Using Climate and Disaster Risk Information for Designing Pro-poor Community Infrastructure

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What are some examples of community infrastructure that are usually affected by climate-related natural phenomena?

Scroll down and click on the Mentimeter link to type and submit your answer.

Mentimeter

COMMUNITY INFRASTRUCTURE

Small-scale basic structures, technical facilities and systems built at the community level that are critical for sustenance of lives and livelihoods of the population living in a community

Global Facility for Disaster Reduction and Recovery (GFDRR), Post Disaster Needs Assessment Guidelines Volume B: Community Infrastructure
https://www.gfdrr.org/sites/default/files/publication/pdna-guidelines-vol-b-community-infrastructure.pdf

- Community access roads
- Minor structures
- Socio-economic infrastructure
- Community-based water supply and sanitation
- Communication and early warning systems
- Community-based non-conventional energy plants
- Community-managed small and micro enterprises

Strengthening the climate change and disaster resilience of pro-poor programs

Will require a combination of social-technical interventions that collectively promote coping, incremental, and transformational strategies.

- The development of policy interventions needs to be supported by an effective enabling environment covering three key areas: governance, data, and finance.
- Infrastructure need to be designed for a level of robustness and adaptability for future social-demographic and climate scenarios that collectively promote coping, incremental, and transformational strategies.

The Urban Poor and Elements of Risk

Vulnerability

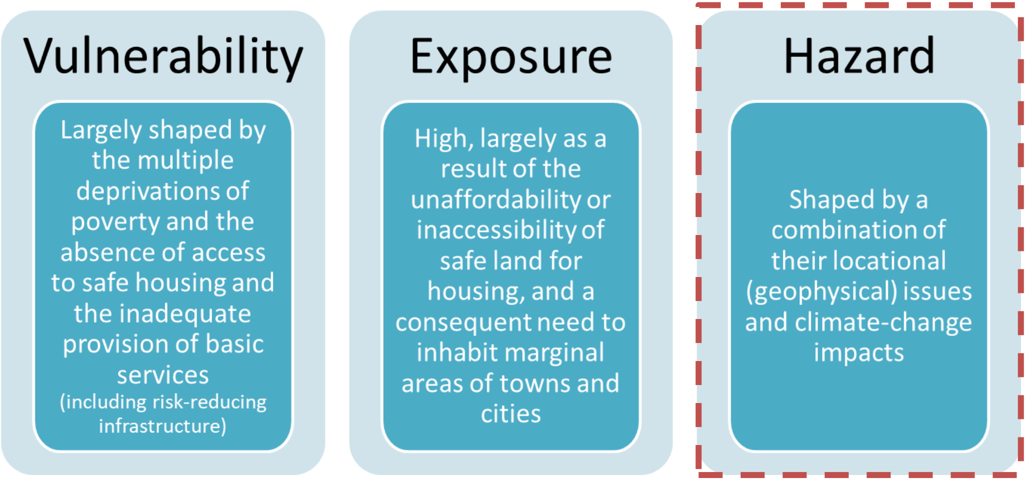
Largely shaped by the multiple deprivations of poverty and the absence of access to safe housing and the inadequate provision of basic services
(including risk-reducing infrastructure)

Exposure

High, largely as a result of the unaffordability or inaccessibility of safe land for housing, and a consequent need to inhabit marginal areas of towns and cities

Hazard

Shaped by a combination of their locational (geophysical) issues and climate-change impacts



Climate and disaster risk information on Hazards

PART 1

Climate & Disaster Risk Information on Hazards

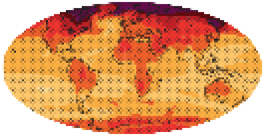
The Asia and Pacific region is vulnerable to extreme temperatures, flooding by heavy rainfall, sea level rise, coastal erosion, and damage by tropical cyclones.

Climate change has varying degrees of influence on the severity of such disasters.

- The location of the infrastructure is a key determinant of their exposure profile.
- Key climate change drivers associated with sea-level rises, changing rainfall patterns and magnitudes, rising temperature, and changing global meteorological patterns affecting wind and storm surges will expose community infrastructure to greater operational vulnerability.

The focus of this presentation is on the *planning and design of community infrastructure* and the use of climate change and disaster risk information on hazards in ensuring their resilience.

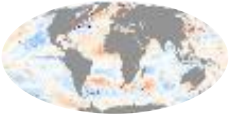
Climate influence on the natural physical environment and consequential disaster impact



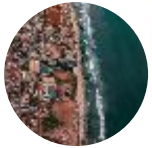
Increased Global Temperature

Melting of polar caps and sea ice

Increased sea surface temperature



Sea-level rise



Heat-waves

TABLE 8. Estimates of global mean sea-level rise by rate and total rise compared to 1986–2005 including likely range shown in brackets, data from Chapter 13 of the IPCC's Fifth Assessment Report with upper-end estimates based on higher levels of Antarctic ice-sheet loss from Le Bars et al. 2017.[58]

Scenario	Rate of Global Mean Sea-Level Rise in 2100	Global Mean Sea-Level Rise in 2100 Compared to 1986–2005
RCP2.6	4.4 mm/yr (2.0–6.8)	0.44 m (0.28–0.61)
RCP4.5	6.1 mm/yr (3.5–8.8)	0.53 m (0.36–0.71)
RCP6.0	7.4 mm/yr (4.7–10.3)	0.55 m (0.38–0.73)
RCP8.5	11.2 mm/yr (7.5–15.7)	0.74 m (0.52–0.98)
Estimate inclusive of high-end Antarctic ice-sheet loss		1.84m (0.98–2.47)

FIGURE 9. Boxplots showing historical (1986–2005) and projected (2080–2099) annual number of days with Heat Index > 35°C under four emissions pathways.[33] **Indonesia**

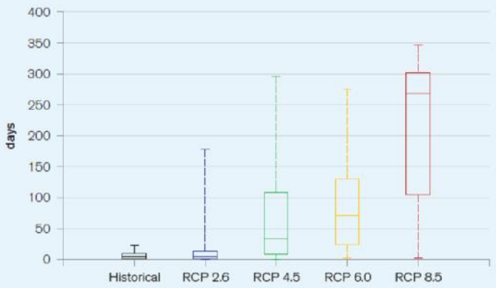
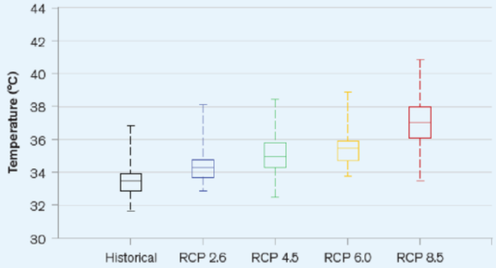
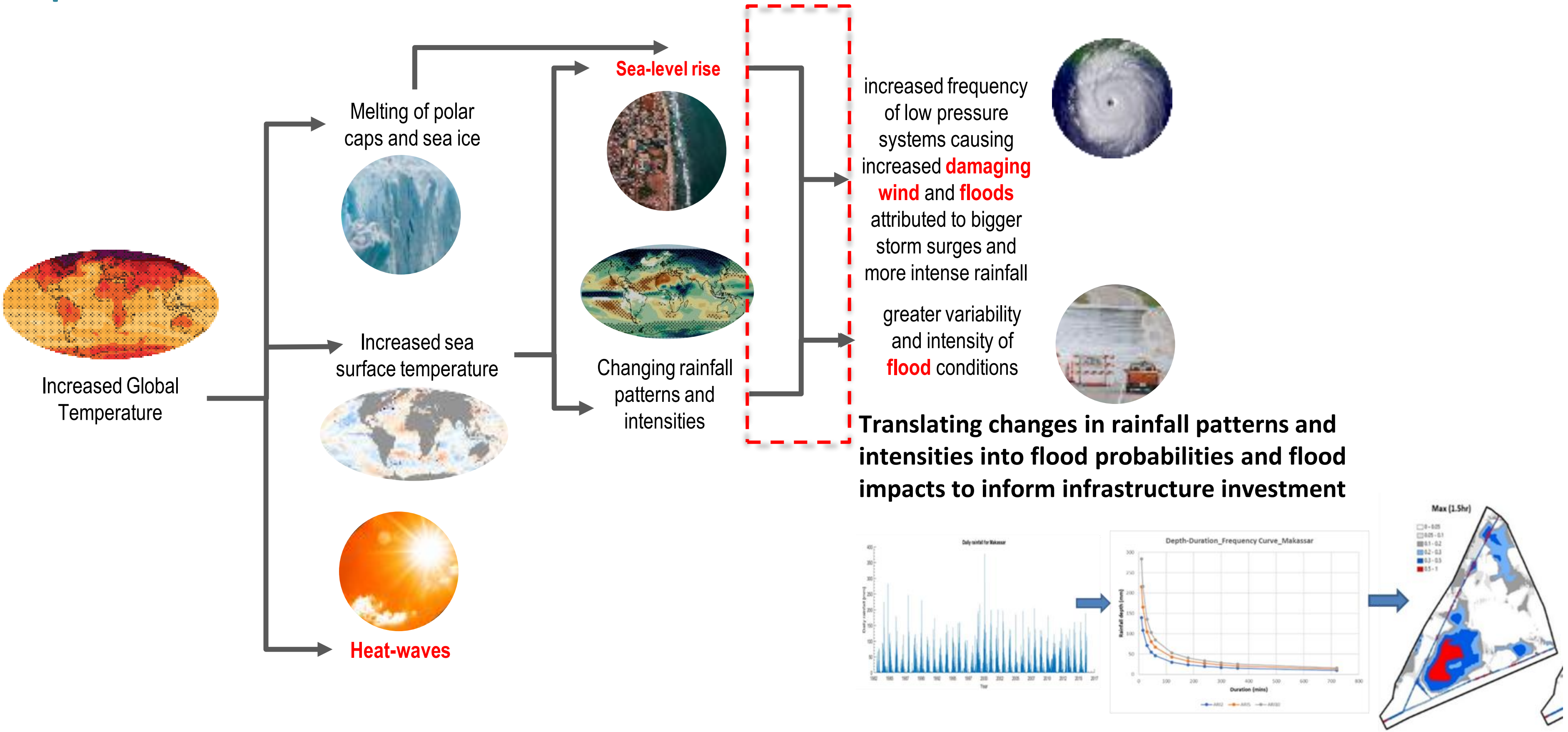


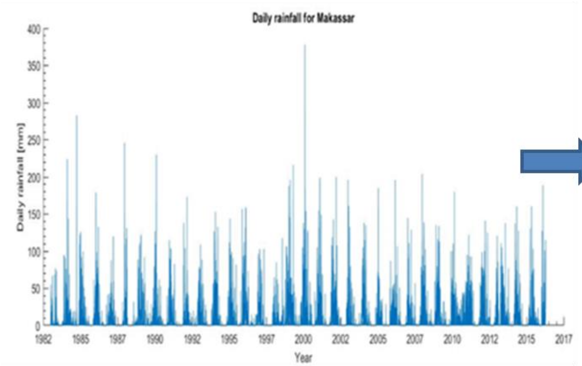
FIGURE 9. Historical (1986–2005) and projected (2080–2099) annual maximum of daily maximum temperatures under four emissions pathways in the **Philippines**.[28]

