five indicators of which relate to the area of exposure and 23 to the area of vulnerability. In all, 17 of the 23 vulnerability indicators have been updated (see table in the menu item "Indicators" at **www.WorldRiskReport.org**). For the remaining six indicators, the data from the previous year was used, since no updated data was available. There has been no new data for the five indicators on exposure since 2012.

The worksheets for the 28 indicators together with the latest data sets and their sources are available at **www.WorldRiskReport.org**.

Results of the WorldRiskIndex 2016

Since no new data is available on exposure, the changes in the country rankings relate exclusively to changes in vulnerability. The results of the individual values for 171 countries are listed in the table in the annex. The graphic representations of the Index can be viewed on Map C on the right fold-out page of the cover and on the World Map on pages 50/51.

From a scientific perspective, changes in the indicators over a short or limited period have to be interpreted carefully since data quality and data currency in the individual indicators sometimes differ considerably (Freudenberg 2003; Meyer 2004). In this year's WorldRiskIndex, this applies particularly to the updated data in the sub-category "Public infrastructure" in the susceptibility component and in the

sub-category "Environmental status /Ecosystem protection" in the adaptive capacities component. In the area of "Public infrastructure", both indicators (A and B) were updated in the course of taking stock of the Millennium Development Goals in 2015, using new calculations (data source: World Bank). In the sub-category "Environmental status /Ecosystem protection" all four indicators (E – H) come from the "Environmental Performance Index" (EPI) 2016, which is updated every two years. This year, the methodology of EPI was revised, using new indicators in particular to improve the meaningfulness of the categories agricultural management and biodiversity and habitat protection (Hsu et al. 2016).

The indicators chosen and their changes over time allow certain options for risk reduction to be derived from them. In this respect, the ranking lists ought to serve the purpose of initiating discussions and measures among political decision-makers in the context of disaster preparedness and development planning.

In the following, the top 15 countries are described with regard to the four respective components, and their potential changes compared to 2015 are discussed (Welle/ Birkmann 2015a). Furthermore, major changes within the ranking are assessed, and a selection of countries that changed classes are also looked at.

Susceptibility

As in the analyses of previous years, most of the countries with the highest susceptibility are in the Sahel Zone and in the tropical areas of Africa, as Map B1 on the left foldout page of the cover shows. The only exceptions are Afghanistan, Haiti, Papua New Guinea and East Timor. Haiti is the only country among the top 15 that does not belong to the African continent. In comparison to the previous year, Zimbabwe and Malawi experienced the largest shift. Zimbabwe fell from rank 18, with a value of 55.76 in the previous year, to 13th, with a value of 57.49. This is above all due to a reduction in the share of the population with access to clean water and improved sanitation. With both indicators, approximately three percent of the population are worse off than in the previous year. Furthermore, the share of the undernourished population increased from 31.8 percent to 33.4 percent. In contrast, compared to the previous year, Malawi improved by eight ranks, and occupies rank 18. The main reason for this is its population's access to improved sanitation. Whereas just below eleven percent had access in 2012, according to the World Bank, there were already 41 percent in 2015. This considerable growth level should most likely be attributed to the new method of data calculation (see above). In comparison to the previous year, access to clean drinking water increased by five percentage points to 90 percent. The largest negative change was recorded for Lebanon, which worsened by 20 ranks and shifted from the "very low" class to the "medium" class. This is due on the one hand to a reassessment of the data for the population with access to improved sanitation and on the other to an increase in the share of under-15- and over-65-year-olds in the working population.

The 15 countries with the highest **susceptibility** worldwide

Country	Sus. (%)	Rank
Madagascar	65.23	1.
Central African Republic	64.68	2.
Mozambique	63.24	3.
Burundi	63.23	4.
Liberia	62.70	5.
Haiti	61.81	6.
Zambia	61.73	7.
Chad	61.07	8.
Eritrea	60.97	9.
Comoros	58.66	10.
Tanzania	58.51	11.
Niger	57.72	12.
Zimbabwe	57.49	13.
Togo	57.36	14.
Sierra Leone	57.06	15.

Lack of coping capacities

The cartographic representation of the lack of coping capacities (Map B2, left fold-out page of the cover) shows hotspot regions in Africa and Asia, as the Top 15 table also demonstrates. The shifts in rankings of the countries

are above all due to alterations in the two "Governance" indicators ("Corruption Perceptions Index" and "Good governance"). Within the Top 5 table, there have been a number of shifts. For instance, Afghanistan replaces Sudan at rank 1, since unlike with Sudan, the "Governance" indicators have worsened. In all 171 countries, the biggest shifts in rankings have been recorded for Syria, Libya, and Mali, which have been assigned to other classes. Syria has worsened by ten ranks owing to the disastrous political situation, which is reflected in the "Governance" indicators.

The 15 countries with the highest **lack of coping capacities** worldwide

Country	Lack of C. C. (%)	Rank
Afghanistan	92.85	1.
Sudan	92.80	2.
Haiti	91.24	3.
Yemen	91.24	4.
Chad	91.09	5.
Central African Republic	90.60	6.
Guinea-Bissau	89.93	7.
Guinea	89.73	8.
Eritrea	89.47	9.
Iraq	89.42	10.
Zimbabwe	88.22	11.
Nigeria	88.15	12.
Uganda	87.99	13.
Burundi	87.71	14.
Myanmar	87.00	15.

Lack of adaptive capacities

The hotspot regions for the lack of adaptive capacities (Map B3, left foldout page of the cover) can be found mainly in West Africa and the Sahel Zone as well as in parts of Southeast Asia. The new calculation of the "Environmental Performance Index" 2016 and the updating of a further five indicators have resulted in significant changes in the Top 15 table in comparison to the previous year, and individual indicators do not clearly explain the shifts in rankings. For instance, Eritrea is ranked first and has worsened by eight ranks compared to the previous year. In addition, there are three new countries among the Top 15: Burkina Faso (from rank 25 to rank 15), Djibouti (from rank 16 to rank 3), and Pakistan (from rank 19 to rank 14).

The 15 countries with the highest **lack of adaptive capacities** worldwide

Country	Lack of A. C. (%)	Rank
Eritrea	72.24	1.
Central African Republic	69.13	2.
Djibouti	68.11	3.
Niger	68.11	4.
Afghanistan	67.48	5.
Liberia	66.70	6.
Chad	66.42	7.
Benin	66.06	8.
Sierra Leone	65.55	9.
Guinea-Bissau	64.38	10.
Mali	63.58	11.
Guinea	62.70	12.
Haiti	62.49	13.
Pakistan	62.48	14.
Burkina Faso	62.11	15.

Vulnerability

Both the map for vulnerability (Map B, right foldout page of the cover) and the Top 15 table show that the countries with the highest vulnerabilities can be found mainly on the African continent. With the exception of Haiti and Afghanistan, all 15 countries with the highest levels of vulnerability are in Africa. Sudan and Zimbabwe are new in the Top-15 table, having moved from rank 17 to rank 14 and from rank 28 to rank 15 respectively. On the other hand, Mali and the Comoros are no longer represented among the top 15, both of them having improved in comparison to the previous year (Mali from rank 13 to 16 and the Comoros from rank 15 to 20). There are other conspicuous examples in the ranking for vulnerability. In comparison to the previous year, Paraguay improved by two ranks, shifting from the class with the "highest vulnerability" to the class with "medium vulnerability", especially owing to the data updates for its adaptive capacities. In the previous year, Malaysia was at rank 104, and can now be found at rank 99, which has led to a shift to the class with "low vulnerability". Here, interestingly, data updating in the adaptive capacities component has no major impact, since, in comparison to the previous year, Malaysia even improved by one rank. The reason for the deterioration is poorer values for the "Governance" indicators.

The 15 countries with the highest **vulnerability** worldwide

Country	Vuln. (%)	Rank
Central African Republic	74.80	1.
Eritrea	74.23	2.
Chad	72.86	3.
Afghanistan	72.12	4.
Haiti	71.85	5.
Liberia	71.54	6.
Niger	70.80	7.
Sierra Leone	69.69	8.
Madagascar	69.52	9.
Guinea-Bissau	68.99	10.
Mozambique	68.28	11.
Guinea	68.21	12.
Burundi	67.98	13.
Sudan	67.37	14.
Zimbabwe	67.24	15.

Exposure to natural hazards

No updated information has been available in this component since WorldRiskReport 2012 as the data concerned is not updated annually but only at longer intervals because of the small temporal changes in exposure. For this reason, the world map for exposure (Map A, right foldout page of the cover) shows the same global hazard zones as in the previous years.

The 15 most **exposed** countries worldwide

Country	Exp. (%)	Rank
Vanuatu	63.66	1.
Tonga	55.27	2.
Philippines	52.46	3.
Japan	45.91	4.
Costa Rica	42.61	5.
Brunei Darussalam	41.10	6.
Mauritius	37.35	7.
Guatemala	36.30	8.
El Salvador	32.60	9.
Bangladesh	31.70	10.
Chile	30.95	11.
Netherlands	30.57	12.
Solomon Islands	29.98	13.
Fiji	27.71	14.
Cambodia	27.65	15.

WorldRiskIndex 2016

The global hotspot regions of risk have not changed in comparison to the previous years and continue to be located in Oceania, Southeast Asia, Central America and the Southern Sahel.

In comparison to 2015, Brunei Darussalam experienced the biggest change within the Top-15 countries. The kingdom worsened by five ranks, from rank 12 to rank 7, which is due to an increase in vulnerability. Among the total 171 countries, two further changes are conspicuous. Serbia switched classes in comparison to the previous year, and is now in the class with a "high risk", instead of its previously belonging to the class with a "medium risk". This is due to a deterioration of Serbia's vulnerability, primarily in conjunction with data updating within the adaptive capacities, but also owing to a reduction in coping capacities ("Governance" indicators). In contrast, Namibia has improved, moving from the class with a "medium risk" to the class with a "low risk". This is thanks to improvements in adaptive capacities and an increase in coping capacities (improvement in "Governance" indicators).

