Working Session 2

Resilience of Key Infrastructure Sectors

13:45 – 15:15

Wednesday, 20th March 2019

Taj Mahal Hotel, New Delhi

The Panel

Speakers

- Introduction by Kamal Kishore, National Disaster Management Authority, India

Session Format

This session will have two parallel breakout sessions, each covering two infrastructure sectors. (Group 1: WS2 - A and B; and Group 2: WS2 - C and D)

Each session will have presentations by 5 - 6 speakers of 7 minutes each followed by a moderated panel discussion.

Overview

Building resilience has a broader implication, beyond just risk assessment and disaster management. Management of infrastructure systems is already complex encompassing overlapping and interconnected systems and multiple stakeholders, financial and political considerations; all of which must come together in consensus for integrated development.

The session will discuss the challenges and opportunities of incorporating disaster resilience in rapidly expanding, and interconnected infrastructure systems/nodes that must balance these aspects while also playing a key role in the socio-economic prosperity of the region. For each sector, the speakers will assess strategies of physical and economic resilience of the infrastructure system including: possible impacts of a disaster, significance of vulnerabilities, prioritizing investments, adaptation measures and engagement with stakeholders. It will conclude with an actionable agenda for knowledge building for each of the sectors pertaining to an issue or a type of economy.

The following issues need to be addressed for every sector:

- How have risk management systems in older infrastructure systems (power plants, ports, railway lines, etc) been updated in line with the evolving understanding of natural hazards?
- What is the state of art practices being adopted to incorporate resilience in newly developed infrastructure systems? What are the systems for using risk metrics and standards?
- How are the projected impacts of climate change taken into account for long-term decision making?

Background and Context

The Need for Infrastructure

Increasing physical infrastructure, both in quality and quantity, is a pre-requisite for supporting economic growth.[1] Infrastructure spending is the most direct way of creating and sustaining employment.[2] This is particularly significant for short-term growth restoration after a shock, as seen in response to the 2008 financial crisis.[3] In the long term, the indirect spill-overs of increased infrastructure create a base upon which future growth and long-term development objectives can be achieved, and are therefore particularly significant to developing countries. Some infrastructure investments can yield cost benefit ratios of up to 1:20 if they are planned and executed well.[4]

Current Status of Infrastructure

Currently annual global infrastructure investment stands at about USD 2 trillion.[5] The investment in infrastructure has grown at an average 2.9% from 2007 to 2015.[6] While there is steady growth in the year-on-year investment, several estimates indicate that in the mid-term in the business as usual scenarios, investments are going to fall short of what is required for healthy economic growth. Global Infrastructure Hub pegs the global annual infrastructure investment needs at USD 3.7 trillion per year, going from 2016 to 2040.[7] They estimate the annual shortfall to be in the range of USD 650 billion. Furthermore, if we consider the targets set under the UN Sustainable Development Goals, these investment-needs increase to USD 4–4.4 trillion per year.[8] That represents a gap of USD 1 to 1.5 trillion per year. This is likely an underestimate, since most estimates only take into account provision of household electricity and water supply — some account for household sanitation.

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[1] Estache and Garsous, 2012; Spence et al., 2008; Straub, 2008
[2] International Labour Organization, 2009
[3] Estache and Garsous, 2012
[4] McKinsey Global Institute, 2016
[5] McKinsey Global Institute, 2016; Global Infrastructure Hub, 2017
[6] Global Infrastructure Hub, 2017
[7] Based on the assumption that World GDP will grow at an average 3.6% over the period of 2016-2040
[8] McKinsey Global Institute, 2016; Global Infrastructure Hub, 2017; United Nations Conference on Trade and Development, 2014

Geographical Variation in Infrastructure Needs

Emerging economies account for 54–60% of the total global investment needs in infrastructure. Nearly 60% of the world's total investment needs from 2016–30 will be in Asia.[9] Just China, USA, Japan and India account for more than 50% of the global investment needs.[10] In Europe, Americas and Oceania — which predominantly consist of developed countries — the investment needs are typically for replacement of aging infrastructure and/or incremental changes to improve infrastructure which has already been built. In contrast the investment needs in Asia and Africa are for mainly for construction of brand new infrastructure. As with the nature of investment needs, across the globe there is also great variation in the sectors which require the greatest investment.[11] In Asia the energy and road transport sectors require the highest amount of investment, and also face the largest gaps, closely followed by telecom. In Africa large investments are necessary in all four infrastructure sectors. In the Americas the investment needs and gap are maximum in roads. Europe needs investment in roads, energy, rail, and telecom, however, in a business as usual scenario there is no gap between potential investment and what is required. In Oceania investment is required in energy, ports, and rail, but similar to Europe, these countries are expected to have their investment needs met in the business as usual scenario.

It is in this context of limited funding, that the disaster and climate resilience of the infrastructure that will be built in the coming years becomes a non-negotiable consideration.