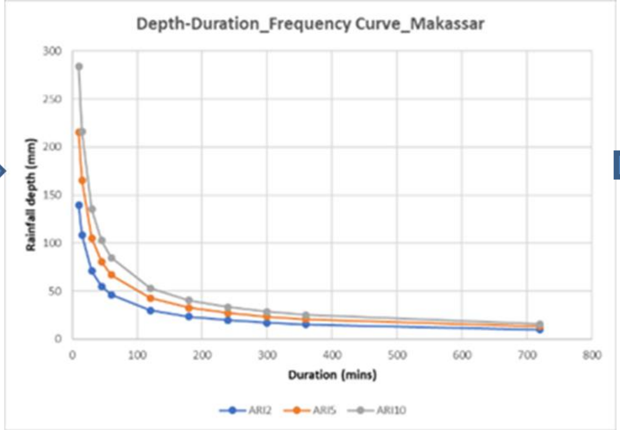


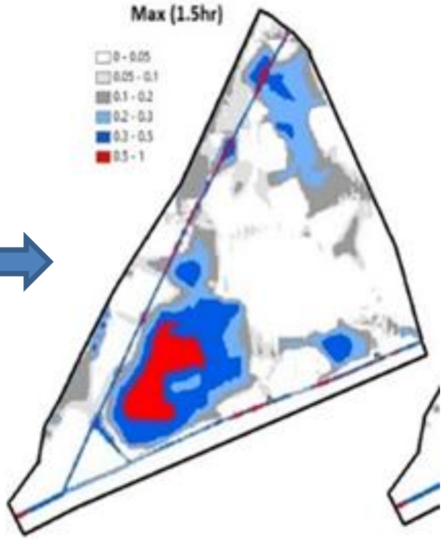
Climate influence on the natural physical environment and consequential disaster impact



Translating rainfall to flood depths and extent

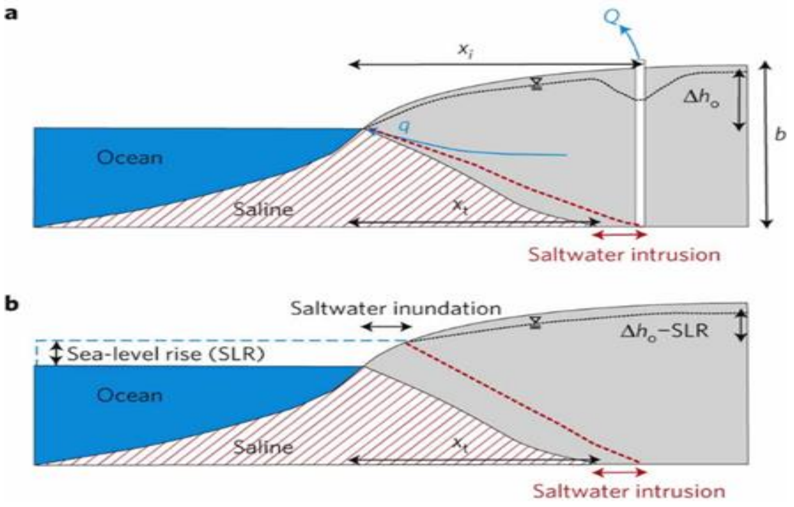




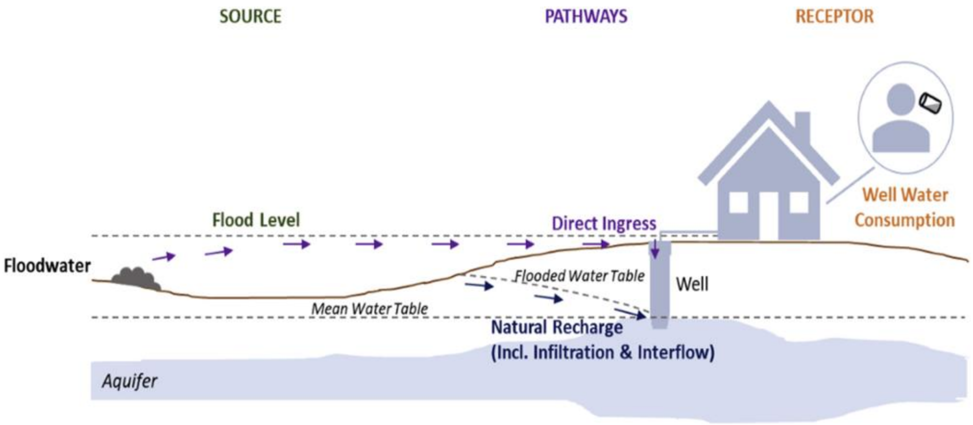


Local knowledge of past flood conditions (flood levels, video recording of floods, dominant flood flow paths etc.) are invaluable and help inform the calibration or validation of the approach adopted.

Sea level rise and floods contamination of water supply

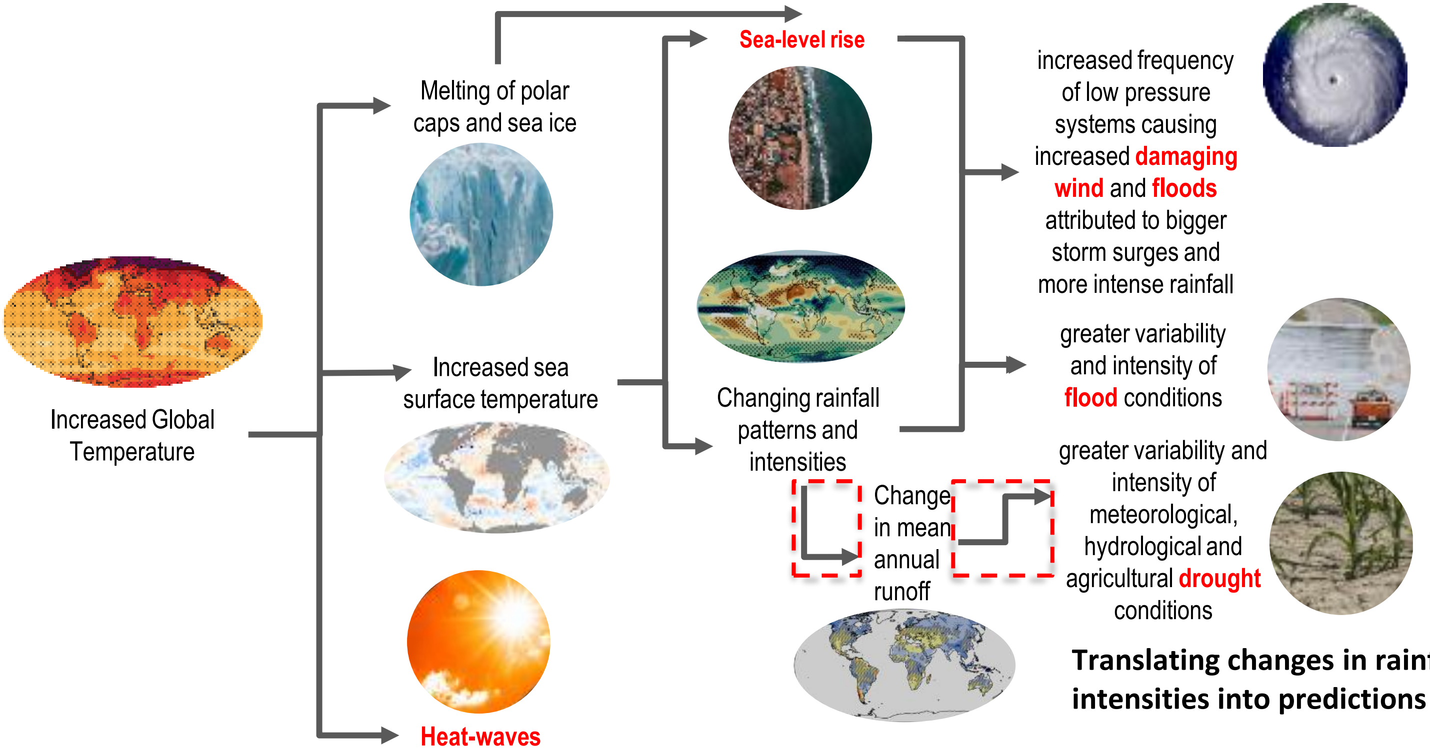


Coastal aquifers are affected both by groundwater extraction and sea-level rise. a,b, Conceptual model used for simulating the impact of groundwater extraction (a) and sea-level rise (b) including both saltwater intrusion and saltwater inundation. https://doi.org/10.1038/nclimate1413



Contamination of surface wells may be by floodwater overflow the walls of the well or by sub-surface migration of contaminants. Surface contamination may also occur when well are in close proximity to sewage systems such as drop-toilets or leaky septic tanks. https://doi.org/10.1016/j.envpol.2018.01.104

Climate influence on the natural physical environment and consequential disaster impact



Translating changes in rainfall patterns and intensities into predictions of droughts

Climate influence on the natural physical environment and consequential disaster

FIGURE 10. Annual probability of experiencing a 'severe drought' in Indonesia (–2 SPEI index) in 2080–2099 under four emissions pathways.[33]

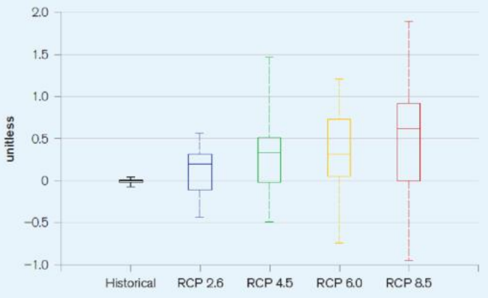
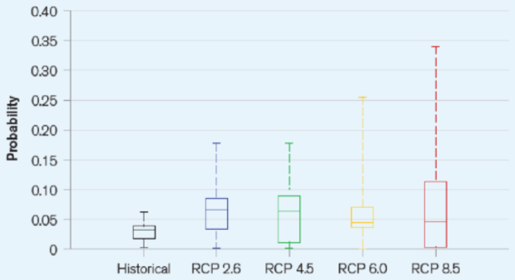


FIGURE 10. Boxplots showing the annual probability of experiencing a 'severe drought' in the Philippines (–2 SPEI index) in 2080–2099 under four emissions pathways.[28]



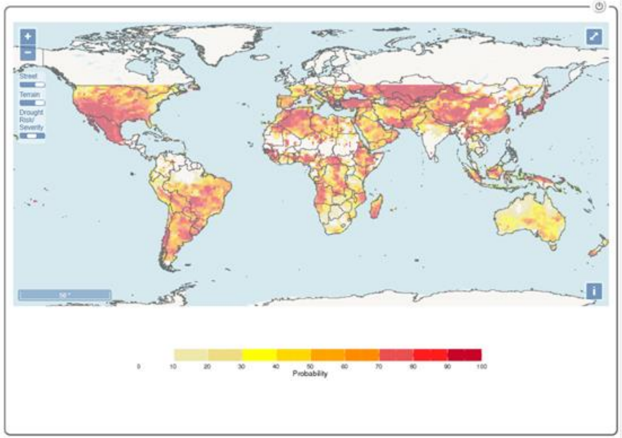
Global Forecast Drought Tool

This tool displays maps of meteorological drought risk using the standardized precipitation index SPI. It allows the user to choose between maps of either the predicted drought severity for a user-specified likelihood or the risk of a certain magnitude of drought level happening.

The timescale presented here for demonstration is the 6-month Standardized Precipitation Index (SPI6). The SPI6 drought forecast combines the prior 3 months of observed precipitation and forecasted upcoming 3 months of seasonal rainfall. The menu *Map Type* presents two options of display: Drought Severity or Drought Risk.

