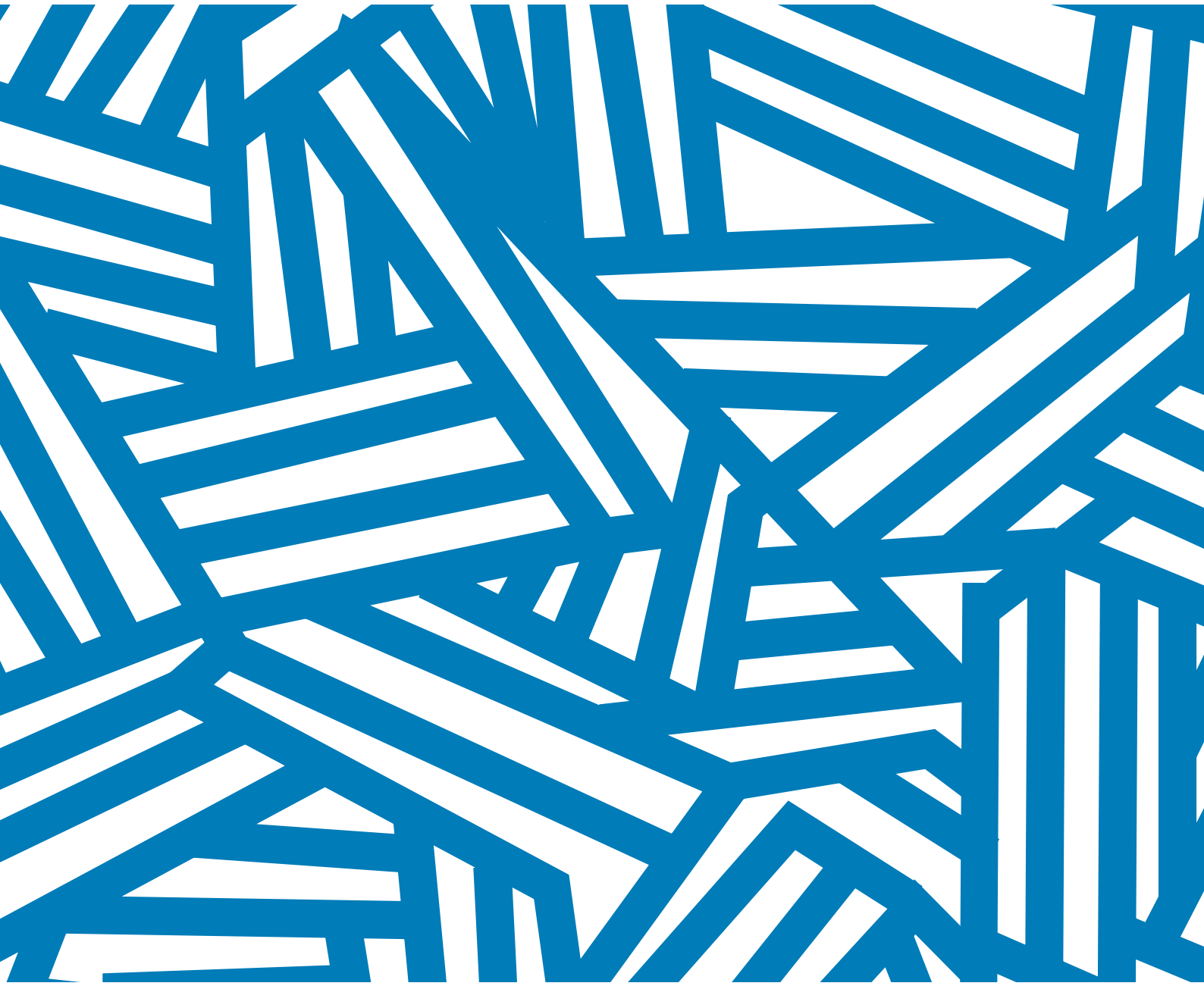
Infrastructure and Disaster

A contribution by the United Nations to the consultation leading to the Third UN World Conference on Disaster Risk Reduction



United Nations

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Overview/rationale

Hazards impact rich and poor countries differently because of differences in vulnerability, which is the probability and exposure of a population to risks. These differ dramatically between rich and poor populations. The world's poor have fewer choices as to where they can live, fewer protections, and less backstops when shock events such as flooding and earthquakes occur.

In poor countries, the trend of rapid urbanization occurs in particularly hazardous areas; areas that would otherwise be undesired for development. Non-existent infrastructure and building codes plague these communities, leaving them vulnerable to a variety of natural events. When shock events like floods and cyclones occur, there are fewer backstops available such as insurance, cash pay-outs, and cheap loans for post-disaster relief.

