RESEARCH PAPER

Regional fellowship program

Assessing the Severity of the Impact of Flood on Infrastructure in Myanmar

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February 2018

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1. Introduction

Myanmar is one of the most vulnerable countries in the world in terms of climate change.[1] Global warming, which is acknowledged as the main impact of climate change,[1] causes the sea level to rise every year with the potential to submerge a substantial part of the flood-prone coastal areas of Myanmar by 2050[1]. Rising sea levels causes frequent floods.[1]

Extreme weather events include storm surges, heavy rains, severe droughts, cyclones, and floods. The frequency and intensity of these events have been increasing over the last 60 years as a result of human-induced climate change.[2] From 1990 to 2015, there were 38 extreme weather disasters in Myanmar, during which more than 139,000 people were killed, and a total of 13 million people were affected overall. The total economic damage added up to USD 48 billion.[3]

Flooding is the second most frequently occurring natural disaster in Myanmar after fire. It happens every year,[4] and accounts for 11 per cent of all natural disasters.[4] Every year the risk of flooding is greatest during the monsoon season, which lasts from mid-May to October.[4] According to the Department of Metrology and Hydrology in Myanmar, every year floods occur most frequently in August (49 percent), with 23 percent taking place in July, 14 percent in September, 8 percent in October and 6 percent in June. The most significant floods of 2015, 1974, 1997, 1991, 1973 and 1988 had disastrous effects on infrastructure in Myanmar.[5] For example, in 2015, Myanmar experienced severe flooding throughout the country.[5] A total of 69 people were killed, 259,000 people and 39,474 households were affected, 4046.85 square kilometers were flooded and 2104.36 square kilometers were totally destroyed.[5] According to the report relating to floods in Myanmar by the international Federation of the Red Cross and Red Crescent Societies (IFERC), Ayeyarwady Region, Magway Region, Sagaing Region, Rakhine State and Chin State were the five areas of Myanmar most affected by that flood.[6]

People lose their lives and properties due to flooding and it also damages infrastructure and creates economic losses as well as health problems. [7] Critical infrastructure systems of Myanmar relate to energy, buildings, telecommunications, water and sanitation. As Myanmar moves towards the status of 'developed nation', people rely more and more on infrastructure and this sector is crucial for the country's development.[8]

According to Sulivan and Sheffrin 2003, 'infrastructure is the set of interconnected structural elements that provide framework supporting an entire structure of development. It includes energy, telecommunication, roads, housing, rail recreation grounds and parks, health, education, bridges, transport agriculture and security.'[9]

According to the Oxford dictionary, infrastructure is defined as the basic physical and organizational structures and facilities that are needed for the operation of a society such as buildings, roads and power supplies.

In this paper, the elements of infrastructure are housing, electricity, transportation, communication and water and sanitation.

This research paper aims to identify the severity of impact of floods on infrastructure, and possible mitigation and adaptation strategies to reduce the severity, by addressing the following research questions:

(i)   How much infrastructure is lost or damaged as the result of floods each year?
(ii)   What are the current government policies to reduce the potential/future impacts of flooding?
(iii) What can Myanmar learn from other counties to address flood risks effectively?

2. Floods Impact on Infrastructure

2.1. Housing

In July and August 2015, more than 1.6 million people were displaced by flooding and landslides. According to a government report, nearly 525,000 houses were affected: 39,000 were destroyed and 485,000 were damaged to varying degrees.[10]

The Ayeyarwady Region suffered the worst impact, with the highest number of houses affected: 19,000 were destroyed and 108,000 were damaged. The other heavily affected areas were Rakhine State, Sagaing Region, Bago State, Chin State and Yangon Region.[10]

Areas with the highest number of houses affected by flood

CHINA

INDIA

SAGAING

BANGLADESH

CHIN

LAO PDR

RAKHINE

BAGO

THAILAND

AYEYARWADY

YANGON

The impact on the number of houses varied among States and Regions not only in the amount of damage and the relative impact on the overall housing sector, but also in the type of damage experienced.

The biggest housing needs after the floods were urgent relocations, repair and reconstruction of housing, and restoration of household water and sanitation services. Local authorities said that 3,000 households in Chin State and 1,600 in the Sagaing Region needed to be relocated to safer areas during the recovery phase.[10]

The housing recovery program allows the government to partially finance and oversee homeowner-driven repairs and the reconstruction program. This program implements safe building practices.

There are various types of housing, including:
- apartments/condominiums;
- bungalows/brick houses;
- semi-pacca houses (i.e. buildings of which either the walls or the roof are made of brick, cement, or stone, but not both - either the roof or the walls are made of an inferior material);
- wooden houses;
- huts.

