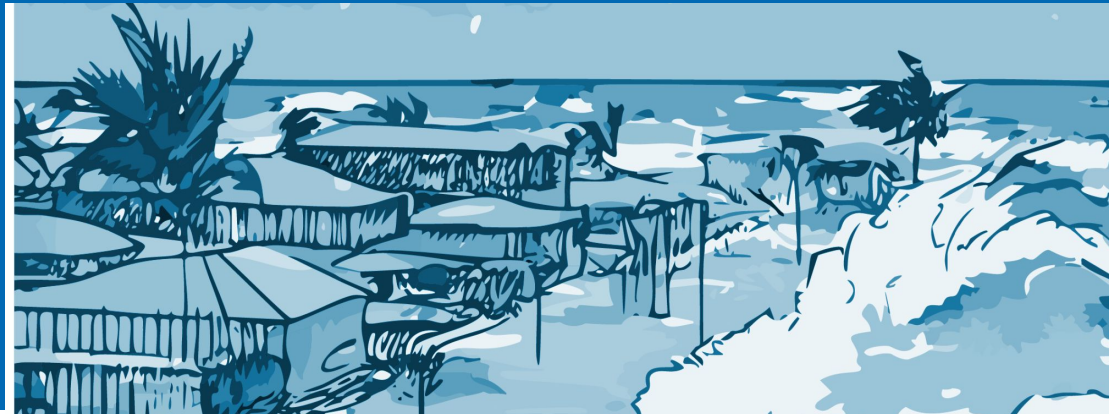
Tsunami Evacuation Mapping Workshop



Montpellier, France **30 June – 4 July 2025**

Dr. Matthieu Péroche
Pr. Frédéric Leone
Louis Monnier
Emilie Lagahé
Monique Gherardi

CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

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Contact : matthieu.peroche@univ-montp3.fr

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Intergovernmental Oceanographic Commission

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2021 2030 United Nations Decade of Ocean Science for Sustainable Development

CoastWAVE NEAMTWS

LAGAM
LABORATOIRE DE GEOGRAPHIE ET D'AMENAGEMENT DE MONTPELLIER

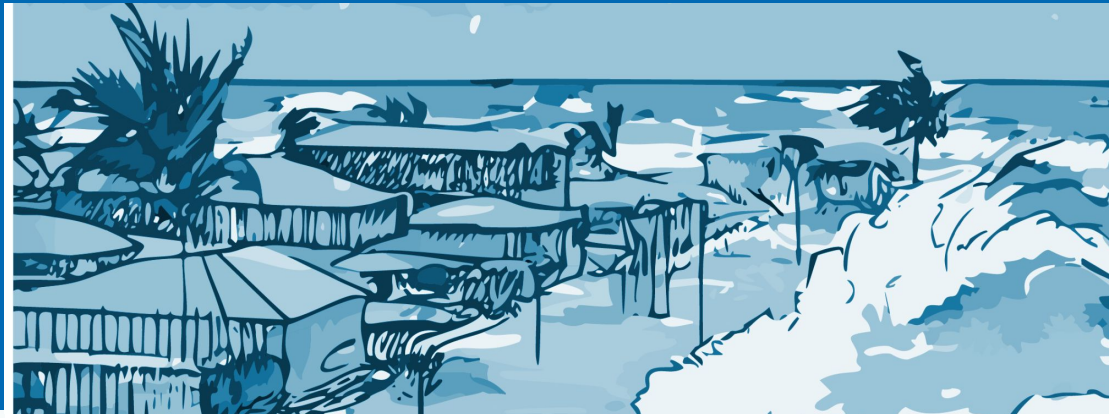
Université Paul Valéry Montpellier 3

Contents

Thank you to all the workshop participants for this week of knowledge sharing, for your involvement and your good mood despite this heatwave !

Tsunami Evacuation Mapping Workshop

30 June – 4 July 2025



CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

Dr. Matthieu Péroche
Louis Monnier

Lesson #1

Tsunami evacuation zone mapping

Contact : matthieu.peroche@univ-montp3.fr

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Lesson's overview

Use of a DEM to map a "standardized" inland tsunami evacuation zone.

1. Theory

- Cannes area
- Presentation of the selected approach for evacuation area definition in France
- Pro and cons

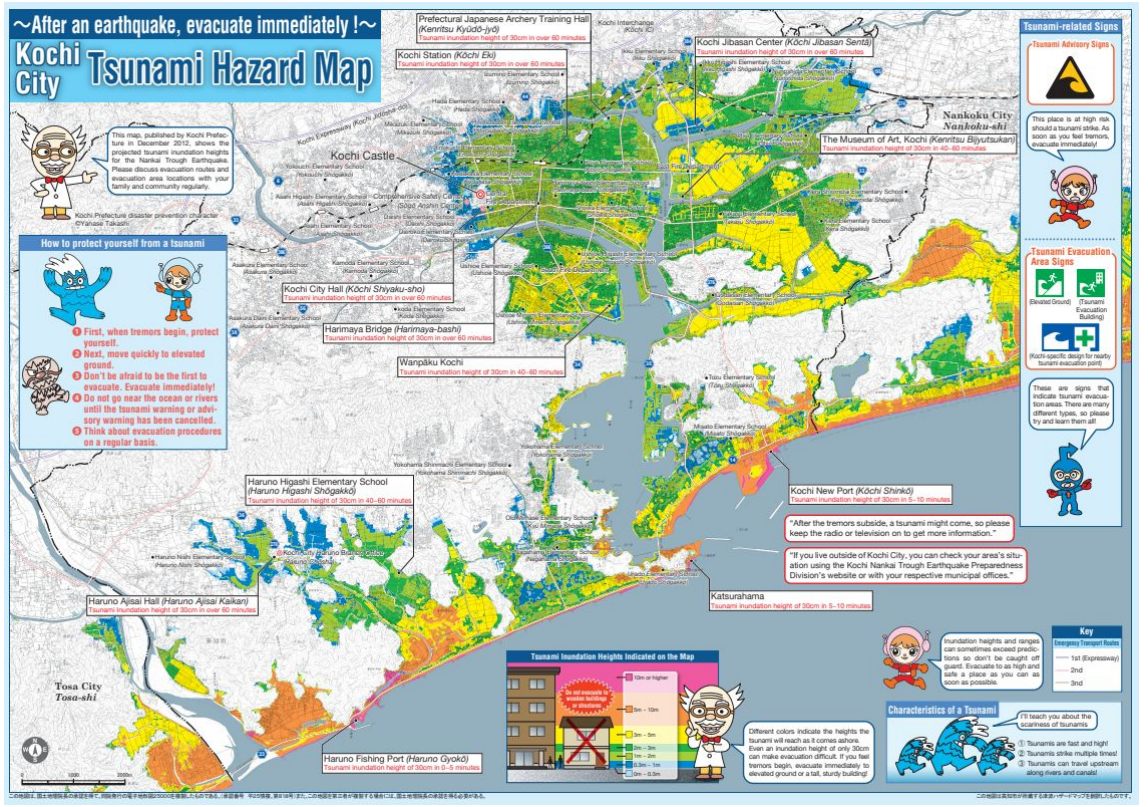
2. Practice

- Extract the altitude range set from numerical modelisation using DEM and GIS
- Corrections needed for a coherent evacuation zone
- Derivate safe zone

Tsunami evacuation zone mapping

Mapping Tsunami Evacuation Zones: 4 Key Methods

- Different methods exist to map tsunami danger zones
- The choice depends on data availability, local knowledge, and technical capacity
- Methods range from advanced simulations to basic elevation-based approaches
- Each method offers trade-offs in precision, effort, and accessibility



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Tsunami evacuation zone mapping

Mapping Tsunami Evacuation Zones - 1. Envelope from Multiple Simulations (deterministic or probabilistic)

Definition

This method combines the results of several validated tsunami simulations to produce a single envelope representing the maximum potential inundation.

Applications

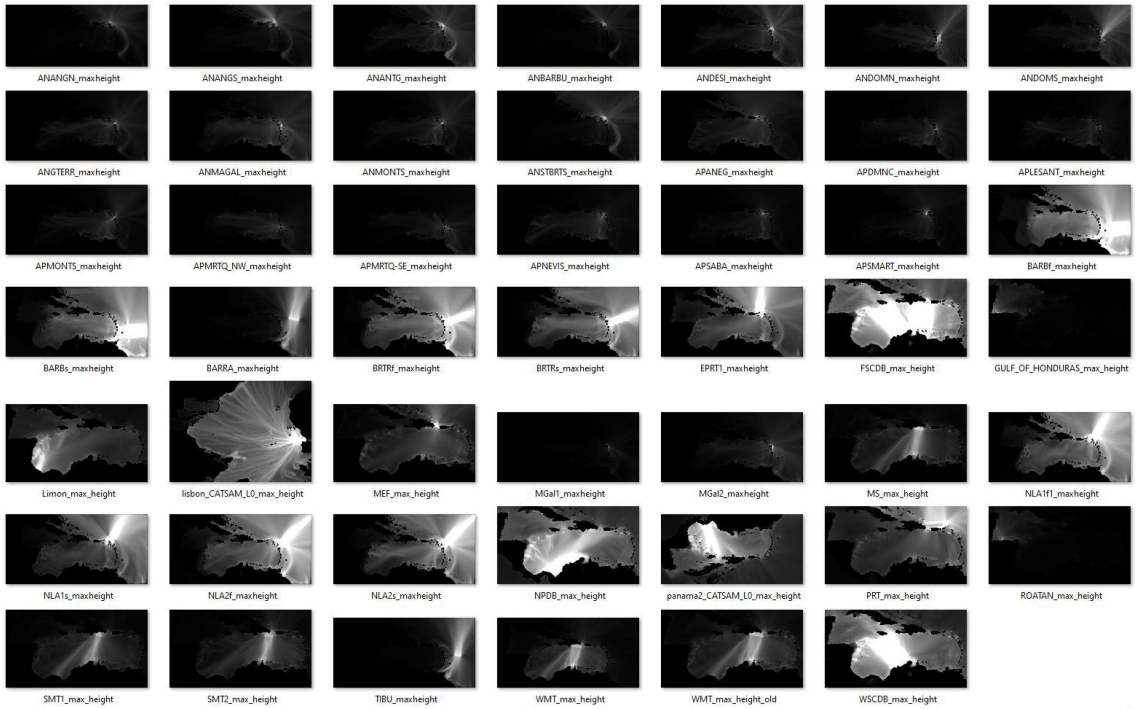
- High-exposure coastal zones
- Critical infrastructure (ports, airports, energy sites)

Strengths

- Conservative and robust
- Detailed outputs for maximums : wave arrival time, water depth, flow speed
- Integrates uncertainty from different scenarios
- Ideal for long-term planning and zoning

Limitations

- Requires multiple simulations
- High technical and financial cost
- Not always feasible for small territories



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Mapping Tsunami Evacuation Zones - 2 : Hydrodynamic Modelling (Single Scenario)

Definition

Numerical simulation of tsunami generation, propagation, and inundation for **one predefined scenario** (often the worst-case plausible event).

Applications

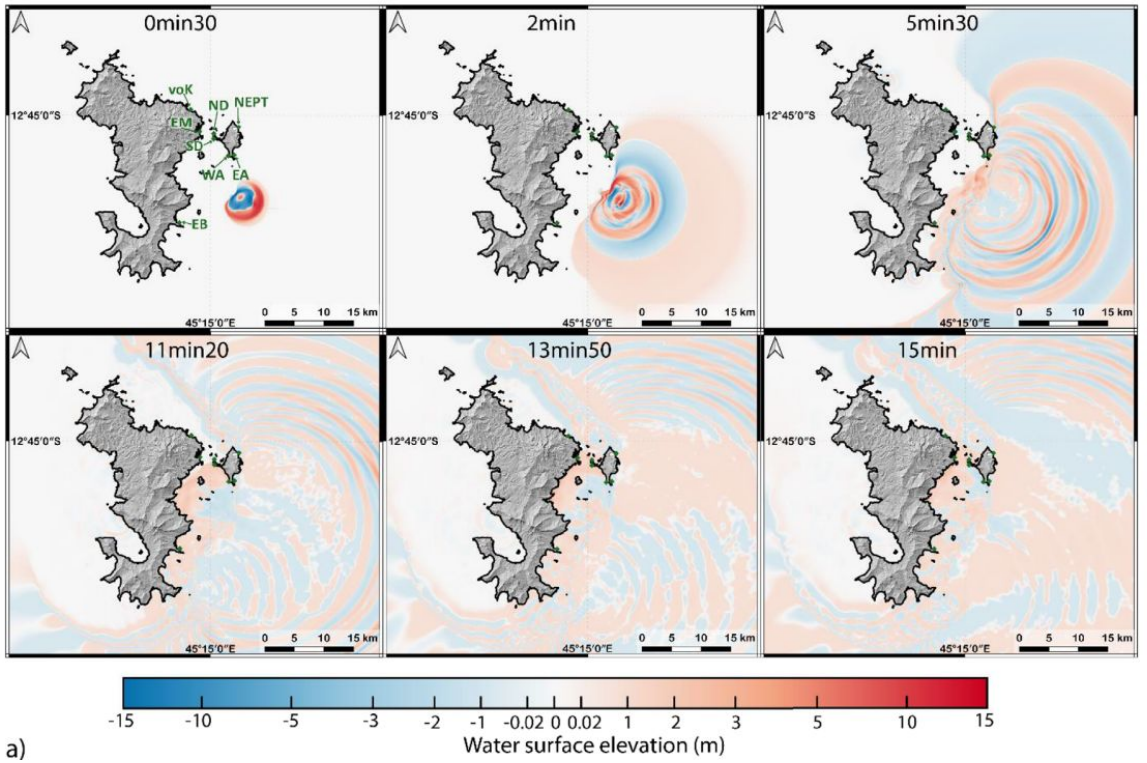
- High-exposure coastal zones
- Critical infrastructure (ports, airports, energy sites)

Strengths

- Physically accurate and scenario-specific
- Detailed outputs: wave arrival time, water depth, flow spe
- Helps visualize and communicate local risk
- Ideal for long-term planning and zoning

Limitations

- Requires multiple simulations
- Only reflects one event configuration
- May miss other potential threat sources



Pablo Poulain et al, 2022

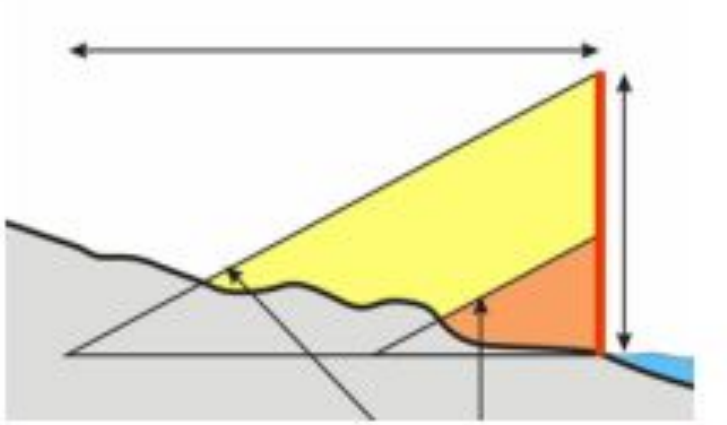
Mapping Tsunami Evacuation Zones - 3 : Topographic Projection from Simulated Coastal Heights

Definition

Inundation zones are derived by **projecting simulated maximum wave heights onto land**, using a Digital Elevation Model (DEM). No inland flood modelling is performed.

Applications

- Territories with access to tsunami simulations but limited modelling capacity
- Easier to generalize over **large coastal areas**
- Suitable for regional-scale evacuation planning



Strengths

- Uses outputs from actual tsunami scenarios
- Faster and less costly than full inundation models
- Requires fewer computational resources

Limitations

- Still needs accurate input data (DEM, coastal wave heights)
- Doesn't account for local hydrodynamics (flow, obstacles, direction)
- May overestimate or underestimate extent in flat or complex terrain

Mapping Tsunami Evacuation Zones - 4 : Simple Elevation-Based Method ("Bathtub")

Definition

Tsunami danger zones are mapped using a fixed elevation threshold (e.g. 10–15 m), without relying on simulation outputs. It is also recommended to set a maximum inland penetration distance, to avoid unrealistic inland extents in flat terrain.

Applications

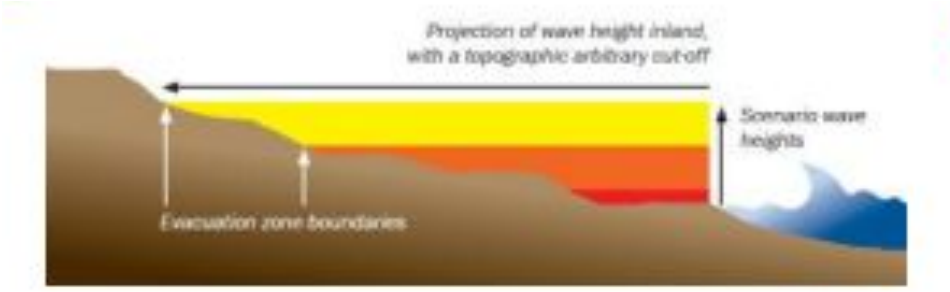
- Territories with no access to tsunami modelling
- Useful for early-stage planning and awareness
- Can be applied using basic topographic data (DEM)

Strengths

- Requires no simulation
- Easy to implement and to communicate to the public
- A good starting point for evacuation planning

Limitations

- May overestimate inland extent
- No information on wave dynamics or timing
- Assumptions must be validated by risk management authorities



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Tsunami evacuation zone mapping

A Common Approach for French Territories

An Operational Choice

- Evacuation planning in France began with the **Simple Elevation-Based Method (10 m threshold)**
- Selected due to the **lack of usable simulation data** and the need for **consistency across territories**
- Informed by **international practices**, **historical runup values**, and **partial modelling outputs**

Progressive National Deployment

- Method first used in the **French Antilles (2013–2014)**
- Then **adapted and applied in the Mediterranean (2019)** under the **TASOMA project**
- Finally **adopted in Mayotte (2020)** as a starting point for tsunami preparedness

A simple, shared method has enabled nationwide progress in tsunami evacuation planning, despite data gaps and regional diversity.

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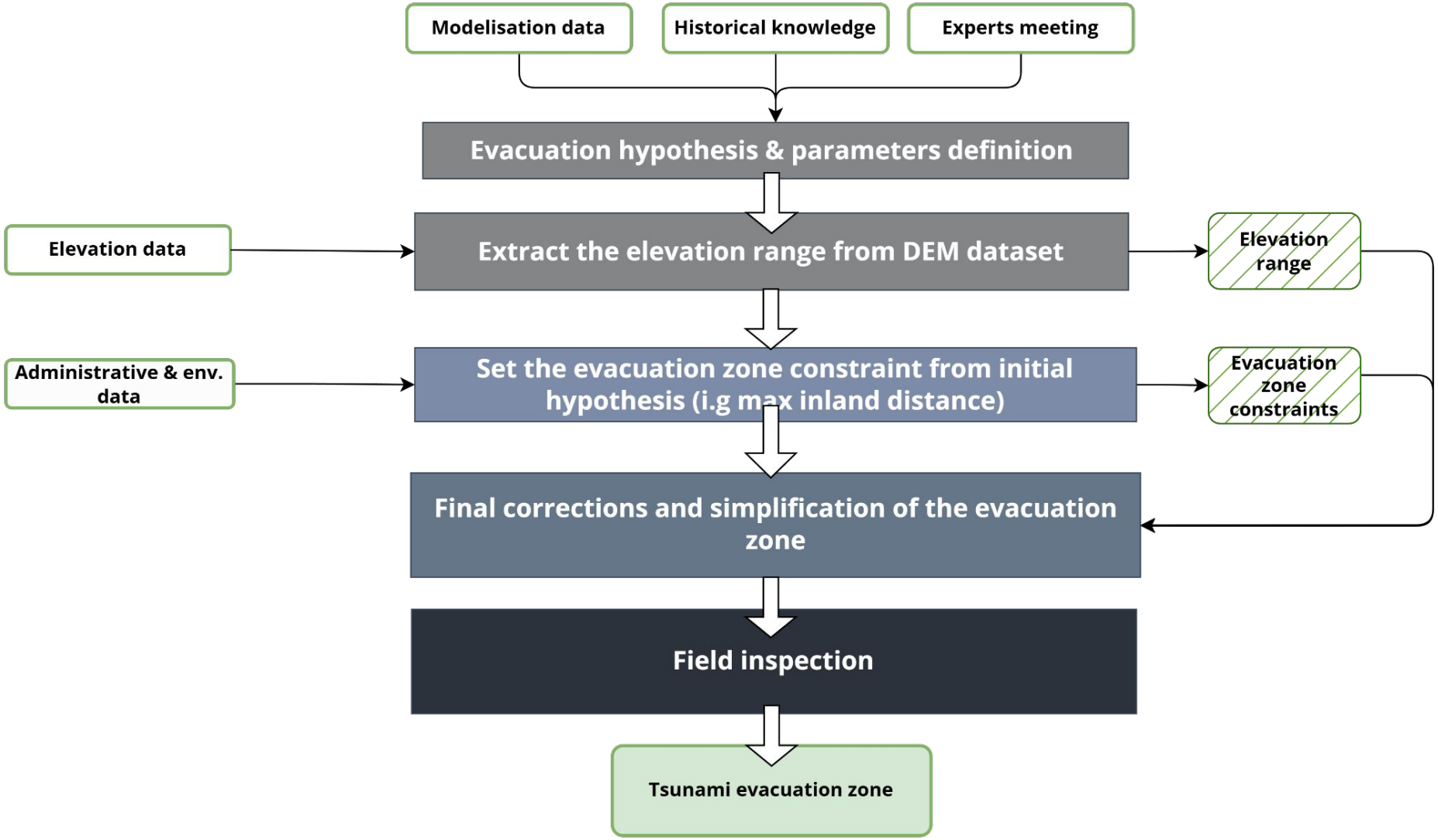
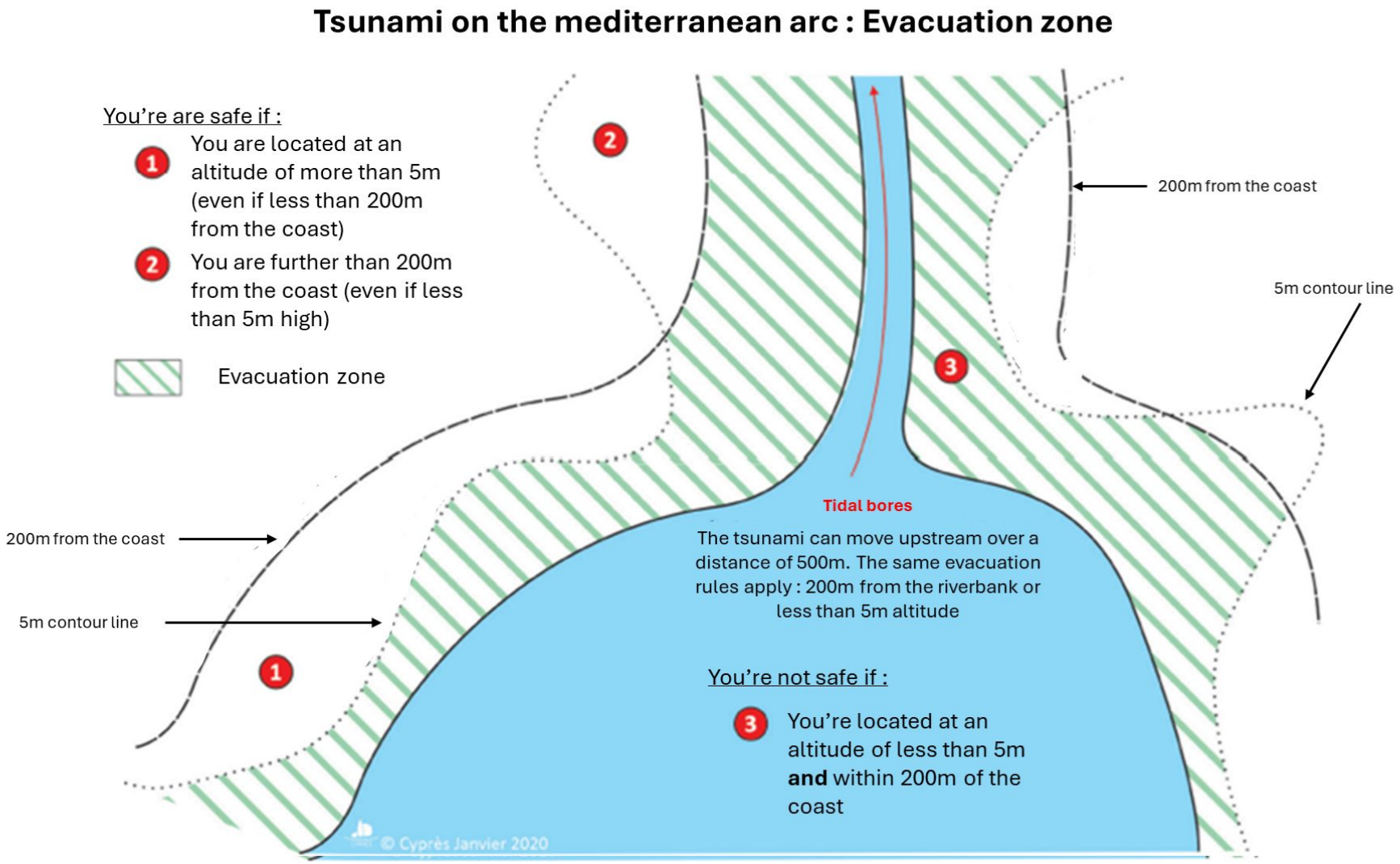
Overview of the theoretical stages



Selected tsunami evacuation zone definition for the french mediterranean coast



Tsunami evacuation zone mapping

Selected tsunami evacuation zone definition for the french mediterranean coast

Using this method, we were able to map the evacuation zone for the entire coastline in around a month during the

TASOMA Project

https://arcg.is/1vfGSz

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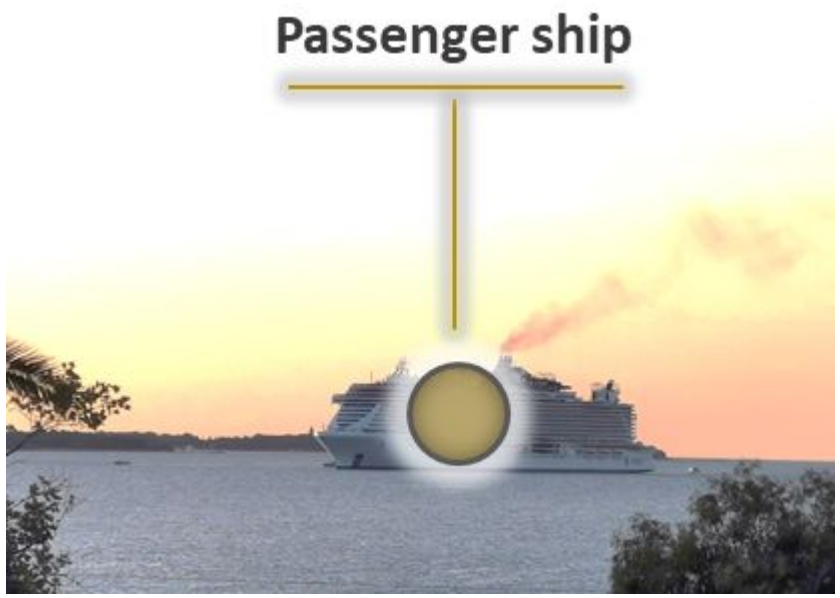
Tsunami evacuation zone mapping

Cannes area presentation

- ✓ Population of 74,686 *(INSEE, 2019)*
- ✓ 3 million visitors per year
- ✓ 320 cruise passengers in 2017
- ✓ Nearly 130 hotels and 500 restaurants
- ✓ Accommodation capacity of 17,000 people

City of Cannes evacuation challenges in case of tsunami alert …



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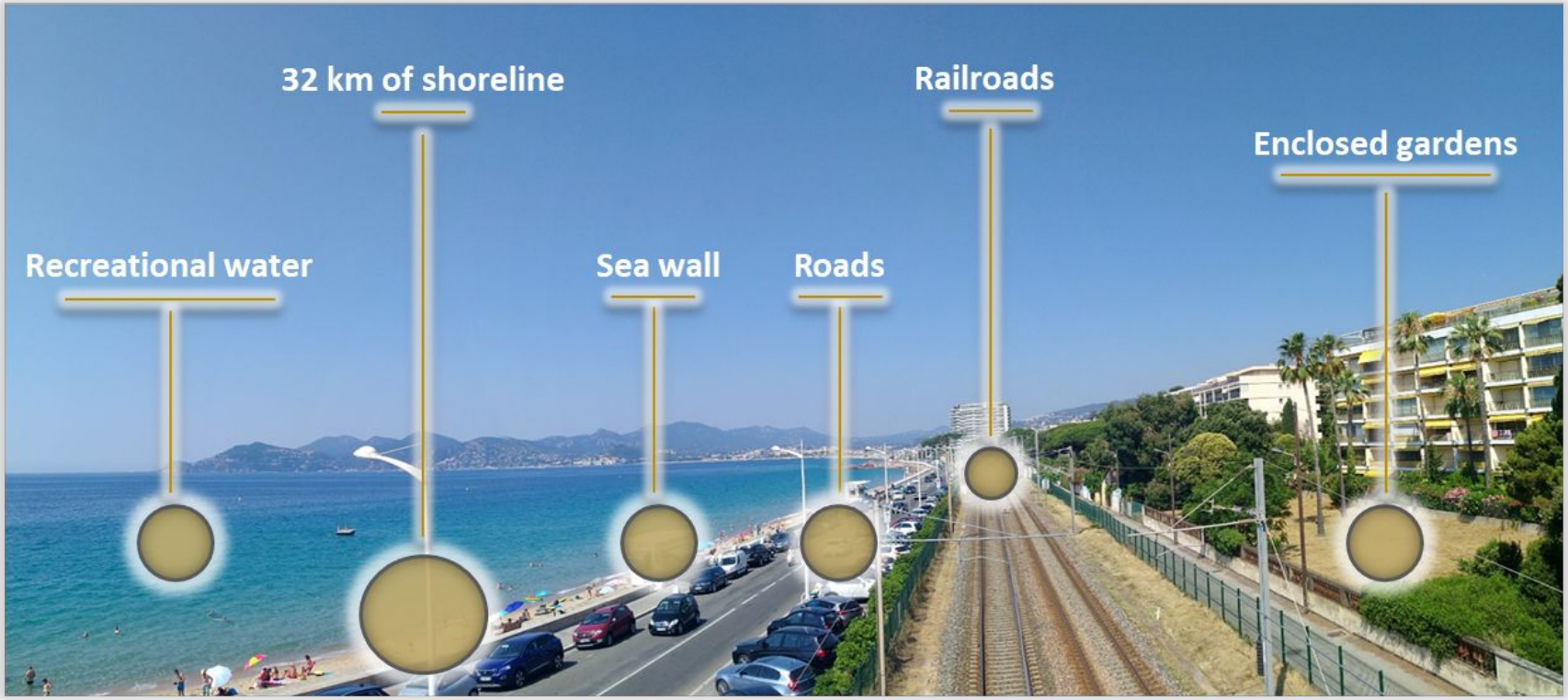
Tsunami evacuation zone mapping

Cannes area presentation

1. For the past year, awareness-raising activities (public meeting, meeting in schools) have been carried out locally, in particular in collaboration with CENALT and DGSCGC.
2. Discussions within the national Tsunami working group have led to recommendations that have been validated at the national level.
3. A scientific partnership with the University Paul-Valéry Montpellier 3, has enabled the design of standardised evacuation plans and tsunami signage according to a method already deployed in the French West Indies (Caribbean sea)



"The taking into account of the Tsunami hazard in Cannes is part of a strong political will initiated since 2015 for a concerted management of natural risks and a better awareness of citizens".

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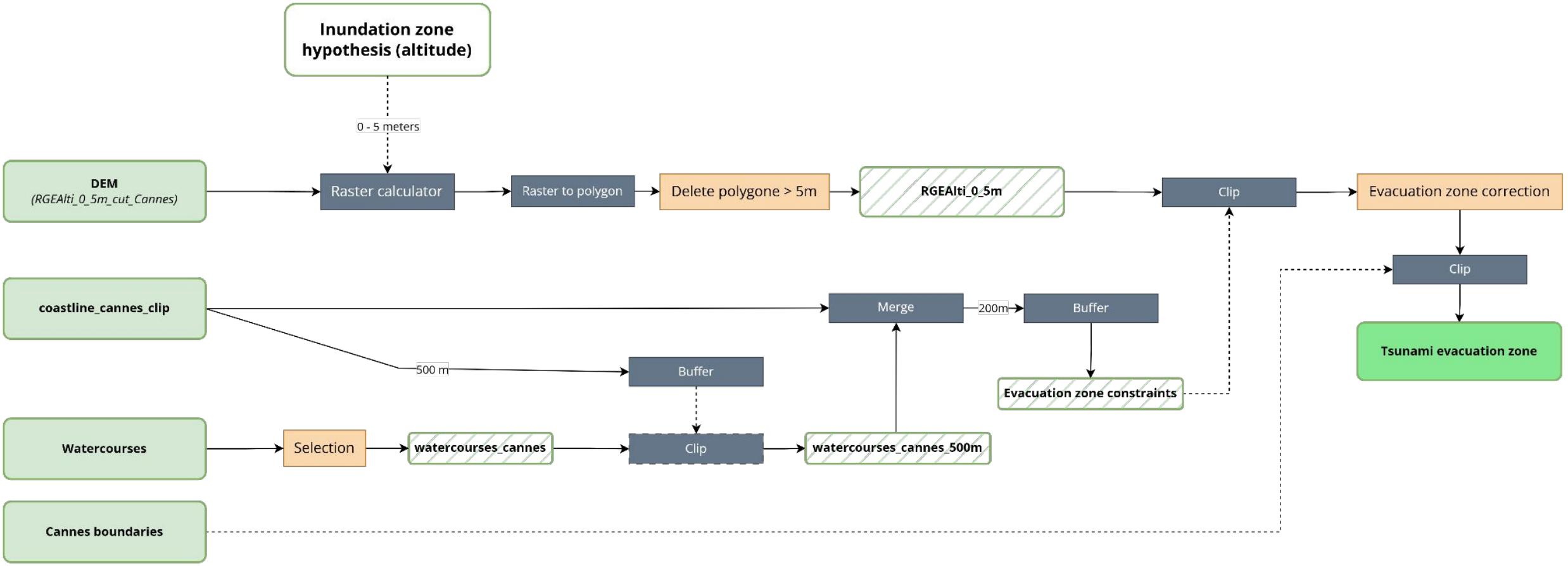
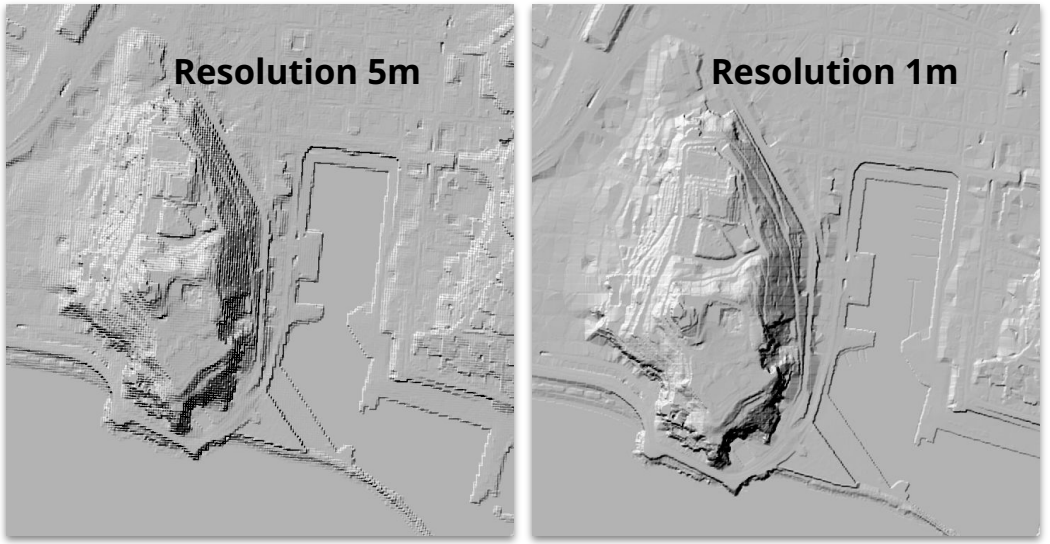
GIS detailed overview



Tsunami evacuation zone mapping

5m and 1m resolution DEM accessibility varies between countries.



Pro

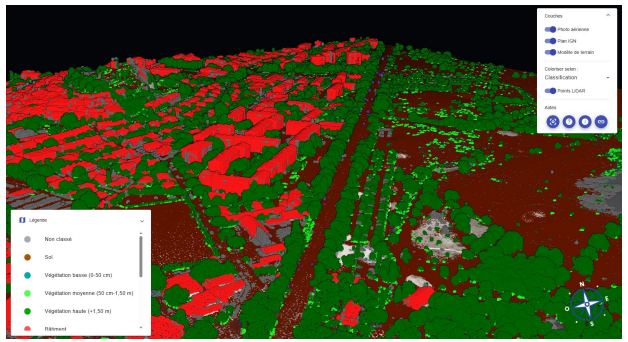
- Better accuracy for terrain with significant altitude variation
- High resolution evacuation zone

Cons

- Slow to process
- 1m res DEM cannot be used for a whole region on most computer.

Programme national LiDAR HD :

https://geoservices.ign.fr/lidarhd



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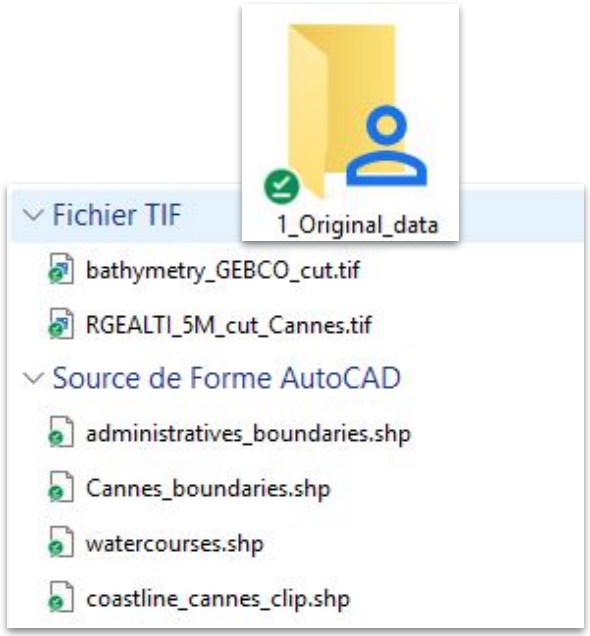
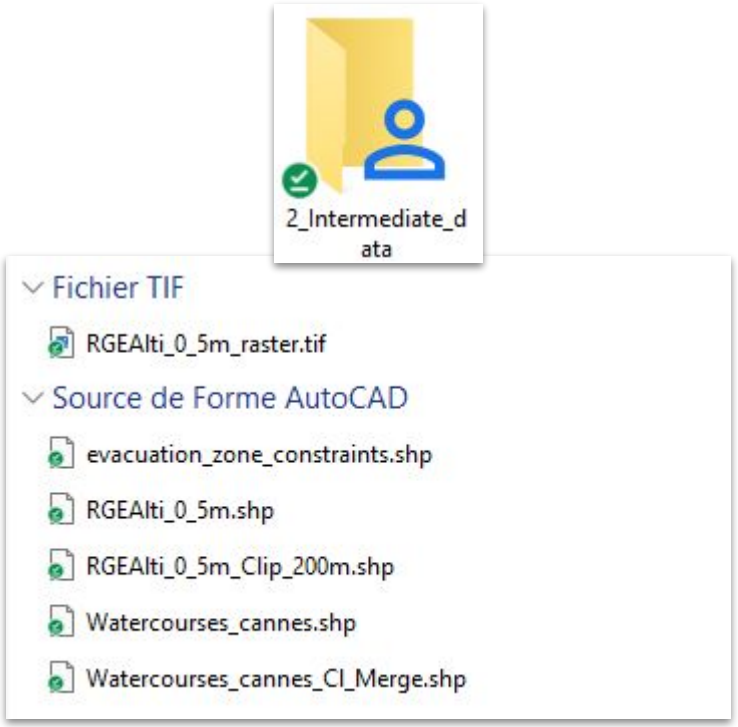
Tsunami evacuation zone mapping

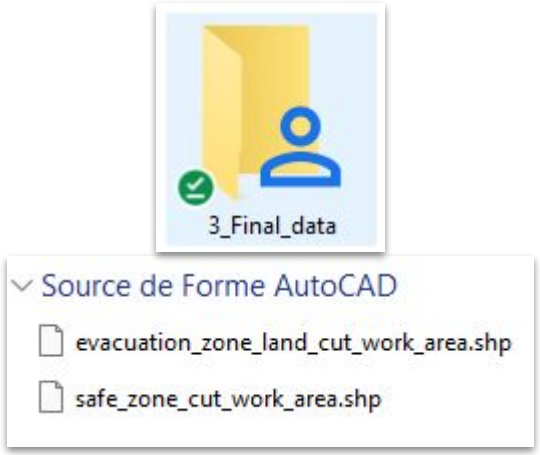
Lesson's data



Required layers for the lesson



Processed layers



Results

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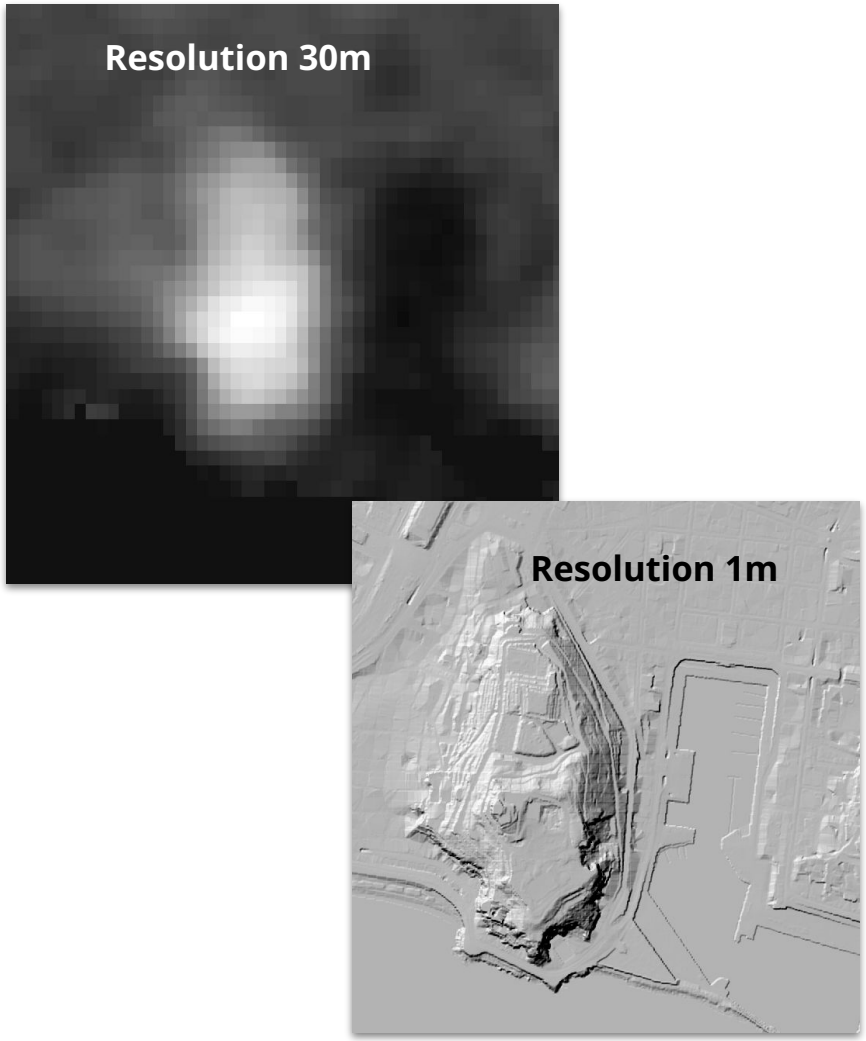
Tsunami evacuation zone mapping

30m resolution DEM with a world coverage are largely available in open access.

