



IPDC Online Sessions

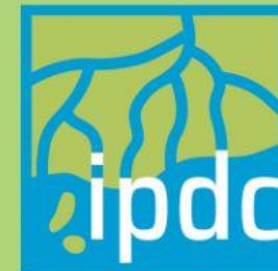
Facilitating Knowledge Exchange about Water Climate Adaptation

International Panel on Deltas and Coastal Areas – IPDC



Roel de Goede

12 December 2024



ONLINE SESSION

EARLY WARNING SYSTEMS AND FLOOD EVACUATION PLANNING

Including case
studies from South
Africa and
Mozambique

THURSDAY 12 DECEMBER

14:00 - 15:00 CET



Early Warning Systems and Flood Evacuation Planning

- ◆ Critical to saving lives, reducing impacts, and building community resilience
- ◆ Increasingly important in the face of growing climate risks
- ◆ **Today's program:** exploring how EWS can be used to predict pluvial and coastal floods and how (flood) forecasting data can be transformed into actionable plans
 - ◇ Case study 1: Flood Early Warning Systems in Durban, South Africa
 - ◇ Case study 2: Flood Evacuation Planning in Quelimane, Mozambique
 - ◇ Interactive Q&A with the speakers
- ◆ Post your questions in the chat!
- ◆ Microphone/camera off during presentations

Speakers

Early Warning Systems in Durban, South Africa



Kemira Naidoo



Sanele Nkala



Cameron Gabin



Siphesihle Mtshali

Flood Evacuation Planning in Quelimane, Mozambique



Lieke Meijer



Ap van Dongeren



INTERNATIONAL PANEL ON DELTAS AND COASTAL AREAS - IPDC

ETHEKWINI MUNICIPALITIES FORECAST EARLY WARNING
SYSTEM

KEMIRA NAIDOO (SENIOR CIVIL ENGINEER)

CAMERON GABIN (SENIOR CIVIL ENGINEER)

SANELE NKALA (CIVIL ENGINEER)

SIPHESIHLE MTSHALI (CIVIL ENGINEER)

DECEMBER 2024

INTRODUCTION:

SANELE NKALA



THE GROWING THREAT OF FLOODS

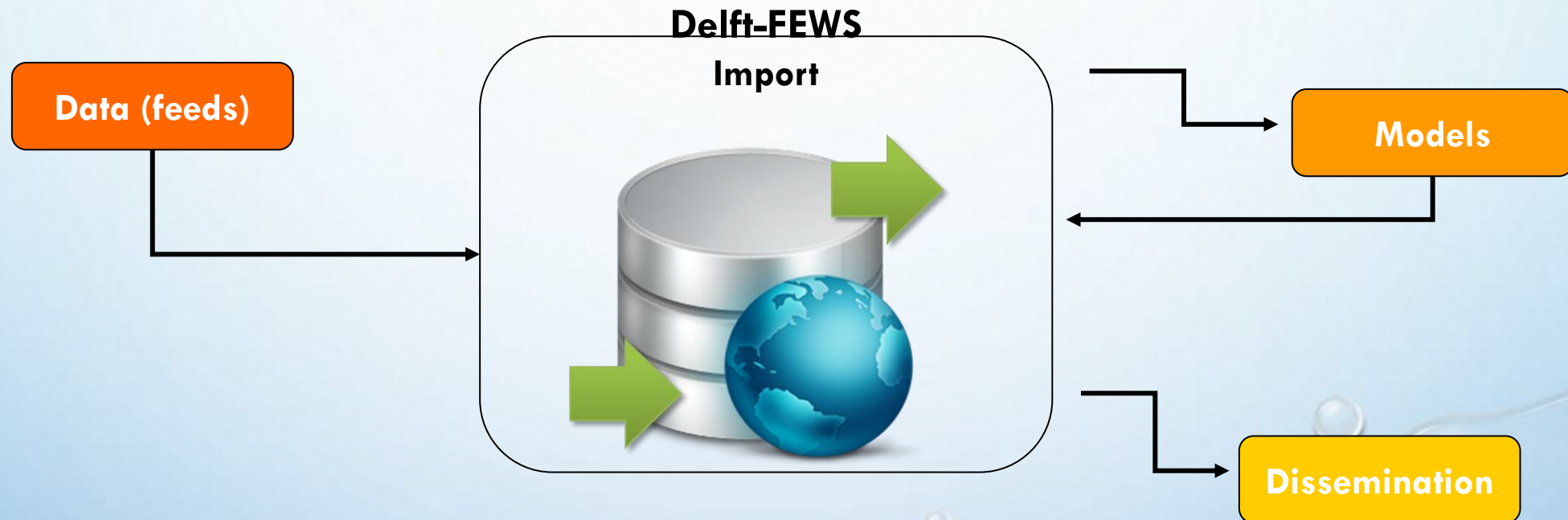
FLOODS, PARTICULARLY COASTAL AND RIVERINE FLOODS, HAVE BEEN ESCALATING IN FREQUENCY AND SEVERITY. SINCE 1987, THE CITY OF DURBAN AND SURROUNDING REGIONS HAVE EXPERIENCED DEVASTATING FLOOD EVENTS, CAUSING SIGNIFICANT DAMAGE TO INFRASTRUCTURE, HOMES, AND LIVELIHOODS.



1987 floods

WHAT IS A FLOOD EARLY WARNING SYSTEM (FEWS)?

A FLOOD EARLY WARNING SYSTEM (FEWS) IS A PROACTIVE TOOL THAT HELPS PREDICT AND COMMUNICATE POTENTIAL FLOODING EVENTS IN ADVANCE, ALLOWING COMMUNITIES AND AUTHORITIES TO PREPARE AND RESPOND EFFECTIVELY.



FEWS IN DURBAN – A LOCALIZED APPROACH

DURBAN'S IMPLEMENTATION: DURBAN HAS DEVELOPED A TAILORED FEWS TO PROVIDE HYPER-LOCALIZED FLOOD PREDICTIONS. WHILE NATIONAL METEOROLOGICAL SERVICES GIVE BROAD REGIONAL FORECASTS, FEWS IN DURBAN FOCUSES ON SPECIFIC NEIGHBOURHOODS, RIVERS, AND COASTAL AREAS TO PINPOINT WHERE FLOODS ARE MOST LIKELY TO OCCUR.

HOW FEWS WORKS IN DURBAN:

- DATA FEEDS AND MODELS:
- WEATHER DATA FROM LOCAL WEATHER STATIONS.
- RIVER GAUGES THAT MONITOR WATER LEVELS IN REAL-TIME.
- TIDE MONITORING ALONG THE COASTLINE TO PREDICT STORM SURGES.
- SPECIALIZED MODELS FOR SIMULATING FLOOD IMPACTS, BASED ON REAL-TIME AND FORECASTED DATA.
- PREDICTIONS AND ALERTS: THE SYSTEM CAN PREDICT NOT ONLY IF FLOODING IS LIKELY BUT WHICH PARTS OF DURBAN ARE AT GREATEST RISK, ALLOWING FOR MORE PRECISE EMERGENCY RESPONSE.



THE ROLE OF FEWS IN ADDITION TO SAWS

- **COMPLEMENTARY TO NATIONAL SERVICES:** WHILE SAWS PROVIDES VALUABLE FLOOD FORECASTS FOR BROADER REGIONS, FEWS OFFERS A MORE DETAILED AND LOCALIZED APPROACH. IT DOESN'T REPLACE NATIONAL SERVICES BUT AUGMENTS THEM BY:
- PROVIDING MORE GRANULAR, AREA-SPECIFIC FLOOD PREDICTIONS.
- OFFERING TIMELY WARNINGS ABOUT THE PRECISE AREAS WITHIN THE CITY THAT ARE AT RISK, ALLOWING LOCAL AUTHORITIES TO ACT SWIFTLY AND FOCUS THEIR RESOURCES WHERE NEEDED MOST.
- **WHY DETAILED DATA MATTERS:** FEWS HELPS LOCAL AUTHORITIES, COMMUNITIES, AND BUSINESSES UNDERSTAND EXACTLY WHERE THEY SHOULD PREPARE—WHETHER THAT'S REINFORCING FLOOD DEFENCES IN VULNERABLE NEIGHBOURHOODS, EVACUATING PEOPLE, OR MANAGING INFRASTRUCTURE RISKS.



GETTING AHEAD OF FLOOD DISASTERS

- THE DEVASTATING IMPACT OF FLOODS, AS WE'VE SEEN FROM IMAGES SPANNING OVER 30 YEARS, DEMONSTRATES THE URGENT NEED FOR A MORE LOCALIZED AND PREDICTIVE APPROACH TO FLOOD MANAGEMENT. BY UTILIZING A FLOOD EARLY WARNING SYSTEM, PARTICULARLY IN DURBAN, WE CAN BETTER PROTECT LIVES, PROPERTY, AND THE LOCAL ECONOMY. FEWS ALLOWS US TO STAY AHEAD OF DISASTER BY PREDICTING THE AREAS MOST AT RISK AND GIVING US THE TIME TO RESPOND EFFECTIVELY.
- IT'S ESSENTIAL TO CONTINUE INVESTING IN AND IMPROVING FEWS FOR BETTER DISASTER PREPAREDNESS. BY WORKING WITH NATIONAL METEOROLOGICAL SERVICES AND UTILIZING LOCALIZED DATA, WE CAN REDUCE THE DEVASTATING IMPACT OF FLOODS ON OUR COMMUNITIES.



Our Team Setup

HYDRAULIC TEAM

- **PCSWMM modelling assistance (1D and 2D)**
- **Floodline delineation using PCSWMM**
- **Forecast Information**
- **Hindcast data for model runs**

INSTRUMENTATION TEAM

- **Rainfall /Wind / Tide data**
- **Flow meters for Model calibration**
- **Instrument positions and status**

GIS SPECIALIST

- **PCSWMM model clippings**
- **Lidar data**
- **Long sections and cross sections from lidar survey**

NB- Free software, open source coding – No black box



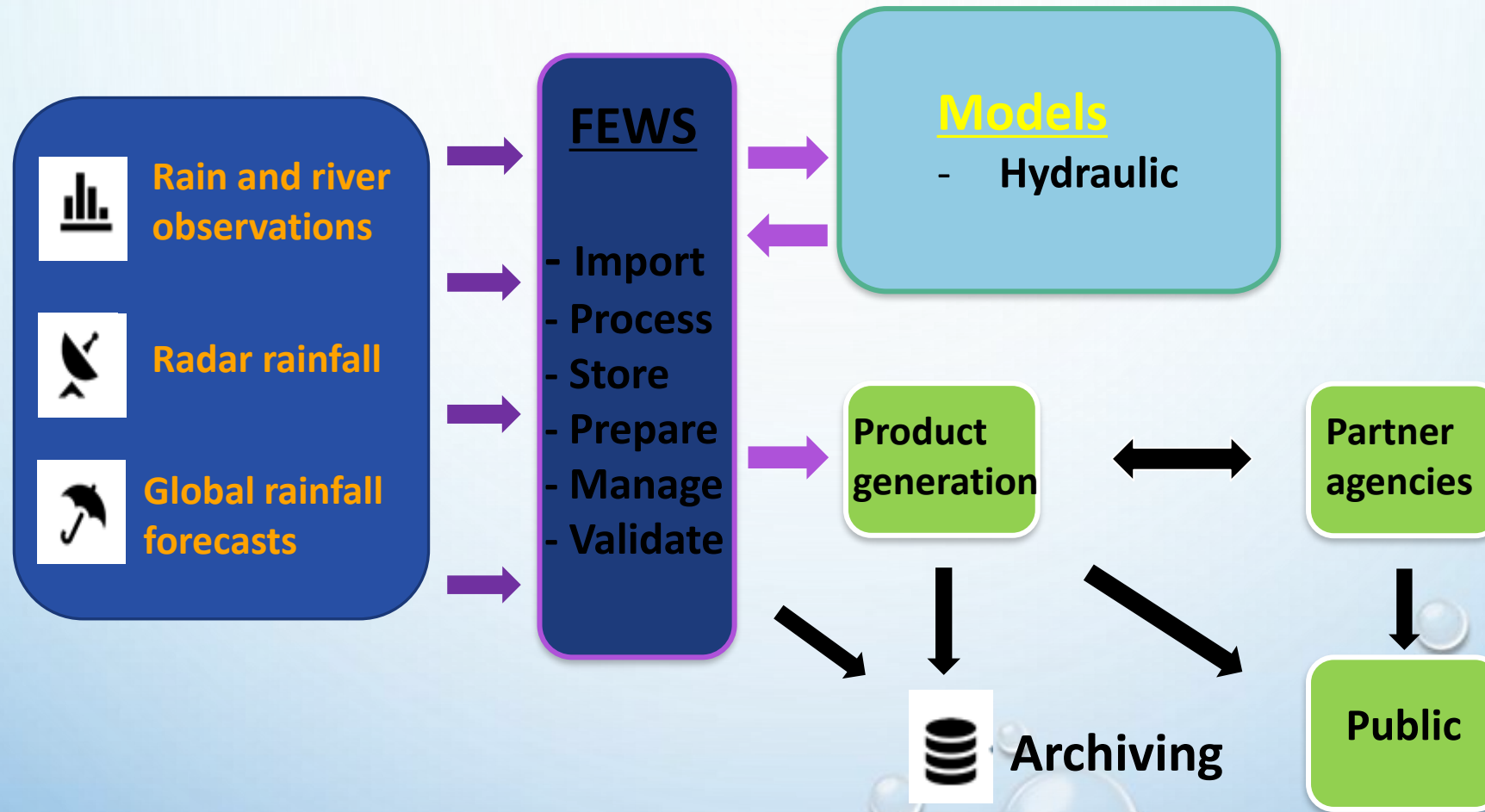
FEWS: INLAND

CAMERON GABIN

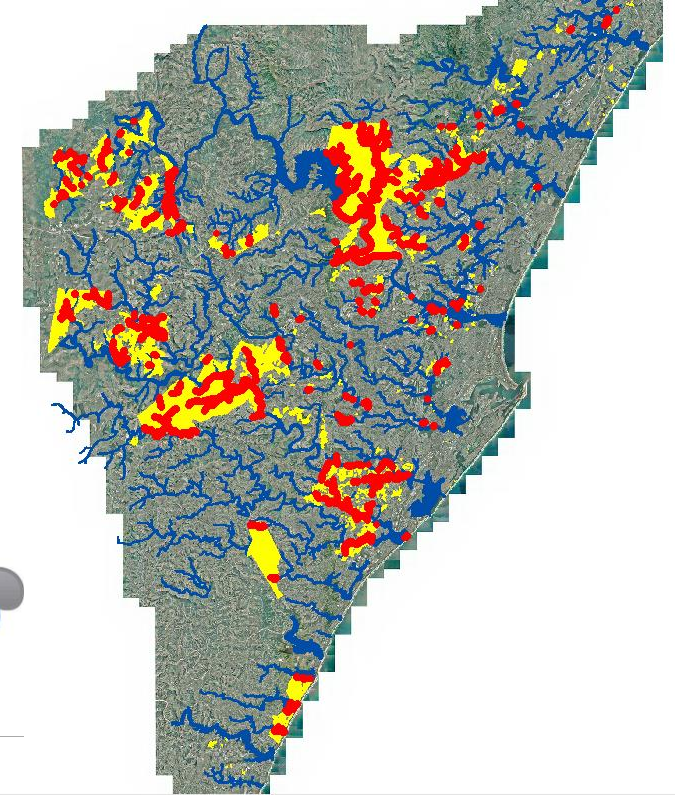
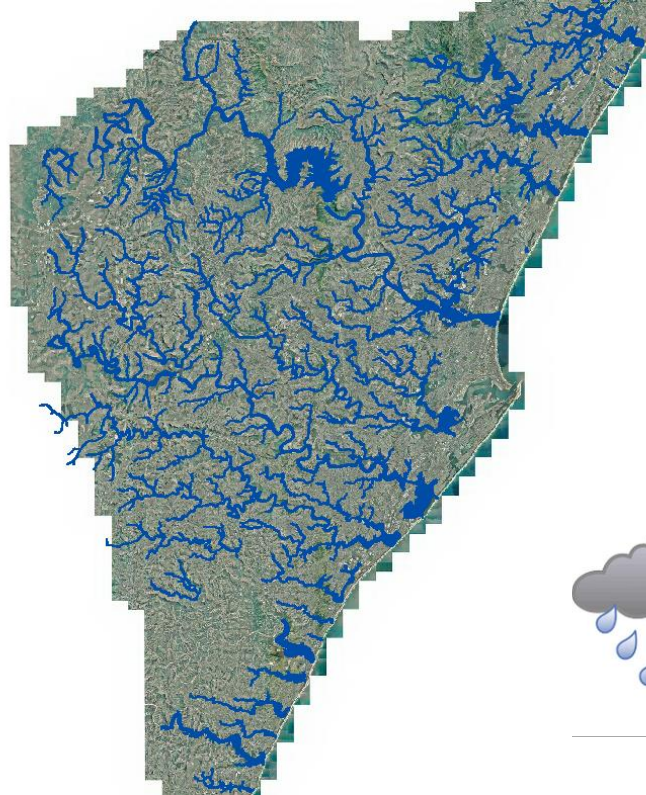
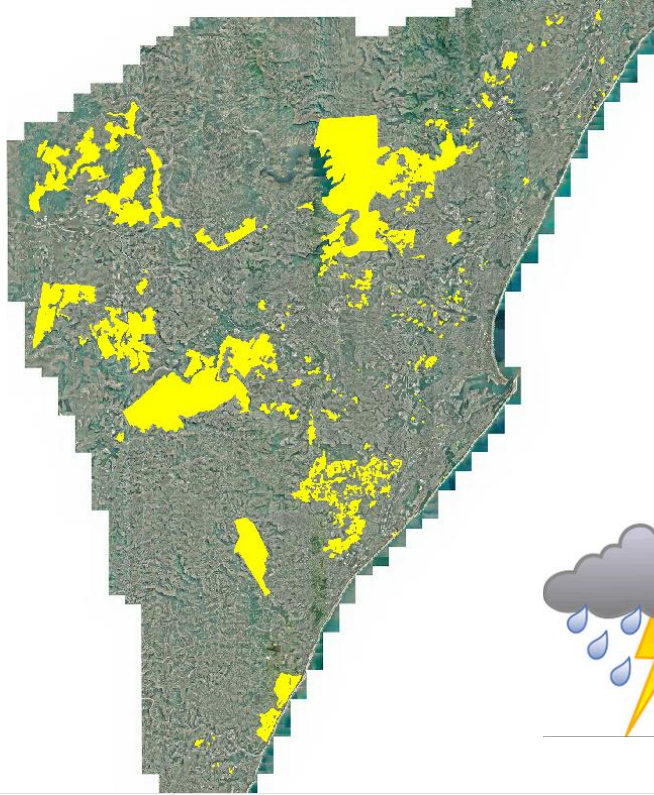


FEWS

RAINFALL FORECASTING AND MODELLING



TYPICAL SCENARIO FOR MOST ENGINEERS AND DECISION MAKERS



Informal settlements

1:100 Year floodline

250 Regions prone to flooding



DATA FEEDS

SAWS

Observed vs Forecast

Instrumentation

WARNINGS FORECAST OBSERVATIONS CLIMATE NEWS & EVENTS PRODUCTS AND SERVICES CORPORATE FAQ CONTACT US
VACANCIES WEATHER MEDIA RELEASES

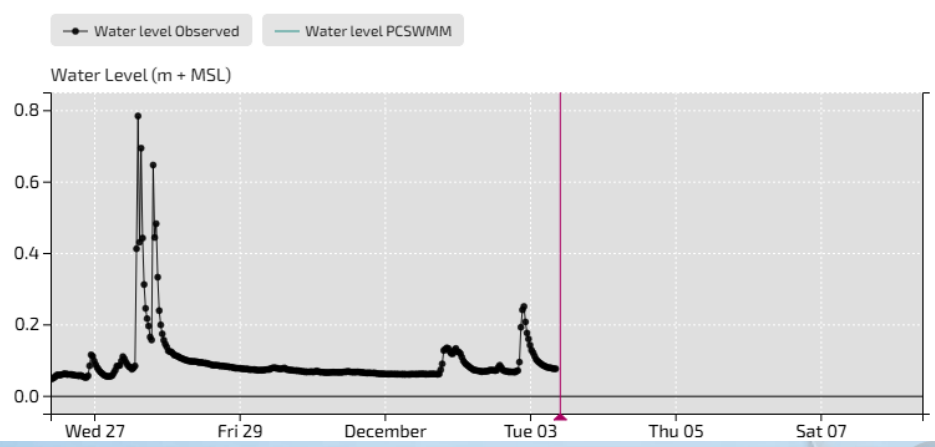
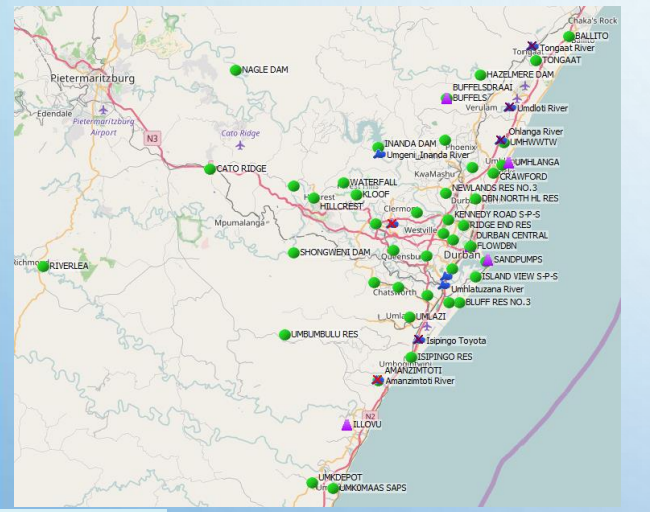
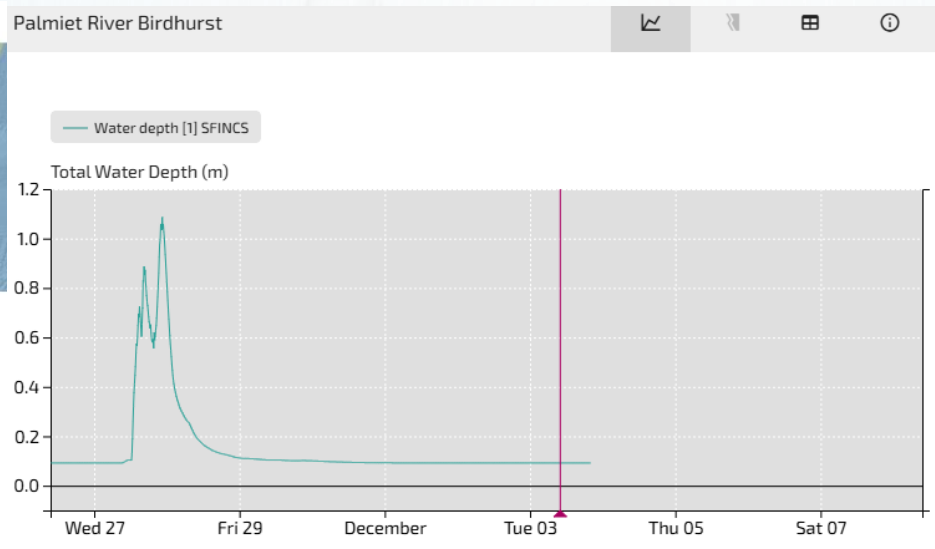
South Africa
Wednesday 29th March 2017
20:00