Wooden houses and bamboo houses are found mostly in rural areas and these types of houses were the ones most commonly affected by the 2015 floods and landslides.[10]

Table 1: Construction Materials [10]

Rural Areas			Urban Areas		
Leaves	Bamboo	Wood	Bamboo	Wood	Brick
12%	56%	21%	38%	22%	34%

2.2. Electricity
Damage to the electricity sector in the country from the 2015 floods and landslides was small in comparison with that suffered by other sectors.

Table 2:   Comparison of Damage and Losses among Infrastructure Sectors in Kyat (1 billion kyat is equal to approximately USD 740,000)

Sectors	Damage	Losses
Housing	508 billion	34 billion
Communications	1.2 billion	1.3billion
Electricity	6.2 billion	0.6 billion
Water and Sanitation	15.7 billion	-

Source: Myanmar Post-Disaster Needs Assessment relating to Floods and Landslides July-September 2015 Report

In Table 2, and throughout the rest of this section, `damage' is defined as costs associated with direct destruction, or damage to hard infrastructure. However, in addition to the direct impact, there may be additional costs due to disrupted economic flows. For example, the cost of a house that is destroyed due to floods is classified as `damage', while the loss of rental income for a landlord would be considered a `loss'.

In the electricity sector it is estimated that there was 6.2 billion kyat worth of damage (approximately USD 4.6 million) and 0.6 billion kyat of losses.[10] The damage and losses were mostly caused by short-circuiting, collapsed poles and distribution lines, and power cut-offs in flooded areas. For instance, 15 mini-hydropower stations were damaged in Chin State accounting for a total capacity of 150 KW.[10]

In response, an inventory of the damage was compiled by the Ministry of Electric Power and a recovery plan was drafted.[10]

The Myanmar Ministry of Electric Power (MoEP) estimated that 6 billion kyat (approximately USD 4.5 million) was needed for recovery of the electricity sector, 1 billion of which was used for short-term recovery and 5 billion for medium- and long-term recovery.[10]

Chin, Rakhine, Magway, and Sagaing suffered the worst damage from the floods and landslides in relation to the electricity sector according to the Myanmar Ministry of Electric Power (MOEP).[10]

Areas with electricity sector seriously damaged by flood and landslide

2.3. Transportation

Due to the 2015 floods and landslides, transport infrastructure throughout the country was extensively damaged. Most of the damage occurred in the west: Chin, Sagaing, Rakhine and Magway States.

The direct impact on the transport sector consisted of road and rail transportation links that were blocked, disrupted market access, and lack of access to social facilities in both urban and rural areas.[10, page 125]

For a considerable amount of time, the damage to the road network limited capacity to deliver emergency supplies and hampered recovery for the communities that were most affected.[10, page125]

2.4. Communications

The communications sector covers infrastructure needed to convey information and includes the postal delivery and telephone systems, radio and television, and the internet. Myanmar's communications sector has experienced significant damage due to floods and landslides especially relating to telecommunication networks, postal services and government offices in the regions affected.[10, page 133] The total costs of damage and losses are estimated at 1.2 billion kyat (approximately USD 8.9 million) and 1.3 billion kyat (approximately USD 9.6 million), respectively (see Table 1).

The budget for the cost of recovery and reconstruction is estimated at 106 billion kyat (approximately USD 78.6 million).[10]

Myanmar's telecommunications market consists of three major operators, which are Myanmar Posts and Telecommunications (MPT), Telenor, and Oreedoo. The first, MPT, is a state-owned enterprise, whereas the others are private enterprises.

Telecommunications is a key infrastructure sector that has received a large amount of foreign direct investment. Teledensity[i] in Myanmar has increased from 10 percent to 60 percent due to foreign investments of more than USD 3 billion (about 4,000 billion kyat), which have created a significant number of direct and indirect jobs.

The 2015 flood highlighted the fact that there was no strategy in place for the communications sector in case of a disaster and no official plans were set out for network infrastructure.

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[i] 'Teledensity' is the number of telephone connections for every hundred individuals living within an area. It varies widely across nations and also between urban and rural areas within a country" (https://en.wikipedia.org/wiki/Telephone_density)

Flood affected transceiver stations and service provision was hampered by power disruptions and lack of fuel supply.[10, page 135] Some of the offices and equipment buildings of MPT were damaged in affected areas.[10, page 135] International telecommunications were unaffected by the 2015 floods, but some areas in Myanmar were cut off because both land lines and wireless hard infrastructure were damaged. For an overview of the costs of the damage see Table 3.