Additionally, due to the concentration of urbanization, a larger number of people are likely to be affected, and poor infrastructure makes it hard to effectively distribute relief supplies. Finally, urbanization has weakened traditional networks and community-based hedges, leaving those affected more dependent on external sources for aid.

On the other hand, disaster situations in rich countries cost more money, but result in fewer deaths. To begin with, rich countries have more infrastructures and that infrastructure is more expensive to rebuild. Additionally, disaster situations affect the workforce and production, causing net economic damage beyond the rebuilding required. In other words, economic loss incorporates the multiplier effect on the labour of rich, high-productivity societies.

Five of the ten costliest hazard events, in terms of money rather than lives, have occurred in the past four years Munich Re estimates their economic costs were $378 billion last year, breaking the previous record of $262 billion in 2005 (in constant 2011 dollars). Besides the Japanese and Thai calamities, New Zealand suffered an earthquake, Australia and China floods, and America a cocktail of hurricanes, tornadoes, wildfires and floods.

Impact of hazards on infrastructure

In 2012, 357 natural hazard triggered catastrophes were registered. This was both less than the average annual frequency observed from 2002 to 2011 (394), and represented a decrease in associated human impacts of shock events in 2012, which were at their lowest level compared to previous years. However, natural hazards still killed a significant number, a total of 9,655 people were killed (annual average 2002-2011:107,000) and 124.5 million people become victims worldwide (annual average 2002-2011:268 million). Contrary to other indicators, economic damages from natural hazard events did show an increase to above average levels (143 billion 2012 US $), with estimates placing the figure at US$ 157 billion.

From 2003 to 2012 the estimate of economic losses from disaster situations is $627 Billion. This has increased from the $154 Billion lost due to disasters between 1993 and 2002.

The world has succeeded in making natural hazards less deadly, through better early-warning systems, better public information about evacuation plans, tougher building codes in quake-prone areas and encouragement for homeowners to adopt simple precautions such as installing tornado-proof rooms in their homes. Annual death tolls are heavily influenced by outliers, such as Haiti's earthquake in 2010 (which killed more than 200,000) or the Bangladeshi cyclones in 1970 (300,000). But, adjusted for the Earth's growing population, the trend in death rates is clearly downward.

However, even if natural hazards may be no more common and no more likely to kill people than before, there is no doubt that their economic cost is rising. This is because a growing share of the world's population and economic activity is being concentrated in high-risk places: on tropical coasts and river deltas, near forests and along earthquake fault lines

Global expenditure on infrastructure

The simultaneous crumbling of aging infrastructure in advanced economies and surge of development in developing economies will drive a steady four percent annual growth on infrastructure investment well into the second half of this decade, pushing total investment to a figure of four trillion dollars; according to global business consultancy Bain & Company.

Core infrastructure sectors like electric utilities, oil & gas, and transport, which will grow at an average three percent per year through 2017, and Social infrastructure such as water, healthcare, and education which will grow at an annual average of four percent over the same period

According to the World Economic Forum, global spending on basic infrastructure—transport, power, water and communications—currently amounts to $2.7 trillion a year when it ought to be $3.7 trillion. This is in line with the $4 trillion dollars suggested by Bain & Company that will be invested.

The long-run global average spend on infrastructure is 3.8% of GDP. The McKinsey Global Institute estimates the average total value of big economies infrastructure at 71% of GDP.

Whether the economic toll of hazard impacts is rising faster than global GDP is unclear, since a wealthier world naturally has more wealth at risk. Still, the incidence of spectacular, multi-billion-dollar catastrophes seems certain to rise. A 2007 study led by the OECD reckoned that by 2070, seven of the ten greatest urban concentrations of economic assets (buildings, infrastructure and the like) that are exposed to coastal flooding will be in the developing world; none was in the 2005 study. In that time, assets exposed to hazards such flooding will rise from 5% of world GDP to 9%. A World Bank study led by Apurva Sanghi estimated that between 2000 and 2050 the of the city population exposed to tropical cyclones or earthquakes will more than double, rising from 11% to 16% of the world's population.

Development by its nature also aggravates risks. As cities encroach on coasts, wetlands and rivers, natural barriers such as mangrove swamps and sand dunes are obliterated and artificial ones—dykes and sea walls—are erected to keep the water out. The result is to put more people and property in harm's way if those barriers fail.

As cities on river deltas extract groundwater for industry, drinking and sanitation, the ground subsides, putting it further below sea level and thus requiring even higher dykes. Since 1980 Jakarta's population has more than doubled, to 24m, and should reach 35m by 2020. Land that once absorbed overflow from the city's 13 rivers has been developed, and is now subsiding; 40% of the city is now below sea level.