- Shuttle Radar Topography Mission (SRTM) - https://dwtkns.com/srtm30m/

- Copernicus DEM - Global and European Digital Elevation Model https://dataspace.copernicus.eu/explore-data/data-collections/copernicus-contributing-missions/collections-description/COP-DEM



Pro

- Fast to process
- Suitable for large studie's area (country)
- World coverage

Cons

- Low evacuation zone precision
- Not suitable on terrain with significant altitude variation

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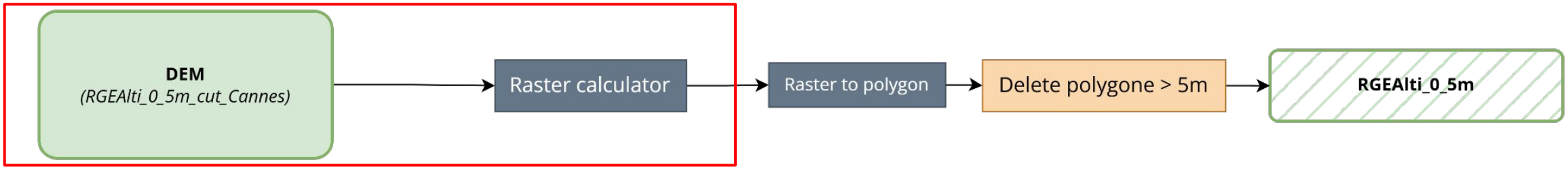
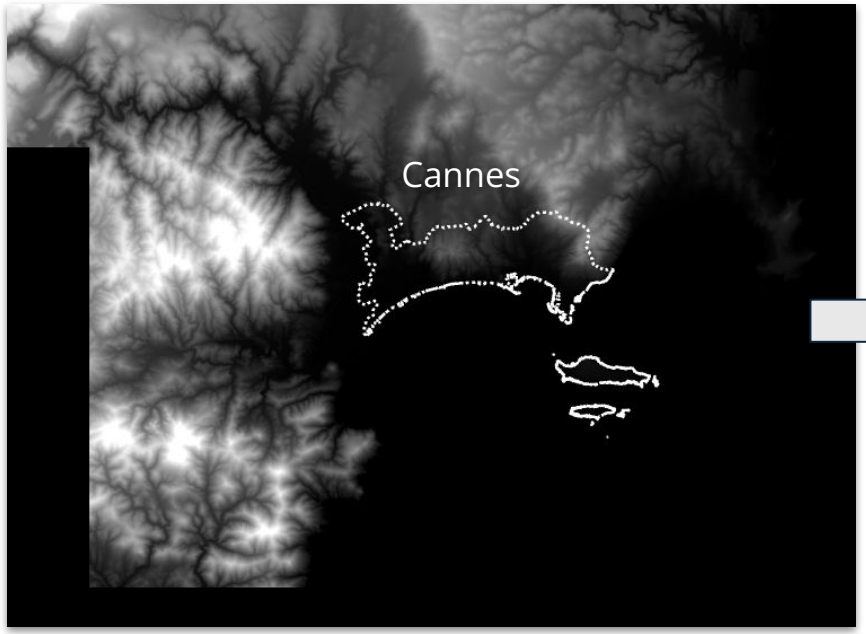
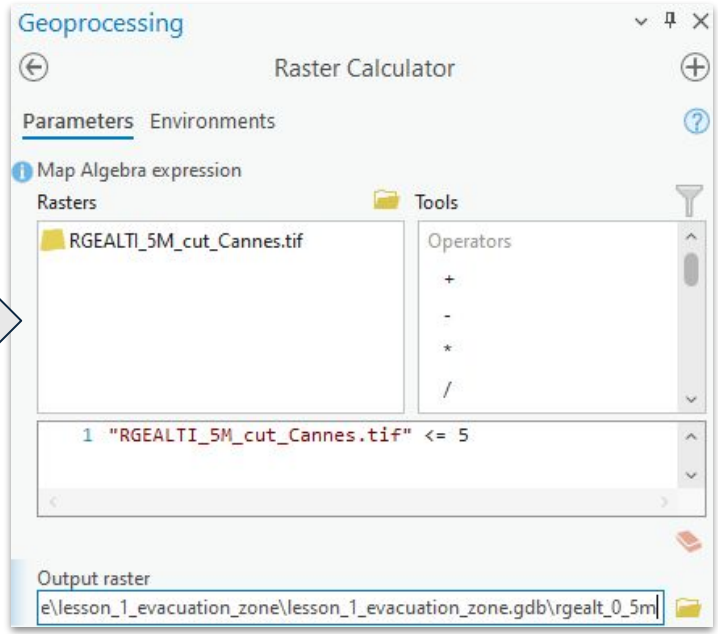
Tsunami evacuation zone mapping





Each pixels in the image have a pixel elevation value



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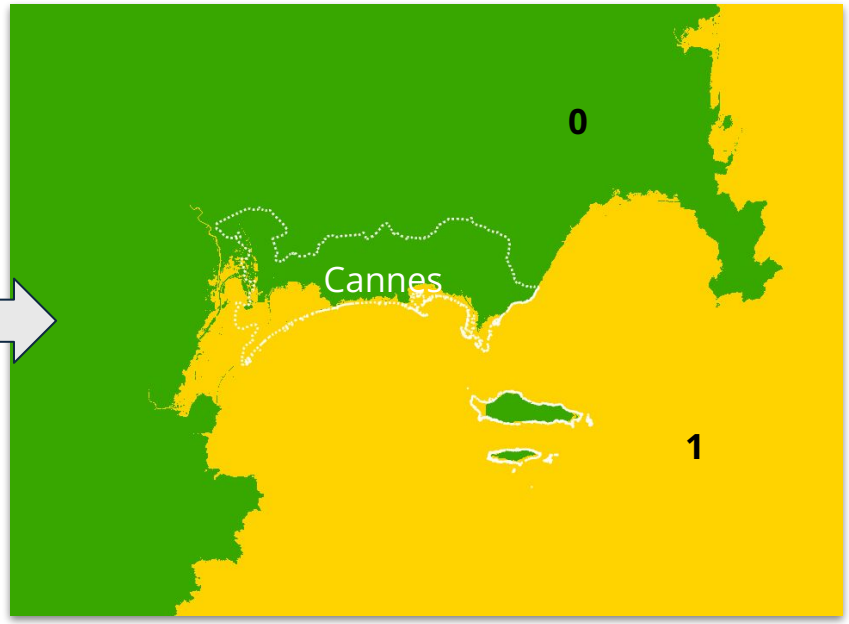
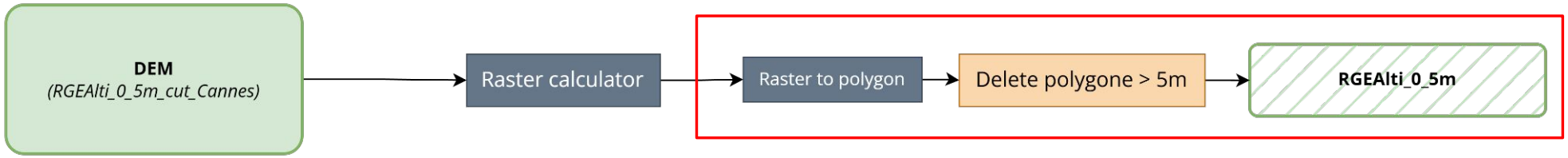
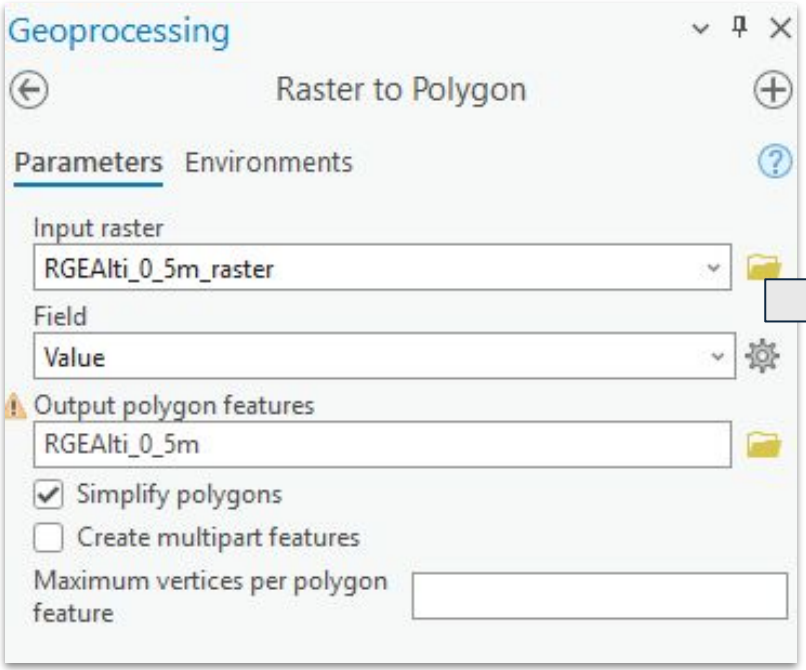
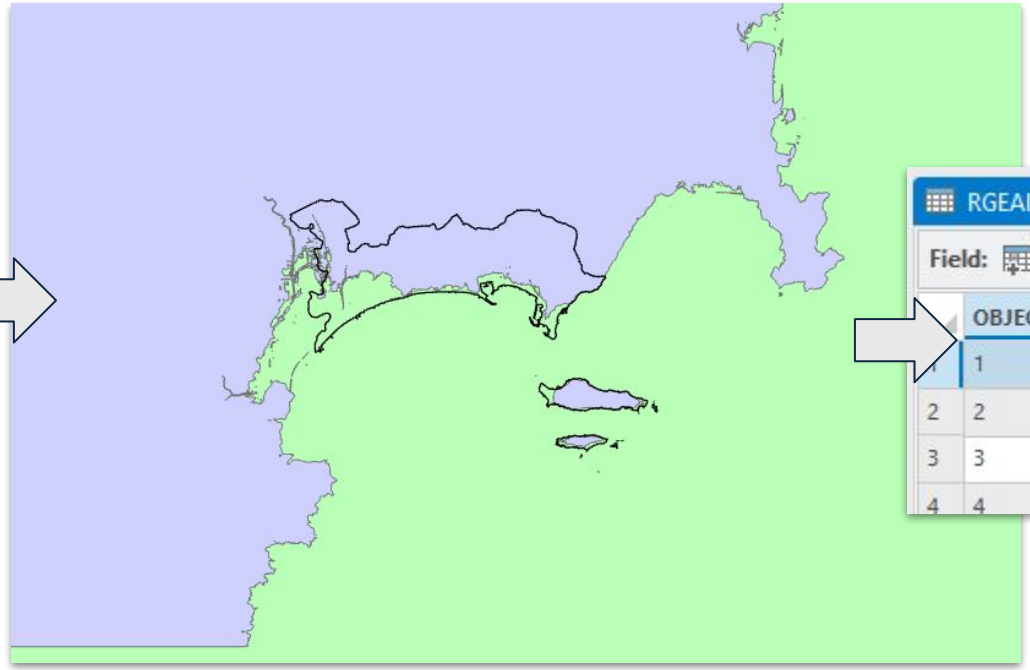


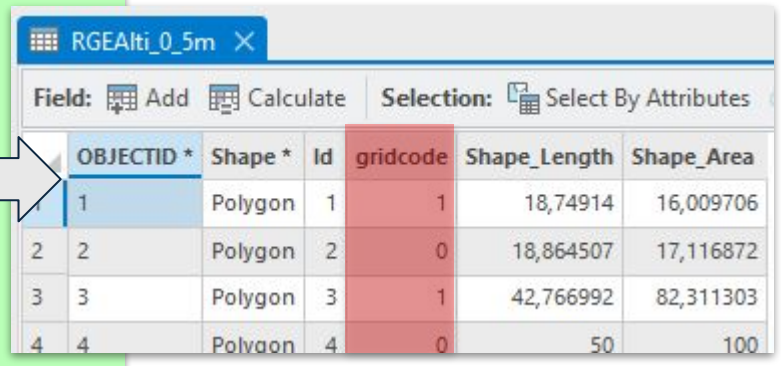
Pixel's value is now "**0**" or "**1**" depending if the pixel elevation value matched the condition or not.

Tsunami evacuation zone mapping









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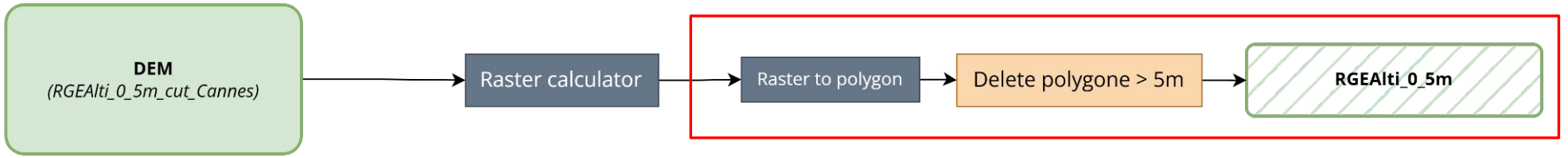
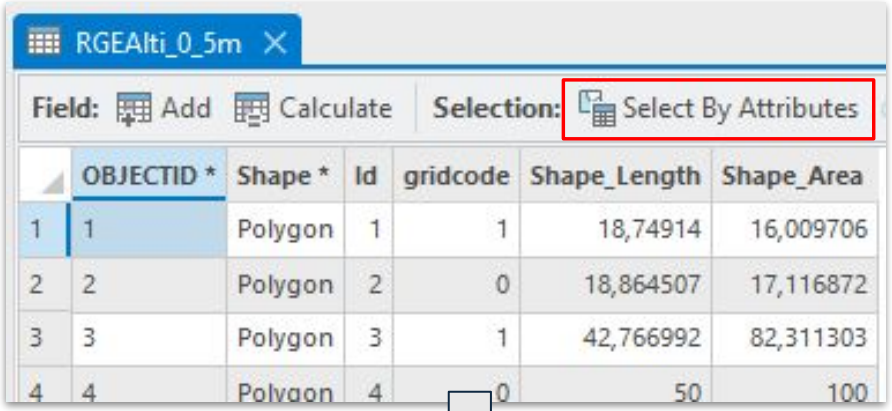
The previous raster's pixel values are in the field "**gridcode**".

Tsunami evacuation zone mapping





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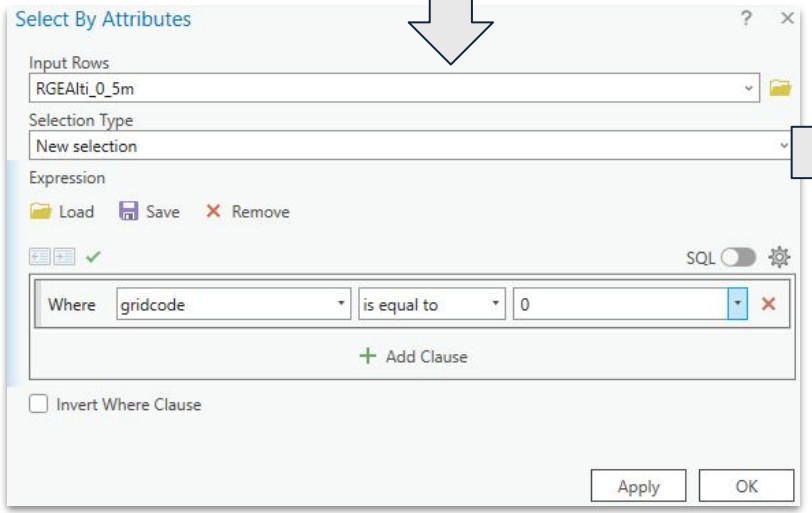
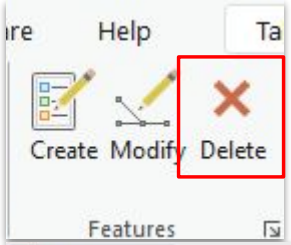
4	4	Polygon	4	0	50	100





RGEAlti_0_5m

Field: Add Calculate Selection: Select By Attributes

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5	5	Polygon	5	1	50	1
6	6	Polygon	6	0	18,864512	17,11688
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9	9	Polygon	9	0	18,864504	17,116865
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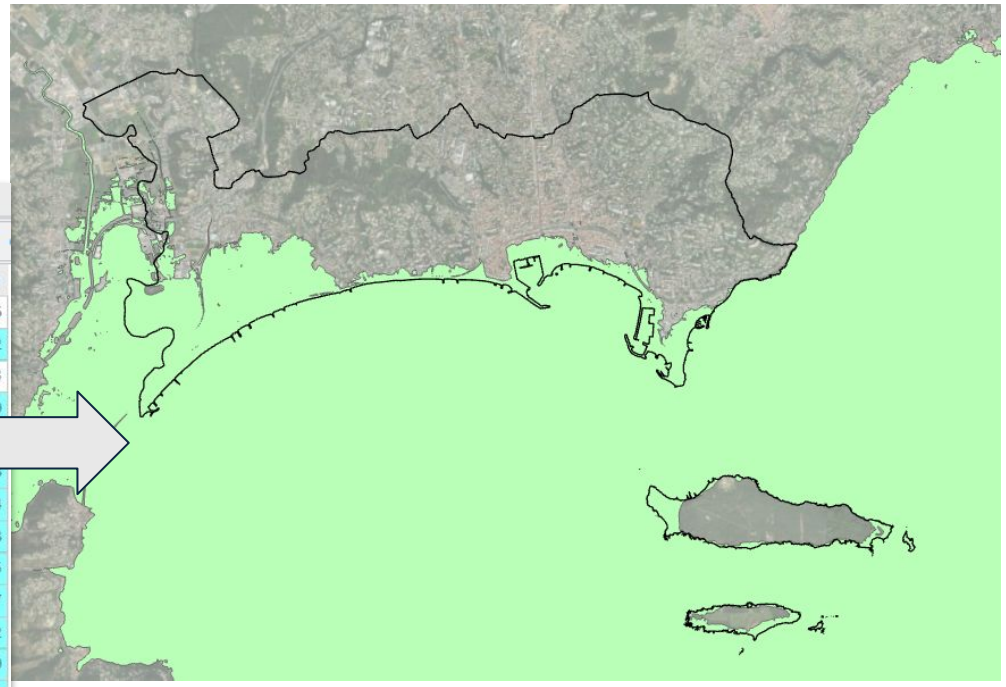

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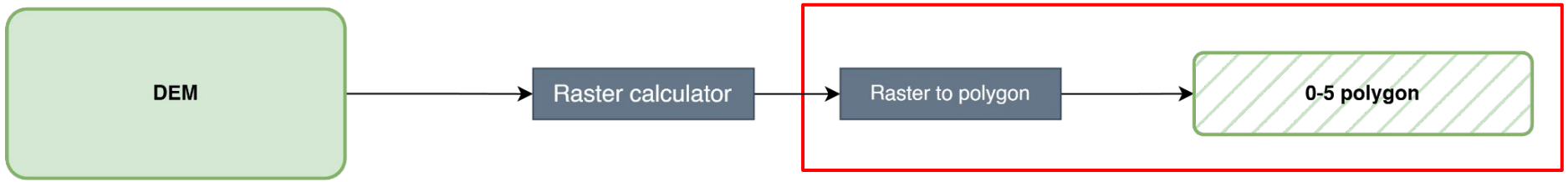
Tsunami evacuation zone mapping

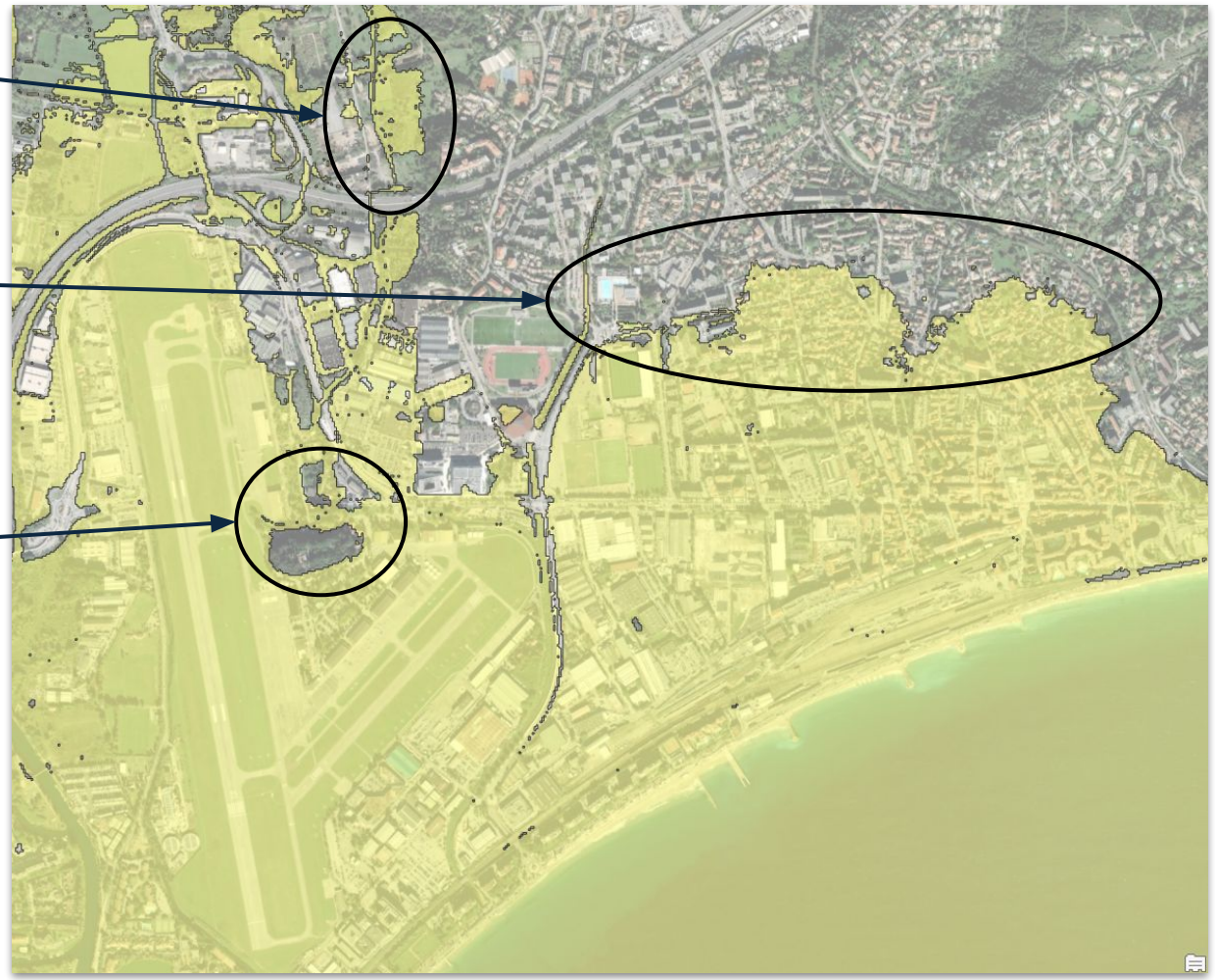


we obtain a polygon with a very precise level of detail that leads to several geometries to be generalized

Isolated polygon

Polygon's edges need simplification

local variations in altitude must be deleted



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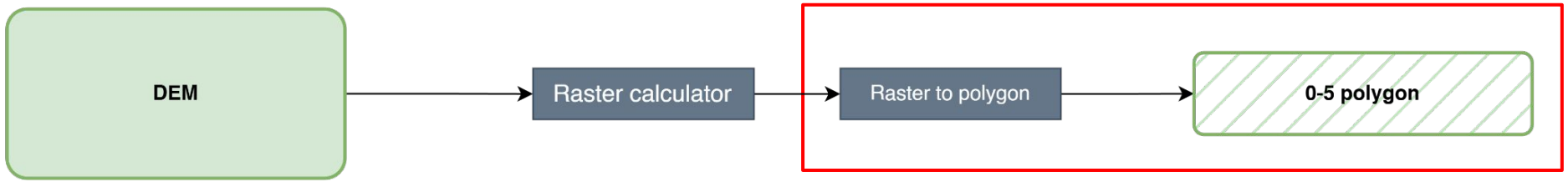
Tsunami evacuation zone mapping



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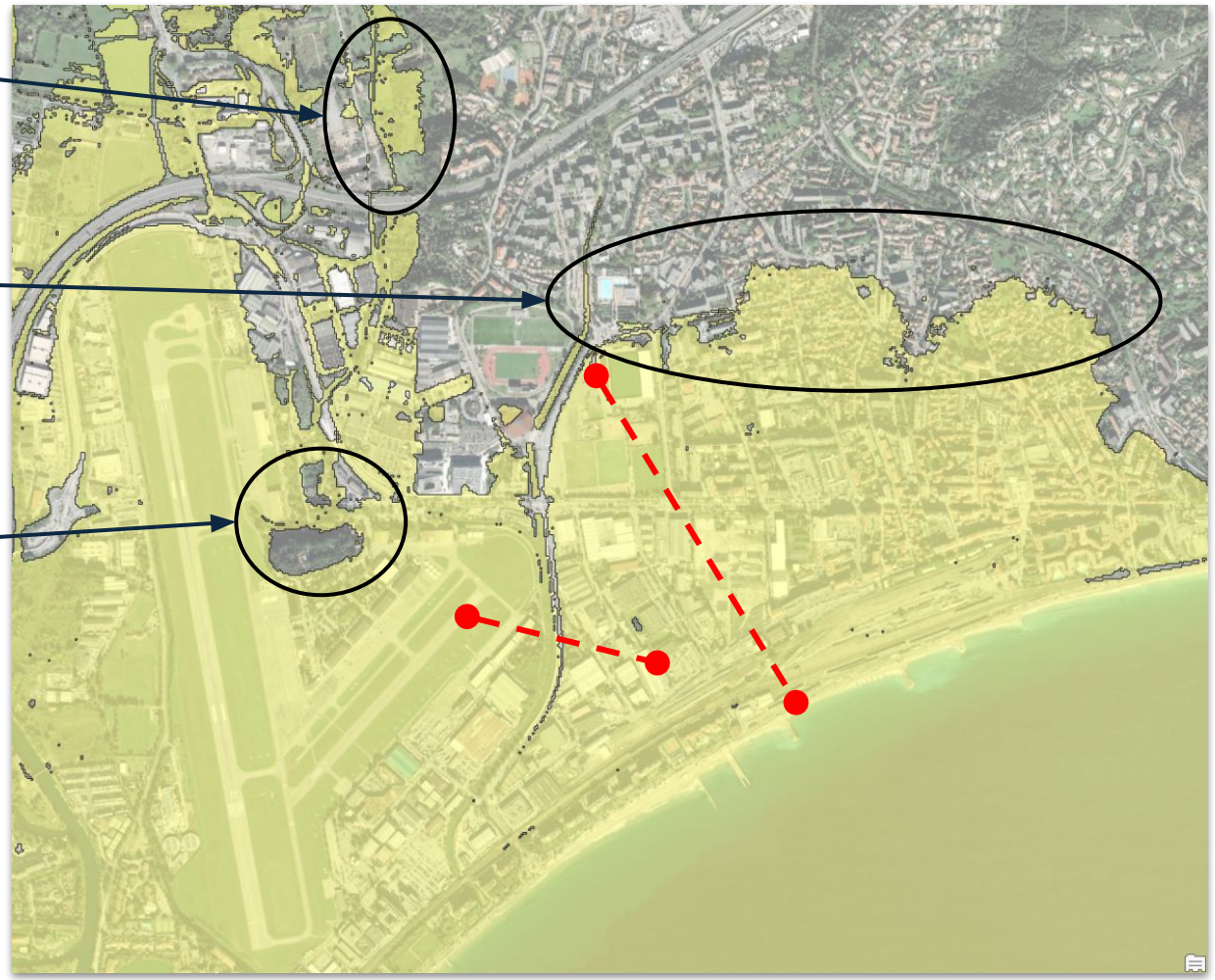

Before this step, **we need to take into account the initial assumptions regarding maximum distances inland and around watercourses**.

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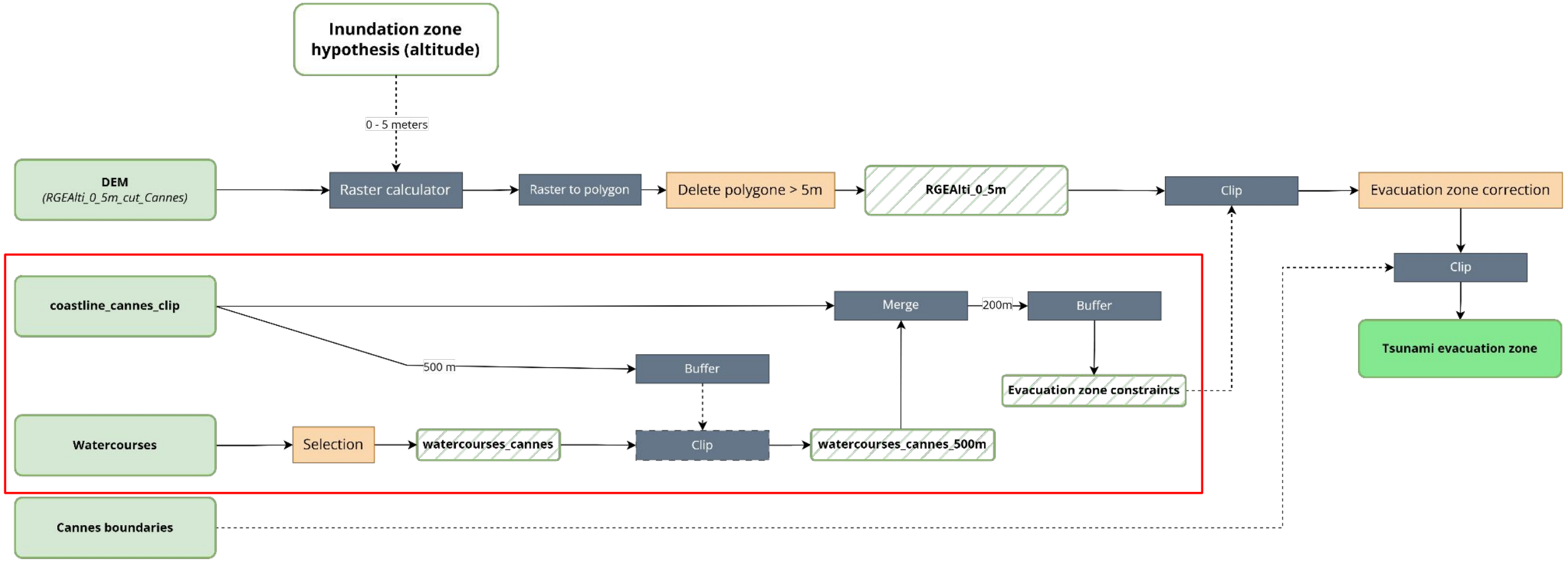
Tsunami evacuation zone mapping



Tsunami evacuation zone mapping

Only open-air hydrographic network will be taken into account for the evacuation zone

⇒ During **field mission** or trough **aerial image interpretation**

✓ Non cased drainage

✗ Cased drainage

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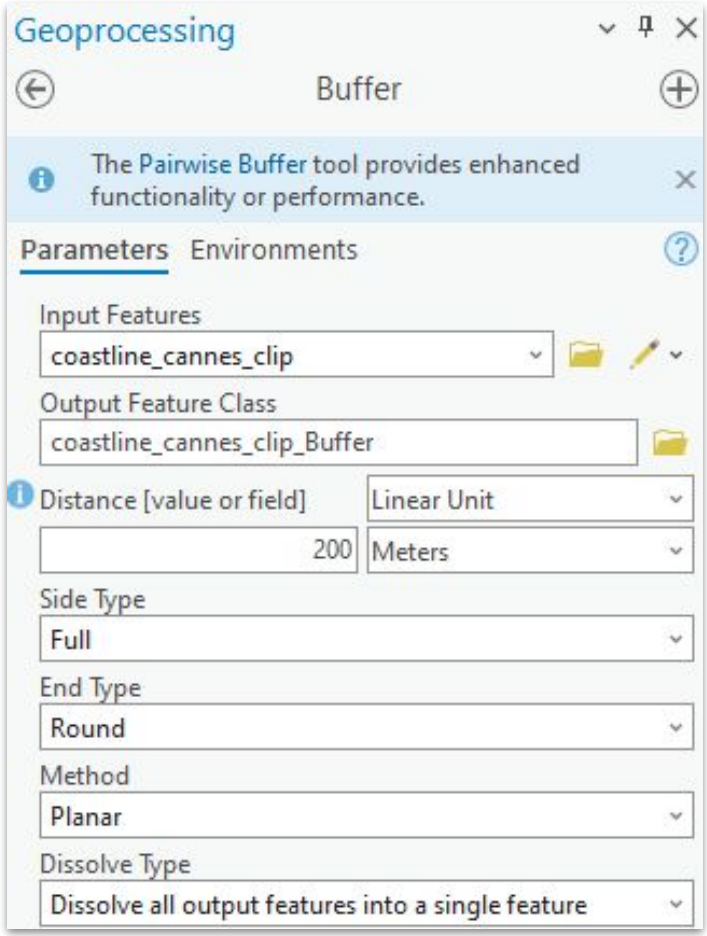
Tsunami evacuation zone mapping

Generate **500 meters buffer** on clipped coastline



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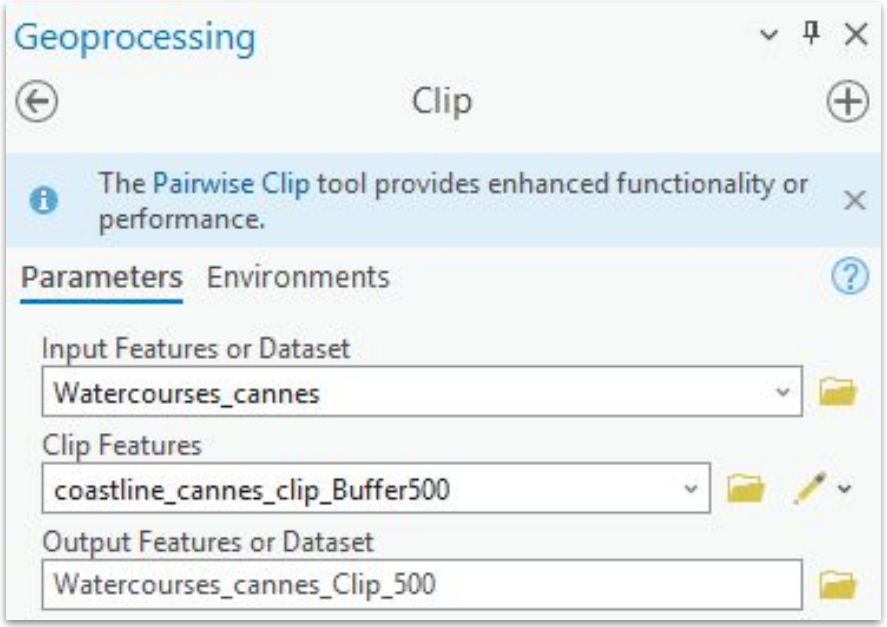
Tsunami evacuation zone mapping

Clip watercourse with previous buffer



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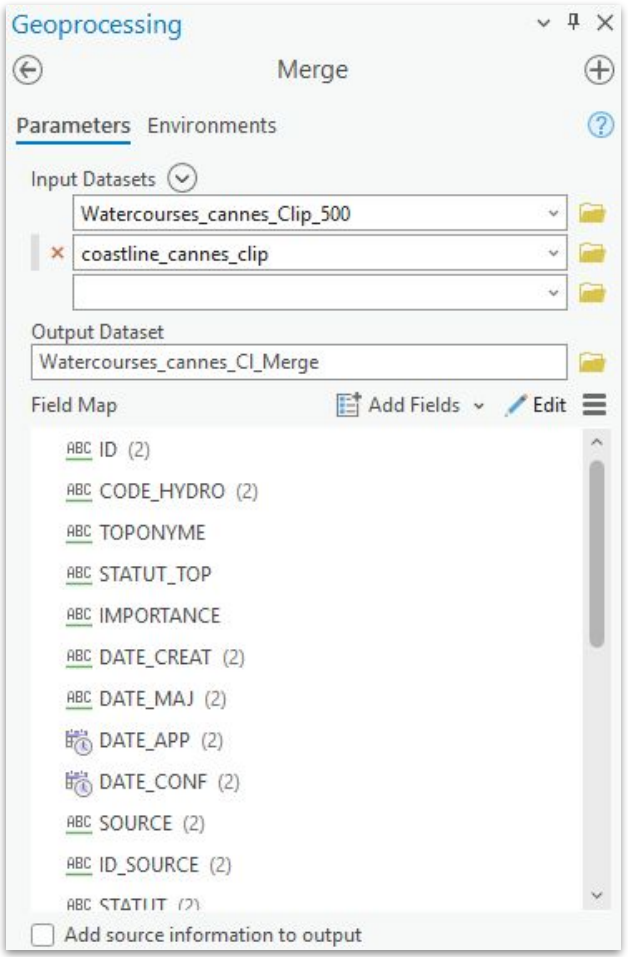
Tsunami evacuation zone mapping

Merge both watercourse & coastline



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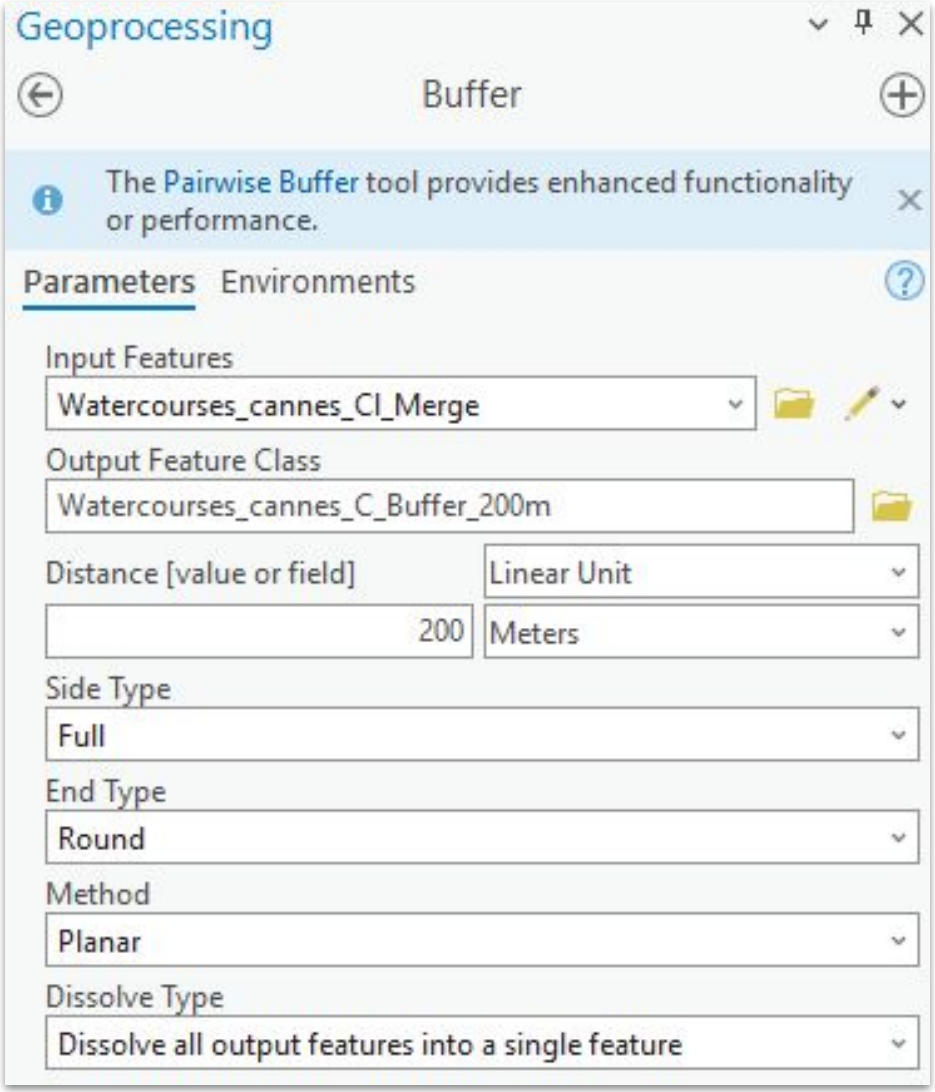
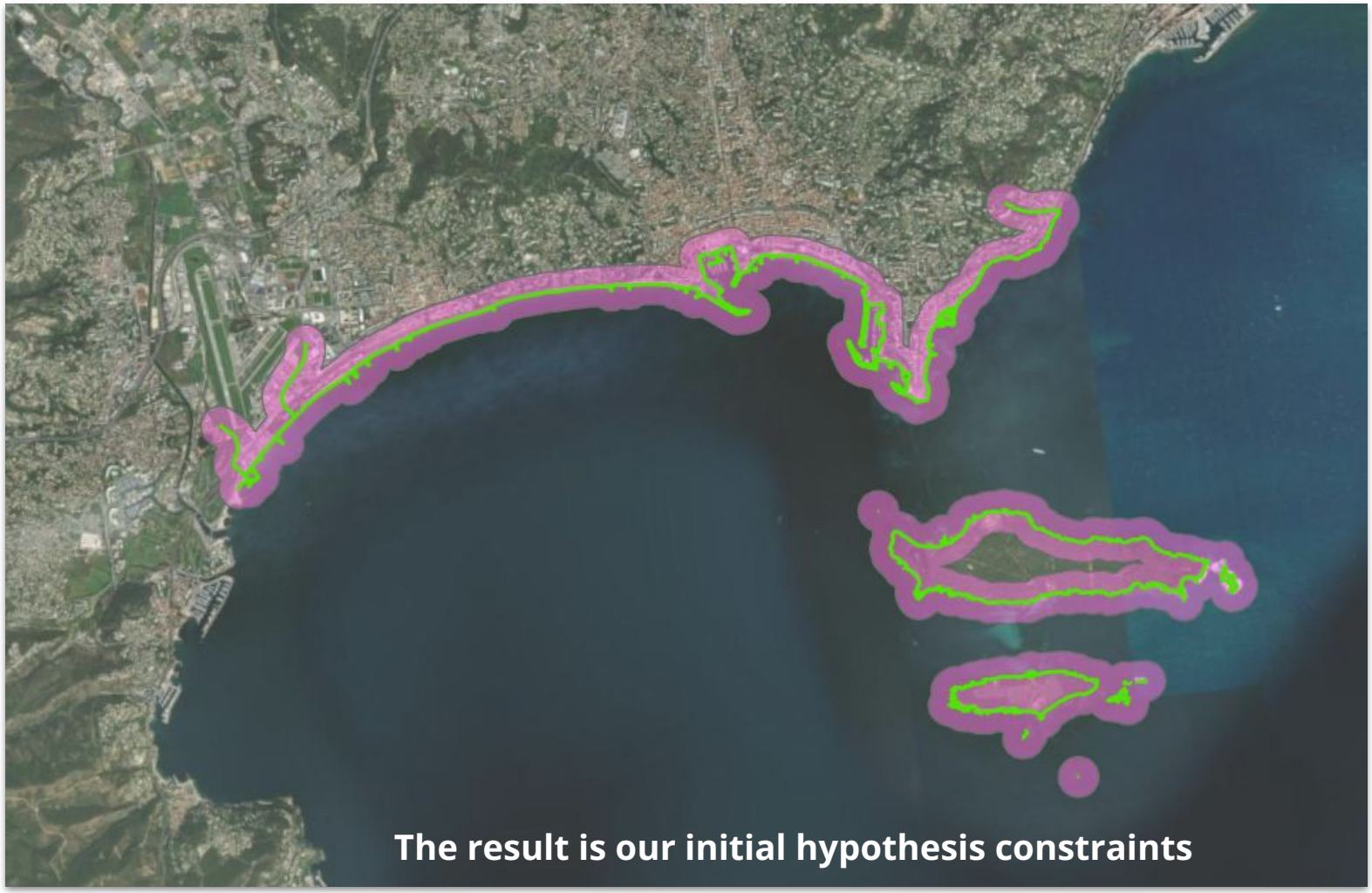
Tsunami evacuation zone mapping

Generate **200 meters buffers** with the merged layer and export the result as "**evacuation_zone_constraints"**





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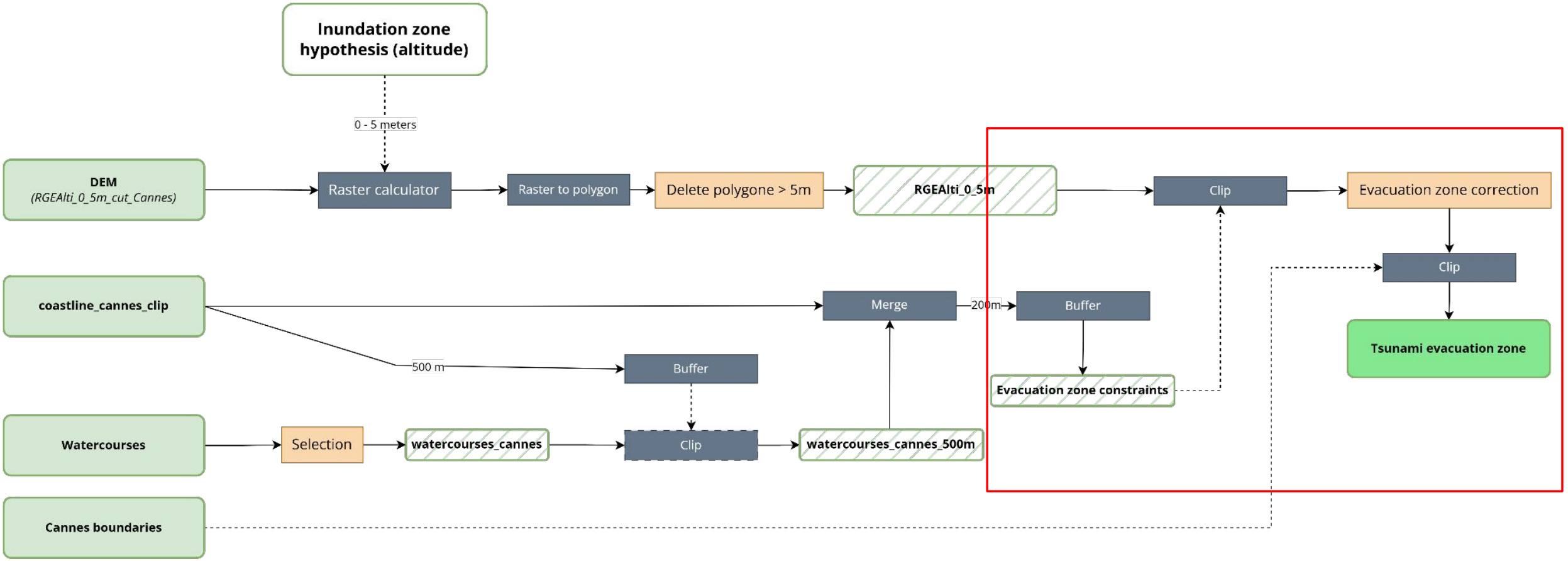
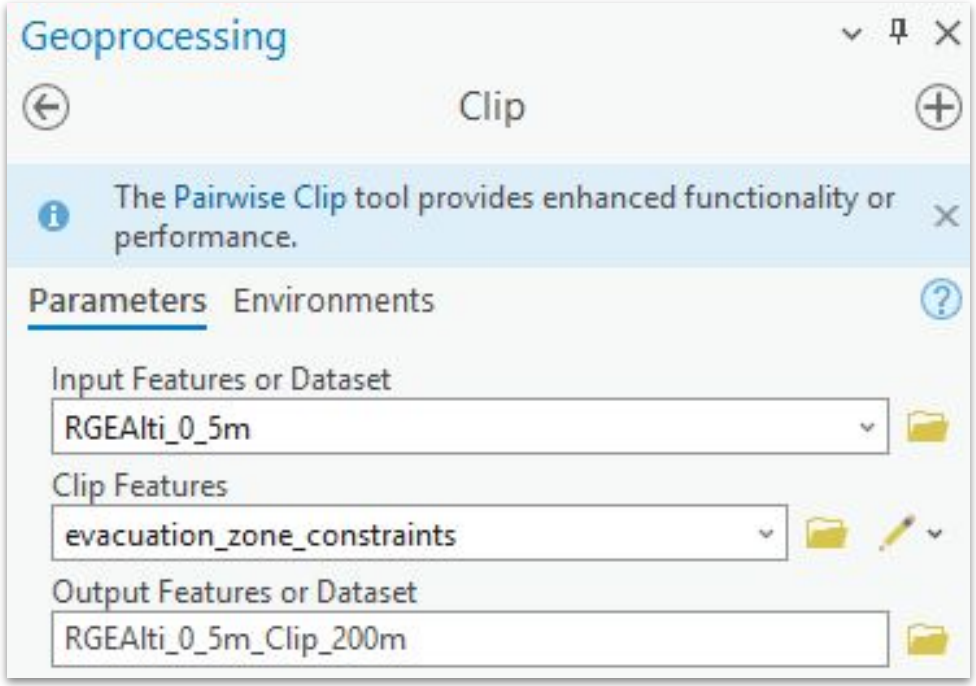
Tsunami evacuation zone mapping



Tsunami evacuation zone mapping

Clip the **RGEAlti_0_5m** on the **evacuation_zone_constraints** layer.



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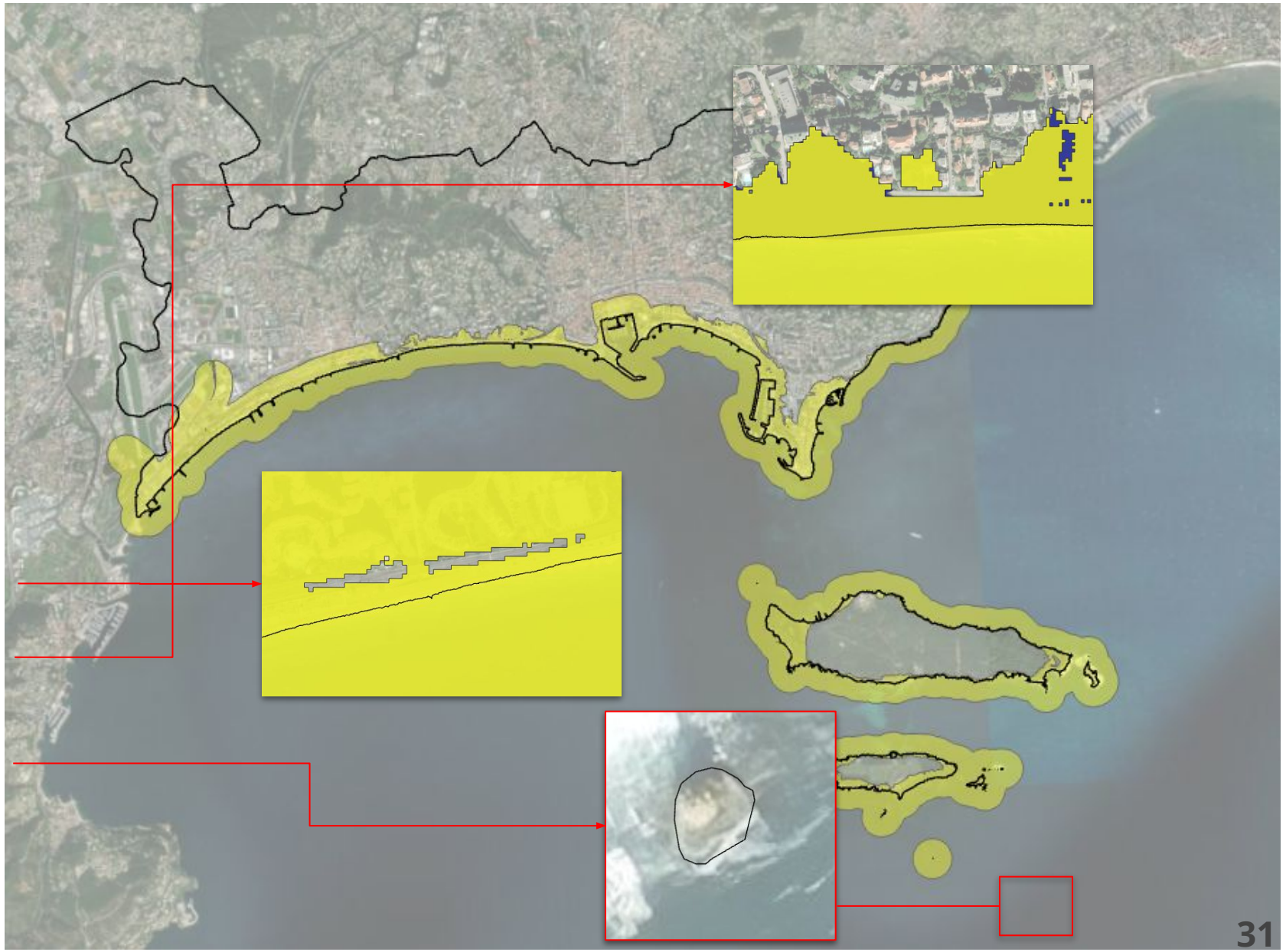
Tsunami evacuation zone mapping

Clipping the RGEAlti_0_5m with the constraints polygon provide us a **raw version** of the evacuation zone which will be used to create the final tsunami evacuation zone.

