Space-Aided Climate Change Adaptation



Adapting to Water and Air Realities on Earth



Space Studies Program 2018

UNOOSA Scientific and Technical Subcommittee, Vienna, 11-22 February 2019 Tom Meinert on behalf of team AWARE

ISU Team Project



S Team Project AWARE:

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





- + 34 external experts:
 - UNOOSA/UNSPIDER
 ESA Climate Change Office (UK)
 - **ESTEC**
 - 🛰 Airbus
 - No Deltares



KNMI
MIT MediaLab
SRON
S&T
Tauw

TNO
 TU Delft
 University of Leiden

Monitoring



SUnderstanding:

Monitoring & Modelling

Risk Level of Increased Flood Damage





Monitoring Mitigation

SUnderstanding:

Monitoring &
 Modelling

Solution:
 ◆ Mitigation:
 avoiding the
 unmanageable

Risk Level of Increased Flood Damage





Monitoring Mitigation Adaptation

- SUnderstanding:
 - Monitoring &
 Modelling
- Action:
 Mitigation:
 avoiding the
 unmanageable
 Adaptation: managing the unavoidable

Risk Level of Increased Flood Damage





Adaptation to Climate Change

SThree parallel agendas:

- + 2030 Agenda for Sustainable Development
- + Sendai Framework for Disaster Risk Reduction 2015-2030

14 LIFE BELOW WATER

+ 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



- S By 2050, 68% population in urban areas
- So City challenges: floods, air quality, heat stress, green spaces, energy
 - First three are environmental hazards exacerbated by climate change
- O Urbanization trends increase risks



Area of Interest

City A

- S Large amount of data required:
 - + Floods and air pollution sources may be outside of cities
 - \rightarrow 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)



\odot Complex problem \rightarrow 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)
- S 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

Subse of space technologies



Water Level Risk Indicator

Low



Stay informed and AWARE

AWARE foundation



- $\ensuremath{\textcircled{}^{\scriptsize \ensuremath{\bigcirc}}}$ 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



13 CLIMATE

 Adaptation scenarios to climate change hazards have become a necessity

 $\ensuremath{\boxdot}$ Urban areas face high and complex risks

- S 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
- Security Summary and report:

https://isulibrary.isunet.edu/index.php?lvl=notice_display&id=10461

Space Aided Climate Change Adaptation



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Netherlands Space

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Additional slides

Case study: Rotterdam



AWARE

S 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

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

Surrent solutions

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







Pollutants	Effects on health
Particle pollutants (PM _{2.5} - PM ₁₀)	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 O ₃	Ground ozone O₃has 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 (SO ₂)	Sulphur Dioxide is said to irritate respiratory functions, and exacerbate an existing cardiovascular problem (Ghorani-Azam, Riahi-Zanjani, and Balali-Mood, 2016).
Nitrogen oxide (NO ₂)	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).
benzene, and dioxin	Zanjani, and Balali-Mood, 2016).













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

Bangladesh