Table 3: Comparison of damage and losses for the communications sector in kyat (1 million kyat is approximately USD 740)

	damage	Losses
Telecommunications buildings	144 million	None
Telecommunications equipment	1,068 million	1,243 million
Postal sector buildings	34 million	0.74million

Source: Myanmar Post-Disaster Needs Assessment of Floods and Landslides July-September 2015 Report

The communications sector faces increased vulnerability to network down-time because Myanmar does not have a national emergency telecommunications plan.[10, page 136] In the aftermath of the disaster, rural areas were very reliant on back-up power solutions such as diesel generators and solar power. Rural areas were dependent on back-up power for longer than urban areas, and had more network down-time, because it was hard to get both fuel as well as new hard infrastructure to rural areas.[10, page 136]

2.5. Water and Sanitation

Because access to water, sanitation and hygiene are so interdependent, they are often grouped into one sector called WaSH. Sanitation is necessary to prevent water sources from becoming contaminated, while water is necessary for basic hygiene. Although Myanmar is rich in natural resources, the problems for their management remain a challenge.[11] Furthermore, unbalanced rainfall patterns create problems such as floods, water shortages and droughts. In addition, point source discharge (point source discharge is pollution stemming from a single (small) source such as a pipe, ship, smokestack, etc.) and non-point source discharge (non-point discharge comes from many diffuse sources, such as land run-off and seepage, etc.) causes poor water quality in many places.[11]

Universal access to all components of WaSH is one of the sustainable development goals.[12] However, during natural disasters – especially during floods – adequate provision of WaSH can be more difficult. For example, the 2015 floods had a negative impact on WaSH infrastructure which affected 12 of the 14 Regions and States in the country. The losses and damage are estimated to have amounted to 58 billion kyat (approximately USD 43 million). The combined damage and losses to the public water supply infrastructure amounted to 15 bil-

lion kyat (approximately USD 11 million) and damage and losses to vulnerable household sanitation were estimated to have amounted to 35 billion kyat (approximately USD 26 million). The budget necessary for the cost of recovery was 25.6 billion kyat (approximately USD 19 million), which was based on the assumption that reconstruction would be conducted on the principle of "build back better" and would take disaster risk management into account.[10](114) "Build back better" as a guiding principle means that damaged infrastructure will be rebuilt using "recovery, rehabilitation and reconstruction phases [that] increase the resilience (…) through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies, and the environment".[13, page 6]

3. Government Policies

The Government of Myanmar has adopted some general policies to mitigate the effects of climate change and disasters, and to protect the environment as follows.

3.1. General policies

3.1.1. Climate change policy

The Myanmar Climate Change Policy was prepared by the Myanmar Climate Change Alliance and was submitted to the Ministry of Natural Resources and Environmental Conservation. The first draft was submitted in March 2017 and expressed the view that Myanmar should be a country that was resilient to climate change (e.g. through reducing carbon–dioxide emissions), and that it should be prepared to deal with climate change in the future. The Myanmar Climate Change Policy aims to provide long–term instructions and guidelines for taking action in terms of adaptation and mitigation, and in coordinating climate change action at the national level. [2, page 6]

3.1.2. National disaster policy

As part of the national disaster policy, the Union Assembly (Pyidaungsu Hluttaw) enacted the Natural Disaster Management Law on 31 July 2013 with five objectives. These are to:

- implement natural disaster management activities in a systematic way to decrease the risks of disaster;
- organize the National Committee and local agencies to undertake effective and systematic initiatives for natural disaster management programs;
- cooperate with all organizations both national and international in performing activities within the natural disaster management program;
- preserve and improve the environment after natural disasters;
- undertake the sharing of knowledge in the health, education, social and livelihoods sectors to create better living standards for the people affected by natural disasters.[14]

3.1.3. Environment protection policy

The Environmental Conservation Law was also enacted by the Pyidaungsu Hluttaw on 30 March 2012 with the main objectives to:

- protect and expand a healthy and clean environment;
- "reclaim ecosystems";
- promote public awareness and education in respect of the environment;
- foster more cooperation between international and regional actors as well as between various domestic government departments;
- set out the basic principles and guidance for the systematic integration of environmental conservation into the sustainable development process.

This law also set up the "Environmental Conservation Committee", which is responsible for implementing conservation policies and alerting the Myanmar government to any environmental emergencies.[15]

In more specific terms, the relevant government policies addressing challenges identified in section 2 above are examined in the following section.

3.2 Specific infrastructure-oriented policies

3.2.1   Housing issues

3.2.1.1. Resettlement of the population affected, and reparation and reconstruction of housing

In terms of a resettlement/relocation plan for flood victims, the government does not appear to have a clear and specific public policy.