Corrections are needed at this point :

1. Removing off-lands parts
2. Removing holes due to local elevation change
3. Removing parts not connected with the sea
4. Smoothing the polygon's edges
5. Removing small inhabited islet



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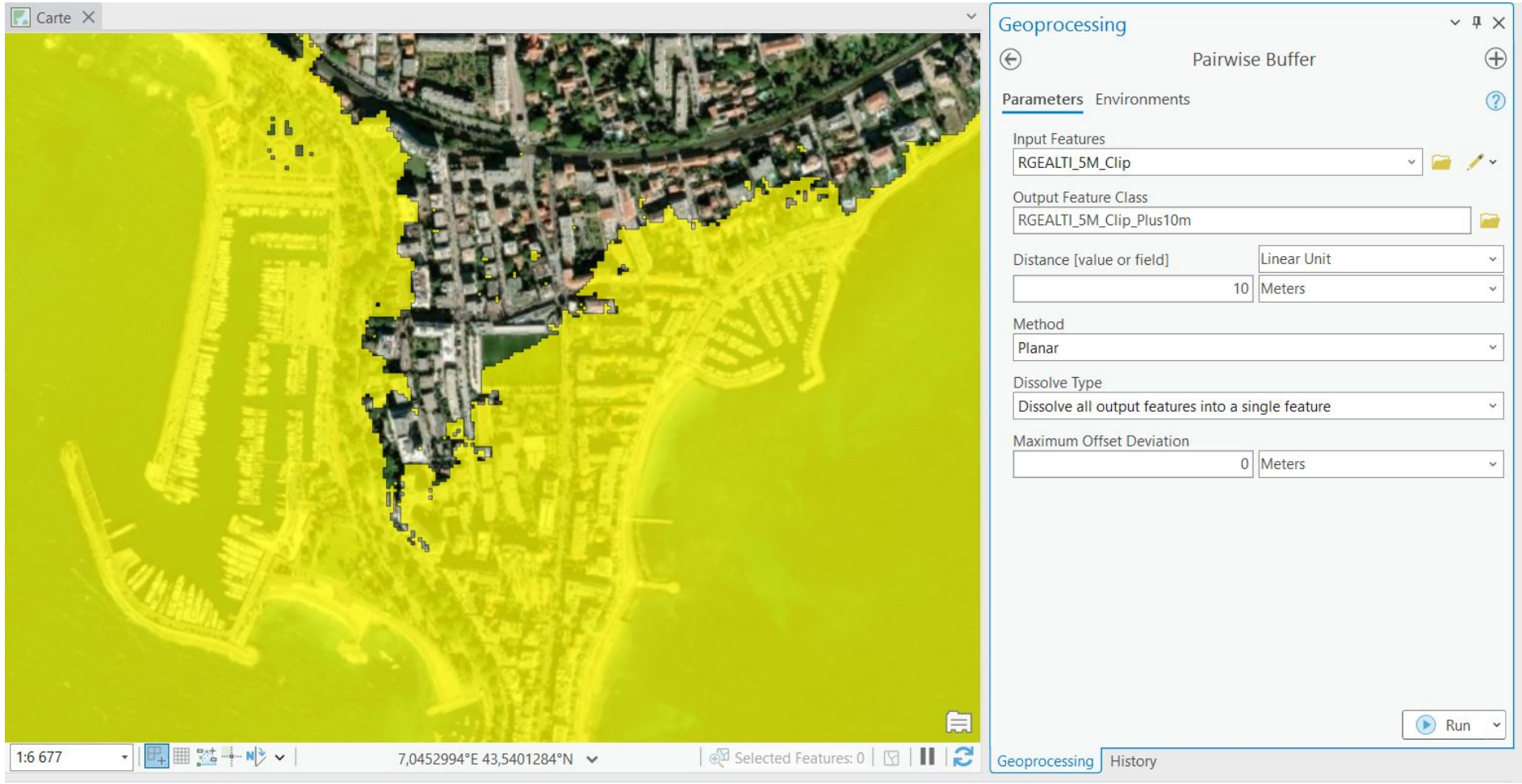
Erosion & Dilation on Vector Data

Buffer the "evacuation_zone" layer by **10 meters** to smooth and connect isolated depressions.



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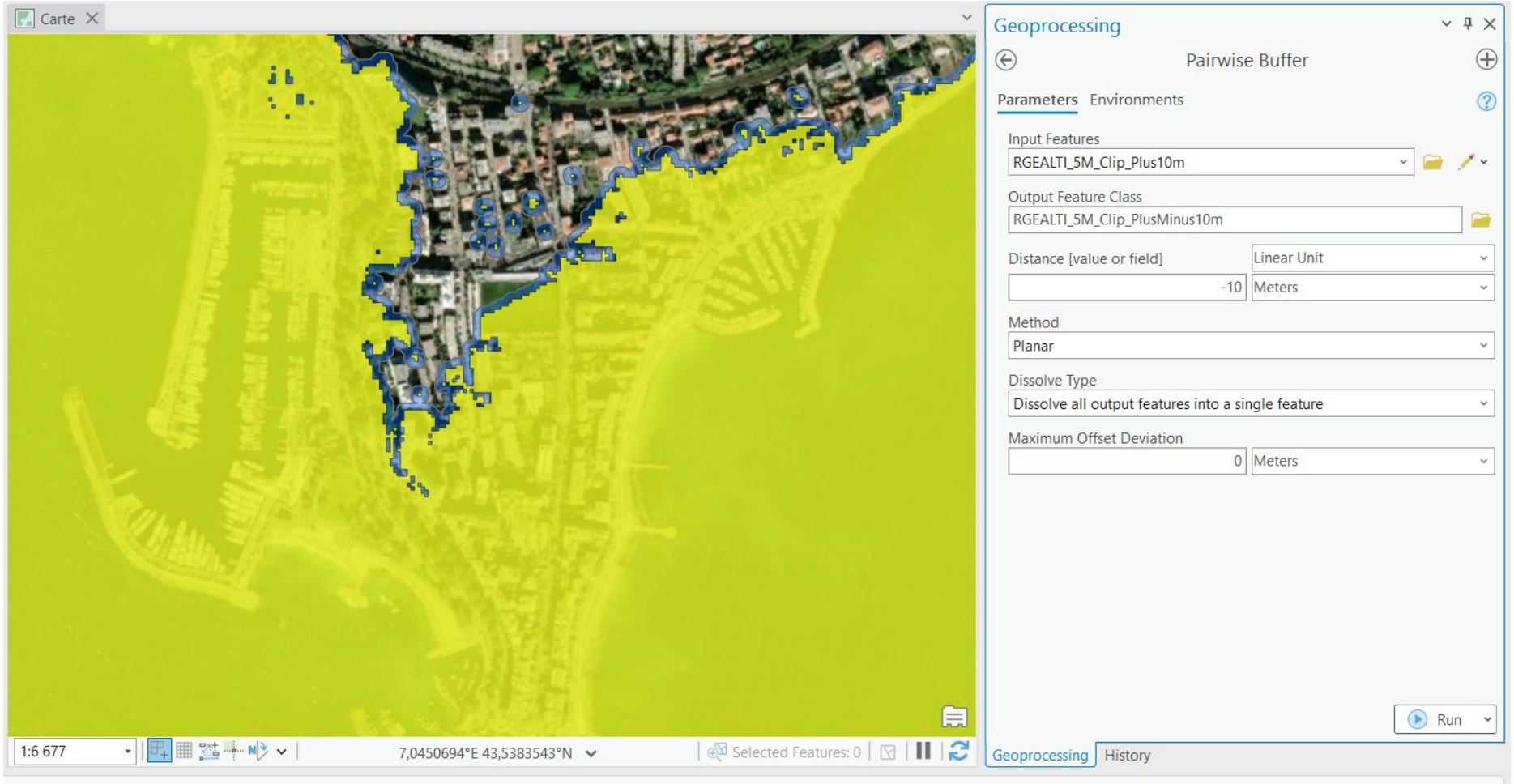
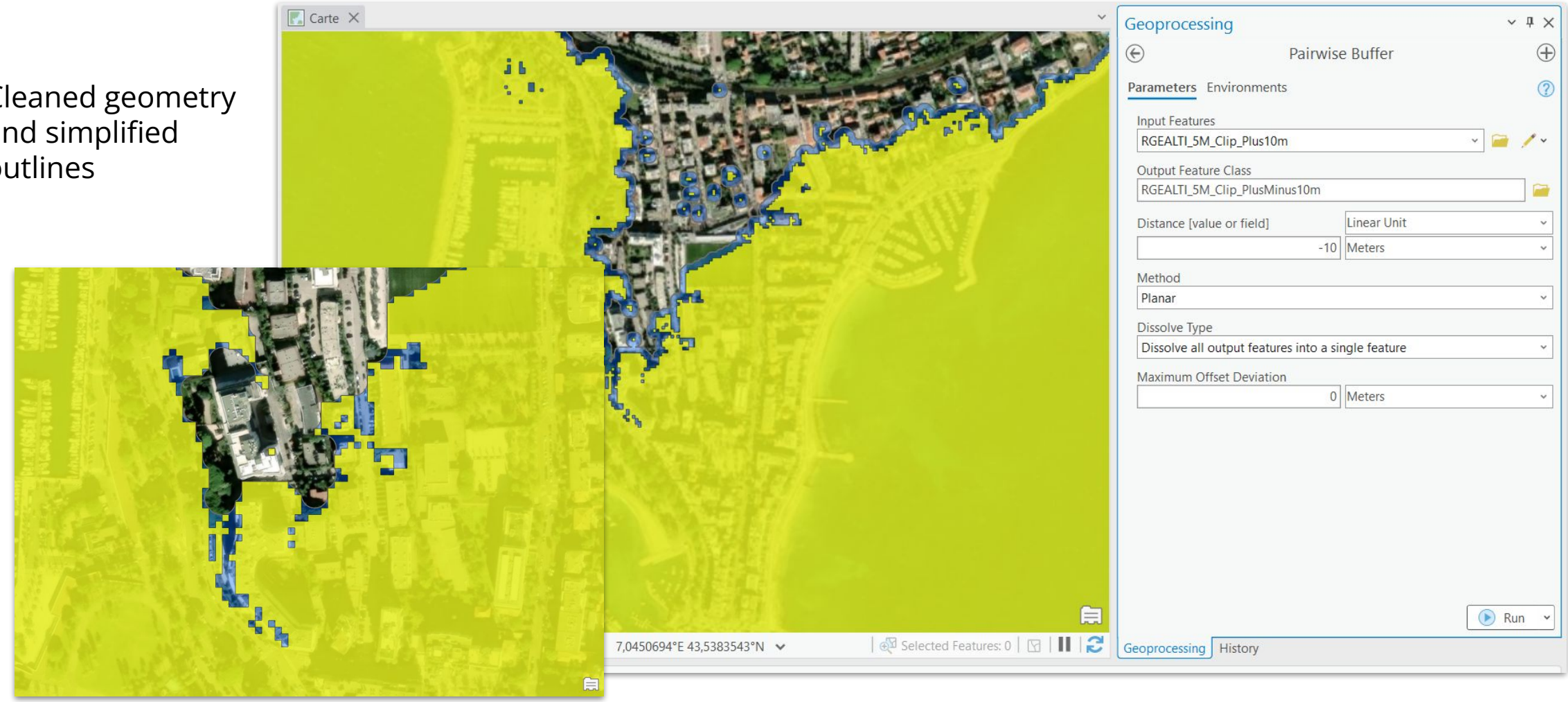
Erosion & Dilation on Vector Data

Buffer the "evacuation_zone" layer by **-10 meters** to simplify the geometry and eliminate narrow connections.



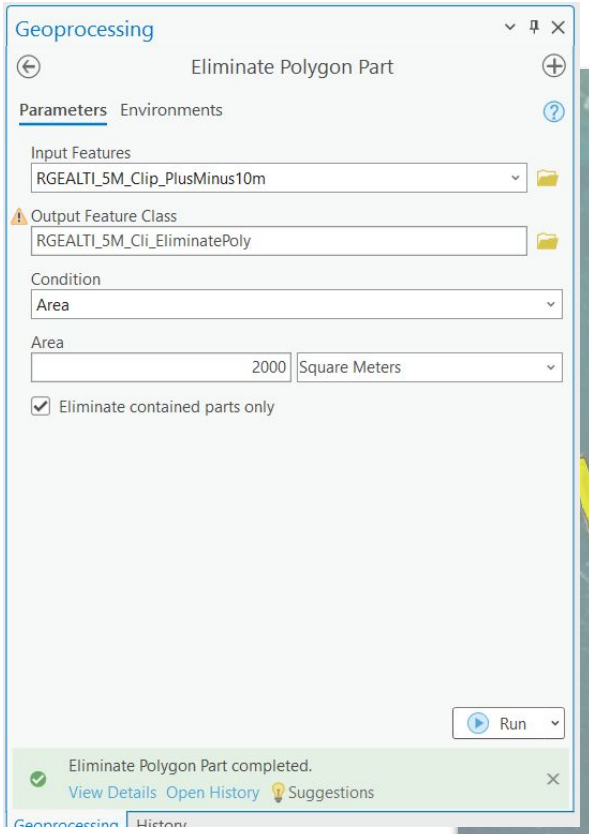
Erosion & Dilation on Vector Data

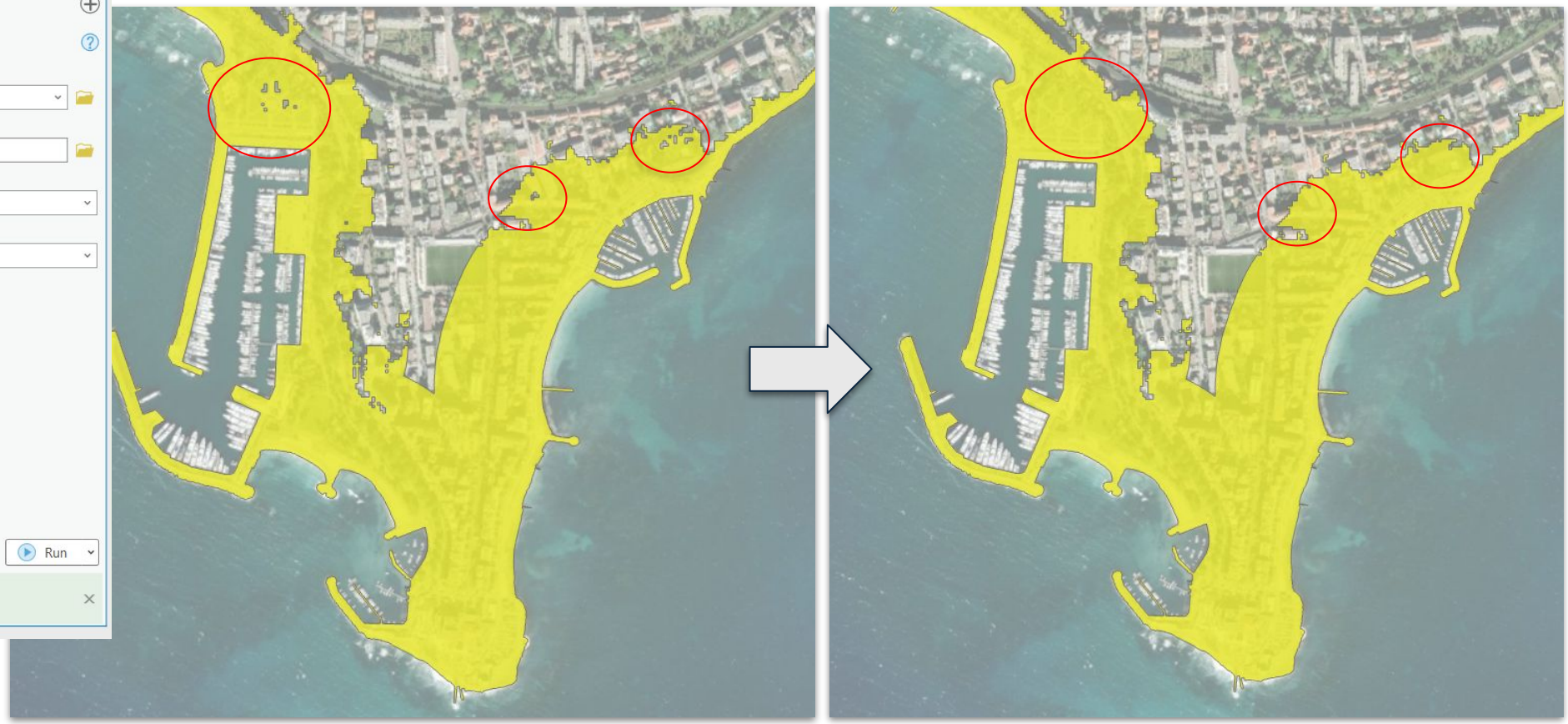
Cleaned geometry and simplified outlines



Tsunami evacuation zone mapping

The **Eliminate Polygon Part** geoprocessing tool allows holes larger than the ***minimum hole size*** parameter
→ The result of the algorithm can vary significantly depending on the input parameters.





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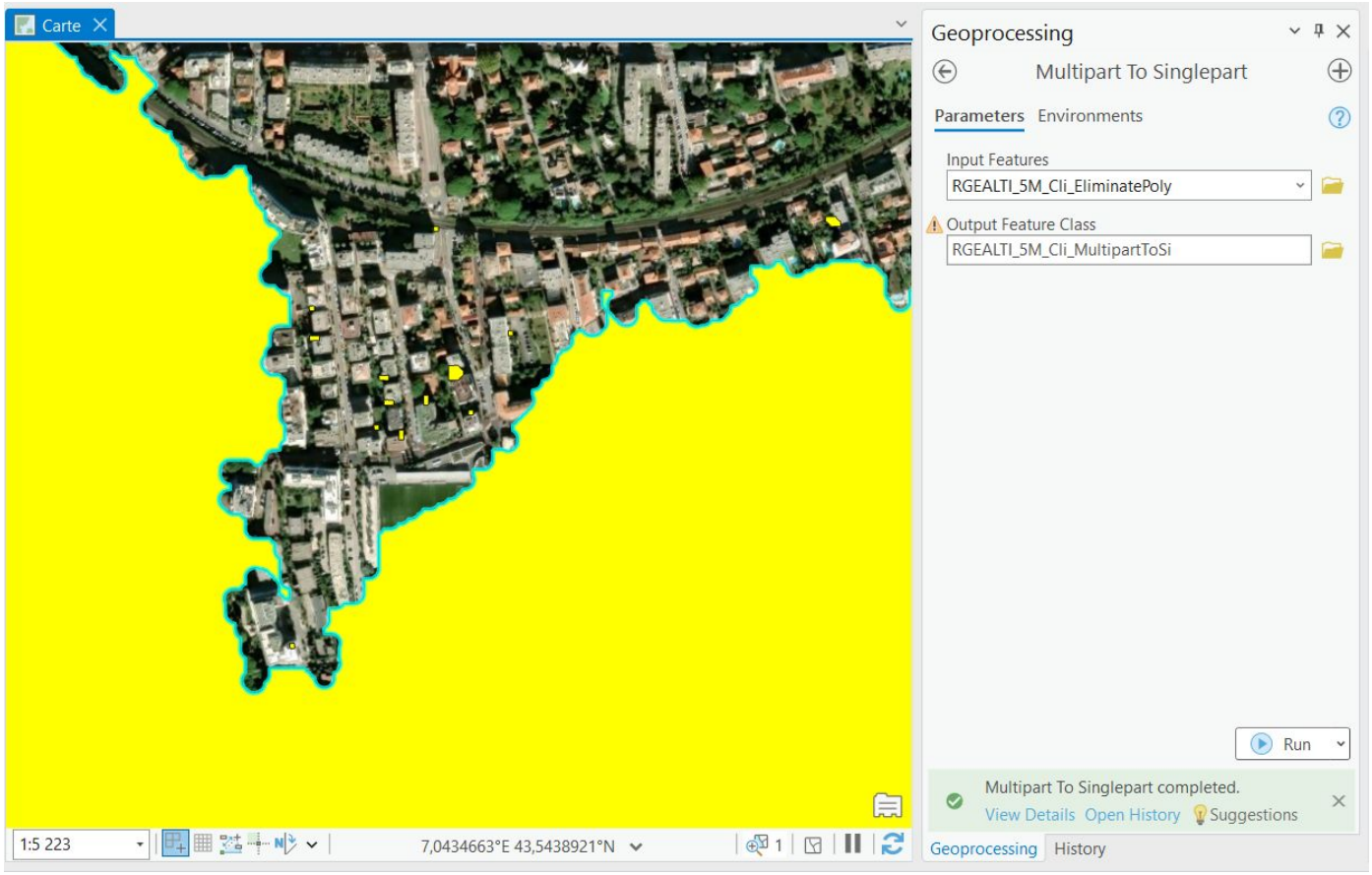
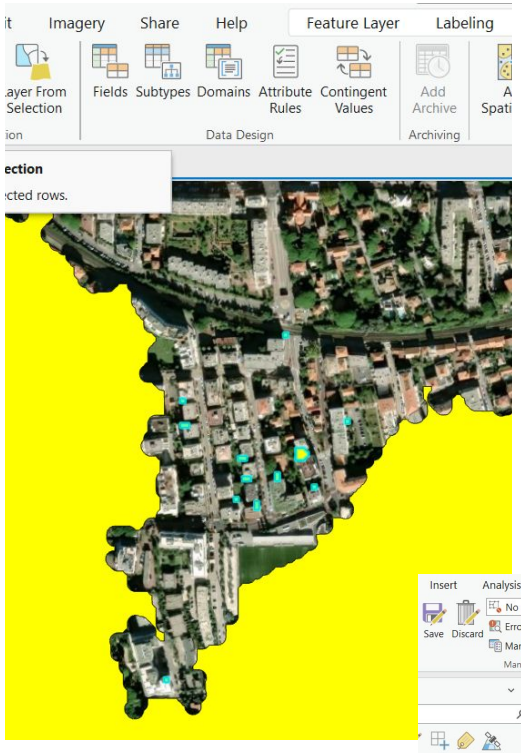
Tsunami evacuation zone mapping

The **Eliminate Polygon Part** geoprocessing tool allows holes larger than the ***minimum hole size*** parameter
→ The result of the algorithm can vary significantly depending on the input parameters.

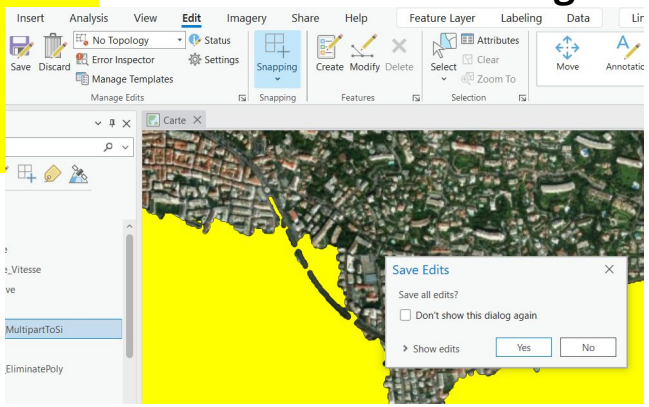
Select



Inverse selection



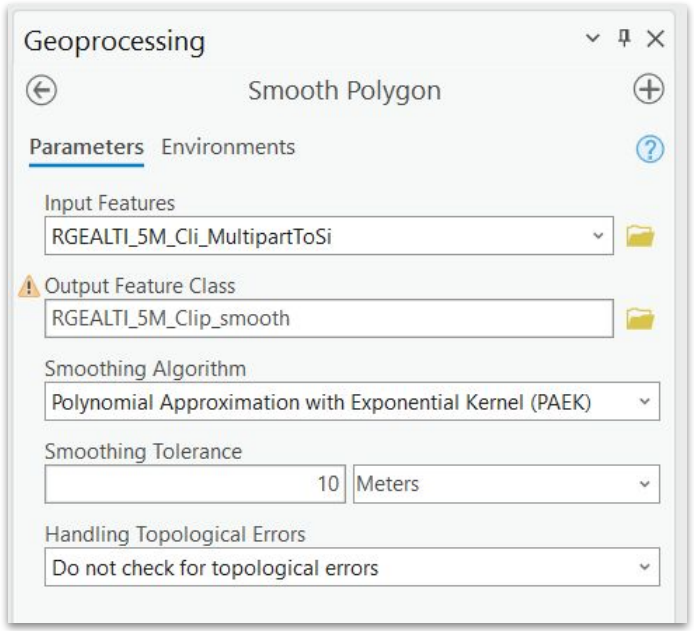
Delete and save changes

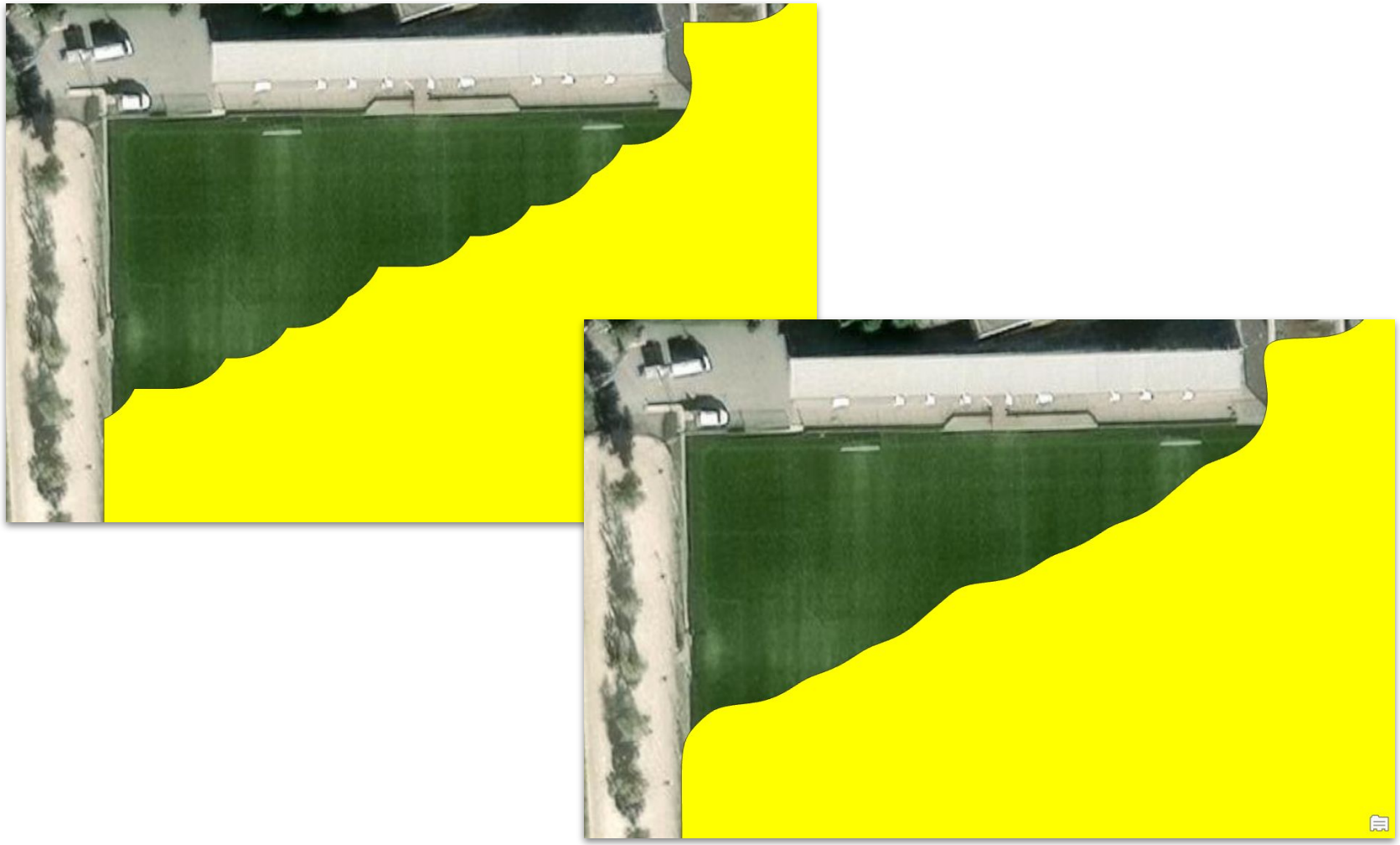


Tsunami evacuation zone mapping

Polygon Smoothing for Clearer Boundaries

Smooth the evacuation_zone layer to reduce angular shapes and improve boundary readability.





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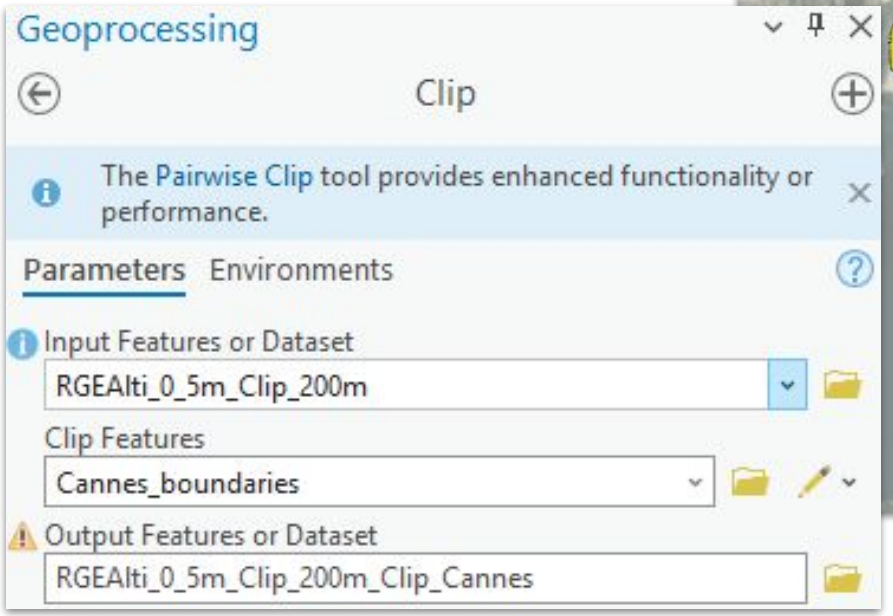
Tsunami evacuation zone mapping

Removing off-land parts by clipping the layer with Cannes boundaries polygon.

→ Clipping the layer with coastline is also possible if the communitie's boundaries aren't accurate along the coast.

If so, generate a polygon using a high resolution coastline and the edges of your work area



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Tsunami evacuation zone mapping

Make sure that the result of the clipping operations is conform to our initial hypothesis (0-5m high & 200m inland or 500m inland near watercourses that are connected to the sea)

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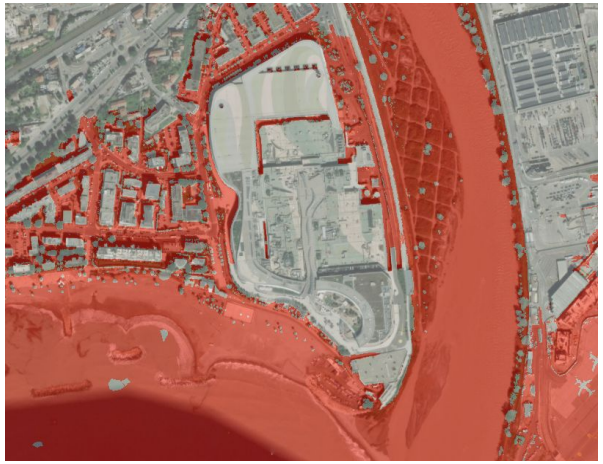
Tsunami evacuation zone mapping

Field verification is mandatory in order to detect errors or the need for local adaptations that cannot be assessed through imagery analysis.

Lidar's 0-5m range extraction (in red)



E.g : Cap 3000, Nice's metropole's largest mall

Due to the large numbers of visitors, the authorities decided to make an exception to the standard evacuation instructions for this shopping center : people already in the mall will have to stay inside.

Field visit allowed to take into account the recently constructed seafront terrace that wasn't available on satellite imagery at the beginning of the project.

The evacuation zone along the mall was modified based on the field verification and up-to-date Lidar data

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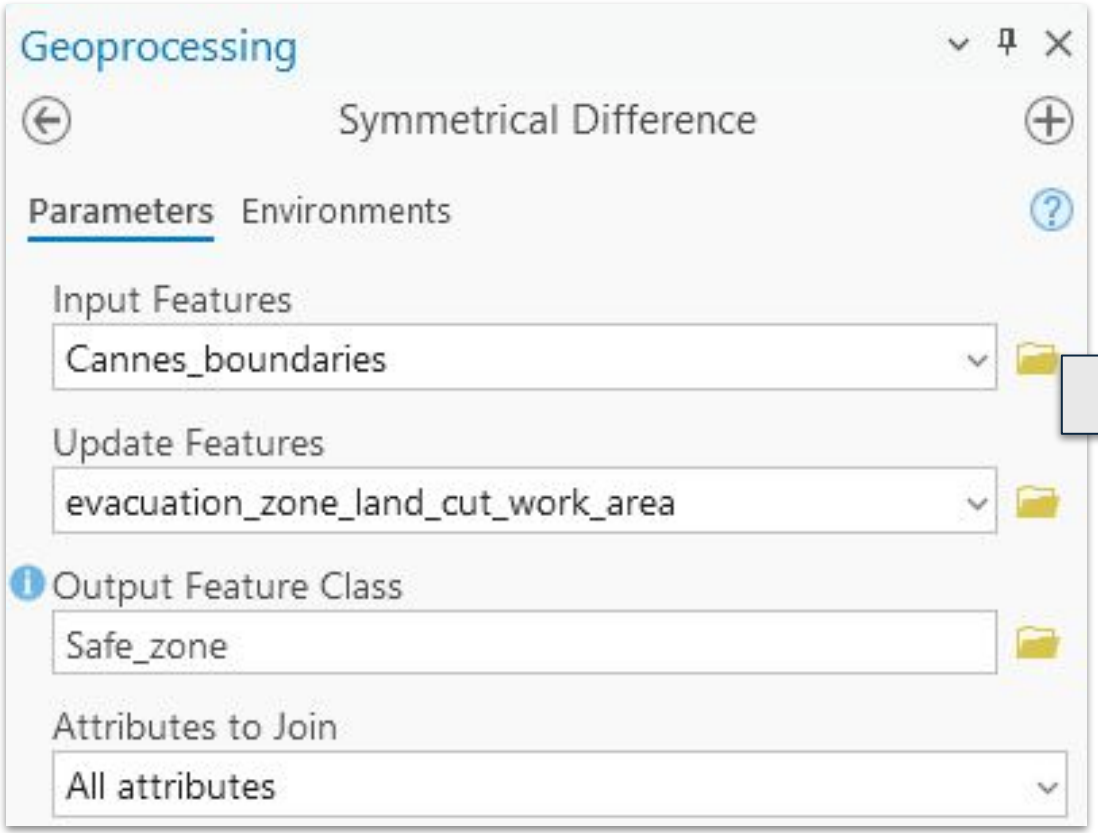
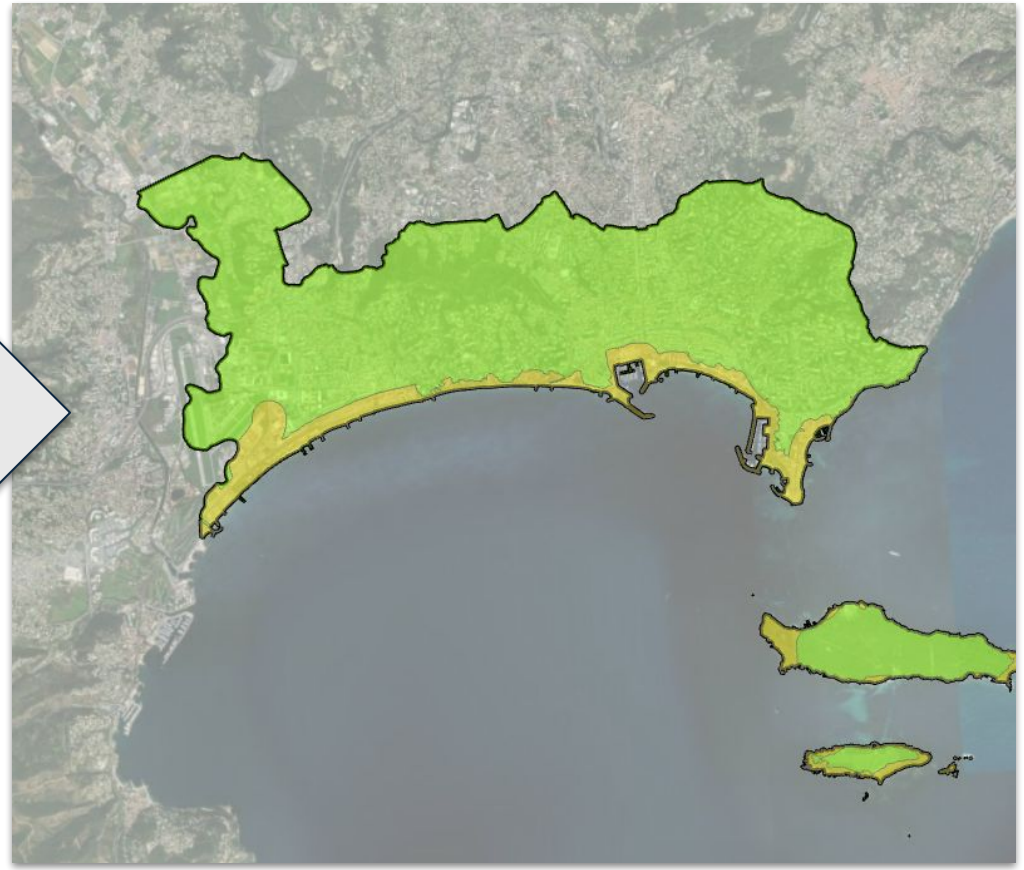
Generate the tsunami safe zone !

Tsunami evacuation zone mapping

Use the **Symmetrical difference** tool between the evacuation zone and Cannes boundaries to generate the safe zone





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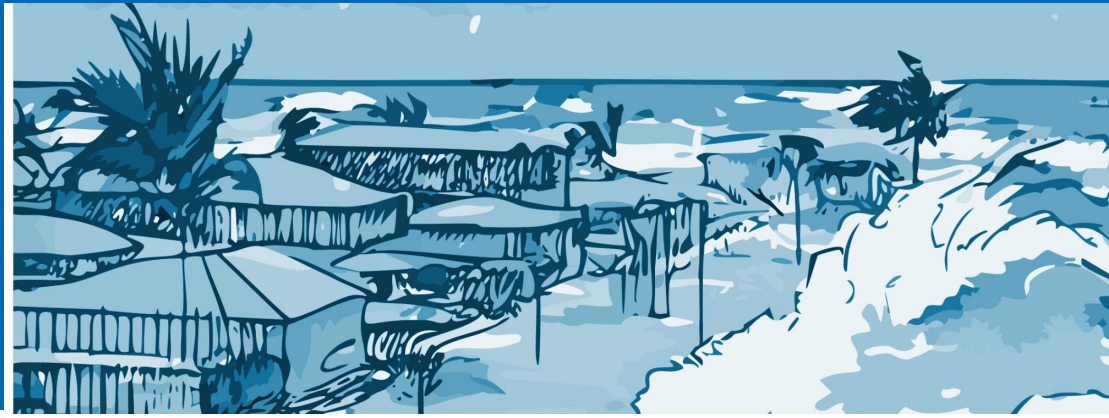
Tsunami Evacuation Mapping Workshop



CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

Dr. Matthieu Péroche
Louis Monnier

30 June – 4 July 2025

Contact : matthieu.peroche@univ-montp3.fr

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Intergovernmental Oceanographic Commission

Funded by European Union Humanitarian Aid

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

CoastWAVE NEAMTWS

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LABORATOIRE DE GEOGRAPHIE ET D'AMENAGEMENT DE MONTPELLIER

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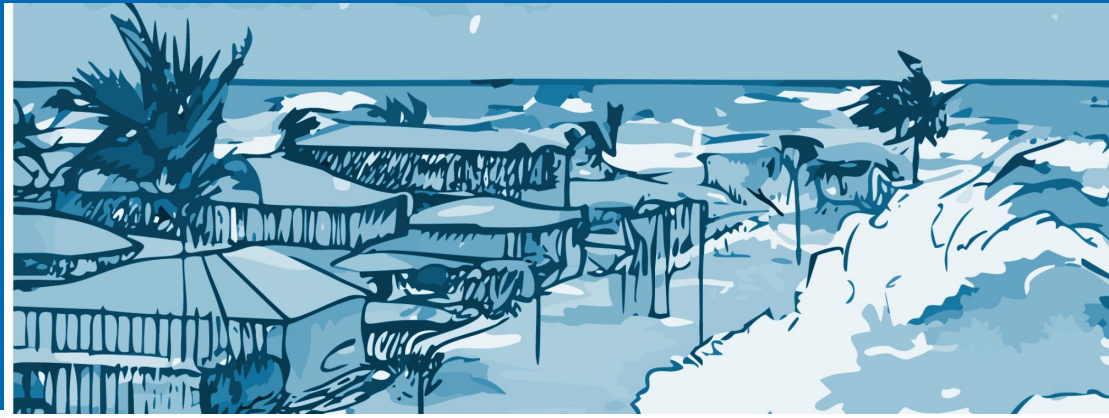
Tsunami Evacuation Mapping Workshop

30 June – 4 July 2025



CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

Dr. Frédéric Leone
Dr. Matthieu Péroche
Louis Monnier

Lesson #2

Method for identifying tsunami assembly points

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Funded by European Union Humanitarian Aid

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Lesson's overview

1. Theory

- Selection criteria
- Authorities validation process

2. Practice

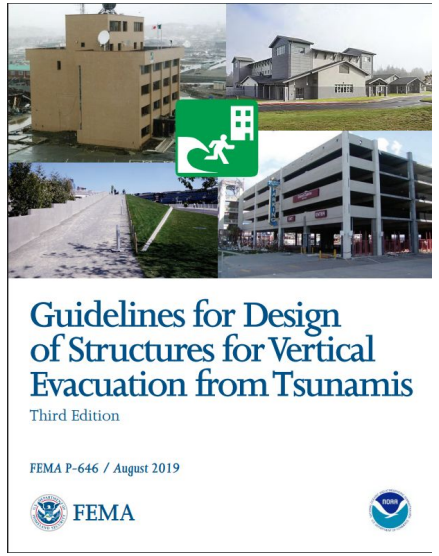
- Mapping the entry points in the safe zone
- Assembly point pre-identification
- Field inspection & quality assessment
- Deliverable

Why define tsunami assembly points?

- To give people a clear direction and a specific place to reach
- To identify and communicate the location both on maps and on the ground
- To help emergency services locate and regroup the population
- To encourage evacuation on foot to a safe and suitable area

Horizontal vs. Vertical Tsunami Assembly Points

	Horizontal Refuge	Vertical Refuge
Definition	Outdoor safe zone located outside the inundation area	Elevated structure (e.g. tall building or tower) designed to resist tsunami forces
Used in our studies?	✅ Yes, systematically	❌ No



https://www.fema.gov/sites/default/files/documents/fema_rsl_guidelines-for-design-of-structures-for-vertical-evacuation-from-tsunamis_050925.pdf

Why ?

- Safer in seismic contexts (no risk of collapse)
- Easily identifiable and accessible
- No structural evaluation required
- Requires strict engineering standards (e.g. FEMA guidelines)
- Risk if structure is not designed/tested
- Complex legal and technical validation

In French territories, walking short distances to safe areas is usually sufficient — **horizontal evacuation is both feasible and safer** in our context.

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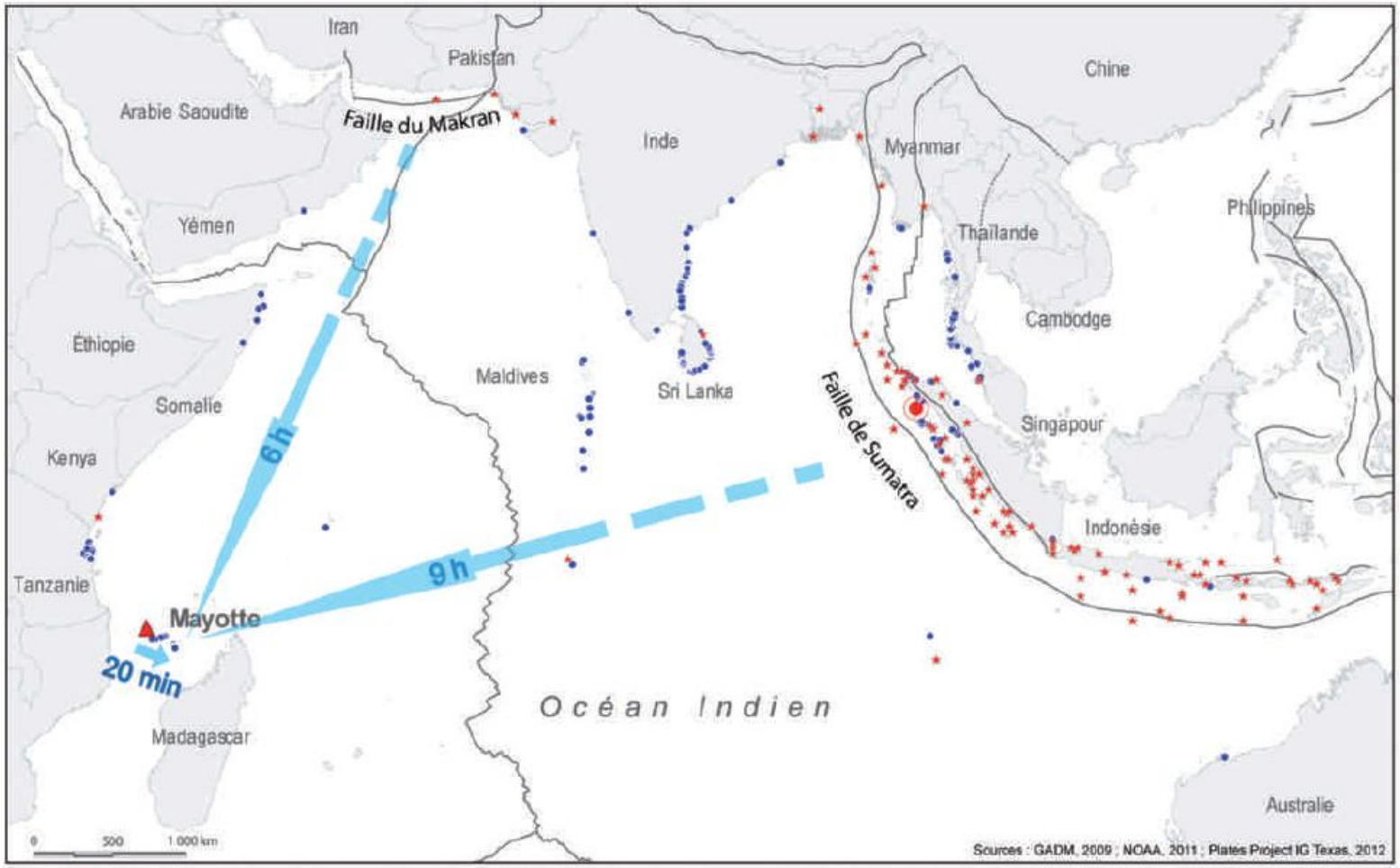
Modelled distant tsunami sources and effects of the 2004 tsunami in Mayotte



Method for identifying tsunami assembly points

Several potential local sources linked to the seismic-volcanic activity of a new submarine volcano named Fani Maoré (May 2018)

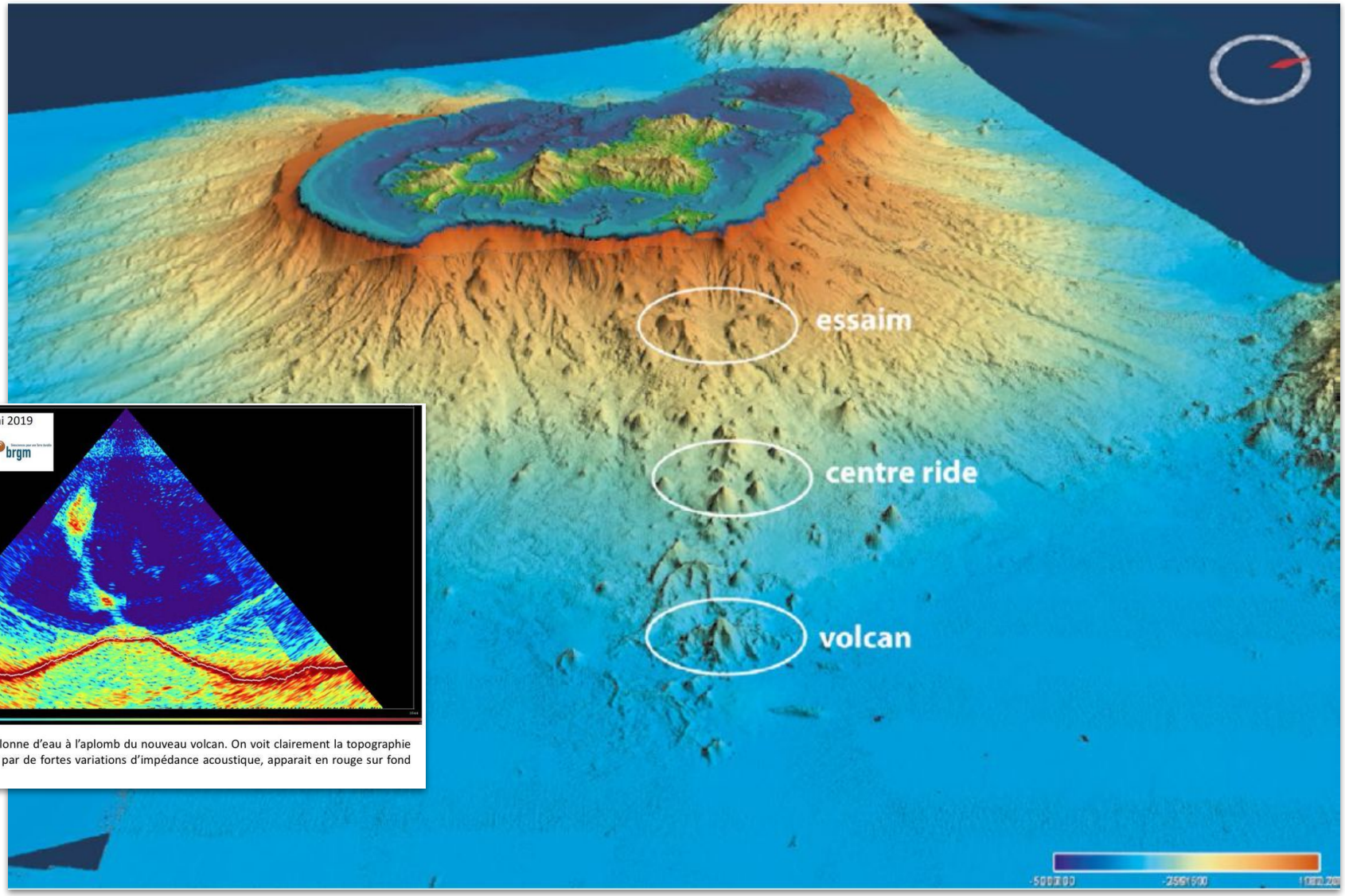


Image multifaisceaux de la colonne d'eau à l'aplomb du nouveau volcan. On voit clairement la topographie du volcan. Le panache, défini par de fortes variations d'impédance acoustique, apparait en rouge sur fond bleu.