- For example, the *Forecasted Drought Severity SPI6* for a six-month period ending in March is based on the observations of rainfall during the months of October to December and on the forecast rainfall totals made at the end of December, for the period of January to March. For this type of map, the user can choose a *Probability of Drier Conditions* (for example: 90%) and the map will represent the SPI6 value forecast. It is 90% likely that the SPI6 observed over that 6-month period will be drier than the value presented in the map. This information can help decision-makers by providing them the probability of rainfall deficit or surplus. It also can be used in conjunction with recent drought observations (**Standardized Precipitation Index for multiple monthly accumulation periods**) to indicate whether drought conditions are likely to develop, worsen or improve. This can be valuable information particularly for agricultural and water resources planning.
- The *Drought Risk* map shows the probabilities that the forecast SPI6 value will be equal to or lower than a user-selected drought severity level. Probabilities are displayed on a scale between 0% and 100%. The user can select a value of *Drought Severity Levels* in the dropdown menu. This level of drought corresponds to a SPI Threshold as described in the table below. The map will display the likelihood of a drought as severe or worse than the level selected, according to the SPI threshold chosen.

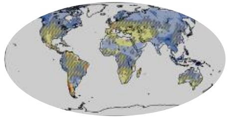
SPI6 Value	Drought Severity	Frequency
2.0	Severe Wetness	1 in 43-year event
1.5	Intermediate Wetness	1 in 23-year event
1.0	Moderate Wetness	1 in 11-year event
0.0	Normal	2 in 3-year event
-1.0	Moderate Dryness	1 in 11-year event
-1.5	Intermediate Dryness	1 in 23-year event
-2.0	Severe Dryness	1 in 43-year event



intensities

Change in mean annual runoff

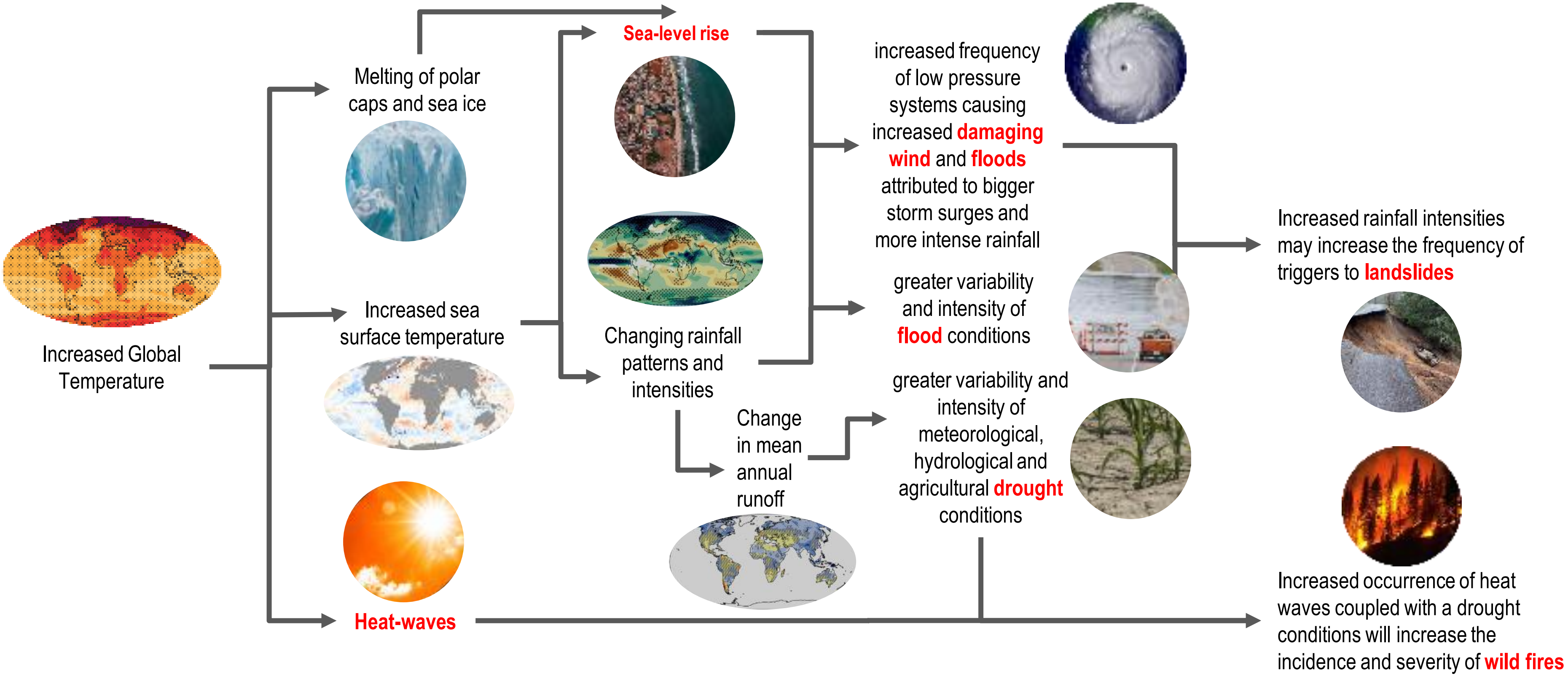
greater variability and intensity of meteorological, hydrological and agricultural **drought** conditions



Translating changes in rainfall patterns and intensities into predictions of droughts

- Meteorological droughts
- Hydrological droughts
- Agricultural droughts

Climate influence on the natural physical environment and consequential disaster impact



Pop Quiz

questions about specific types of community infrastructure and what climate and disaster risk information on hazards that should be collected to guide their design to ensure infrastructure resilience.

END OF PART 1

Table 2 Influence of climate-sensitive hazards on the serviceability of some selected community infrastructure

Typical Community Infrastructure	Climate-sensitive hazards						
	Sea level rise	Storm Surges	Floods	Droughts	Heat waves	Damaging Wind	Wild fires
Community access road							
Flood walls and levees							
Marketplace[1]							
Community school[1]							
Dwelling cyclone proofing[2]							
Community telephone[1]							
Groundwater abstraction							
Community-based sewerage system							
Non-conventional energy production[1]							

[1]Energy production facilities and communal social infrastructure such as marketplace, schools and health centres or similar should ideally be located away from impact of sea-level rises and storm surges as much as possible in reducing "exposure"or have hazard mitigating community infrastructure mitigating its vulnerability to hazards.

[2]While this relates to community housing, community infrastructure has a significant influence on the flood proofing of this structure

Table 2 Influence of climate-sensitive hazards on the serviceability of some selected community infrastructure

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	Sea level rise	Storm Surges	Floods	Droughts	Heat waves	Damaging Wind	Wild fires
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Marketplace[1]			✓	✓	✓	✓	✓
Community school[1]			✓	✓	✓	✓	✓
Dwelling cyclone proofing[2]						✓	✓
Community telephone[1]			✓			✓	✓
Groundwater abstraction	✓	✓	✓	✓			
Community-based sewerage system	✓	✓	✓	✓			
Non-conventional energy production[1]			✓			✓	✓

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Using climate and disaster risk information in planning and assessing hazard resilience of community infrastructure

PART 2

Framework for Scenario-based Resilience Planning and Assessment of Community Infrastructure

Vulnerability

Related to the quality of construction and designed structural integrity of the community infrastructure

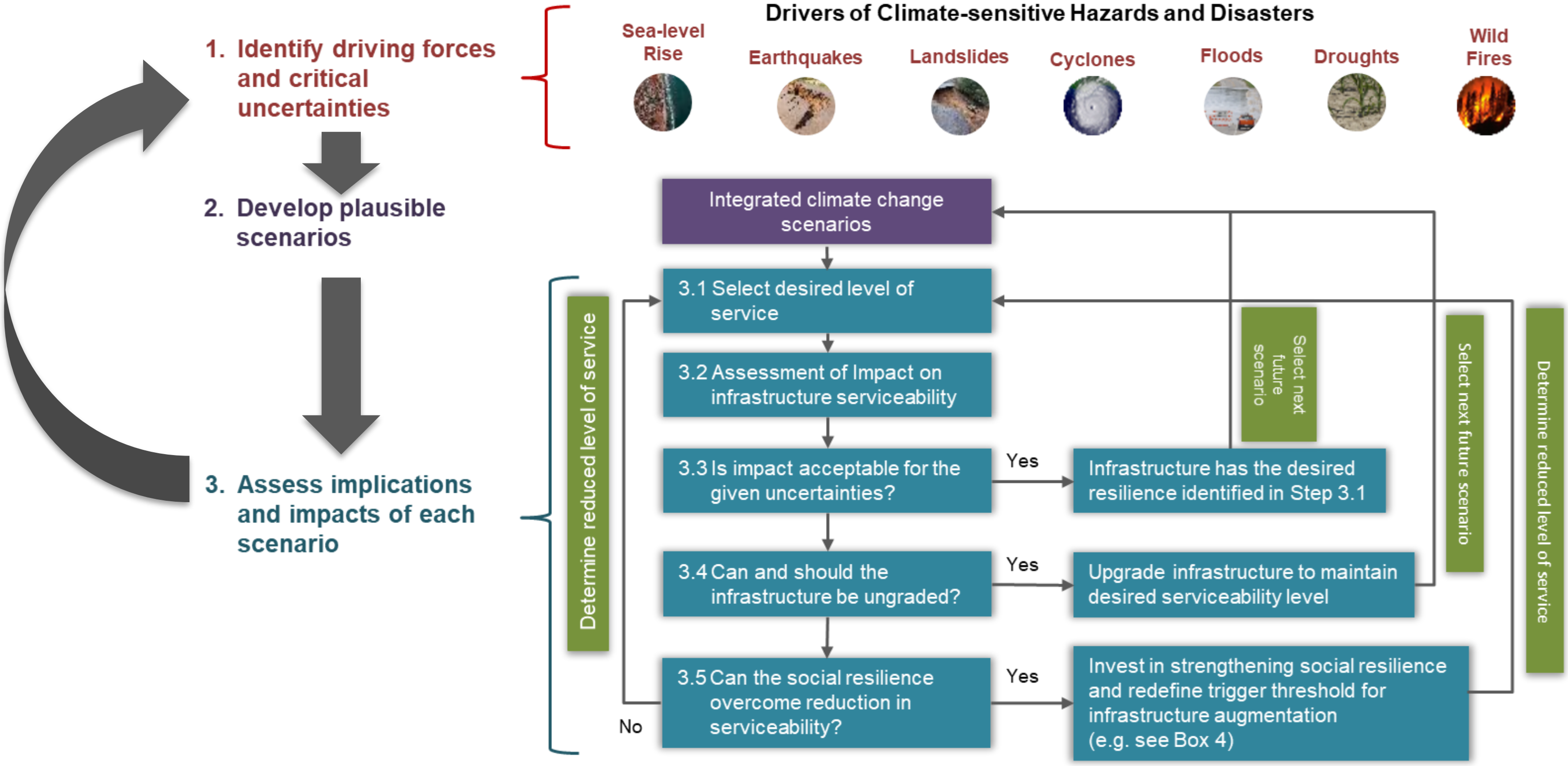
Exposure

Related to the location and design standard and serviceability of the community infrastructure

Hazard

Shaped by a combination of locational (geophysical) issues and climate-change impacts

Framework for Scenario-based Resilience Planning and Assessment of Community Infrastructure

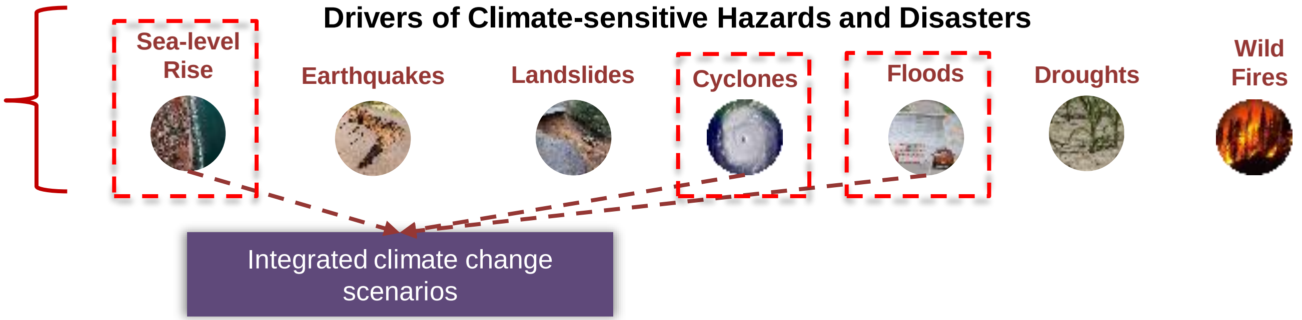


Worked Example #1

The informal settlement at Batua, City of Makassar in South Sulawesi is frequently subjected to flooding causing extreme difficulties in inhabitants accessing their respective dwellings.