However, in 2012, the government put in place a policy to "make cities inclusive, safe, resilient and sustainable" which included the building of new infrastructure that was resilient and sustainable.[16]

According to the Asian Development Bank, large-scale construction and resettlement programs have been implemented over the past two decades, with approximately 250,000 sites and serviced plots of land for approximately 1 million people in Yangon[17]. Moreover, as early as 1993, the government had initiated the development of industrial zones to promote job creation, including for relocated families.[17, page 9]

The government plans to build 1 million houses by 2030 as part of its National Housing Policy [16]

However, it appears that this national policy has been put in place only to meet the needs generated by urbanization in the coming years. A question arises as to whether or not this will be sufficient to relocate the numerous victims of natural disasters, who numbered 1.6 million in July/August 2015 [10, page 86]

Furthermore, the government recognizes that informal settlements have been a significant problem for Myanmar's cities for several decades. Although the national proportion of people living in slums and squatter areas is not yet known, this number is likely to increase, especially in view of the high degree of rural exodus to the cities as a result of the country's economic transition. Despite changes in land legislation and the election of a new government (the National League for Democracy) at the end of 2015, those in power are aware of the significant increase in the number of "professional" and "opportunistic" squatters, who could claim compensation in the future. They are also aware that large cities are suffering from severe systemic shortages of affordable housing.

The government acknowledges that it does not yet have a comprehensive policy on slums or informal settlements, but is satisfied with regional initiatives such as in Yangon, where an estimated 10 percent of the population live in informal settlements, and where the Yangon Regional Government has planned a city-wide initiative to address the problem of slums and squatters by assessing, and resettling them.[16]

The government is continuing to plan small-scale settlements outside the major cities, with a particular focus on small villages in forest areas[16, page 31]

3.2.1.2. Restoration of household water and sanitation services
In 2014, the Cabinet and National Water Resources Committee, whose chairperson is the Vice President of the Union of the Republic of Myanmar, approved the National Water Policy. In addition, a number of pilot activities for the WaSH sector have been responded to at the policy level. For example, water was a priority area of focus to be addressed by the Framework for Economic and Social Reform and National Comprehensive Development Plan.

The government was also working on a national rural WaSH strategy and investment plan in March 2016. Its final draft was in May 2016 and it covers the years 2016 to 2030. The strategic objectives have been divided into two parts. The first group includes the actual services of water supply, sanitation and hygiene promotion, including WaSH in schools, WaSH in health facilities and WaSH in emergencies and for humanitarian action. In the second part , finance and institutional arrangements are addressed.[18] Furthermore, from the results of public consultations conducted between 2014 and 2015, the Myanmar National Water Framework Directives were drafted to approve the National Water Law [10]

3.2.2 Electricity policy
Again, it does not appear that Myanmar has a specific policy to address flood damage to the electricity sector. The only government policy on electricity was adopted in January 2014, with the following actions:

- electricity should have a minimum effect on the environment by putting into practice comprehensive energy development (for both the short- and long-term);
- establish an appropriate legal framework to stimulate energy development by the private sector and other organizations in accordance with the State Economic Reform Policy;
- classify the different types of energy resources by analyzing statistics on domestic supply and demand;
- set up programs for local people to access energy in a proportional way;
- put more emphasis on renewable energy resources including wind, solar, hydropower, geothermal and bioenergy;
- enhance energy capability and energy conservation;
- create an energy capacity building institution in order to comply with international standards;
- enhance international cooperation on energy issues; and
- develop suitable policy for energy rates in order to enhance economic security.[19]

3.2.3 Transport infrastructure policy

As described in Section 2 above, transport infrastructure in Myanmar has been extensively damaged by past floods and the government does not seem to have a specific policy to address this. [10]

However, the government has adopted a national and broader policy with the National Transportation Master Plan to provide a roadmap that will permit reforms of the transport sector, including airports, deep sea ports, inland waterways, railways, highway systems and cross border infrastructure. This will result in greater efficiency for the transport sector, especially in enhancing the connectivity at both the national and regional levels. This Master Plan was enhanced to provide a roadmap for a long-term investment agenda that will help the government reach its economic growth goals by 2030. Furthermore, the Master Plan is intended to integrate with Myanmar's National Comprehensive Development Plan (NCDP), which defines the country's development perspectives and strategic goals.

3.2.4 Telecommunications policy

Even if there is not yet a clear ICT policy to address the issue of damage to the communications sector, the government realizes that ICT plays a vital role in socio-economic development. Therefore, an ICT Master Plan 2015, was developed to harness ICT potential in order to promote the better integration of Myanmar into the ASEAN economic community.