Making cities more resilient involves starker trade-offs in the developing world. On the one hand, urbanisation strips cities of their natural defences against threats and exposes more people to loss of life and property when an earthquake or cyclone hits. On the other hand, urbanisation makes poor people richer. The density and infrastructure of cities makes people more productive and more able to afford the measures needed to keep them safe. So mitigation measures should not discourage people from crowding into vulnerable cities but rather establish incentives for cities and their inhabitants to protect themselves better.

Many cities have tough building codes but fail to enforce them. The World Bank study argues that giving more urban dwellers title to their property would encourage investment in their safety, and lifting rent controls would encourage landlords to comply with building codes, since they could then recoup the cost. Ordinary infrastructure can be designed to double as a risk mitigation or protection entity, ensuring that it will be properly maintained when the time comes. Two examples the World Bank gives are schools built on higher ground that double as cyclone shelters and a road tunnel in Kuala Lumpur that doubles as a flood-containment tank.

As societies develop they can afford the human and physical infrastructure needed to protect against, and respond to, natural hazards. In time, last year's earthquake and tsunami and floods will be mere blips in the GDP of Japan and Thailand, thanks to the rapid reconstruction made possible by the same wealth that meant the damages were so costly to start with. The lesson for poorer countries is that growth is the best risk-mitigation policy of all.

Status of mainstreaming disaster risk in the infrastructure sector

(i) Progress in addressing hazard risk in infrastructure, including:

Infrastructure Sector and cross-sector impact analysis, planning and post/disaster assessment as a lessons learned contribution.

There is a clear two-way relationship between the concept of disaster risk reduction and quality of infrastructure design and construction methodology, which is not yet well explored. The focus in the sector is still very "asset based" which considers infrastructure as a discrete set of assets and risk assessments are thus undertaken on this basis and in many cases do not consider the wider implications on the systems as a whole. In designing and constructing infrastructure the concept of disaster risk reduction needs to be introduced which addresses risk from a systems perspective to ensure that the role that the asset plays in enhancing the performance of the system and associated risks to the system are well understood. The incorporation of lessons learned from post disaster assessments is usually reflected in updates to planning and development policies, regulations and codes, but does not appear to translate into a risk-based approach to planning and development of infrastructure and is still very asset focussed.

Infrastructure sector legislation/policies

The sector is still largely characterised by planning and development policies, regulations and codes that are in many cases outdated or do not take into account risk based approaches to development.

Infrastructure sector capacities and technology

There are still capacity constraints at national and regional level in two critical areas:

1. Monitoring and enforcement of planning and development regulations and codes is often lacking. The regulations and codes maybe up-to-date and reflect best practise, however lack of capacity and resources to enforce them results in construction of poor quality infrastructure.

2. Operation and maintenance of infrastructure is often neglected due to lack of finance or capacity (skills and knowledge) which increases the vulnerability of the infrastructure to damage from natural events.

Technologies and capacities in the sector are evolving rapidly and the ability to manage big data is enhancing the sectors ability to understand infrastructure as systems and more importantly to determine the complex interdependencies that exist between systems. This will enable the impacts of "cascading failure" as a result of damage or destruction to components of the system to be better understood and addressed through systems based risk assessments.

Technology has been developed that can model the impacts of natural events such as floods or earthquakes on infrastructure which enables decision makers to understand the potential risks and vulnerabilities that exists in respect of existing infrastructure or identify high-risk areas when considering the development of new infrastructure.

Infrastructure sector preparedness (early warning systems, assessments, other tools)

Early warning systems exist and are available to the sector, however these tools are largely reactive in nature and provide information on events that have occurred or are about to occur within a very short timescale.

The development of infrastructure requires tools that will enable owners, designers and constructors to make informed decisions about possible future risks (infrastructure typically has a designed operating lifespan of 15 to 30 years but will often operate for even longer) and how to mitigate them. This information is critical during the feasibility and concept stages of infrastructure design. The tools and technologies exist (and are constantly being enhanced and improved) that enable infrastructure designers to model the threats posed by hazards and the potential impacts on infrastructure. These tools are being expanded to move away from an asset based approached to risk, to take into account that infrastructure should be viewed from a systems perspective when assessing risk. This enables designers to think about enhancing the performance of a system in the face of multiple hazards as opposed to simply preventing the loss of an asset due to a specific event.