WEDNESDAY 02h 08h 14h 20h THURSDAY 02h 08h 14h 20h FRIDAY 02h 08h 14h 20h

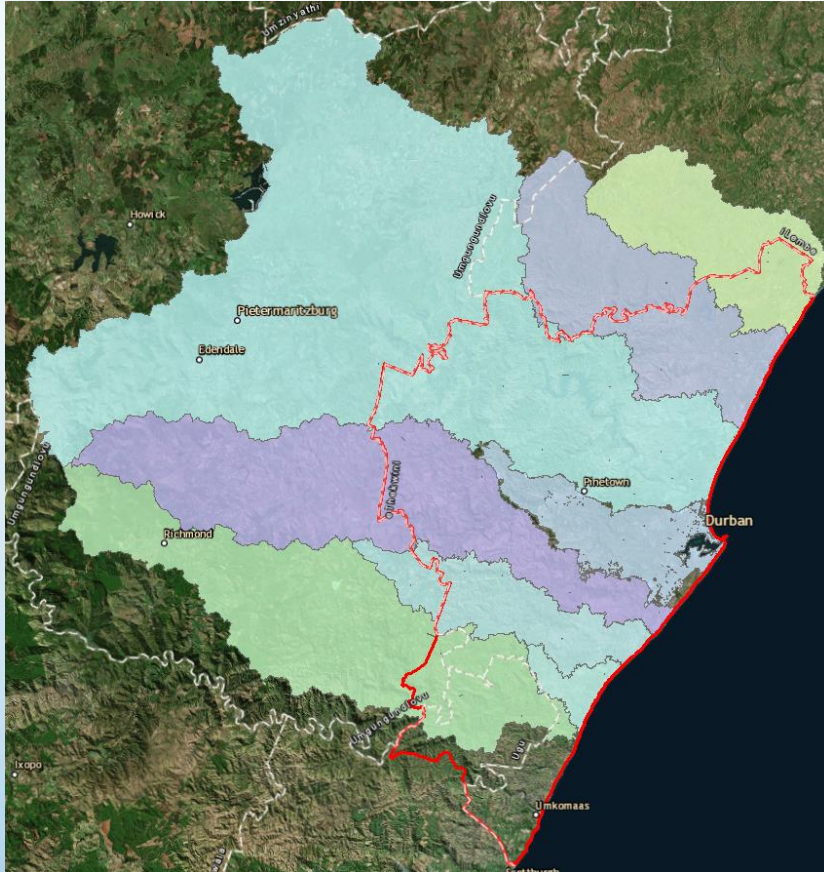
Forecast for City of Tshwane 5 represented by Pretoria

| Today | Thu | Fri | Sat | Sun | Mon | Tue |
|--------------------------|----------------------|--------------------|------------------|--------------------|------------|------------|
| 31° 13° | 29° 15° | 31° 12° | 33° 13° | 32° 15° | 29° 13° | 31° 15° |
| Rainfall Probability (%) | Rainfall Amount (mm) | Apparent Temp (°C) | Sunrise / Sunset | Moonrise / Moonset | | |
| 0 | 0 | 20° | 06:17 / 18:05 | 07:24 / 19:24 | | |

Read more



Models



HYDRAULIC MODELS

- 9 ACTIVE MODELS - PCSWMM
- EXTEND BEYOND ETHEKWINI
- REUSE AND CONTINUOUS IMPROVEMENT
- APPROX. 250 CRITICAL NODES

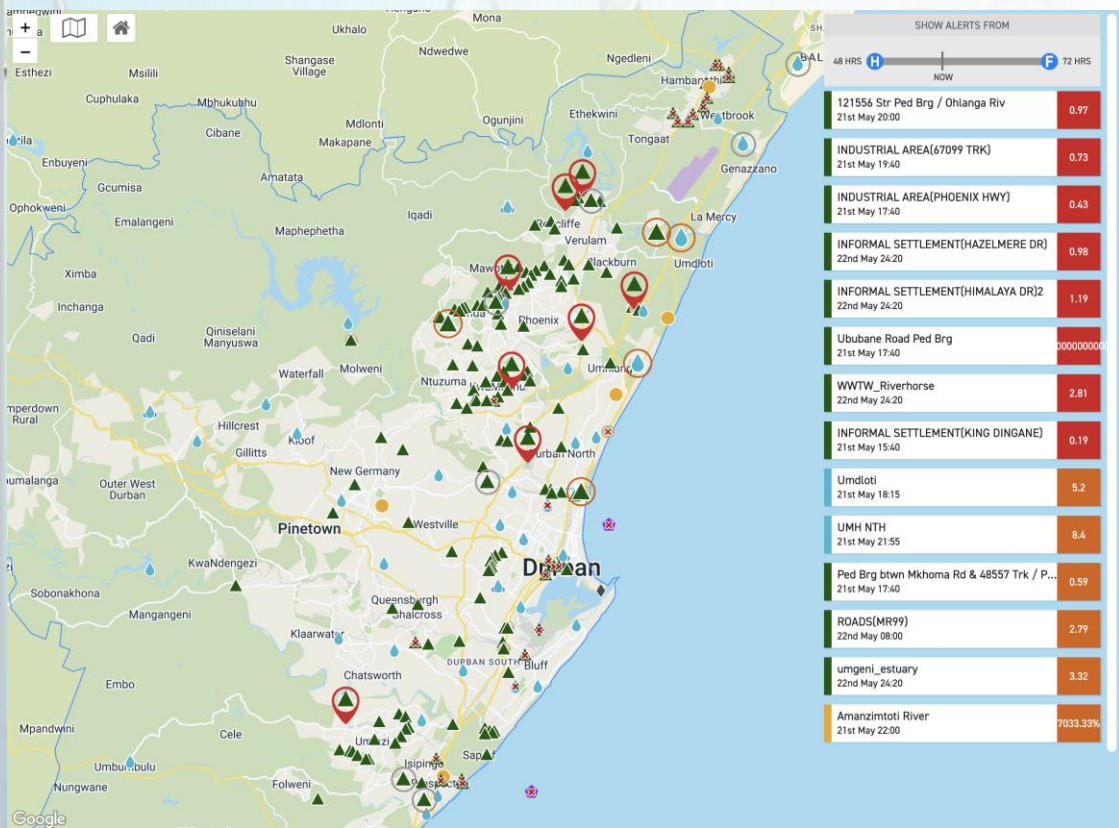


FEWS PROCESS

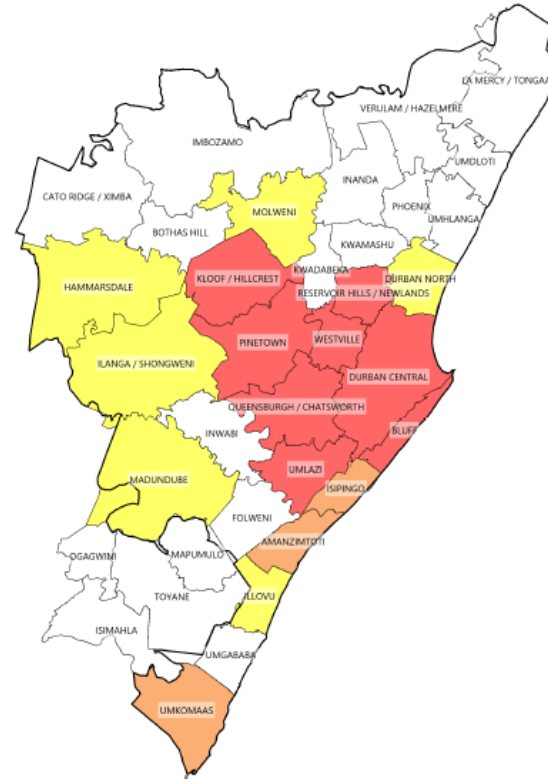
- SAWS provides 3 Day Forecast every 12 hours
- The FEWS system runs the river hydraulic models every 12 hours
- The FEWS system then highlights if any critical point alert level is likely to be exceeded.
- The FEWS team then monitors the forecasts and informs Disaster management through a Whatsapp group of any alerts shown by the system.
- The FEWS team also liaises with the SAWS team and assesses other global forecast models.
- Disaster Management then instructs communications on public announcements on the back of SAWS warnings.
- The FEWS team monitors the real time Rain Gauges, Level gauges and the SAWS radar to assess the severity of the storm and its directions.
- This information is fed via a Whatsapp group to Disaster Management who informs communities.



FEWS SYSTEM OUTPUT



Hazard map 0 to 24 hours

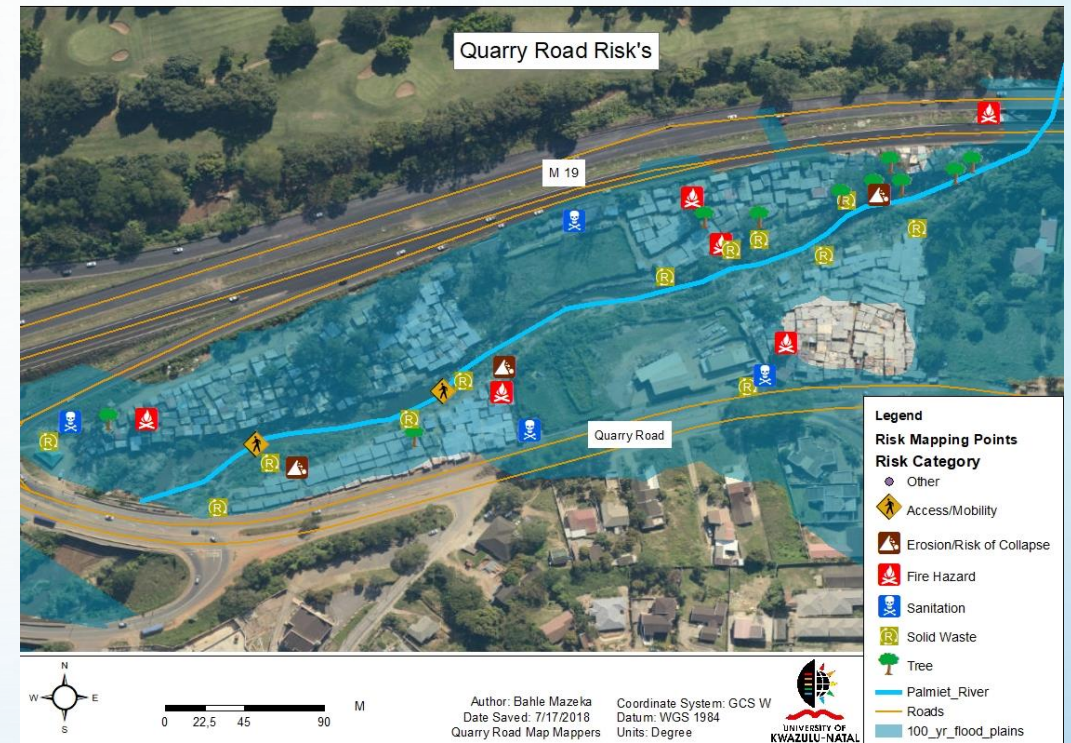
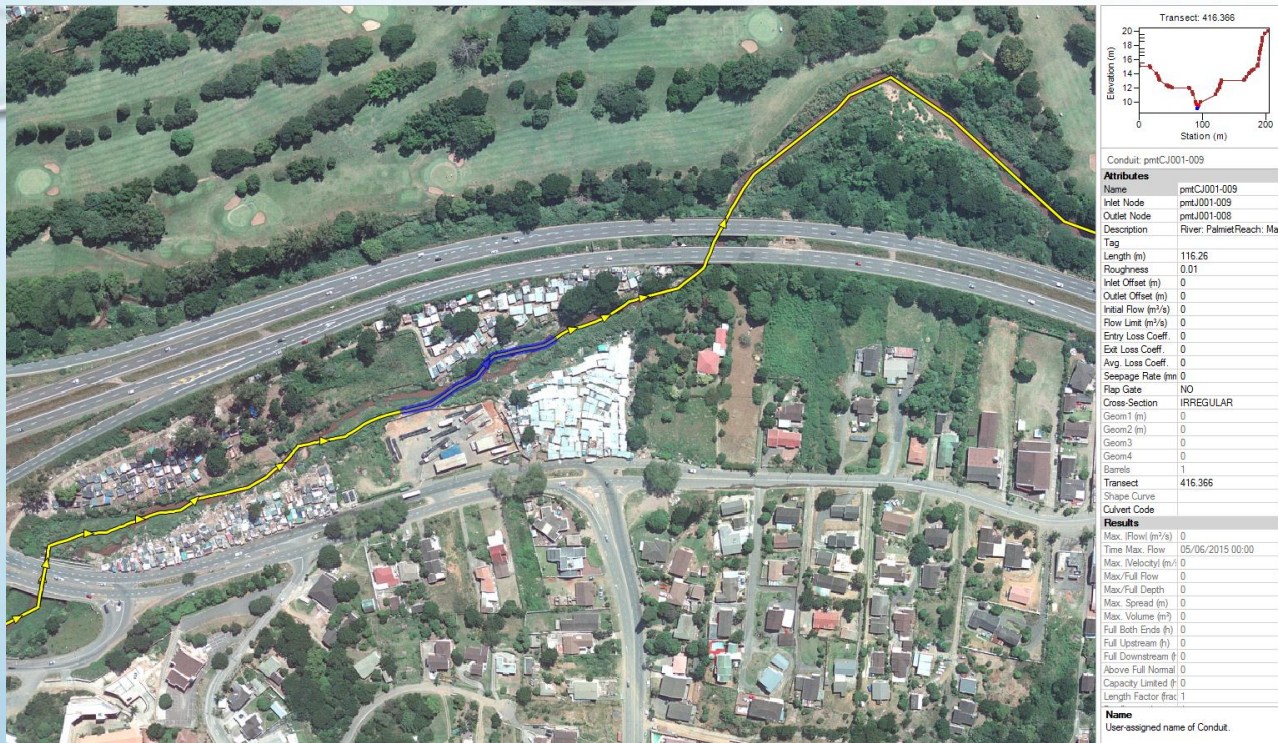


| Region | Forecasted Return Period | Maximum rainfall in 1 hour (mm) | Time of maximum rainfall |
|----------------------------|--------------------------|---------------------------------|--------------------------|
| AMANZIMTOTI | 5 YEAR | 58.29 | 22-10-2022 09:00 |
| BLUFF | 10 YEAR | 81.76 | 22-10-2022 10:00 |
| DURBAN CENTRAL | 10 YEAR | 106.26 | 22-10-2022 10:00 |
| DURBAN NORTH | 2 YEAR | 35.40 | 22-10-2022 12:00 |
| HAMMARSDALE | 2 YEAR | 36.31 | 22-10-2022 10:00 |
| ILANGA / SHONGWENI | 2 YEAR | 34.53 | 22-10-2022 09:00 |
| ILLOVU | 2 YEAR | 37.38 | 22-10-2022 09:00 |
| ISIPINGO | 5 YEAR | 58.29 | 22-10-2022 09:00 |
| KLOOF / HILLCREST | 10 YEAR | 139.65 | 22-10-2022 09:00 |
| MADUNDUBE | 2 YEAR | 34.07 | 22-10-2022 09:00 |
| MOLWENI | 2 YEAR | 45.09 | 22-10-2022 09:00 |
| PINETOWN | 10 YEAR | 105.92 | 22-10-2022 09:00 |
| QUEENSBURGH / CHATSWORTH | 10 YEAR | 105.82 | 22-10-2022 09:00 |
| RESERVOIR HILLS / NEWLANDS | 10 YEAR | 67.06 | 22-10-2022 10:00 |
| UMKOMAAS | 5 YEAR | 51.75 | 22-10-2022 08:00 |
| UMLAZI | 10 YEAR | 65.31 | 22-10-2022 10:00 |
| WESTVILLE | 10 YEAR | 103.71 | 22-10-2022 10:00 |

| Warning level | Description |
|---------------|--|
| 2 YEARS | 2 year return period for hourly forecasted rainfall |
| 5 YEARS | 5 year return period for hourly forecasted rainfall |
| 10 YEARS | 10 year return period for hourly forecasted rainfall |



SFINCS – Palmiet River Pilot Project



QUARRY ROAD WEST

- INFORMAL SETTLEMENT LOCATED WITHIN 1:100 YEAR FLOOD LINE. PRONE TO FLOODING
- 1 070 INFORMAL HOUSES LOCATED IN FOUR SECTIONS, TWO ON EACH SIDE OF THE RIVER
- COMMUNITY BASED EARLY WARNING SYSTEM.
- MONITORING STORM EVENTS BY FEWS TEAM. INFORMATION DISSEMINATED TO COMMUNITY LEADER VIA WHATSAPP GROUPS

FEWS: COASTAL
SIPHESIHLE MTSHALI



THE NEED FOR COASTAL FLOODING PREDICTIONS

- COASTAL FLOODING IS A GROWING CONCERN FOR CITIES LIKE DURBAN, WHERE THE COMBINATION OF RISING SEA LEVELS, STORM SURGES, AND HEAVY RAINFALL CAN LEAD TO DEVASTATING IMPACTS ALONG THE COASTLINE. PREDICTING THESE EVENTS CAN HELP PROTECT PEOPLE, INFRASTRUCTURE, AND BUSINESSES ALONG THE PROMENADE AND BEACHES.



THE ROLE OF MODELLING AND FORECASTING IN COASTAL FLOOD PREDICTION

- **COASTAL MODELLING:** USES COMPUTER SIMULATIONS TO PREDICT HOW OCEAN CONDITIONS, SUCH AS TIDES, WAVES, AND CURRENTS, INTERACT WITH LOCAL GEOGRAPHY AND WEATHER TO CAUSE FLOODING.
- **FORECASTING:** BASED ON REAL-TIME DATA AND PREDICTIVE MODELS, FORECASTING HELPS ESTIMATE WHEN AND WHERE FLOODING WILL OCCUR ALONG THE COASTLINE.
- **HOW IT WORKS:**
- **OCEAN DATA FEEDS:** DATA FROM WEATHER STATIONS, AND OCEAN BUOYS ARE COLLECTED AND ANALYSED.
- **MODELS:** PREDICTIVE MODELS SIMULATE WAVE HEIGHTS, STORM SURGES, AND TIDAL EFFECTS ON LOCAL SHORES.
- **FLOOD FORECASTS:** THESE MODELS HELP IDENTIFY AREAS LIKE THE PROMENADE, BEACHES, AND LOW-LYING COASTAL AREAS AT RISK OF FLOODING.



HOW THIS SYSTEM WORKS FOR DURBAN

- LOCAL DATA:
- DATA FROM OCEAN BUOYS AND SATELLITE IMAGERY PROVIDE REAL-TIME MONITORING OF WAVE HEIGHTS, TIDES, AND SEA TEMPERATURES ALONG DURBAN'S COASTLINE.
- WEATHER FORECASTS ARE INTEGRATED TO ACCOUNT FOR RAINFALL, WINDS, AND STORMS THAT COULD WORSEN THE RISK OF COASTAL FLOODING.
- PREDICTION MODELS:
- HYDRODYNAMIC MODELS: SIMULATE THE FLOW OF WATER AND WAVE INTERACTIONS WITH THE COASTLINE.
- STORM SURGE MODELS: PREDICT THE RISE IN WATER LEVELS CAUSED BY STORMS OR STRONG WINDS.
- FLOOD INUNDATION MODELS: ESTIMATE AREAS MOST AT RISK OF FLOODING BASED ON CURRENT AND FORECASTED OCEAN CONDITIONS.



HYDRODYNAMIC MODELLING AT ETHEKWINI COAST



- **DELFT3D-FLOW FLEXIBLE MESH** (OR D-FLOW FM): TWO- OR THREE-DIMENSIONAL MODELLING OF HYDRODYNAMICS (WATER LEVELS, CURRENTS, SALINITY, TEMPERATURE GRADIENTS) IN COASTAL WATERS (RIVERS, OR LAKES), AND BASE MODEL FOR WATER QUALITY AND PARTICLE TRACKING

SWAN



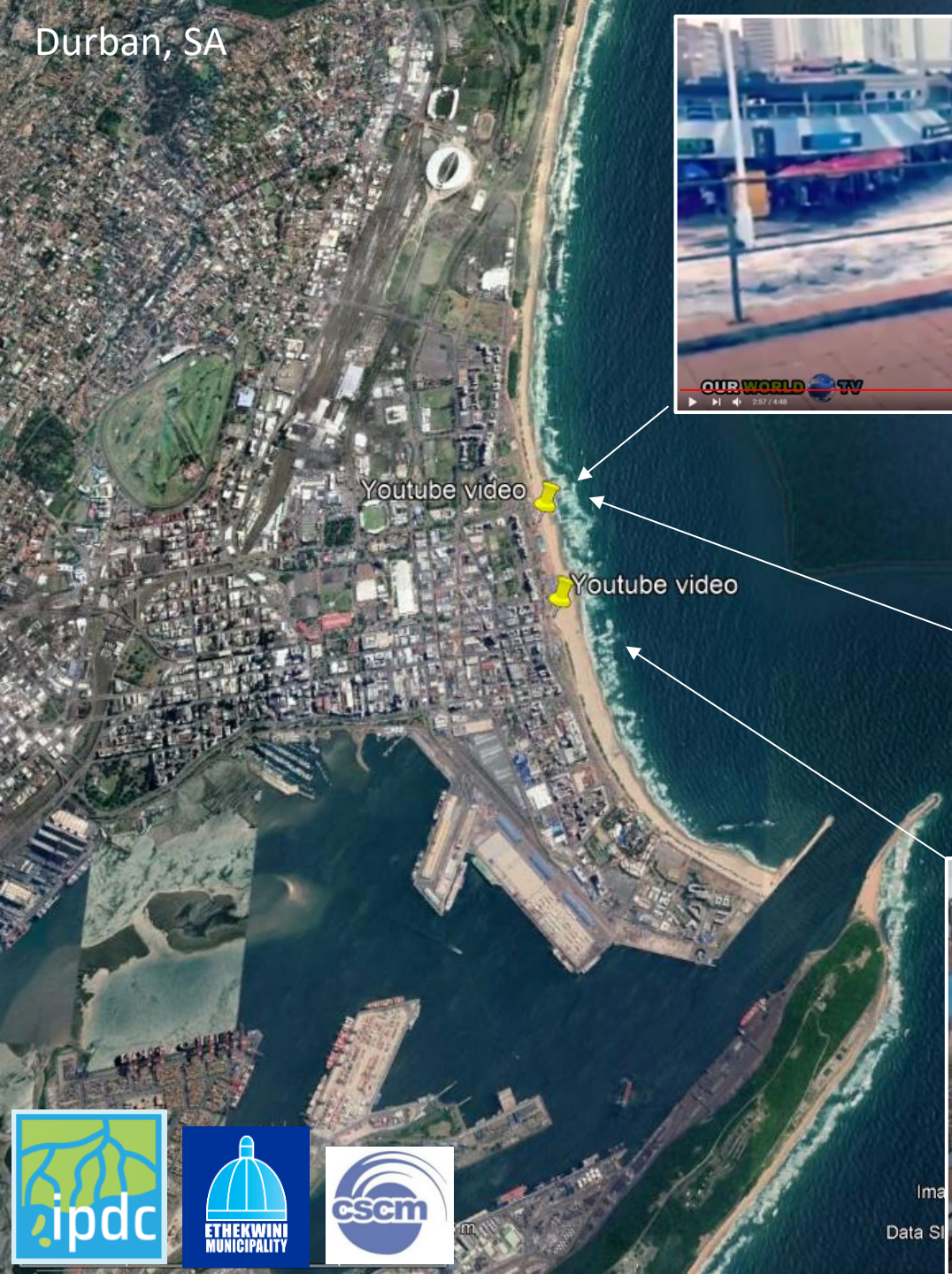
- **SWAN**: TWO-DIMENSIONAL SHALLOW-WATER WAVE MODEL (PHASED-AVERAGED)
- **XBEACH**: ONE- OR TWO-DIMENSIONAL MODEL TO COMPUTE WAVE TRANSFORMATION AND SEDIMENT TRANSPORT AT THE COAST