As part of a revitalization program to provide essential safe sanitation services to the community, a composite flood-safe accessway and constructed septic tank and wetland for sewage treatment was constructed.

1. **Identify driving forces and critical uncertainties**



2. **Develop plausible scenarios**

Table 2 Influence of climate-sensitive hazards on the serviceability of some selected community infrastructure

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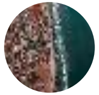

Sea-level rise

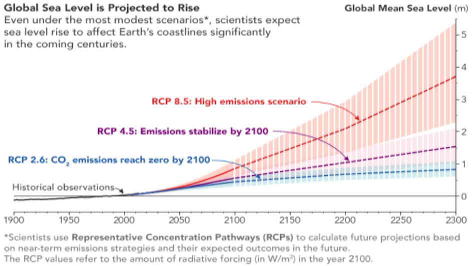

TABLE 8. Estimates of global mean sea-level rise by rate and total rise compared to 1986-2005 including likely range shown in brackets, data from Chapter 13 of the IPCC's Fifth Assessment Report with upper-end estimates based on higher levels of Antarctic ice-sheet loss from Le Bars et al. 2017.[58]

Scenario	Rate of Global Mean Sea-Level Rise in 2100	Global Mean Sea-Level Rise in 2100 Compared to 1986–2005
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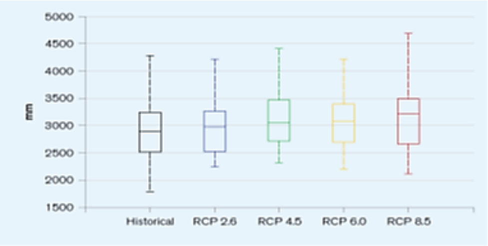
Estimate inclusive of high-end Antarctic ice-sheet loss		1.84m (0.98–2.47)

Floods



Median annual precipitation is projected to increase by 7% under RCP6.0 pathway and 11% under RCP8.5 pathway, from the historical baseline median of 2,884 mm.

The intensity of sub-daily extreme rainfall events appears to be increasing with temperature

Climate change could amplify coastal flood risk by 19–37% by 2030

Cyclones

Modelling of climate change impacts on cyclone intensity and frequency conducted across the globe point to a general trend of reduced cyclone frequency, but increased intensity and frequency of the most extreme events.

1. Identify driving forces and critical uncertainties

Drivers of Climate-sensitive Hazards and Disasters

Sea-level Rise | **Earthquakes** | **Landslides** | **Cyclones** | **Floods** | **Droughts** | **Wild Fires**

2. Develop plausible scenarios

Integrated climate change scenarios

3.1 Select desired level of service

Cost-effective provision of infrastructure to alleviate daily water-related stressors (i.e. water supply, sewerage services and environmental pollution) may only require them to:

- operate effectively for the majority of time (e.g. 90% or 95% of the time); and
- have the robustness for the service may be disrupted during climate-related phenomena (e.g. floods) but returned to operation soon after a particular event.

The “level of service” for many community infrastructure are often set at a lower level compared to more mainstream city infrastructure in order to facilitate cost-effective delivery of critical essential services for water security as a minimum service criterion

Example

Flood-safe accessway & roads in urban poor communities affected by pluvial flood scenarios (floods generated within the local catchment) may be designed for:

- a 1 in 3 month exceedance flood standard (i.e. a high likelihood for flood inundation of at least four times a year); and
- with serviceability (access by pedestrian and vehicle) maintained for flood events up to the 1 in 1 year exceedance event by limiting inundation to less than 200mm and water velocity less than 1 m/s.
- Infrastructure typically designed for a 1 in 3 month capacity will yield a serviceability of 95% to 99% of the time, provided good drainage is provided to enable flood water to recede rapidly following an event.

1. **Identify driving forces and critical uncertainties**

Drivers of Climate and Disasters Risks

(e.g. see Box 1)

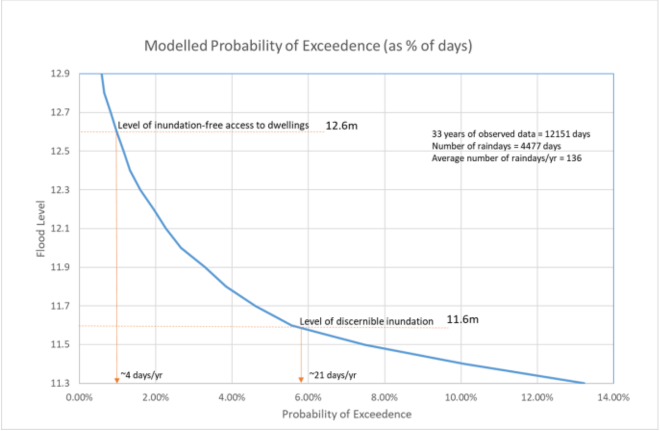
Sea-level Rise | Earthquakes | Landslides | Cyclones | Floods | Droughts | Wild Fires

2. **Develop plausible scenarios**

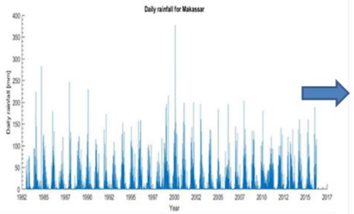
Integrated climate change scenarios

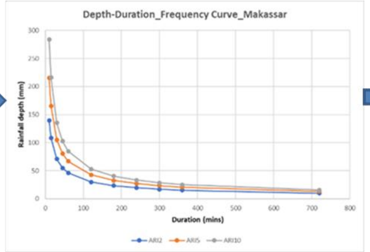
3.1 Select desired level of service

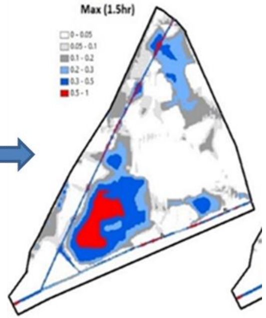
3.2 Assessment of Impact on infrastructure serviceability