Infrastructure sector institutional set up

The sector is characterised by institutional structures that are responsible for particular infrastructure systems (e.g. transport or water or power authorities) with little or no coordination and information sharing between them. There is however a growing recognition that this is essential when determining risks to infrastructure systems and there are initiatives to promote sharing of data and a coordinated approach to understanding vulnerabilities of infrastructure systems.

Annual budget allocation

Funding is often directed to DRM and disaster response rather than planning and development of resilient infrastructure. There are also many examples of budget cuts to maintenance of infrastructure which have resulted in increased vulnerability and ultimately failure during an event. Allocation of funding for proactive management and maintenance of infrastructure is critical in reducing its vulnerability to damage and destruction from natural events.

Infrastructure sector-specific institutional mechanisms

There are at present no institutional mechanisms or structures to drive implementation of DRR and resilience in infrastructure development. A complicating factor in this is the role of the private sector in developing infrastructure and in particular in the urban context. This will require institutional mechanisms to coordinate within and across related sectors (public and private), drive policy formulation and planning to integrate DRR into development practice. Oversight and monitoring of implementation at all levels needs to be strengthened to enforce policy and regulation.

Infrastructure sector implementation (sectors' capacity to deliver at national and local levels)

The sectors capacity to deliver at national and local level is often hampered by lack of resources. There is recognition that in many cases the lack of finances, skills and knowledge has an adverse impact on the development of new infrastructure as well as the operation and maintenance of existing infrastructure.

(ii) Emerging trends

Examples of good practice that should be explicitly supported in the HFA2 and used as models for accelerating sector mainstreaming.

- Trends are emerging for countries to start assessing their risk exposure to natural hazards (Caribbean multi-hazard risk assessment, Nepal, Seychelles, and Maldives) and incorporate this into their long-term planning and development strategies. This is incorporated into planning legislation which requires a risk based approach to development.

- There have also been a number of initiatives such as updates to building codes being done by the Turks and Caicos Islands as a result of the damage to buildings caused by Hurricane Ike. This highlighted that fact that the building code did not make adequate provision for these kinds of events resulting in buildings that were over exposed and at high risk to withstand them.

Integration across natural hazards, climate and other risks

- This is being done through the analysis of future and existing risk, the establishment of risk databases, enhanced capacity to access and utilise risk information to influence policy, planning and practice within and across sectors including regulations and codes.

Drivers for mainstreaming disaster risk reduction into the tourism/infrastructure

- There are a number of incentives for integrating hazard and climate risk into the sector:
- Capital cost of infrastructure – there is a significant capital investment in building infrastructure which can be at risk if this is not done in a way which takes into account risks associated with climate change and natural hazards.
- Economic cost of damage to infrastructure – There are not only significant replacement costs to repair or replace damaged infrastructure but also significant economic losses and impacts on GDP due to disruption of flows of goods and services.
- Loss of life – It is often stated that earthquakes don't kill people, collapsing buildings do! Reduce the loss of life associated with natural hazards provides a significant incentive for taking a risk based approach to infrastructure development.
- Investment in disaster risk reduction and resilience is far smaller than the rebuilding costs post disaster. It has been estimated that an investment of $1 in resilience saves $7 in reconstruction costs.

Challenges when mainstreaming hazard risk into the infrastructure sector

- Transformational change in the way government at all levels (national regional and local) view DRR as being integral to the a countries long-term development agenda and in particular investment in infrastructure.
- Changing how DRR is marketed so that it is understood by development practitioners. This may involve using terminology that is relevant to development. For example increase resilience rather than reduce disaster risk.
- It requires political will to ensure planning policies; regulations and codes are contextualised and up to date, based on world best practice and experience from previous disaster events.
- Enforcement of building regulations codes as they cannot exist on paper alone. This requires sufficient skilled resources and capacity to ensure they are monitored and enforced.
- Planning and building regulations codes etc. require on-going review and updating as the situation changes and this requires skills and resources to do this.
- The necessity to understand infrastructure as systems that are interdependent and support the flows of goods and services. A systems based approach is about enhancing the performance of the system as a whole in the face of multiple hazards, not simply preventing or mitigating the loss of an asset due to an event.
- Recent research on City Resilience has highlighted the emphasis placed on proactive management and maintenance of infrastructure and the environment, rather than the presence of infrastructure. Poor maintenance and management of infrastructure is often a significant contributing factor to the loss and damage of infrastructure as a result of major hazard events.
- Post disaster recovery funding and processes and are often focussed on short term gains (humanitarian response) rather than longer term reconstruction and development goals. There is a clear need in the post disaster context to move from response to recovery and development (build back better) as quickly as possible ensuring that lessons learned and risk based approaches are incorporated into reconstruction planning.
- The urban environment is often not well understood and with rapidly growing urban population the likelihood of urban disaster situations is increasing. Modalities of working in urban environments are very different to rural or semi-urban environments so new ways of dealing with impact of hazards on urban infrastructure will have to be developed.