SFINCS

- **SFINCS**: COASTAL INUNDATION MODEL

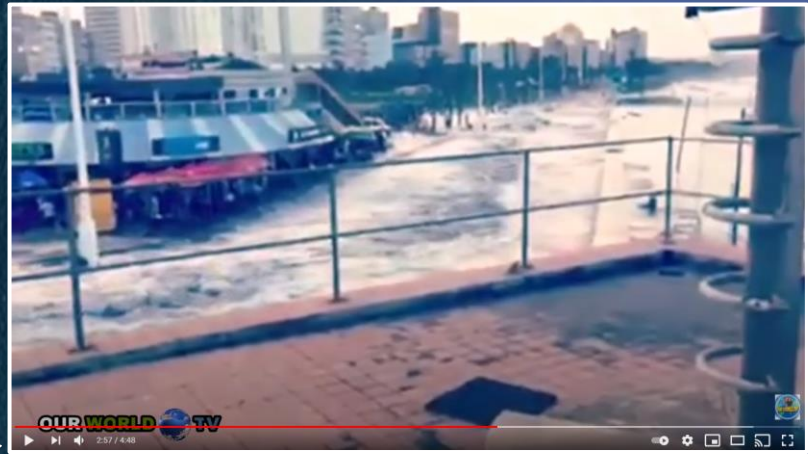


Durban, SA



Youtube video

Youtube video

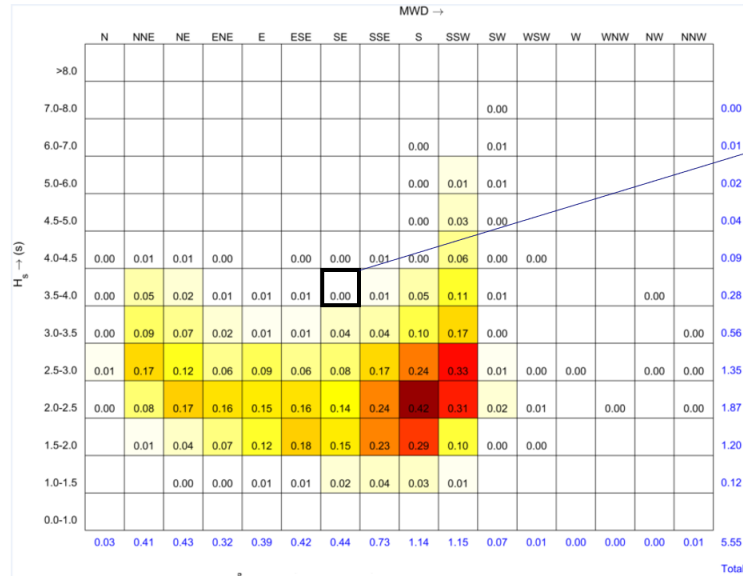


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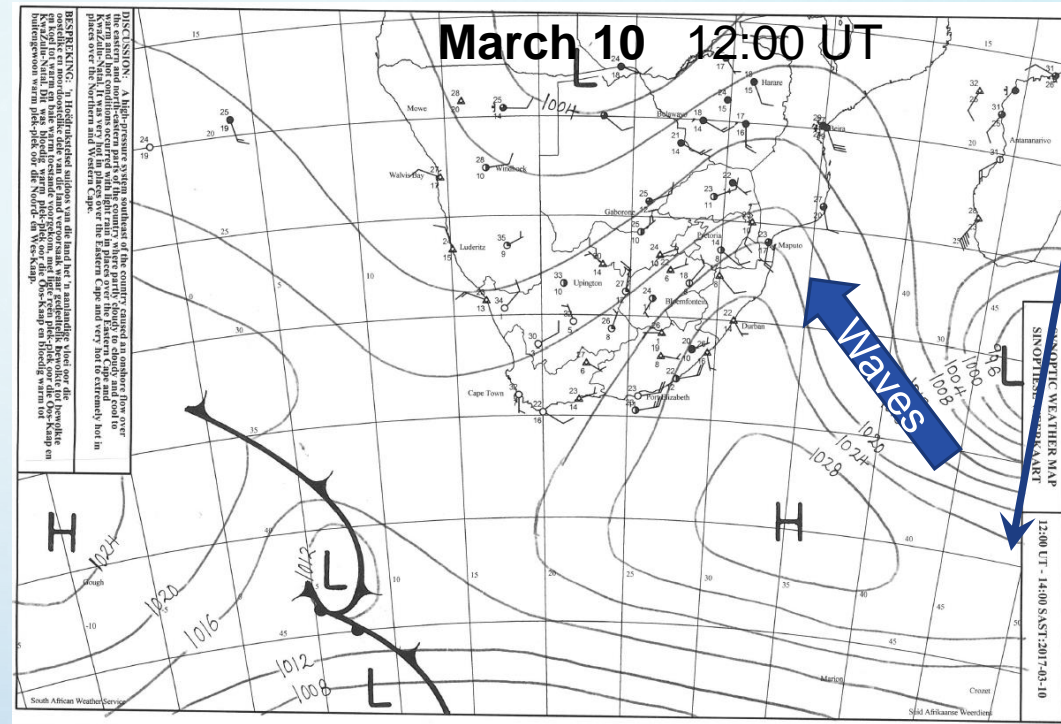
Scenario?

Investigate!

Joint occurrence: Hs vs MWD for WL > MSL +0.7m



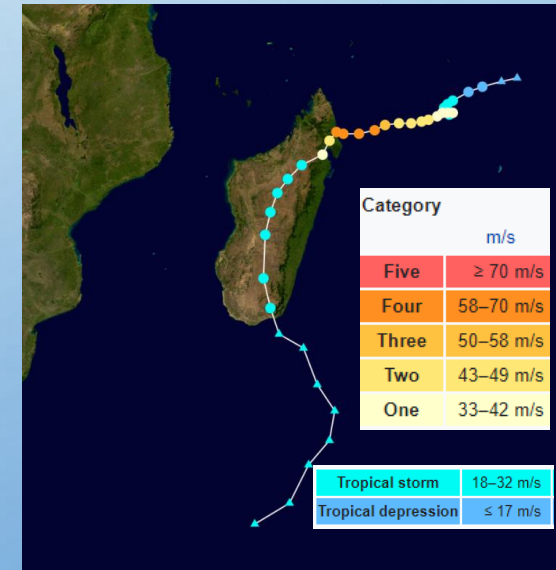
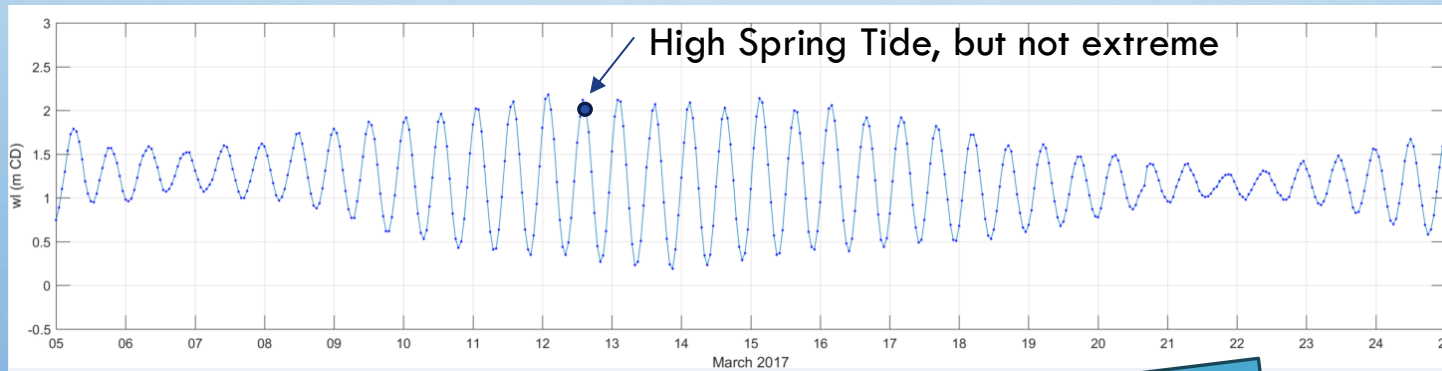
Hs = 3.85m
MWD: SE
WL = MSL +1.25m



Enawo Tropical Storm



Enawo over Madagascar on 8 March



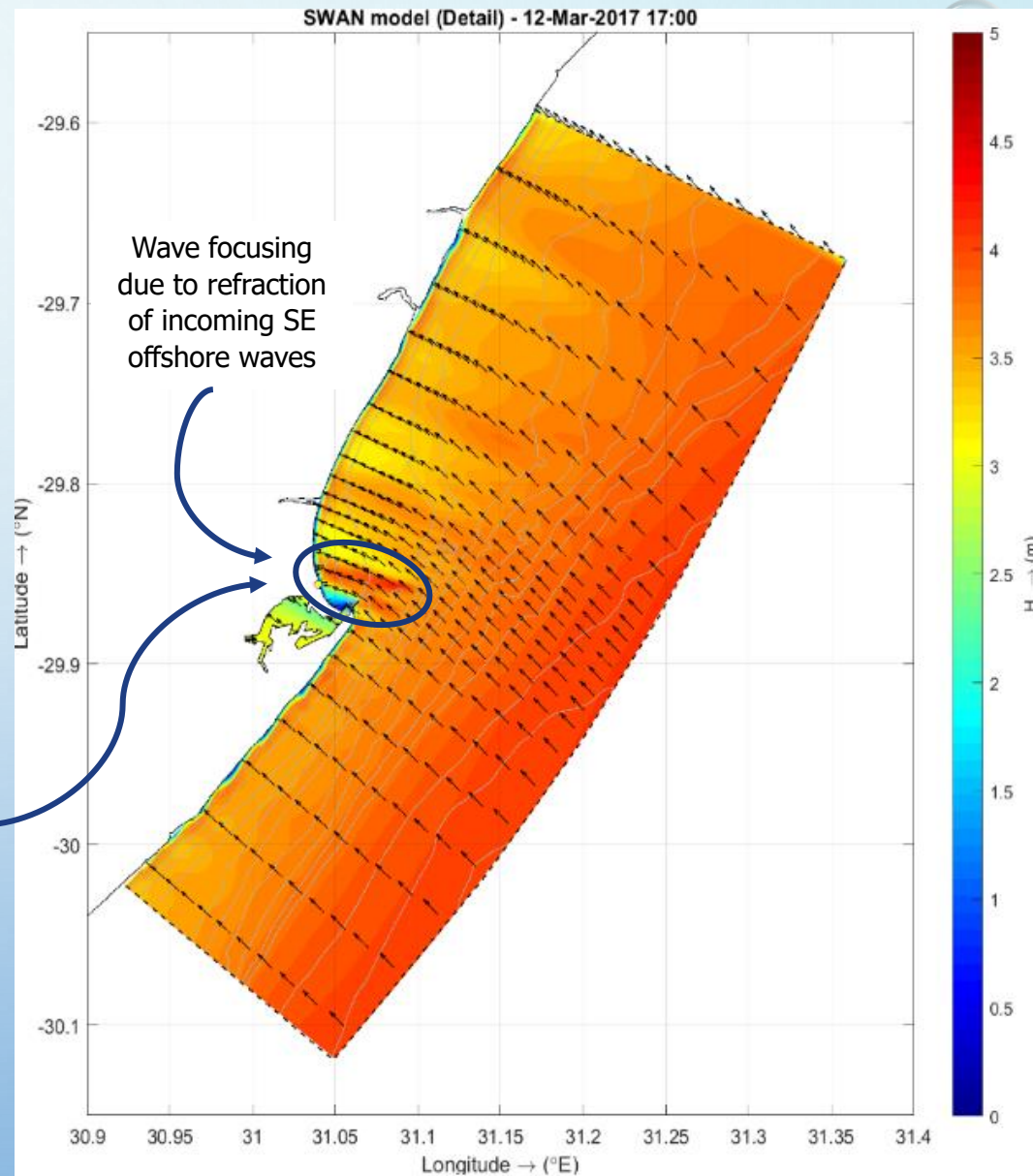
No report of tsunamis in Indian Ocean

The Model

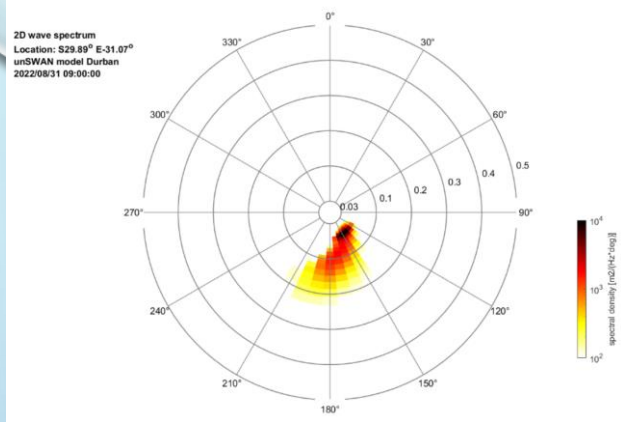
- SWAN Wave Model
- Unstructured Grid
- Extent: 150 km long-shore, 60 km cross-shore
- 3 open boundaries (north, east and south)
- Coarse resolution (2 km) in deep water, high resolution (20 m) along the coast
- Forcing: Tide, Wind, Wave Height, Wave Direction



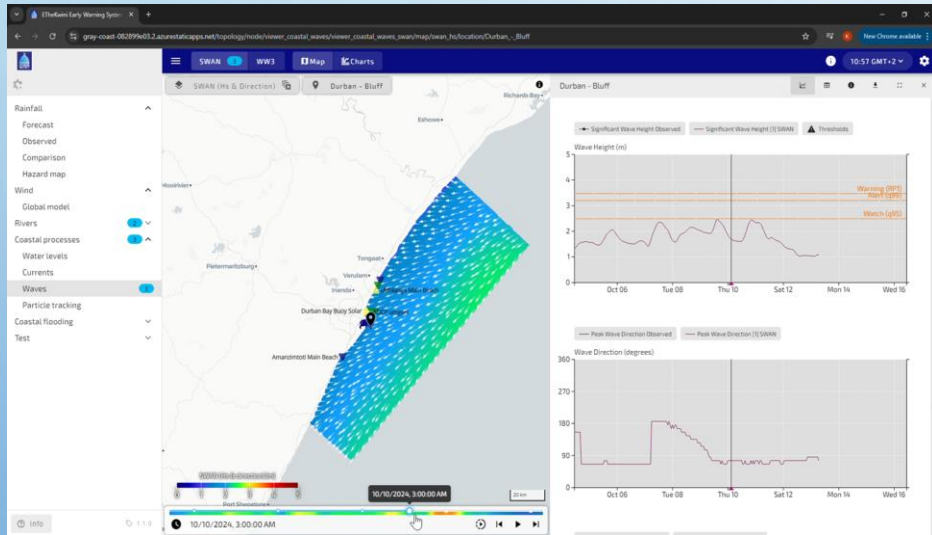
Source: Youtube



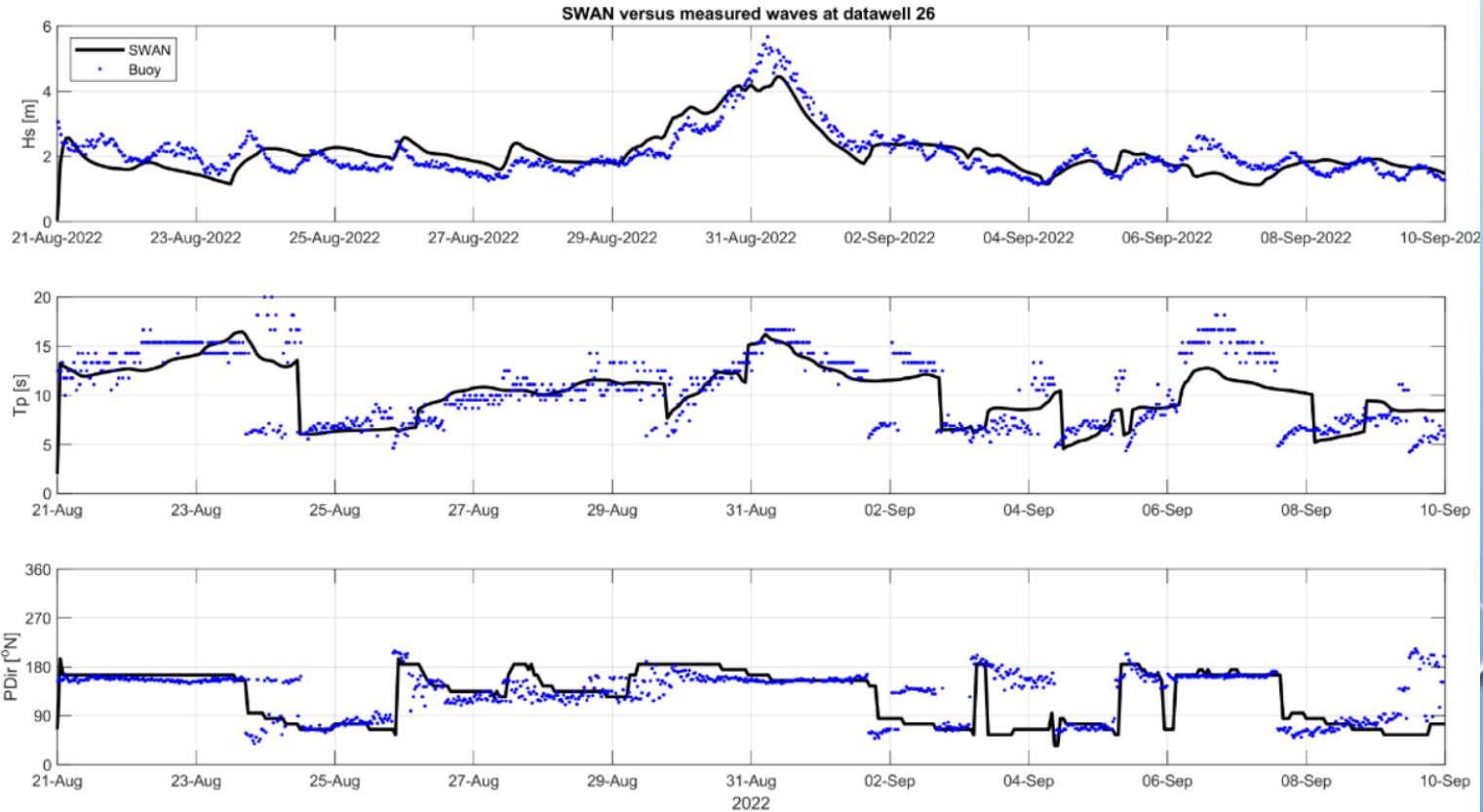
Model Comparisons



Wave Rose

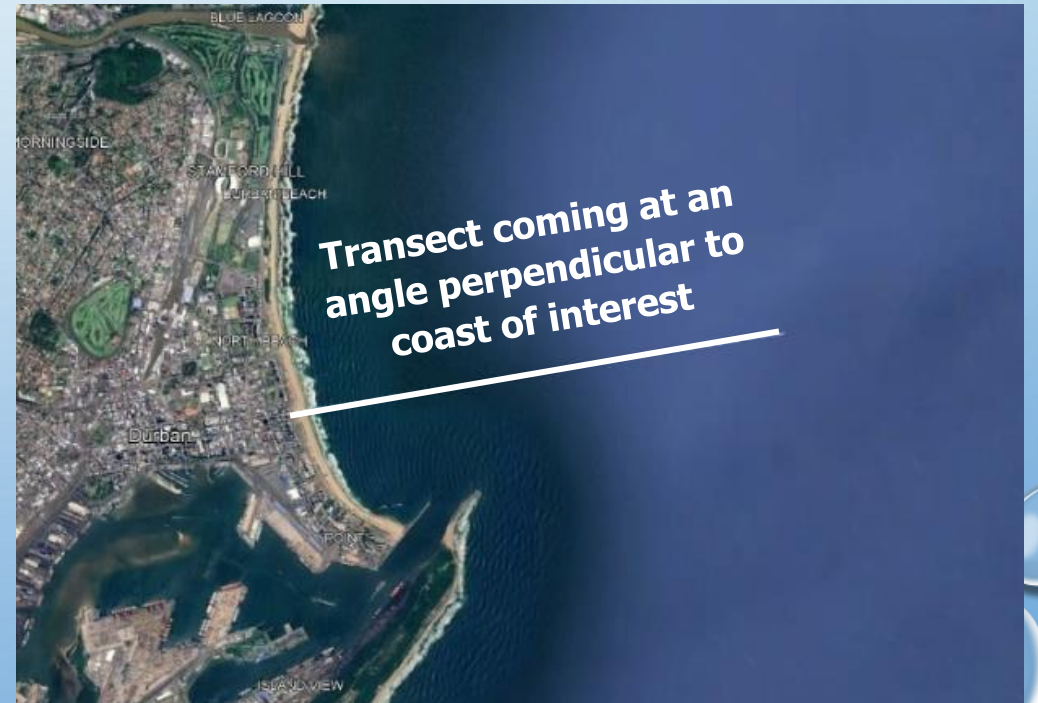


Wave Height (H_s),
Wave Period (T_p),
Wave Direction (P_{dir})