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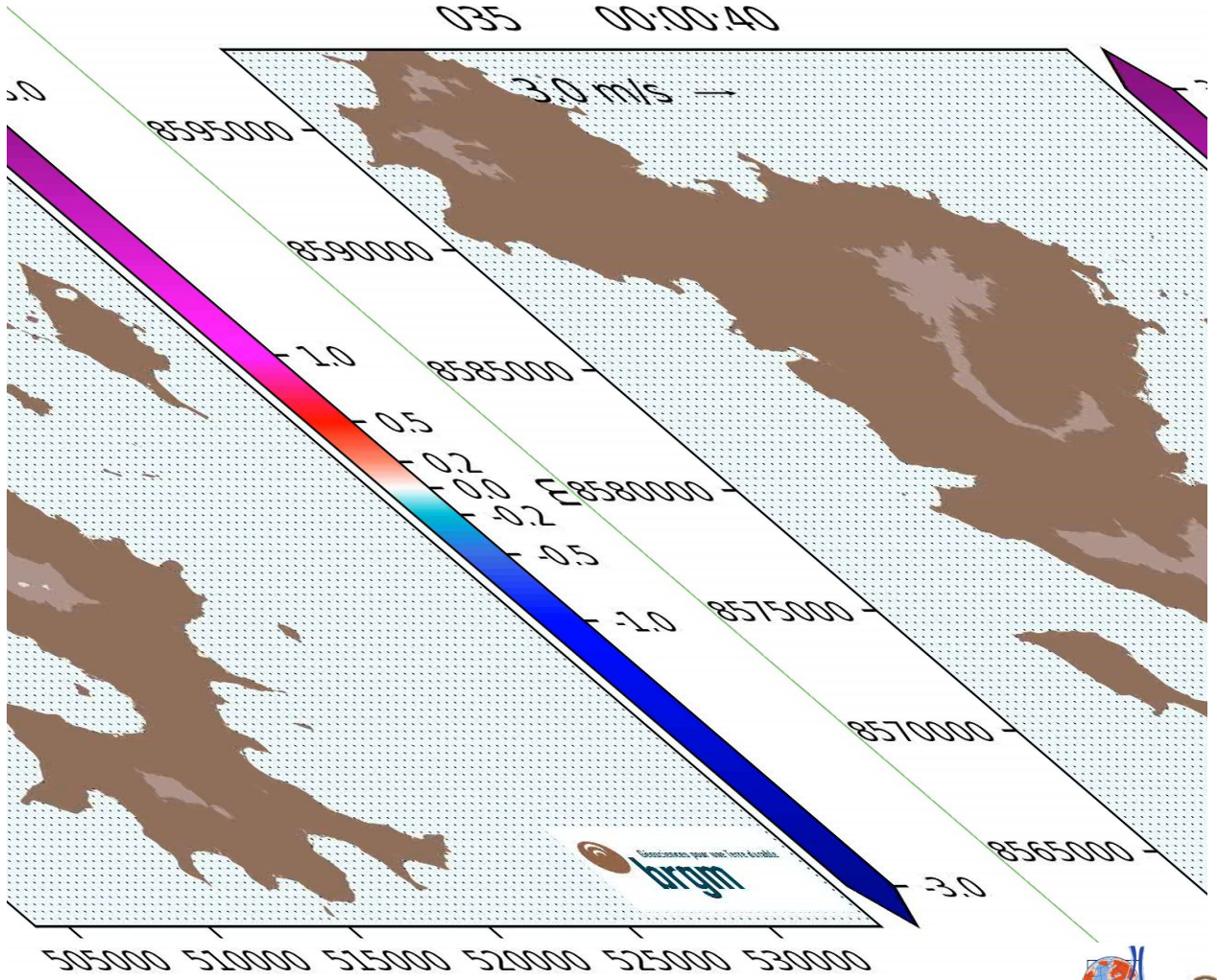
Models show low amplitudes along the coast (1 to 2 m) but a very short travel time



Modeling of a tsunami triggered by slope instability off the coast of Petite-Terre (R. Pedreros)

The east coast of Petite-Terre remains the most exposed to the effects of a tsunami (close sources and absence of protective reefs).

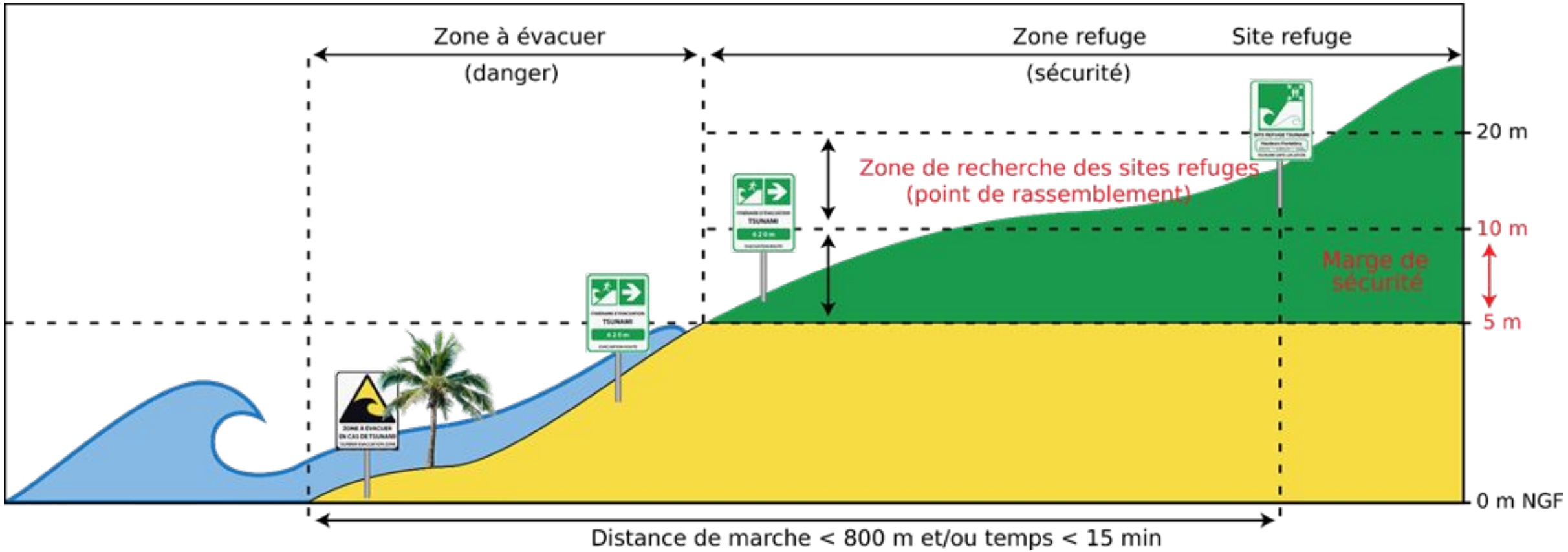
The models generate local water level rises of more than one meter, resulting in surges of several meters on the coast.

The scenarios modeled for the east of Petite-Terre show very short arrival times for the waves on the coast, ranging from **a few minutes in the east of Petite-Terre to around 18 minutes for** the east coast of Grande-Terre.

> Be prepared for a phenomenon that is moderate in amplitude but can arrive very quickly.

Search areas for refuge sites

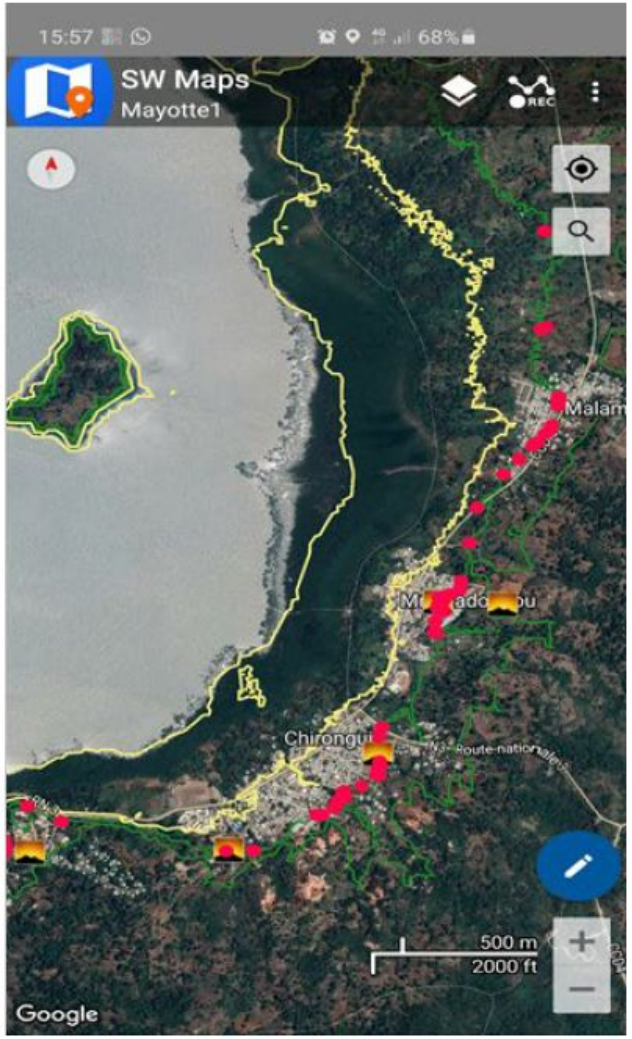
Evacuation zone set between 0 and 5 m altitude in Mayotte



Method for identifying tsunami assembly points

Pre-survey for eligible refuge sites using aerial imagery and field surveys (August 2020)

Field Research orientation using refuge zone entry points automatically generated in GIS (intersection points between isolines and roads : **red dots here**)



12 Criteria for selecting refuge sites (temporary assembly/meeting/refuge places)

> We walked 100 km in three weeks !

1. The right altitude

Select topographic sites higher than the upper limit of evacuation zone

But with a safety margin of a few meters (5 m here)

> Horizontal evacuation

2. The right distance

Ensure that the site is less than a 15-minute walk (or < 800 m) from the evacuation zone

No need to go too high or too far !

Beyond that, people become exhausted or demotivated

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3. A good accessibility

Favor if possible a good accessibility with multiple routes

Avoid stairs and narrow passages (unless there is no other choice > mark them on the evacuation plan)

4. A sustainable availability

Check the current and future availability of sites

No construction projects planned

> Check this with the local authorities

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5. A secure zone and more...

If possible, choose a secure and safe site, in particular with regard to road traffic or buildings collapse in case of tsunami triggered by an earthquake

And why not a fully equipped, shaded, with hot and cold drinks, and pastis on request!

6. A strategic view

Preferably with a view of the sea

Seeing the source of danger is one way to track the tsunami and the situation

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7. Easy to find

A Public and/or well-known site with a good reputation

8. Go higher if need

Always offer the possibility of going higher to reassure people

9. The right capacity

With adequate capacity

(less of a problem on road sections)

Depending on the areas to be evacuated (day, night, rush hour, low or high tourist season

> This requires a frequentation study

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10. Do not disturb the spirits

A place without cultural restrictions

(no cemeteries for example)

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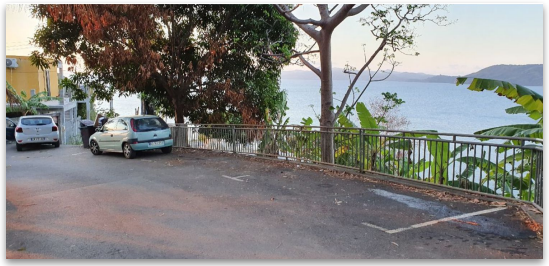
11. Don't pile on the problems

Avoid exposing the site to other natural hazards

12. Do not disturb…

Always stay away from sensitive and strategic locations to manage the crisis (police forces, firefighters centers, town hall) to clear access routes in case of emergency.

Criteria for selecting refuge sites (temporary assembly/meeting/refuge places)



Topographic sites higher than the upper limit of evacuation zone
But with a safety margin of a few meters (5 m) > Horizontal evacuation

Less than a 15-minute walk (or < 800 m) from the evacuation zone
(No need to go too high or too far !)

Favor if possible a good accessibility with multiple routes
Avoid stairs and narrow passages

Check the current and future availability of sites (no construction planned)

Preferably with a view of the sea (seeing the source of danger is one way to track the tsunami)

If possible, a secure and safe site (in particular with regard to road traffic)

A place without cultural restrictions (no cemeteries)

Avoid exposing the site to other natural hazards

Public and/or well-known site with a good reputation

Always offer the possibility of going higher to reassure people

With adequate capacity (less of a problem on road sections)

Always stay away from sensitive and strategic locations to manage the crisis

Validation levels and process for refuges sites

Depending on the target territory, its territorial organization, levels of competence, and levels of responsibility

Mayotte

Principle of hierarchical bottom-up validation

3. **Préfet / Senior State Authority** (highest representative of the State at the departmental level, appointed by the government, guarantor of public service, responsible for administrative control and enforcing State policy)

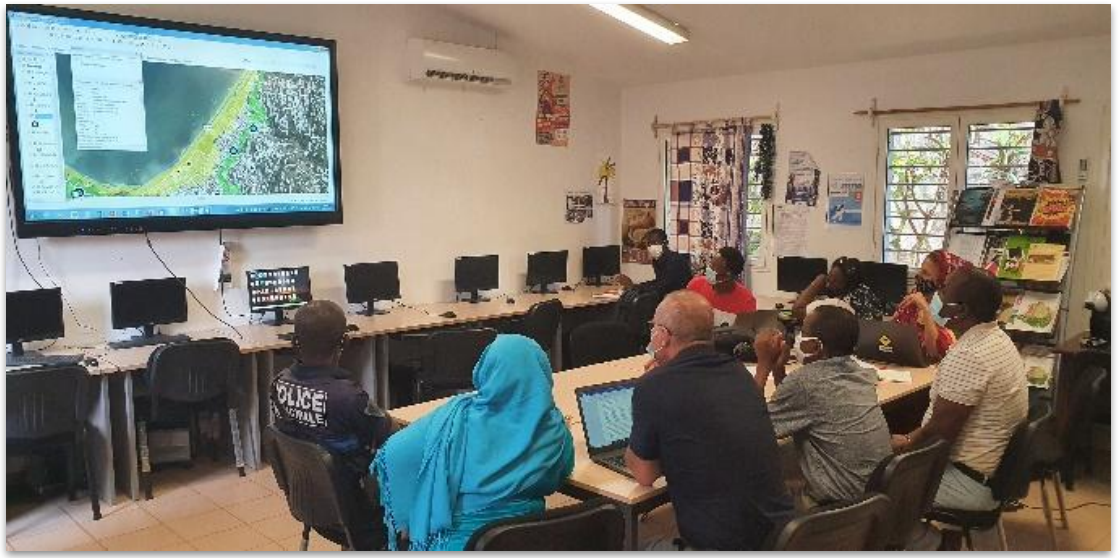
2. **Government departments in charge of risk and crisis management** (here at the departmental level)
> SIDPC (Prefecture) with technical support from DEAL (Department responsible for risk management)

1. **Community** via an *ad hoc* committee with :
- Local elected officials (mayor, deputy mayors)
- Municipal technical services (DGS)
- Fire department
- Municipal police
- Representative of state services
- Others (population via associations, elected representatives of the local community)
- And ourselves as researchers !

Participatory validation of refuge sites in each of the 16 coastal municipalities (January 2021)

Session schedule (2 to 3 hours):

- Presentation of the context (risks, challenges, evacuation)
- Questions and answers
- Practical exercises **on screen** and **then in the field**



Objectives:

- ✔ Check the suitability of the site
- ✔ Move, delete, or add to it
- ✔ Look at possible developments
- ✔ Test certain routes
- ✔ Name it
- ✔ Validate the site

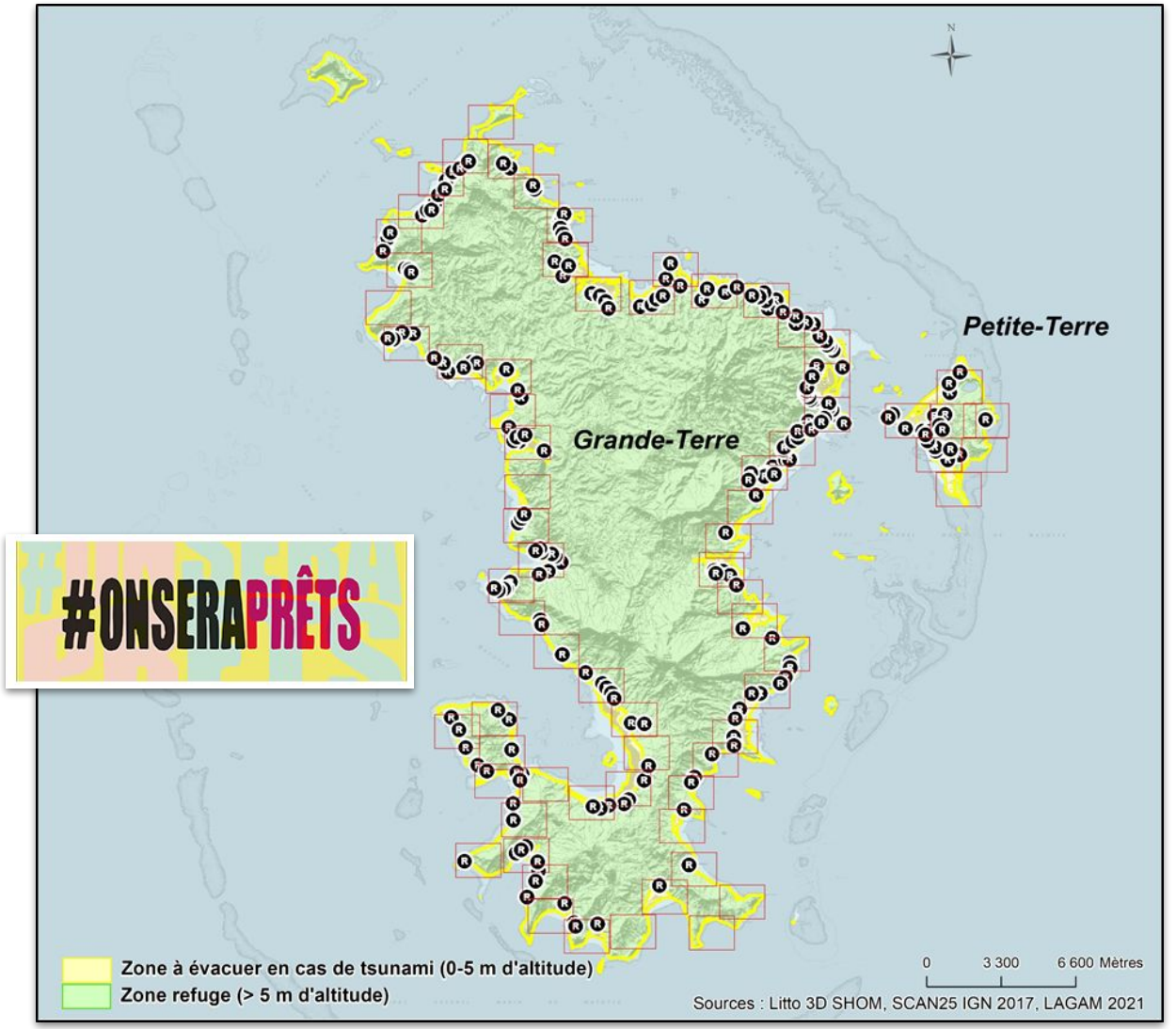
> 90 people met and involved in the process

Final validation and presentation to the public (press conference)

> 216 shelters approved by the Prefect in October 2021 (**14 months after the first field surveys**)

> 87 plans edited (16 communes)
> 3 prevention videos
> 1 website internet and more...

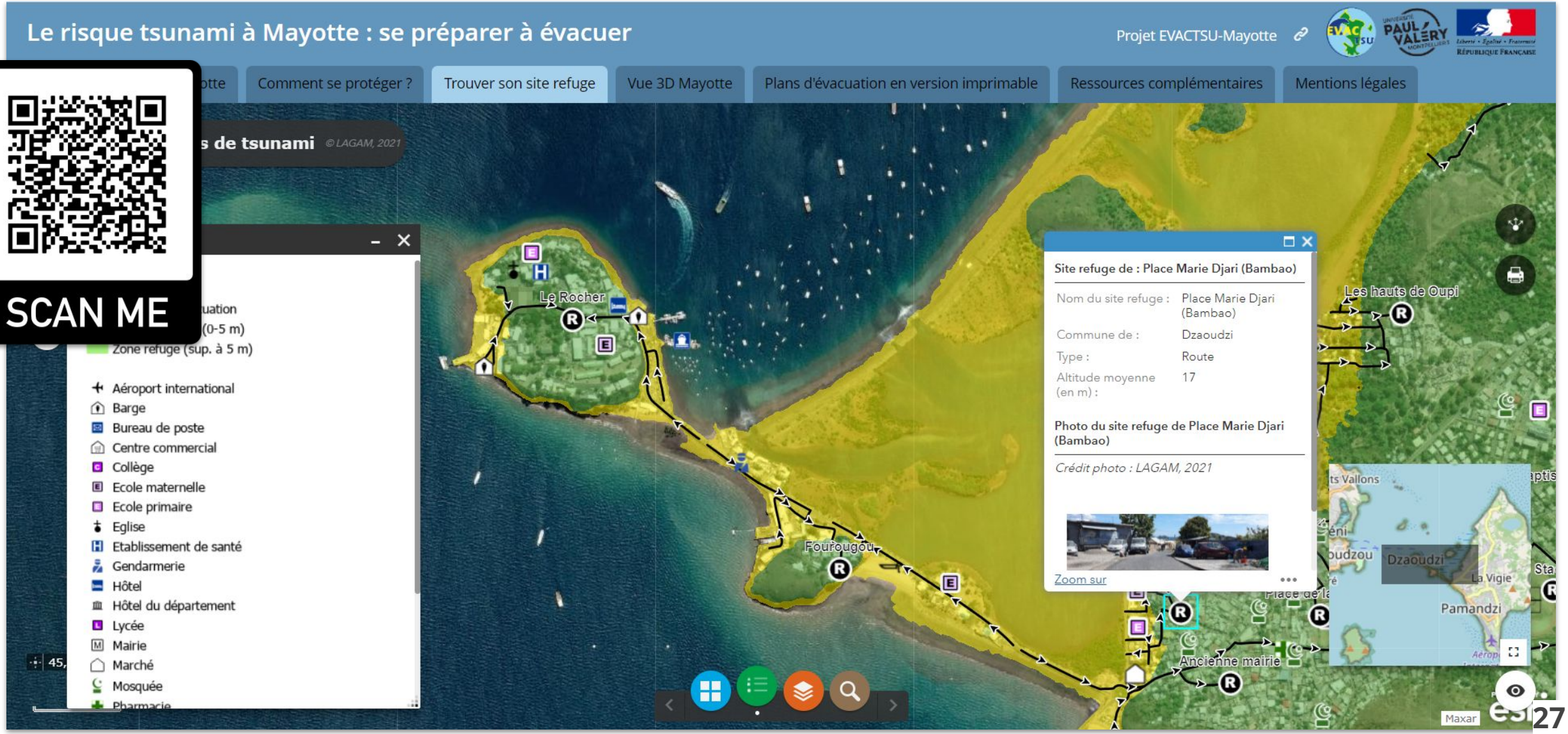
Launch of the official preventive information campaign by the Prefect on October 20, 2021, and **inauguration of the EVACTSU project website**



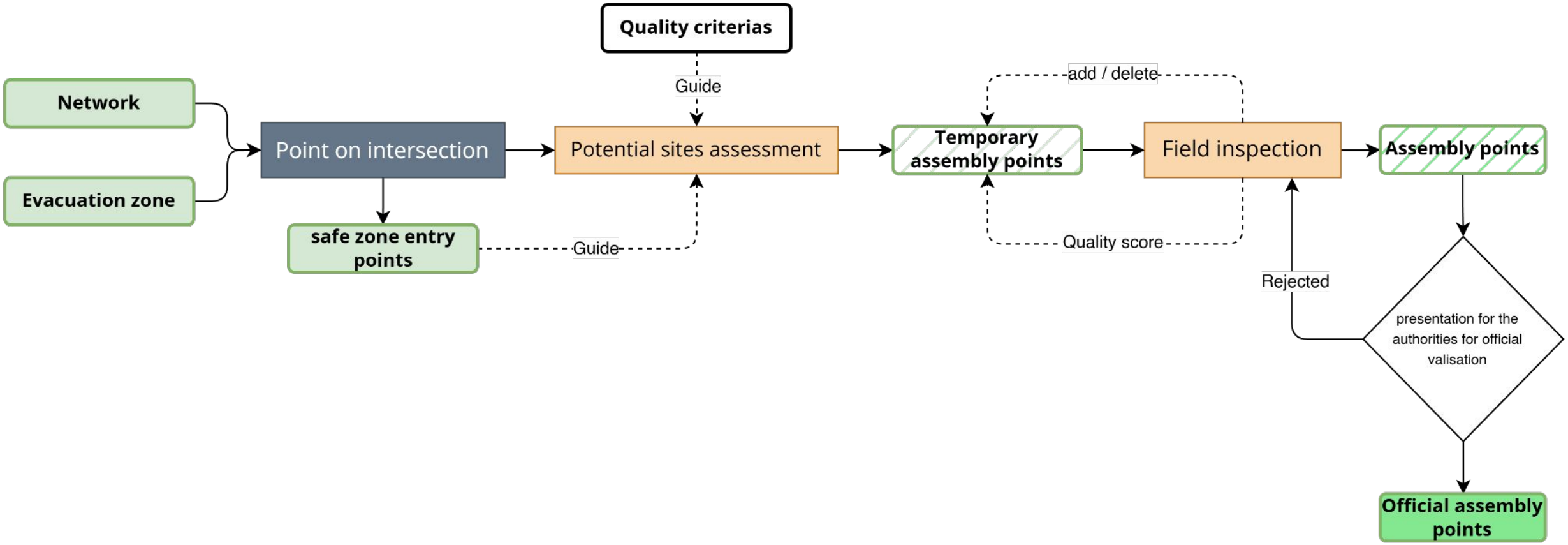
Method for identifying tsunami assembly points

Website with interactive map

https://arcg.is/1be4iC0



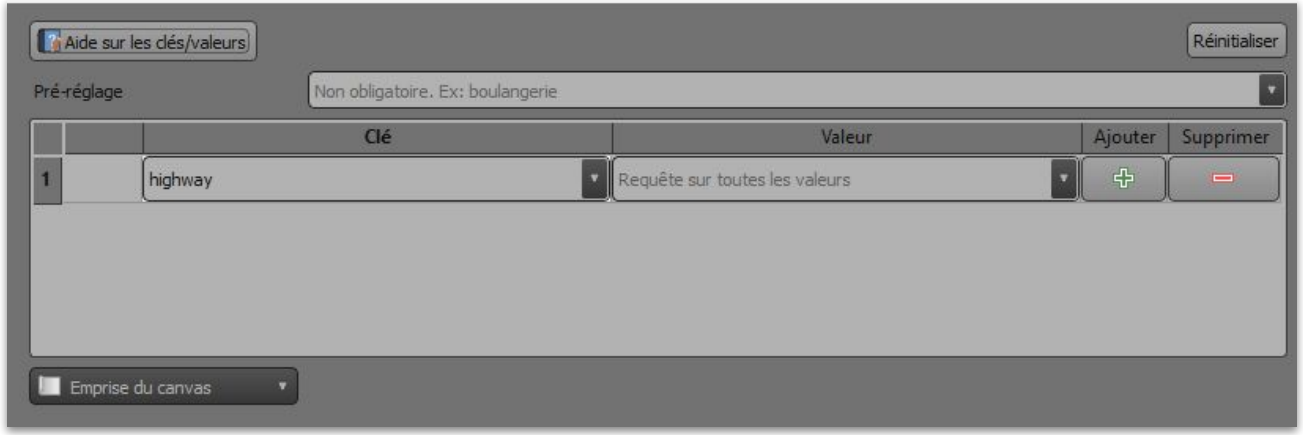
Method for identifying tsunami assembly points

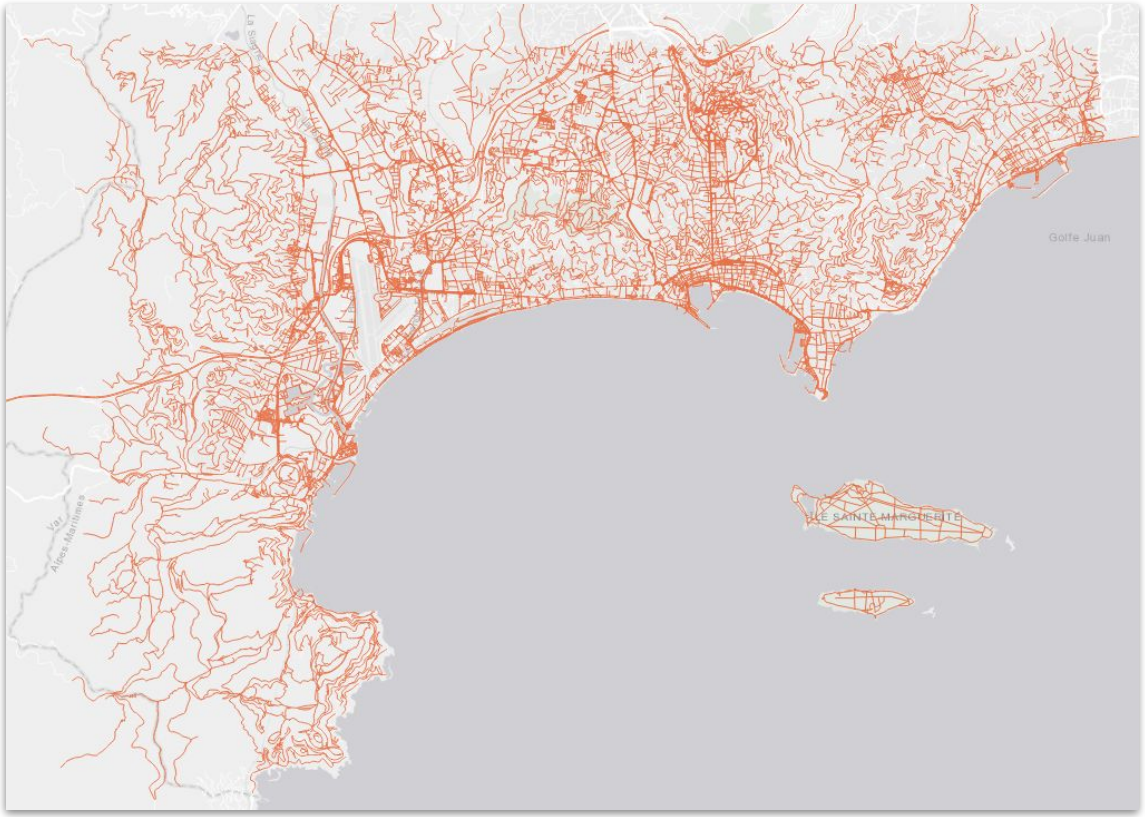


Dr. Matthieu Péroche (matthieu.peroche@univ-montp3.fr) - Louis Monnier

Download road's network

1. Use **QuickOSM** in QGIS :
   - **Key** : highway
   - **Value** : all
2. Discard non-linear features

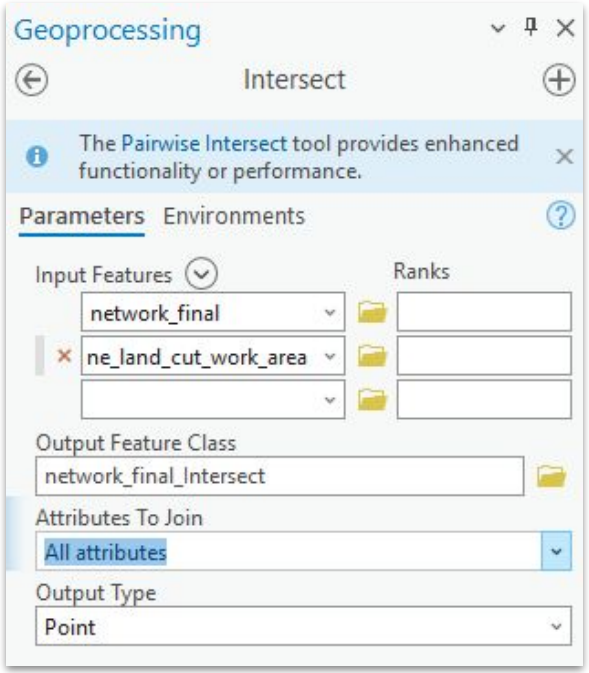


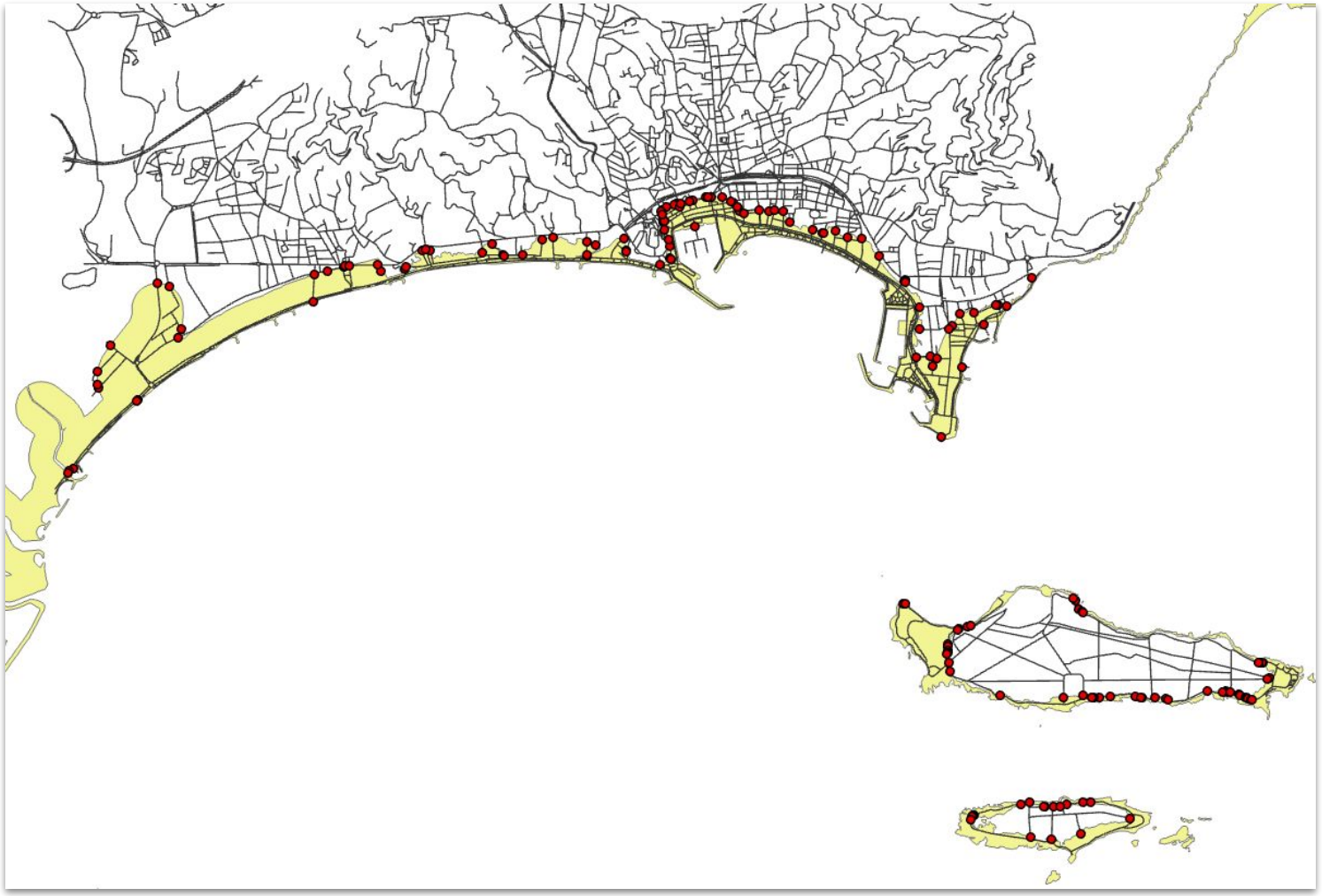


- For more info on data's values : https://wiki.openstreetmap.org/wiki/Map_features#Highway

Safe zone entry points

Use the **intersect** geoprocessing tool to generate point on intersections between roads features and the evacuation zone.

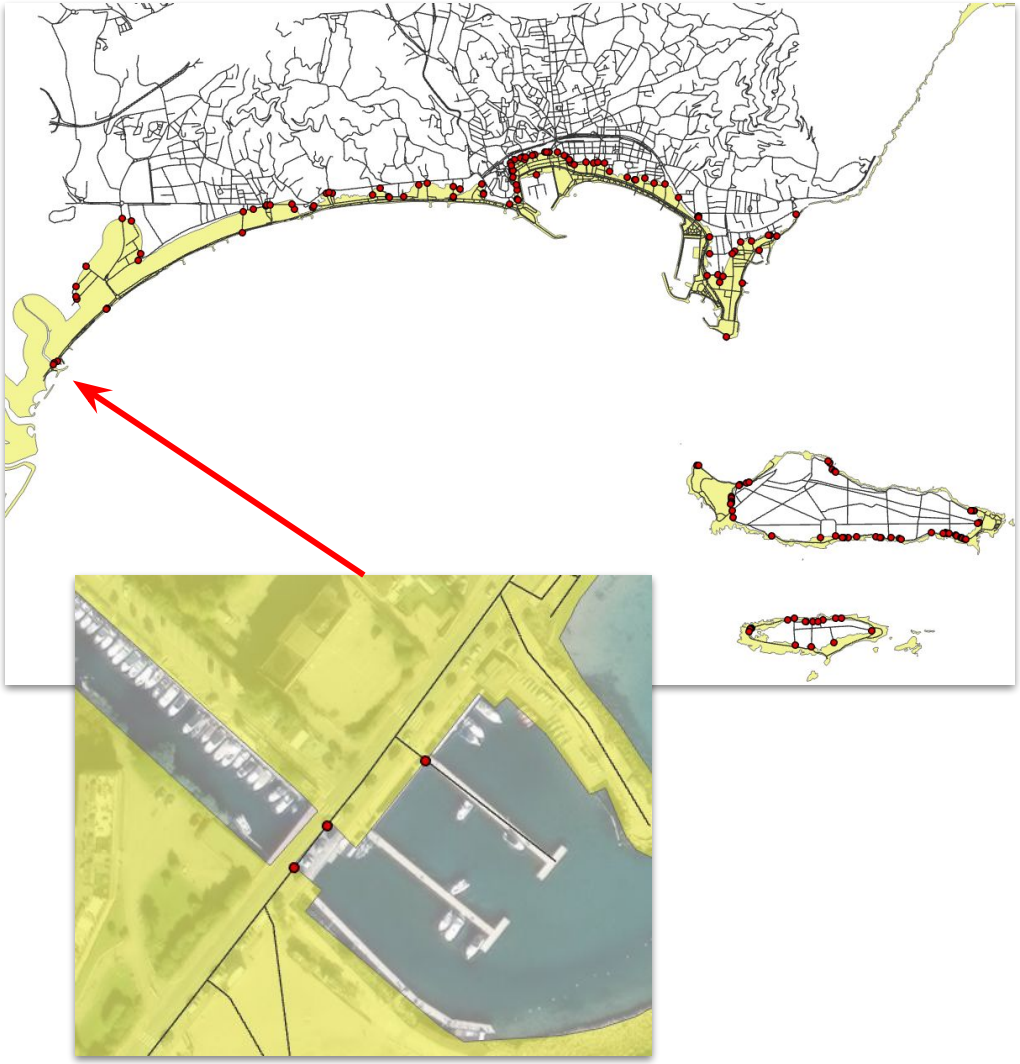




Safe zone entry points

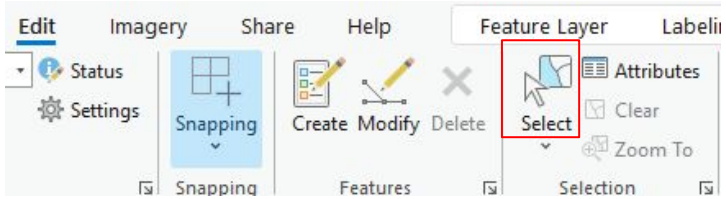
Due to intersecting geometry between in some areas (port, levees, dock), irrelevant points features can be generated.