The Socio-Economic Reform Framework, which was developed in 2013, set out key policies to be accomplished before 2016. The development of mobile telephones and the internet is mentioned in this framework. It also outlines the objectives of ICT related reforms, which are to:

- achieve 80 percent penetration of services by 2015;
- permit full sector liberalization;
- upgrade internet infrastructure;
- increase the technical competence of users. [20]

The Asian Development Bank has agreed that Myanmar needs to establish ICT infrastructure and to upgrade its telecommunications and internet networks.[20] A clear regulatory framework is also needed to attract foreign and private investment into the sector. Myanmar is in the process of making the necessary regulations for a new telecommunications law.[20]

3.2.5   Water and sanitation policies

The impact of floods on water, sanitation, and hygiene (WaSH) infrastructure could be addressed by the management of water resources at the national level by the Myanmar National Water Resources Committee (NWRC). This consists of members from several Ministries and was established in 2013. This is the highest body in Myanmar dealing with the management of water resources. At the present time, it has two general public policy instruments at its disposal, but lacks specific public policies to address the impact of floods on WaSH infrastructures. The general policies are described below.

3.2.5.1 National Water Framework Directives

In 2014, the NRWC adopted a significant policy framework called the National Water Framework Directives[ii]. This policy framework focuses on River Basin Management Plans and provides an important baseline for the development of a new holistic water law.

Nine Ministries work on water related issues. These include the Ministry of Livestock, Breeding, Fisheries and Rural Development that deals with domestic and rural water supply and sanitation, while the Ministry of Construction is responsible for domestic water supply, city water supply and sanitation, and water conservation and protection.

Some of the key principles of the National Water Framework Directives are that:
- people should have clean and safe water (ground and surface water);
- the National Water Budget should be used for assessing the status of ground water;
- the status of water should be evaluated taking into account biological and hydro-morphological qualities; and
- there should be cooperation between the Union government, the States and Divisional governments to allow for the participation of interested agencies.[11]

[ii] With the support of EU Water Framework Directive.

3.2.5.2 National Water Policy

The National Water Policy was approved in March 2014 and focuses on the management and use of water resources with the goal of applying integrated water resources management to enable continuous development.

The vision of the National Water Policy is to supply enough water for all people throughout the nation by 2020 and its mission is to initiate the implementation of water policy for all organizations that are related to the water sector for developing more relevant rules and regulations.[21, page 2]

3.3 Preliminary findings

At present, there are few public policies specifically designed to combat the effects of floods on the country's infrastructure. Although some general policies are undertaken by the authorities to reduce the impact of floods, most of the issues identified in the previous section remain unaddressed by Myanmar policies, such as the resettlement of the people affected, the reparation and reconstruction of housing, the restoration of household water and sanitation services, as well as repairs to infrastructure for transport, conveying information (including the delivery of post, telephone calls, radio and television, and the internet), for electricity and for water, sanitation and hygiene.

4. Best practices and policy options
4.1. Best practices regarding general flood policy

Some experts identify the main components of general flood policy as the following:

- *Living with the risk of flooding:* Learning to live with flood risks is one of the main lessons of flood risk management. People and governments need to recognize that the risks of danger and damage caused by floods cannot be completely eliminated: they need to accept a certain degree of risk in exchange for the benefits they derive from the use of flood-prone land.[22] For example, people could be urged to plan residences, transportation systems and fruit orchards in ways that limit damage caused by frequent flooding. People could also be asked to build houses that can adapt to flood conditions, and loans could be offered to help people to undertake measures to prevent flooding. The building of exterior dikes, delaying harvest time, and using plant species adapted to flooded areas, could be encouraged as part of this.[23]

- *Flood forecasting:* China introduced flood forecasting procedures in the 1980s. These are useful in managing floods in the context of high population density and rapid development of a country. The accuracy and timeliness of many existing forecasting systems could be enhanced by improving data monitoring networks and updating methods. Recent advances in new technologies have made it possible to achieve inte-

grated forecasting procedures. In particular, technological advances in the acquisition of spatial topographic data have allowed forecasting procedures to be linked to flood mapping to provide much more detail on the extent of floods and their impacts.[22]

− *Land use management:* Appropriate land use management can limit exposure to flood risk. For example, China has resettled populations as a means of flood risk management. In other countries, a different approach is being taken, namely the introduction of sophisticated land use regulations, including delineating flood risk areas, classifying land according to flood risk and/or imposing construction-related land use rules in different flood risk zones. However, in China, this flood risk management process has suffered from the fact that the Ministry of Water Resources, which led the flood control exercise, did not have the power to manage the land since this fell within the scope of the Ministry of Land Management.[22] It seems essential, therefore, to establish working partnerships with other administrative authorities and to coordinate the planning of ongoing flood management. However, it appears, that there are no effective mechanisms to achieve this in China.[22]

− *Decision-support systems*: Decision-support systems can improve flood and vulnerability risk management. Thanks to modern computer modelling, decision-support tools can be produced. Natural processes, such as the run-off from precipitation and flood waves in valleys and floodplains, are more difficult to reproduce. Improvements in data acquisition and field monitoring, the accumulation of event data in flood databases, and refinement and recalibration of applied models are crucial to progress in this area.[22]