Status of Key Sustainable Development Goal (SDG) Indicators

According to the UN's SDG Atlas: [1]

- 2.5 billion people (67%) worldwide lack access to basic sanitation;
- 91% of the population has access to improved sources of drinking water. That still means 663 million people still lack it;
- 1–1.5 billion people do not have access to reliable phone services;
- One in five people still lacks access to electricity;
- 3 billion people rely on wood, coal, charcoal or animal waste for cooking and heating.
- Data on global transport connectivity are not easily available for any kind of assessment of shortfall, but it is generally observed that transport infrastructure in the developing world is not well developed and of low quality.

[9] McKinsey Global Institute, 2016
[10] Global Infrastructure Hub, 2017
[11] McKinsey Global Institute, 2016; Global Infrastructure Hub, 2017

Losses Due to Disasters

Disasters cause massive human and economic loss across the world. Between 2005 and 2015 the UNISDR estimates that disasters have killed 0.7 billion, and affected another 1.7 billion. According to Internal Displacement Monitoring Centre more than 26 million people have been displaced by disasters every year from 2008.[12] The UNISDR estimates that between 1995 and 2015, disasters caused between USD 2 to 2.5 trillion in economic losses. Figure 1 shows the distribution of losses caused by disasters across the globe by type of hazard and region. More than 70% of the losses are due to hydro-meteorological or climatological disasters. These types of hazards are likely to cause even more damage in the future due the unpredictability in their frequency, intensity and location, as a result of climate change.

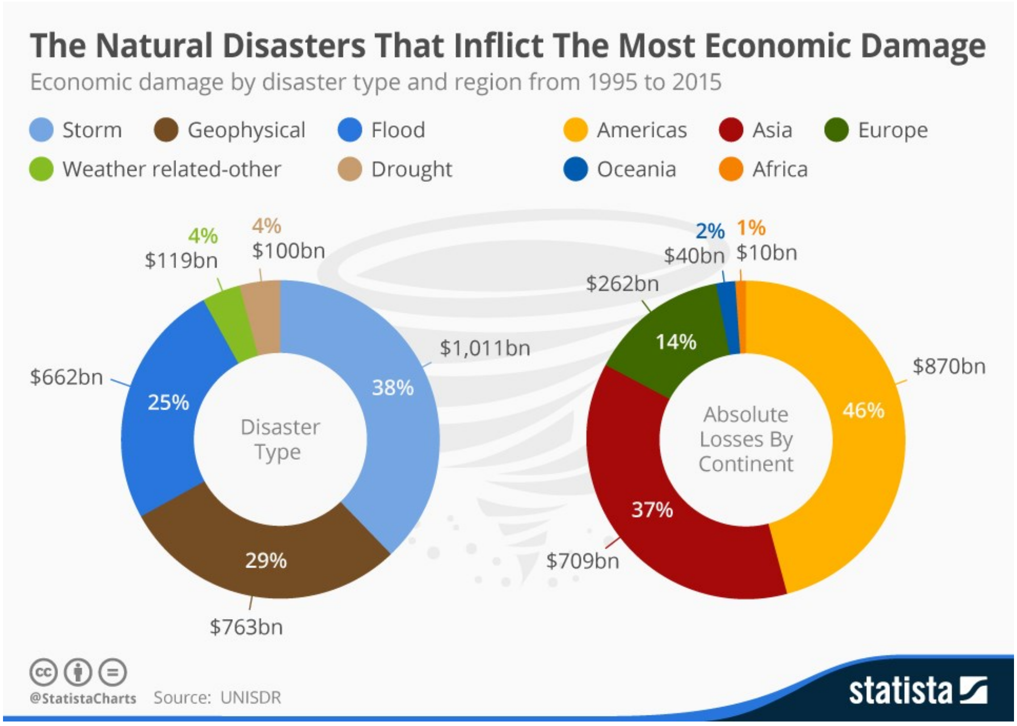

Figure 1: Economic losses by hazard and region

The impact of disasters on infrastructure manifests itself in two forms. One is the outright destruction of an infrastructure asset due to a high intensity disaster event. The other is the gradual degradation of assets over successive medium or low intensity events. The frequency of medium and low intensity events is much higher, and the attention they receive is lower than high intensity events. Therefore, it is likely that such degradation overall contributes to higher damage and economic losses than events which lead to the

[12] Internal Displacement Monitoring Centre, Norwegian Refugee Council, 2015

physical destruction of infrastructure. Figure 2 summarises the infrastructure losses due to recent disasters.

Country / Year	Event	Total damages and losses (D&L) (USD mn)	Infrastructure D&L as % of TOTAL losses	Infrastructure D&L as % of PUBLIC losses
India/ 2001	Earthquake	**2.131**	16%	n/a
Indonesia/ 2004	Tsunami	**4.452**	20%	56%
Sri Lanka/ 2004	Tsunami	**970**	13%	n/a
Pakistan/ 2005	Earthquake	**2.852**	17%	n/a
Indonesia/ 2006	Earthquake	**3.134**	2%	17%
Pakistan/ 2010	Floods	**10.056**	20%	n/a
Samoa/ 2012	Cyclone	**204**	37%	66%
Cape Verde/ 2014	Volcano	**28**	8%	30%
Nepal/ 2015	Earthquake	**7.065**	9%	30%
Fiji/ 2016	Cyclone	**1.327**	9%	47%

Figure 2: Infrastructure losses in recent disasters

The table shows that the loss of infrastructure is a significant part of disaster loss, especially public loss. This could be attributed to the fact that usually major infrastructure assets are publicly owned. Furthermore, the aggregate impacts of disasters on infrastructure are often greater than their impacts on individual assets.