3. **Assess implications and impacts of each scenario**

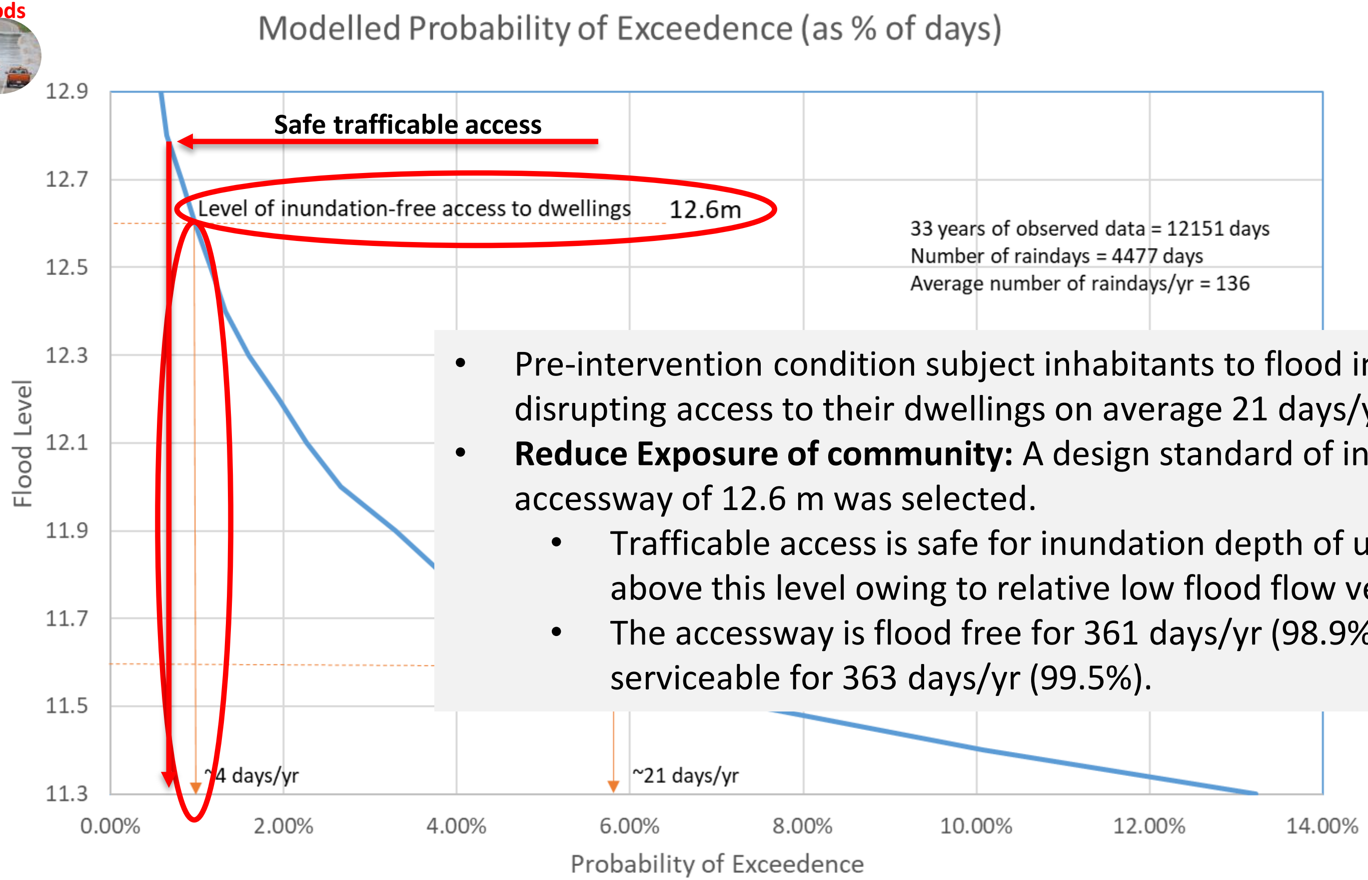






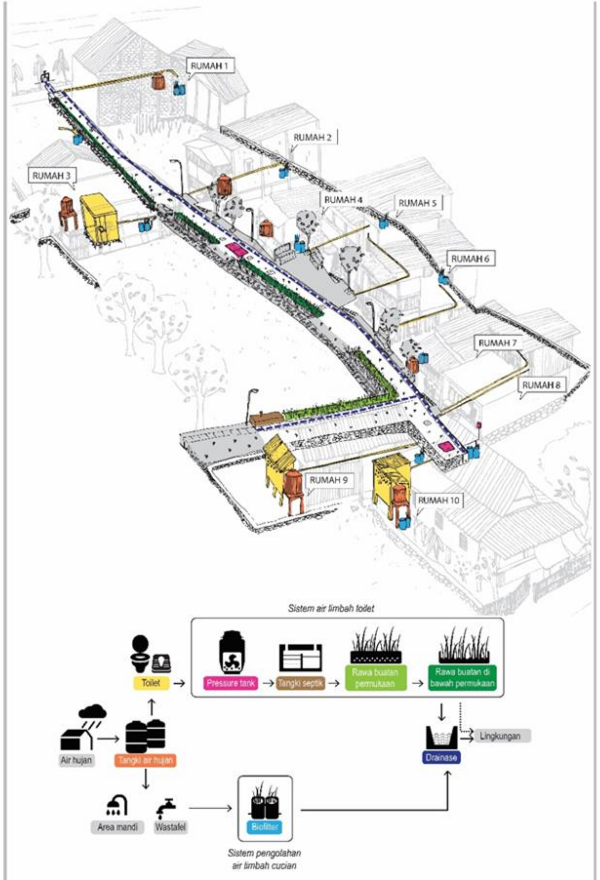
Pluvial flooding behaviour

floods



- Pre-intervention condition subject inhabitants to flood inundation disrupting access to their dwellings on average 21 days/yr.
- **Reduce Exposure of community:** A design standard of inundation-free accessway of 12.6 m was selected.
  - Trafficable access is safe for inundation depth of up to 0.2m above this level owing to relative low flood flow velocities.
  - The accessway is flood free for 361 days/yr (98.9%) and serviceable for 363 days/yr (99.5%).

Tahap 1 - Bagaimana Sistem bekerja?



02. Sistem Pengolahan Air Limbah

1. **Identify driving forces and critical uncertainties**

Drivers of Climate and Disasters Risks

(e.g. see Box 1)

Sea-level Rise | Earthquakes | Landslides | Cyclones | Floods | Droughts | Wild Fires

Integrated climate change scenarios

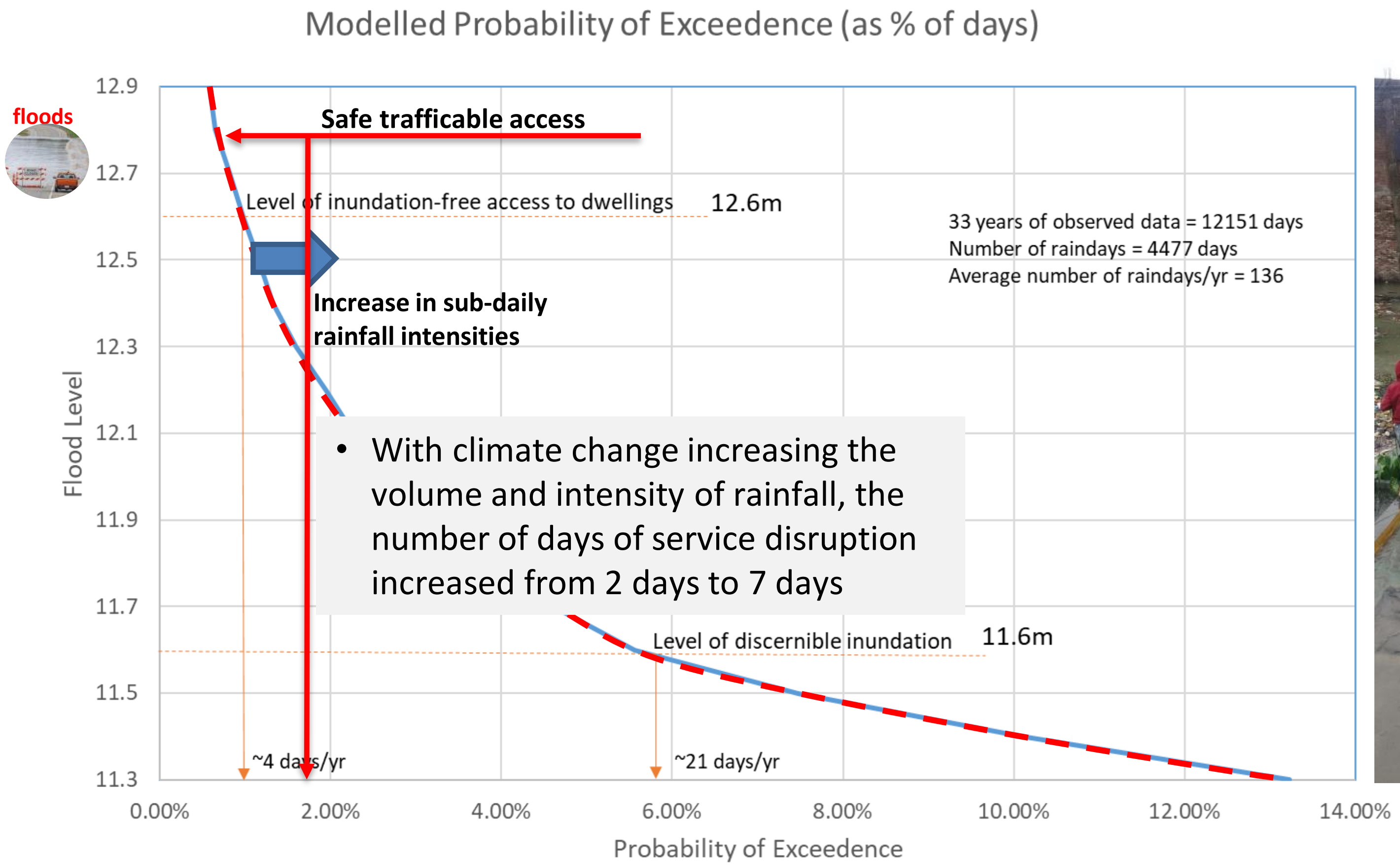
2. **Develop plausible scenarios**

3.1 Select desired level of service

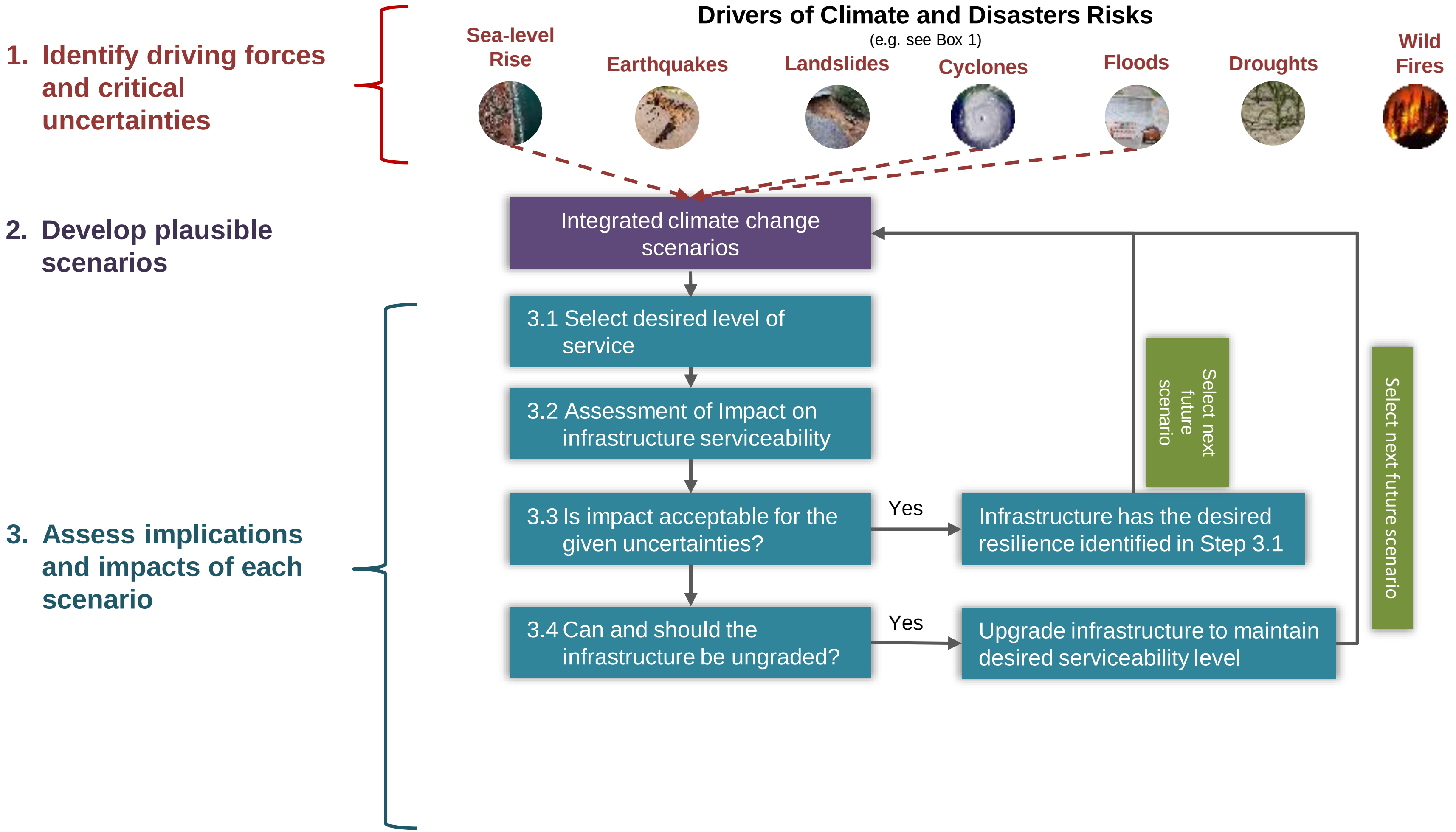
3.2 Assessment of Impact on infrastructure serviceability

3. **Assess implications and impacts of each scenario**

<u>Hypothetical</u>: Effect of changing rainfall patterns



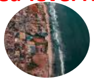
- With climate change increasing the volume and intensity of rainfall, the number of days of service disruption increased from 2 days to 7 days