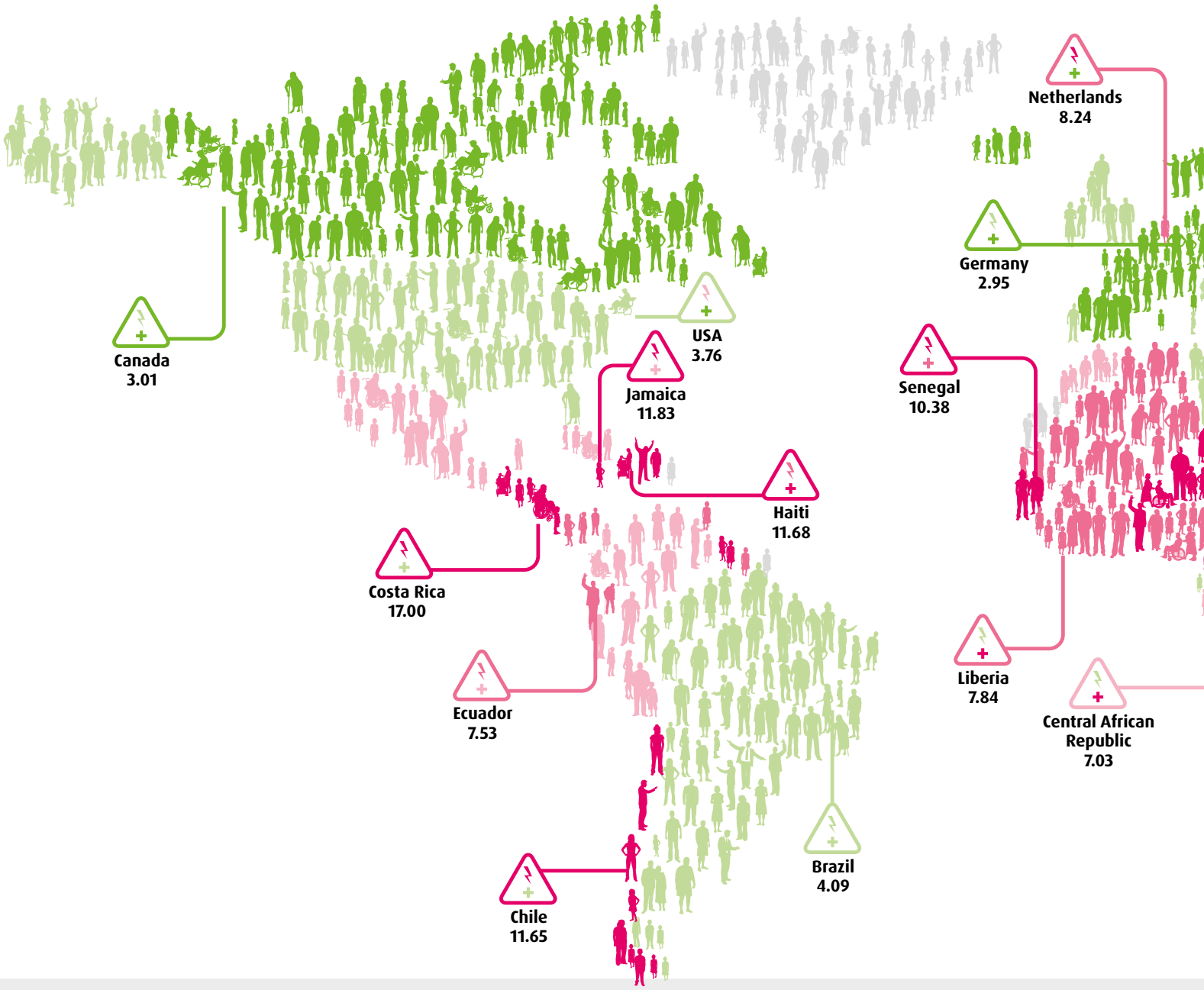
The 15 countries that are most at **risk** worldwide

Country	Risk (%)	Rank
Vanuatu	36.28	1.
Tonga	29.33	2.
Philippines	26.70	3.
Guatemala	19.88	4.
Bangladesh	19.17	5.
Solomon Islands	19.14	6.
Brunei Darussalam	17.00	7.
Costa Rica	17.00	8.
Cambodia	16.58	9.
Papua New Guinea	16.43	10.
El Salvador	16.05	11.
Timor-Leste	15.69	12.
Mauritius	15.53	13.
Nicaragua	14.62	14.
Guinea-Bissau	13.56	15.

The map representing the WorldRiskIndex for 171 countries is shown on the right foldout page of the cover (Map C) and on pages 50/51. The individual values for the 171 countries are listed in the table in the Annex.

Bündnis Entwicklung Hilft

WorldRiskIndex



Components of the WorldRiskIndex at the global and local level

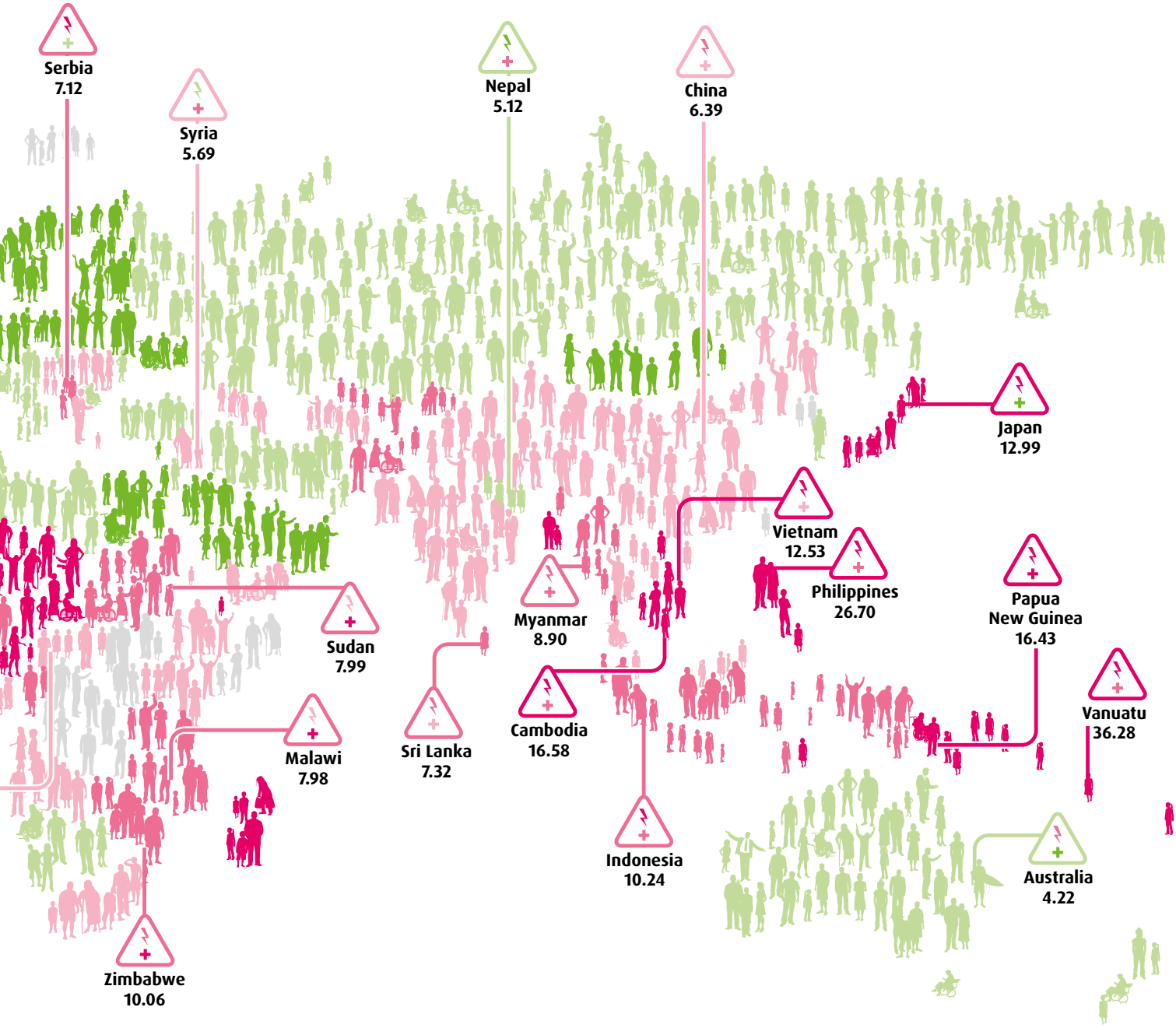
Natural hazard sphere	Vulnerability – Societal sphere		
Exposure Exposure to natural hazards	**Susceptibility** Likelihood of suffering harm	**Coping** Capacities to reduce negative consequences	**Adaptation** Capacities for long-term strategies for societal change

WorldRiskIndex (WRI) in %	
very low	0.08 – 3.46
low	3.47 – 5.46
medium	5.47 – 7.09
high	7.10 – 10.28
very high	10.29 – 36.28
no data available	

Exposure in %	
very low	0.28 – 9.25
low	9.26 – 11.53
medium	11.54 – 13.85
high	13.86 – 17.45
very high	17.46 – 63.66
no data available	

Vulnerability in %	
very low	24.79 – 34.40
low	34.41 – 43.11
medium	43.12 – 49.72
high	49.73 – 62.58
very high	62.59 – 74.80
no data available	

Data: Source IREUS, based on the PREVIEW Global Risk Data Platform, CReSIS, CIESIN and global databases; detailed information at



Country	WRI		
Australia	4.22 %	15.05 %	28.01 %
Brazil	4.09 %	9.53 %	42.92 %
Cambodia	16.58 %	27.65 %	59.96 %
Canada	3.01 %	10.25 %	29.42 %
Central Afr. Rep.	7.03 %	9.39 %	74.80 %
Chile	11.65 %	30.95 %	37.66 %
China	6.39 %	14.43 %	44.29 %
Costa Rica	17.00 %	42.61 %	39.89 %
Ecuador	7.53 %	16.15 %	46.63 %
Germany	2.95 %	11.41 %	25.87 %

Country	WRI		
Haiti	11.68 %	16.26 %	71.85 %
Indonesia	10.24 %	19.36 %	52.87 %
Jamaica	11.83 %	25.82 %	45.81 %
Japan	12.99 %	45.91 %	28.29 %
Liberia	7.84 %	10.96 %	71.54 %
Malawi	7.98 %	12.34 %	64.66 %
Myanmar	8.90 %	14.87 %	59.86 %
Nepal	5.12 %	9.16 %	55.91 %
Netherlands	8.24 %	30.57 %	26.94 %
Papua New Guinea	16.43 %	24.94 %	65.90 %

Country	WRI		
Philippines	26.70 %	52.46 %	50.90 %
Senegal	10.38 %	17.57 %	59.08 %
Serbia	7.12 %	18.05 %	39.46 %
Sri Lanka	7.32 %	14.79 %	49.52 %
Sudan	7.99 %	11.86 %	67.37 %
Syria	5.69 %	10.56 %	53.85 %
USA	3.76 %	12.25 %	30.68 %
Vanuatu	36.28 %	63.66 %	56.99 %
Viet Nam	12.53 %	25.35 %	49.43 %
Zimbabwe	10.06 %	14.96 %	67.24 %

www.WorldRiskReport.org; Max. = 100 %, Classification according to the quantile method. ϟ = Exposure, + = Vulnerability

4. Challenges and prospects

What are the biggest problems concerning humanitarian logistics and infrastructure? What tasks does this imply for politics, science, economics, and, last but not least, non-governmental organizations? What opportunities and risks does the use of new technologies bear? And what optimum condition of humanitarian logistics and infrastructure appears to be feasible within the next two decades? We asked four external experts in this field as well as one employee of each of the two publishers of this WorldRiskReport for answers to these and further issues.