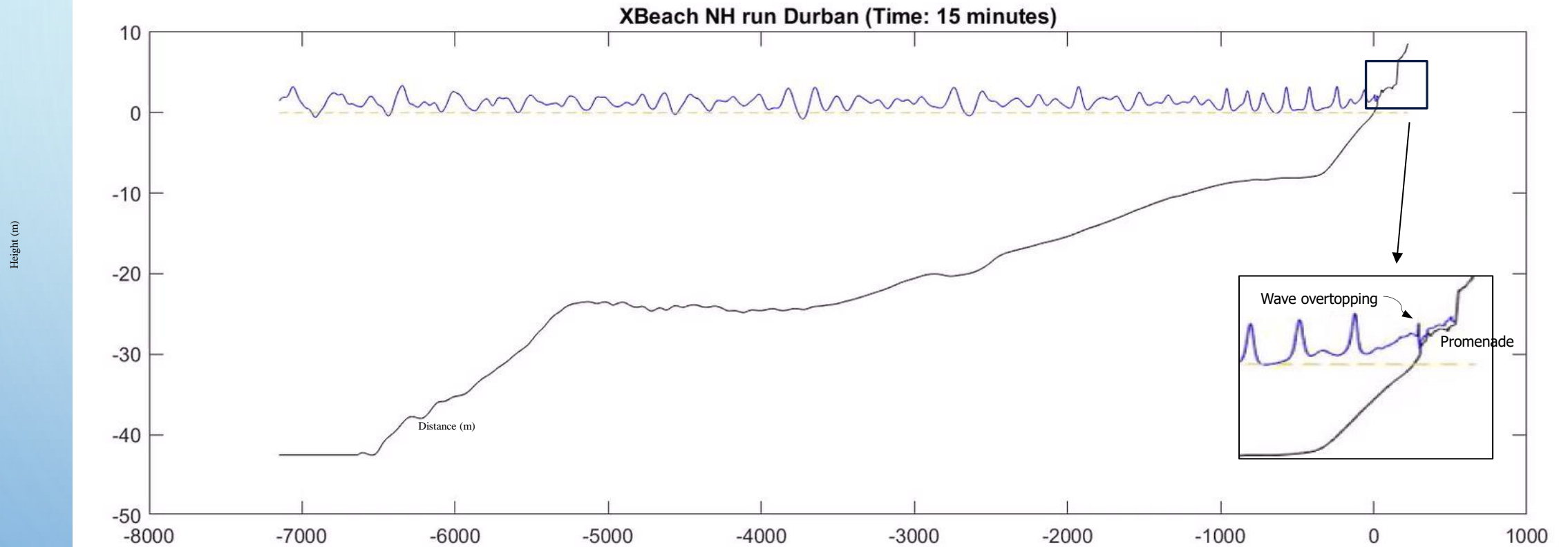


The Model

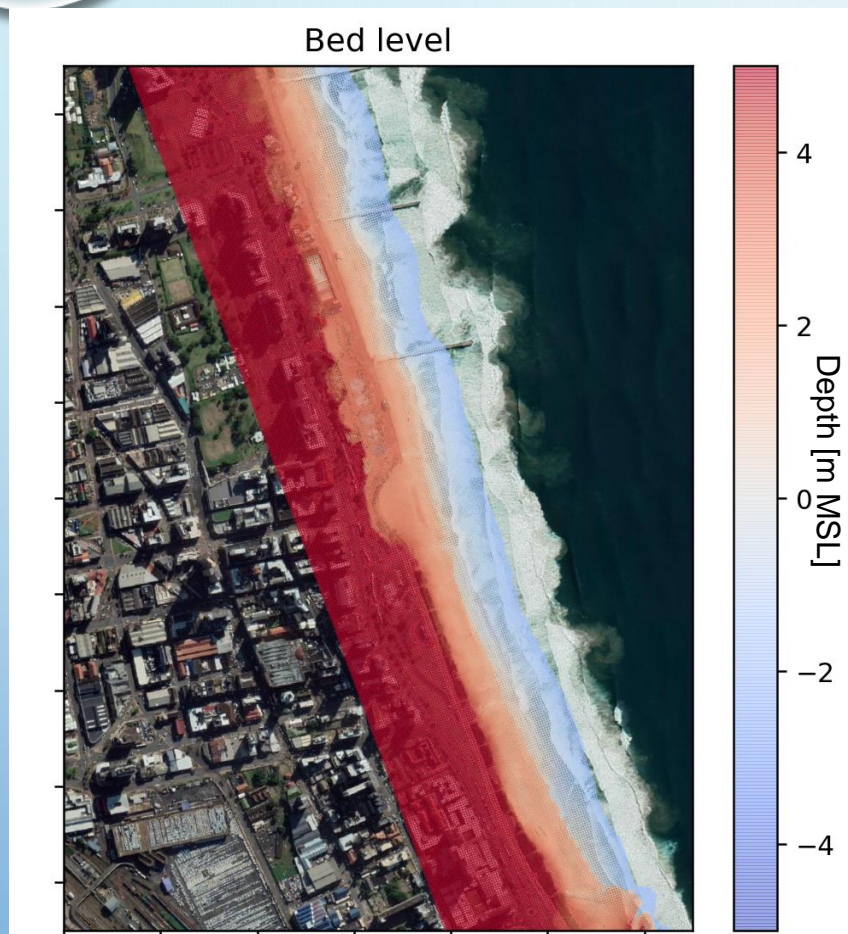
- X-Beach 1D Model
- Forced offshore with a Jonswap spectrum
- Extent: 1D transect out to 40m water depth
- $H_{m0} = 3.9$ (Significant wave height offshore)
- $T_p = 15.3$ (Peak period)
- $z_s = 1.25\text{m}$ above MSL (tidal water level)
- Forcing: Tide, Wind, Wave Height, Wave Direction



X-Beach 1D Model Results



The Model



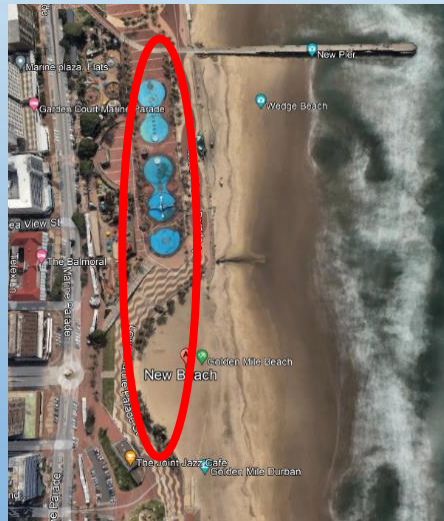
- Overland Flood Model
- Extent: 1D transect out to 40m water depth
- Boundary conditions = Incoming waves + tide (1.25m above MSL) + wave setup
- Promenade topography where topo > 1.5m above MSL was taken from eThekweni Lidar
- eThekweni bathy survey was merged with topography
- Split water level into in- and outgoing wave components at 2m water depth - only incoming waves contribute to inundation

Flooding

Compare



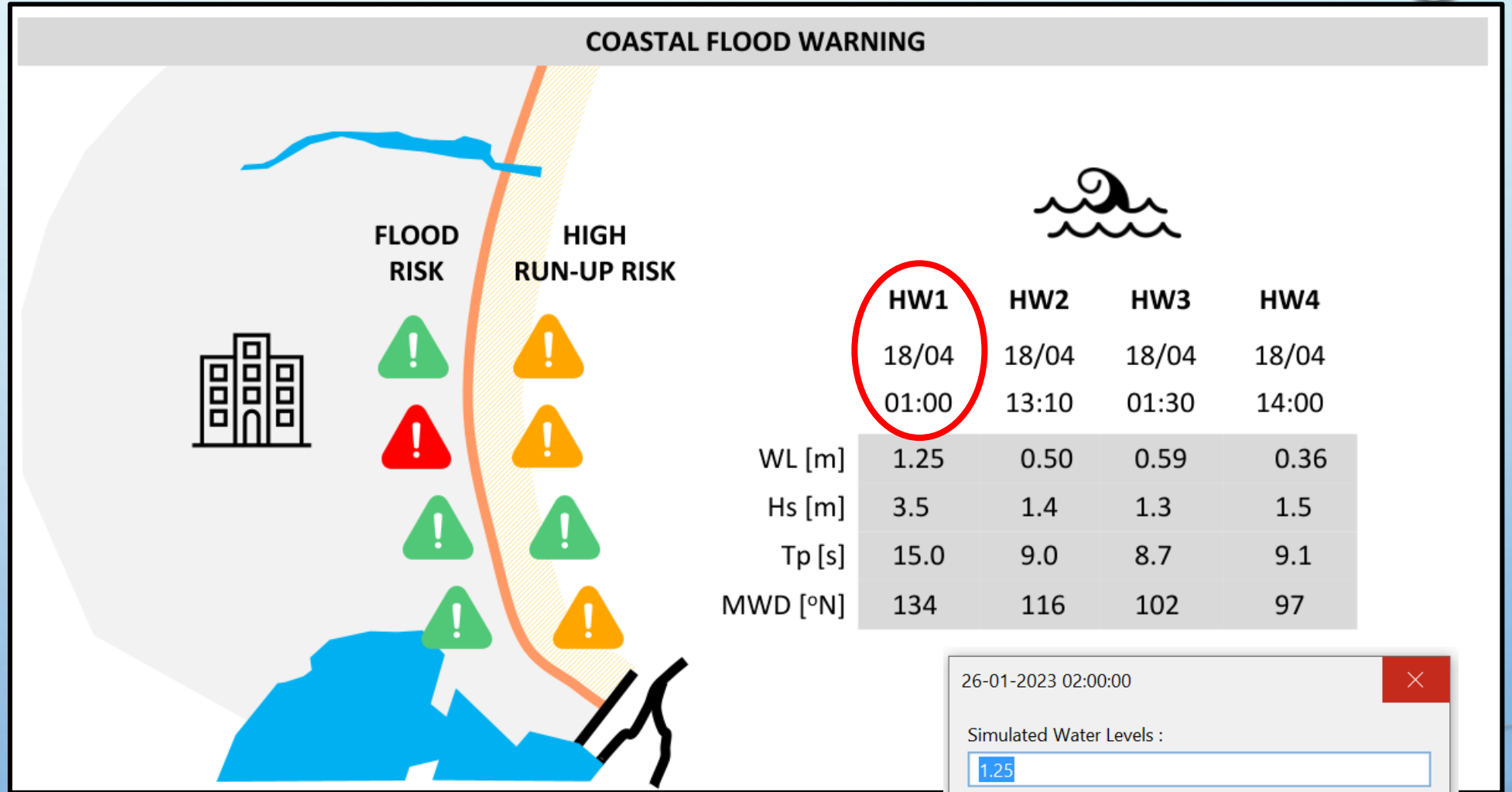
Source: Youtube



Flooding

Running Operationally in FEWS

**Overland
Flooding**



26-01-2023 02:00:00

Simulated Water Levels :

OK Cancel



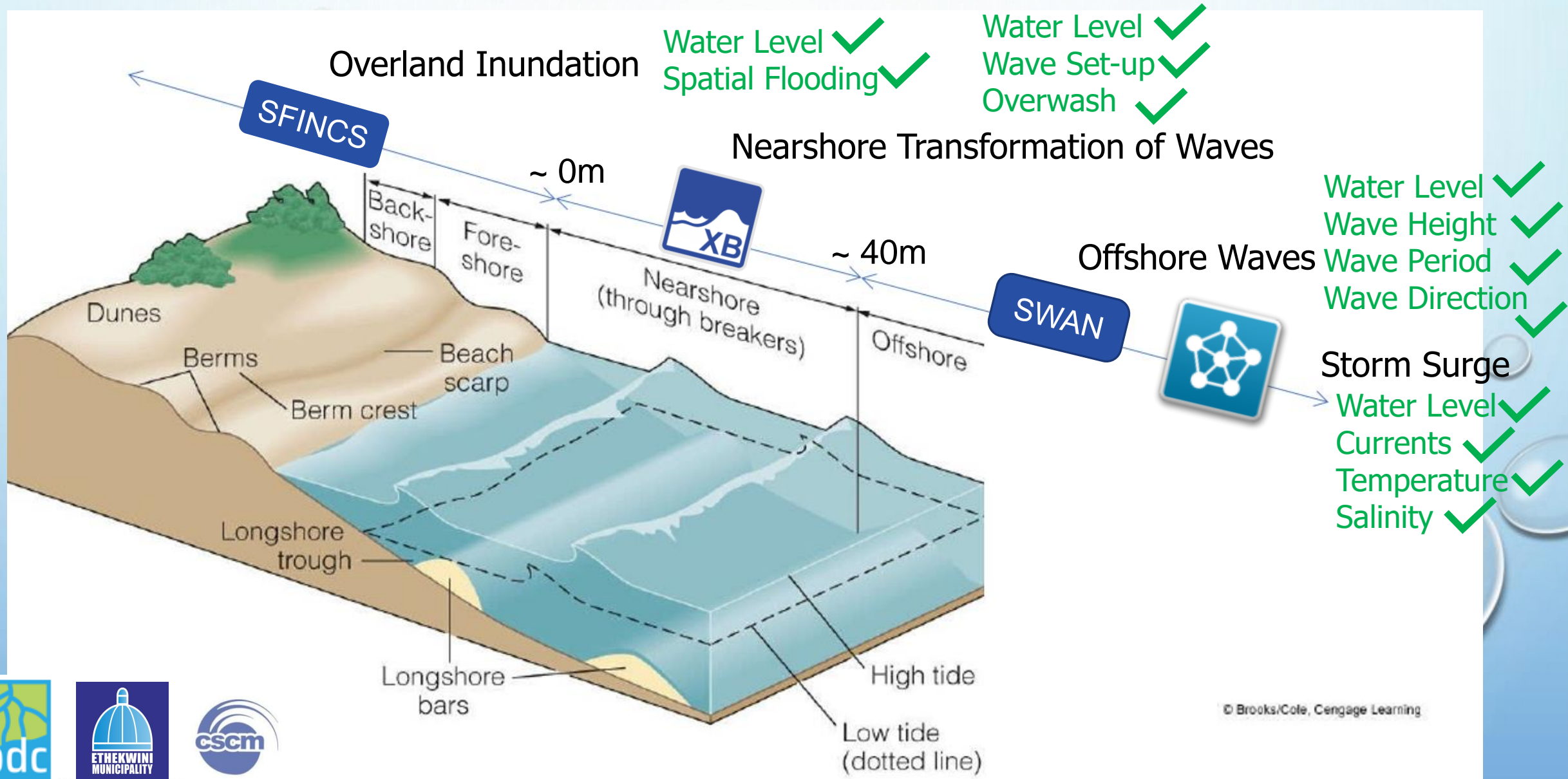
BENEFITS AND ACTIONS FROM COASTAL FLOOD PREDICTIONS

- KEY BENEFITS OF FORECASTING:
- EARLY WARNINGS: PREDICTING COASTAL FLOODING ALLOWS AUTHORITIES TO ISSUE ALERTS IN ADVANCE, GIVING RESIDENTS AND BUSINESSES TIME TO PREPARE.
- TARGETED RESPONSE: IDENTIFYING WHICH AREAS ARE MOST AT RISK (E.G., SPECIFIC PARTS OF THE PROMENADE OR BEACH) ENABLES FOCUSED EVACUATION OR FLOOD PROTECTION EFFORTS.
- IMPROVED RESILIENCE: HELPS LOCAL PLANNERS DESIGN INFRASTRUCTURE THAT CAN WITHSTAND FUTURE FLOODING EVENTS AND RISING SEA LEVELS.
- CONCLUSION: THE INTEGRATION OF OCEAN AND NEARSHORE WATER FORECASTING INTO FLOOD MANAGEMENT WILL HELP DURBAN STAY AHEAD OF DISASTERS, MINIMIZE DAMAGE, AND PROTECT BOTH PEOPLE AND PROPERTY ALONG THE COAST.



CONCLUSION:
KEMIRA NAIDOO

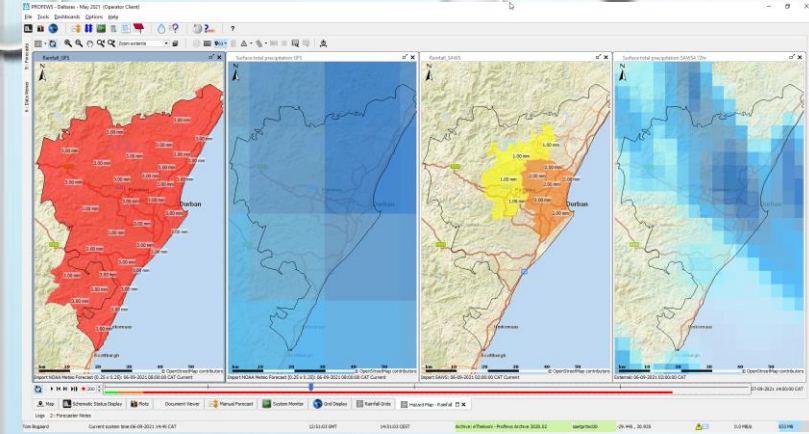
HYDRODYNAMIC MODELLING AT ETHEKWINI COAST



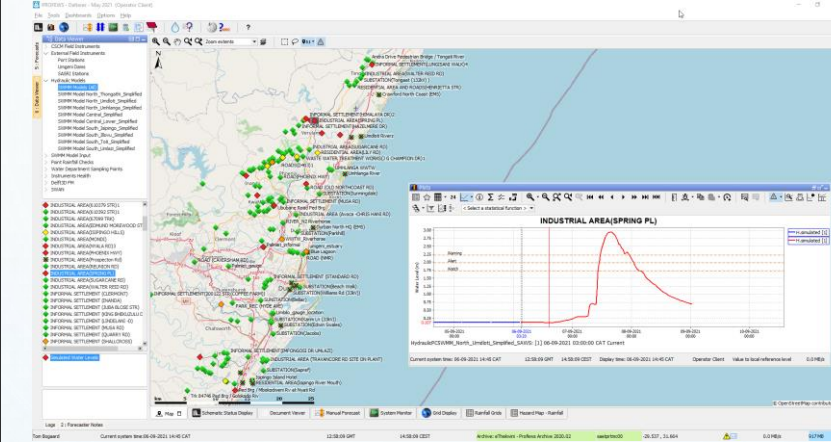
© Brooks/Cole, Cengage Learning

eThekwi FEWS

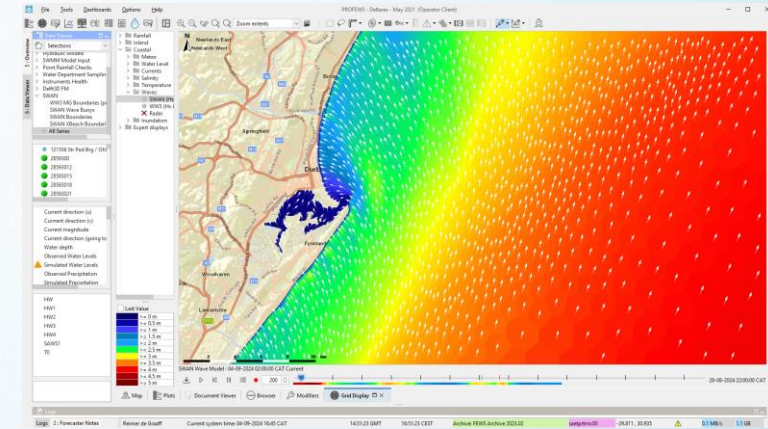
Rainfall Forecasts and Fluvial Modelling (SWMM)



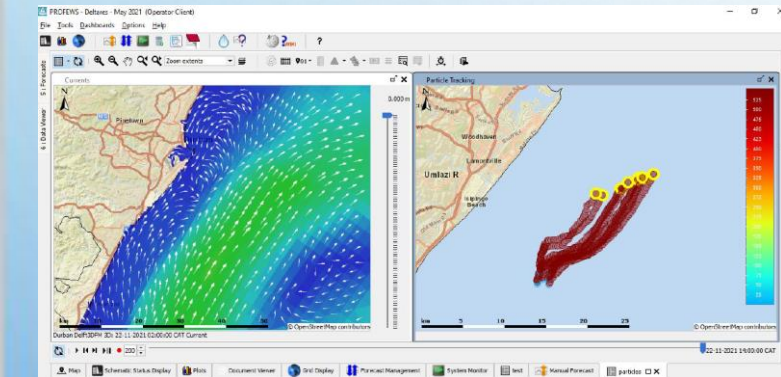
Observations and External Forecasts



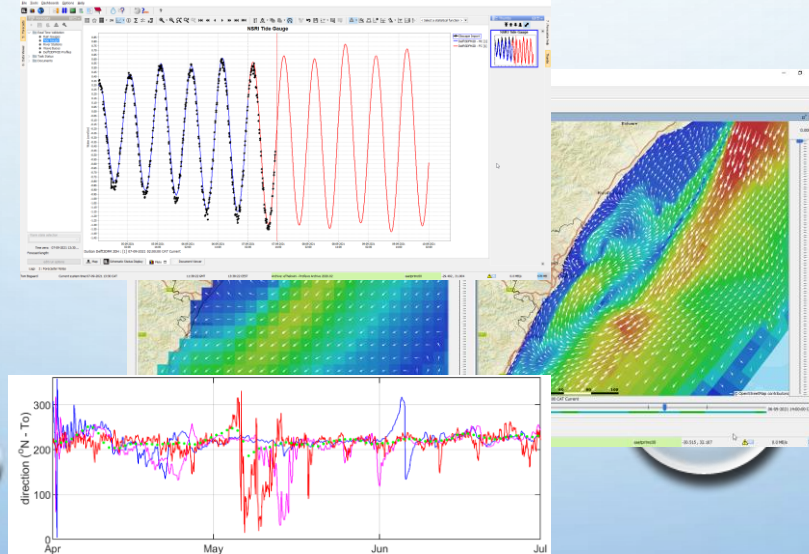
Wave Modelling (SWAN)



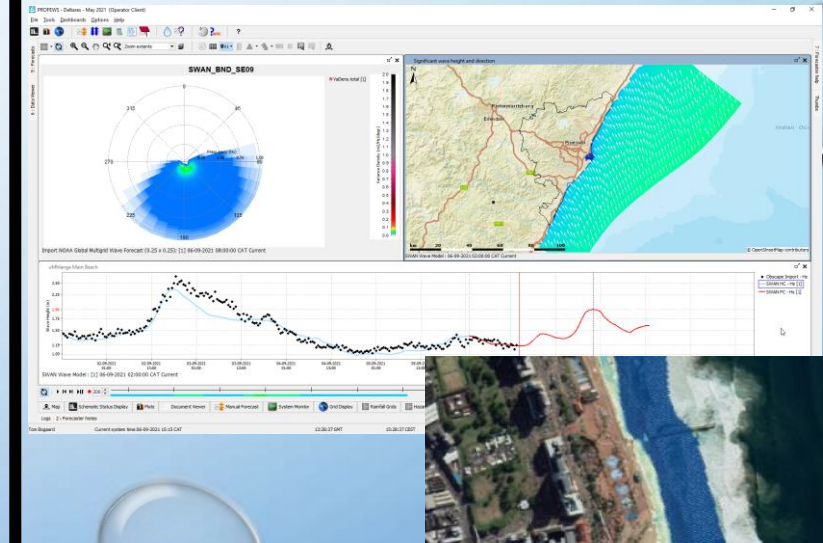
Particle Tracking Module



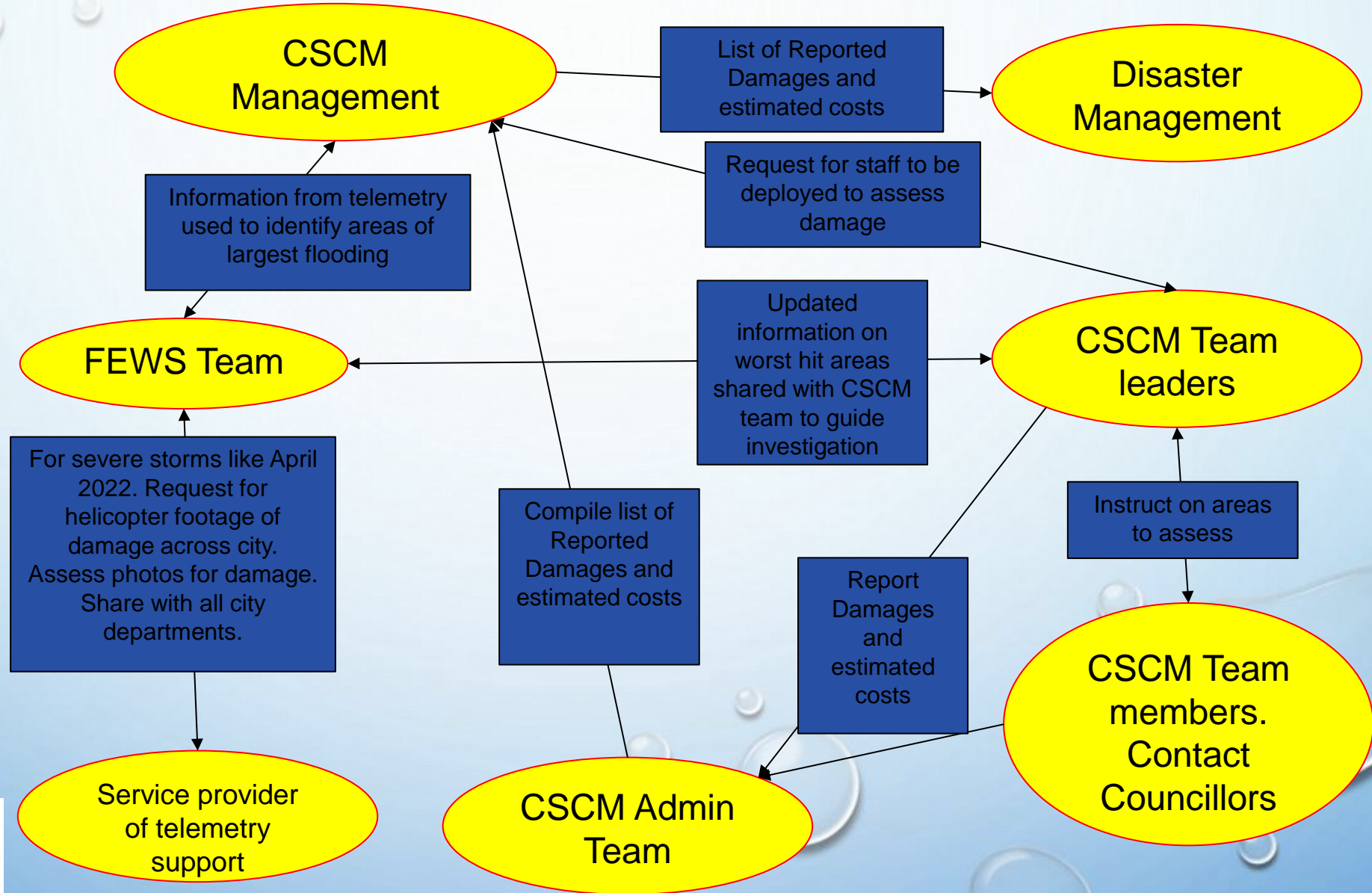
Hydrodynamic Modelling (Delft3D-FM) and Comparisons

