

Space-Aided Climate Change Adaptation



Adapting to **Water** and **Air** Realities on **Earth**

UNOOSA Scientific and Technical Subcommittee,
Vienna, 11-22 February 2019

Tom Meinert on behalf of team AWARE



Space Studies Program 2018



ISU Team Project

☉ Team Project AWARE:

- ✦ 33 participants
- ✦ 3 “I”s of ISU
- ✦ 36+ working sessions
- ✦ 4 visits, 1 workshop
- ✦ 2 sponsors

Netherlands
Space
Office

AIRBUS



✦ 34 external experts:

- | | | |
|----------------------------------|----------------|------------------------|
| ✦ UNOOSA/UNSPIDER | ✦ KNMI | ✦ TNO |
| ✦ ESA Climate Change Office (UK) | ✦ MIT MediaLab | ✦ TU Delft |
| ✦ ESTEC | ✦ SRON | ✦ University of Leiden |
| ✦ Airbus | ✦ S&T | ✦ ... |
| ✦ Deltares | ✦ Tauw | |

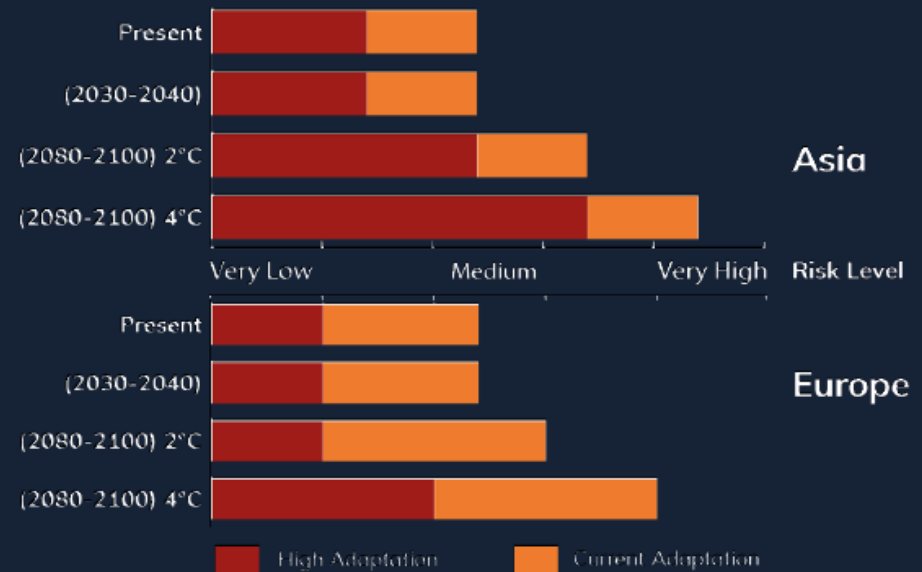


Monitoring

Understanding:

★ Monitoring & Modelling

Risk Level of Increased Flood Damage



Adapted from IPCC



Monitoring → Mitigation

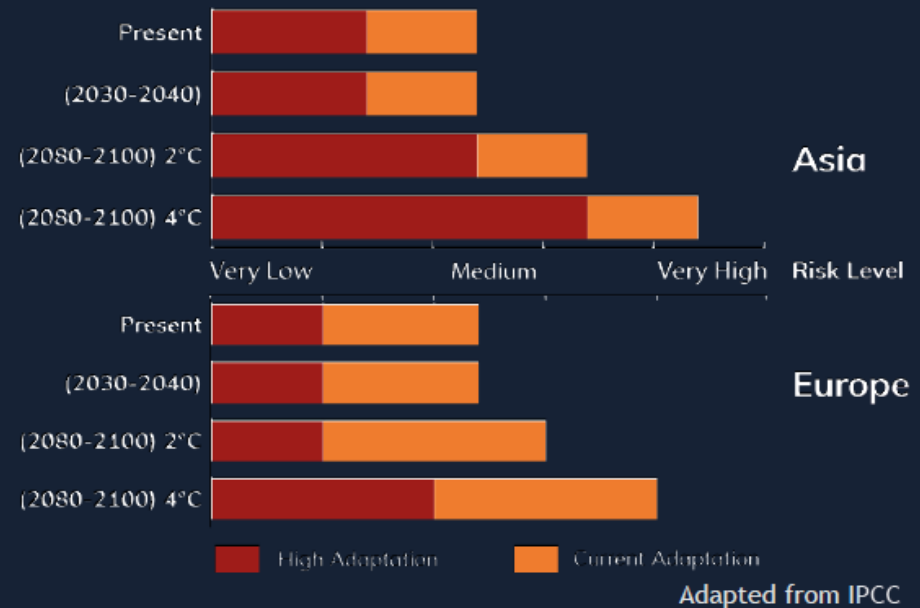
Understanding:

★ Monitoring & Modelling

Action:

★ Mitigation:
avoiding the
unmanageable

Risk Level of Increased Flood Damage





Monitoring → Mitigation → Adaptation

Understanding:

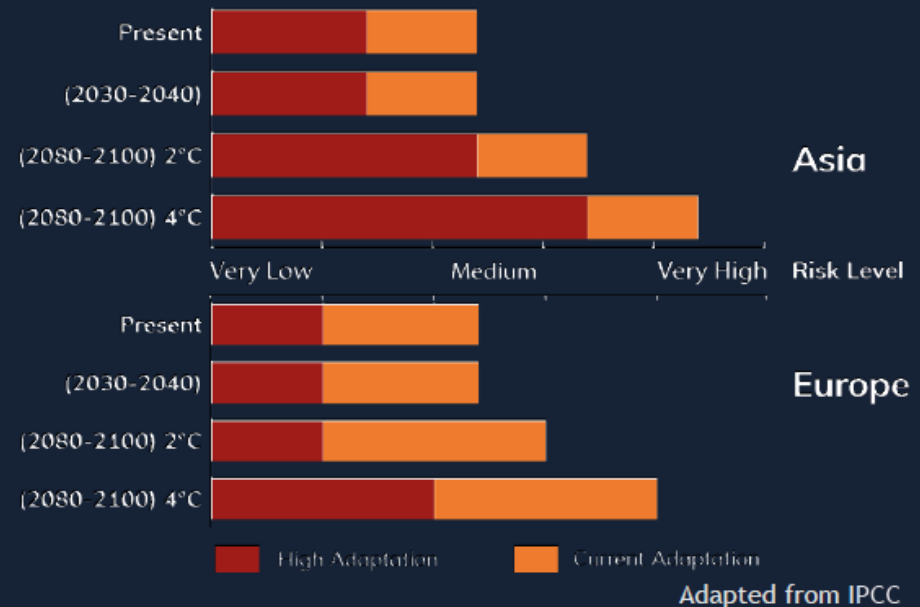
★ Monitoring & Modelling

Action:

★ Mitigation:
avoiding the unmanageable

★ Adaptation: managing the unavoidable

Risk Level of Increased Flood Damage





Adaptation to Climate Change

☉ Three parallel agendas:

- ✦ 2030 Agenda for Sustainable Development
- ✦ Sendai Framework for Disaster Risk Reduction 2015-2030
- ✦ Paris Agreement – UNFCCC from 2020

“In the context of climate change, **address next to mitigation efforts** also opportunities in the context of **climate change adaptation [...]**”

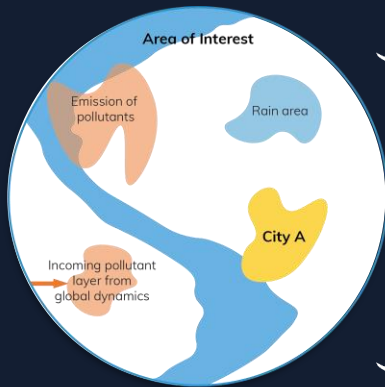
☉ Importance of Space



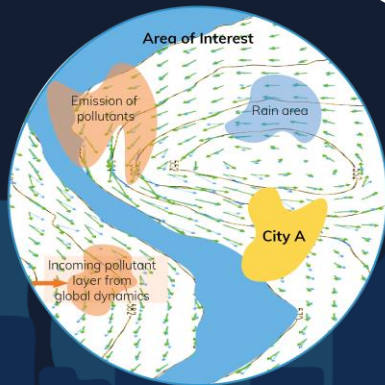


Focus on Cities: floods and air quality

- By 2050, 68% population in urban areas
- City challenges: **floods, air quality**, heat stress, green spaces, energy
 - First three are environmental hazards exacerbated by climate change



- Urbanization trends increase risks
- Large amount of data required:



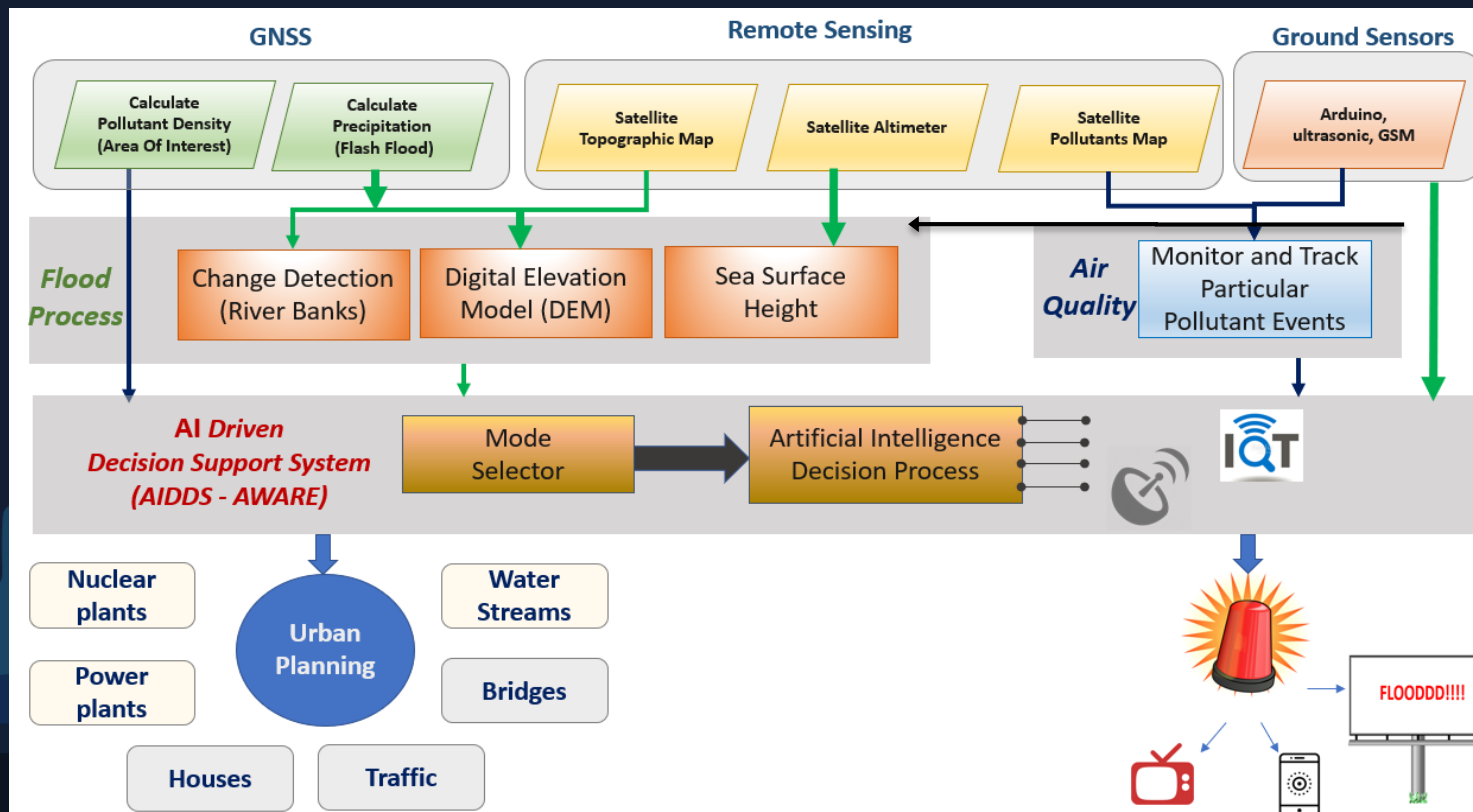
- Floods and air pollution sources may be outside of cities
→ large area of interest, satellite images
- Local variability: Satellite data needs to be combined with ground based sensors in city
- Winds and orography require complex models

Solution 1: integrated Early Warning System (iEWS)



Complex problem → complex system

- Supervised AI system analyses the data to determine when an alert must be raised
- Data refreshed and remodelled continuously
- Alerts in multiple media from SMS to web-based apps



Solution 1: iEWS (cont'd)



- ⌚ Integrates floods and air quality hazards
- ⌚ Modular: Extendable to other hazards (e.g. heat stress, earthquakes)
- ⌚ Customizable for each particular urban area
 - ✦ Depending on the geography, climate, level of development and infrastructure
- ⌚ And also:
 - ✦ Infrastructure planning: nuclear and power plants, green areas and water streams, bridges...
 - ✦ Real-time traffic management

Solution 2: Smart City Infrastructure







☉ Trend towards smart cities and Internet of Things: iEWS integrated in city development