External experts on the topic of humanitarian logistics and infrastructure

Prof. Dr. Martina Comes works at the Centre for Integrated Emergency Management (CIEM) at the University of Agder in Kristiansand.

Sean Rafter is Managing Director of HELP Logistics AG, a subsidiary of the Kühne Foundations.

Kathrin Mohr heads the Deutsche Post DHL Group's "GoHelp" program.

Edsel Macasil is Emergency Relief Coordinator at Kindernothilfe's Filipino partner organization AMURT.

As co-staff of the publishers

Dr. Matthias Garschagen is Head of Section, "Vulnerability Assessment, Risk Management & Adaptive Planning", at UNU-EHS.

Bruno Vandemeulebroecke is Emergency Relief Coordinator and Senior Advisor Humanitarian Logistics at Welthungerhilfe.

The interviews were conducted by **Julia Walter** und **Lars Jeschonnek**. Full-length versions of the interviews are available at the website **www.WorldRiskReport.org**. Excerpts from these interviews are given on the following pages.

1. From a global angle, what are the three biggest problems in human logistics and infrastructure?

Martina Comes: In a nutshell, they are the following three: First, better coordination, second, handling the data revolution and the implications of new technologies, and third, the discrepancy between supporting local groups, i.e. the notion of community resilience on the one hand, and the tendency to centralize information and decisions at international level on the other.

Bruno Vandemeulebroecke: It is very expensive to run large logistics operations and it is partly more expensive because it is hard to find trained and qualified staff to perform the logistics duties in the most efficient way. This is hard because there is no common logistician's profile in the world. You have different profiles which are all summed up under the same name. You can have a logistician who is very good at setting up an operation from zero. You can have logisticians who, for instance, are very good at supporting the construction of a piece of infrastructure. You have logisticians who are very good at supply chains in general. Then you have people who are very good at the distribution of different items. These are all different and complementary skill sets and it is very hard to find somebody who has everything. Of course, more and more it is not so much about doing it yourself but managing people. So, on top of it all you need to have people with a lot of management skills. Furthermore, there is a problem of protection in the sense of international humanitarian law. The risk that people have to take to get into some areas is sometimes bordering on being unacceptable. Strategic foresight is also crucial, especially when we think of infrastructure. This has a lot to do with preparedness. You can mitigate a large part of the consequences of extreme natural events. You can mitigate the impact of the disaster on the population in disaster-prone regions by setting up infrastructure in advance which is resistant to the disaster that could take place and which could contribute to the alleviation of the suffering that follows the disaster.

It is very expensive to run large logistics operations, and it is partly more expensive because it is hard to find trained and qualified staff to perform the logistics duties in the most efficient way.

Kathrin Mohr: Transparency in the area of relief supplies, a lack of preparations and coordination. Transparency regarding relief supplies: As a rule, the UN is usually very quickly aware of what it needs – in my opinion, these assessments are carried out very well. But often, the UN does not know what is really arriving in a country. What has actually been delivered in relation to the existing needs cannot be properly counted. Neither does the UN know what kinds of relief supplies have been provided – whether the items that it requested or things that the countries just happened to have sent. Unfortunately, this also happens very often. The second problem is insufficient preparations. Again and again, we can witness that airports are not at all prepared for having to suddenly cope with a tenfold increase in cargo or ten times the number of personnel in one day. The third aspect is coordination at the local level. Sometimes it works well, and sometimes not so well. We maintain a partnership with OCHA, the UN Office for the Coordination of Humanitarian Affairs, so that we are integrated in the humanitarian system. However, there are also organizations on the ground that simply cannot be coordinated but just do their own thing. This may at least partly be an advantage for the organizations because they can get going without any fuss, although it is a considerable disadvantage for the humanitarian chain as a whole, also in terms of transparency.

2. What do you think of the work of the German Government and the international community in the field of humanitarian logistics and infrastructure over the last few years? What will be their most important tasks over the next few years?

Edsel Macasil: I think they have done a good job, insofar as they tried to deliver relief in a very efficient way. However, the international community should not take over the leading role in disaster management, but should instead acknowledge the sovereignty of the local government and the capacity of its inhabitants. On the other hand, the governments of other states pledging aid should not channel the money through the national government where the outcomes are difficult to trace. This is one of the reasons why we have NGOs. And ideally they are locally based NGOs. For example, when we talk about logistics, for me it is not just a supply chain for bringing blankets from A to B because people need these blankets. It is a process of responding to a humanitarian need with an aim to develop local capacities from the beginning.

The international community should not take over the leading role in disaster management, but should instead acknowledge the sovereignty of the local government and the capacity of its inhabitants.

Matthias Garschagen: There needs to be a stronger emphasis on the capacity to maintain infrastructure necessary for disaster response in a precautionary way, regardless of whether or not a disaster has set in. In other words, is the infrastructure operational in the respective countries? Have institutional and political agreements been made for cooperation and contingencies in a crisis situation? All those preparations that have to be made by organizations ahead of crises.

Sean Rafter: One area that has improved in recent years – that was begun after Haiti, when there were huge numbers of actors arriving on the scene – is coordination. The quantity and diversity of humanitarian actors is increasing. There are more military, civil society actors and the local private sector present in big humanitarian responses. Collaboration and investment in strengthening local actors and civil society will be critical in the future. Donors contribute significant amounts to NGOs and bilaterally to governments, but often it is rather time-bound. It would be good to see actions begun in an emergency continue with additional investment so that we can move towards building appropriate and resilient infrastructure for future disasters. Expanding the establishment of local networks and aligning these to humanitarian preparedness scenarios, could greatly contribute to future response effectiveness. Assessment and optimization of existing national supply chains and organization processes and systems would also make operations more efficient.

Kathrin Mohr: BMZ support for our GARD program is greatly to the German Government's credit. The BMZ is providing around 400,000 euros to UNDP for a two-year period to implement GARD. The German Government's recognition that the program makes sense is an important signal. Thanks to the positive results of an external evaluation of the program, financing has been extended. This is a good example of how the private sector can be involved and a concrete, measurable project can be supported without just pouring out money somewhere. Politicians ought to continue to promote such things and also make them visible to inspire other companies.

3. What missions do you see for science, for the NGOs, and for business?

Kathrin Mohr: The NGOs have the advantage that they have often been active locally for several years and are very familiar with the circumstances there. Frequently, however, they are not that good at getting relief supplies into the country. As a rule, the NGOs themselves care for the last mile because they are much more acquainted with this aspect. In my opinion, science could contribute more to formulating measurable, concrete goals. At scientific events, I find that the discourse is often far too elaborate. The researchers like to compile optimization models for logistics chains. In my opinion, this has nothing to do with reality. Science ought to formulate tangible targets that business and NGOs can implement together.

Science ought to formulate tangible targets that business and the NGOs can implement together.

Martina Comes: I believe that the biggest task for science is not to merely analyze ongoing developments but to develop concrete support as well – such as software components, training programs or lessons learned. As one colleague remarked, the humanitarian system has a tendency to forget because the rotation cycles are often short. And this is where universities or academics can play an important role. They can establish a knowledge base and train different actors in applying various methods. Another very big mission that I would suggest is conducting relevant research. Personally, I would advocate intensive collaboration with the humanitarian organizations or with other local actors. I think it is important for academics to leave their desks and enter the field. However, a mutual effort is required, because humanitarian organizations often falsely expect academics to work as consultants and come up with standardized solutions or quick fixes that can then be implemented immediately.

And this is where universities or academics can play an important role. They can establish a knowledge base and train different actors in applying various methods.

Matthias Garschagen: NGOs have done a lot of very valuable work in the past. However, at times, they also tend to contribute to hectic action. Many NGOs need to adjust to short-term time spans of attention and donations. A key question is therefore how long-term engagement can be developed and maintained after a crisis, not only for proper humanitarian logistics during the first few weeks, but also for long-term reconstruction and rehabilitation, when the major streams of donations cease to flow. I think that in this context, many international organizations could improve the way they present themselves and their work to the outside world.

Bruno Vandemeulebroecke: One of the biggest challenges for the three actors – economy, science and NGOs – is definitely how we can have a better ecological footprint and how we are going to do reverse logistics. Reverse logistics means to make sure that you are going to clean up after humanitarian operations. When you distribute a lot of stuff or just run a "normal" operation, what are you going to do with all the waste? This is a question we need to answer. The old advice "Don't give a man fish, but teach him how to fish" is supplemented by "teaching a man to fish so that there is going to be enough fish tomorrow" – this is sustainable fishing. And now we are heading towards the question, how to make sure that while fishing we are not polluting the water in which the fish is living.

4. What optimum state of humanitarian logistics and infrastructure do you think will be feasible in ten to twenty years' time?

Sean Rafter: There was a very relevant concept discussed in a paper entitled "Delivering in a Moving World" published for the recent World Humanitarian Summit. It simply said: „We want to be as local as possible and as international as necessary". I think this captures where the humanitarian community would like to see investment in preparedness and strengthening of human resources. We don't want future large scale emergencies to have dependencies on international intervention. More investment at local level in preparedness will support affected communities, make economies more resilient and reduce loss of life. That would be my hope for the future, and I think we already get a sense of that when we see what is happening in Europe in terms of environmental or migration issues. These are global issues that require global initiatives, but it is local people and communities that can provide immediate response and also be the catalyst for recovery and change.

More investment at local level in preparedness will support affected communities, make economies more resilient and reduce loss of life.

Edsel Macasil: My aim is to have real trained relief teams in place and decentralized relief storages in all disaster-prone areas. I think that this is realistic. Disaster Risk Reduction must be a requirement for public expenditure for humanitarian crises. I am not saying that the NGOs should spend their own money to do this. Governments should collaborate with those NGOs that do this kind of work. We need to take preventive measures before the disaster, not a patch-up afterwards.