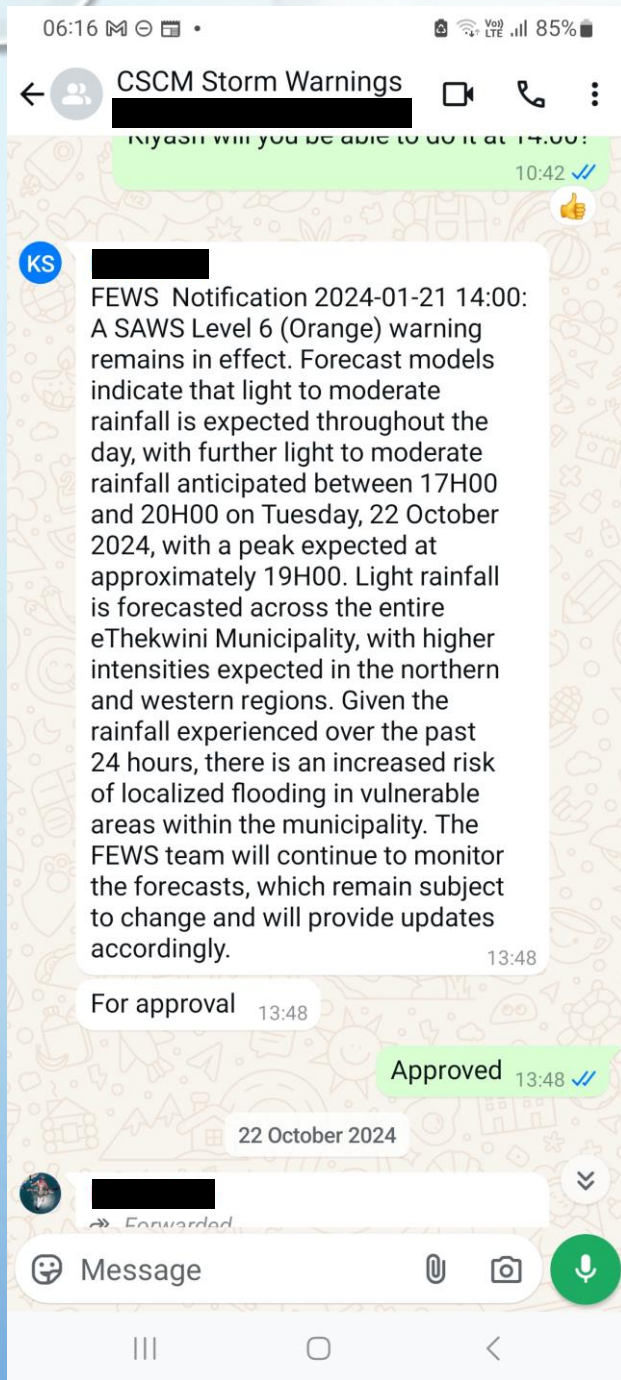


Coastal Inundation (XBeach/SFINCS)

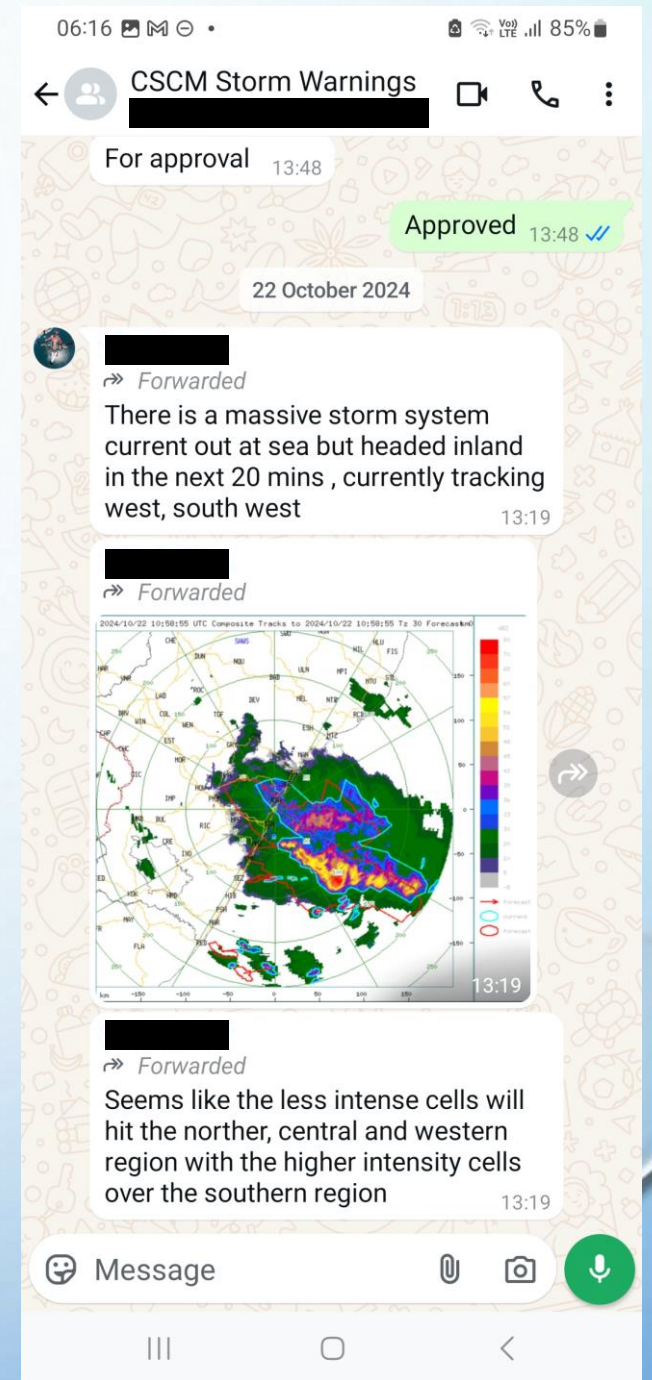


ROLE PLAYERS DURING STORM EVENT

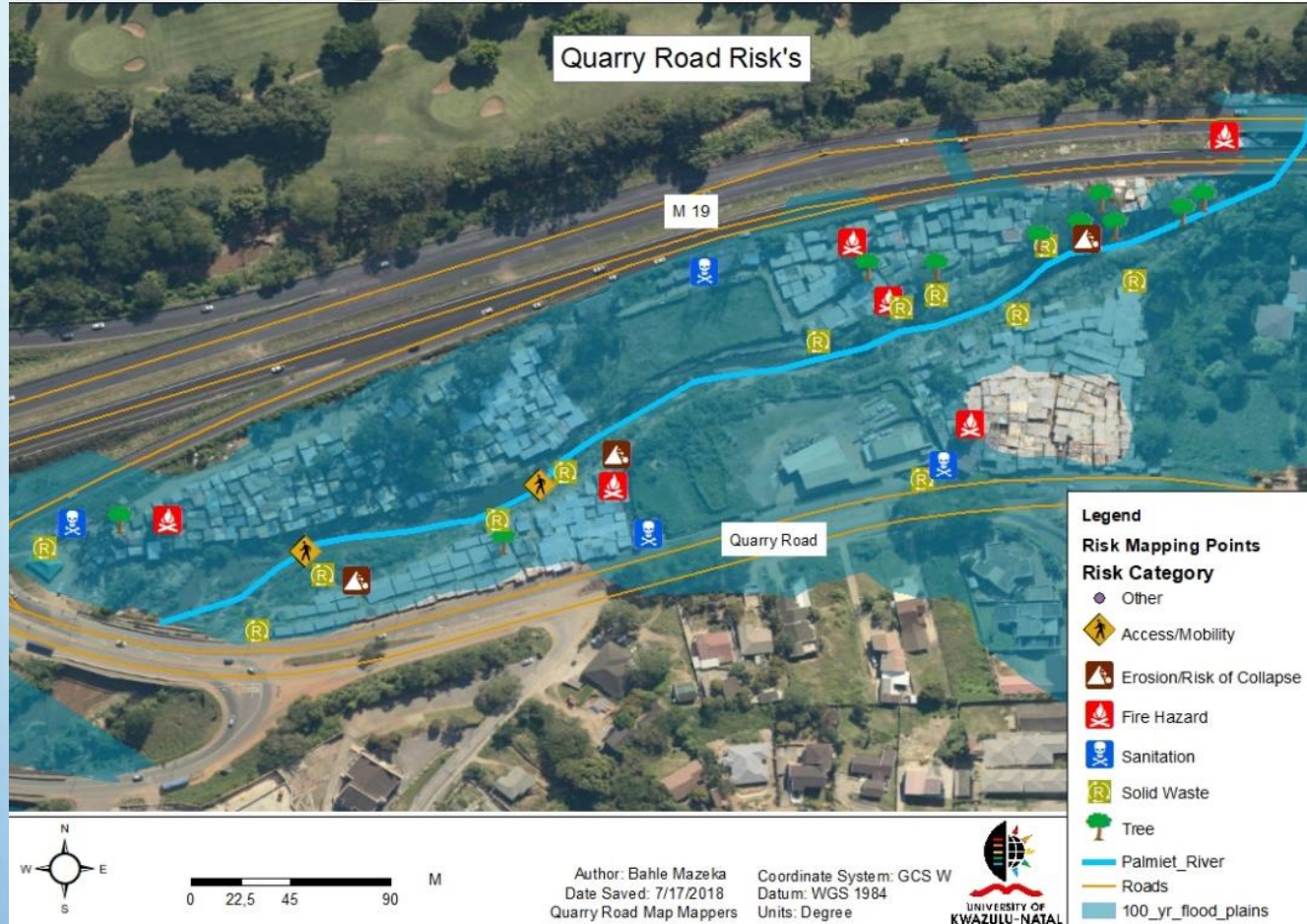




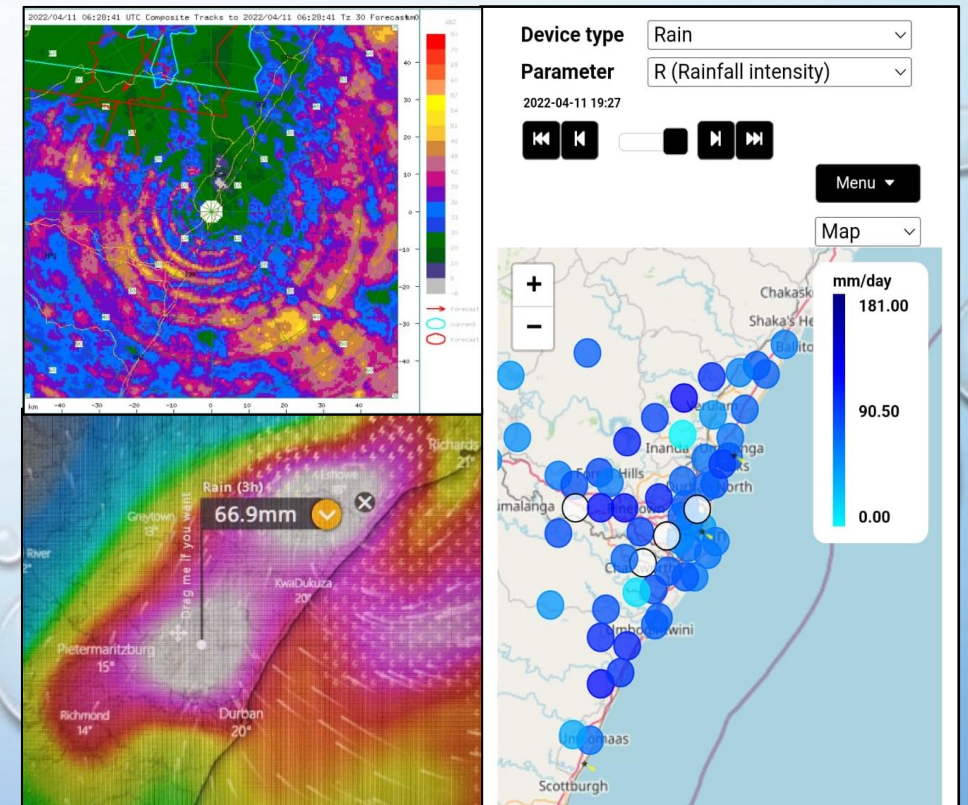
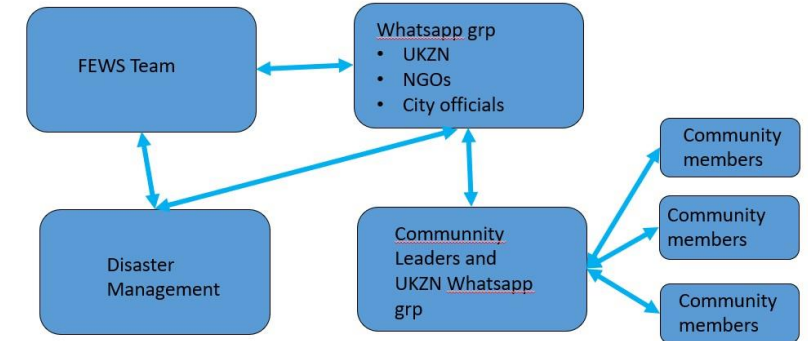
TYPICAL NOTIFICATIONS FOR INTERNAL DEPARTMENTS



INFORMAL SETTLEMENT LIAISON



Quarry Road West Informal Settlement Communication plan



The Way Forward...

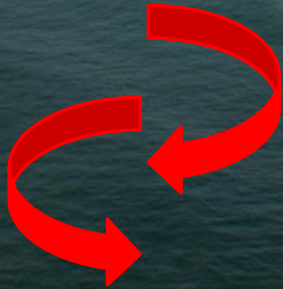
- **Continuous validation of all models**
- **Updated bathymetry**
- **Updated cross-sections**
- **Extend SFINCS to entire eThekweni coastline**
- **Compound SFINCS model for both inland and coastal inundation**



A very big thank you...

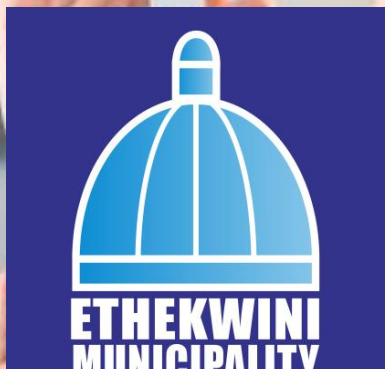


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THANK YOU!



Evacuation and response before and after a cyclone event

Results of a workshop on Mozambique:
cyclone Freddy and Quelimane

Lieke Meijer, Eva Costa de Barros, Roel de Goede and Ap van Dongeren

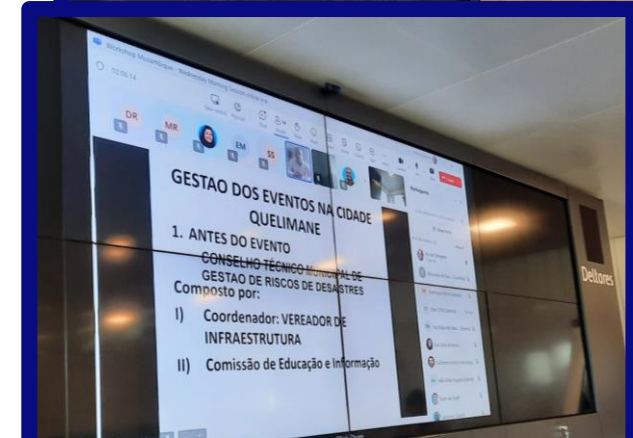
DISCLAIMER: The results presented in this document are experimental and based on global datasets. These results have not been validated and should be interpreted with caution. No actions or decisions should be made solely based on the information provided herein.

Enhancing Flood Management in Mozambique Participatory Workshop

Objective: Workshop for representatives from Beira and Quelimane and the UN World Food Programme, focusing on flood response strategies.

Key Approach: Integration of flood data (SFINCS model) with road connectivity information (RA2CE model) to identify optimal evacuation routes before, during, and after floods.

Outcome: Empowering local decision-makers to plan effective evacuation and supply distribution routes for vulnerable populations



Before



Which areas are most probably affected by floods?

Who should be warned and evacuated?



What are the evacuation routes to shelters?

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During and After



How can implementing an Early Warning System address the needs of vulnerable communities?

How many people are affected by the floods, and where will they be?



How can they be reached?

Case study, Cyclone Freddy

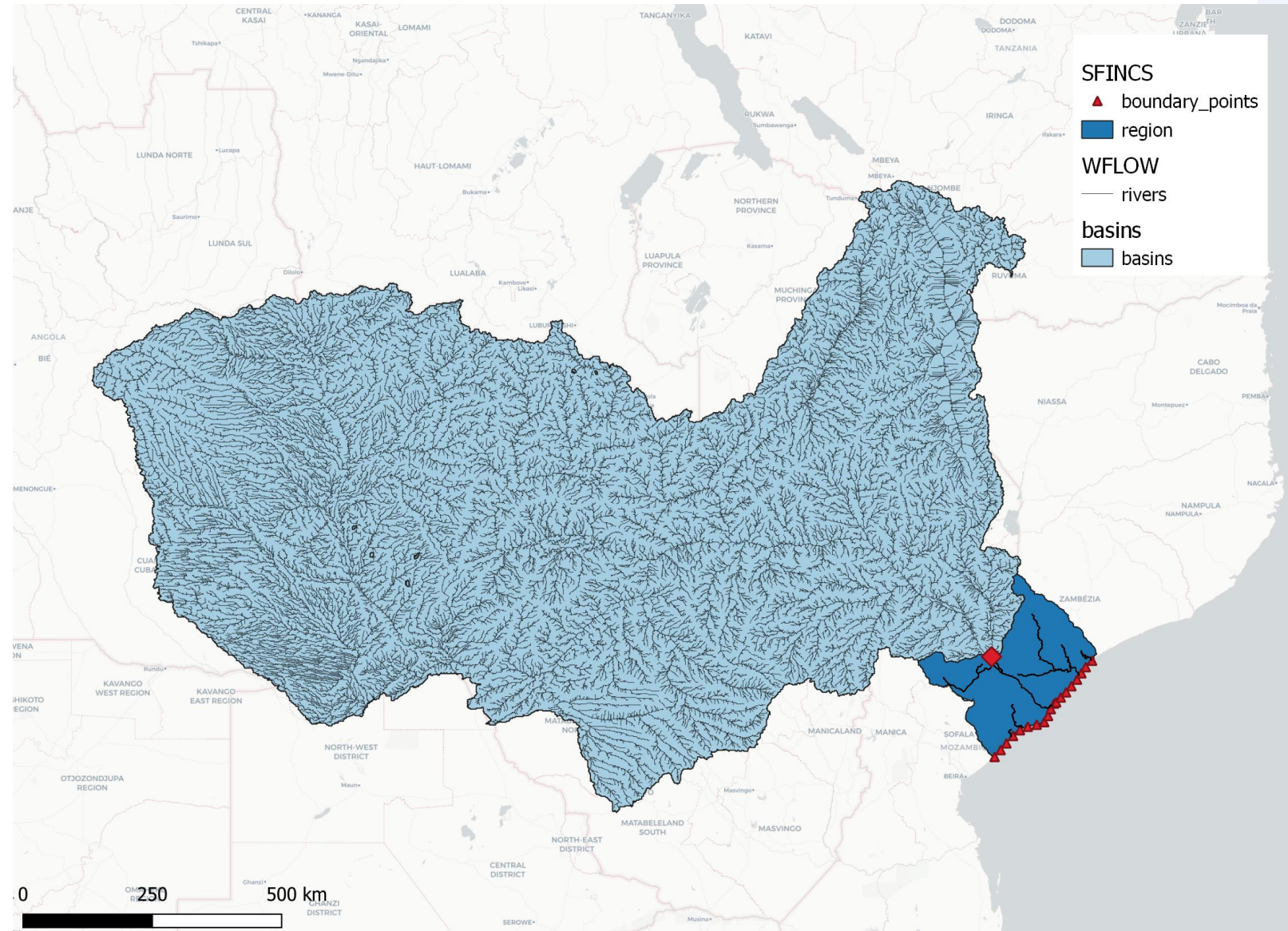
- Tropical cyclone Freddy, the longest cyclone on record
- Multiple landfalls in multiple countries
- Let's zoom in on the situation at Quelimane, Mozambique

The collage consists of several overlapping elements:

- Top Left:** A satellite map of the Indian Ocean region, showing the path of Cyclone Freddy with a blue and white line.
- Top Center:** A street-level photograph showing significant damage and debris, including a damaged car and a building.
- Top Right:** A red header for a news article from '360' with a search icon.
- Middle:** A white text overlay on a dark background that reads "Cyclone Freddy: Deaths and Destruction".
- Bottom Right:** A map of East Africa with a red pin and dashed arrow pointing to Quelimane, Mozambique. Labels for Malawi, Harare, Zimbabwe, Swaziland, and Maputo are visible.
- Bottom Left:** An aerial photograph of a flooded village with houses and trees partially submerged in brown water.
- Bottom Center:** A snippet of a news article with the text "Tropi the lo on re" and "Reco poun secor".

What is SFINCS?

- Fast dynamic flood model
- Compound flooding: precipitation, river discharge, tide and surge
- Coupled to hydrological model to include the discharge from the Zambezi



Flooding affects larger area than the maximum winds

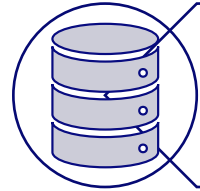


What is the RA2CE impact model?