− *Flood diversion and retention policies for flood management:* One of the flood mitigation measures in downstream areas is the construction of flood diversions and dams. After the historic 1971 Red River flood, China implemented a flood diversion and retention policy , with particular attention paid to the living conditions of the population.[23]

− *Policy for disaster aftermath in disaster-prone areas:* The central government in Myanmar wants the local governments to be involved in post-disaster management. The government has also implemented a series of post-disaster policies that have been implemented to rapidly stabilize people's lives and restore production in the areas that have been damaged. The policies cover:
  - the allowances paid to families for people killed by disasters;
  - the allocation of medical care for disaster victims;
  - assistance for families whose property has been destroyed by natural disasters;

- food aid for flood-affected areas where crops have been destroyed. This includes seed and fertilizer aid for the restoration of agricultural production, and loans for the restoration of agricultural production;
- aid for the rehabilitation of infrastructure related to transport and water, schools, health clinics, etc. in flood-affected areas.

Other experts[iii] have added suggestions for Myanmar to adopt the following policy options:

– Implement programs to establish projects and methods of construction that take flood cyclones and other climatic events into consideration: these are called "**Interacting Hazards**";[24]

– **Emergency response plans**: in respect of flooding in coastal areas, policies for immediate response should be analyzed with the cooperation of regional and national governments; [24]

– **Insurance:** as flood risk cannot be mitigated in coastal areas, the costs of taking out insurance should be considered as part of the overall financial costs of flooding. [24].

With the adoption of the policies described above, the localities that are affected can more quickly overcome the consequences of floods, stabilize living conditions and restore production.[23]

4.2. Targeted best practices

5.2.1. Resilient telecommunications networks

India supports the resilience of its telecommunications networks (infrastructure that is required for the delivery of post, telephone calls, radio, television, and the internet) so that the threat of flood is anticipated, and recovery is therefore rapid, through a series of processes:

– Standardized operating procedures for emergencies have been adopted (e.g. National Telecom Policy 2012; Unified Emergency Response Mechanism);
– An appropriate legal, regulatory and institutional framework for a reliable communication system has been established;
– The use of ICTs for monitoring, anticipating and/or warning relevant stakeholders about floods has been promoted.[25]

[iii]Global Facility for Disaster Reduction and Recovery (GFDRR) is an international organization that supports developing countries to decrease their vulnerability to natural disasters and climate change. GFDRR is also responsible for financial funding under the control of the World Bank and it provides assistance in disaster risk management projects performed globally. It is cooperatively working with more than 400 local, national, regional and international partners to provide knowledge, funding and technical assistance.

4.2.2. Water and sanitation
4.2.2.1. Integrated Water Resources Management

In order to enhance the management of water resources for sustainable and equitable development, the Global Water Partnership (GWP)[iv] highlights the usefulness of "*a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*". This is called Integrated Water Resources Management (IWRM). According to the ASEAN Working Group on Water Resources Management[v], this holistic process should be implemented in Myanmar to address water management issues identified in Section 2 above.

Indeed, water is an essential engine of economic and social development, but it also has a basic function in preserving the integrity of the natural environment. However, there are also many other vital natural resources. It is therefore crucial that water issues are not considered in isolation.[26]

Furthermore, managers in the public or private sectors need to make difficult water allocation decisions because they have to mete out decreasing resources to satisfy ever-increasing demand. Factors such as demographic and climatic changes further increase the pressure on water resources, and the traditional approach, which is fragmented, is not then sustainable. A more holistic approach to water management would seem now to be required. This is precisely why the IWRM approach is the most relevant, according to the ASEAN working group on Water Resource Management.[26]

4.2.2.2. Combined roadway drainage systems

The implementation of road drainage strategies conducted in isolation is generally inefficient. According to a New York City Department report (City Planning-Transportation Division), a combination of design solutions that reduce volume and slow the rate at which rainwater flows from roads and other paved surfaces (thereby reducing the likelihood that drains and sewers will flood) would be more effective. This report focuses on two cities, Portland and Seattle, that have effectively combined various storm-water run-off management practices with very positive results.[27]These combined drainage strategies should also be taken into account when rebuilding transport infrastructure.

[iv]The Global Water Partnership Organization (GWPO) is an intergovernmental organization established in 2002. The Secretariat is based in Stockholm, Sweden. This international network was created to promote an integrated approach to water resources management. It includes some UN agencies and government and non-government institutions.
[v] The ASEAN Working Group on Water Resources Management was established to enhance cooperation on freshwater management in the ASEAN region.