Martina Comes: One trend is increased data collection, which can be an important decision aid in the field of logistics. Let's take the example of vaccines. They have to be cooled, transported, and stored along the entire supply chain. Today it is possible to record the temperature during a delivery and monitor it more or less continuously. But this does not mean that the vaccines are really kept cool. The information that "it is going to get warmer this week" needs to be linked to information about where electricity or ice can be found. And this in turn must connect to a very simple navigation stating that "The route via Village A will take five hours, and the route via Village B three hours, so it would be better to take the route via Village B". This means that, at least ideally, combining different information is also going to become extremely important in the field of logistics. The knowledge we've got, we have to combine with changing things.

5. In your opinion, what are the key mistakes that NGOs are still making too often in humanitarian logistics and infrastructure measures?

Matthias Garschagen: My colleagues who are specializing in humanitarian logistics often complain about the lack of cooperation. Visibility and a certain profile are absolutely necessary for NGOs. But sometimes, this can mean that you will find too many actors in those places that receive media attention while there are not enough actors elsewhere. NGOs do have to present themselves and be visible in the media. But sometimes, this results in rivalry rather than useful task-sharing and cooperation. The cluster approach is aimed at tackling this challenge.

NGOs do have to present themselves and be visible in the media. But sometimes, this results in rivalry rather than useful task-sharing and cooperation.

Sean Rafter: Our team has worked with many different organizations, and in our collective experience, we still find that many humanitarian organizations undervalue supply chain management and logistics. For example, you often find a supply chain manager sitting on the board of directors in a commercial organization because the function is considered an integral part of the core business. In the humanitarian sector, the position sits alongside other support services. It is potentially a decade behind the commercial sector in recognising the importance of logistics. This is often reflected in the capacity of logistics staff and in their ability to progress their careers. There is often a ceiling to how far they can advance in the organisation. Talented and ambitious logistics personnel often move into other functions in order to stay in the humanitarian sector while progressing their careers. That's a shame and we cannot afford to lose that talent. It would make sense to ensure a supply chain manager or director is on the senior management team to influence strategic decision-making. Also, we see again and again, that logistics perform incredibly well initially but at the onset of an emergency. However, over time without a bigger pool of well-trained senior personnel to relieve fatigued staff, gaps start to appear. A recent paper which was done by the Kühne Logistics University for the World Bank Group demonstrated that middle management is an area both in the commercial and humanitarian sectors that is struggling to have enough resources. This is certainly the case in the humanitarian sector and so we really need to encourage more people to come into supply chain and logistics by improving the standing of logistics, providing better career paths and creating a mechanism for personnel to transfer to equivalent positions from commercial to humanitarian organisations and vice-versa.

In our collective experience, we still find that in every organization – some are better than others – there is a huge underevaluation of supply chains and logistics in the humanitarian sector.

Martina Comes: That they simply roll out their standard protocols and do not attempt to first of all understand the local situation. For example, if you look at maps or information materials for very different natural disasters throughout the world, they always look the same. Of course standardization offers the advantage that you can respond very quickly. But one has to ask whether referring in the same manner to very different environments, ranging from drought crises to earthquakes like the one in Nepal, really is justified. So excessive standardization is a mistake. And then there is the aspect that NGOs sometimes behave as if they were the sole authority, and that they are often too poorly coordinated.

6. What are the prospects for humanitarian logistics and infrastructure, which technology could result in sustainable changes, and what risks does the application of these technologies entail?

Kathrin Mohr: I don't see any true risks. Perhaps that you may be relying too much on them and the entire infrastructure then collapses after a natural disaster. This has happened often enough. On the other hand, telecommunications companies have developed very good solutions to get the infrastructure going again very quickly. We are constantly being presented with new technologies. Some people obviously believe that everything has to be equipped with scanner technology and barcodes. This faith in technology annoys me sometimes. Once in a while it is just better to rely on common sense, and the preparations and experiences.

This faith in technology rather annoys me sometimes. It is often better to rely on common sense, making preparations, and drawing on experience.

Bruno Vandemeulebroecke: Traceability is going to improve. The technology is already there, only the prices are still a little bit too high. You know where a product comes from, where it is on the road, how long it is going to take to get there, and where it arrives. Afterwards you can assess whether it was the correct charge and the correct person who received it. So we have many more analysis possibilities. But of course, there is a risk that we spend too much time on analysis and too little time on actually providing support. Basically, logistics is still about bringing goods from A to where they are most needed in the most efficient, correct and fastest way. And that has been the same for many hundreds of years. Technology helps us in being transparent, whether we are efficient or not. I think this is a very important aspect – be it transparency towards donors or transparency within an organization. A lot of money goes into logistics. 60 to 80 percent of all the money distributed passes through the hands of logistics sooner or later, whether it is procurement or whether it is handling. So technology-based transparency especially is going to be very useful and necessary in the response to protracted crises, where you need a massive amount of resources and funds to keep on going. Transparency is crucial for getting the best out of every dollar and euro.

Matthias Garschagen: One important risk I see is that people expect too much from these new technologies. They are increasingly being referred to as the major panacea for crises management. I often hear that significant progress can be achieved if we only apply these technologies properly. I think this is a fallacy, or at least a highly questionable expectation. All analysis indicates that we will come back to similar questions again and again: how good is governance in a country; do resources arrive in the right places; are certain parts of the population facing institutional barriers in terms of the access to resources; and are there constraints on the utilization of assets. Here, I see the risk that the current debate on new technologies in the humanitarian community often misses the main point, by shifting attention away from these essential issues. So why is there no basic infrastructure in some countries, no functioning system of bridges, railway network, transformer system, grid system, etc. – and why has this been the case for decades? No smartphone in the world is going to change this state of affairs significantly.

7. Which myth in humanitarian logistics and infrastructure would you like to dispel?

Bruno Vandemeulebroecke: For those who think logistics is a male-dominated field: It is not. There is a massive amount of very professional female logisticians out there. Furthermore, it is no longer true that a logistician is a MacGyver with a Swiss army knife fixing things. A logistician is a manager who plans complex activities while adhering to numerous rules and regulations and who needs to organize a team and needs to make sure that the team is going to do the job like it should be done. Just about anyone can become a logistician, but it is a myth that one can become a logistician without training.

Edsel Macasil: We have this belief that big organizations are more efficient than small ones. This is why the access to resources is often very limited to a cluster of large international NGOs. But actually it is the opposite: The small ones are more efficient than the big ones. We are a small NGO, but we have done a lot. We minimize the cost and maximize the outputs.

But actually it is the opposite: The small organizations are more efficient than the big ones.

Martina Comes: That you are helping a country by merely providing as many relief supplies as possible. Instead, you have to work together with the population to restore local structures and the infrastructure. We have to get away from the myth of the international community heroically entering the scene and getting the country going again for the poor local victims. What counts instead is to allow people to reconstruct their own infrastructure and economy.

We have to get away from the myth of the international community heroically entering the scene and getting the country going again for the poor local victims.

Sean Rafter: The myth that humanitarian logistics is less capable or competent than logistics in other sectors. I don't believe it is at all, it is just that technical competence is a subset of much broader skills and competencies that are required. However, just as important are personal skills such as communication, adaptability, resilience, cultural awareness, etc. In addition one must know donor policies, international and national rules and regulations, human rights laws, etc. And it's all changing constantly.

Kathrin Mohr: Drones are my favorite myth. Again and again, I am asked whether we have drones. Yes, as Deutsche Post DHL group, we do have them available. We are relatively active in this area, although I believe that this is more of a long-term project. It does make sense commercially. But I am often asked whether we could make use of drones in humanitarian logistics operations. Some suggest that this would be of great use and that drones could even carry medicine supplies to remote villages. I think this is complete nonsense. Just realize what one of these drones can carry: Not more than one to three kilograms. This really is an extremely limited amount. And then you must consider that these drones are often only allowed to fly by visual flight rules, which restricts their usefulness even more. And drones have to be authorized by the respective country's aviation authority. If you consider that many countries do not even allow others than the armed forces's to fly helicopters, you can immediately forget about drones. No doubt films recorded with a drone-mounted camera showing the extent of damage caused in Kathmandu in the wake of the earthquake are impressive. This is something they can be used for, but not to perform logistical tasks. I don't believe this will be feasible in the more immediate future.