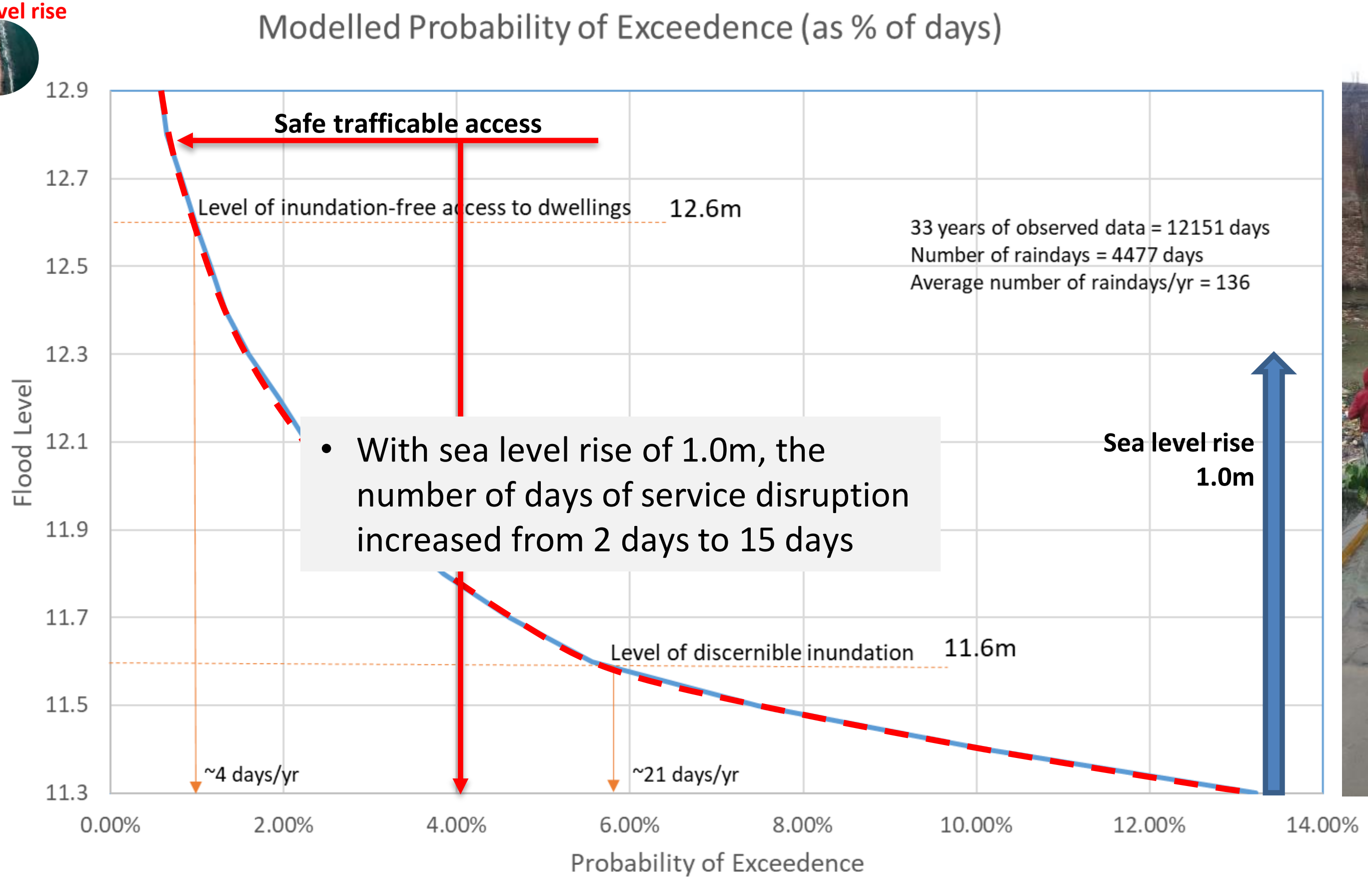


1. Identify driving forces and critical uncertainties
2. Develop plausible scenarios
3. Assess implications and impacts of each scenario
Drivers of Climate and Disasters Risks
(e.g. see Box 1)
Sea-level Rise
Earthquakes
Landslides
Cyclones
Floods
Droughts
Wild Fires
Integrated climate change scenarios
3.1 Select desired level of service
3.2 Assessment of Impact on infrastructure serviceability
3.3 Is impact acceptable for the given uncertainties?
Yes
Infrastructure has the desired resilience identified in Step 3.1
3.4 Can and should the infrastructure be ungraded?
Yes
Upgrade infrastructure to maintain desired serviceability level
Select next future scenario
Select next future scenario

Hypothetical: Effect of rising sea level (note: Batua is not affected by sea-level rise)

sea-level rise

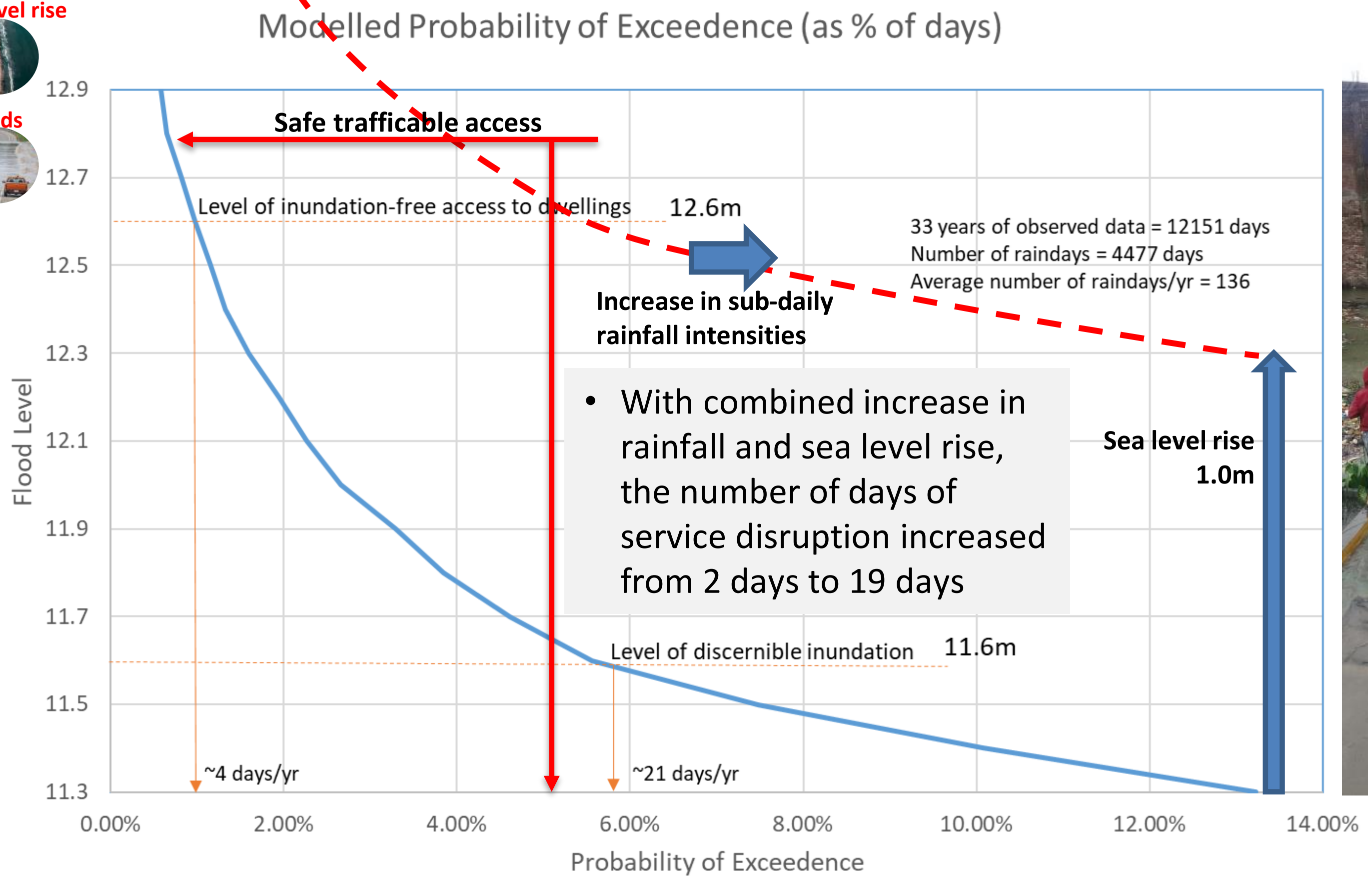




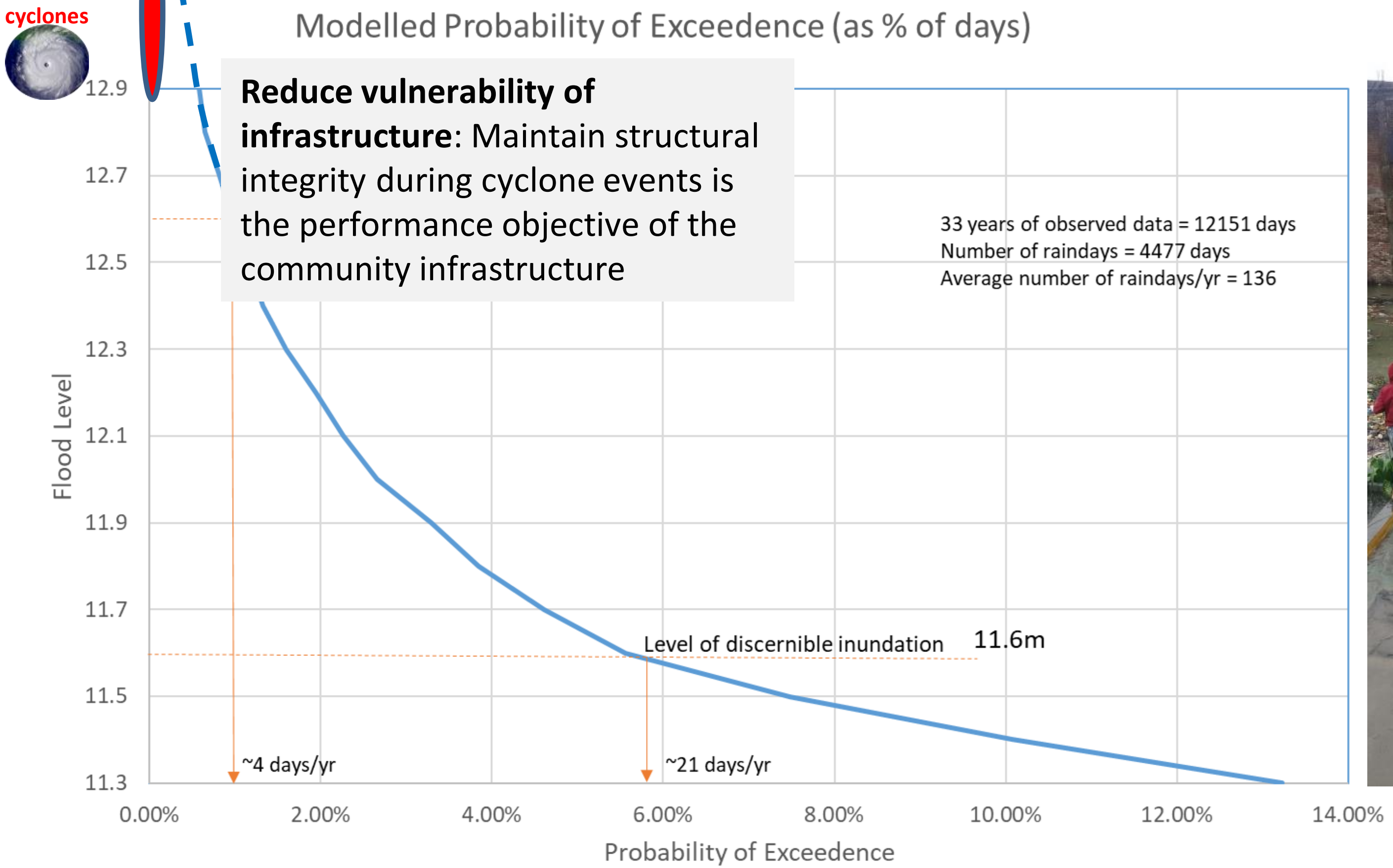
<u>Hypothetical:</u> Combining changing rainfall pattern and rising sea level (note: Batua is not affected by sea-level rise)