RA2CE

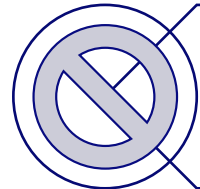
Resilience Assessment and Adaptation
planning for Critical infrastructure (RA2CE)



Flexible python-based model,
open source



Impact of hazards on roads



Accessibility in hazard situation

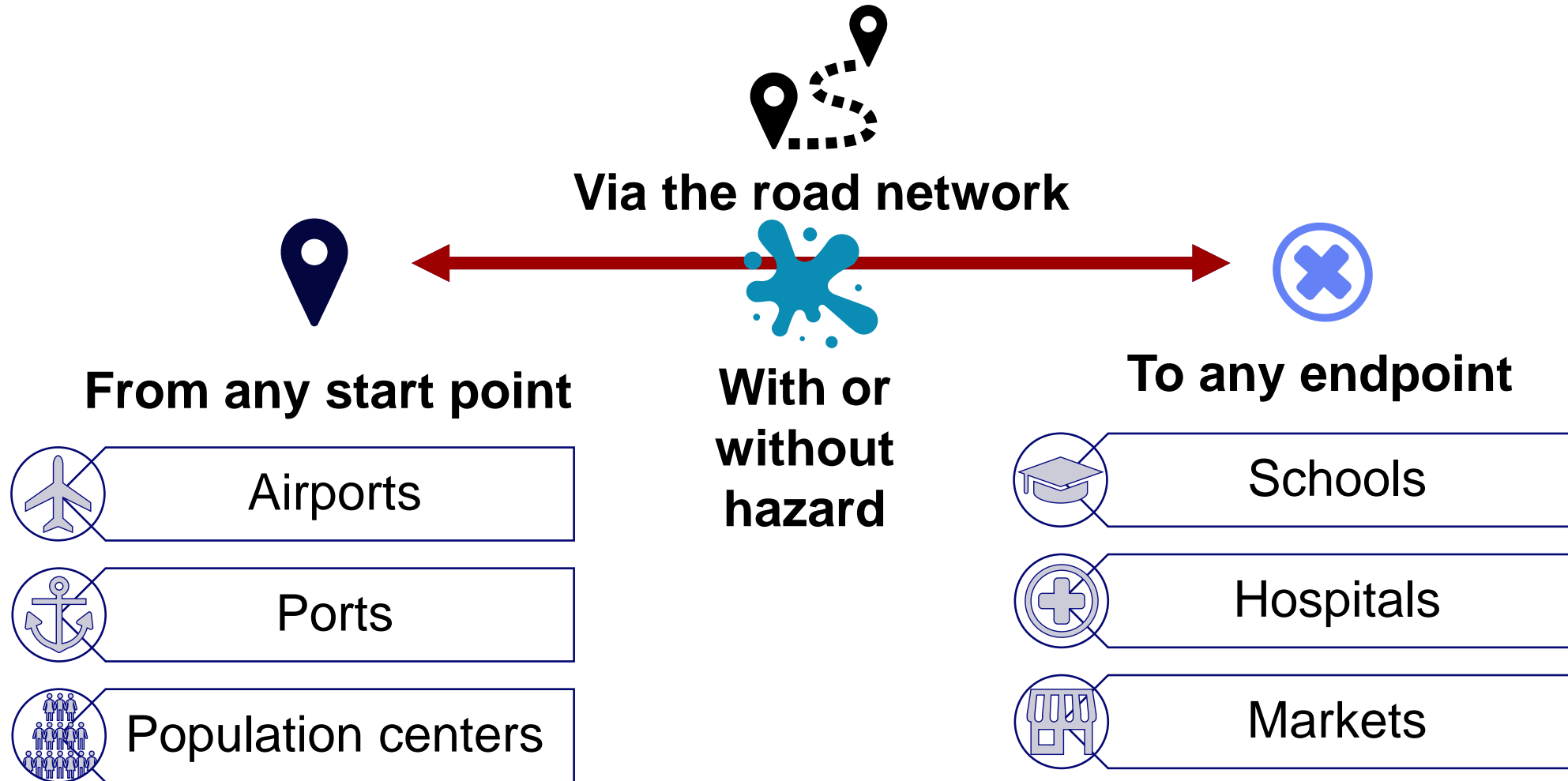


Societal disruption quantification



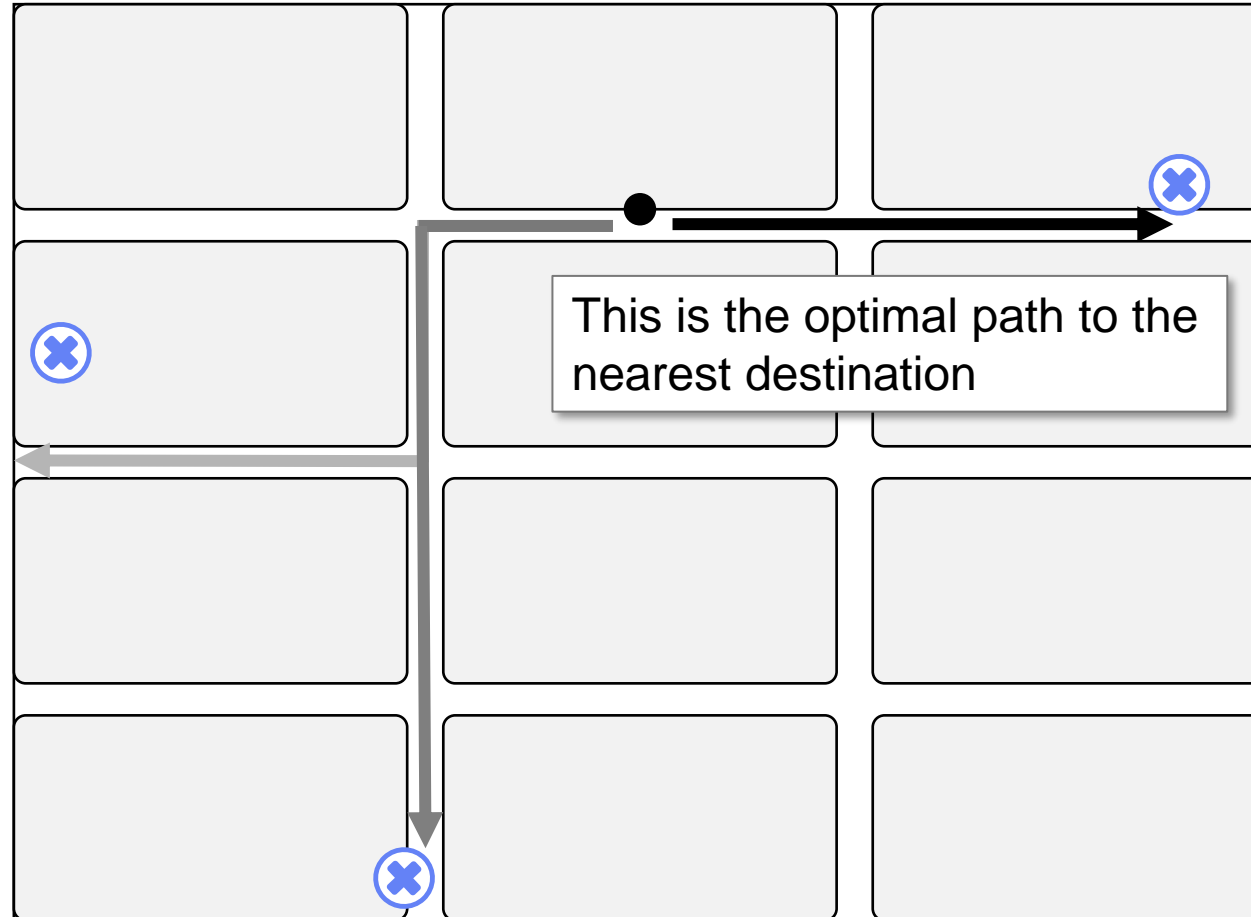
Physical damages to roads

From anywhere to anywhere: 'origin-destination'

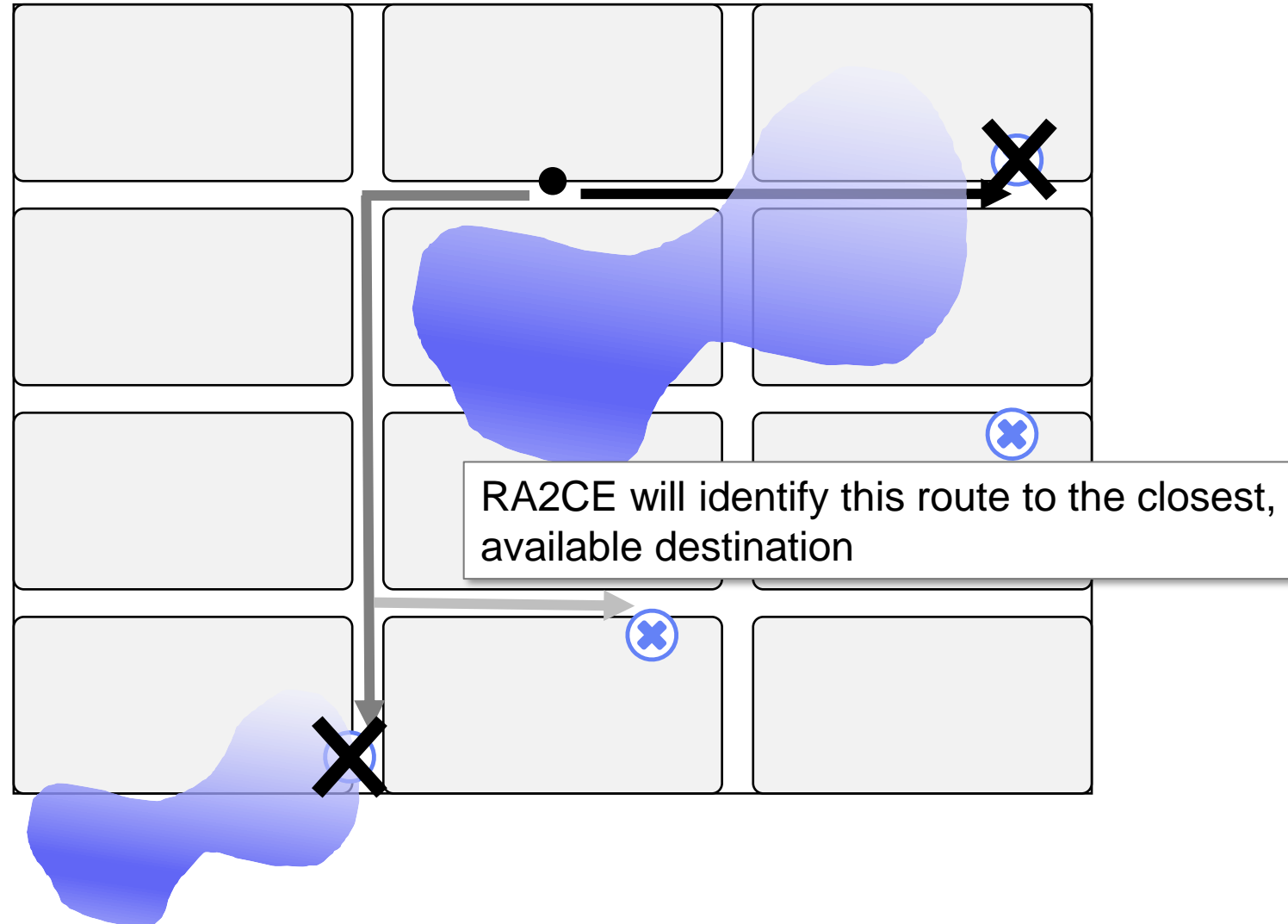


Find optimal path to closest destination

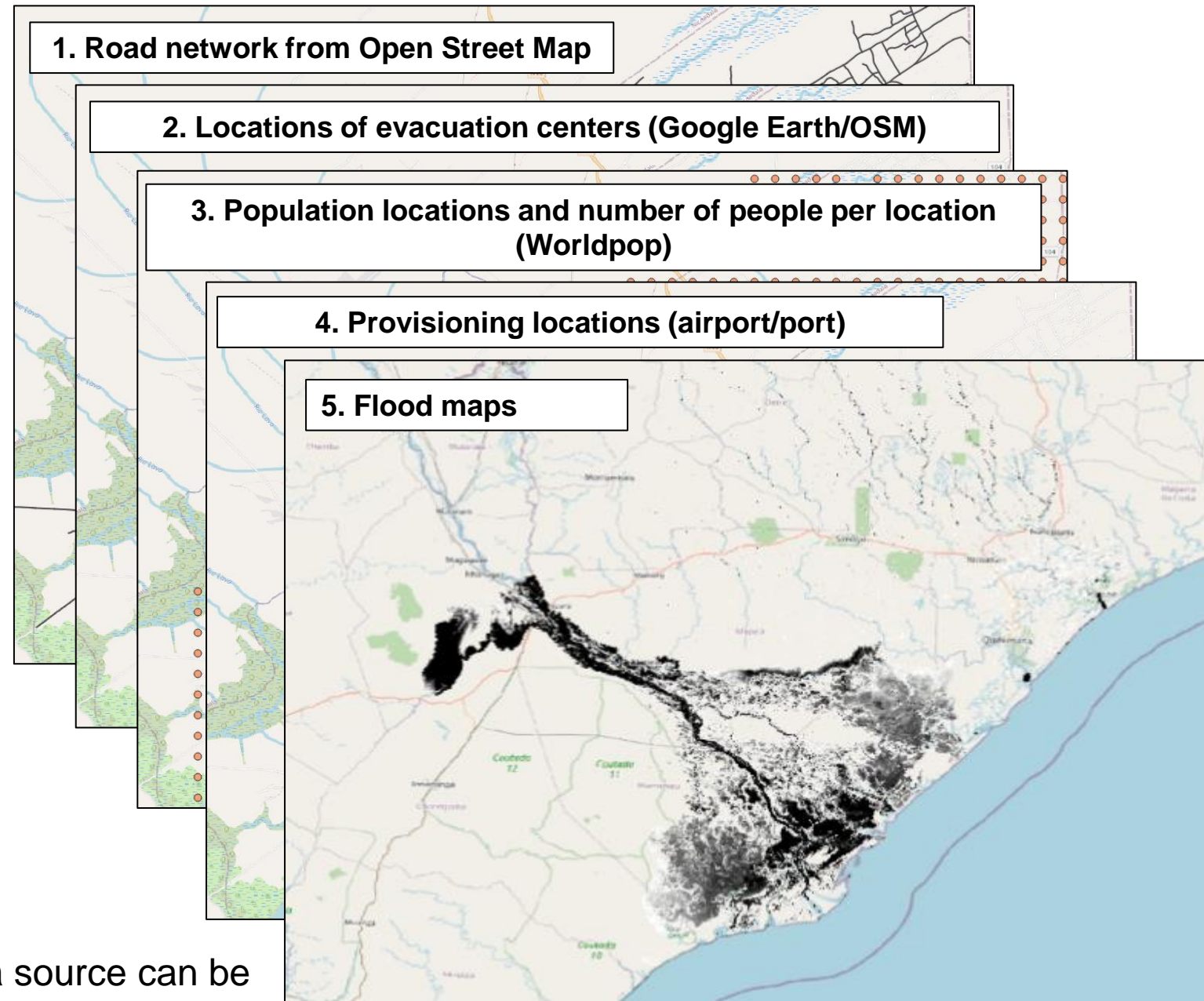
- 'From' = origin
- ⊗ 'To' = destination



Find closest available location during hazard

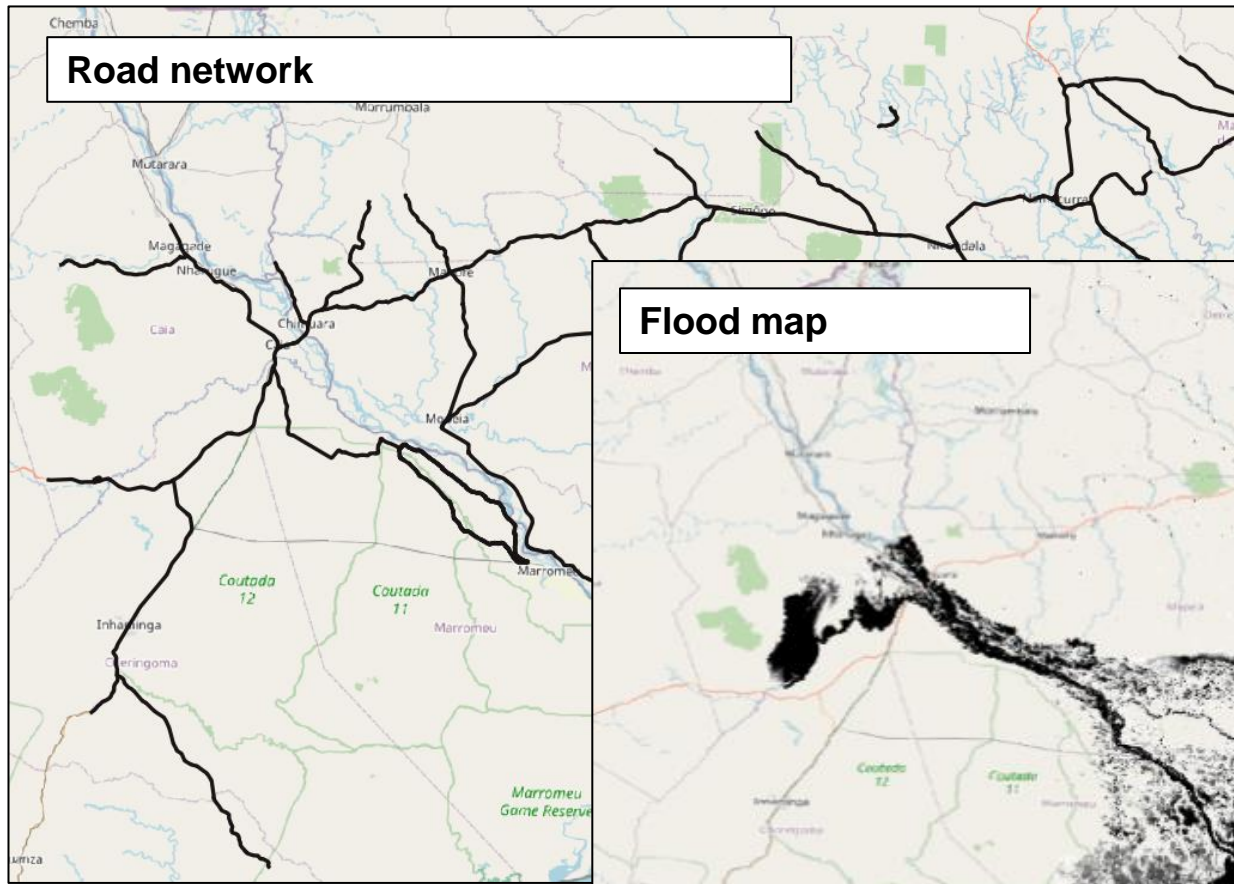


Input data



Our model is flexible! Any data source can be used. For example: local road data or local population data. For any location.