Country	WRI	Rank	Country	WRI	Rank	Country	WRI	Rank	Country	WRI	Rank
Afghanistan	9.50	41.	Ethiopia	7.04	70.	Morocco	6.45	82.	Turkmenistan	6.44	84.
Albania	9.50	40.	Fiji	13.15	16.	Mozambique	8.69	44.	Uganda	6.52	80.
Algeria	7.36	62.	Finland	2.21	160.	Myanmar	8.90	42.	Ukraine	2.97	146.
Angola	6.52	81.	France	2.62	152.	Namibia	5.37	104.	Unit. Arab Emirates	1.97	163.
Argentina	3.56	129.	Gabon	6.04	93.	Nepal	5.12	108.	United Kingdom	3.54	131.
Armenia	6.07	92.	Gambia	12.07	19.	Netherlands	8.24	49.	Uni. Rep. of Tanzania	7.65	57.
Australia	4.22	121.	Georgia	6.27	88.	New Zealand	4.55	116.	United States	3.76	127.
Austria	3.39	135.	Germany	2.95	147.	Nicaragua	14.62	14.	Uruguay	4.03	124.
Azerbaijan	5.54	102.	Ghana	8.39	47.	Niger	11.24	25.	Uzbekistan	8.59	45.
Bahamas	4.14	122.	Greece	6.70	76.	Nigeria	7.98	52.	Vanuatu	36.28	1.
Bahrain	1.69	165.	Grenada	1.42	167.	Norway	2.19	161.	Venezuela	5.93	96.
Bangladesh	19.17	5.	Guatemala	19.88	4.	Oman	2.64	151.	Viet Nam	12.53	18.
Barbados	1.32	168.	Guinea	8.20	50.	Pakistan	6.96	72.	Yemen	5.97	94.
Belarus	3.11	141.	Guinea-Bissau	13.56	15.	Panama	7.26	65.	Zambia	7.25	66.
Belgium	3.07	143.	Guyana	11.39	24.	Papua New Guinea	16.43	10.	Zimbabwe	10.06	38.
Belize	6.55	79.	Haiti	11.68	21.	Paraguay	3.48	132.			
Benin	11.39	23.	Honduras	10.68	30.	Peru	6.59	78.			
Bhutan	7.51	60.	Hungary	5.32	105.	Philippines	26.70	3.			
Bolivia	4.58	114.	Iceland	1.52	166.	Poland	3.20	140.			
Bosnia a. Herzeg.	6.10	91.	India	6.64	77.	Portugal	3.45	133.			
Botswana	5.14	107.	Indonesia	10.24	36.	Qatar	0.08	171.			
Brazil	4.09	123.	Iran (Islam. Rep. of)	4.73	111.	Rep. of Moldova	4.79	110.			
Brunei Darussalam	17.00	7.	Iraq	4.49	117.	Romania	5.92	97.			
Bulgaria	4.22	120.	Ireland	4.60	112.	Russia	3.58	128.			
Burkina Faso	9.54	39.	Israel	2.30	157.	Rwanda	7.09	69.			
Burundi	10.28	35.	Italy	4.42	119.	Saudi Arabia	1.14	169.			
Cambodia	16.58	9.	Jamaica	11.83	20.	Senegal	10.38	32.			
Cameroon	10.91	28.	Japan	12.99	17.	Serbia	7.12	68.			
Canada	3.01	145.	Jordan	4.58	115.	Seychelles	2.55	153.			
Cape Verde	10.39	31.	Kazakhstan	3.56	130.	Sierra Leone	10.21	37.			
Central Afr. Rep.	7.03	71.	Kenya	6.77	74.	Singapore	2.27	159.			
Chad	10.85	29.	Kiribati	1.78	164.	Slovakia	3.39	136.			
Chile	11.65	22.	Korea, Republic of	4.59	113.	Slovenia	3.41	134.			
China	6.39	85.	Kuwait	3.28	139.	Solomon Islands	19.14	6.			
Colombia	6.45	83.	Kyrgyzstan	7.86	55.	South Africa	5.58	101.			
Comoros	7.29	64.	Lao People's D. R.	5.59	100.	Spain	3.05	144.			
Congo	7.19	67.	Latvia	3.31	138.	Sri Lanka	7.32	63.			
Costa Rica	17.00	8.	Lebanon	5.01	109.	Sudan	7.99	51.			
Cote d'Ivoire	8.88	43.	Lesotho	6.84	73.	Suriname	8.44	46.			
Croatia	3.97	125.	Liberia	7.84	56.	Swaziland	7.52	59.			
Cuba	6.13	90.	Libyan Arab Jamah.	3.79	126.	Sweden	2.12	162.			
Cyprus	2.68	150.	Lithuania	2.92	148.	Switzerland	2.37	155.			
Czech Republic	3.37	137.	Luxembourg	2.43	154.	Syrian Arab Rep.	5.69	99.			
Denmark	2.89	149.	Madagascar	11.15	26.	Tajikistan	6.72	75.			
Djibouti	10.30	34.	Malawi	7.98	53.	Thailand	6.19	89.			
Dominican Rep.	10.96	27.	Malaysia	6.39	86.	Rep. of Macedonia	5.87	98.			
Ecuador	7.53	58.	Mali	8.39	48.	Timor-Leste	15.69	12.			
Egypt	2.29	158.	Malta	0.60	170.	Togo	10.36	33.			
El Salvador	16.05	11.	Mauritania	7.95	54.	Tonga	29.33	2.			
Equatorial Guinea	4.46	118.	Mauritius	15.53	13.	Trinidad a. Tobago	7.50	61.			
Eritrea	6.35	87.	Mexico	5.97	95.	Tunisia	5.40	103.			
Estonia	2.36	156.	Mongolia	3.08	142.	Turkey	5.20	106.			

Countries not listed in the WorldRiskIndex
Andorra
Antigua and Barbuda
Democratic Republic of Congo
Dominica
Federated States of Micronesia
Liechtenstein
Maldives
Marshall Islands
Monaco
Montenegro
Nauru
North Korea
Palau
Samoa
San Marino
Sao Tome and Principe
Somalia
South Sudan
St. Kitts and Nevis
St. Lucia
St. Vincent and the Grenadines
Tuvalu

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of coping capacities	Lack of adaptive capacities
1.	Vanuatu	36.28 %	63.66 %	56.99 %	34.90 %	81.16 %	54.90 %
2.	Tonga	29.33 %	55.27 %	53.08 %	28.66 %	81.80 %	48.76 %
3.	Philippines	26.70 %	52.46 %	50.90 %	31.83 %	80.92 %	39.96 %
4.	Guatemala	19.88 %	36.30 %	54.76 %	35.82 %	81.00 %	47.46 %
5.	Bangladesh	19.17 %	31.70 %	60.48 %	38.23 %	86.36 %	56.84 %
6.	Solomon Islands	19.14 %	29.98 %	63.83 %	44.01 %	85.56 %	61.90 %
7.	Brunei Darussalam	17.00 %	41.10 %	41.36 %	17.40 %	63.17 %	43.53 %
8.	Costa Rica	17.00 %	42.61 %	39.89 %	21.32 %	63.78 %	34.57 %
9.	Cambodia	16.58 %	27.65 %	59.96 %	37.55 %	86.84 %	55.49 %
10.	Papua New Guinea	16.43 %	24.94 %	65.90 %	54.81 %	83.94 %	58.95 %
11.	El Salvador	16.05 %	32.60 %	49.25 %	27.84 %	74.78 %	45.14 %
12.	Timor-Leste	15.69 %	25.73 %	60.98 %	49.93 %	81.39 %	51.61 %
13.	Mauritius	15.53 %	37.35 %	41.58 %	18.02 %	61.59 %	45.14 %
14.	Nicaragua	14.62 %	27.23 %	53.69 %	33.67 %	80.70 %	46.71 %
15.	Guinea-Bissau	13.56 %	19.65 %	68.99 %	52.64 %	89.93 %	64.38 %
16.	Fiji	13.15 %	27.71 %	47.47 %	24.18 %	74.69 %	43.55 %
17.	Japan	12.99 %	45.91 %	28.29 %	17.82 %	38.04 %	29.00 %
18.	Viet Nam	12.53 %	25.35 %	49.43 %	24.95 %	76.67 %	46.67 %
19.	Gambia	12.07 %	19.29 %	62.58 %	44.77 %	83.87 %	59.11 %
20.	Jamaica	11.83 %	25.82 %	45.81 %	25.43 %	71.30 %	40.70 %
21.	Haiti	11.68 %	16.26 %	71.85 %	61.81 %	91.24 %	62.49 %
22.	Chile	11.65 %	30.95 %	37.66 %	19.67 %	58.61 %	34.70 %
23.	Benin	11.39 %	17.06 %	66.76 %	52.23 %	82.00 %	66.06 %
24.	Guyana	11.39 %	22.90 %	49.72 %	27.16 %	78.96 %	43.05 %
25.	Niger	11.24 %	15.87 %	70.80 %	57.72 %	86.56 %	68.11 %
26.	Madagascar	11.15 %	16.03 %	69.52 %	65.23 %	83.79 %	59.55 %
27.	Dominican Republic	10.96 %	23.14 %	47.36 %	27.55 %	73.16 %	41.38 %
28.	Cameroon	10.91 %	18.19 %	59.95 %	42.07 %	84.97 %	52.80 %
29.	Chad	10.85 %	14.89 %	72.86 %	61.07 %	91.09 %	66.42 %
30.	Honduras	10.68 %	20.01 %	53.36 %	33.29 %	81.00 %	45.78 %
31.	Cape Verde	10.39 %	20.26 %	51.29 %	31.38 %	70.88 %	51.61 %
32.	Senegal	10.38 %	17.57 %	59.08 %	45.87 %	80.15 %	51.23 %
33.	Togo	10.36 %	15.56 %	66.62 %	57.36 %	84.42 %	58.08 %
34.	Djibouti	10.30 %	16.34 %	63.01 %	37.87 %	83.03 %	68.11 %
35.	Burundi	10.28 %	15.13 %	67.98 %	63.23 %	87.71 %	53.01 %
36.	Indonesia	10.24 %	19.36 %	52.87 %	30.09 %	79.49 %	49.04 %
37.	Sierra Leone	10.21 %	14.65 %	69.69 %	57.06 %	86.46 %	65.55 %
38.	Zimbabwe	10.06 %	14.96 %	67.24 %	57.49 %	88.22 %	56.00 %
39.	Burkina Faso	9.54 %	14.32 %	66.65 %	53.97 %	83.87 %	62.11 %
40.	Albania	9.50 %	21.25 %	44.71 %	19.64 %	73.01 %	41.49 %
41.	Afghanistan	9.50 %	13.17 %	72.12 %	56.05 %	92.85 %	67.48 %
42.	Myanmar	8.90 %	14.87 %	59.86 %	35.63 %	87.00 %	56.93 %
43.	Cote d'Ivoire	8.88 %	13.67 %	64.94 %	47.01 %	85.78 %	62.04 %
44.	Mozambique	8.69 %	12.73 %	68.28 %	63.24 %	84.69 %	56.89 %
45.	Uzbekistan	8.59 %	16.18 %	53.10 %	29.69 %	77.34 %	52.26 %
46.	Suriname	8.44 %	18.12 %	46.60 %	27.54 %	70.44 %	41.83 %
47.	Ghana	8.39 %	14.48 %	57.94 %	44.42 %	77.93 %	51.48 %
48.	Mali	8.39 %	12.55 %	66.84 %	52.66 %	84.28 %	63.58 %
49.	Netherlands	8.24 %	30.57 %	26.94 %	15.46 %	41.23 %	24.14 %
50.	Guinea	8.20 %	12.03 %	68.21 %	52.20 %	89.73 %	62.70 %
51.	Sudan	7.99 %	11.86 %	67.37 %	51.25 %	92.80 %	58.06 %
52.	Nigeria	7.98 %	12.06 %	66.22 %	52.35 %	88.15 %	58.15 %
53.	Malawi	7.98 %	12.34 %	64.66 %	55.23 %	84.06 %	54.68 %
54.	Mauritania	7.95 %	12.47 %	63.71 %	44.85 %	86.46 %	59.83 %
55.	Kyrgyzstan	7.86 %	16.63 %	47.26 %	26.32 %	75.53 %	39.92 %
56.	Liberia	7.84 %	10.96 %	71.54 %	62.70 %	85.24 %	66.70 %
57.	United Republic of Tanzania	7.65 %	12.01 %	63.70 %	58.51 %	83.79 %	48.79 %