Remove them before saving the layer

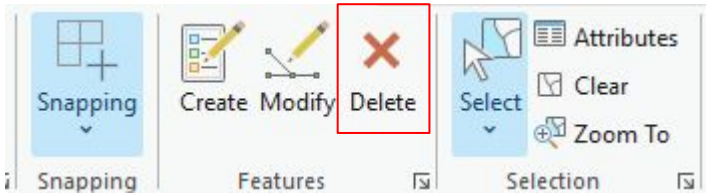


Select the irrelevant points feature and delete them :

1. **Top ribbon** > **Edit** > **Select**



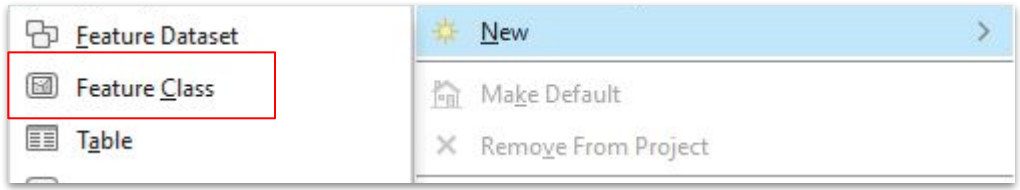
2. **Top ribbon** > **Features** > **Delete**



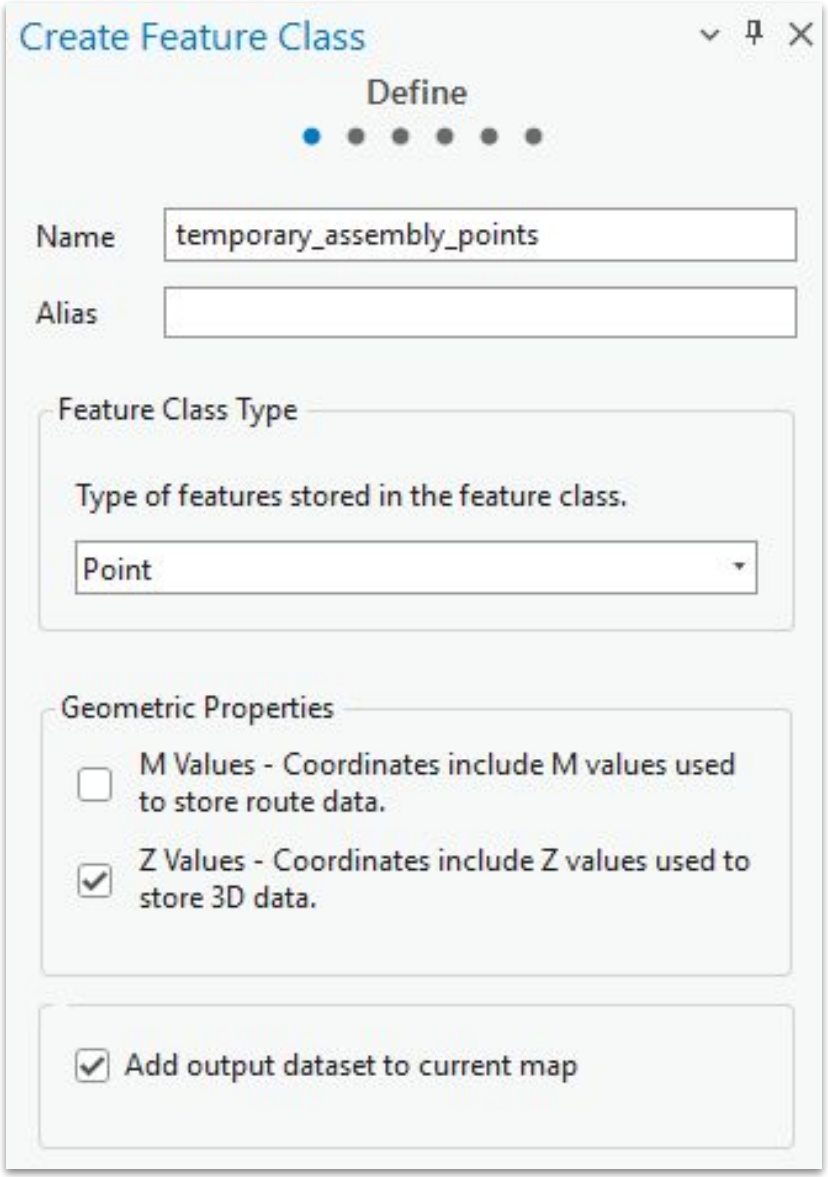
Assembly points pre-identification

Create a **temporary_assembly_points** layer :

1. **Top ribbon** > **View** > **Catalog Panel**
2. **Catalog panel** > **Project** > **Databases** > “project database”
3. Right click > **New** > **Feature Class**



4. **Name** your layer
5. Set the **geometry** type
6. Click on **Next**



Assembly points pre-identification

1. **Set up the fields in the layer's dataset :**

Create **4 fields** and set the **Data Type** for each field **:**

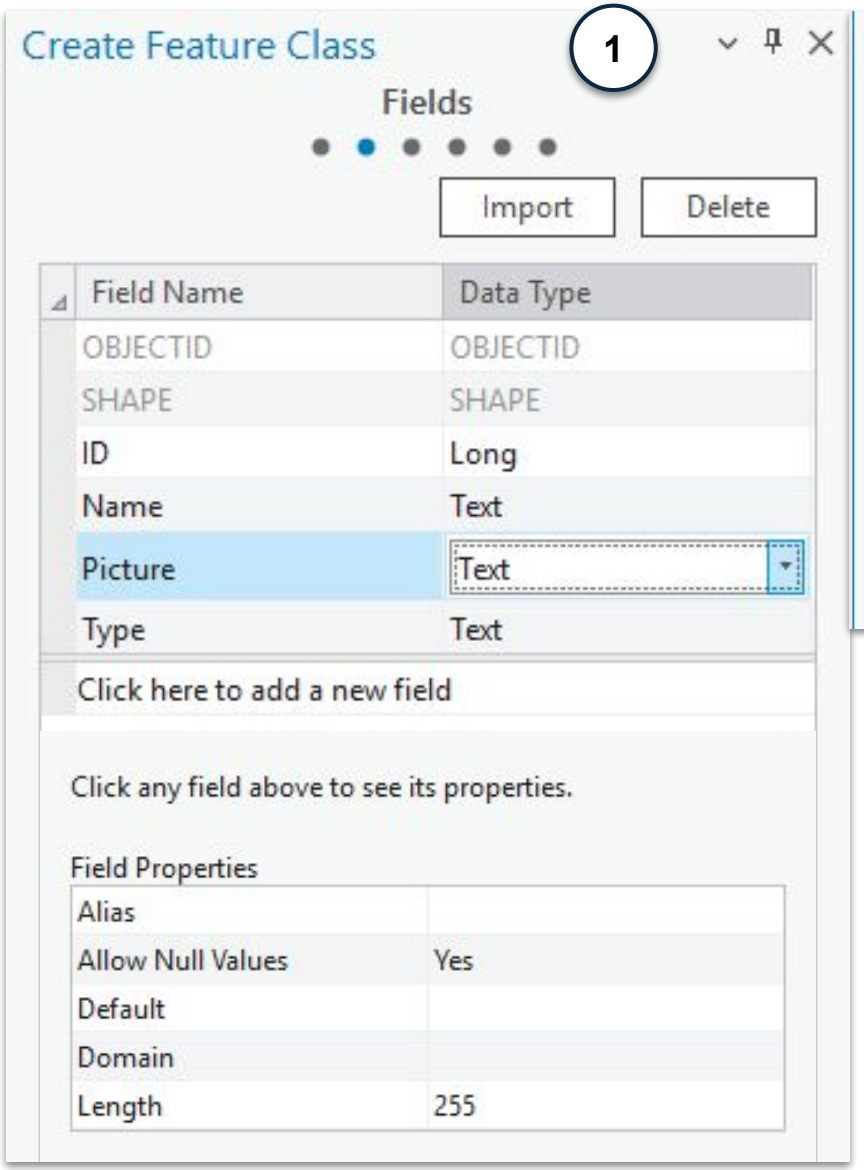
   a. **ID** (Long)
   b. **NAME** (Text)
   c. **Picture** (Text)
   d. **Type** (Text)

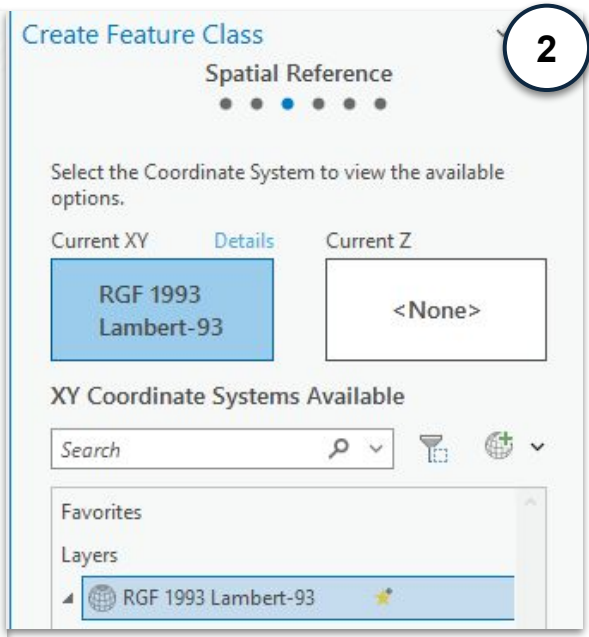
2. **Set the coordinate system**

Create **4 fields** and set the **Data Type** for each field **:**

Select **RGF 1993 Lambert-93** (EPSG: 2154)

3. Click on **Finish**

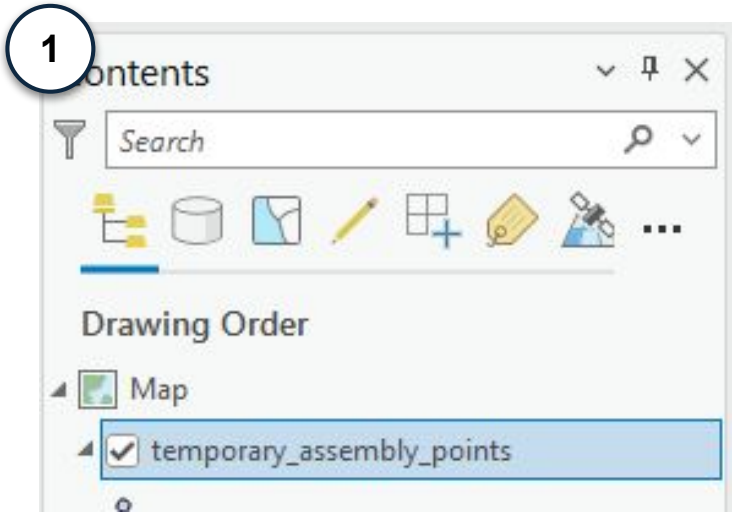


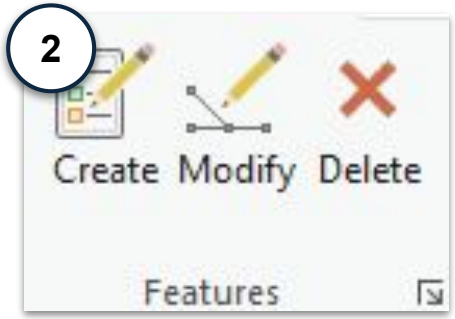


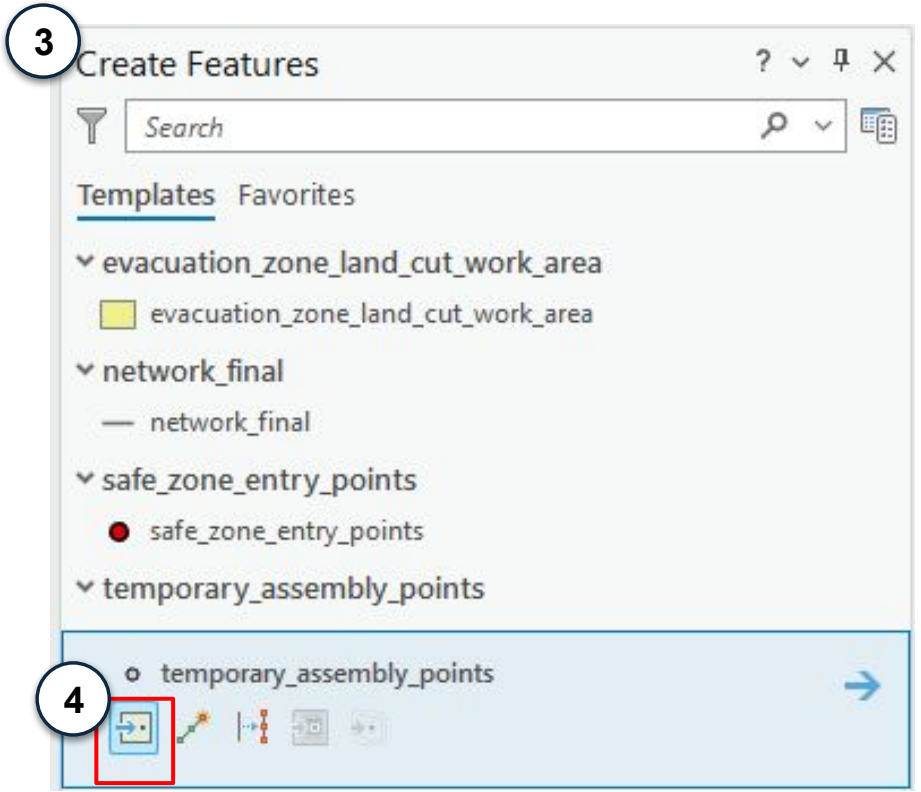
Assembly points pre-identification

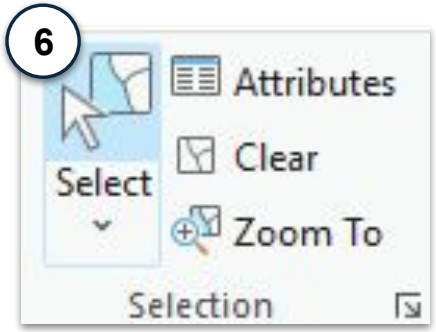
In order to create new features :

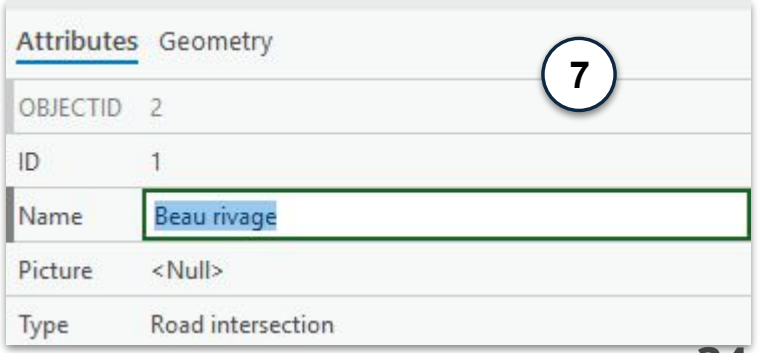
1. Select **temporary_assembly_points** in the **Contents panel**
2. In the **Top ribbon > Edit > Create**
3. Select the layer in the **Create Features** panel
4. Select **Point**
5. Create feature by clicking on the map canvas
6. Toggle the Attributes panel (**Top ribbon** > **Edit** > **Attributes**)
7. Fill in the value











Assembly points pre-identification

Identify the 12 most suitable places for assembly points

Time for field work

- **Quality assessment** for temporary assembly points
- If possible, bring someone with you from your teams and another one **from the community** (technical staff, ...)
- Take **geotagged photos**
- **Collect data** using GIS mobile application (SW Maps, QField, Fieldmap)

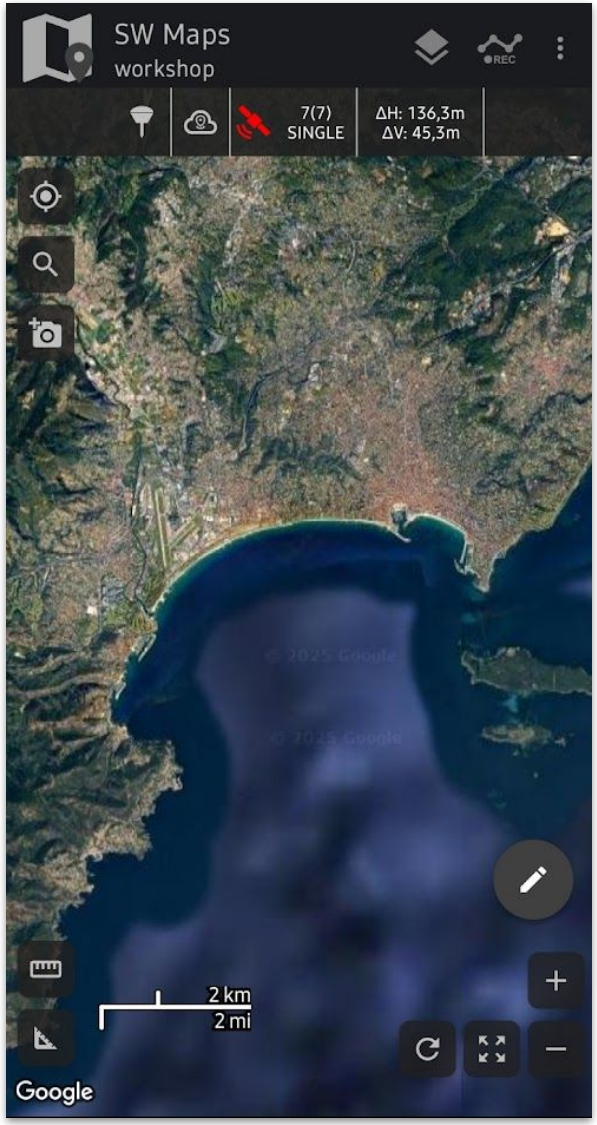
Field mapping : SW Maps

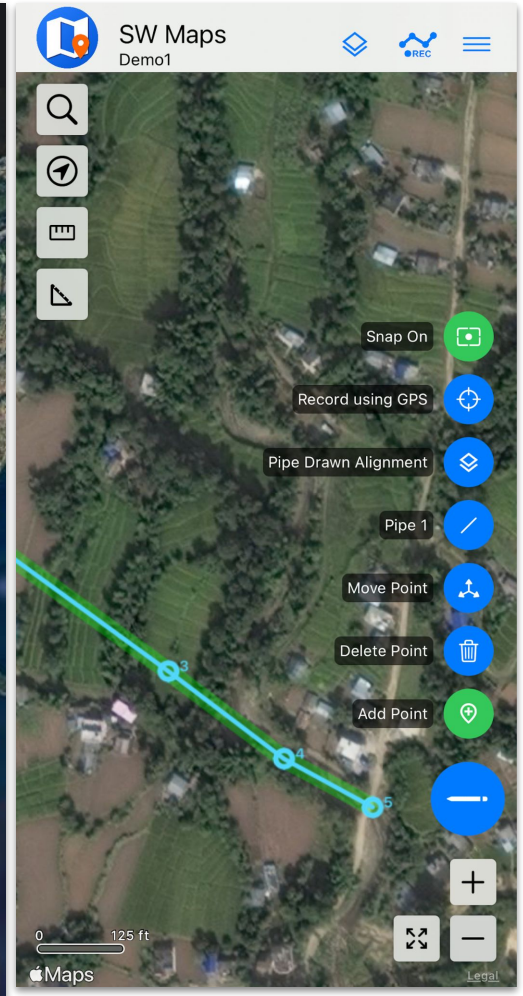
SW Maps is a free GIS mobile mapping application available for both Android and Apple phones.

SW Maps provide all the features needed during the field work :

- Load multiples layers in various formats (kml, shapefile, geopackage, etc.)
- Create layers
- Symbology management
- Edit layer's feature geometry
- Edit layer's data attributes
- Link photos with feature
- Measure distance / area
- Record GPS track

SW Maps Android User manual : https://aviyaantech.com/SwMaps/assets/SW%20Maps%20Manual%20V3.0.pdf

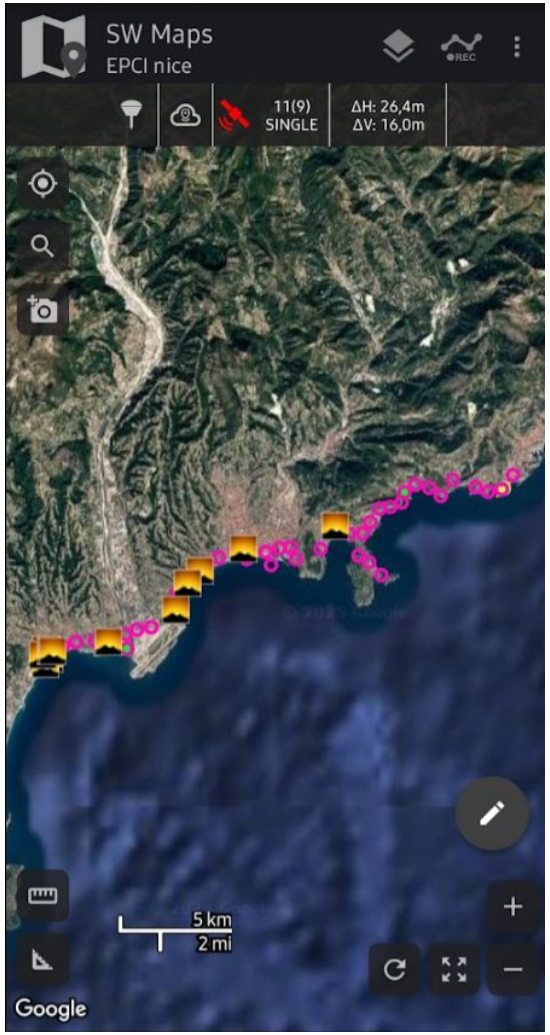


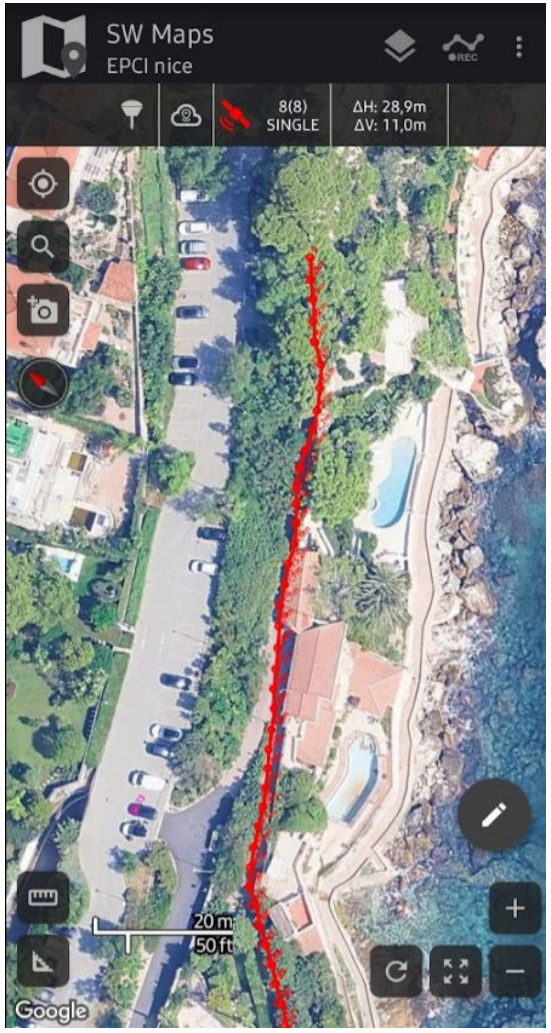


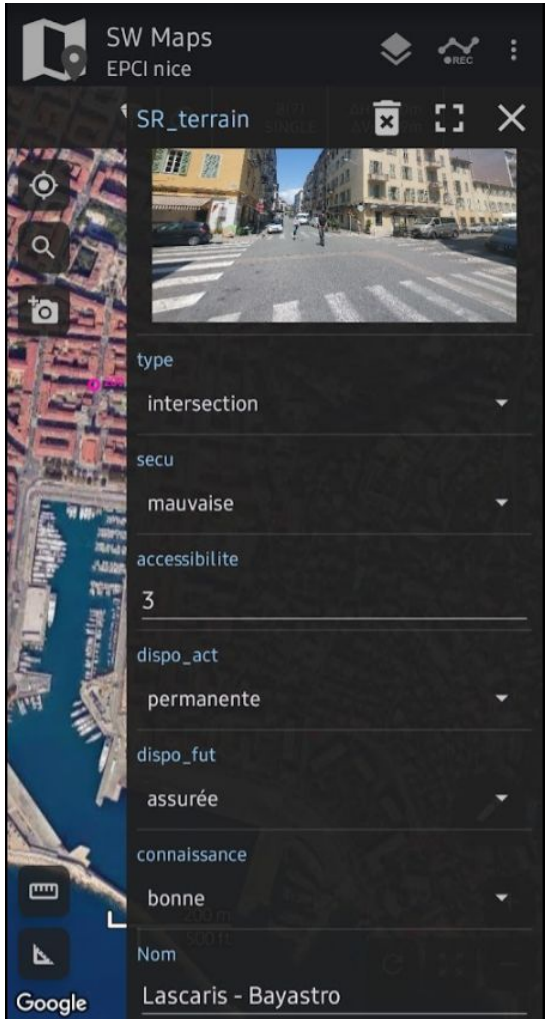
Field mapping : SW Maps

SW Maps doesn't allow to add or remove a layer's field once it have been imported on the phone. Layer's field configuration must be done in a **desktop GIS software.**

Setting up the field beforehand allows us to set **constraints, domains or attachments on the field values**, making the process of filling in data easier, and reducing the risk of error.





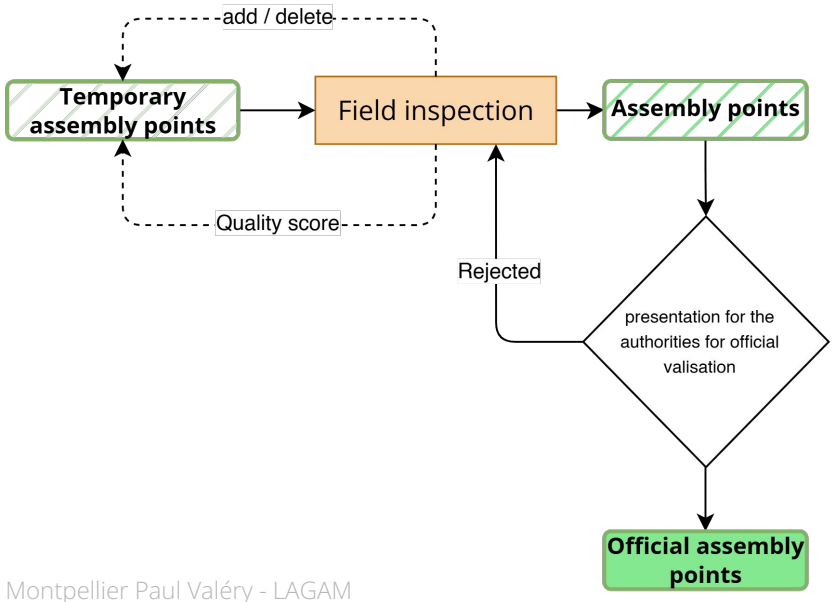


Assembly points pre-identification

Experience sharing : the importance of field work

The most important step in this process is to validate assembly points with the local authorities.

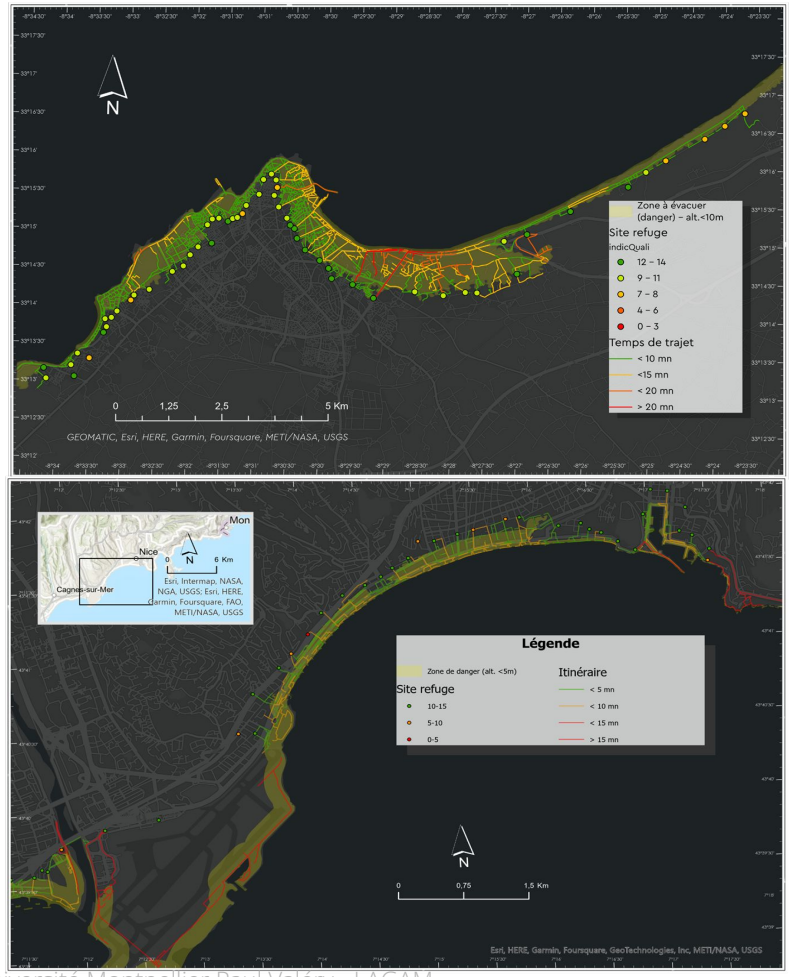
- Present each refuge site
- Discuss the advantages and disadvantages of each assembly points
- Improve coverage where it's needed
- Allow to take into account future urban change
- Benefit from local knowledge



Method for identifying tsunami assembly points

The most important step in this process is to validate assembly points with the local authorities.

Supports documents must be produced to give insight during the validation meetings.



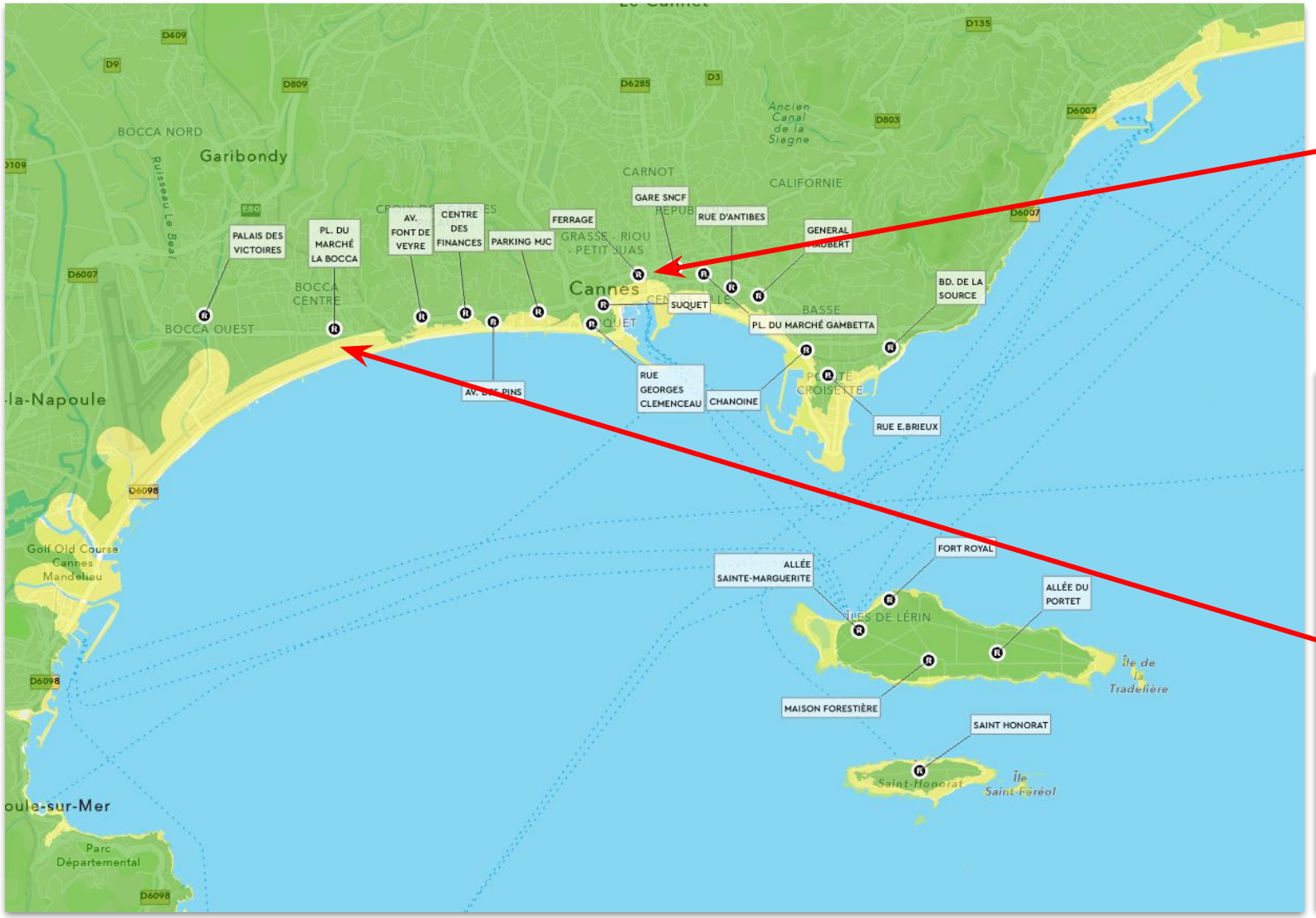
Case-Pilote		CSP_3					Critères de qualité
Nature du site	Nom local	Note	Qualité	Capacité d'accueil	Nombre d'accès	Disponibilité actuelle	
Bord de route	Ancienne route Fond Bourlet	14	R	222	2	Permanente	

Date : 09/05/2016 | Source : IGN, 2013

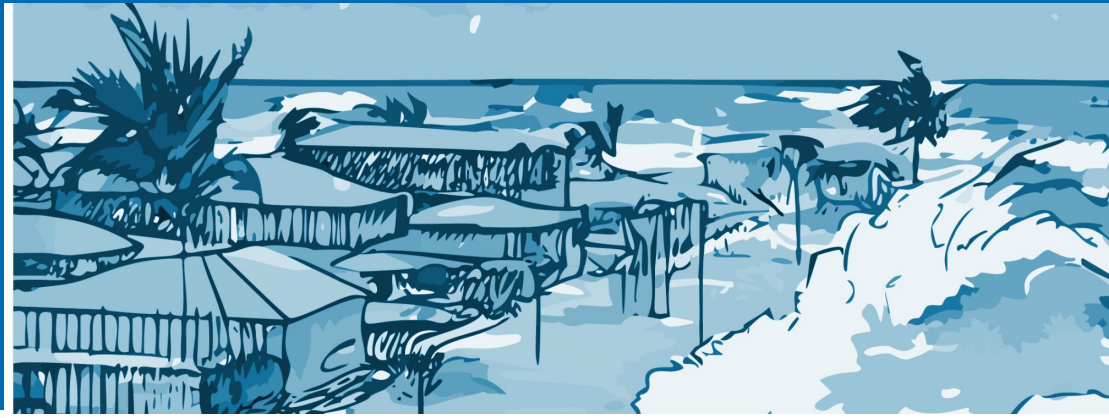
Commentaires

Date de validation par le comité local d'experts : 12/04/2017

21 official assembly points in Cannes



Tsunami Evacuation Mapping Workshop



CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

30 June – 4 July 2025

unesco
Intergovernmental Oceanographic Commission

Funded by European Union Humanitarian Aid

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

CoastWAVE NEAMTWS

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LABORATOIRE DE GEOGRAPHIE ET D'AMENAGEMENT DE MONTPELLIER

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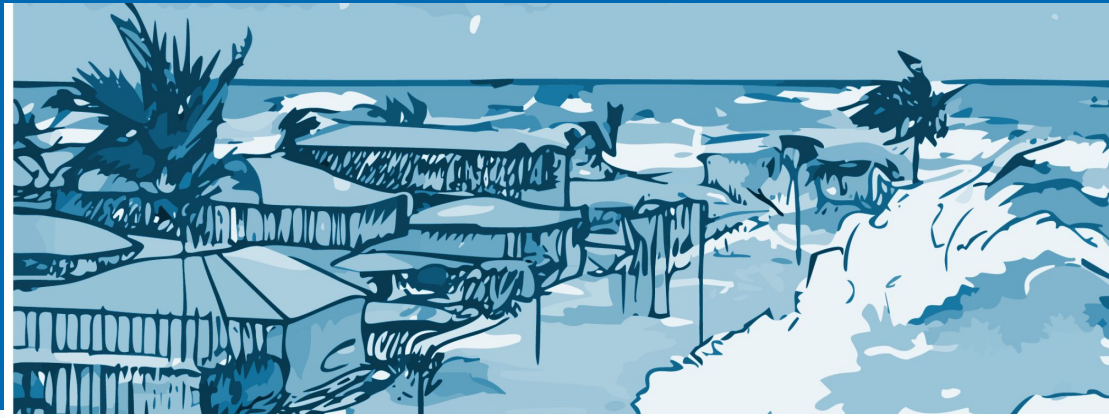
Tsunami Evacuation Mapping Workshop

30 June – 4 July 2025



CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

Dr. Matthieu Péroche
Louis Monnier

Lesson #3

Tsunami evacuation routes calculation using graph-based GIS methodology

Contact : matthieu.peroche@univ-montp3.fr

unesco
Intergovernmental Oceanographic Commission

Funded by European Union Humanitarian Aid

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

CoastWAVE NEAMTWS

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Lesson's overview

Semi-automatic mapping of tsunami evacuation routes using graph-based GIS tools

1. Theory

- Graph's theory
- Walking pace reference
- Others methods

2. Practice

- Get the data and check topological rules
- Field work
- Specials cases
- Setting the starting points for the analysis
- Lauching the analysis

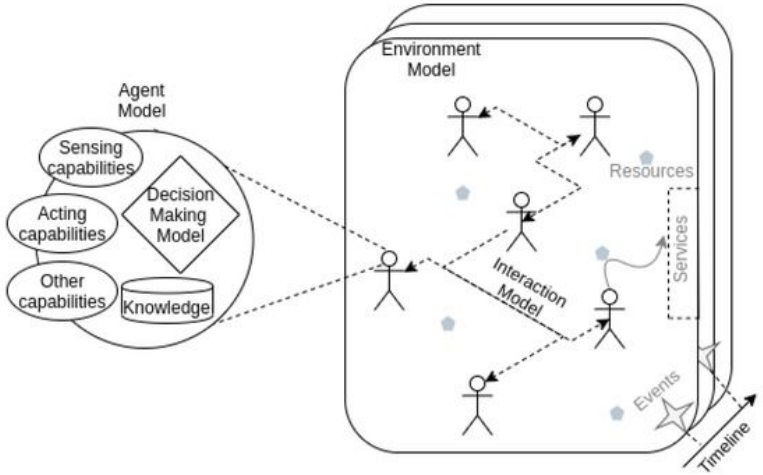
Method 3 – Agent-Based Modeling (ABM) - Simulating behavior on an individual level

- **Principle**:
  Individual-level simulation of the evacuation process. Each agent interacts with its environment and others based on predefined rules.

- **Required Data**:
  Behavioral profiles, spatial environment (raster or vector), alert scenarios, infrastructure and obstacles.

- **Configurable Parameters**:
  - Agent attributes: mobility, delay before action, knowledge of the area
  - Behavior rules: route choice, alert response, social interaction
  - Dynamic environment: congestion, blocked roads, tsunami impact

- **Expected Outputs**:
  - Individual and collective evacuation times
  - Flow maps, congestion points, critical areas
  - Success rate of evacuation under different alert and management scenarios



Herrera *and al*, 2020

✅ **Advantages**: highly realistic, allows testing of planning and communication strategies

⚠️ **Limitations**: complex setup, requires behavioral data and careful calibration

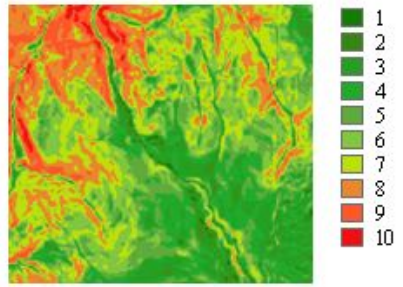
Method 2 – Raster-Based GIS: Modelling evacuation with cost surfaces

- **Principle**:
  Each raster cell is assigned a travel cost; algorithms calculate the least-cost path to a safe zone (cost distance analysis).

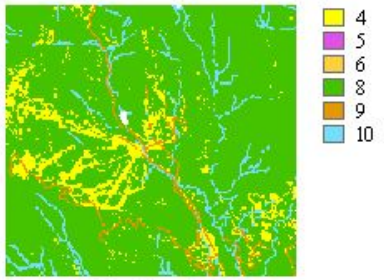
- **Required Data**:
  Digital Elevation Model (slope), land use, road/terrain surface types, restricted areas.

- **Configurable Parameters**:
  - Multiple parameters (slope, land use, road type) merged into a single **cost raster**
  - Reclassification of input layers to a common measurement scale
  - Weighting of each criterion based on its impact on travel speed

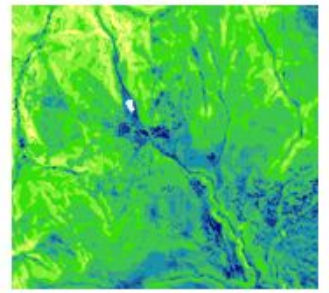
- **Expected Outputs**:
  - Minimum evacuation time maps
  - Identification of areas not reachable within safe time limits
  - Scenario comparisons across large and heterogeneous territories



Reclassified slope input



Reclassified land-use input


Final cost raster

https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/creating-a-cost-surface-raster.htm

✅ **Advantages**: flexible, well suited for poorly structured or natural environments
⚠️ **Limitations**: accuracy depends on raster resolution; less precise in dense urban settings

Method 1 – Graph-Based Models: Using networks for strategic planning

- **Principle**:
  The circulation network (roads, paths, stairs) is modeled as a graph composed of nodes and edges, allowing optimal route calculation to safe zones.

- **Required Data**:
  Road/path network, attributes (slope, surface type, hierarchy), location of safe areas.

- **Configurable Parameters**:
  - Edge orientation to enforce walking direction
  - Edge costs based on: slope, road hierarchy (width/importance), surface type
  - Travel speed can be weighted by segment characteristics

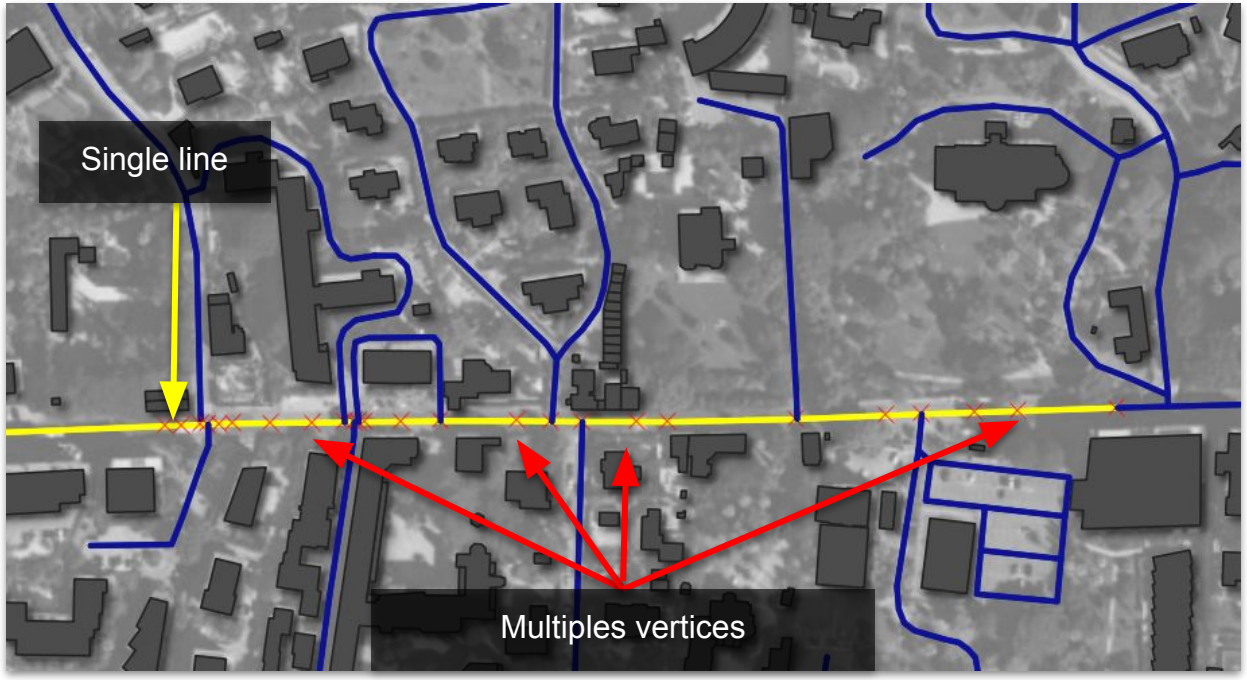
- **Expected Outputs**:
  - Shortest or safest evacuation paths
  - Evacuation isochrone maps
  - Identification of bottlenecks and critical segments

✅ **Advantages**: fast computation, easily readable, suited to urban environments
⚠️ **Limitations**: assumes optimal behavior, does not account for human interactions

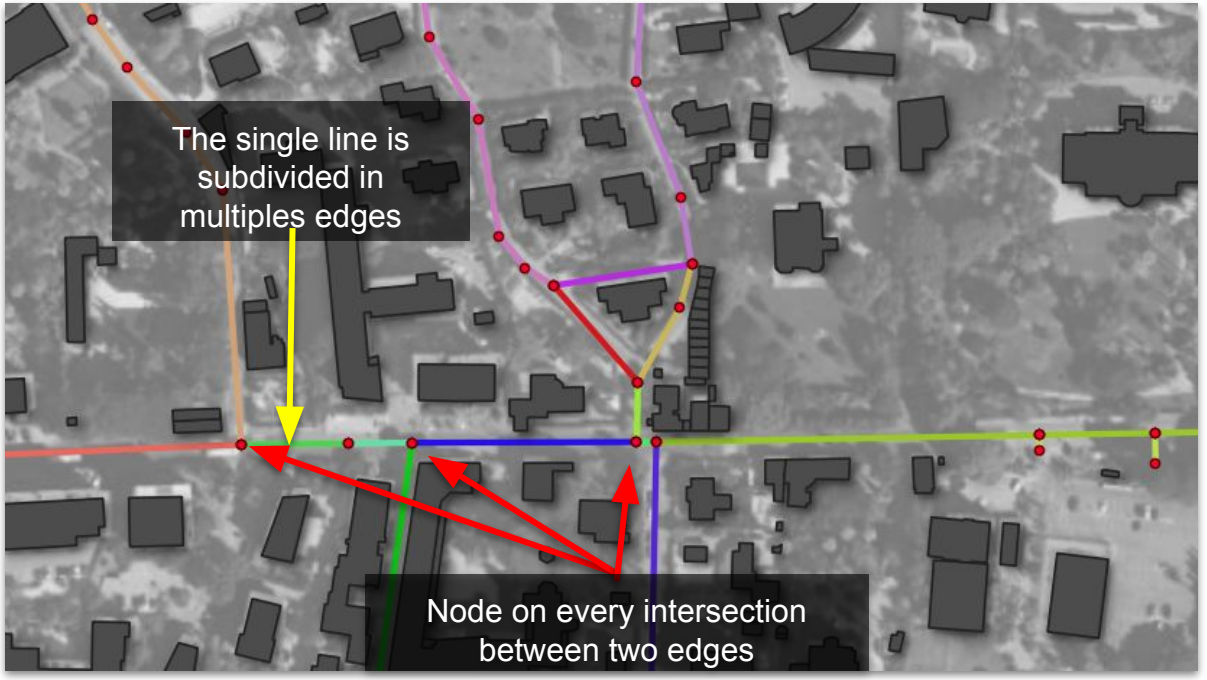
Sahal, A., F. Leone & M. Péroche.
« **Complementary Methods to Plan Pedestrian Evacuation of the French Riviera's Beaches in Case of Tsunami Threat: Graph- and Multi-Agent-Based Modelling** ».
Natural Hazards and Earth System Sciences 13, nº 7 (2013): 1735-43.
https://doi.org/10.5194/nhess-13-1735-2013.

Difference between network and graph

Network



Network in graph configuration



Depending on your national data providers, the transportation network can be already configured as a graph.

This isn't the case with OSM data

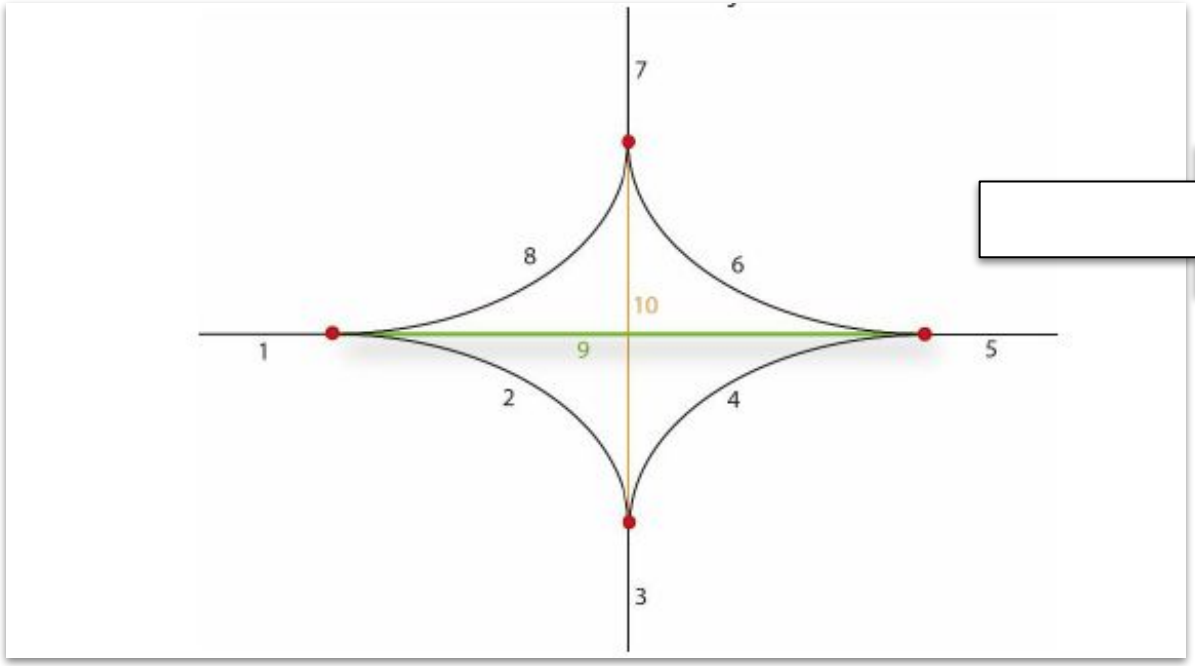
Graph topology

Eg. Two roads cross at different heights.

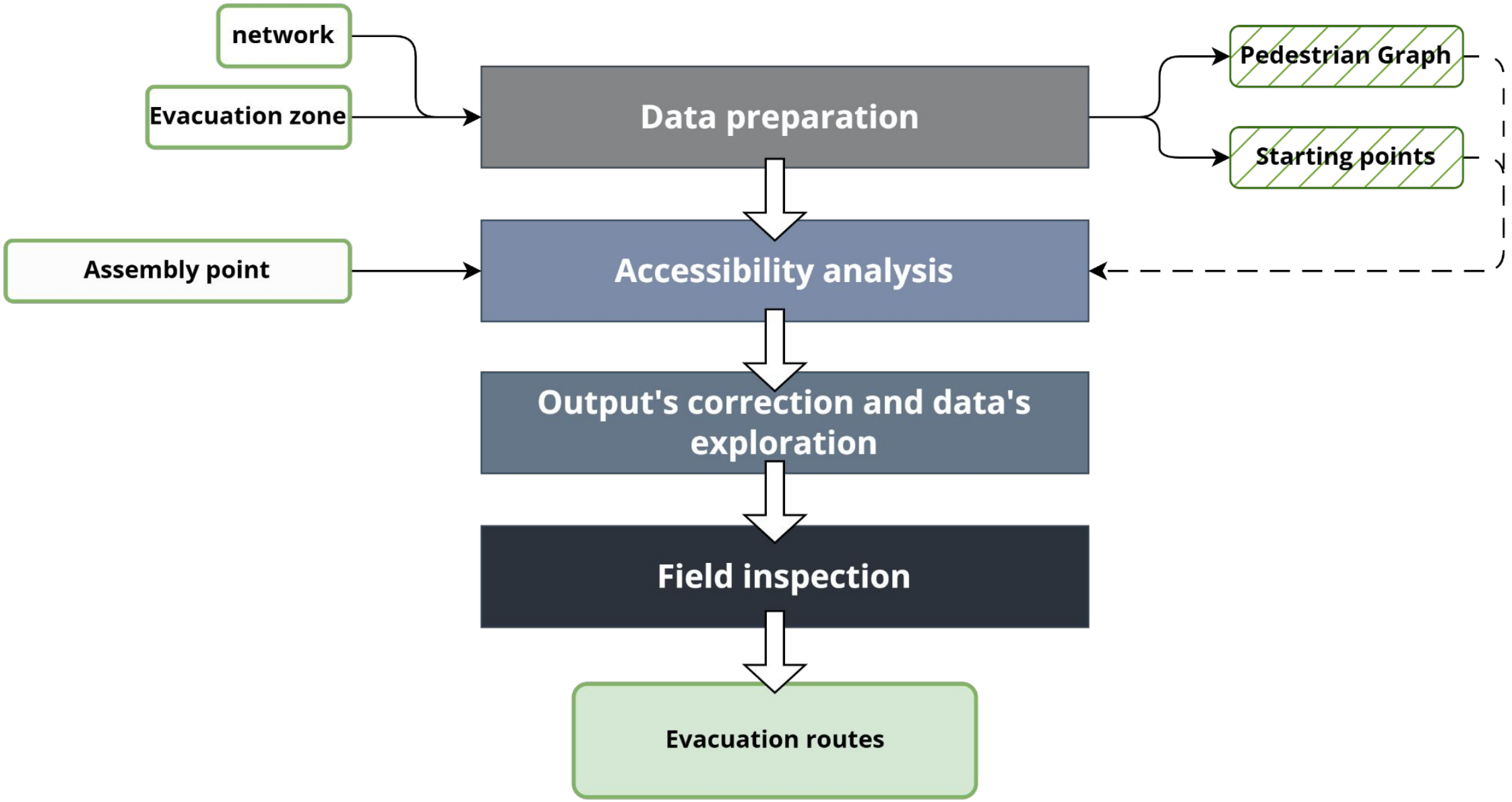
The graph topology rules allow an accurate representation of the connectivity between roads in real life

"[...] topology is the arrangement that defines how point, line, and polygon features share **coincident geometry**."