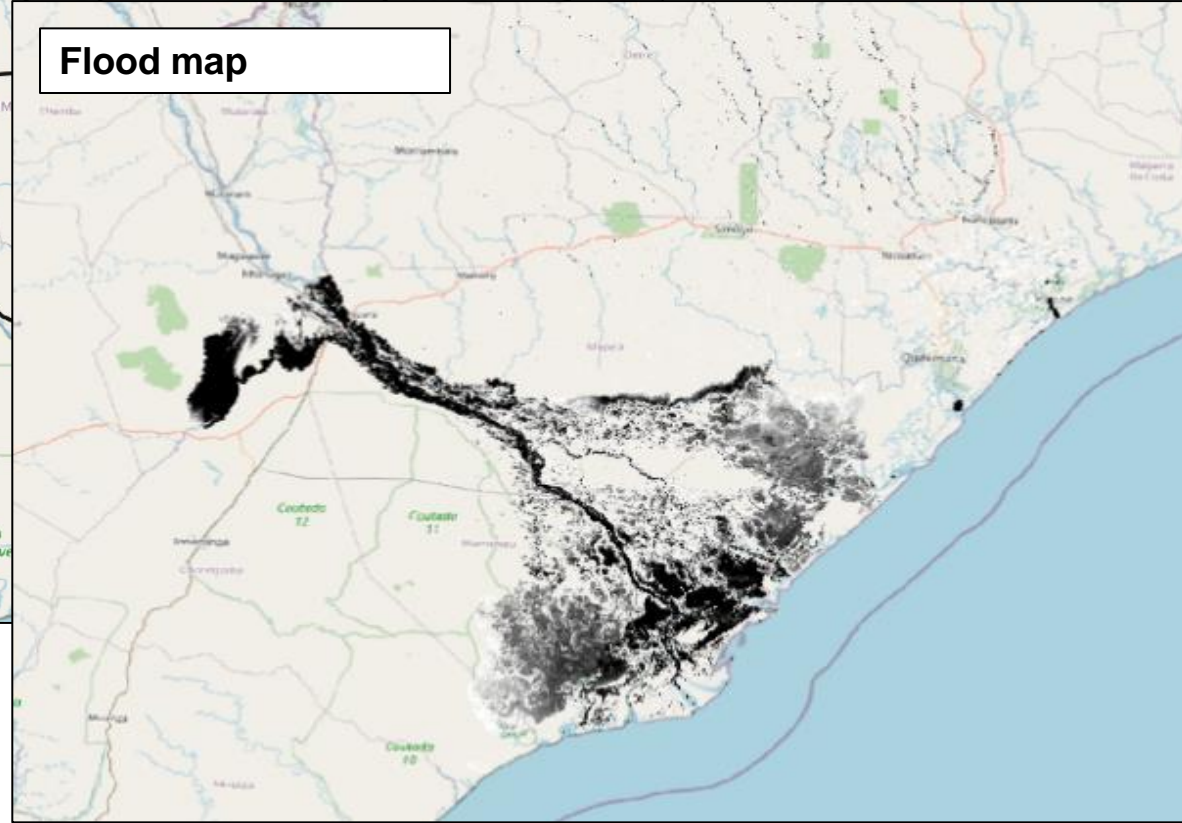
Road network



+

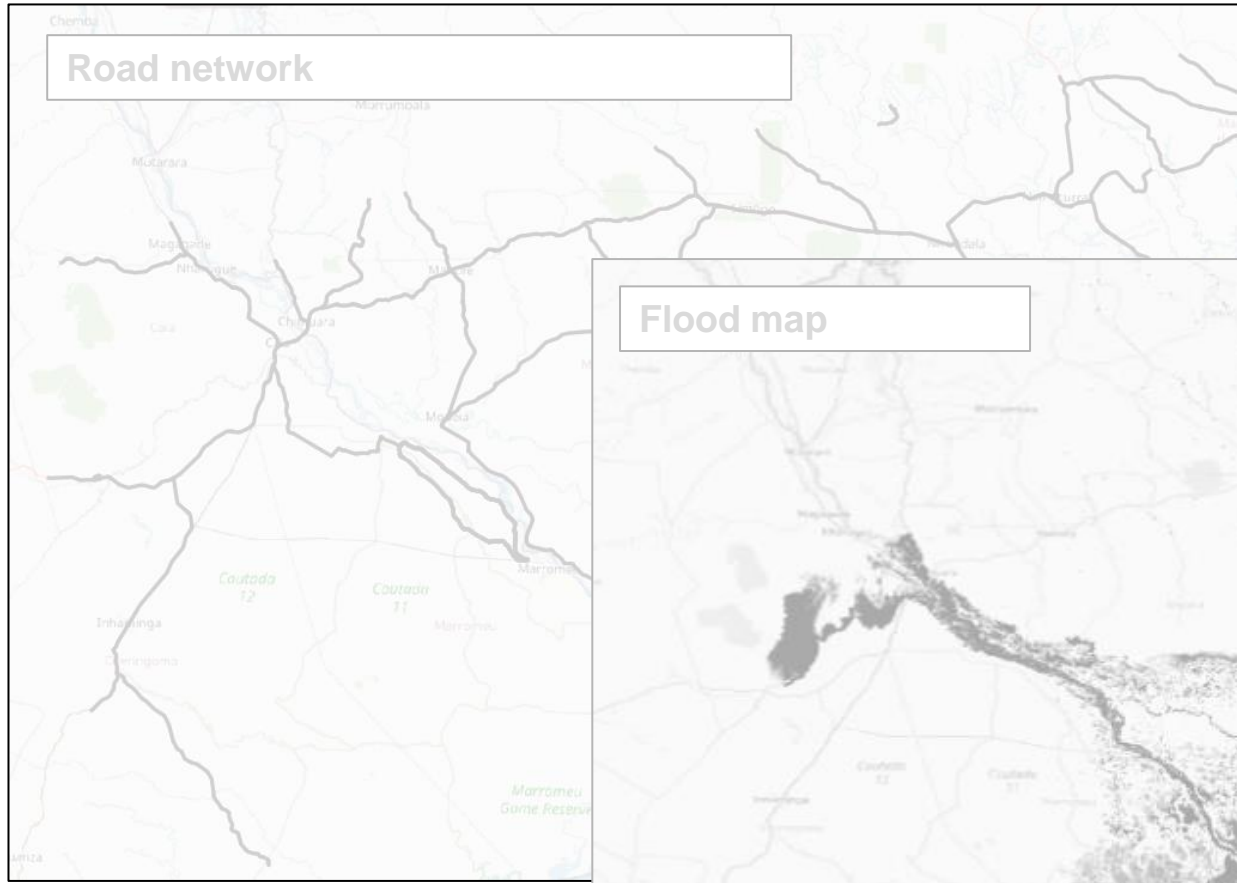
Road connectivity information

Flood map

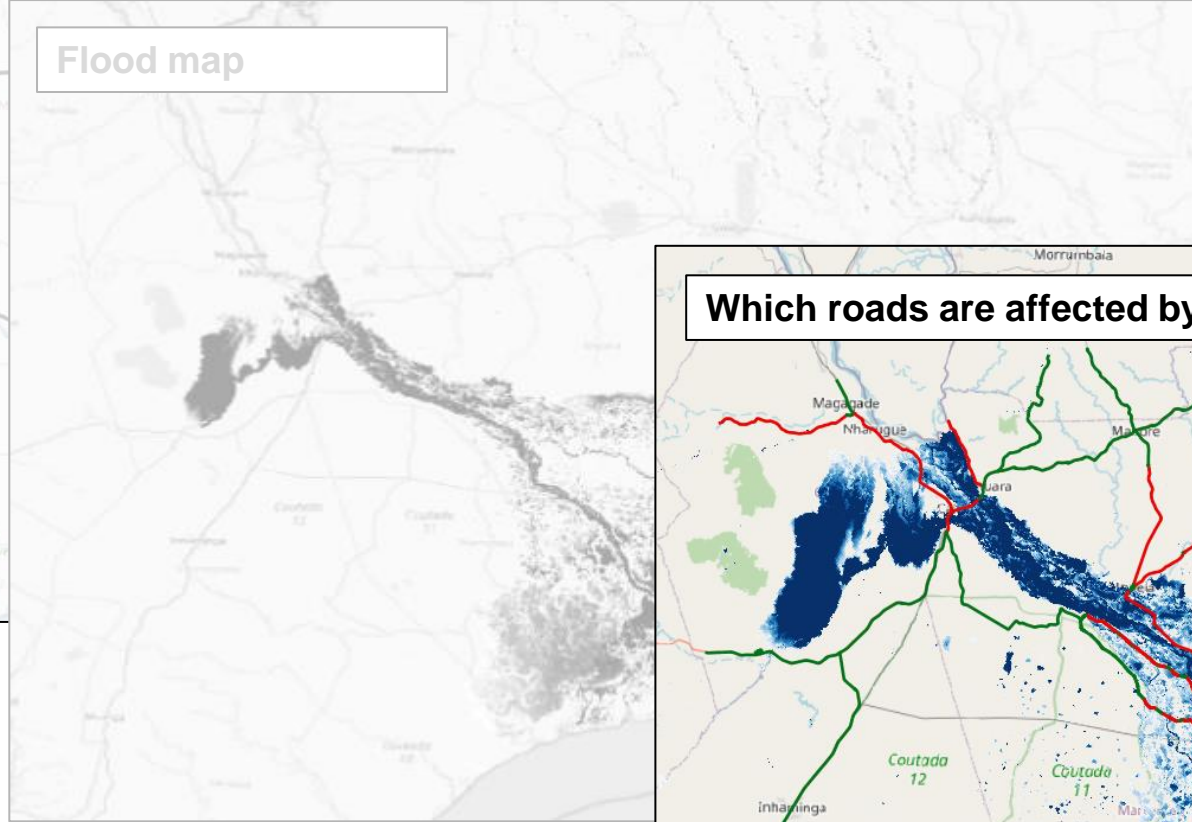


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Road network



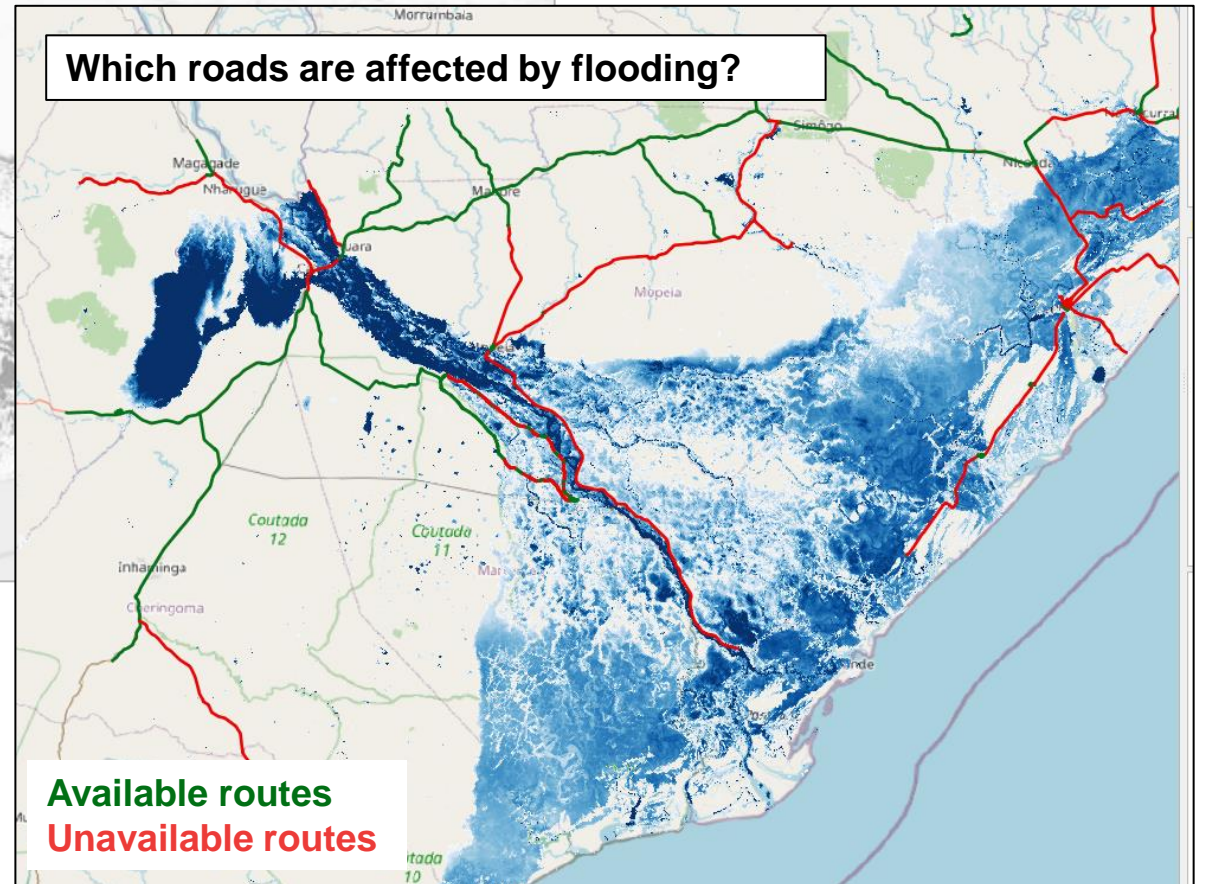
Flood map



Road connectivity information



Which roads are affected by flooding?

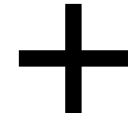
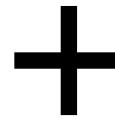


Available routes
Unavailable routes

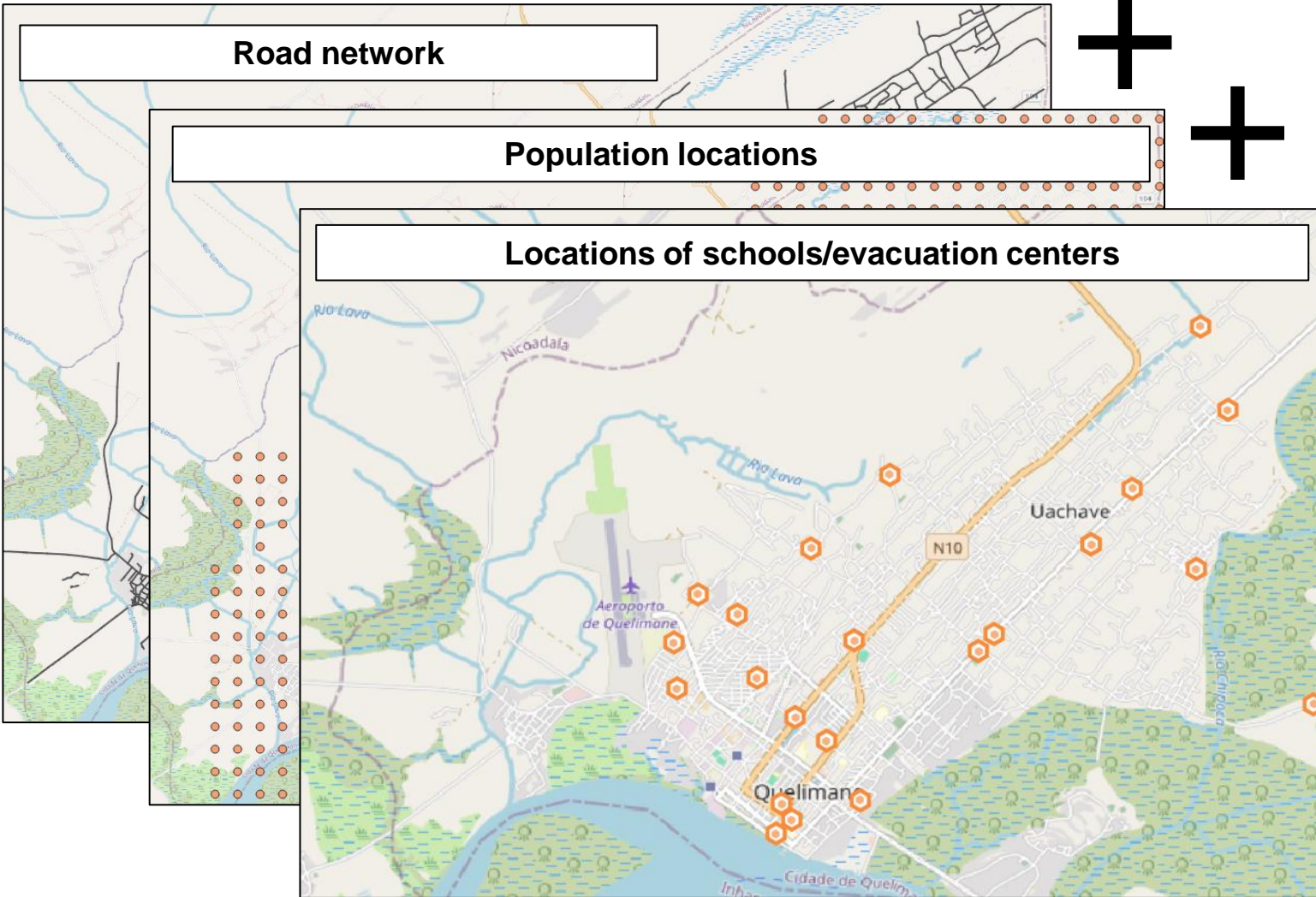
Road network

Population locations

Locations of schools/evacuation centers



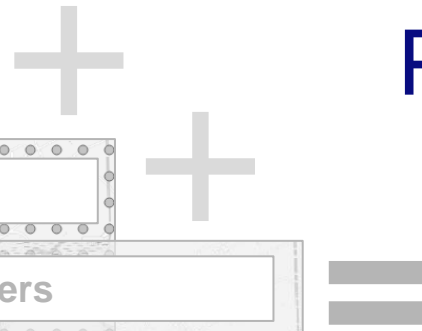
Planning before an event: evacuation routes



Road network

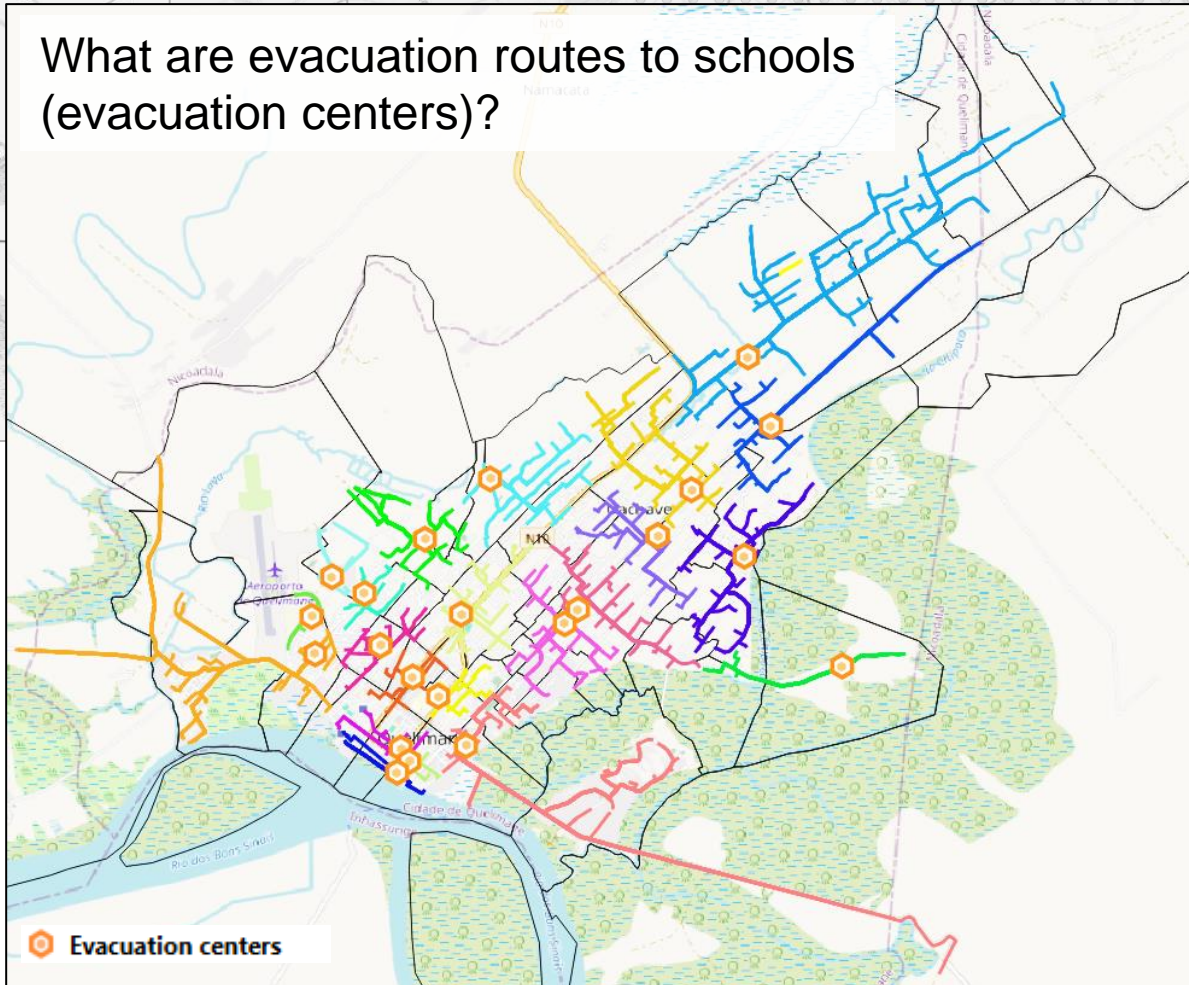
Population locations

Locations of schools/evacuation centers

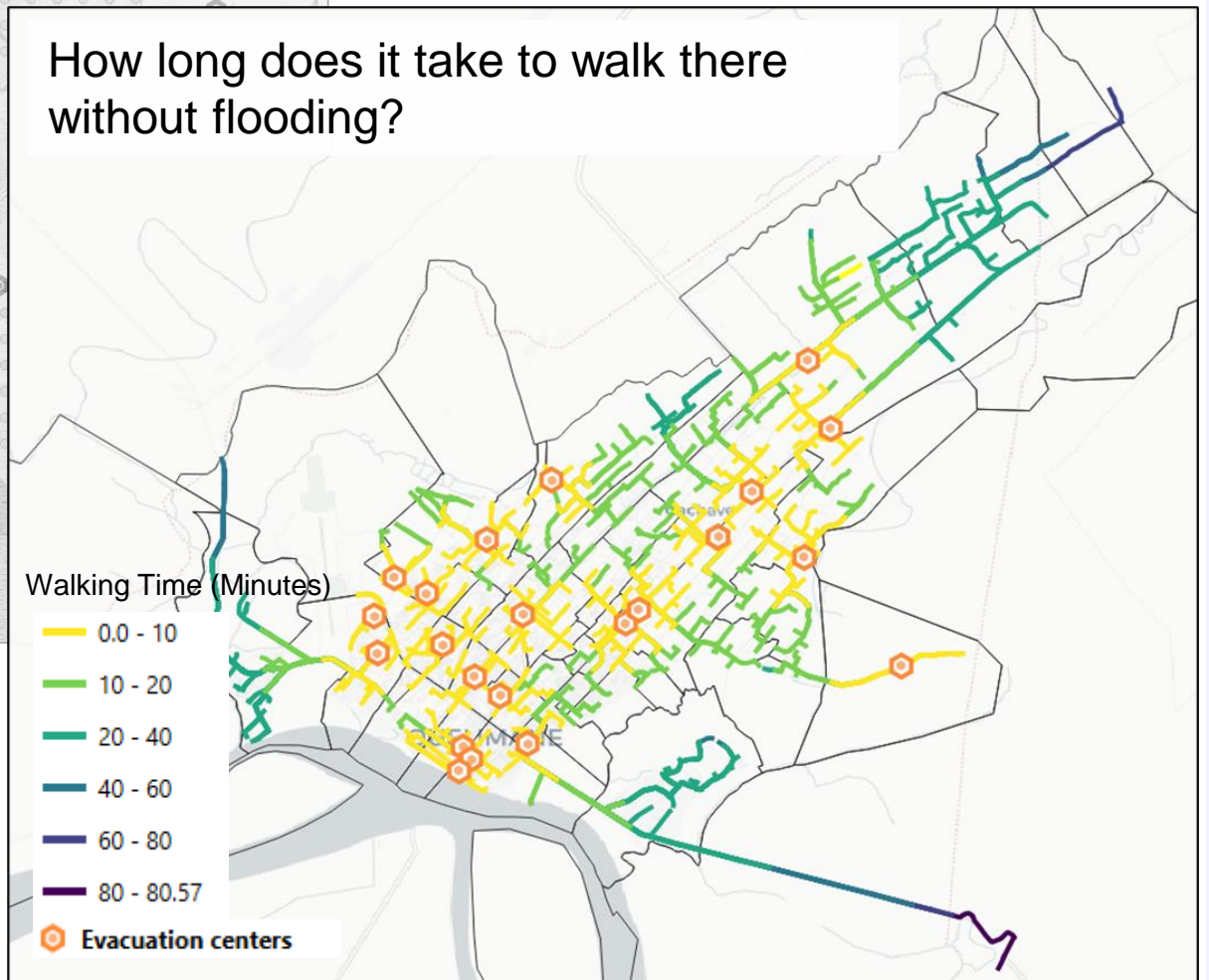


Planning before an event: evacuation routes

What are evacuation routes to schools (evacuation centers)?



How long does it take to walk there without flooding?



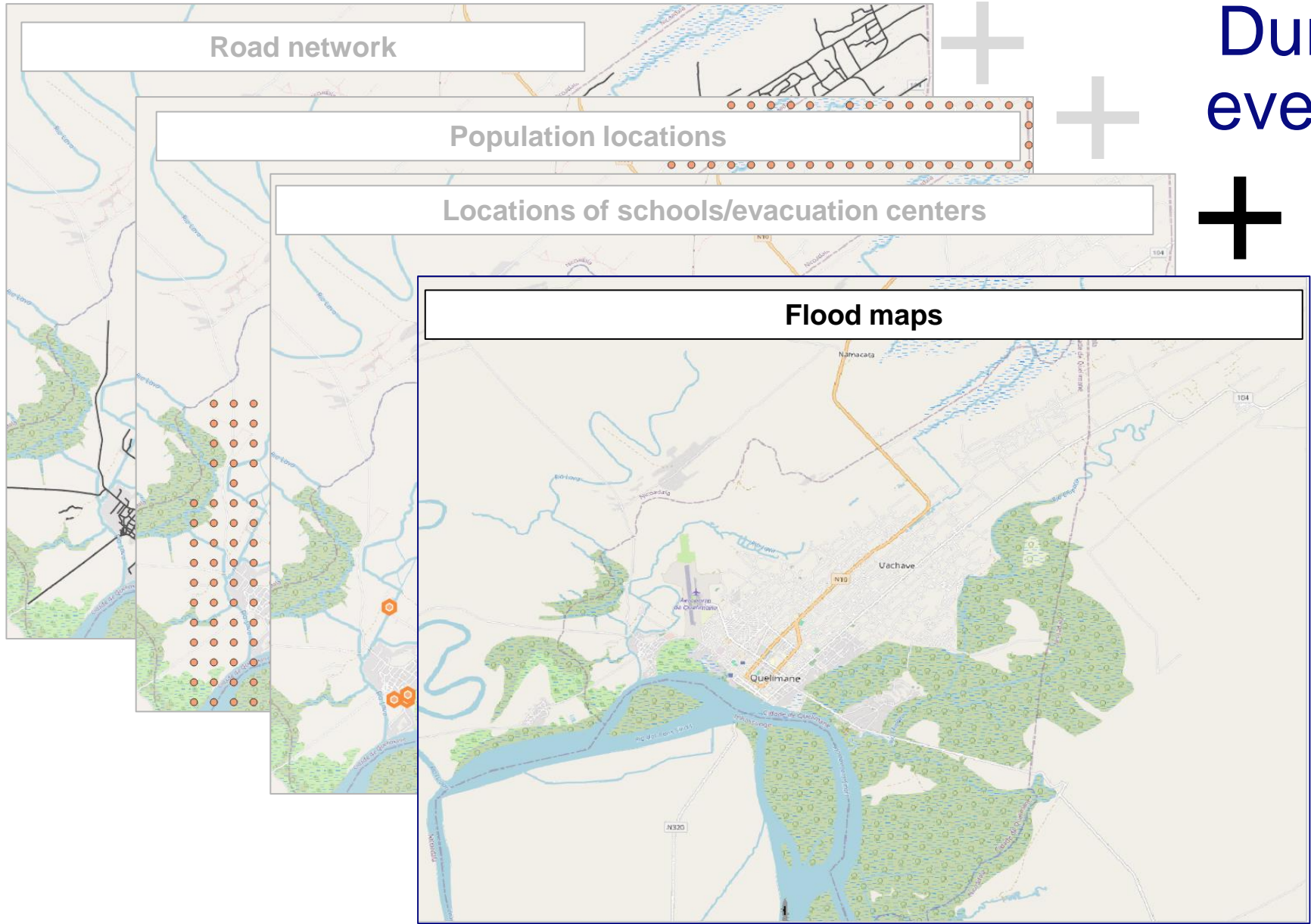
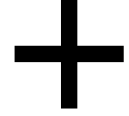
Road network

Population locations

Locations of schools/evacuation centers

Flood maps

During and after an event: flood impacts



During and after an event: flood impacts

Road network

Population locations

Locations of schools

Flood maps

How many people have access to a school?

How many people are flooded?

Who should be warned and/or evacuated?

● Access 158k
● Flooded 200k
● No Access 14k

Which schools are flooded?

Which roads are available to schools?