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of coping capacities	Lack of adaptive capacities
58.	Ecuador	7.53 %	16.15 %	46.63 %	27.40 %	73.94 %	38.55 %
59.	Swaziland	7.52 %	12.76 %	58.95 %	44.14 %	80.01 %	52.70 %
60.	Bhutan	7.51 %	14.81 %	50.70 %	29.43 %	73.77 %	48.90 %
61.	Trinidad and Tobago	7.50 %	17.54 %	42.79 %	19.30 %	67.80 %	41.26 %
62.	Algeria	7.36 %	15.82 %	46.52 %	24.20 %	77.20 %	38.15 %
63.	Sri Lanka	7.32 %	14.79 %	49.52 %	24.15 %	78.08 %	46.32 %
64.	Comoros	7.29 %	10.97 %	66.43 %	58.66 %	84.46 %	56.18 %
65.	Panama	7.26 %	16.45 %	44.15 %	26.32 %	66.53 %	39.61 %
66.	Zambia	7.25 %	11.37 %	63.81 %	61.73 %	79.79 %	49.92 %
67.	Congo	7.19 %	11.65 %	61.69 %	50.71 %	86.09 %	48.28 %
68.	Serbia	7.12 %	18.05 %	39.46 %	18.78 %	66.51 %	33.08 %
69.	Rwanda	7.09 %	11.98 %	59.15 %	52.58 %	79.09 %	45.80 %
70.	Ethiopia	7.04 %	11.12 %	63.33 %	53.94 %	79.97 %	56.09 %
71.	Central African Republic	7.03 %	9.39 %	74.80 %	64.68 %	90.60 %	69.13 %
72.	Pakistan	6.96 %	11.36 %	61.26 %	35.04 %	86.26 %	62.48 %
73.	Lesotho	6.84 %	11.40 %	60.05 %	48.21 %	79.72 %	52.22 %
74.	Kenya	6.77 %	10.69 %	63.34 %	53.01 %	85.62 %	51.39 %
75.	Tajikistan	6.72 %	12.98 %	51.75 %	33.62 %	75.53 %	46.10 %
76.	Greece	6.70 %	21.11 %	31.76 %	18.01 %	50.24 %	27.03 %
77.	India	6.64 %	11.94 %	55.60 %	35.79 %	80.22 %	50.78 %
78.	Peru	6.59 %	14.40 %	45.74 %	27.34 %	73.65 %	36.23 %
79.	Belize	6.55 %	13.31 %	49.22 %	27.34 %	73.87 %	46.46 %
80.	Uganda	6.52 %	10.16 %	64.21 %	55.68 %	87.99 %	48.96 %
81.	Angola	6.52 %	10.18 %	64.08 %	50.66 %	86.87 %	54.71 %
82.	Morocco	6.45 %	13.25 %	48.70 %	27.16 %	75.98 %	42.97 %
83.	Colombia	6.45 %	13.84 %	46.62 %	26.35 %	74.65 %	38.85 %
84.	Turkmenistan	6.44 %	13.19 %	48.82 %	24.76 %	75.61 %	46.11 %
85.	China	6.39 %	14.43 %	44.29 %	22.81 %	69.86 %	40.18 %
86.	Malaysia	6.39 %	14.60 %	43.76 %	19.02 %	67.52 %	44.73 %
87.	Eritrea	6.35 %	8.55 %	74.23 %	60.97 %	89.47 %	72.24 %
88.	Georgia	6.27 %	14.69 %	42.67 %	24.60 %	63.13 %	40.28 %
89.	Thailand	6.19 %	13.70 %	45.22 %	19.34 %	75.53 %	40.79 %
90.	Cuba	6.13 %	17.45 %	35.10 %	17.46 %	55.97 %	31.87 %
91.	Bosnia and Herzegovina	6.10 %	14.02 %	43.53 %	18.72 %	70.18 %	41.67 %
92.	Armenia	6.07 %	14.51 %	41.85 %	20.38 %	70.99 %	34.19 %
93.	Gabon	6.04 %	11.95 %	50.57 %	32.41 %	74.23 %	45.08 %
94.	Yemen	5.97 %	9.04 %	66.01 %	44.87 %	91.24 %	61.93 %
95.	Mexico	5.97 %	13.84 %	43.10 %	23.36 %	71.69 %	34.27 %
96.	Venezuela	5.93 %	13.15 %	45.06 %	22.70 %	75.54 %	36.95 %
97.	Romania	5.92 %	15.77 %	37.56 %	19.54 %	59.94 %	33.21 %
98.	Republic of Macedonia	5.87 %	14.38 %	40.78 %	20.50 %	64.17 %	37.66 %
99.	Syrian Arab Republic	5.69 %	10.56 %	53.85 %	26.49 %	86.12 %	48.94 %
100.	Lao People's Democ. Republic	5.59 %	9.55 %	58.51 %	37.41 %	84.37 %	53.76 %
101.	South Africa	5.58 %	12.08 %	46.22 %	30.88 %	69.02 %	38.76 %
102.	Azerbaijan	5.54 %	13.16 %	42.09 %	19.77 %	70.03 %	36.47 %
103.	Tunisia	5.40 %	12.45 %	43.40 %	20.42 %	73.05 %	36.72 %
104.	Namibia	5.37 %	10.41 %	51.60 %	46.63 %	69.97 %	38.19 %
105.	Hungary	5.32 %	15.61 %	34.10 %	16.39 %	53.95 %	31.97 %
106.	Turkey	5.20 %	12.25 %	42.44 %	19.44 %	69.11 %	38.79 %
107.	Botswana	5.14 %	10.55 %	48.66 %	35.92 %	67.32 %	42.73 %
108.	Nepal	5.12 %	9.16 %	55.91 %	38.05 %	81.05 %	48.64 %
109.	Lebanon	5.01 %	11.14 %	44.99 %	23.15 %	70.33 %	41.50 %
110.	Republic of Moldova	4.79 %	11.11 %	43.11 %	23.82 %	67.57 %	37.95 %
111.	Iran (Islamic Republic of)	4.73 %	10.19 %	46.45 %	19.32 %	80.66 %	39.37 %
112.	Ireland	4.60 %	14.74 %	31.23 %	17.16 %	45.99 %	30.53 %
113.	Korea, Republic of	4.59 %	14.89 %	30.82 %	14.31 %	46.55 %	31.59 %
114.	Bolivia	4.58 %	8.98 %	51.05 %	35.81 %	79.67 %	37.66 %

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of coping capacities	Lack of adaptive capacities
115.	Jordan	4.58 %	10.53 %	43.47 %	21.98 %	67.21 %	41.21 %
116.	New Zealand	4.55 %	15.44 %	29.48 %	16.55 %	44.45 %	27.45 %
117.	Iraq	4.49 %	8.08 %	55.55 %	29.16 %	89.42 %	48.08 %
118.	Equatorial Guinea	4.46 %	8.22 %	54.22 %	33.04 %	84.84 %	44.79 %
119.	Italy	4.42 %	13.85 %	31.88 %	17.43 %	54.66 %	23.56 %
120.	Bulgaria	4.22 %	11.66 %	36.22 %	20.72 %	56.51 %	31.44 %
121.	Australia	4.22 %	15.05 %	28.01 %	15.67 %	42.53 %	25.84 %
122.	Bahamas	4.14 %	10.71 %	38.64 %	18.76 %	52.85 %	44.32 %
123.	Brazil	4.09 %	9.53 %	42.92 %	23.65 %	67.60 %	37.50 %
124.	Uruguay	4.03 %	11.10 %	36.29 %	20.22 %	50.23 %	38.42 %
125.	Croatia	3.97 %	11.53 %	34.40 %	18.12 %	54.71 %	30.37 %
126.	Libyan Arab Jamahiriya	3.79 %	7.80 %	48.65 %	25.03 %	78.33 %	42.58 %
127.	United States	3.76 %	12.25 %	30.68 %	16.35 %	48.24 %	27.46 %
128.	Russia	3.58 %	9.38 %	38.15 %	21.53 %	59.12 %	33.81 %
129.	Argentina	3.56 %	9.55 %	37.29 %	20.67 %	59.00 %	32.20 %
130.	Kazakhstan	3.56 %	9.11 %	39.09 %	17.77 %	62.77 %	36.74 %
131.	United Kingdom	3.54 %	11.60 %	30.54 %	17.29 %	45.95 %	28.37 %
132.	Paraguay	3.48 %	7.03 %	49.53 %	26.09 %	78.07 %	44.42 %
133.	Portugal	3.45 %	10.93 %	31.53 %	17.89 %	47.09 %	29.60 %
134.	Slovenia	3.41 %	11.59 %	29.38 %	15.25 %	50.34 %	22.53 %
135.	Austria	3.39 %	13.60 %	24.93 %	14.83 %	35.86 %	24.10 %
136.	Slovakia	3.39 %	10.21 %	33.15 %	14.61 %	53.54 %	31.28 %
137.	Czech Republic	3.37 %	10.82 %	31.17 %	15.40 %	48.61 %	29.50 %
138.	Latvia	3.31 %	9.26 %	35.80 %	19.85 %	53.30 %	34.27 %
139.	Kuwait	3.28 %	9.04 %	36.28 %	11.24 %	62.46 %	35.14 %
140.	Poland	3.20 %	9.79 %	32.72 %	16.62 %	52.46 %	29.09 %
141.	Belarus	3.11 %	8.46 %	36.74 %	16.76 %	60.43 %	33.02 %
142.	Mongolia	3.08 %	6.52 %	47.22 %	32.43 %	64.30 %	44.92 %
143.	Belgium	3.07 %	11.66 %	26.28 %	16.25 %	37.57 %	25.04 %
144.	Spain	3.05 %	10.23 %	29.79 %	16.71 %	48.75 %	23.92 %
145.	Canada	3.01 %	10.25 %	29.42 %	15.20 %	45.95 %	27.10 %
146.	Ukraine	2.97 %	7.50 %	39.66 %	18.76 %	62.63 %	37.59 %
147.	Germany	2.95 %	11.41 %	25.87 %	15.48 %	36.57 %	25.57 %
148.	Lithuania	2.92 %	8.88 %	32.85 %	18.37 %	48.45 %	31.74 %
149.	Denmark	2.89 %	10.87 %	26.57 %	15.44 %	39.41 %	24.86 %
150.	Cyprus	2.68 %	7.44 %	35.97 %	14.80 %	58.26 %	34.87 %
151.	Oman	2.64 %	6.41 %	41.11 %	15.40 %	63.50 %	44.45 %
152.	France	2.62 %	9.25 %	28.35 %	17.21 %	43.69 %	24.16 %
153.	Seychelles	2.55 %	5.99 %	42.59 %	21.94 %	62.82 %	43.02 %
154.	Luxembourg	2.43 %	9.12 %	26.63 %	12.69 %	40.84 %	26.36 %
155.	Switzerland	2.37 %	9.56 %	24.79 %	14.51 %	37.60 %	22.28 %
156.	Estonia	2.36 %	7.23 %	32.70 %	17.66 %	50.46 %	29.99 %
157.	Israel	2.30 %	6.41 %	35.88 %	19.62 %	58.68 %	29.34 %
158.	Egypt	2.29 %	4.72 %	48.41 %	21.78 %	76.85 %	46.60 %
159.	Singapore	2.27 %	7.82 %	28.99 %	14.24 %	49.44 %	23.28 %
160.	Finland	2.21 %	8.19 %	26.98 %	16.35 %	39.11 %	25.48 %
161.	Norway	2.19 %	8.58 %	25.55 %	14.21 %	38.48 %	23.96 %
162.	Sweden	2.12 %	7.97 %	26.55 %	15.78 %	40.99 %	22.88 %
163.	United Arab Emirates	1.97 %	5.93 %	33.19 %	10.03 %	56.08 %	33.45 %
164.	Kiribati	1.78 %	3.05 %	58.50 %	42.25 %	83.69 %	49.56 %
165.	Bahrain	1.69 %	4.27 %	39.48 %	13.00 %	66.16 %	39.29 %
166.	Iceland	1.52 %	5.67 %	26.84 %	14.96 %	42.69 %	22.87 %
167.	Grenada	1.42 %	3.13 %	45.39 %	24.54 %	68.82 %	42.82 %
168.	Barbados	1.32 %	3.46 %	38.26 %	18.20 %	50.29 %	46.29 %
169.	Saudi Arabia	1.14 %	2.93 %	38.96 %	14.80 %	65.01 %	37.07 %
170.	Malta	0.60 %	1.65 %	36.25 %	15.97 %	59.33 %	33.44 %
171.	Qatar	0.08 %	0.28 %	28.18 %	9.68 %	43.94 %	30.93 %