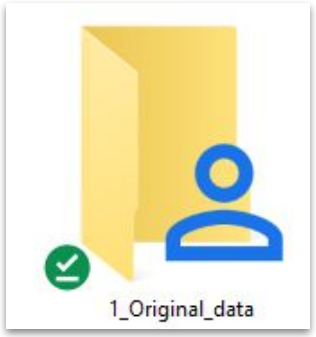
https://pro.arcgis.com/en/pro-app/latest/help/data/topologies/topology-in-arcgis.htm



Tsunami evacuation routes calculation using graph-based GIS methodology

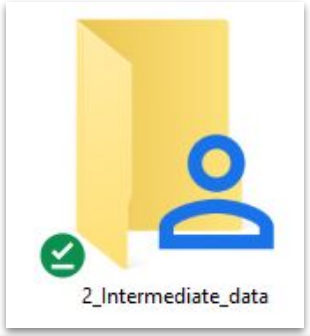


Dr. Matthieu Péroche (matthieu.peroche@univ-montp3.fr) - Louis Monnier

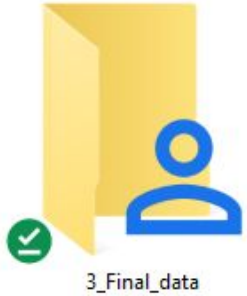


Fichier STYLX
- style_projet.stylx

Source de Forme AutoCAD
- assembly_points.shp
- Cannes_boundaries.shp
- evacuation_zone_land_cut_work_area.shp
- network.shp
- network_clip_Cannes.shp
- network_final.shp
- network_final_correction.shp
- network_OSM_exercice.shp
- safe_zone_cut_work_area.shp

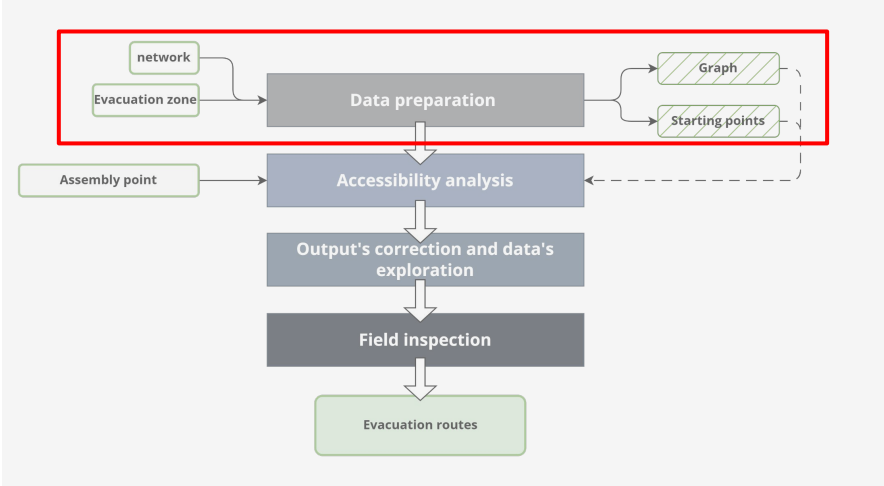


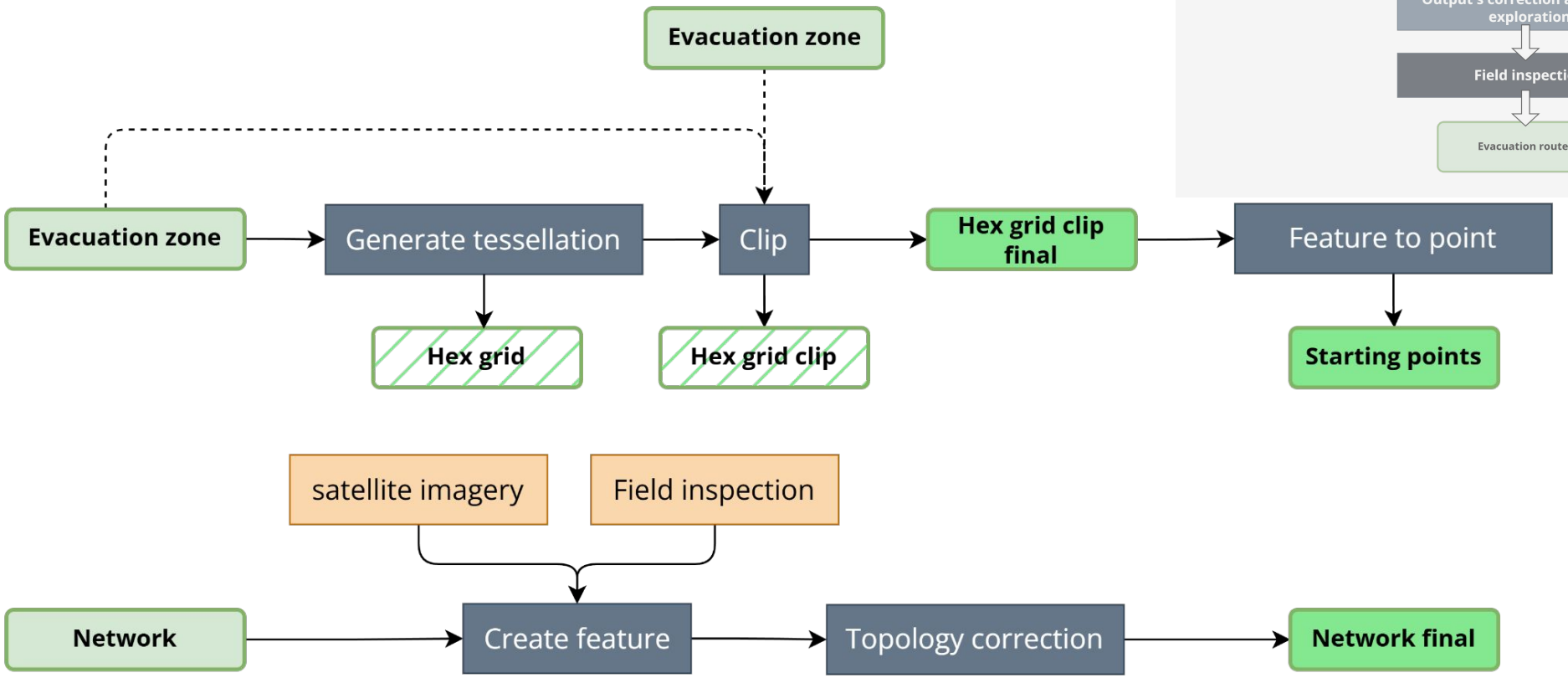
Source de Forme AutoCAD
- added_ways.shp
- hex_grid.shp
- hex_grid_clip.shp
- Routes_dissolves.shp



Source de Forme AutoCAD
- evacuation_routes_final.shp
- hex_grid_clip_final.shp
- starting_points.shp

Data preparation





Generate the starting points for accessibility analysis

Why use a regular grid?

- Ensures **homogeneous coverage** of the evacuation area
- Defines **departure points** for route generation
- Enables spatial analysis and comparison

What can we compute on the grid?

- **Evacuation areas**
- **Evacuation times**
- **Population and assets to evacuate**
- Other **geo-indicators** for risk and capacity assessment

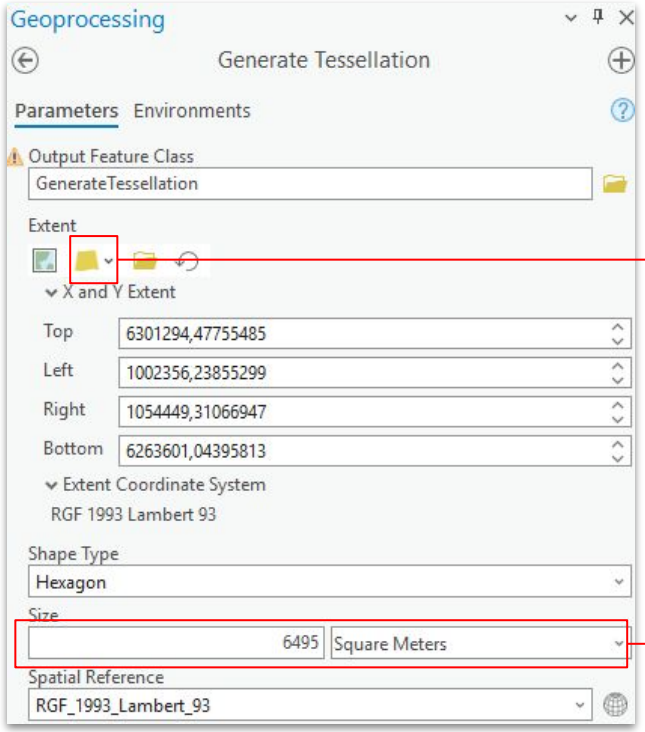
Generate the starting points for accessibility analysis

Why Use Hexagonal Grids Instead of Squares?

- Equal distance to all neighbors → **consistent spatial aggregation**
- **Avoids directional bias** from square grids
- **Matches circular influence zones** (e.g. audibility, evacuation time)
- Supports **natural aggregation of spatial indicators**
- Cleaner visual output → **smoother**, **more readable maps**
- **Uniform shape and size** across the study area
- **Better spatial aggregation** than squares
- No directional bias in spatial patterns
- **More natural for computing indicators** (density, exposure, evacuation time)
- **Visually smoother and easier to interpret**

Generate the starting points for accessibility analysis

1. Generate a hexagonal grid covering the evacuation zone using the **Generate Tessellation** tools, then **clip** it two times : with Canne's administrative boundaries and with the evacuation zone.



Select the evacuation zone layer

Area = **6495 m²** (50m long edges)

Example of spatial data enrichment of the initial grid

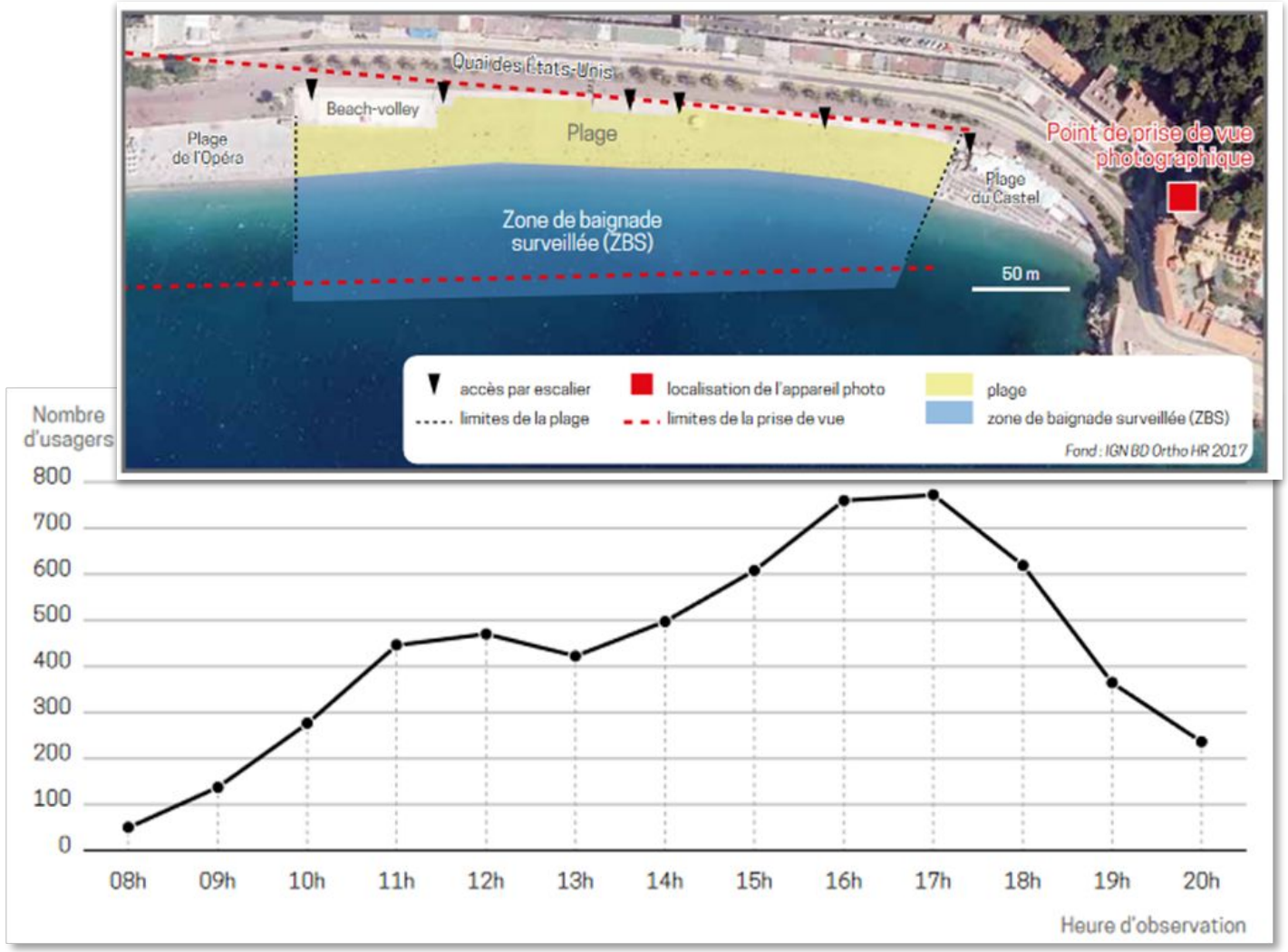
Human frequentation data is used to :

- Assess the most critical area in case of evacuation
- Adapt the assembly points capacity
- Check if the evacuation routes are sized with the traffic

Manual beach's users count method offer precise information on variation of the number of visitor on a **hourly basis**.

Limitations :

- Time consuming
- Need a high observation spot
- Limited to few beaches depending on the number of surveyor



Number of users at the Ponchettes beach, Nice, the friday 17 Jully

Example of spatial data enrichment of the initial grid

Using **high resolution imagery** (10-20 cm res.) for frequentation study allow to collect data for a larger number of beaches.

High resolution imagery was provided by **IGN** (BD Ortho, 2014) :

April 23, 2014 between 10:30 and 10:50
June 5, 2014 between 14:00 and 15:00.

Dr. Matthieu Péroche (matthieu.peroche@univ-montp3.fr) - Louis Monnier

Example of spatial data enrichment of the initial grid

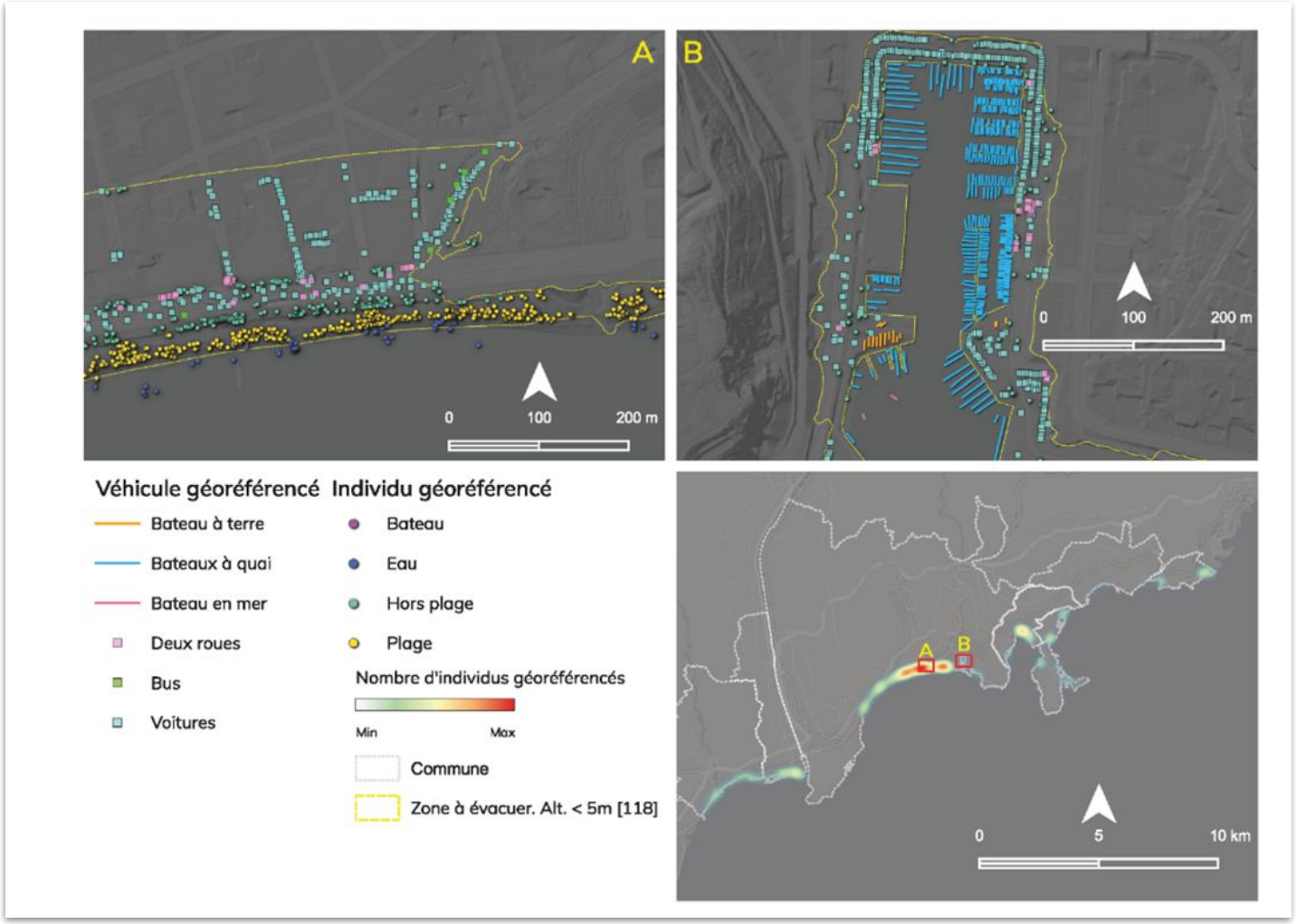
As part of the EVACTSU project, photo-interpretation work was used to reference **all visible individuals, vehicles and boats** in the evacuation zone of Nice's metropole.

A total of **7,659 people** were visible :

- ~ 5 000 were counted on the beach
- ~ 2 000 outside of the beach
- ~ 300 people in the sea

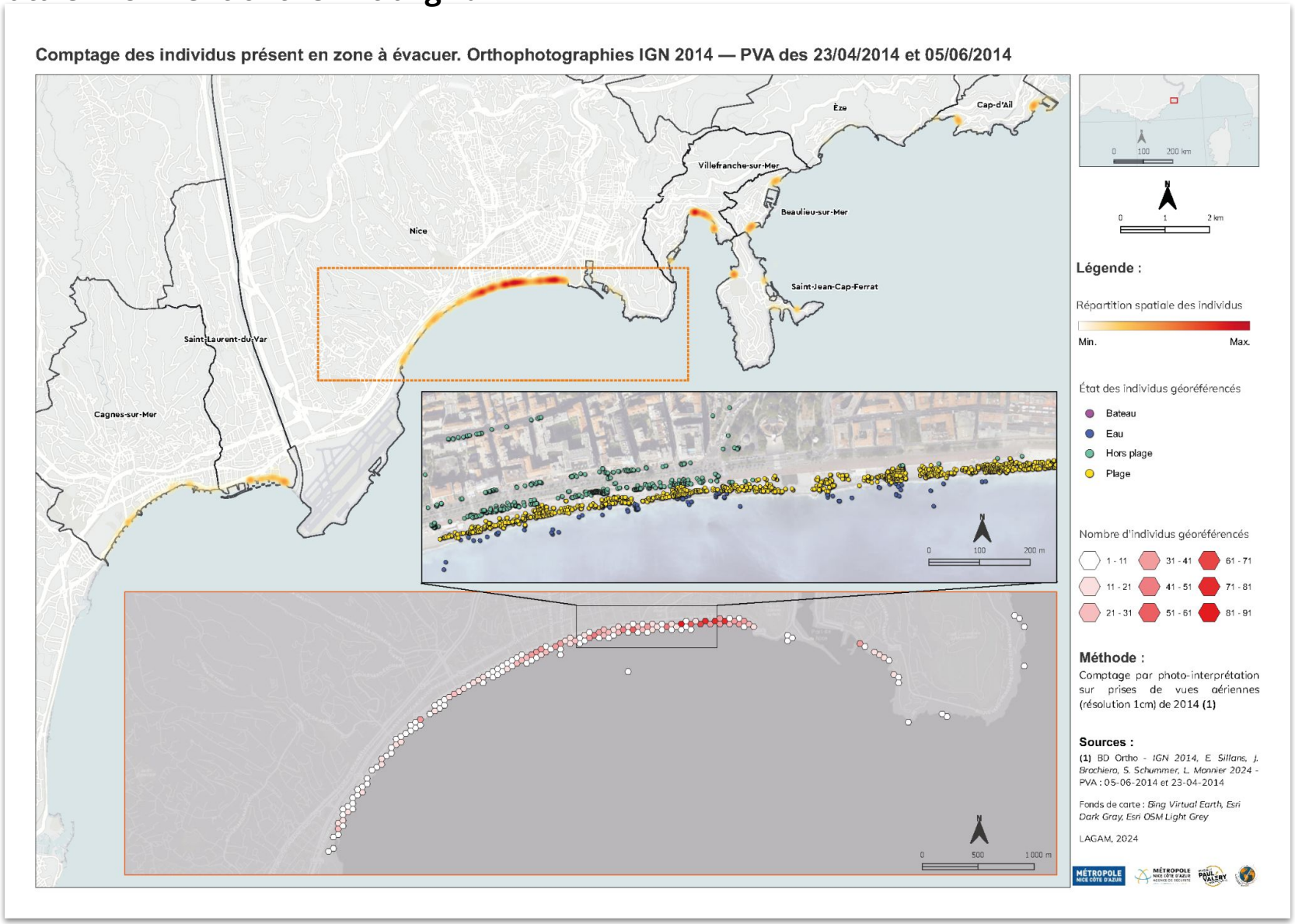
Those data were used to provide :

- A **snapshot of human frequentation** for the whole coastal area of Nice Metropole.
- The **number of people per assembly points** for this specific evacuation scenario.



Tsunami evacuation routes calculation using graph-based GIS methodology

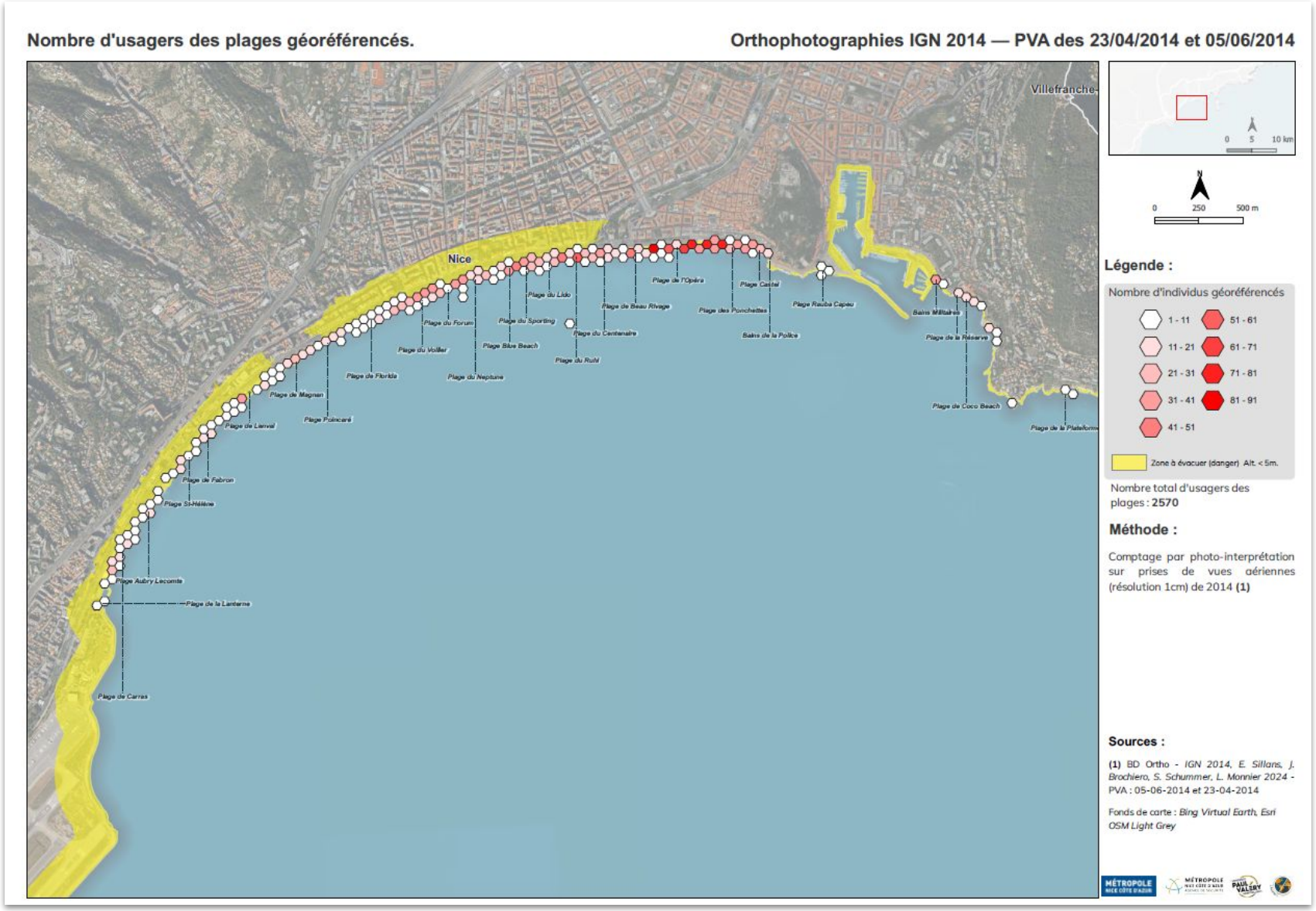
Example of spatial data enrichment of the initial grid



Dr. Matthieu Péroche (matthieu.peroche@univ-montp3.fr) - Louis Monnier

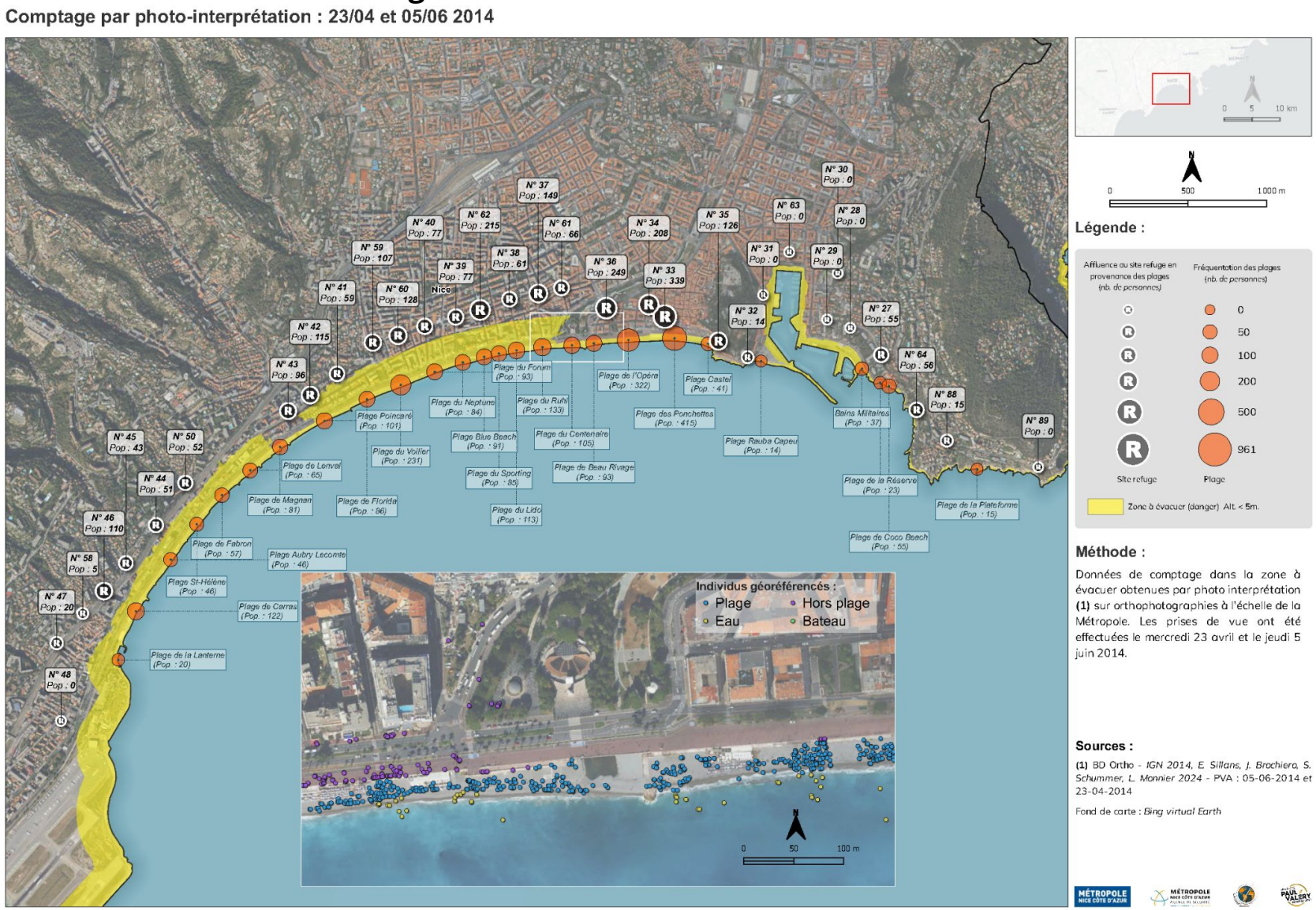
Tsunami evacuation routes calculation using graph-based GIS methodology

Example of spatial data enrichment of the initial grid

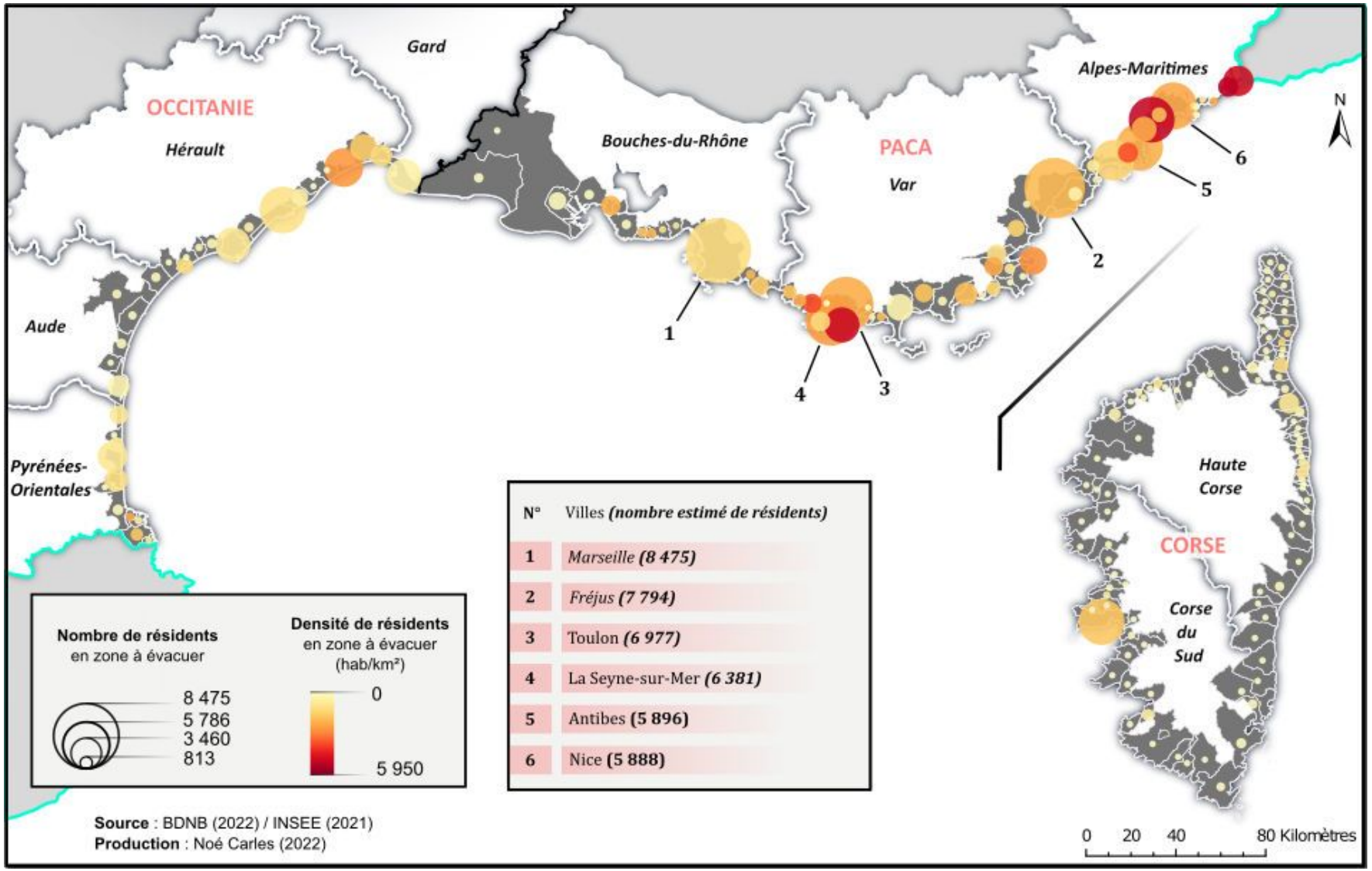


Dr. Matthieu Péroche (matthieu.peroche@univ-montp3.fr) - Louis Monnier

Example of spatial data enrichment of the initial grid



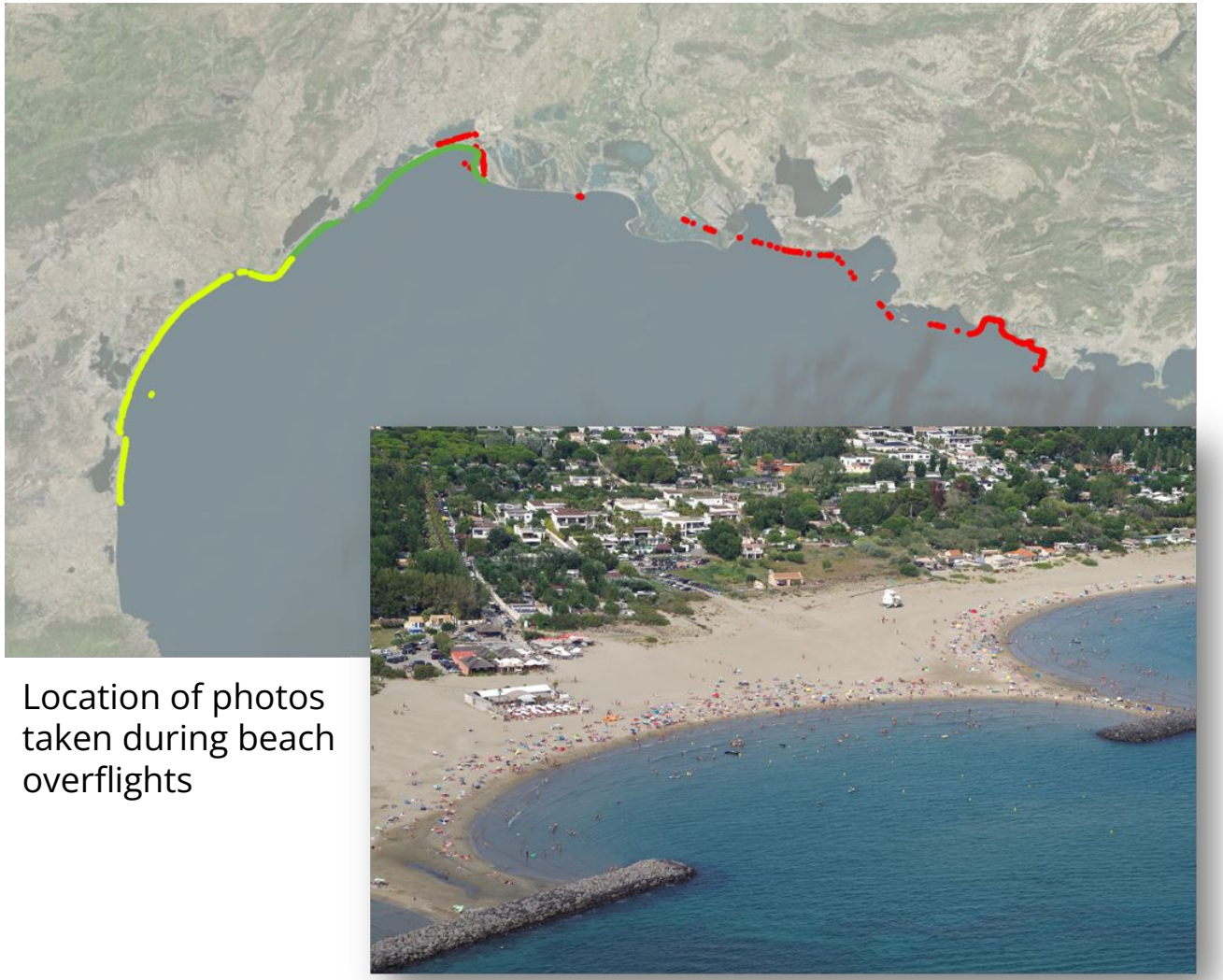
Example of spatial data enrichment of the initial grid



Estimation of the number of residents within the tsunami evacuation zone, based on land registry data and aggregated by municipality.

Noé Carles, Matthieu Péroche, Johnny Douvinet & Pierre Foulquier. « **Estimation du nombre d'individus à évacuer en cas de tsunami à l'échelle du littoral méditerranéen français** ». *Méditerranée, publication en ligne anticipée, 28 mars 2023.* https://doi.org/10.4000/mediterranee.14431.

Example of spatial data enrichment of the initial grid



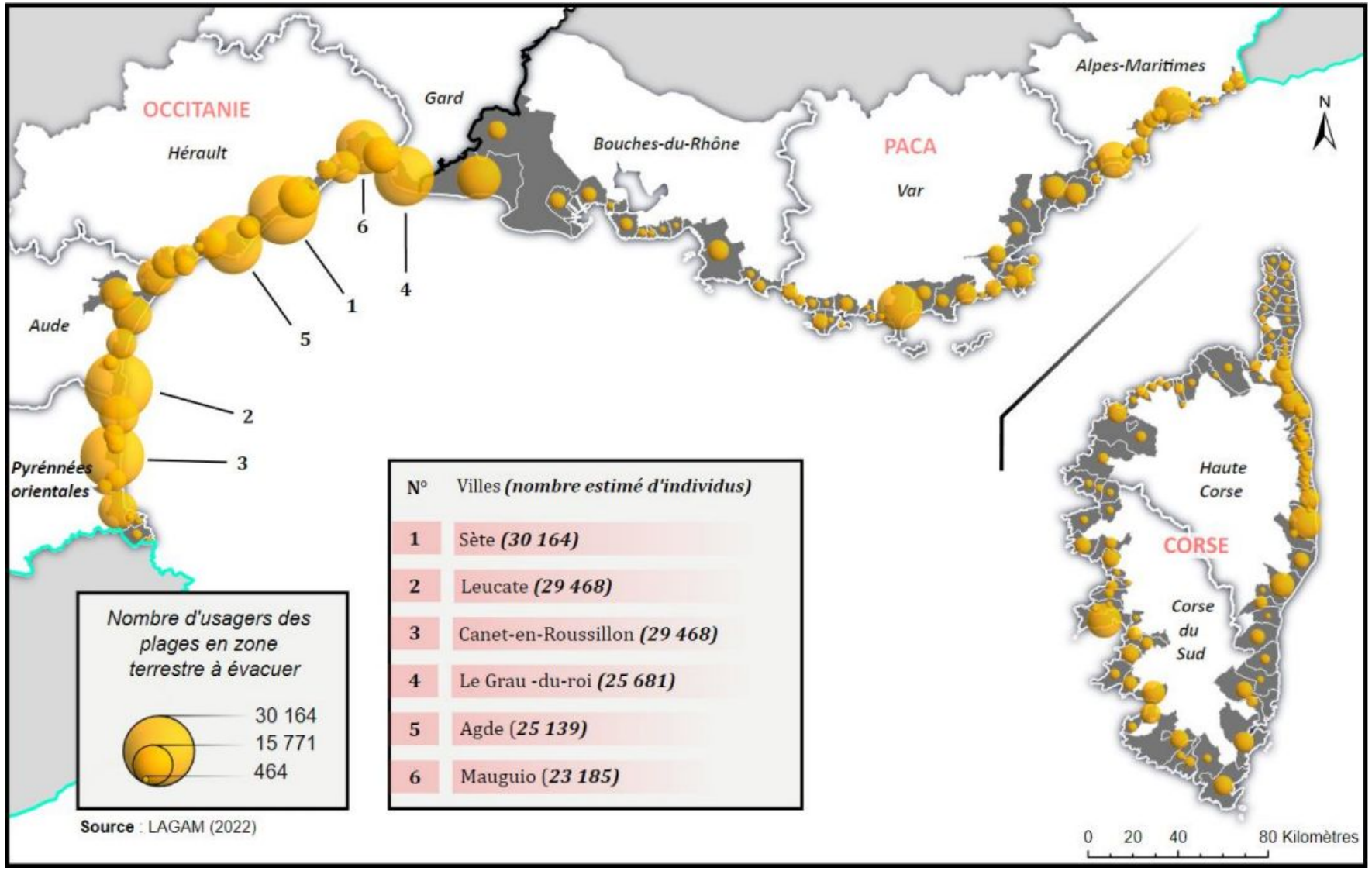
Location of photos taken during beach overflights

Photo : M. Peroche, 2021

Aerial Survey Protocol for Counting Beach Users During Peak Attendance

- **Three flights** conducted around the weekend of **August 15, 2021**
- **Aerial photographs** taken of beaches across **six departments**: Pyrénées-Orientales (66), Aude (11), Hérault (34), Gard (30), Bouches-du-Rhône (13), and Var (83)
- **1,762 geolocated images**
- **Manual counting** of people on the beach and in the bathing area across **27 beaches or beach sections**
- **Digitization of studied beaches** as polygons in a **GIS environment**
- The time of flights was set between **3:00 PM and 4:30 PM**, corresponding to the **peak beach attendance period** according to the literature

Example of spatial data enrichment of the initial grid



Number of beach users extrapolated from aerial images, and aggregated by municipality.

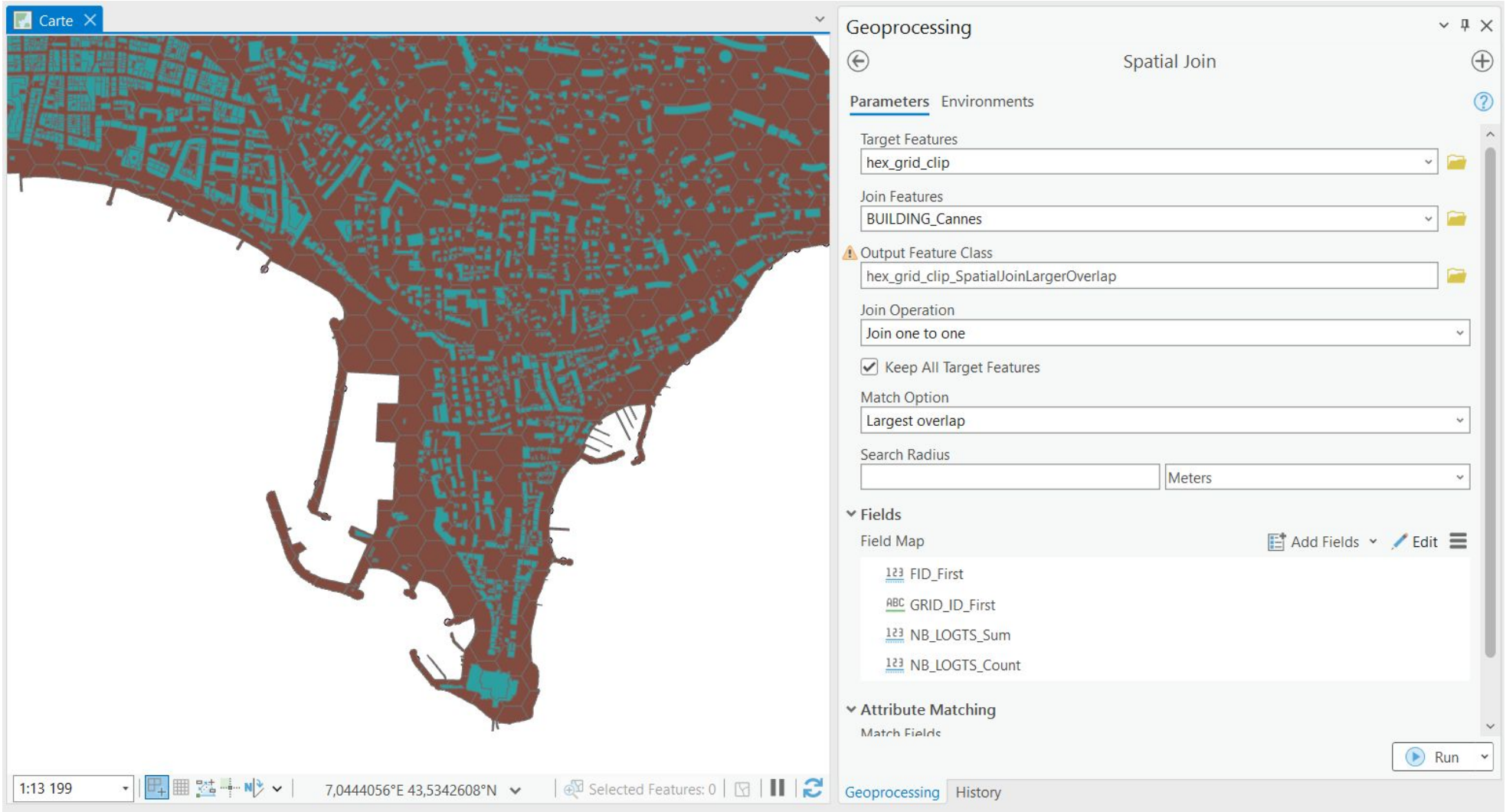
Noé Carles, Matthieu Péroche, Johnny Douvinet & Pierre Foulquier. « **Estimation du nombre d'individus à évacuer en cas de tsunami à l'échelle du littoral méditerranéen français** ». *Méditerranée, publication en ligne anticipée, 28 mars 2023.* https://doi.org/10.4000/mediterranee.14431.

Example of spatial data enrichment of the initial grid

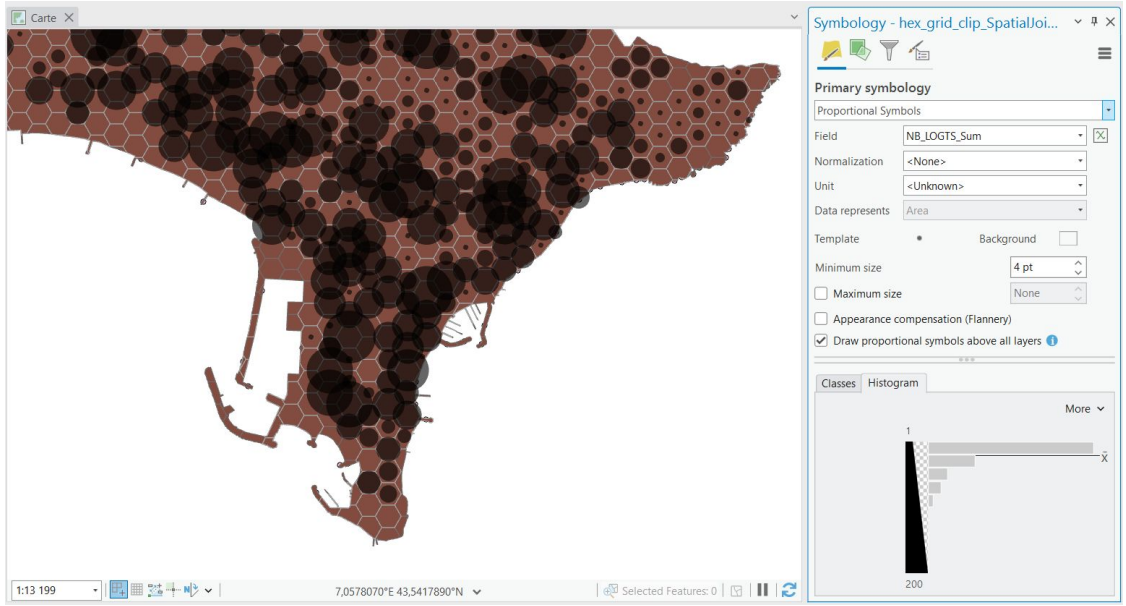
Changes in visitor numbers at the Croisette public beach (Cannes) on Saturday, July 30, 2022 between 10am (**photo A)** and 9pm (**photo B**). (Carles N., 2024)

Example of spatial data enrichment of the initial grid

Spatial join to enrich the hexagonal grid with building data (number of buildings, number of housing units). Use "Largest overlap" to avoid double counting — or convert polygons to points first.