Recommendations for addressing hazard risks in the infrastructure sector in the Post-2015 framework for disaster risk reduction

- Capacity building of governments at all levels to develop, manage, implement and enforce planning policies, legislation, regulations and codes to prevent illegal activities such as the occupation of high-risk land and unauthorised extensions to buildings.
- Develop mechanisms for engagement with the private sector who:
- Have knowledge and skills related to urban infrastructure
- Have extensive networks of resources/skills who understand urban environments
- Are in many cases the owner and operator of urban infrastructure
- Focus on urban environments and develop approaches to DRR and building resilience in these environments as they are not well understood but present significant risks as global urbanisation continues to increase.
- Adopt a systems approach to infrastructure development and not view infrastructure as discreet individual assets

Regional/international policy frameworks and initiatives within the infrastructure sector to be targeted (other than the HFA2)

- MDG, SDG, Convention on Climate change
- Planning and Development policies
- Planning and Development legislation
- Codes and Regulations

Measuring disaster risk in the infrastructure sector

The level of integration of risk within the infrastructure sector national and global monitoring processes is not clearly stated in the reports.

In general the reports contain generic statements about integration of DRR into development policies and planning but no specifics that quantify this. There is also no articulation on ways to measure the outcomes that integration hopes to achieve.

The focus of reporting appears to be on emergency/disaster management, preparedness and response with little or no reference to development of infrastructure (or development as a whole) based on a DRR approach which aims to build resilience.

Infrastructure sector Target and Indicator options (as they would relate to the SDGs and the HFA2)

1. Established database of risk information and its accessibility to stakeholders in user friendly formats.
2. Capacity to understand and utilise risk information to influence sector-wide policy, planning and practice including regulations and codes.
3. Tools and processes to assess critical infrastructure damage and provide feedback on lessons learned to facilitate "build back better" strategies.

List of agencies contributing and description of institutional commitment

UNOPS – Development of sustainable resilient infrastructure

Key documents/source of additional information

1. The Environment As Hazard, Second Edition - Ian Burton ISBN-10: 0898621593
2. www.system-logic.com/commentary/posts/The%20Rising%20Cost%20of%20Disaster1ywl
3. www.economist.com/node/21542755
4. Rebuilding for Resilience – Fortifying infrastructure to withstand disaster –PWC Sept 2013
5. Global Infrastructure Investment To Reach Four Trillion Dollars By 2017 - Bain & Company
6. www.economist.com/news/leaders/21599358-how-get-more-worlds-savings-pay-new-roads-airports-and-electricity

7. www.economist.com/news/special-report/21586680-getting-brazil-moving-again-will-need-lots-private-investment-and-know-how-road
8. http://reliefweb.int/report/world/annual-disaster-statistical-review-2012-numbers-and-trends
9. Roshani Palliyaguru, Dilanthi Amaratunga, (2008) «Managing disaster risks through quality infrastructure and vice versa: Post-disaster infrastructure reconstruction practices», Structural Survey, Vol. 26 Iss: 5, pp.426 – 434
10. Rockefeller Foundation - City Resilience Framework - April 2014
11. Jo da Silva, Sam Kernaghan & Andrés Luque (2012): A systems approach to meeting the challenges of urban climate change, International Journal of Urban Sustainable Development, DOI:10.1080/19463138.2012.718279

About the UN Plan of Action on Disaster Risk Reduction for Resilience: The UN Plan of Action, endorsed by the UN Secretary-General and the Executives Heads of UN Specialized Agencies, Funds and Programmes, includes a commitment for the UN system to work together to ensure disaster risk reduction is a key component of the post-2015 development agenda supported by a post-2015 framework for disaster risk reduction (HFA2). The UN Plan of Action improves system-wide coordinated actions and coherence, as well as increased effectiveness and collaboration in the support to Member States on disaster risk reduction.

UN High Level Programmes Committee Senior Managers Group on Disaster Risk Reduction for Resilience (HLCP/SMG): Members of the HCLP/SMG that oversees the implementation of the UN plan of Action are FAO, IAEA, IFAD, IFRC, ILO, IMO, IOM, ITU, UNAIDS, UNCCD, UNDP, UNEP, UNESCO, UNFPA, UNHABITAT, UNHCHR, UNICEF, UNISDR, UNOCHA, UNOPS, UNOOSA, UNWOMEN, UNWTO, UPU, WFP, WHO and the World Bank.

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