sea-level rise

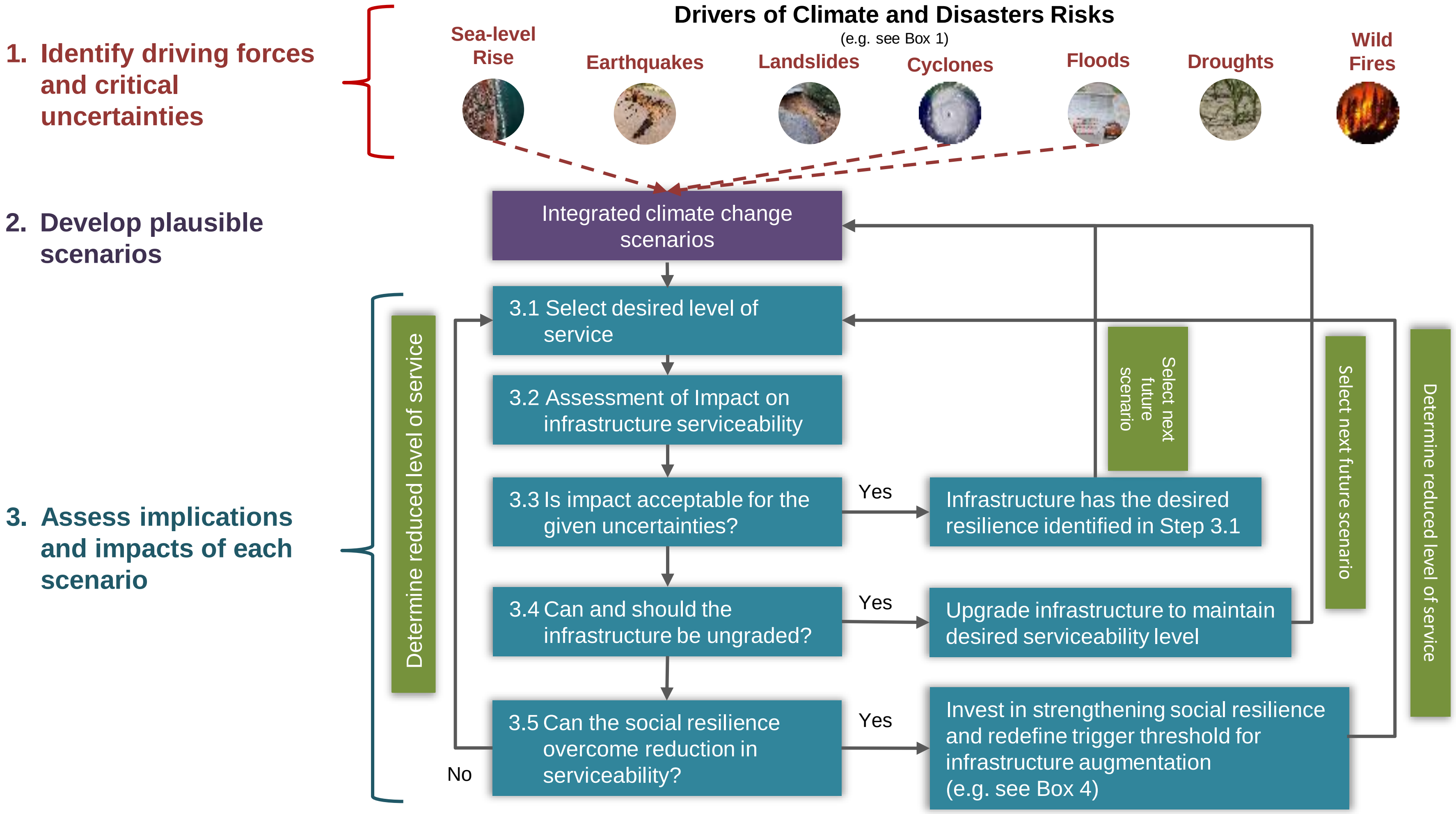
floods

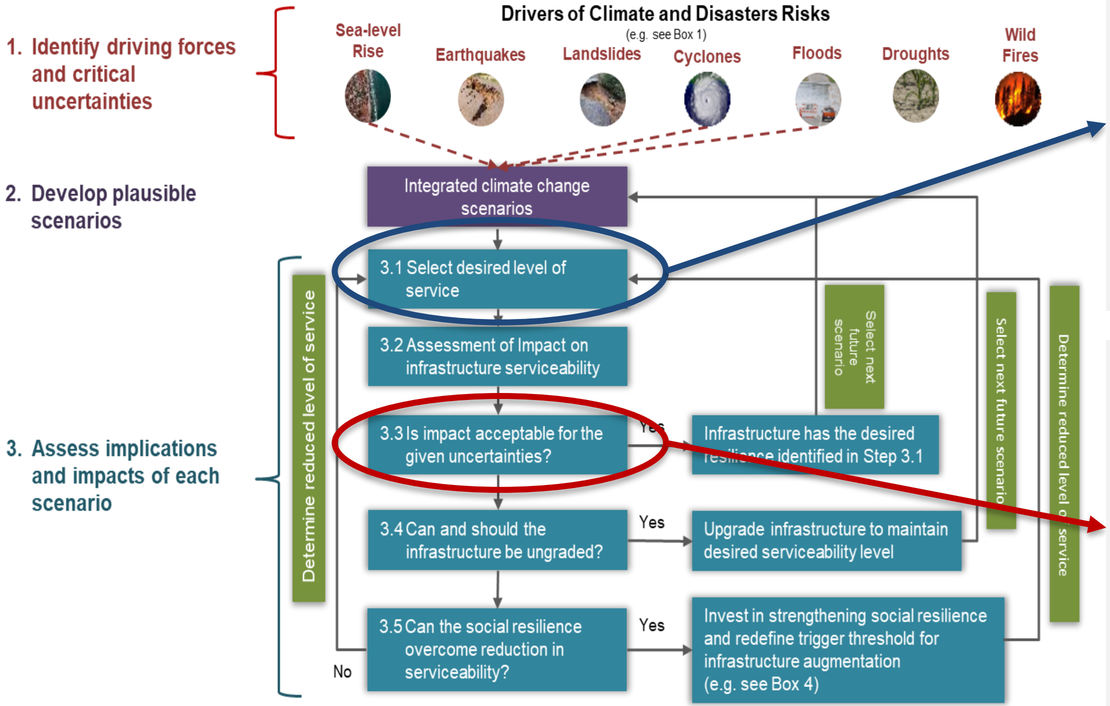


Hypothetical: Effect of cyclones (note: Batua is not affected by cyclones)



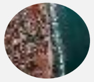
Reduce vulnerability of infrastructure: Maintain structural integrity during cyclone events is the performance objective of the community infrastructure


1. Identify driving forces and critical uncertainties
2. Develop plausible scenarios
3. Assess implications and impacts of each scenario
Drivers of Climate and Disasters Risks
(e.g. see Box 1)
Sea-level Rise
Earthquakes
Landslides
Cyclones
Floods
Droughts
Wild Fires
Integrated climate change scenarios
3.1 Select desired level of service
3.2 Assessment of Impact on infrastructure serviceability
3.3 Is impact acceptable for the given uncertainties?
3.4 Can and should the infrastructure be ungraded?
3.5 Can the social resilience overcome reduction in serviceability?
Yes
Infrastructure has the desired resilience identified in Step 3.1
Yes
Upgrade infrastructure to maintain desired serviceability level
Yes
Invest in strengthening social resilience and redefine trigger threshold for infrastructure augmentation
(e.g. see Box 4)
No
Determine reduced level of service
Select next future scenario
Select next future scenario
Determine reduced level of service

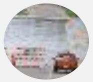


- Pre-intervention condition subject inhabitants to flood inundation disrupting access to their dwellings on average 21 days/yr.
- **Reduce Exposure of community**: A design standard of inundation-free accessway of 12.6 m was selected.
  - Trafficable access is safe for inundation depth of up to 0.2m above this level owing to relative low flood flow velocities.
  - The accessway is flood free for 361 days/yr (98.9%) and serviceable for 363 days/yr (99.5%).

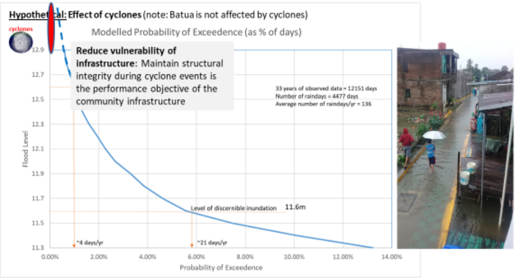
Sea-level rise

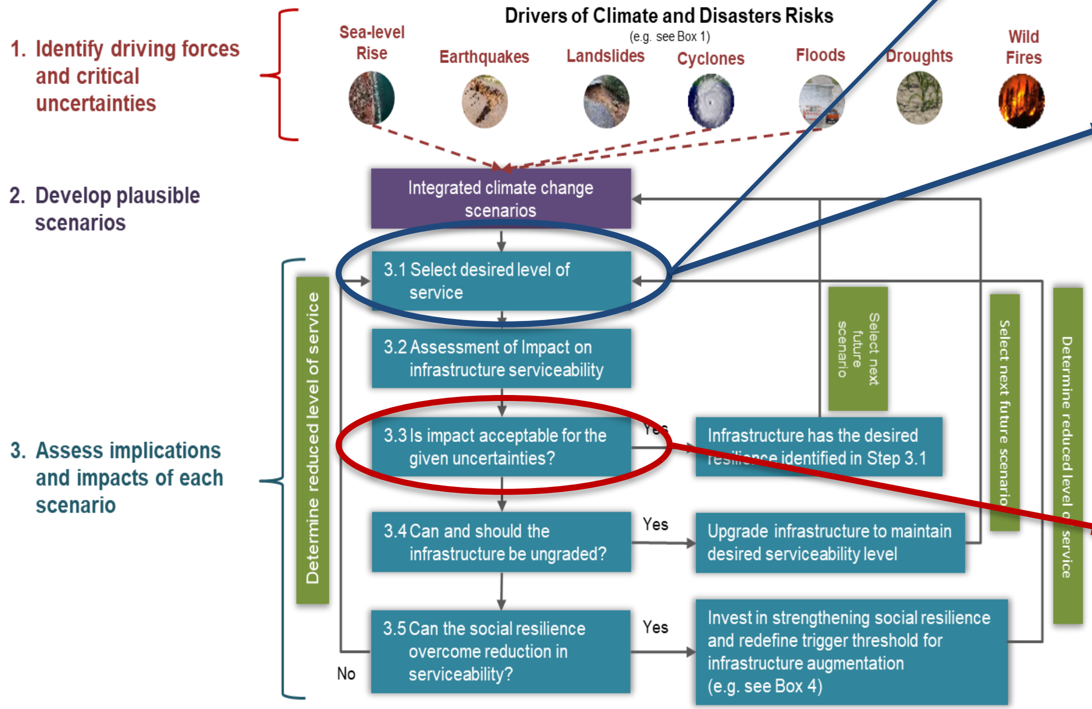


Flood



1. With climate change increasing the volume and intensity of rainfall, the number of days of service disruption increased from 2 days to 7 days
2. With sea level rise of 1.0m, the number of days of service disruption increased from 2 days to 15 days
3. With combined increase in rainfall and sea level rise, the number of days of service disruption increased from 2 days to 19 days



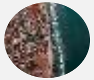


Cyclones

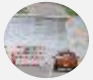
Level of service required: Maintain structural integrity during cyclone events is the performance objective of the community infrastructure

- Pre-intervention condition subject inhabitants to flood inundation disrupting access to their dwellings on average 21 days/yr.
- **Reduce Exposure of community**: A design standard of inundation-free accessway of 12.6 m was selected.
  - Trafficable access is safe for inundation depth of up to 0.2m above this level owing to relative low flood flow velocities.
  - The accessway is flood free for 361 days/yr (98.9%) and serviceable for 363 days/yr (99.5%).