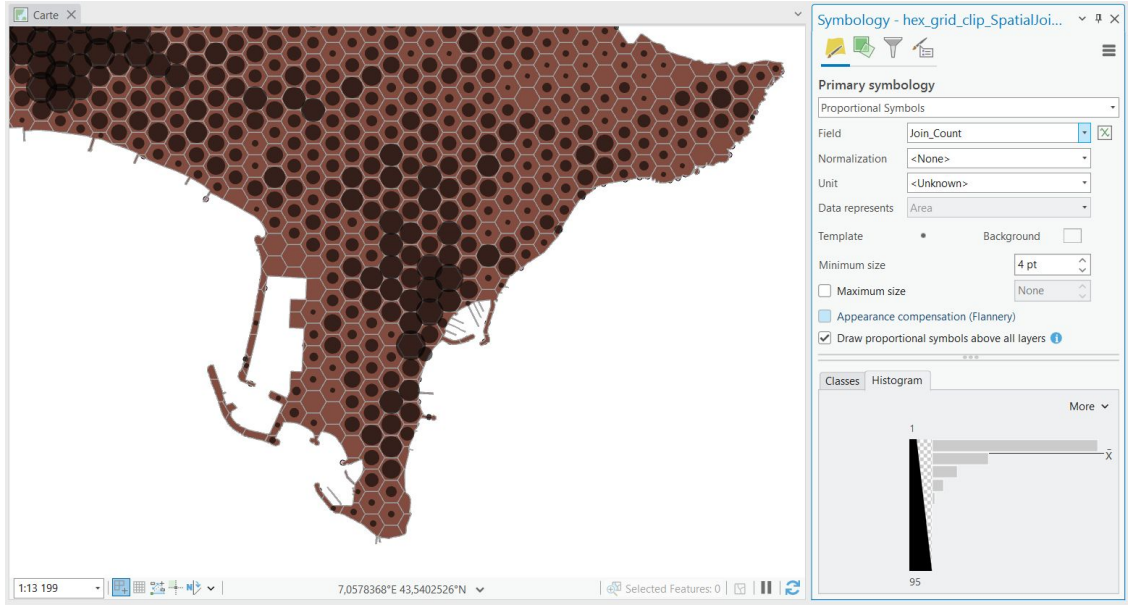


Example of spatial data enrichment of the initial grid



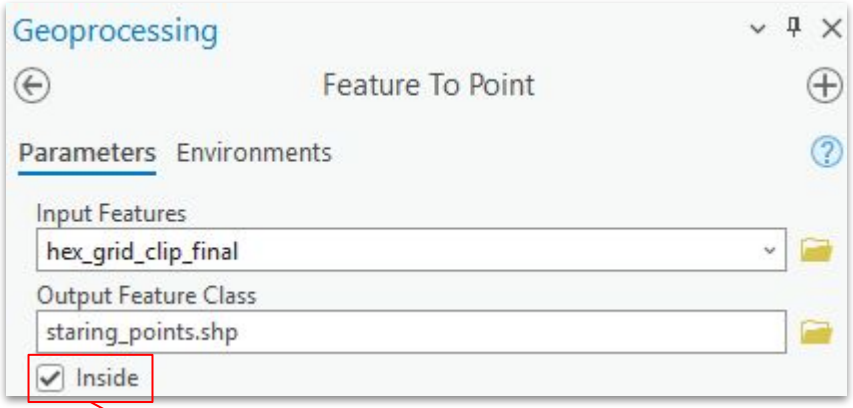
Number of housing units

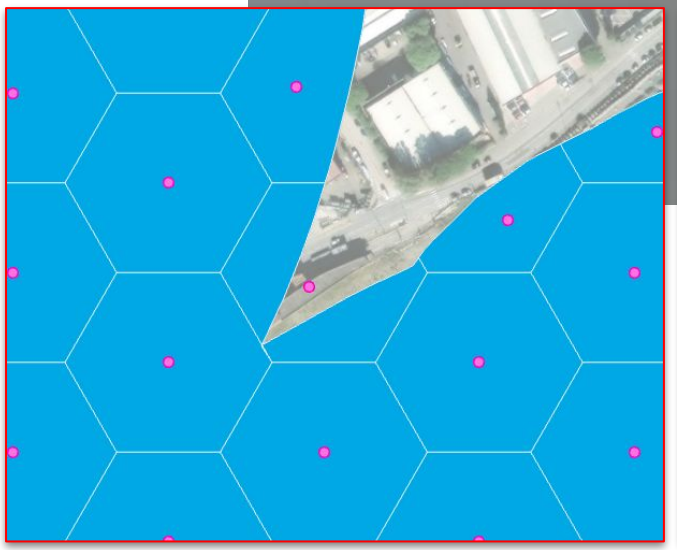
Number of buildings



Generate the starting points for accessibility analysis

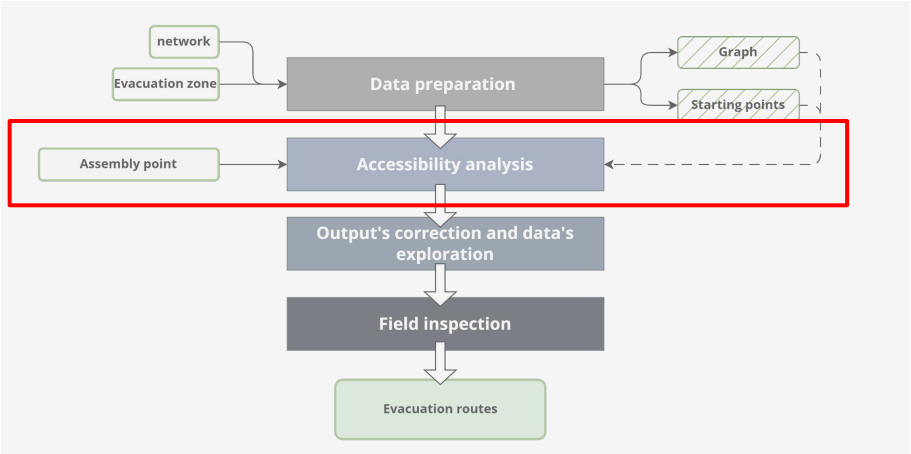
1. Generate the starting points using the **Features to point** tools.

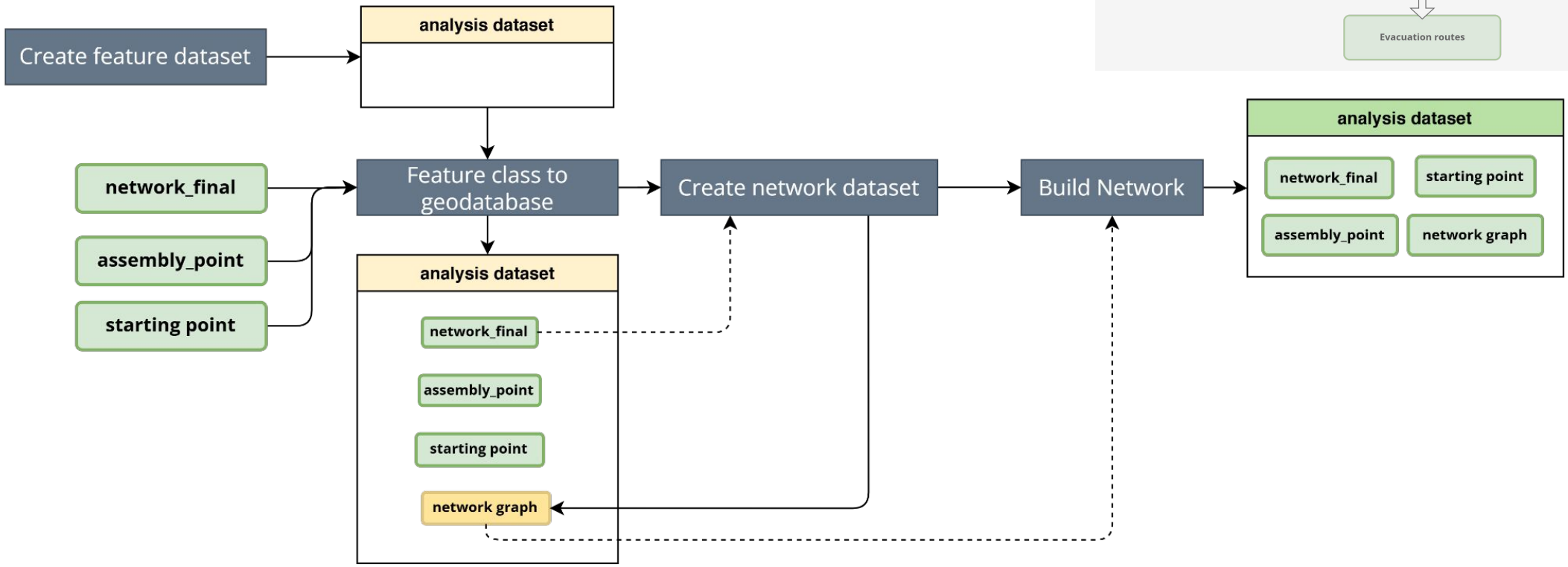




Feature to Point tools generate a point on every feature's centroid. Due to previous clipping processing, "**Inside" parameter must me activated** in order to avoid generating external points :

Accessibility analysis 1/2 : Setting the analysis database

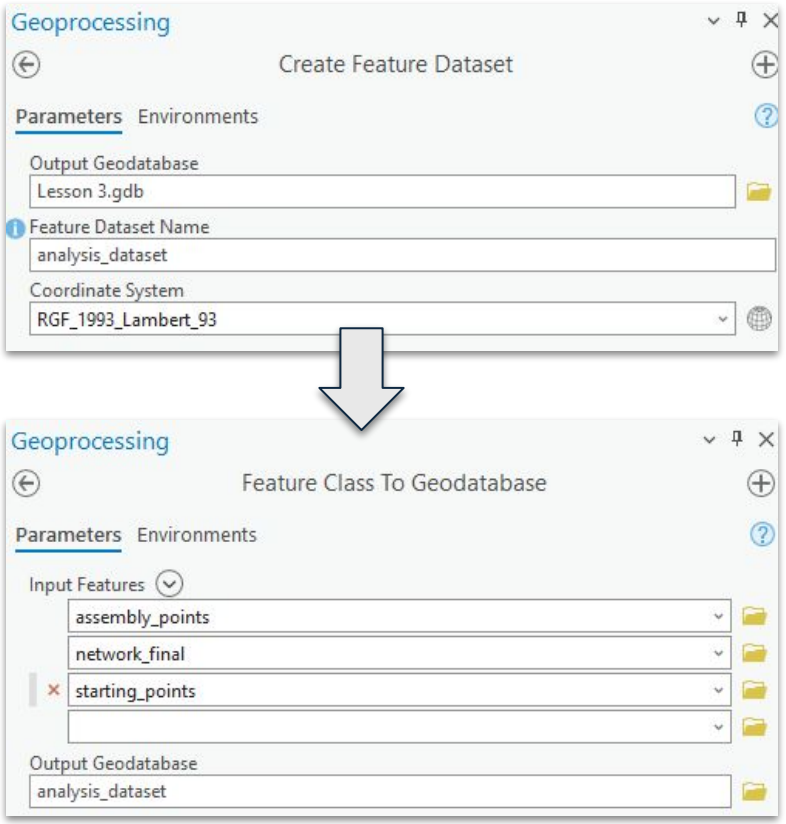




Accessibility analysis 1/2 : Setting the analysis database

In order to realize a accessibility analysis, ArcgisPro require all layers (starting point, network, and assembly point) that will be used to be gathered in a single database.

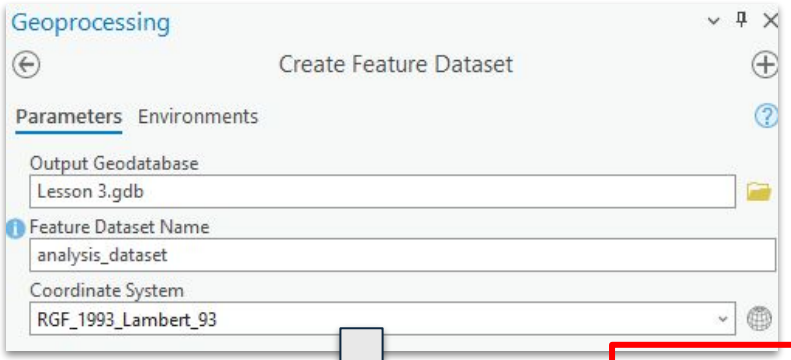
Geodatabase

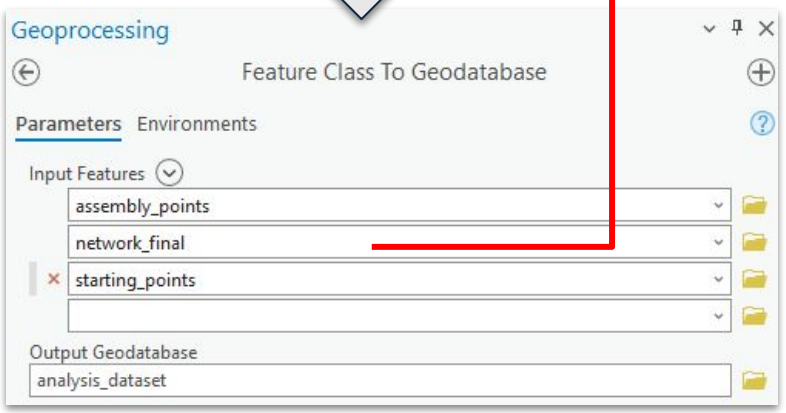


Accessibility analysis 1/2 : Setting the analysis database

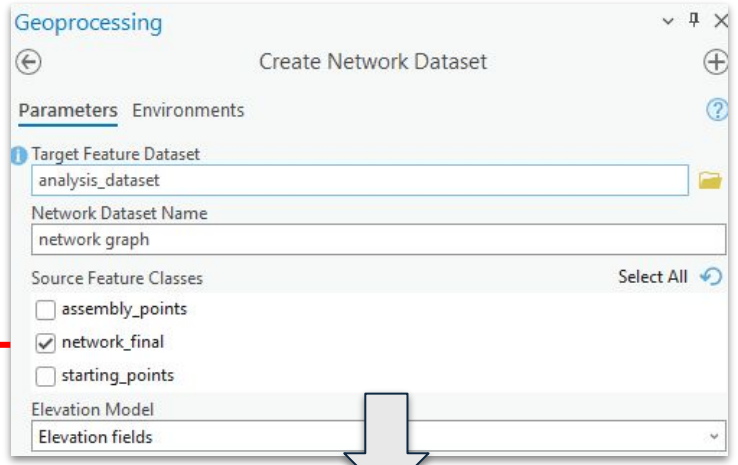
The graph must be added to the geodatabase then build

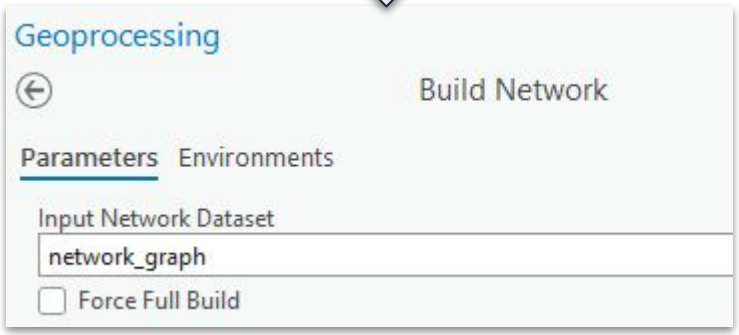
Geodatabase





Network Graph





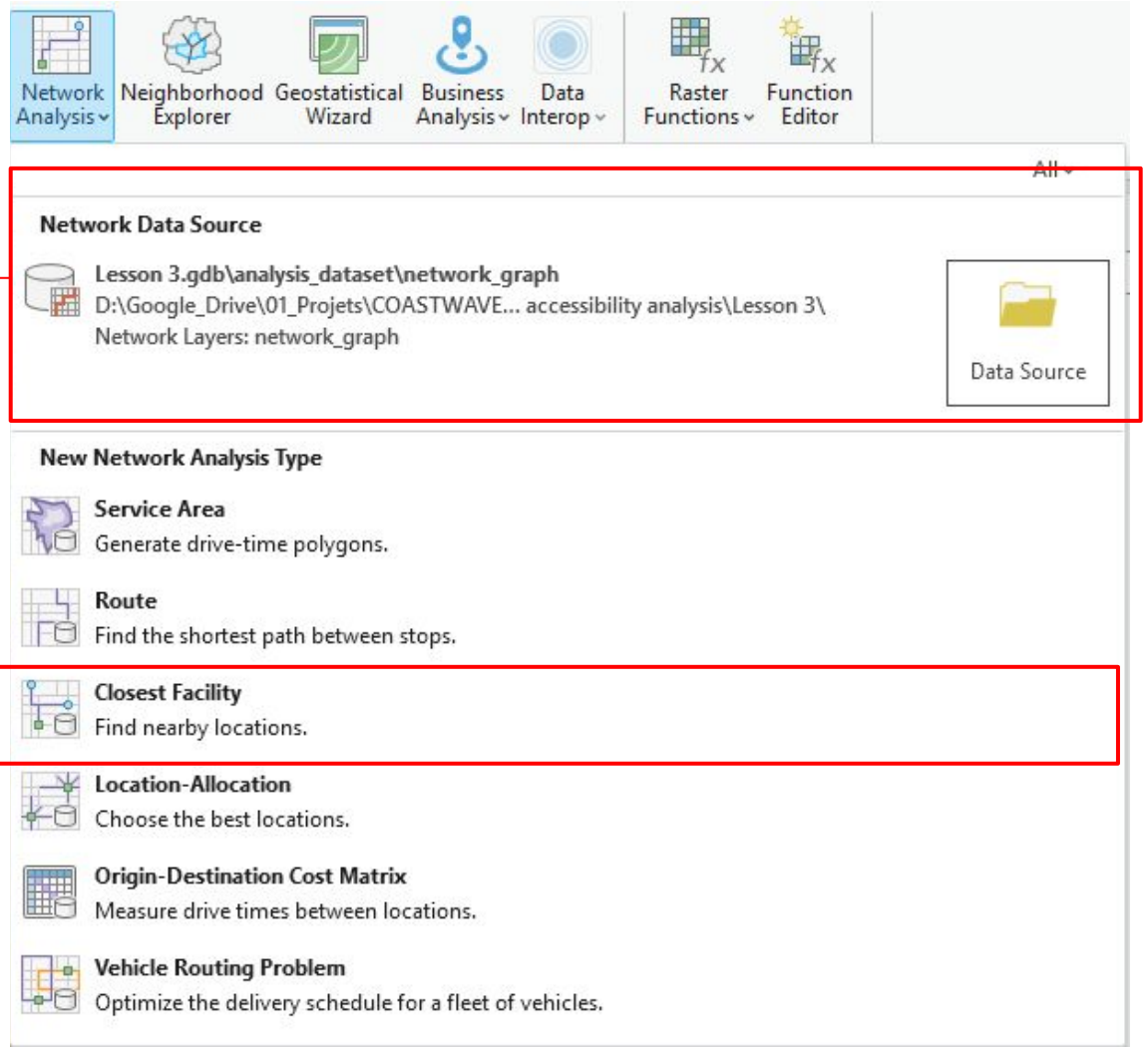
Accessibility analysis 2/2 : Launching Network Analysis

Top ribbon > Analysis > Workflow>Network Analysis

Be sure that your network graphe is set as the network Data Source

"The closest facility solver finds one or more facilities that are closest to an incident based on travel time or travel distance and outputs the best routes between the incidents and the chosen facilities."

In our case, the **facilities will be our assembly points**, and the **incidents will be the starting points.**

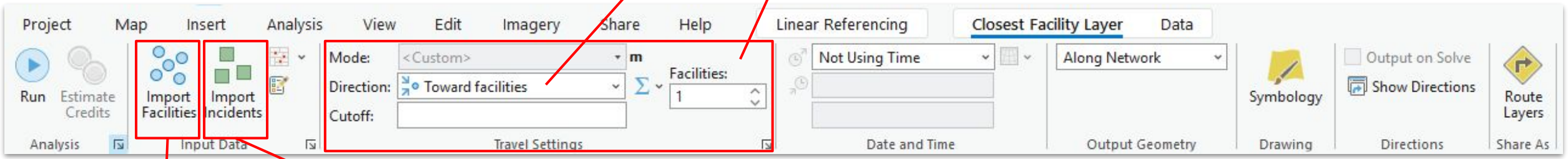


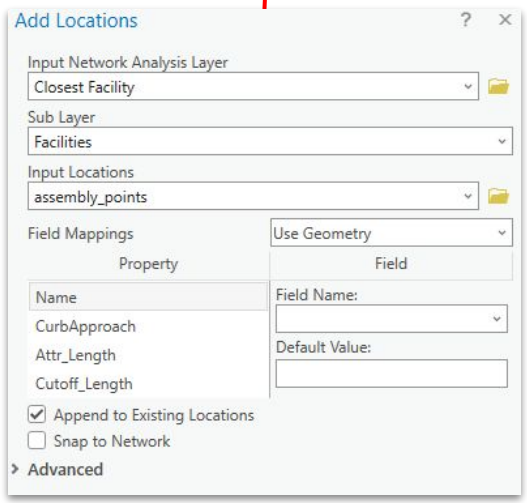
Accessibility analysis 2/2 : Launching Network Analysis

Top ribbon > Closest Facility

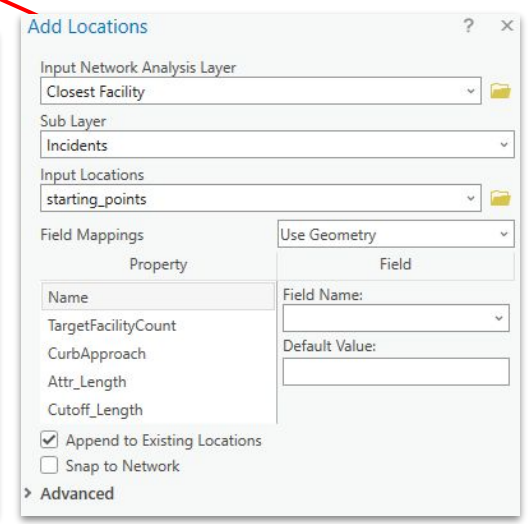
Set search direction toward assembly points

N → 1 relation





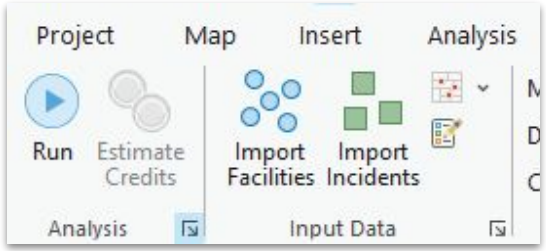
Assembly points



Starting points

Expected result :

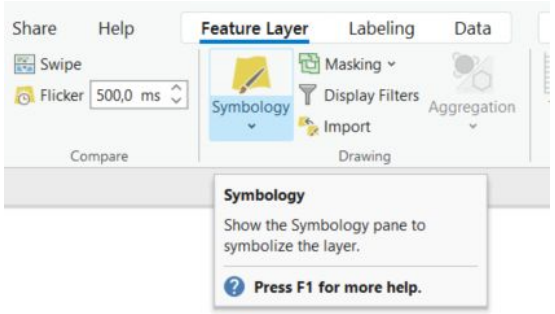
Accessibility analysis 2/2 : Launching Network Analysis

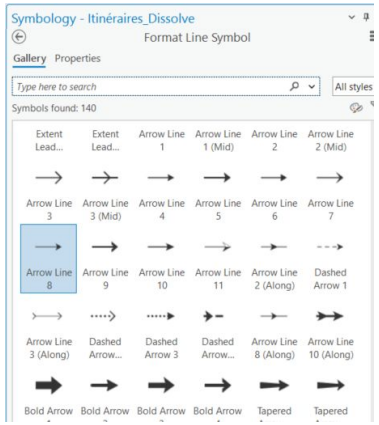


Click on **Run** to compute the shortest routes

Change the routes symbology for a better understanding of the algorithm's output :

- Feature Layer > Symbology



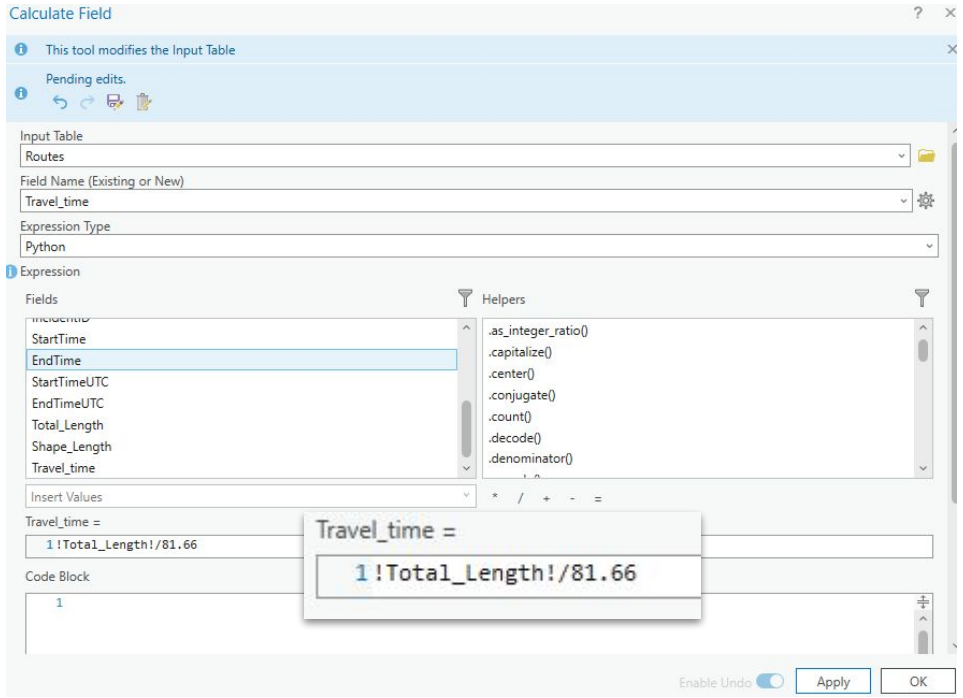


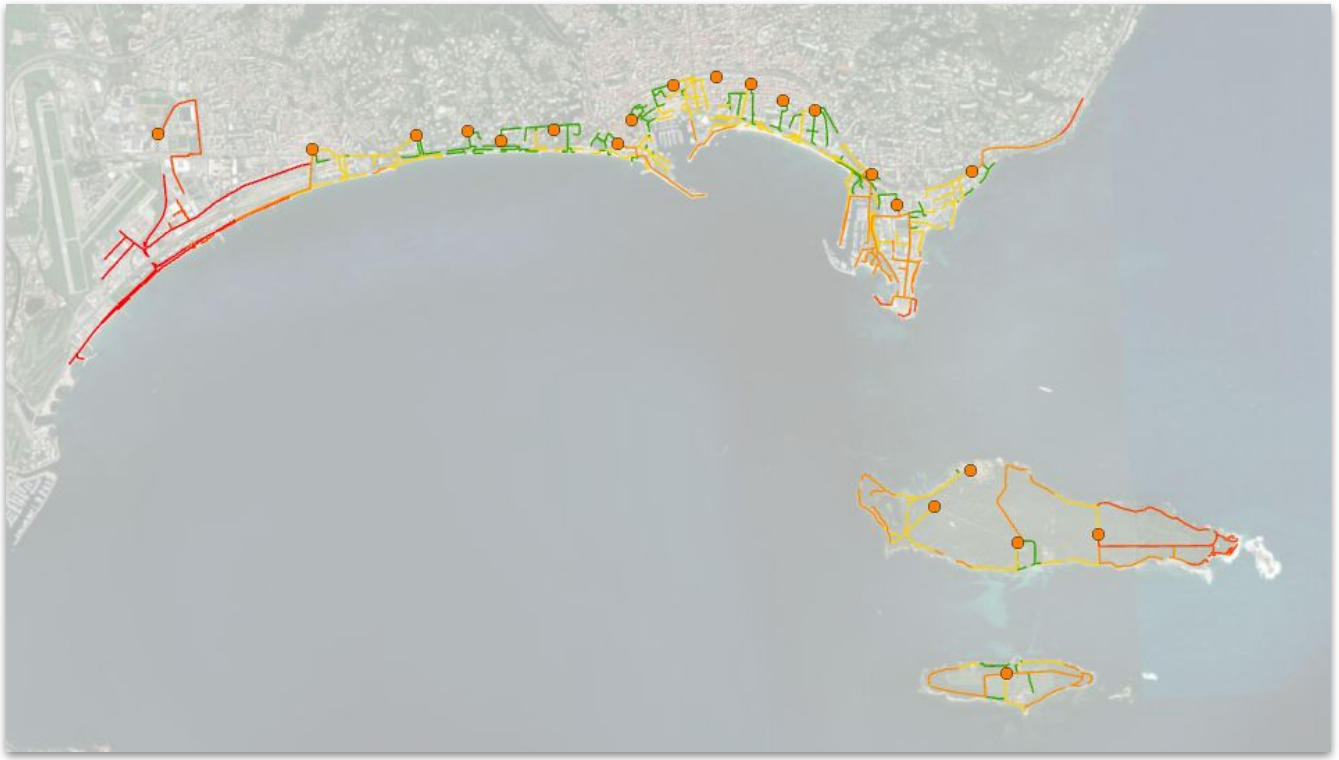
How to explore data?
What improvements can be made?

Output's correction and data's exploration

Add the field "**Travel_time"** to the routes layer. (Data Type = **Double**)

The travel speed is set at **4,9 km/h**. For this exemple, we won't weigh the travel speed.





Other informations can be computed to enhance the discussion with to authorities during the validation process.

i.g : Assembly point mean elevation

Improving the road network to better match actual pedestrian use

Most of the networks available for download are intended for vehicular traffic, therefore, it can lack accuracy for pedestrians dedicated ways :

- Beach access
- Park's entrances / exit
- Unreferenced tracks (often the case along the coast or in wooded areas)
- Staircase
- Underground pedestrian crossing path
- Docks ...

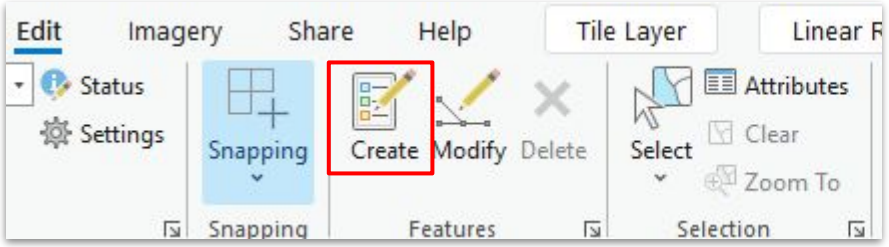
Original network

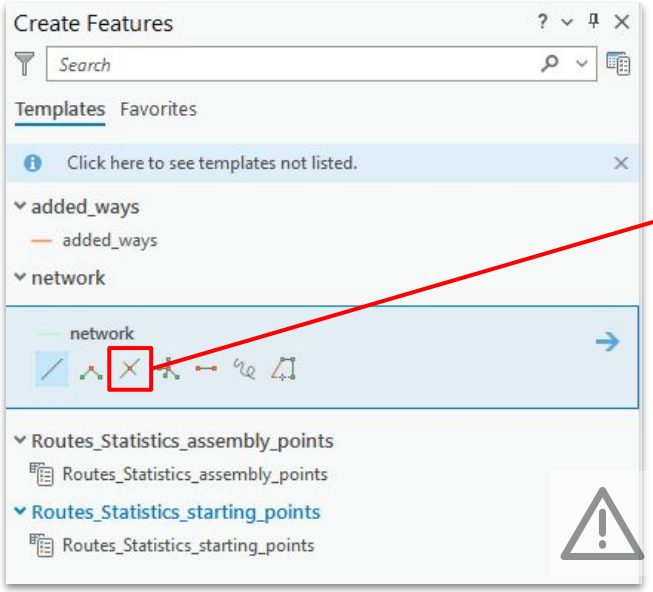
Missing pedestrian ways

Improving the road network to better match actual pedestrian use

Network must be completed manually by vectorizing all the missing pedestrian ways, **using satellite imagery and field mission**.

Once the network is complete, its topology must be checked and corrections made for sections that are not cut at intersections, **in compliance with topology rules.**





Connecting new features to the original network require to split lines where they intersect in order to be used as a graph.

Arcgis Pro provide a build-in vectorisation tools (**Split**) that automatically split lines on their intersection.

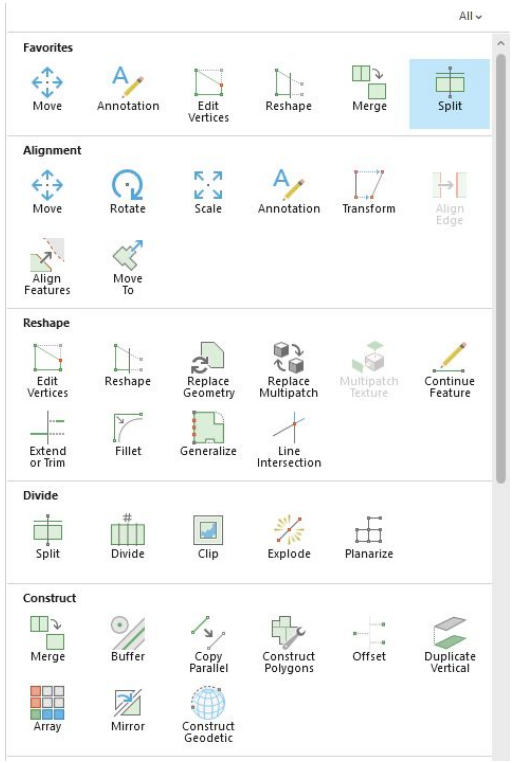
Double check is recommended for every new features created.

Exercice :

Complete the **network layer** with all the missing pedestrian ways and check for existing topology errors.

Try the following edition tools (Top ribbon > Edit > Tools) :

- Split
- Line intersection
- Explode



Why Configure the Pedestrian Network?

Graph Configuration Parameters

- **Edge orientation**: force walking direction (e.g. one-way paths, stairs)
- **Edge weighting**: define travel cost based on:
  - **Slope** (walking slower uphill)
  - **Road hierarchy** (main roads vs minor paths)
  - **Surface type** (paved, gravel, dirt, stairs)
  - **Width and condition** of each segment

Slope (%)	Travel speed (m/s)
< 3	1,3485
[3-6[	1,2644
[6-9[	1,1823
[9-12[	1,1023
[12-15[	1,0245
[15-18[	0,9491
[18-21[	0,876
[21-24[	0,8054
[24-27[	0,7373
≥ 27	0,4751

Example of travel speeds according to network gradient. (Péroche, 2016)

Why Use Graph-Based Analysis?

- Allows testing of **multiple evacuation scenarios**
- Provides **credible travel time estimates over the actual network**
  → *Without accounting for congestion effects*
- Identifies **difficult or constrained areas** in the network
- Adapts to **different walking profiles**:
  → Elderly, children, reduced mobility, responders
- Supports **comparison between evacuation options**
  → Shortest path vs fastest path, route capacity, alternative access

What simple parameters with available data?

✅ What We're Doing

- We'll use a **limited number of walking speeds**
- Speeds will be assigned based on:
  - **Type of segment** (e.g. road, path, stairs,..)
  - **Surface material** (paved, unpaved, etc.)
  - **Width of the segment**

⚠️ What We're Not Doing (and Why)

- **Slope will not be included** in this demonstration
  → It requires extra processing for very **minimal time differences**

  → Especially in the **Cannes**, where:
  - **Evacuation distances are short** (often < 400 m)
  - Slope has **limited impact on total evacuation time**

TRONCON_DE_ROUTE_CANNES

Field: Add Calculate Selection: Select By Attributes Zoom To Switch Clear Delete Copy

	FID	Shape *	NATURE	LARGEUR	IT_VERT	PRIVE	SENS	BUS	URBAIN	VIT_MOY_VL
1	2154	Polyline ZM	Type autoroutier	13,5	Oui	Non	Sens direct		Oui	100
2	2155	Polyline ZM	Type autoroutier	13,5	Oui	Non	Sens direct		Oui	100
3	5229	Polyline ZM	Type autoroutier	13,5	Oui	Non	Sens direct		Oui	100
4	5357	Polyline ZM	Type autoroutier	13,5	Oui	Non	Sens direct		Oui	100
5	8208	Polyline ZM	Type autoroutier	13,5	Oui	Non	Sens direct		Oui	100
6	10630	Polyline ZM	Type autoroutier	13,5	Oui	Non	Sens direct		Oui	100
7	15172	Polyline ZM	Type autoroutier	13,5	Oui	Non	Sens direct		Oui	100
8	15173	Polyline ZM	Type autoroutier	13,5	Oui	Non	Sens direct		Oui	100

Assigned Walking Speeds Based on Segment Type and Width

Step 1 - define travel speed conditions

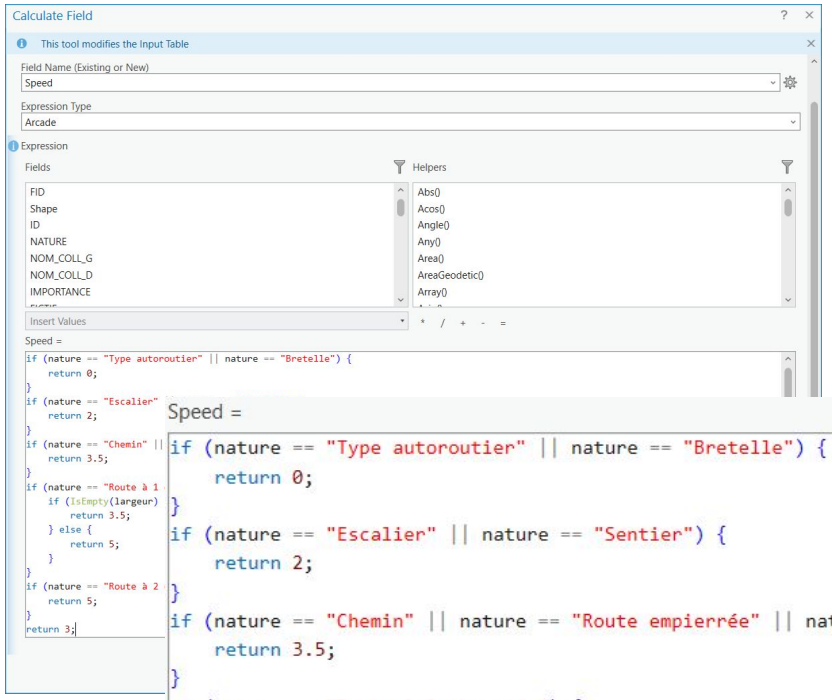
Segment Type (NATURE)	Translation (EN)	Condition (Width if needed)	Assigned Speed (km/l	Remarks
Type autoroutier / Bretelle	Motorway / Ramp	—	0.0	Not walkable (excluded)
Escalier / Sentier	Stairs / Path	—	2.0	Slow speed due to difficulty
Chemin / Route empierrée / Rond-point / Piste cyclable	Track / Unpaved road / Roundabout / Cycle path	—	3.5	Moderate walking speed
Route à 1 chaussée	Single carriageway road	Width < 5 m or unknown	3.5	Narrow or undetermined width
Route à 1 chaussée	Single carriageway road	Width ≥ 5 m	5.0	Standard road, comfortable pace
Route à 2 chaussées	Dual carriageway road	—	5.0	Large road, good walkability
Other (default)	Other (default)	—	3.0	Default speed for unclassified segments

Assigned Walking Speeds Based on Segment Type and Width

Step 2 - Create a New Attribute Field and Implement Walking Speeds

1. Add a new field in the network layer to store **walking speeds (km/h)**

2. Assign values based on **segment type and width**, using IGN attributes (Sample Arcade Expression)




```
if (nature == "Type autoroutier" || nature == "Bretelle") {
    return 0;
}
if (nature == "Escalier" || nature == "Sentier") {
    return 2;
}
if (nature == "Chemin" || nature == "Route empierrée" || nature == "Rond-point" ||
nature == "Piste cyclable") {
    return 3.5;
}
if (nature == "Route à 1 chaussée") {
    if (IsEmpty(largeur) || largeur < 5) {
        return 3.5;
    } else {
        return 5;
    }
}
if (nature == "Route à 2 chaussées") {
    return 5;
}
return 3;
```

Speed =

```
if (nature == "Type autoroutier" || nature == "Bretelle") {
    return 0;
}
if (nature == "Escalier" || nature == "Sentier") {
    return 2;
}
if (nature == "Chemin" || nature == "Route empierrée" || nature == "Rond-point" || nature == "Piste cyclable") {
    return 3.5;
}
if (nature == "Route à 1 chaussée") {
    if (IsEmpty(largeur) || largeur < 5) {
        return 3.5;
    } else {
        return 5;
    }
}
if (nature == "Route à 2 chaussées") {
    return 5;
}
return 3;
```

Assigned Walking Speeds Based on Segment Type and Width

Step 3 – Calculate Travel Time on Each Segment

1. Add a new field in the network layer to store **Travel Time (min)**

2. Compute **travel time in minutes** for each segment based on the segment's length and walking speed

3. Formula (Field Calculator – Python syntax)

0 if !Walk_Speed! == 0 else (!SHAPE_LENGTH! / 1000) / !Walk_Speed! * 60

Explanation

- `!SHAPE_LENGTH!` is in **meters**
- `!Walk_Speed!` is in **km/h**
- We convert meters to kilometers, then hours to minutes
- If the speed is `0`, the travel time is set to `0` (non-walkable segment)

Recalculate and compare results.

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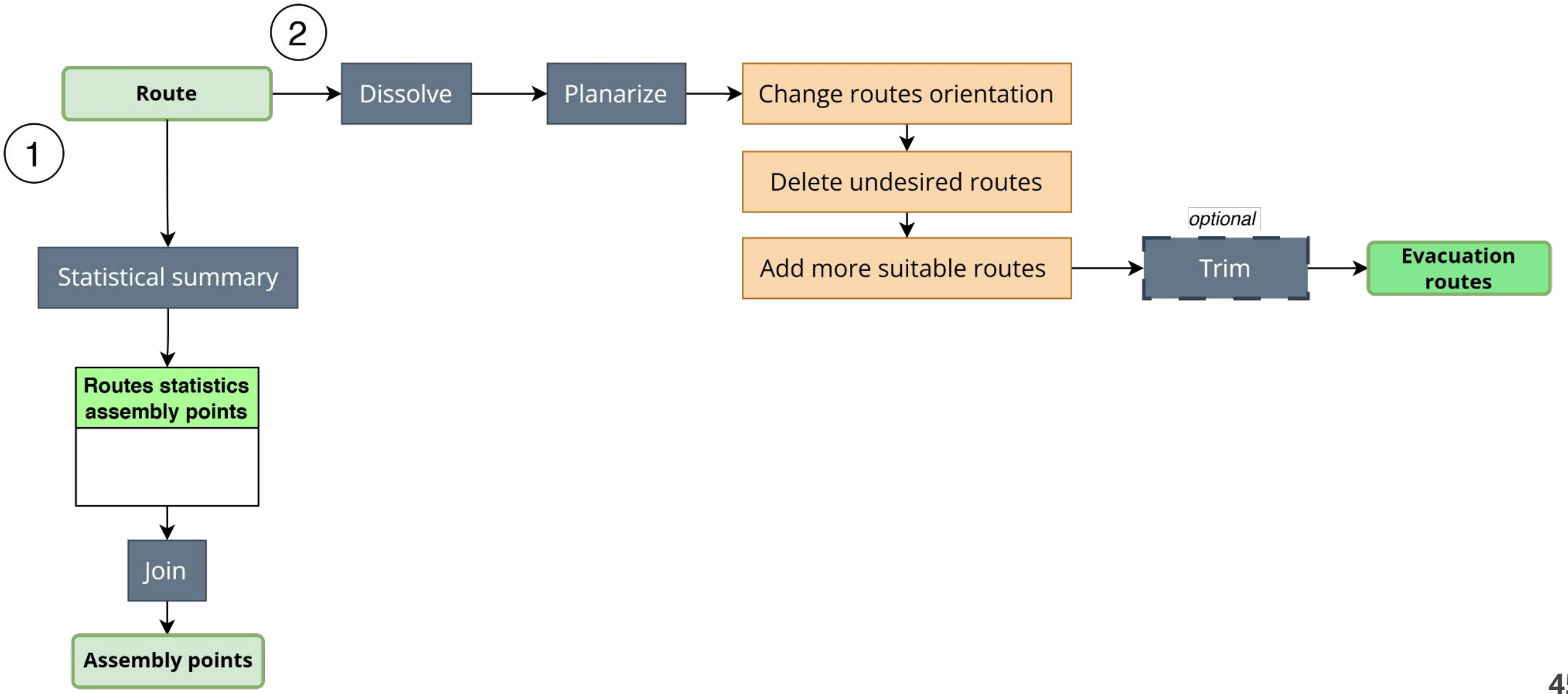
Main result used specifically for tsunami evacuation maps

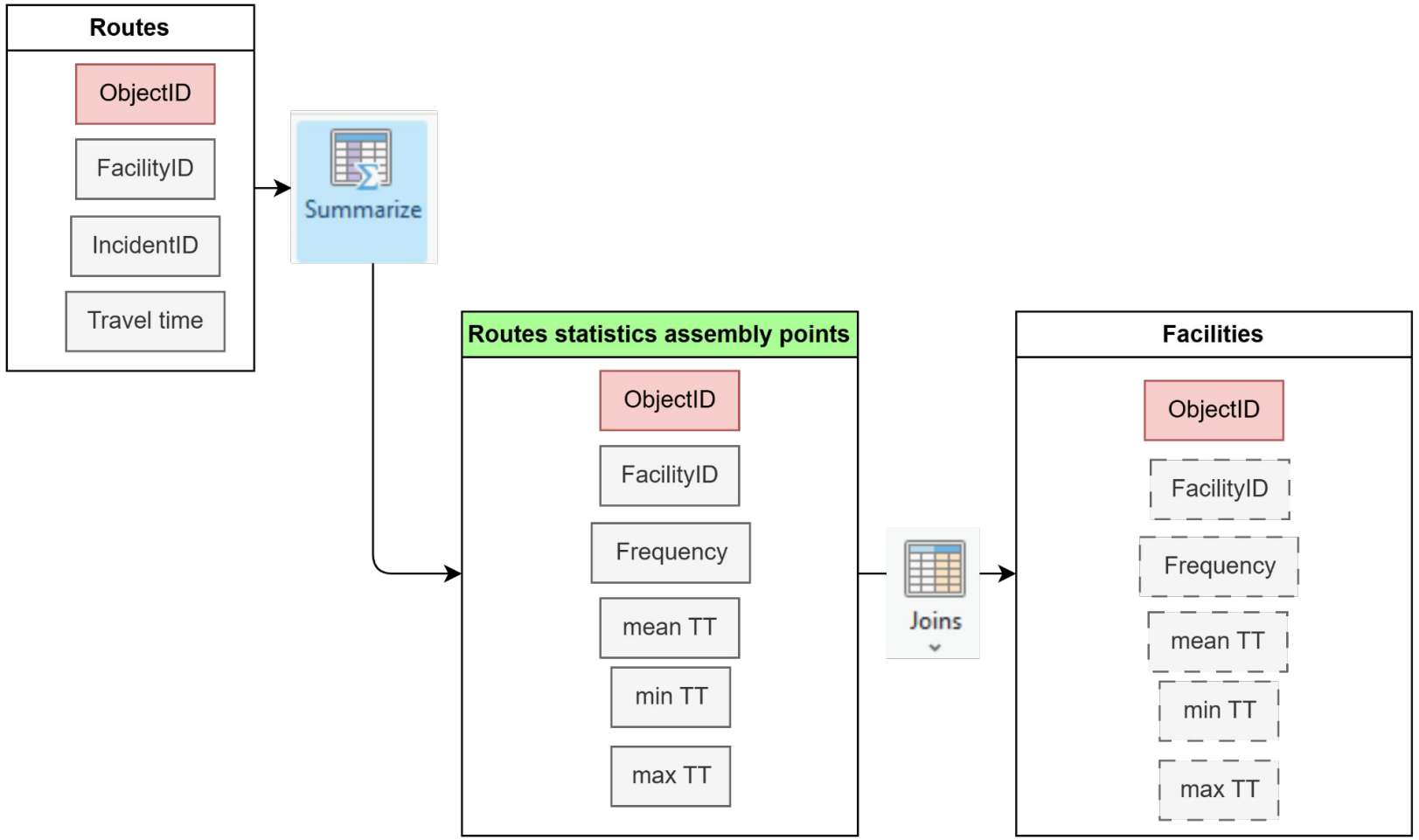
- **Time-optimised evacuation routes** are identified in order to facilitate the fastest evacuation from starting points within the tsunami evacuation zone toward a designed tsunami assembly point.
- In order to obtain this result, it is necessary to set up the road network accordingly.
- The walking speed parameter must be set for each network's edge, in order to accurately reflect the impact of their physical characteristics (e.g. nature and width) on walking speed.