Infrastructure as a system of systems

Modern infrastructure is an interconnected system of systems. Damage to one asset can lead to cascades which result in the reduction in service levels of many different individual infrastructure assets. Beyond the damage to assets themselves, these cascades can result in major disruption of supply chains, which can severely hamper relief and recovery operations, and also lead to major economic losses. An example of such a cascade was seen in the aftermath of Hurricane Katrina which struck New Orleans, USA in 2005. The cyclone damaged power grids, which led to power outages. This led to failure of telecommunications networks, and also led to the shut-down of railways in the region. Three critical transportation conduits were shut down for 48 hours, which later functioned on reduced power for two weeks. This led to massive disruption in transportation and distribution of relief supplies, food and fuel.[13] Relief and rescue efforts were severely hampered by the power outages and disruption of telecommunication. Similar cascades

[13] Wilbanks et al., 2012

were also observed in the aftermath of the earthquake and tsunami in Tohoku, Japan in 2011 and more recently in Houston, Texas in 2017 due to Hurricane Harvey. Further downstream, this kind of systemic disruption can have profound impacts on mid-term economic productivity of the region, and on the lives and livelihoods of residents, especially the poor.

Emerging issues in infrastructure resilience

1. **Infrastructure growth and replenishment**
   As shown earlier, investments in infrastructure are on the rise. While ports and airports in small island nations represent critical economic lifeline services, emerging nations in Africa and Asia are looking at rapidly expanding their infrastructure base to provide their citizens with a foundation for economic activity. The current focus on resilience represents an opportunity to get it right. It has been shown that about 80% of the investment in a new infrastructure project is locked in at the design phase. Thus, it is at this phase that we should aim to lock in the resilience paradigm at the core of an infrastructure system.
2. **Climate change and changing risk profiles:**
   Changing climate patterns around the globe are increasing the intensity, frequency and uncertainty of extreme weather events. This means that infrastructure built on the basis of past risk assessments will need a reassessment of its risks and upgrades to match the current level of risk. The constantly changing nature of these risks, the high volume of initial investment required, and the long life-cycles of infrastructure projects necessitate the continuous monitoring of risks and the development of adaptation strategies that are responsive to the changes in the risk profile.
3. **Technological evolution**
   The rapid evolution of material sciences, building technologies, and energy sources requires the planners of infrastructure to avoid getting locked into specific technologies or materials. There is a need to move from prescriptive standards that specify designs and material specifications to standards that define only the performance required from the infrastructure and allow for the designs and material selection to evolve and innovate. Further research is required on the use of emerging technologies, new materials, building designs, and energy sources and their effect on the resilience of infrastructure systems.

4. **Building infrastructure affects future development**

   Investment in physical infrastructure is a key driver of growth and urbanisation and affects human settlement patterns. This alters the exposure characteristics of the area in which the infrastructure is built and changes the risk profile of these regions. Thus Infrastructure is not only affected by the regional characteristics, but also affects them in return. As an example, the international airport at Chennai was constructed in low lying areas outside the main city. While by itself the airport is resilient to flooding at the time of heavy rainfall, the surrounding residential settlements that have emerged after the construction of the airport are even more susceptible to flooding than before.

   Infrastructure like ports and airports require large land areas and such lands are often found in hazard prone or reclaimed or low lying land (for airports). The existence of the port or airport attracts populations to live in areas surrounding these for employment or providing support services. This increases the population in living in hazardous areas thereby increasing risk. It is important to consider such fallouts at the time of site selection and planning.

Potential actions

A review of literature suggests the following actions that need to be carried out at various levels to build the resilience of key infrastructure sectors.

At national and sub-national level:

1. Defining a national climate adaptation strategy
2. Defining a national strategy / framework / master plan on infrastructure development that incorporate disaster and climate resilience
3. For new infrastructure: Laws requiring plans of new infrastructure to incorporate disaster and climate resilience considerations in every phase.
4. For existing infrastructure: Laws requiring assets to assess their disaster and climate risks and to create adaptation plans and monitor progress
5. Updating national standards on infrastructure construction including disaster and climate resilience
6. Vulnerability assessments of various infrastructure sectors
7. Developing design guidelines for infrastructure sectors incorporating resilience
8. Urban and spatial planning considerations
9. Improving coordination between stakeholders

At infrastructure asset level:

1. Conducting disaster and climate risk and vulnerability assessments
2. Defining an adaptation strategy
3. Incorporating the adaptation strategy into the master plan
4. Developing resilience planning, design, and construction guidelines
5. Upgrading of infrastructure in line with adaptation strategy
6. Business and operational continuity planning in light of risks
7. Regular monitoring and review
8. Involvement of local communities