☉ AWAREness raising

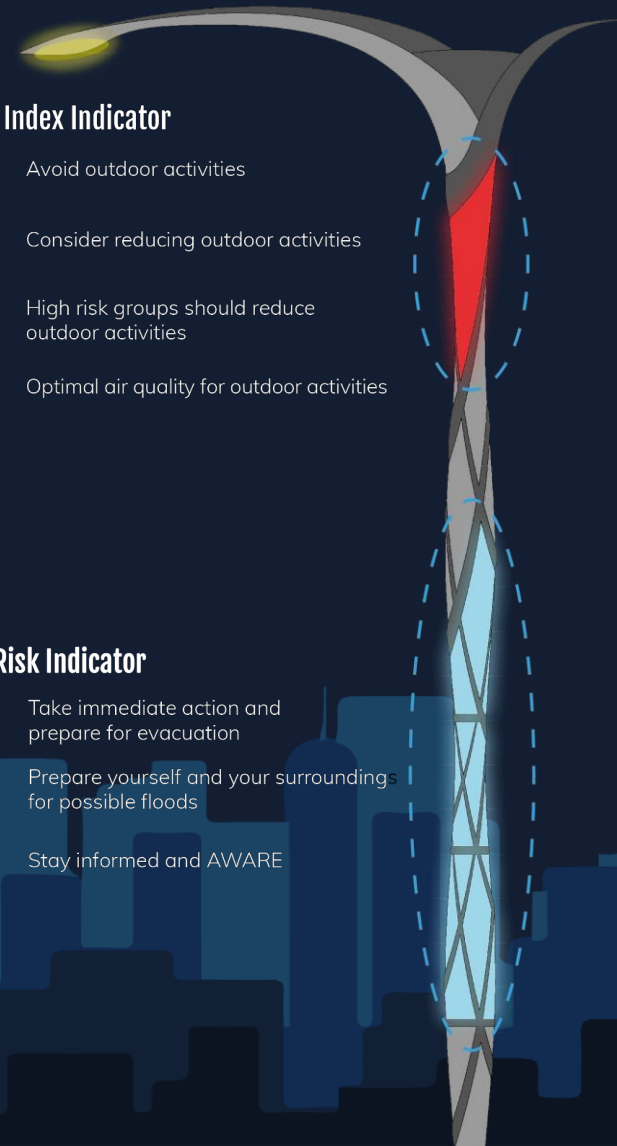
☉ Use of space technologies

Air Pollution Index Indicator

	Very High	Avoid outdoor activities
	High	Consider reducing outdoor activities
	Moderate	High risk groups should reduce outdoor activities
	Low	Optimal air quality for outdoor activities

Water Level Risk Indicator

	High	Take immediate action and prepare for evacuation
	Medium	Prepare yourself and your surroundings for possible floods
	Low	Stay informed and AWARE



AWARE foundation



☉ Non-profit organization

- ✦ outreach and communication:
adapted to each city

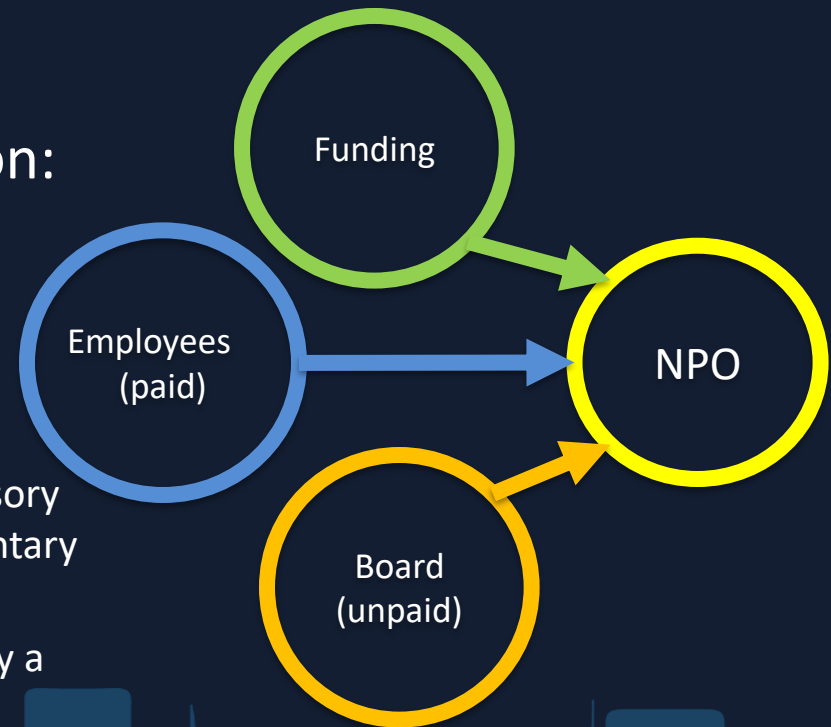
- ✦ case studies

- ✦ potential partners:

- ✦ UNSPIDER and their technology advisory missions at country level: complementary function at city level

- ✦ 100 resilient cities: Rotterdam already a member

- ✦ Covenant of majors for climate & energy (EU)





Conclusions

- ☉ Adaptation scenarios to climate change hazards have become a necessity
- ☉ Urban areas face high and complex risks
- ☉ AWARE can help achieving our development goals and reduce the Space divide leading to more awareness
- ☉ Solutions assessed:

- ✦ Integrated Early Warning System (iEWS)
- ✦ City infrastructure designed for resiliency

- ☉ Executive summary and report:

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Additional slides



Case study: Rotterdam



🌀 Basic facts

- ✦ population: 640,000
- ✦ 2/3 of The Netherlands below sea level
- ✦ air quality is a national issue
- ✦ largest port in Europe

🌀 Situation:

- ✦ densely populated areas along sea coast: evacuated in time?
- ✦ Netherlands Flood Early Warning System Rivers (FEWS Rivieren)
- ✦ European Flood Awareness System (EFAS)
- ✦ NL-Alert cellular broadcasting system: mobile phones / SMS
- ✦ developing smart city initiatives: climate-proof
- ✦ part of the 100 Resilient Cities
- ✦ adaptation plans such as advanced dykes, water drainage areas, flooding parking lots and squares and floating buildings
- ✦ air quality monitoring, based on ground sensors



Case study: Dhakha



Basic Facts

- ✦ population 18.9 million
- ✦ 4th most densely populated city in the world
- ✦ frequent air pollution and floods
- ✦ lack of adequate infrastructure

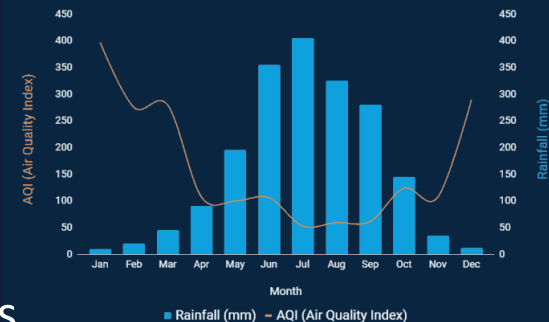
Current solutions

- ✦ Real time flood alert system: early warning in < 24h

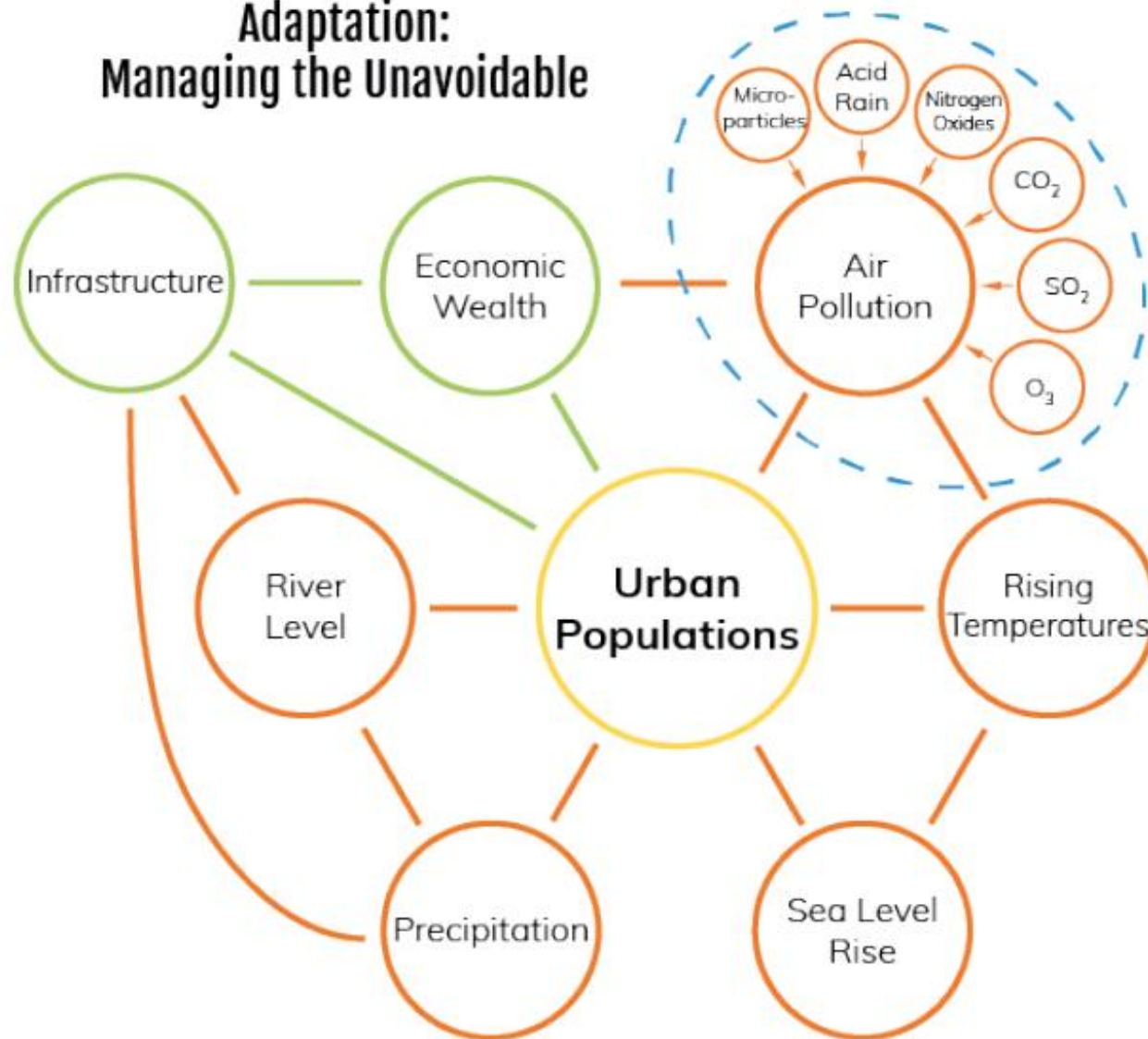
AWARE tailored solutions:

- ✦ iEWS to be deployed for both air pollution and floods
- ✦ real-time, accurate modeling, AI assisted decision making and dissemination of information
- ✦ adaptive city planning with remote sensing data
- ✦ decreasing response for evacuation BEFORE hazard
- ✦ correlation between precipitation and air quality

Average Air Quality Index (2015-2017) and Rainfall (1958-2007) for Dhaka



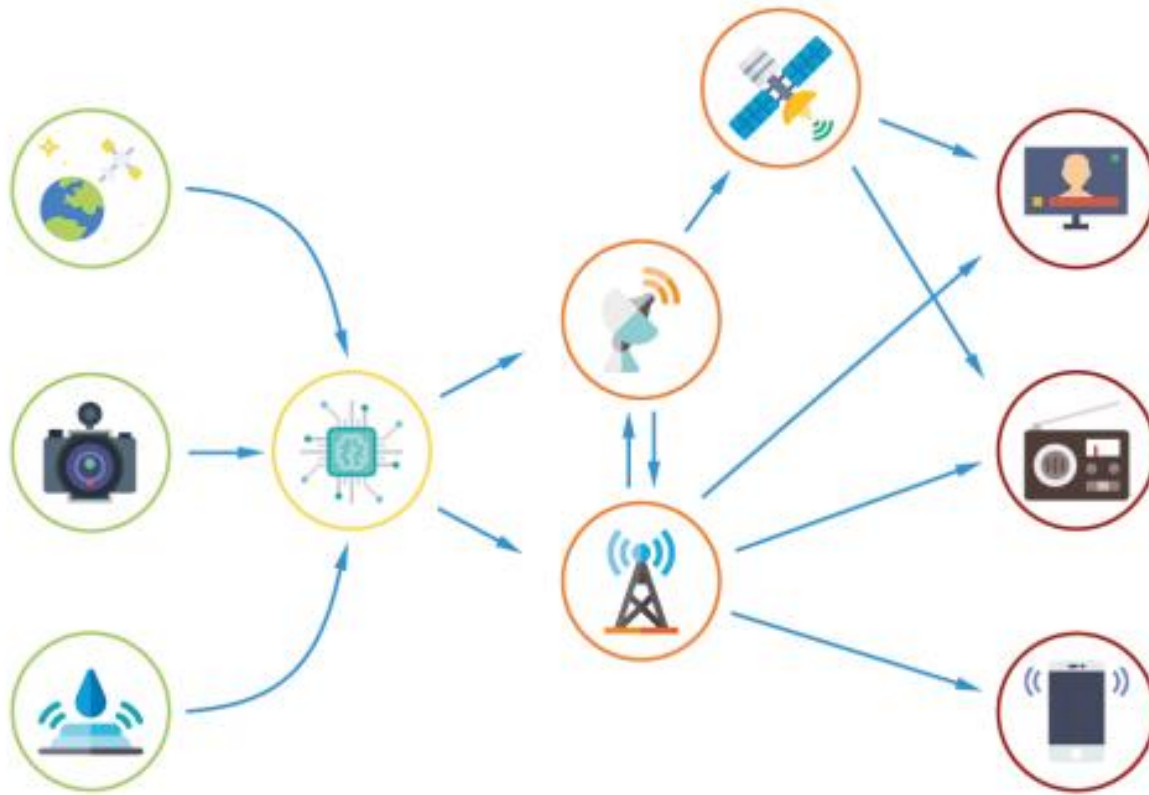
Adaptation: Managing the Unavoidable

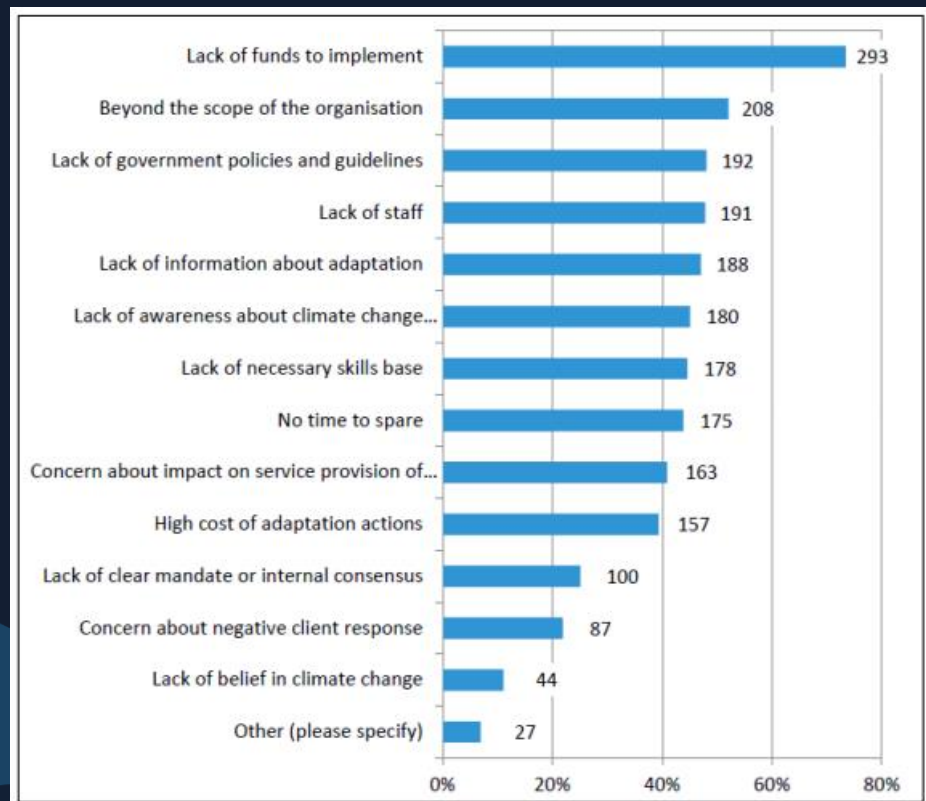
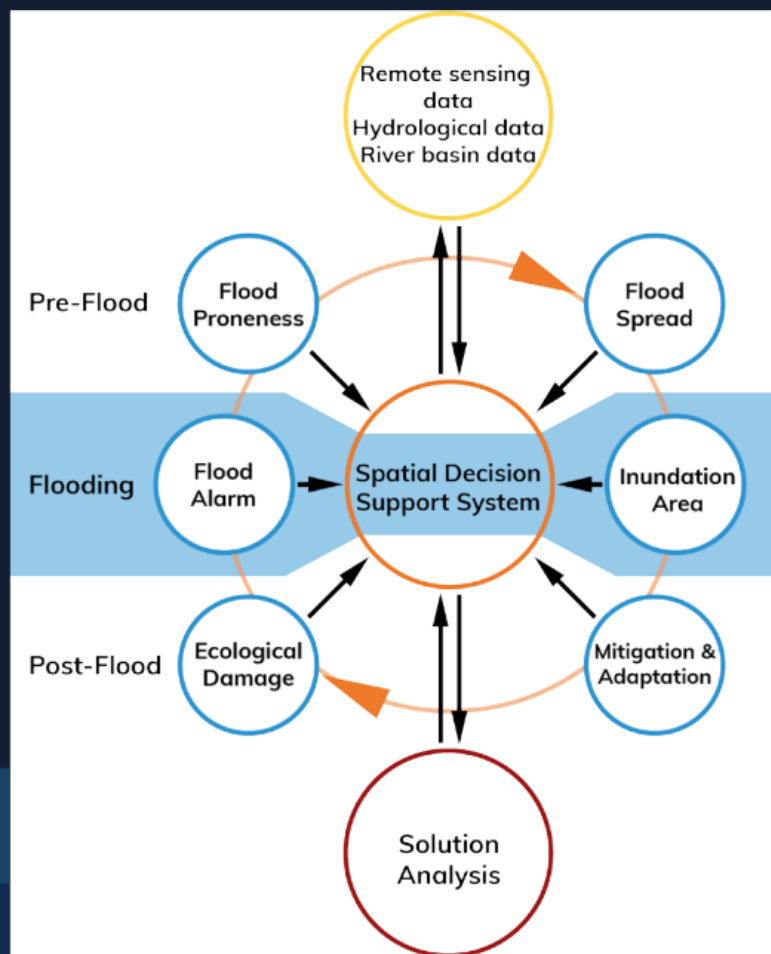