5. Conclusion

While acknowledging that Myanmar is one of the most vulnerable countries in the world in respect of climate change, this research paper is mainly based on the 2015 flood as this affected 12 of the 14 Regions and States in the country and severely affected infrastructure nationwide. In that year, 1.6 million people were displaced, 39,000 houses destroyed and 525,000 houses damaged. Throughout the country, there was more than 6200 million kyat or approximately USD 4.6 million worth of damage to electricity infrastructure (caused by short-circuits, collapsed poles and distribution lines, and power cut-offs), and transport infrastructure was extensively damaged (blocked roads and rail transportation links, disrupted market access and lack of access to social facilities). In this context, the communications sector in Myanmar continues to face an increased vulnerability to network down-time as the country has no national emergency telecommunications plan. During natural disasters, it has also been found that universal access to all components of Water, Sanitation and Hygiene (WaSH) are under threat as damage to WaSH infrastructure was highly significant in 2015 (amounting to nearly 6 billion kyat or USD 4.5 million).

In response to climate change, the Myanmar authorities have adopted a number of general and more specific government policies on infrastructure issues in the country.

A climate change policy is being adopted to make Myanmar a climate-resilient country. It aims to provide long-term guidance and guidelines for taking action on climate change adaptation, mitigation and coordination at the national level. In 2012, the Parliament passed a law on environmental conservation to promote a healthy and clean environment while being part of the process of sustainable development. Then, in 2013, a national disaster management policy was put in place to better manage disaster and post-disaster issues with a more holistic and systematic approach throughout the country.

Other public policies have also been put in place, more specifically focusing on the various components of the country's infrastructure. For example, a housing policy was established in 2012 to build new resilient and sustainable urban infrastructure, with the goal of building 1 million new homes by 2030. A policy for the restoration of household water supplies and sanitation services was also adopted in 2014 to help solve WaSH problems, and a national water law is being adopted to provide a legal framework to support this policy. The government of Myanmar also developed an ICT Master Plan in 2015 to harness the full potential of the country's ICT to support further integration into the ASEAN economic community. Furthermore, from a fairly general perspective, a policy of improving the efficiency of the transport sector has been put in place to increase connectivity throughout the country. Finally, a government policy on electricity was adopted in January 2014.

Despite all of these efforts by the government, which demonstrates a commitment to combat the effects of climate change and to support the sustainable development of the coun-

try's infrastructure, specific actions do not appear to have been initiated to address the impact of floods on infrastructure.

Indeed, the government does not yet seem to have a clear policy for the resettlement or relocation of flood victims, given that housing policy will probably not be sufficient to solve the problems of the resettlement of disaster victims, including those from floods. For instance, there were 1.6 million victims of the flood in 2015 alone, and such numbers could worsen, given the expected growth in the population . The authorities also do not appear to have specific public policies in place to deal with the impact of floods on WaSH infrastructure, nor do they appear to have specific ICT policies to deal specifically with the damage caused by floods to the communications sector. This also applies to the transport sector, where the government does not yet seem to have a specific policy to deal with the issue of transport infrastructure damaged by floods, nor does it seem to have a specific policy to deal with the damage caused by floods in the electricity sector.

Some of the best practices from other countries have been cited in this research paper as policy options for addressing these remaining issues relating to the impact of floods on infrastructure in Myanmar. For example, it was noted that India was ensuring that its telecommunications networks (infrastructure necessary for the provision of postal services, telephone calls, radio, television and the internet) are flood-resistant in advance of any threats and had processes in place to support rapid recovery from such crises. It has also been noted that specialized international organizations have called on Myanmar to establish an integrated water resources management system. This would ensure that the country had a comprehensive approach to water resources management. The adoption of a combination of road drainage systems to reduce the risk of flooding of drains and sewers has also been urged.

More generally, experts recommend that the governments of flood-prone countries such as Myanmar learn to live with flood risk and accept a certain degree of risk in exchange for the benefits they derive from the use of floodable land. Improved flood forecasting systems, particularly with spatial topographic technology - as exemplified in China – are also advocated. According to the same experts, land use management can be a means of controlling flood risk by, for example, identifying flood risks and classifying land according to flood-prone areas. Flood diversion and retention policies are also essential management tools, as China had shown since the historic flooding of the Red River in 1971.

Other experts have suggested that the Myanmar authorities should integrate disaster mitigation methodologies into their construction policies, calling this approach "Interacting Hazards” in that it identifies and suggests means for lessening the threat of hazards that are linked. The provision of appropriate insurance to cover the financial costs of floods is a further issue that warrants advance planning.