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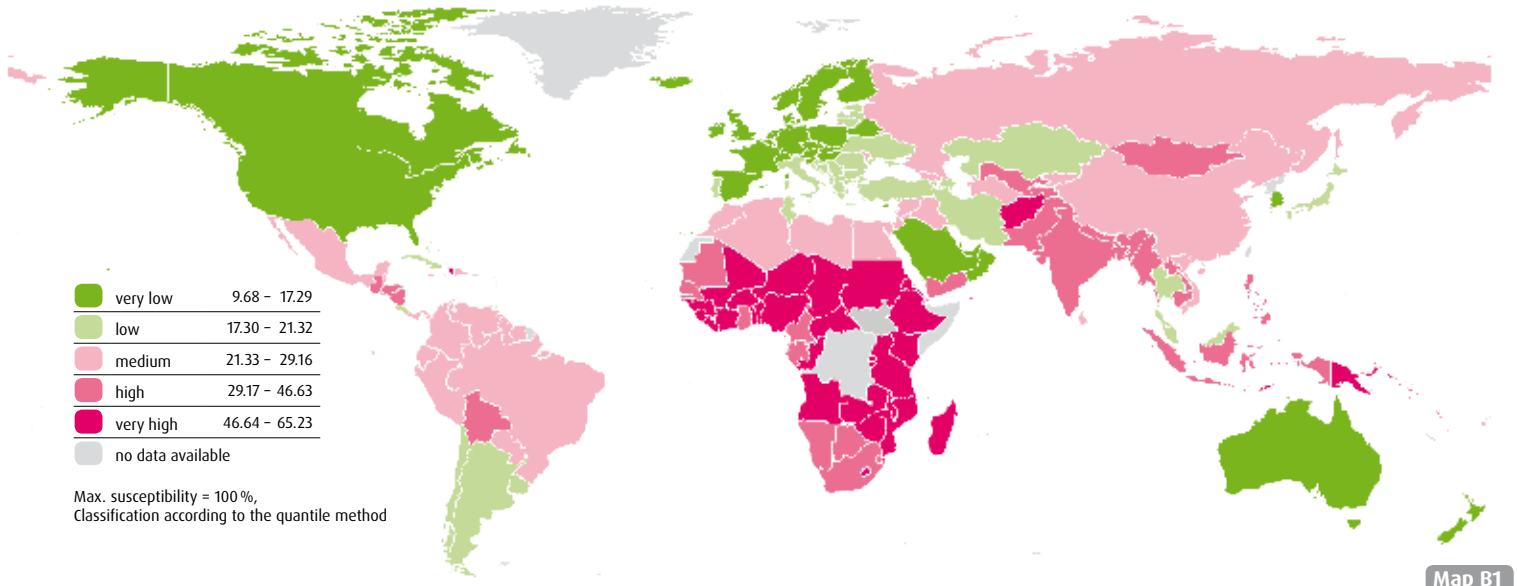
Susceptibility

dependent on public infrastructure, nutrition, income and the general economic framework



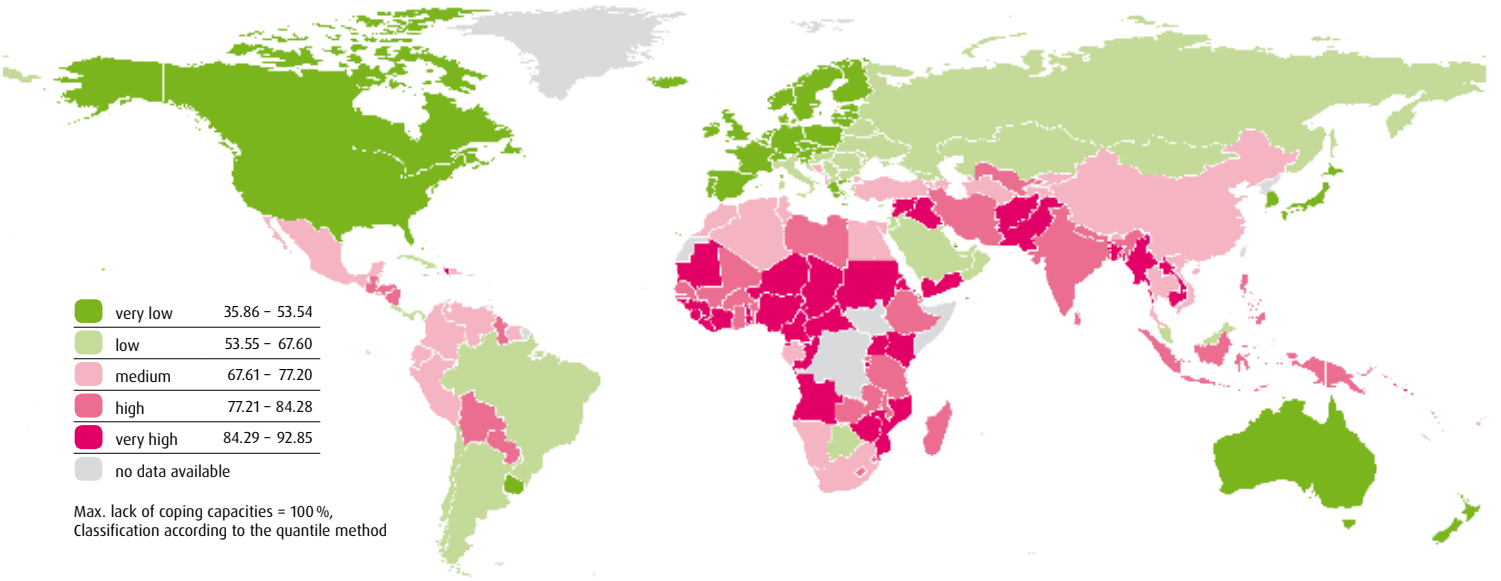
very low	9.68 – 17.29
low	17.30 – 21.32
medium	21.33 – 29.16
high	29.17 – 46.63
very high	46.64 – 65.23
no data available	

Max. susceptibility = 100 %,
Classification according to the quantile method

Map B1
Map B2

Lack of coping capacities

dependent on governance, medical care and material security



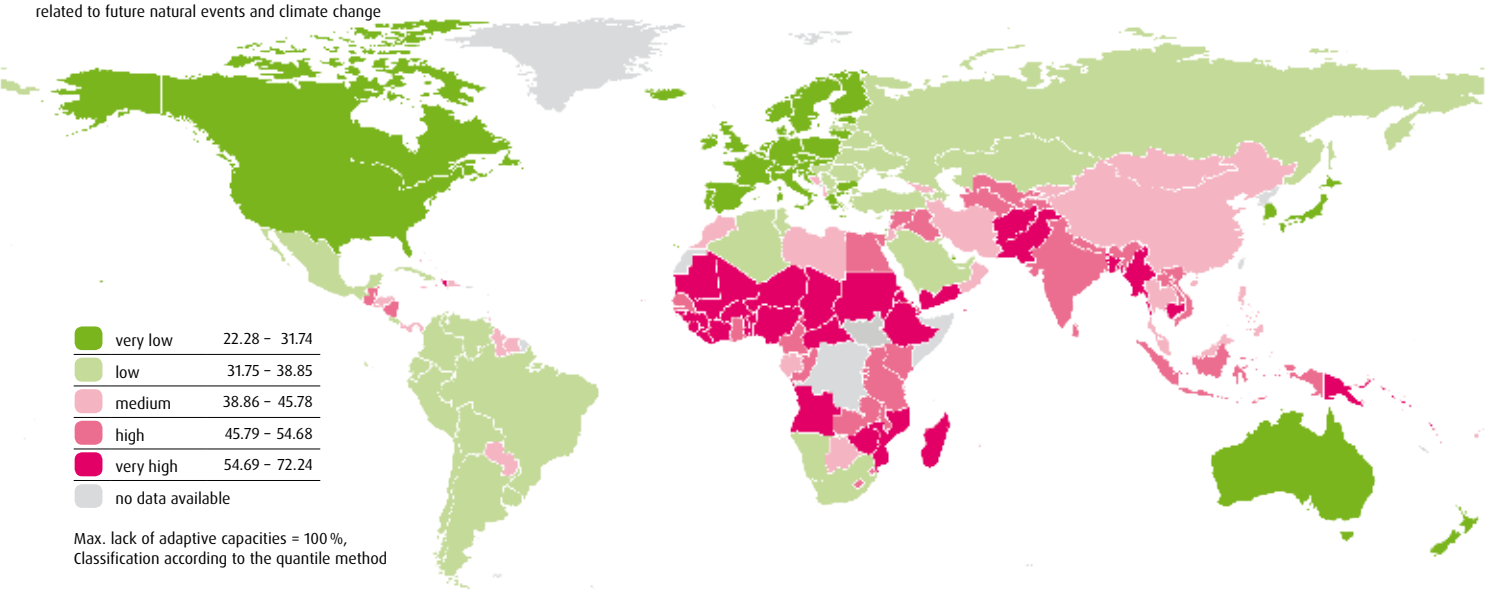
very low	35.86 – 53.54
low	53.55 – 67.60
medium	67.61 – 77.20
high	77.21 – 84.28
very high	84.29 – 92.85
no data available	