— Available routes to schools
● Flooded schools
● Available schools

Road network

Provisioning locations (airport/port)

Locations of schools

Flood maps

During and after an event: impact on provisioning

=

During and after an event: impact on provisioning

Road network

Provisioning locations (airport/port)

Locations of schools/evacuation centers

Flood maps

+

+

+

=

- Available routes to port
- Flooded schools
- Available schools
- ✈ airport
- ⚓ port

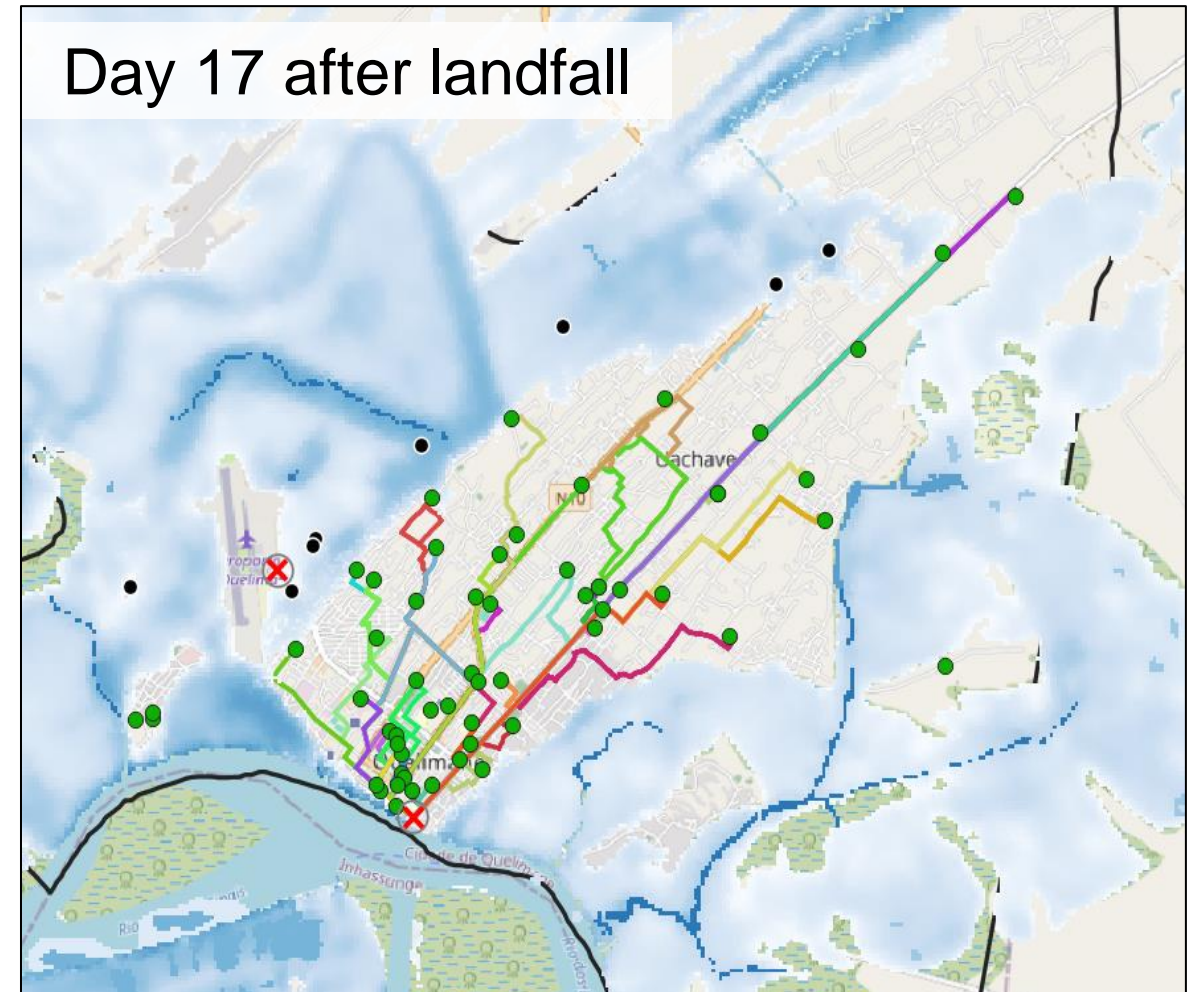
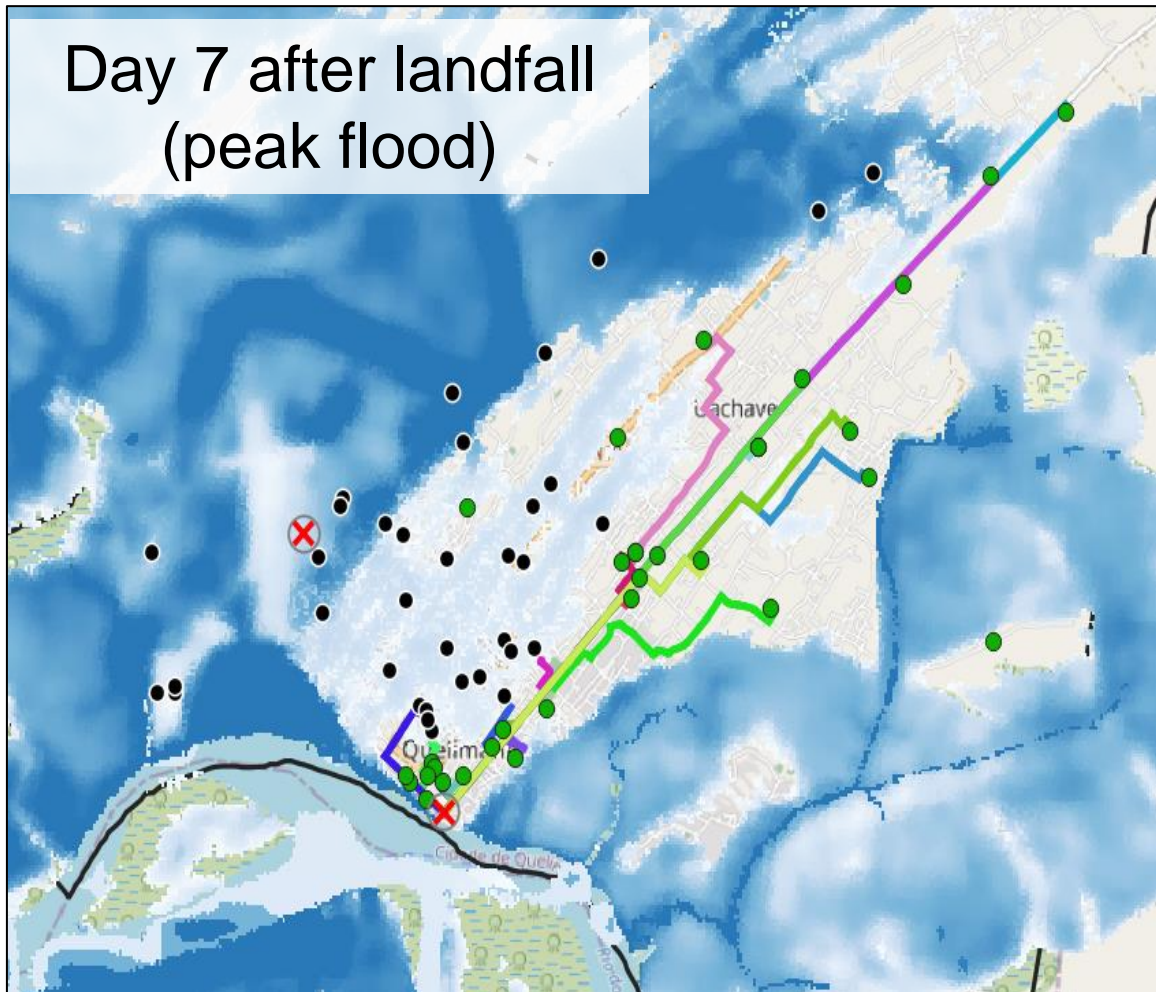
The airport is flooded and cannot be used for provisioning

These schools are not flooded, but cannot be reached from the port for provisioning

Roads to the port are available and some evacuation centers can be reached

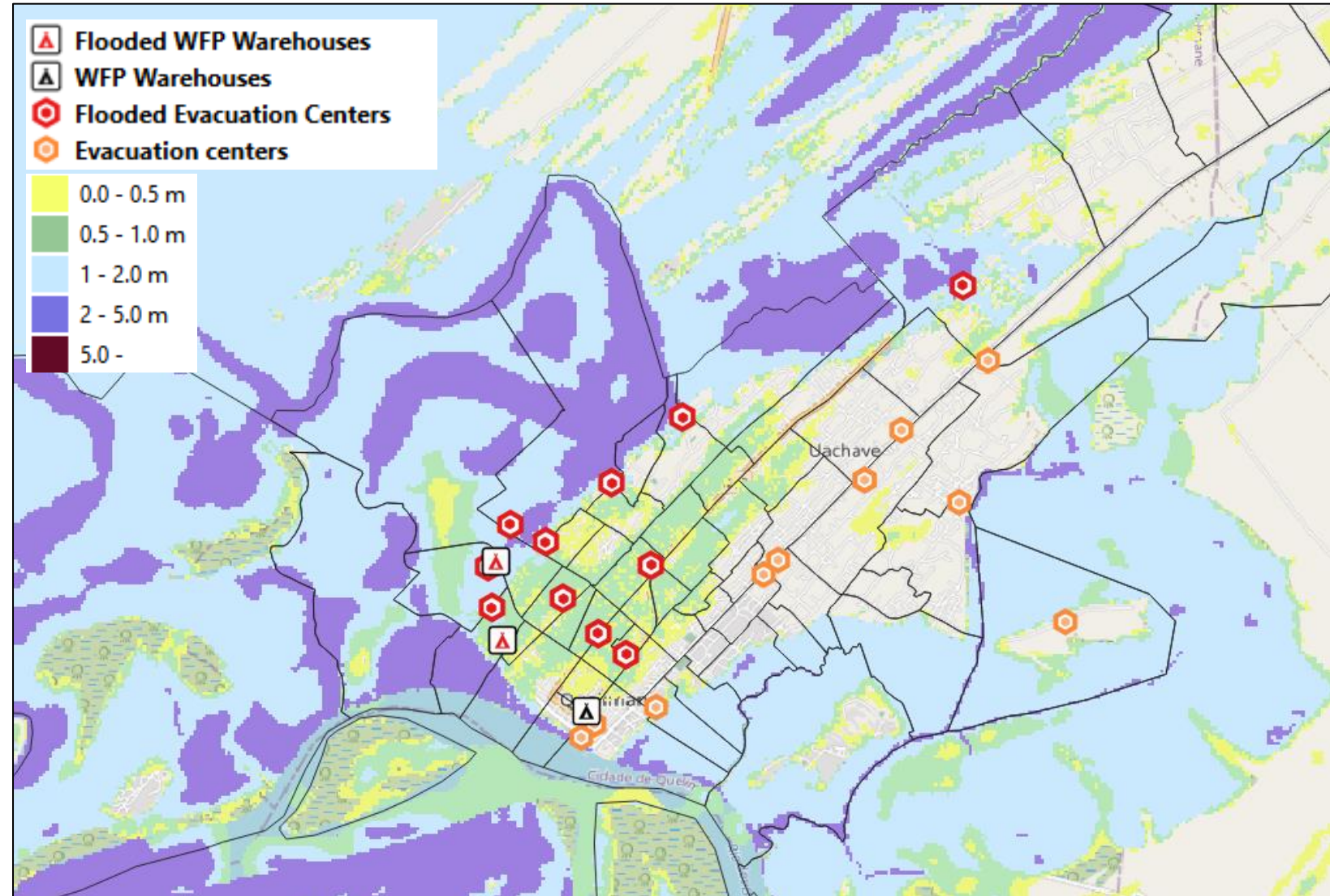
Provisioning over time as floods recede

- Flooded schools or no access from ports
- Non-flooded schools

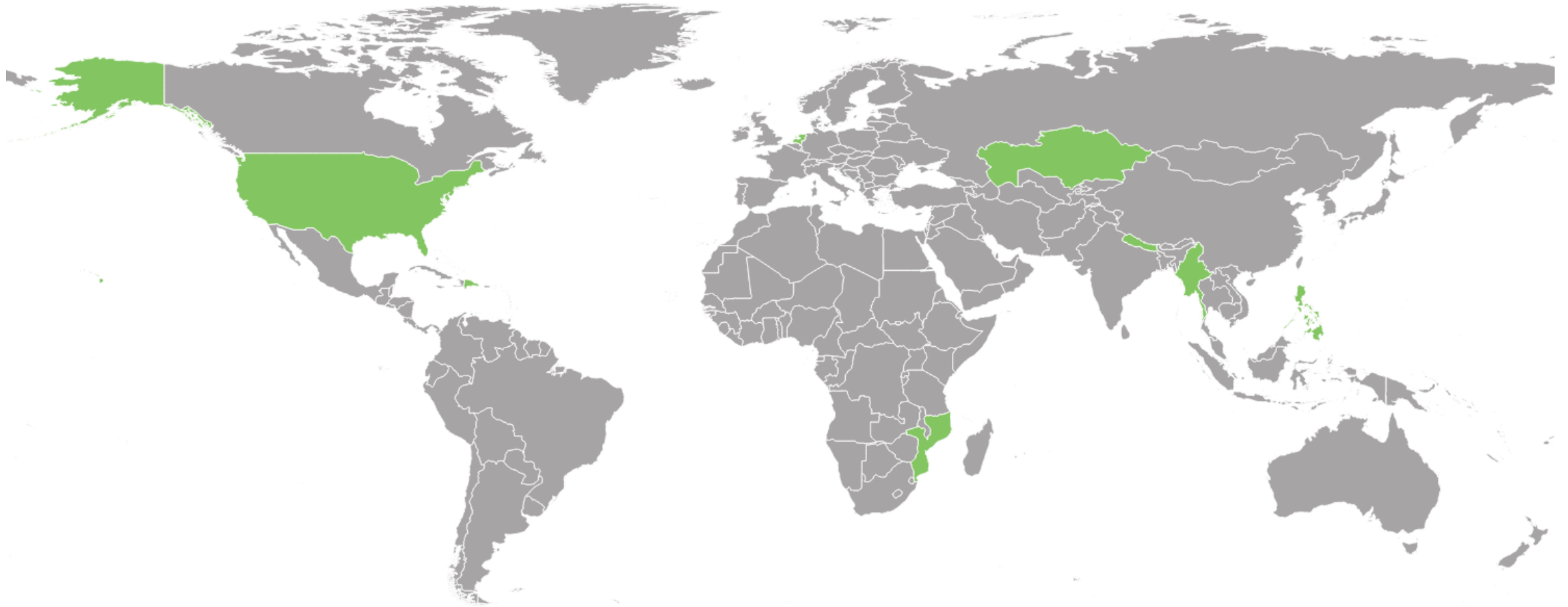


Planning for floods: consider hazard-free zones

- Peak flood situation
- Day 7 after landfall

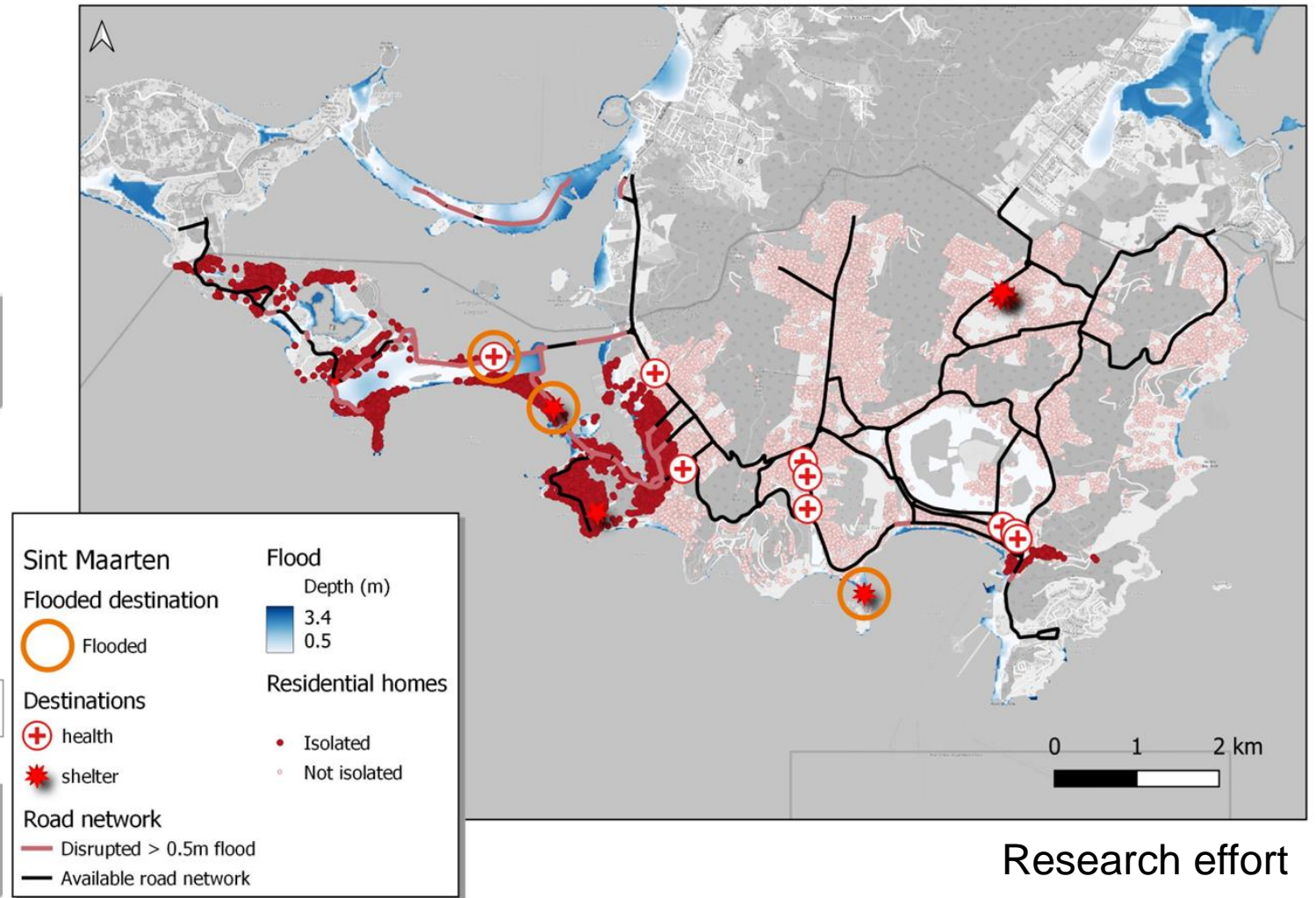


Other RA2CE applications

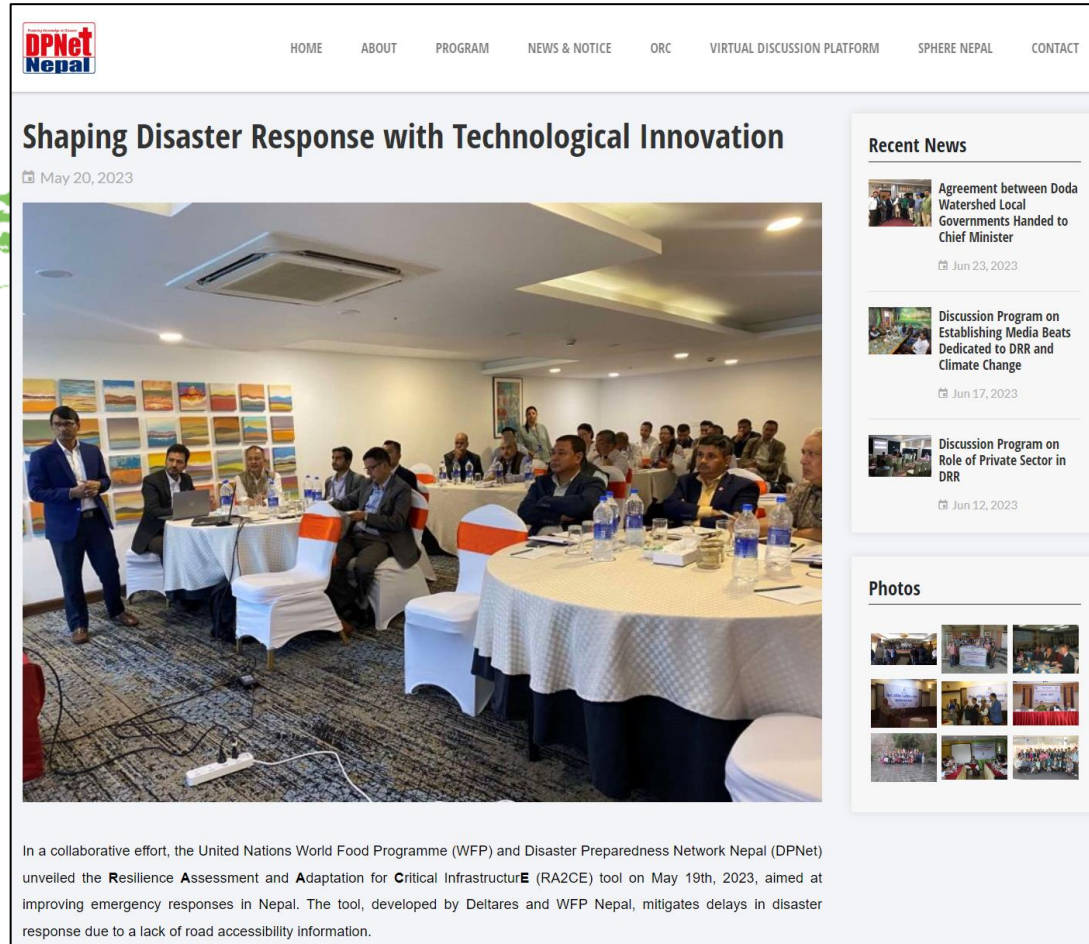


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Other applications



Other applications



DPNet Nepal HOME ABOUT PROGRAM NEWS & NOTICE ORC VIRTUAL DISCUSSION PLATFORM SPHERE NEPAL CONTACT

Shaping Disaster Response with Technological Innovation

May 20, 2023

In a collaborative effort, the United Nations World Food Programme (WFP) and Disaster Preparedness Network Nepal (DPNet) unveiled the **Resilience Assessment and Adaptation for Critical InfrastructureE (RA2CE)** tool on May 19th, 2023, aimed at improving emergency responses in Nepal. The tool, developed by Deltares and WFP Nepal, mitigates delays in disaster response due to a lack of road accessibility information.

Recent News

- Agreement between Doda Watershed Local Governments Handed to Chief Minister
Jun 23, 2023
- Discussion Program on Establishing Media Beats Dedicated to DRR and Climate Change
Jun 17, 2023
- Discussion Program on Role of Private Sector in DRR
Jun 12, 2023

Photos

<https://innovation.wfp.org/project/timely-logistics>
<https://www.dpnet.org.np/news/detail/shaping-disaster-response-with-technological-innovation>

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Project in co-creation with the World Food Program country office Nepal

We look for more case studies



Implement outcomes for real-life situations



Gain context understanding



Where to link to other initiatives?



Co-creation and prioritisation of new developments

github.com/Deltares/ra2ce

README License

Python 3.10 code style black TC build success quality gate passed GitHub Pages documentation passing

blender branch passing launch blender

RA2CE

This is the repository of RA2CE (*just say race!*) - the Resilience Assessment and Adaptation for Critical Infrastructure Toolkit Python Package developed by Deltares. RA2CE helps to quantify resilience of critical infrastructure networks, prioritize interventions and adaptation measures and select the most appropriate action perspective to increase resilience considering future conditions.

Contact Margreet van Marle (Margreet.vanMarle@Deltares.nl)

Find more about the following topics in our [official documentation page](#):

- [Contributing](#)
- [Installation](#)
- [Network user guide](#)
- [Analysis user guide](#)



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