References

1. Government of Myanmar (2016). Water Security and the Sustainable Development Goals. Yangon, Myanmar.
2. Republic of the Union of Myanmar (2017). Myanmar climate change policy.
3. Linda, V. O. (2017). Disaster Risk Reduction and Disaster Management in Myanmar.
4. Give 2 Asia. *DISASTER PREPAREDNESS AND RESILIENCY: MYANMAR* [Online]. Available: http://www.give2asia.org/disaster-preparedness-and-resilience-myanmar-1/.
5. Kyu Kyu Sein & Myint, T. (2016). *Flood Hazard Mapping using Hydraulic Model and GIS: A Case Study in Mandalay City, Myanmar* [Online]. Available: http://www.sstj.sci.ssru.ac.th.
6. International Federation of Red Cross and Red Crescent Societies (2017). Final Report of Myanmar Floods2015.
7. Saw Htwe Zaw Regional characteristics and Disasters in Myanmar.
8. Radley Horton, Manishka De Mel & Peters, D. (2017). Assessing Climate Risk in Myanmar. Myanmar: Myanmar Climate Change Alliance.
9. Olufemi, A. O. Infrastructure Provision in Developing Nations: Value for money approach. . Available: http://www.academia.edu/14660756/Infrastructure_Provision_in_Developing_Nations_Value_for_money_approach.
10. Government of the Union of Myanmar (2015). POST-DISASTER NEEDS ASSESSMENT OF FLOODS AND LANDSLIDES. Myanmar: Government of the Union of Myanmar.
11. Ingrid Nesheim, Bente M. Wathne, Bo Ni & Tun, Z. L. (2016). Myanmar:Pilot introducing the National Water Framework Directive. Available: http://www.niva.no/www/niva/resource.nsf/files/877433188-2016_nivas_myanmar-project_watersolutions_01_2016/$FILE/2016_nivas_myanmar-project_watersolutions_01_2016.pdf
12. UNDP. (2018). *Clean Water and Sanitation* [Online]. Myanmar: UNDP. Available: http://www.mm.undp.org/content/myanmar/en/home/sustainable-development-goals/goal-6-clean-water-and-sanitation.html [Accessed 3 January 2018].
13. United Nations for Disaster Risk Reduction (2017). *Build Back Better,* Geneva, Switzerland.
14. the Union of the Assembly(Pyidaungsu Hluttaw) (2013). Natural Disaster Management Law. *Law No. 21,2013)* Myanmar: The President of the Republic of the Union of Myanmar.
15. The Union of the Assembly(Pyidaungsu Hluttaw) (2013). Environmental Conservation Law. *No. 9 / 2012* Myanmar: President of the Union.
16. Union Minister of Construction (2016). National Habitat Report. *The United Nations Conference on Housing and Sustainable Urban Development.* Quito, Ecuador: Ministry of Construction, Myanmar.
17. Asian Development Bank. (2013). *Myanmar Urban Development and Water Sector Assessment, Strategy, and Road Map* [Online]. Available: http://themimu.info/sites/themimu.info/files/documents/Report_Urban_Water_Sector_Assessment_ADB_2013.pdf.
18. U Khant Zaw (2016). Myanmar: National Strategyfor Rural WASH and WASH in Schools and Health Facilities. *In:* DEPARTMENT OF RURAL DEVELOPMENT, M. O. A.,

LIVESTOCK AND IRRIGATION (ed.). Myanmar: Government of the Republic of the Union of Myanmar,.

19. ADB (2016). Myanmar energy sector, Assessment, Strategy and Road Map

Philippines: Asian Development Bank.

20. Kee-Yung Nam, Maria Rowena Cham & Halili, P. R. (2015). Developing Myanmar's Information and Communication Technology Sector Towards Inclusive Growth

Metro Manila, Philippines Asian Development Bank.

21. Assessment on the National Water Policy of Myanmar Assessment on the National Water Policy of Myanmar. Myanmar.

22. Yoshiaki Kobayashi & Porter, J. W. (2012). Flood Risk Management in the People's Republic of China: Learning to Live with Flood Risk. Philippines and the People's Republic of China. : Asian Development Bank.

23. UNISDR (2004). National Report on Disaster Reduction in Vietnam. *World Conference on Disaster Reduction.* Kobe-Hyogo, Japan: SOCIALIST REPUBLIC OF VIETNAM

24. Global Facility For Disaster Reduction and Recovery (GFDRR). *Coastal Flood in Myanmar* [Online]. Global Facility For Disasster Reduction and Recovery Available: http://thinkhazard.org/en/report/171-myanmar/CF [Accessed 17 January 2018.

25. SANJEEV, B. TELECOM REGULATORY AUTHORITY OF INDIA. Available: https://www.itu.int/dms_pub/itu-d/oth/07/07/D07070000040001PDFE.pdf [Accessed 3 January 2018].

26. Water, U. *Integrated Water Resource Management* [Online]. United Nations Department of Economic and Social Affairs. Available: http://www.un.org/waterforlifedecade/iwrm.shtml [Accessed 18 January 2018.

27. Amanda M. Burden, Richard Barth & Hornick, S. (2008). World Cities Best Practices Innovations in Transportation. New York City.