Pollutants	Effects on health
Particle pollutants (PM_{2.5}-PM₁₀)	Airborne particle pollutants mainly cause lung and respiratory diseases. Symptoms can be asthma, cardiac dysrhythmias, and (non-fatal) heart attacks (Ghorani-Azam, Riahi-Zanjani, and Balali-Mood, 2016).
Ground ozone O₃	Ground ozone O ₃ has an adverse effect on cellular function (epidermal keratinocytes) (Ghorani-Azam, Riahi-Zanjani, and Balali-Mood, 2016).
Carbon monoxide (CO)	Carbon monoxide can result in nausea, headaches, vomiting, and loss of consciousness. Sulphur Dioxide is said to irritate respiratory functions, and exacerbate an existing cardiovascular problem (Ghorani-Azam, Riahi-Zanjani, and Balali-Mood, 2016).
Sulphur Dioxide (SO₂)	Sulphur Dioxide is said to irritate respiratory functions, and exacerbate an existing cardiovascular problem (Ghorani-Azam, Riahi-Zanjani, and Balali-Mood, 2016).
Nitrogen oxide (NO₂)	Nitrogen Oxide can be attributed to fever, chest pain, headaches, and a pulmonary edema. Lead in large quantities can negatively impact young children, due to kidney dysfunction. With adults, too much lead can contribute to potential heart attacks or strokes (Ghorani-Azam, Riahi-Zanjani, and Balali-Mood, 2016).

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Toxic air pollutants such as arsenic, asbestos, benzene, and dioxin	Pollutants of toxic air can heighten a person's risk of cancer; the breathing, eyes, and skin can also be irritated (Ghorani-Azam, Riahi-Zanjani, and Balali-Mood, 2016).





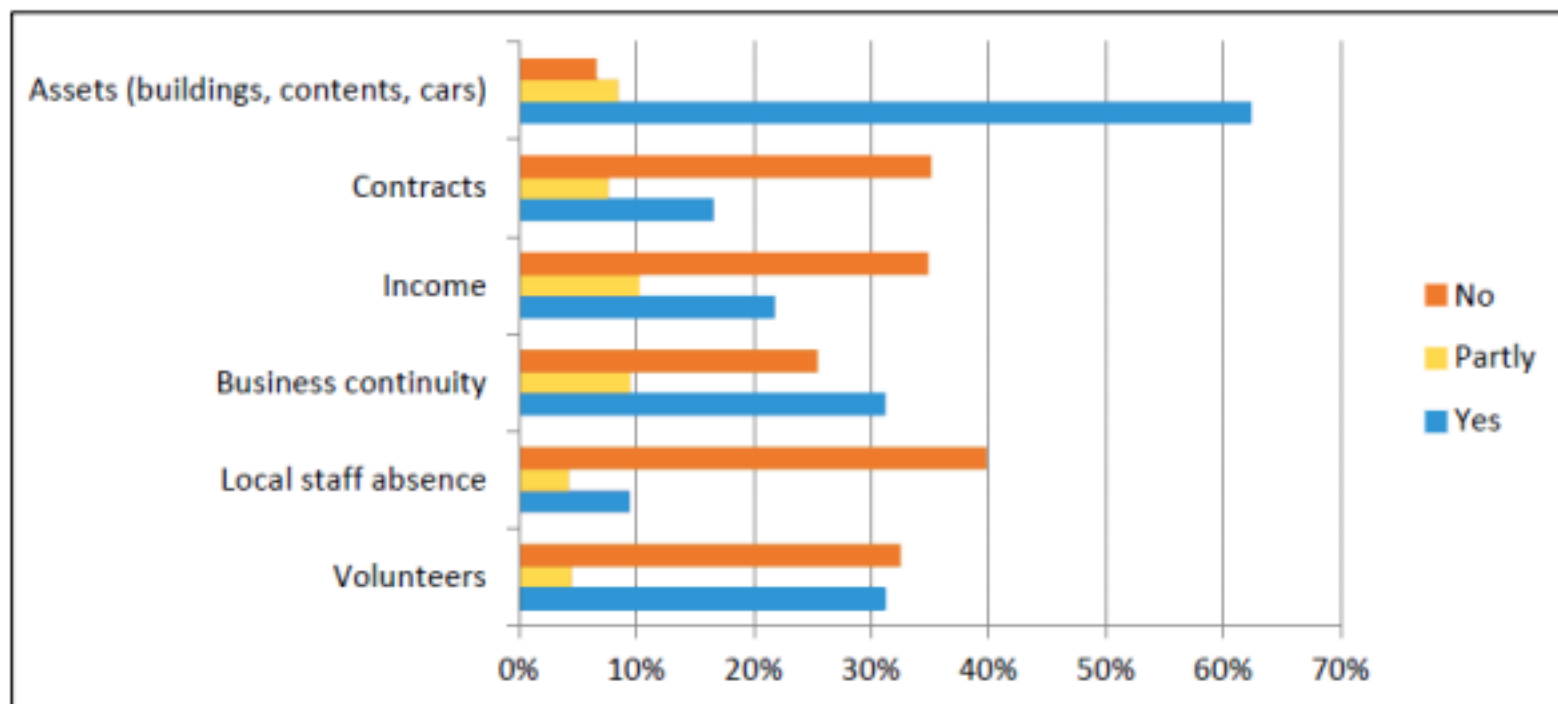


Figure 9 - Losses indicated by extreme weather events per category (adapted from Mallon et al, 2012)

Bangladesh