Max. lack of coping capacities = 100 %,
Classification according to the quantile method

Map B3

Lack of adaptive capacities

related to future natural events and climate change



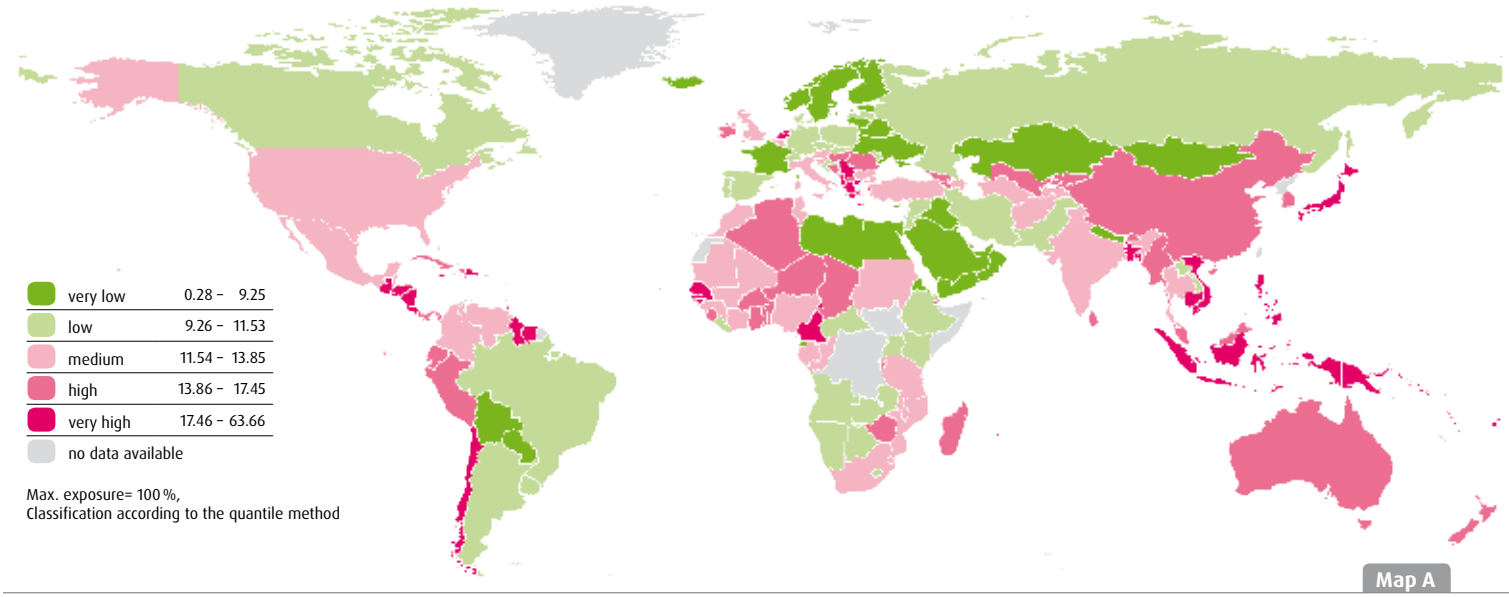
very low	22.28 – 31.74
low	31.75 – 38.85
medium	38.86 – 45.78
high	45.79 – 54.68
very high	54.69 – 72.24
no data available	

Max. lack of adaptive capacities = 100 %,
Classification according to the quantile method

Data: Source IREUS, based on the PREVIEW Global Risk Data Platform, CReSIS, CIESIN and global databases; detailed information at www.WorldRiskReport.org

Exposure

Exposure of the population to the natural hazards earthquakes, storms, floods, droughts and sea level rise.



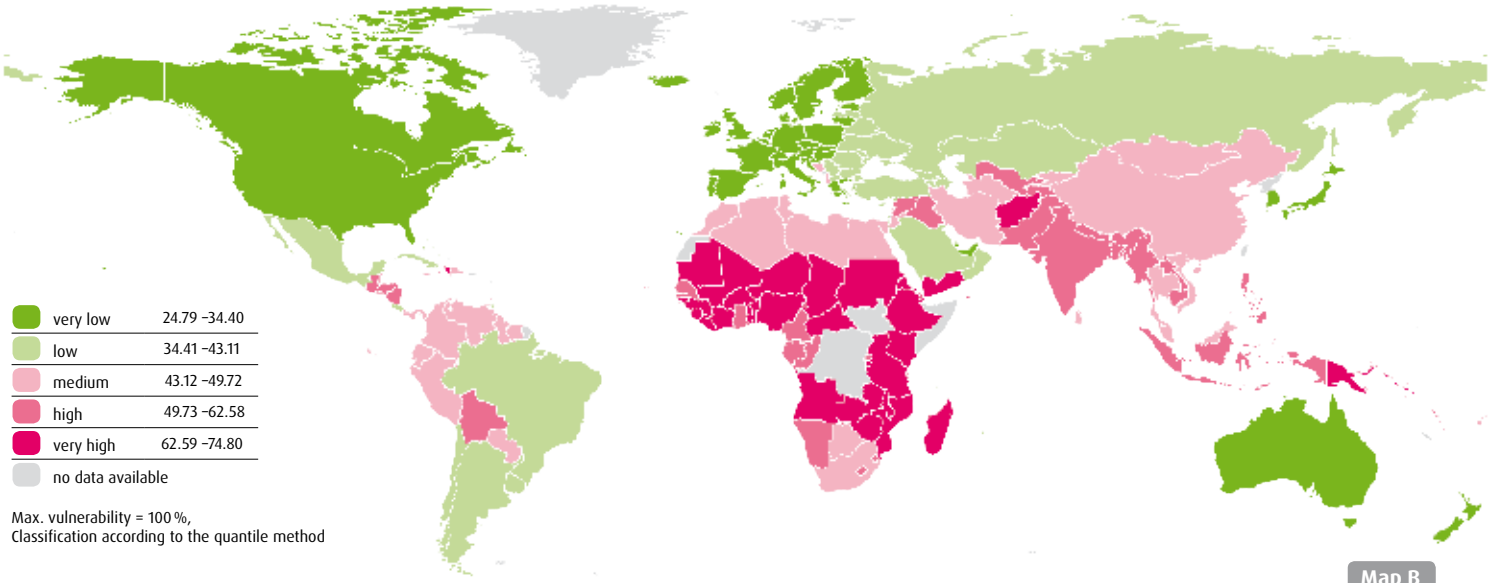
very low	0.28 – 9.25
low	9.26 – 11.53
medium	11.54 – 13.85
high	13.86 – 17.45
very high	17.46 – 63.66
no data available	

Max. exposure= 100 %,
Classification according to the quantile method

Map A

Vulnerability

Vulnerability of society as the sum of susceptibility, lack of coping capacities and lack of adaptive capacities



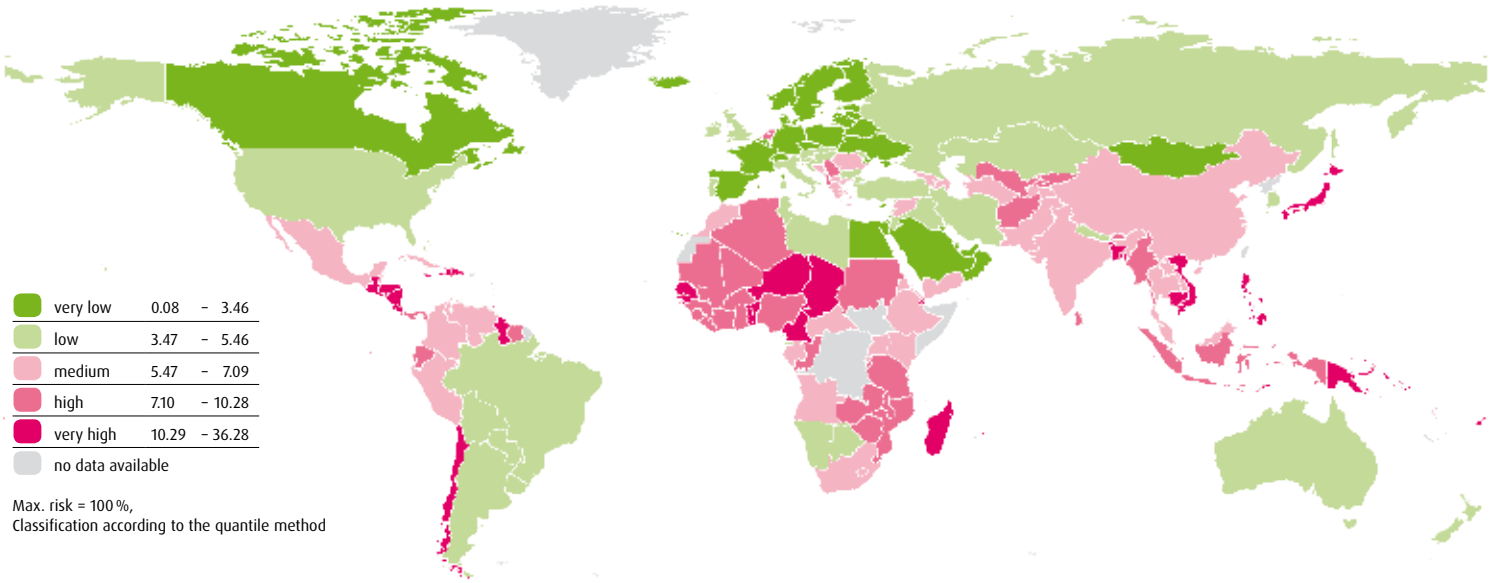
very low	24.79 –34.40
low	34.41 –43.11
medium	43.12 –49.72
high	49.73 –62.58
very high	62.59 –74.80
no data available	

Max. vulnerability = 100 %,
Classification according to the quantile method

Map B
Map C

WorldRiskIndex

WorldRiskIndex as the result of exposure and vulnerability



very low	0.08 – 3.46
low	3.47 – 5.46
medium	5.47 – 7.09
high	7.10 – 10.28
very high	10.29 – 36.28
no data available	

Max. risk = 100 %,
Classification according to the quantile method

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