Sea-level rise



Flood



1. With climate change increasing the volume and intensity of rainfall, the number of days of service disruption increased from 2 days to 7 days
2. With sea level rise of 0.6m, the number of days of service disruption increased from 2 days to 8 days
3. With combined increase in rainfall and sea level rise, the number of days of service disruption increased from 2 days to 12 days

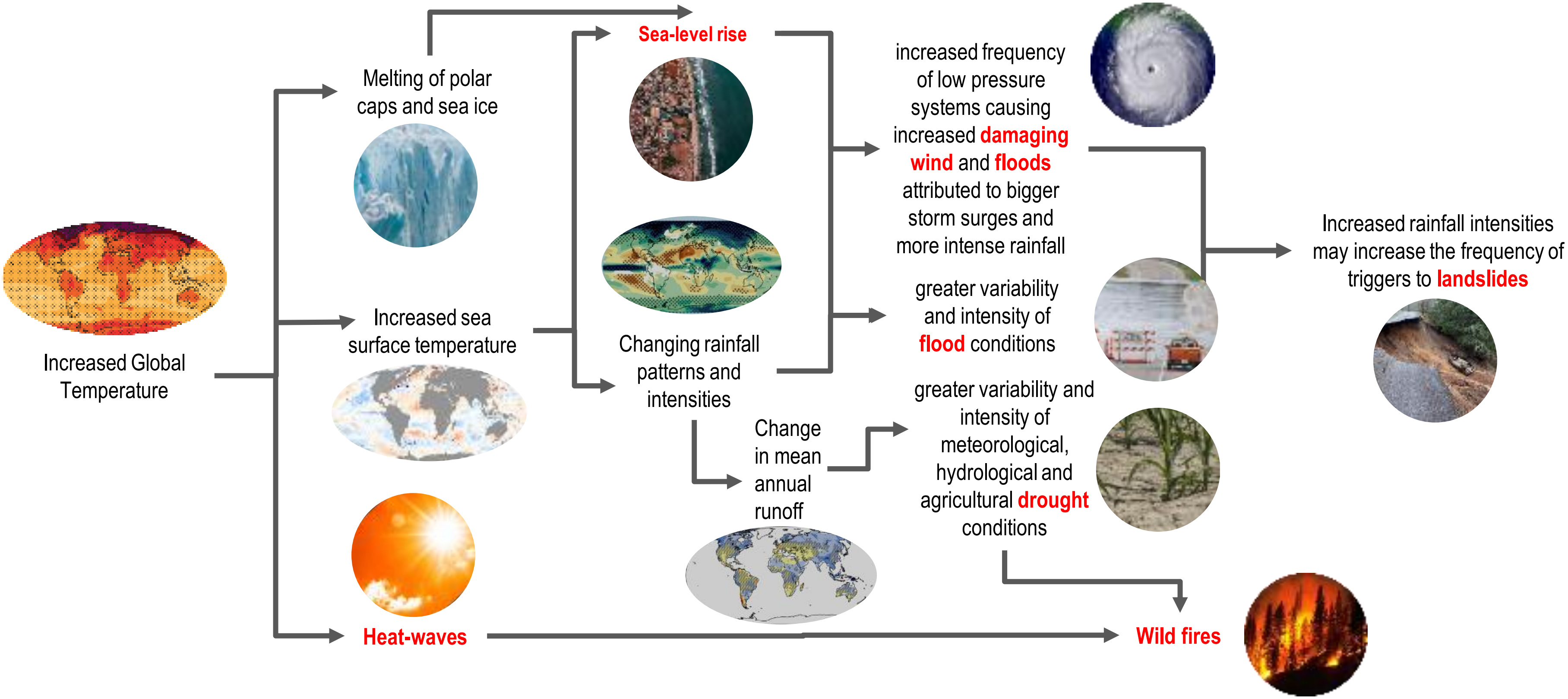
OPEN FORUM

If you were to design an urban pro-poor community infrastructure investment for a community school, what kind of information would you need to collect to guide your planning?

CLOSING ACTIVITY

Thank you

Climate influence on the natural physical environment and consequential disaster impact



ANNEX I: A GENERIC CLASSIFICATION (TYPOLOGY) OF COMMUNITY INFRASTRUCTURES THAT ARE INTIMATELY LINKED WITH COMMUNITY LIVELIHOOD OPTIONS

Generic Types	Description	Examples
Community access roads	These are internal roads, walkways, footpaths within the community providing access for the community people to national arterial or local road systems.	Village roads, earthen walkways in the community, house-to-house connection roads, etc.
Minor structures	These are small-scale and low-cost appurtenant structures built for various community purposes.	Drainage structures, pipe culverts, box culverts, footbridges, retaining walls, protection of slopes, jetties, small embankments or protection walls, small earthen dams, etc.
Socio-economic infrastructure	These are small-scale physical infrastructures in the community developed through local initiative for the community's socio-cultural and economic prosperity.	Small marketplaces and infrastructure within market grounds including pathways, sheds, drains, etc., community shops, community resource centers, religious centers, graveyards, playgrounds and so on
Community-based water supply and sanitation	These are minor infrastructures built in the communities in response to their needs on water supply and sanitation	Water reservoir and water sources, supply pipes, ponds and reservoirs, community water supply systems, pump houses and deep tube wells, drainage lines, waste disposal and composting plants, etc.
Communication and early warning systems	These are small ICT-based installations in the community catering to needs on information, communication and early warning messages.	Community telephone centers, community-based early warning systems, communication devices, etc.
Community-based non-conventional energy plants	These belong to decentralized household or community-based energy sources and renewable energy plants which cater to the energy needs of remote and isolated off-grid communities.	Biogas plants, bio-gassifiers, solar home systems for electrification, and similar community-driven low cost technical plants.
Community-managed small and micro-enterprises	These are household or community-run micro-enterprises and are subject to loss of stocks and equipment during disaster events. These micro-enterprises are likely to collapse in the local economic downturn following a disaster.	Handloom and cottage industries, potteries, fish processing plants, rice husking and agro-based plants, etc.

The GFDRR categorises the types of community infrastructure into the following six categories:

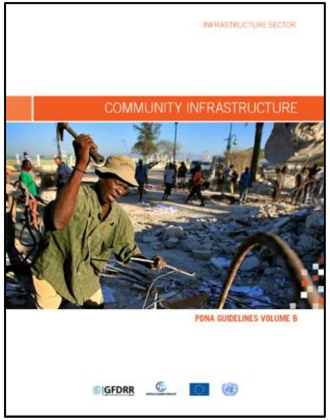
1. Connective infrastructure
2. Protective Infrastructures
3. Socio Economic Structures
4. Water and Sanitation Lifelines
5. Energy Lifelines
6. Communication Lifelines

Global Facility for Disaster Reduction and Recovery (GFDRR), Post Disaster Needs Assessment Guidelines Volume B: Community Infrastructure
https://www.gfdrr.org/sites/default/files/publication/pdna-guidelines-vol-b-community-infrastructure.pdf

ANNEX IV: DISASTER IMPACTS IN THE CI SECTOR

Disaster impacts vary across the types of community infrastructure based on their structural vulnerabilities and the hazard type. The generic level of impact by moderate to high intensity hazards on different types of CI are shown in the table below:

Type of Community Infrastructure	Flood	Cyclone	Tsunami	Earth-quake	Volcano	Landslide	Fire
	(H – high; M- Medium and L – Less)						
Community/Neighborhood Access Road							
Village roads	H	M	H	M	H	H	L
Neighborhood access roads	M	L	M	M	H	M	L
Footpath	M	L	M	M	H	M	L
Earthen Walkways/House	H	M	H	M	H	H	L
Road structure (Culvert/Foot Bridge etc)	M	L	M	L	H	M	L
Slope protection wall	H	M	H	L	H	M	L
Small Drainage and Water Structure							
Drains/Drainage pipes	H	M	H	H	H	H	L
Pipe culverts	M	M	M	L	M	M	L
Footbridge	M	M	H	L	M	M	L
Earthen dam	H	H	H	L	H	M	L
Water reservoir	M	M	M	L	M	M	L
Retaining wall	H	M	H	M	M	H	L
Small embankment	H	M	H	L	H	M	L
Deep tube well	M	L	M	M	M	L	L
Community latrines	H	M	H	M	M	M	M
Solid waste disposal system	H	H	H	M	H	M	M
Waste composting plant	H	H	H	M	H	M	H



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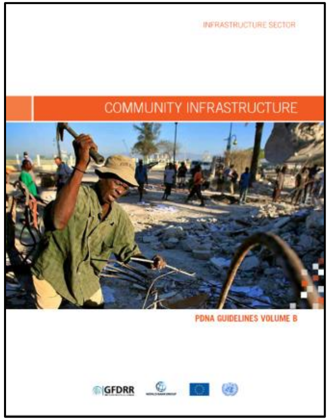
Type of Community Infrastructure	Flood	Cyclone	Tsunami	Earth-quake	Volcano	Landslide	Fire
			(H = high; M- Medium and L = Less)				
Socio-Economic Infrastructure							
Community resource centers Community clubs	M	M	H	H	M	M	H
Mosque/Church/Religious centers	H	M	H	H	M	M	H
Community clinics	H	H	H	H	M	M	H
Community schools	H	H	H	H	M	M	H
Community shops	H	H	H	H	H	H	H
Market grounds	H	M	M	M	H	H	L
Market sheds	M	H	H	H	H	H	H
Communication and Early Warning Systems							
Community telecenters/early warning center	M	H	H	H	H	H	H
Community mobile charging center	M	H	H	M	H	M	H
Community IT Training center	M	H	H	M	H	M	H
Community-Based Non-Conventional Energy Plant							
Biogas plants	H	M	H	H	H	M	H
Solar PV systems	M	H	H	M	M	M	L
Windmills	L	H	H	M	M	L	L



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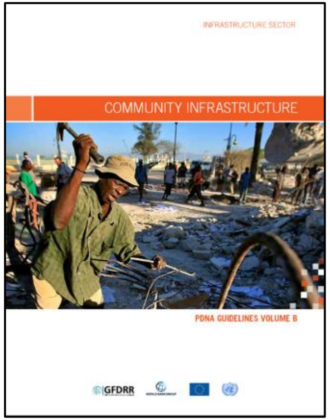
Type of Community Infrastructure	Flood	Cyclone	Tsunami	Earth-quake	Volcano	Landslide	Fire
	(H – high; M- Medium and L – Less)						
Community-Based Small and Micro-enterprise							
Handloom and cottage industry	H	H	H	M	H	H	H
Pottery	H	M	H	M	H	H	M
Fish processing plant	H	M	H	M	M	M	L
Rice husking plant	H	H	H	M	H	M	H
Agro-based plant	H	H	H	M	H	H	M



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