Output's correction and data's exploration



Output's correction and data's exploration

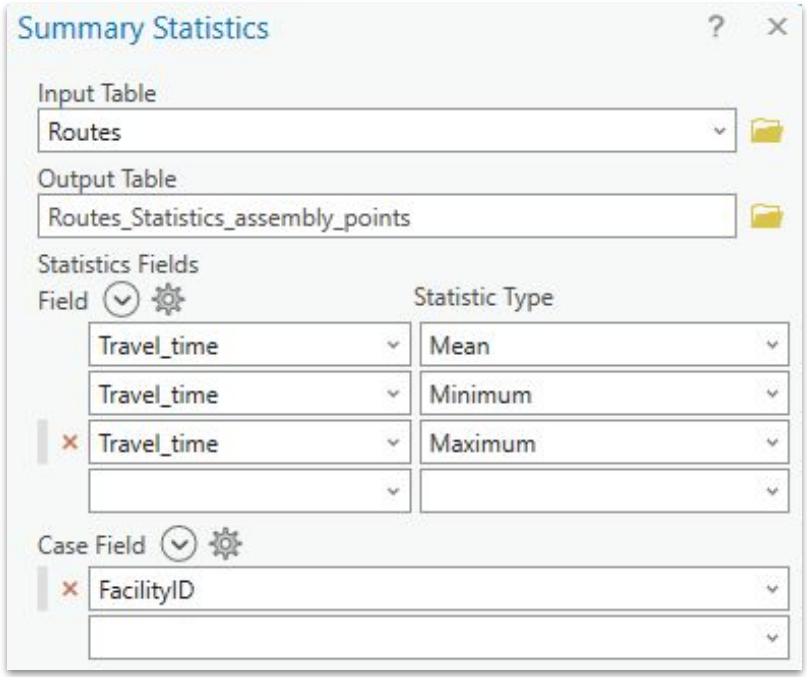
We can compute **statistical summary** (min, max and mean travel time ...) from our routes layer and join the values for both assembly points and starting points.



Output's correction and data's exploration

We can compute **statistical summary** (min, max and mean travel time ...) from our routes layer and join the values for both assembly points and starting points.

1. Open **routes** attribute table > Top ribbon > Table
2. Launch **Summarize Statistics** two time (Using both FacilityID and IncidentsID as grouping fields)



Number of routes pointing to the assembly point

Statistical summary

Routes | Fields: Routes | Routes_Statistics_assembly_points | Routes_S

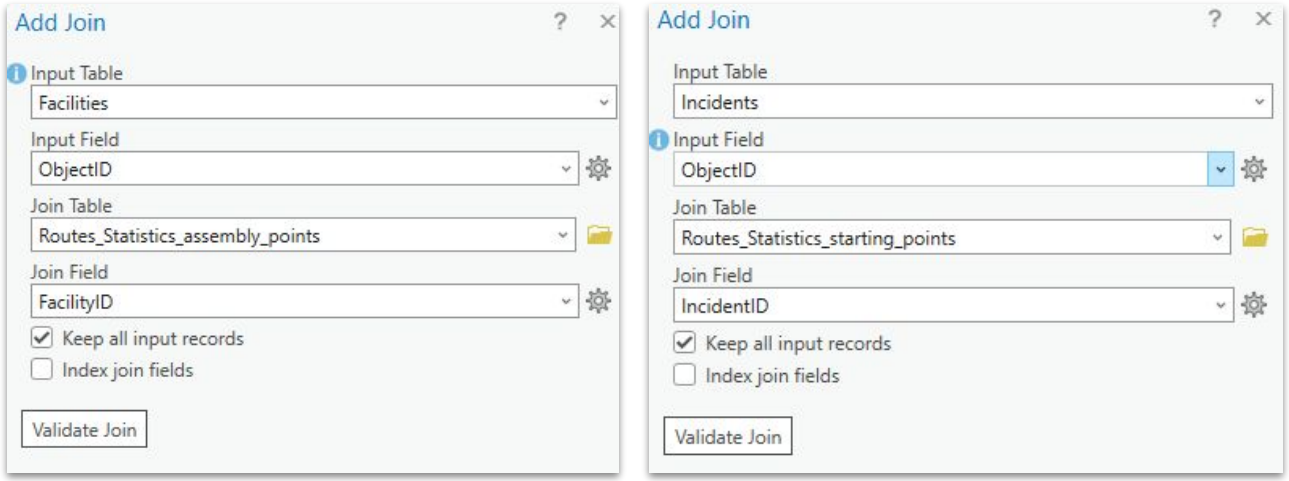
Field: Add | Calculate | Selection: Select By Attributes | Zoom To | Switch

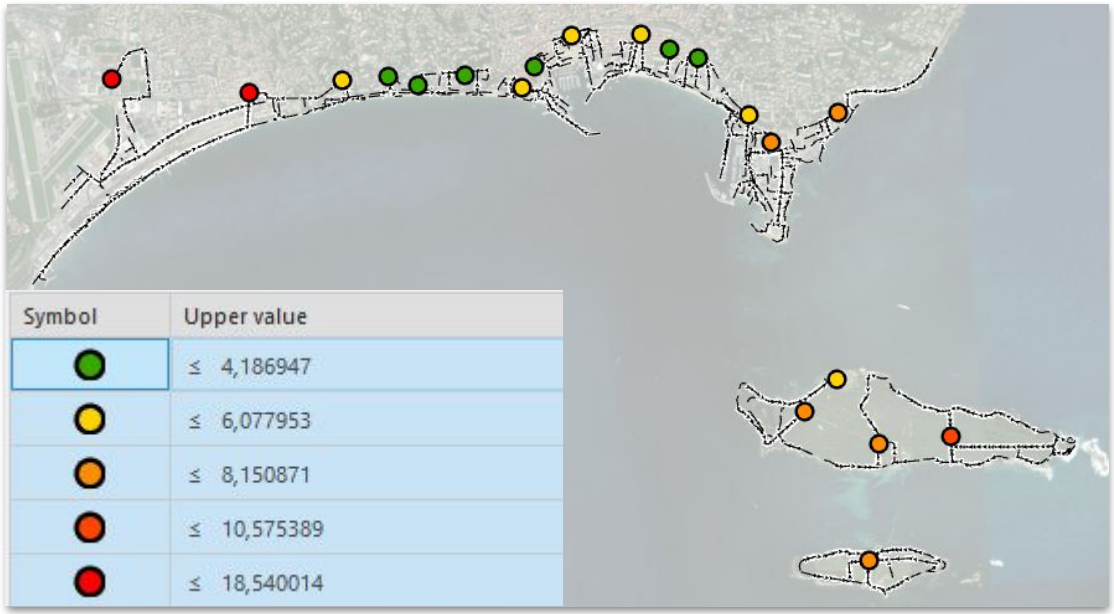
	ObjectID *	FacilityID	FREQUENCY	MEAN_Travel_time	MIN_Travel_time	MAX_Travel_time
1	1	1	17	4,186947	2,576871	7,059947
2	2	2	4	3,914488	3,017675	4,435066
3	3	3	11	3,934841	2,852418	6,102557
4	4	4	21	3,851036	0	5,339962
5	5	5	73	8,150871	2,774964	14,919387
6	6	6	36	5,353824	0,596829	11,205201
7	7	8	12	3,286643	1,529533	5,347811
8	8	9	12	2,940689	0,997663	4,506502
9	9	10	189	18,540014	1,757272	35,016253

Output's correction and data's exploration

We can compute **statistical summary** (min, max and mean travel time ...) from our routes layer and join the values for both assembly points and starting points.

1. Open **Facilities** attribute table > Top ribbon > Table
2. Select **Join**
3. Join the **Facilities** and the **facilities statistic table** using features Id as key values
4. Do the same for the **Incidents**



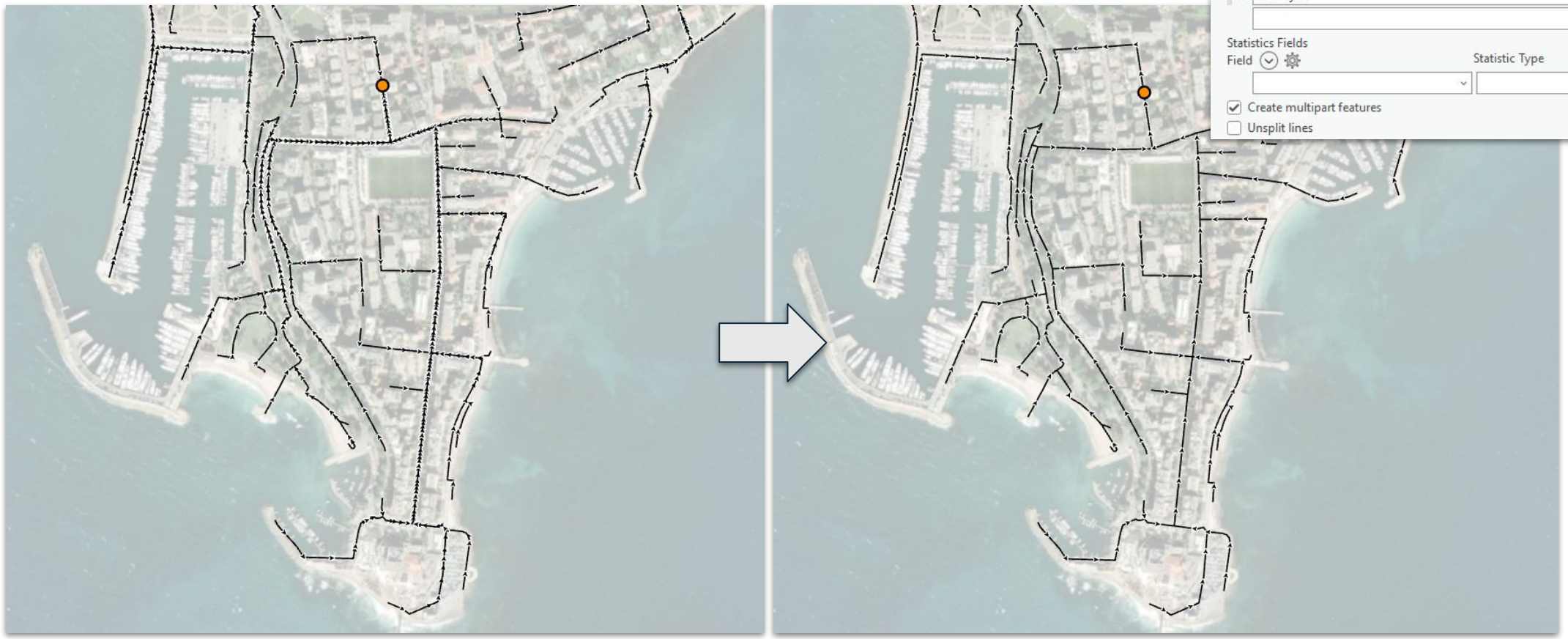


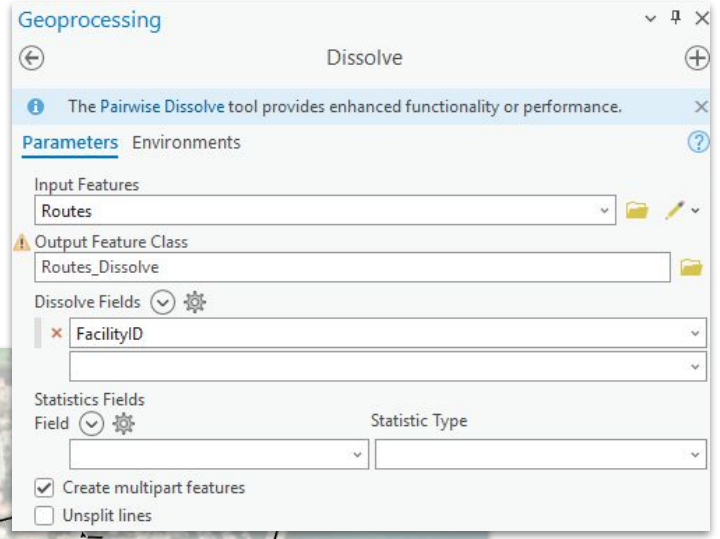
Output's correction and data's exploration

Problem :

One route is generated for each starting points, which result in a difficult to read output

They must be **dissolved** into one feature using the field **FacilityID** as the key.

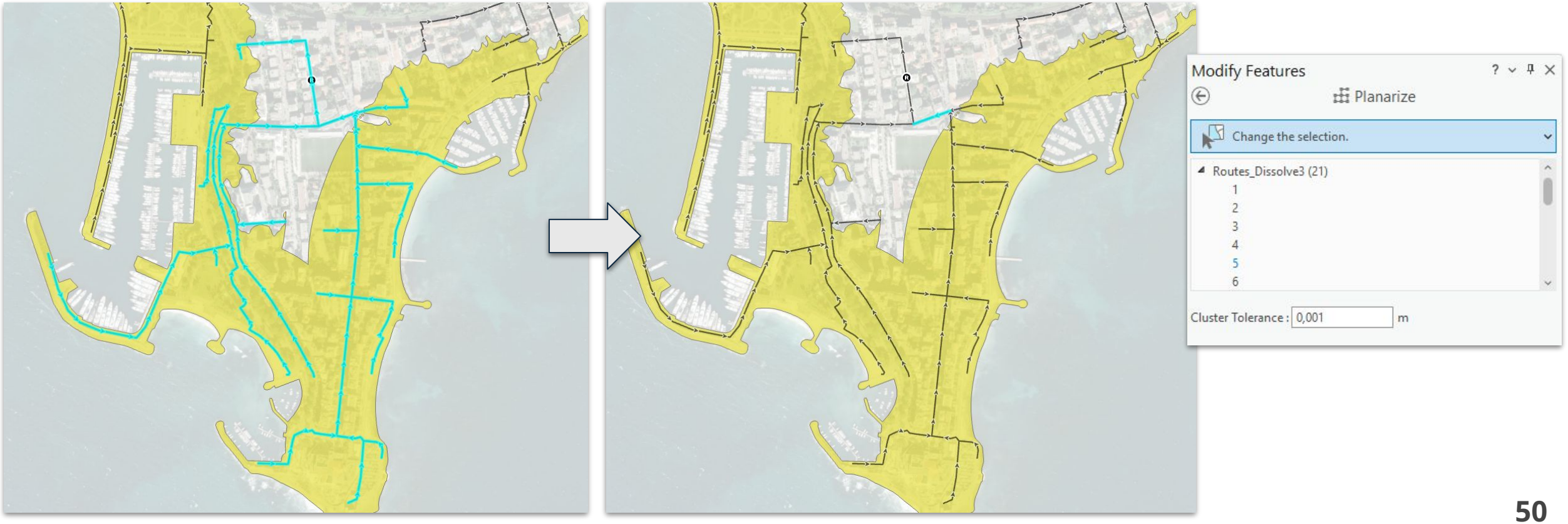




Output's correction and data's exploration

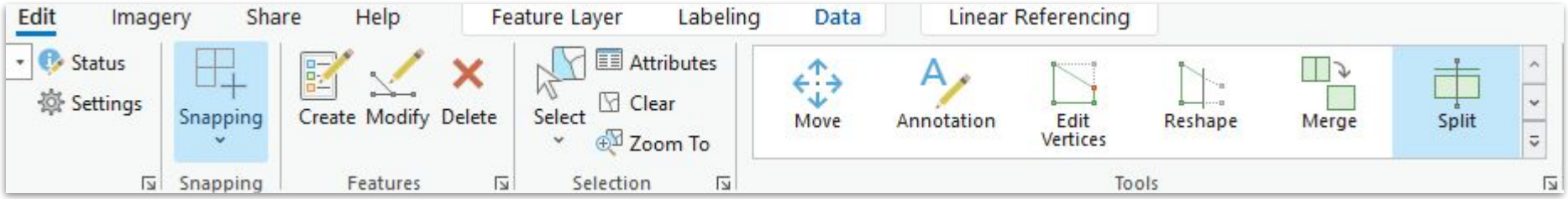
By merging feature based on a shared attributes, the **dissolve** tool can induce error in segments orientation.

In order to simplify the manual corrections easier, we need to split the dissolved routes with the **planarize tool** (Top ribbon > Edit > Tools). Less manual splitting operation will be required



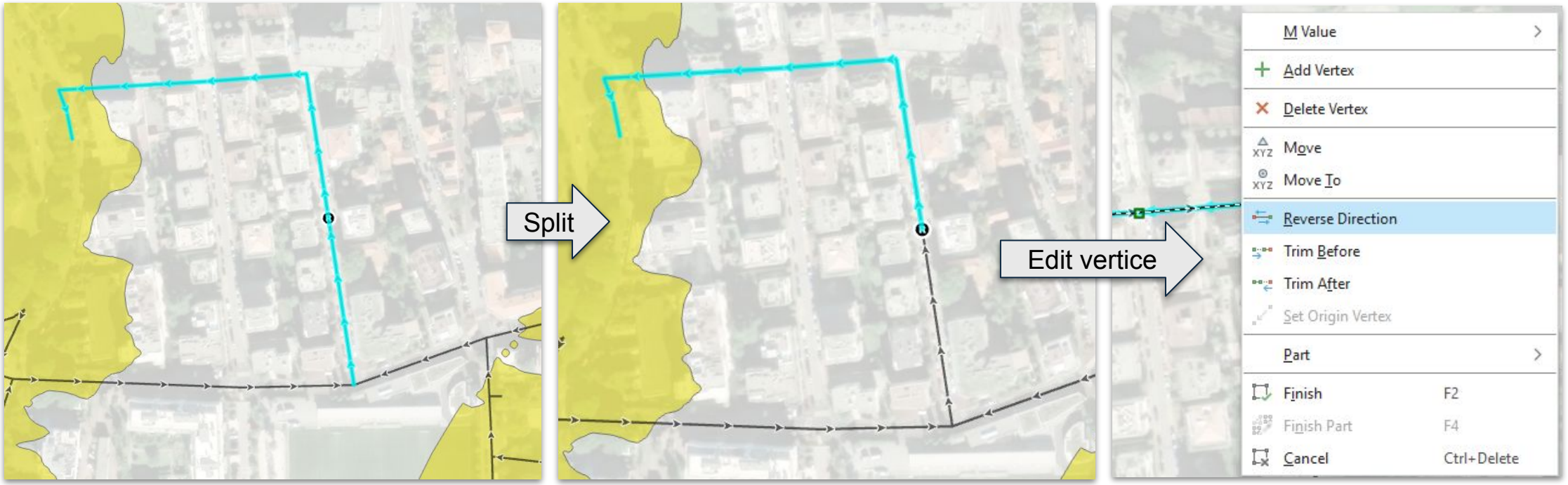
Output's correction and data's exploration

Changing segment's orientation is done manually. This step is also an opportunity to control the generated routes.



Two editing tools will be needed :

- Split
- Edit vertices



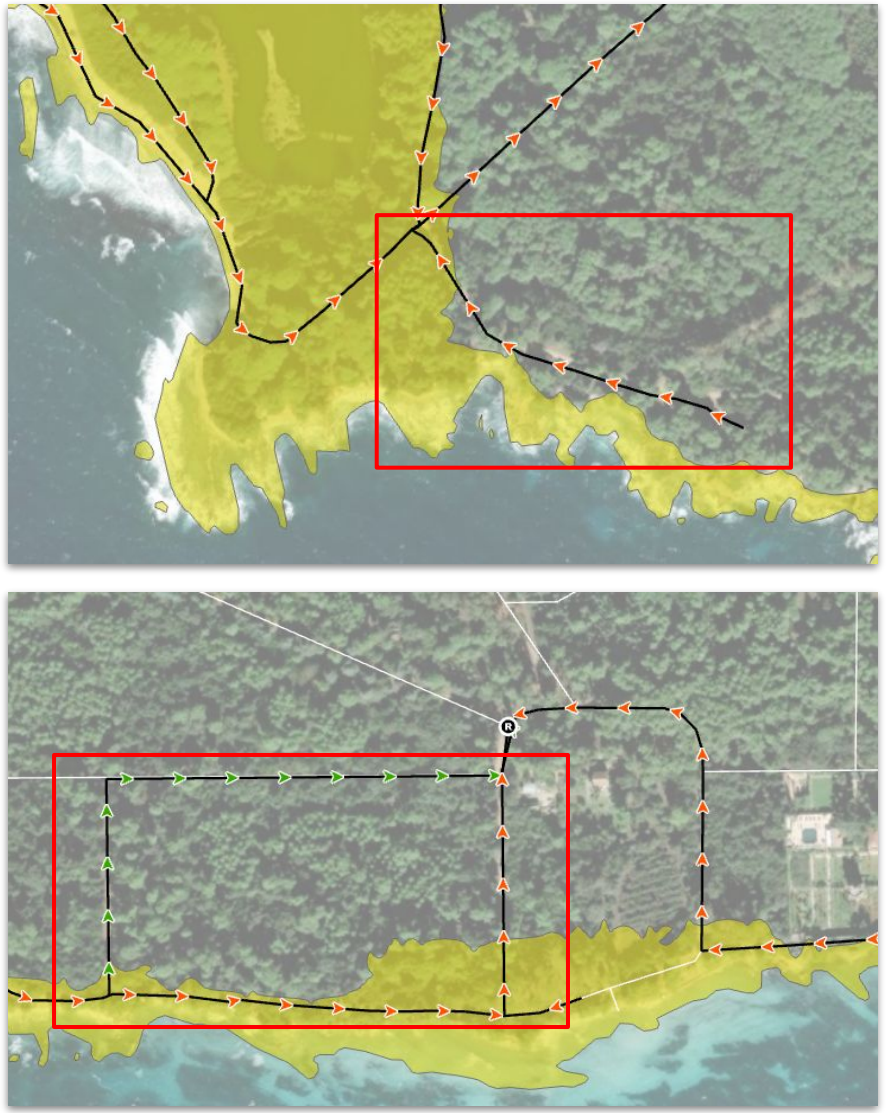
Output's correction and data's exploration

Removing or adding evacuation routes segment is often necessary

All routes must be inspected in order to guarantee that :

1. Once a route has left the evacuation zone, it cannot pass through it again.
2. Allow leaving the evacuation zone as quickly as possible.
3. Allow to get away from coast as quickly as possible.

Field inspection can be organized during tsunami exercices (tsunami walk), recruiting scholars, students, general public …
+ *Vérification des temps d'accès*
+ *Difficultés pratiques liées au terrain*



Other result useful for tsunami evacuation planning

- **Evacuation flow zones** for each tsunami assembly points can be identified once the network analysis has been conducted.
- The grid from which the starting points are derived allow a clear representation of the evacuation flow zone for the stakeholders.
- This grid is the basis upon which additionals geo-indicators will be built on, in order to provide meaningful insights to help the decision-making process.

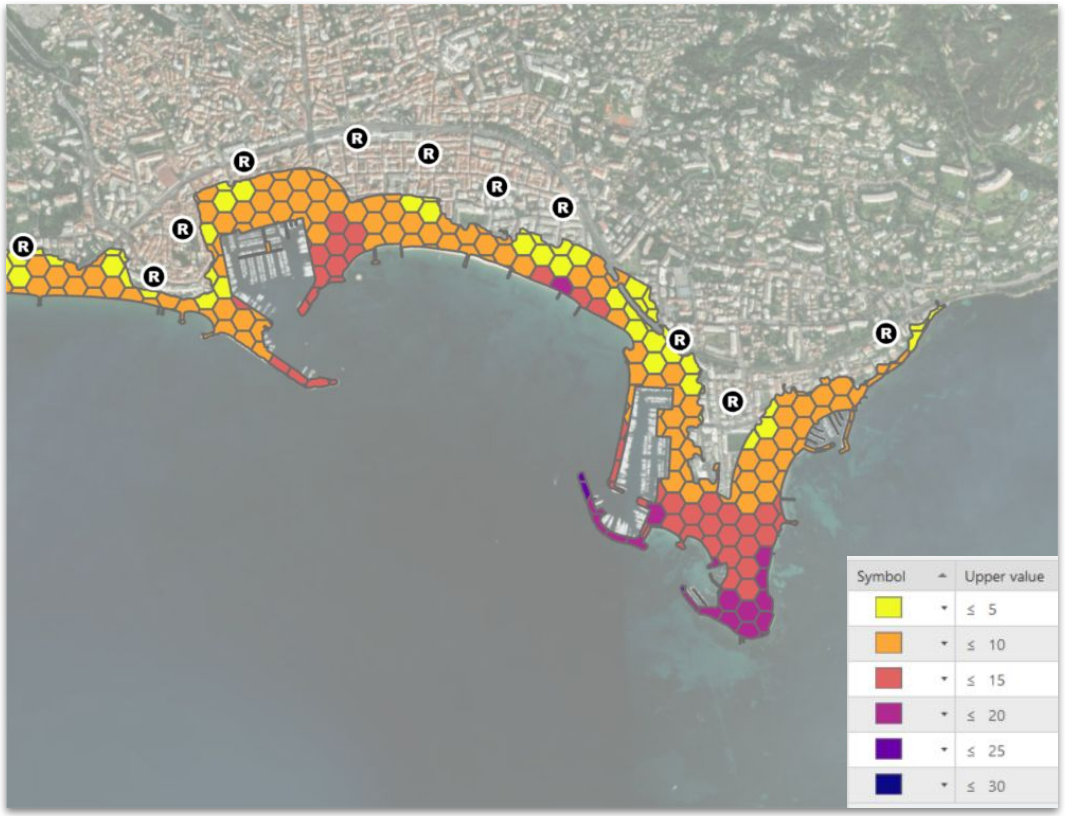
Evacuation flow zone for each assembly points

Other result useful for tsunami evacuation planning

- This cartographic result shows the **time required to reach a refuge site on foot** from each grid of the territory. It shows the areas where these times are longest, and therefore the sectors most at risk in the event of a tsunami.

- Set against the estimated time of arrival of the wave, this result reveals the **risk hotspots**. It guides planning choices: adjusting routes, increasing or relocating refuge sites.

- In the most critical areas, **targeted actions can reduce travel times**: lane openings, adapted equipment, better signage. Depending on the seismic context and topography, vertical evacuation solutions may also be considered when horizontal evacuation is not sufficient.



Evacuation travel time to reach tsunami assembly point *(minutes)*

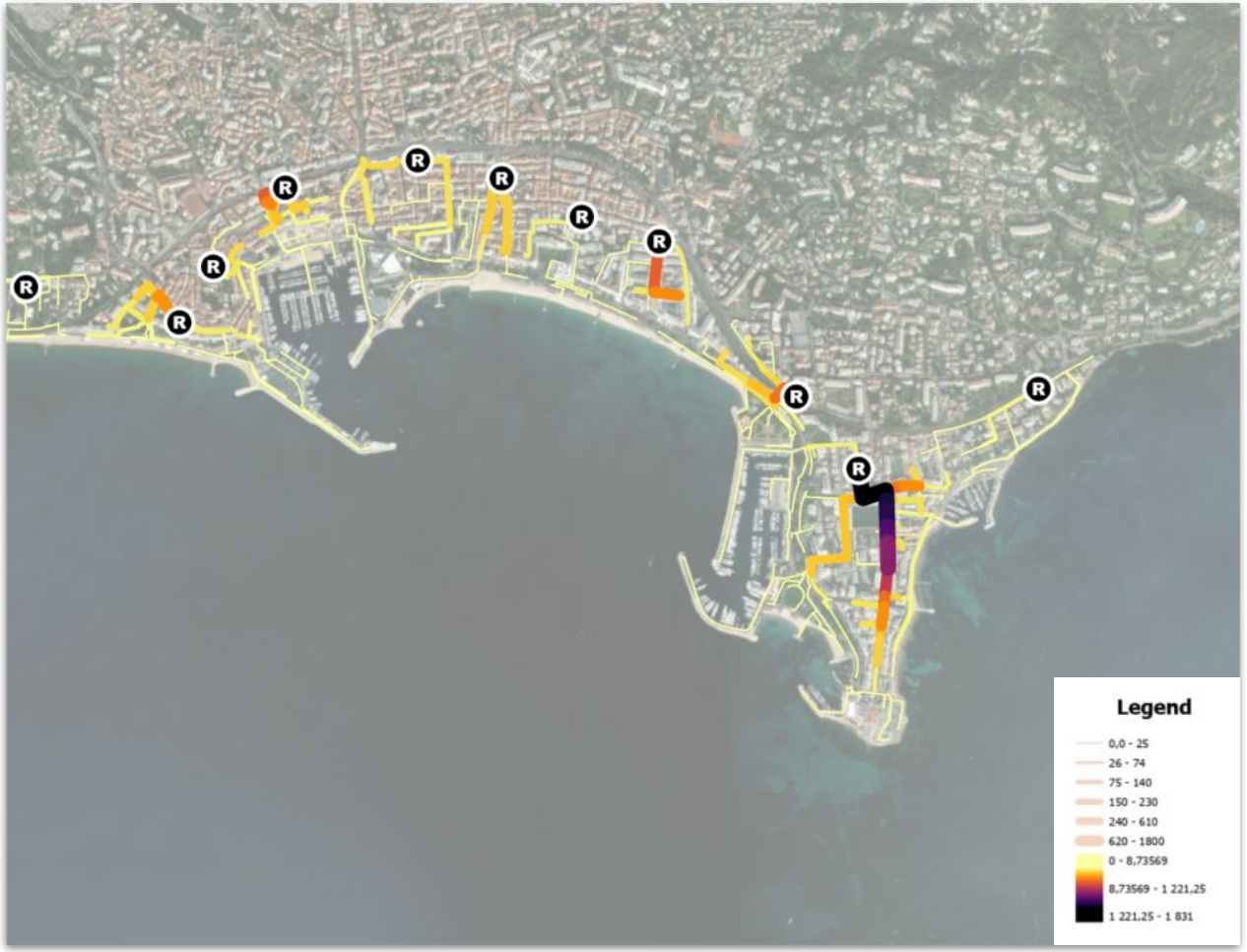
This is travel time, **not full evacuation time**, which also includes at least **warning** and **reaction time**.

Other result useful for tsunami evacuation planning

- **Data aggregation on the road network** can be conducted to visualize the spatial distribution of evacuation flow

- Therefore, in order to underpin this analysis, it is necessary to produce or obtain data regarding the spatial distribution of human population (e.g number of residents, beach's occupancy, with seasonal or daily variation).

- This cross-analysis allow for representation of theoretical number of people who are expected to use a specific evacuation route.



Example of a data aggregation on network segments. Based on the data from this exercise, it shows a number of housing.

Other result useful for tsunami evacuation planning

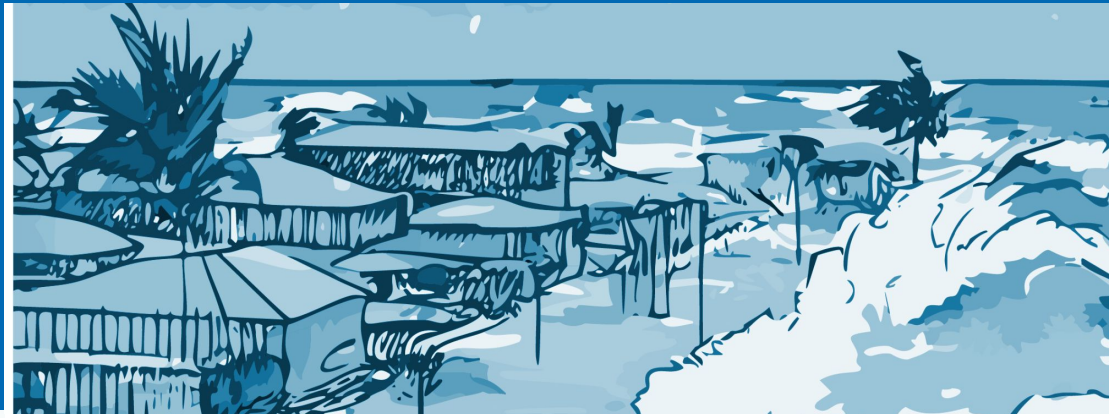
- **Theoretical number of people expected on a tsunami assembly point** is most of the time requested by the local authorities.

- The subsequent analysis provides support for the production of this geo-indicator.

- This final result can be achieved for a *worst case scenario*, or, depending on the available data, can be conducted for multiples scenarios, *e.g* :
  - Seasonal variation in the tourist population (high and low saison)
  - Day and night population variation on the most exposed area (*e.g* beaches)
  - Specific events (*e.g* festival, ceremony, sport events ...)

Theoretical number of housing expected on each assembly point

Tsunami Evacuation Mapping Workshop



CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

Dr. Matthieu Péroche
Louis Monnier

30 June – 4 July 2025

Contact : matthieu.peroche@univ-montp3.fr

unesco
Intergovernmental Oceanographic Commission

Funded by European Union Humanitarian Aid

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

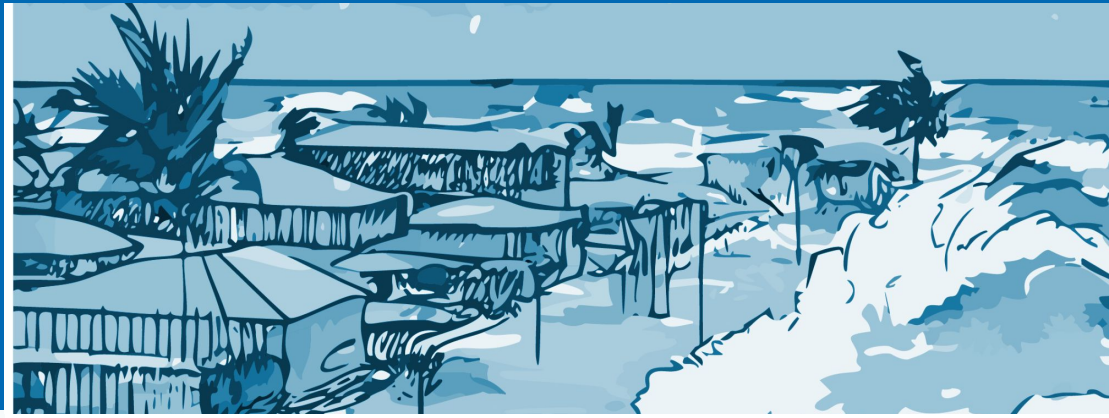
CoastWAVE NEAMTWS

LAGAM
LABORATOIRE DE GEOGRAPHIE ET D'AMENAGEMENT DE MONTPELLIER

Université Paul Valéry Montpellier 3

Tsunami Evacuation Mapping Workshop

30 June – 4 July 2025



CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

Dr. Matthieu Péroche
Louis Monnier

Lesson #4

Graphical semiology and map layout

Contact : matthieu.peroche@univ-montp3.fr

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CoastWAVE NEAMTWS

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Lesson's overview

Produce a set of easy-to-understand maps covering the entire study area

1. Theory

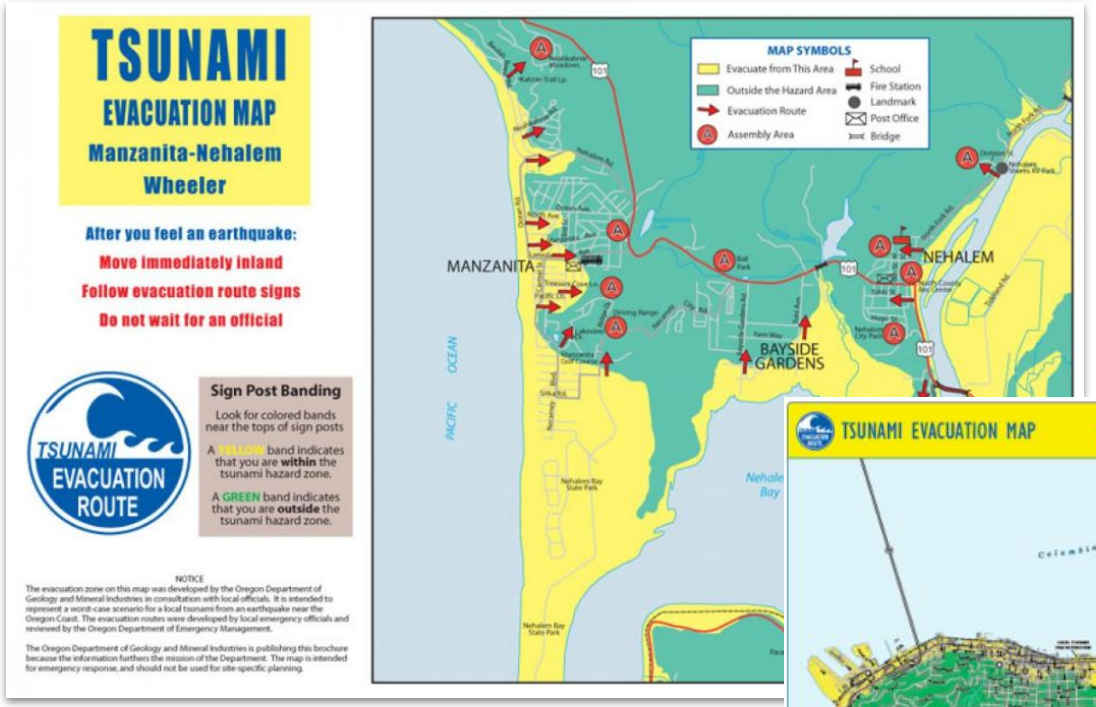
- Information displayed on an evacuation map
- Symbolisation
- Map scale

2. Practice

- Arcgis pro's layout composer
- Single map layout
- Atlas / Map series layout

Graphical semiology and map layout

Diversity of designs in tsunami evacuation map



From Kurowski and al, 2011

ion maps in Punta-Callao (Lima, Peru) provided by the Municipalidad Dis-
he Ministro de Defensa (b).

From Girres and al, 2018

Girres, J. F., Leone, F., Péroche, M., Gustave, G. & Gherardi, M. (2018). ***Analysis of tsunami evacuation maps for a consensual symbolization rules proposal***. *International Journal of Cartography*

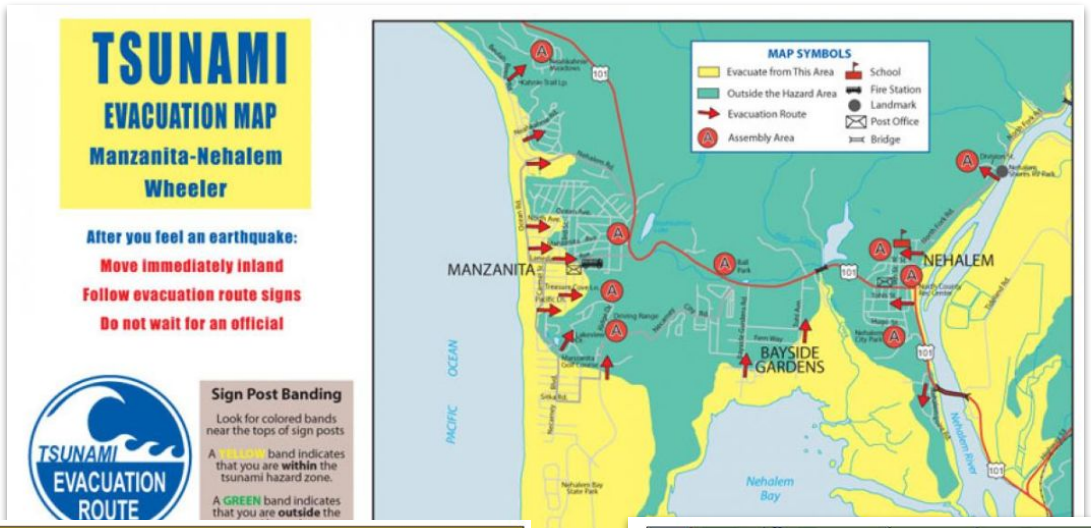
Information displayed on evacuation map

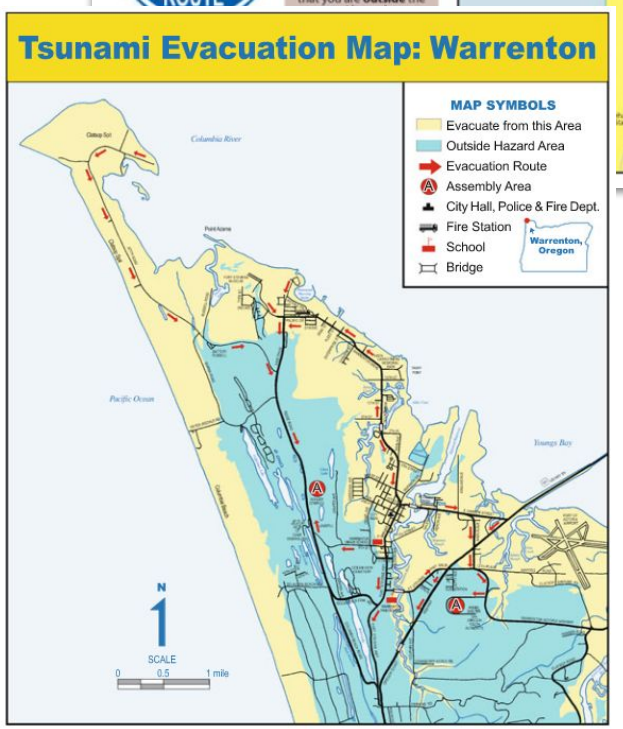
Most tsunami evacuation maps include :

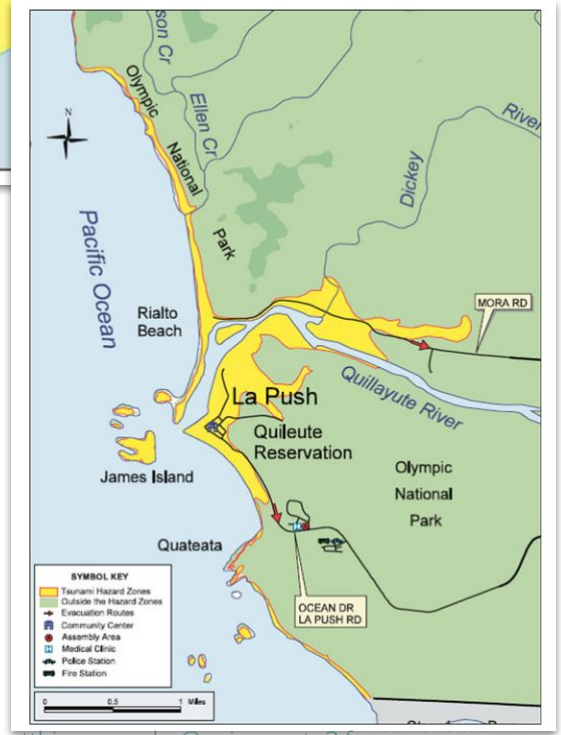
- **Hazard / evacuation zone**
- **Safe zone**
- **Assembly points (or areas)**
- **Evacuation guidance** (general direction or evacuation routes)

Within this frame, differents choices can be made for :

- **Symbolisation**
- **Color scheme**
- **Scale**
- **Textual informations**
- **Basemap**





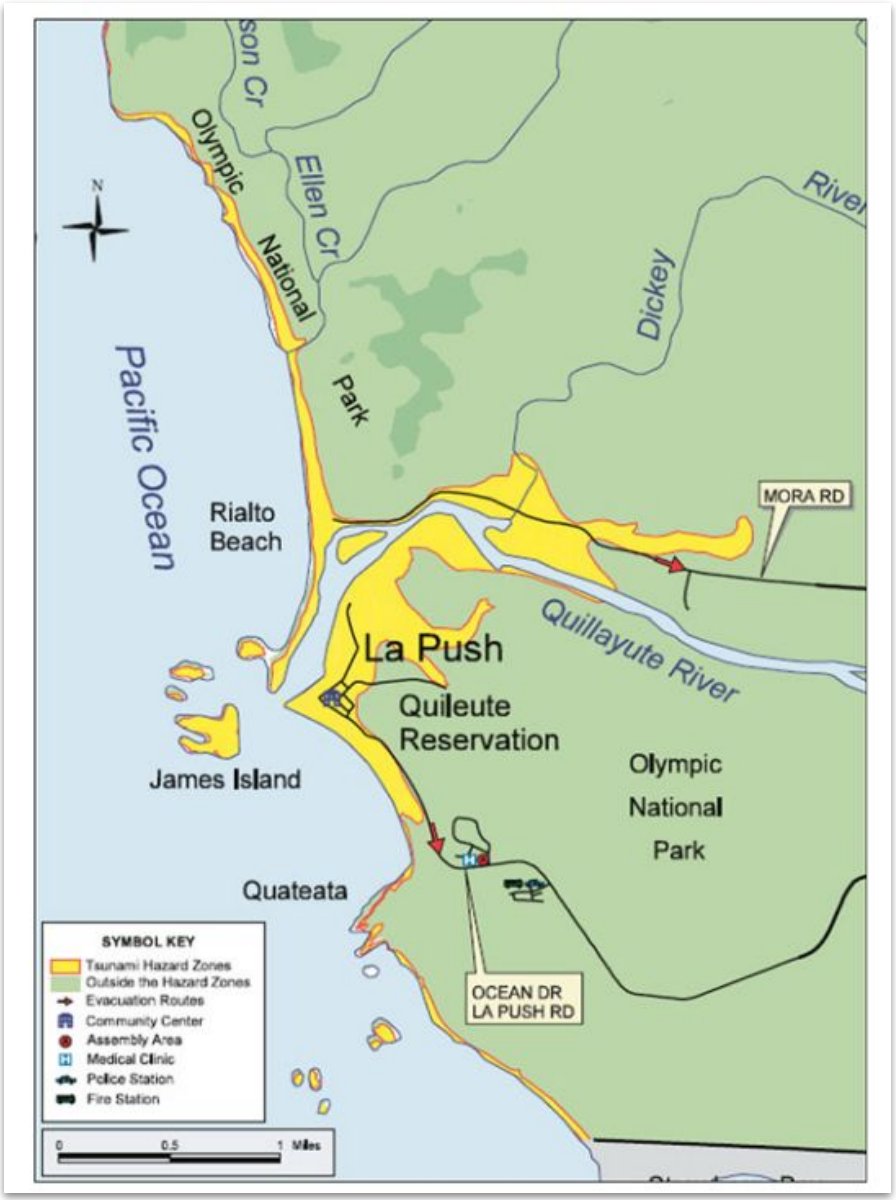


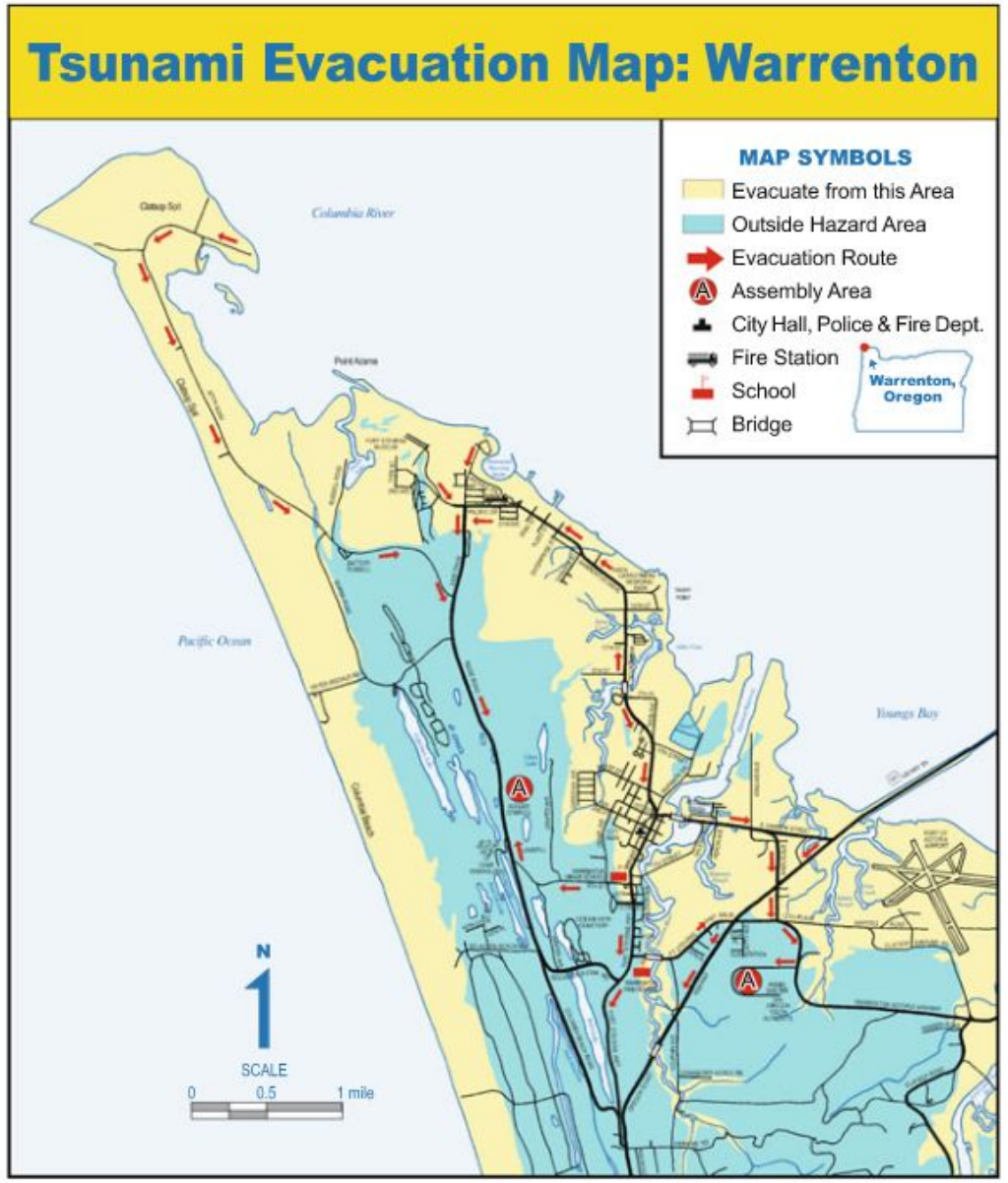
From Kurowski and al, 2011

Graphical semiology and map layout

Differences in :

- Scale
- Color scheme
- Assembly points/area symbol
- Infrastructure information
- Terrain information





From Kurowski and al, 2011

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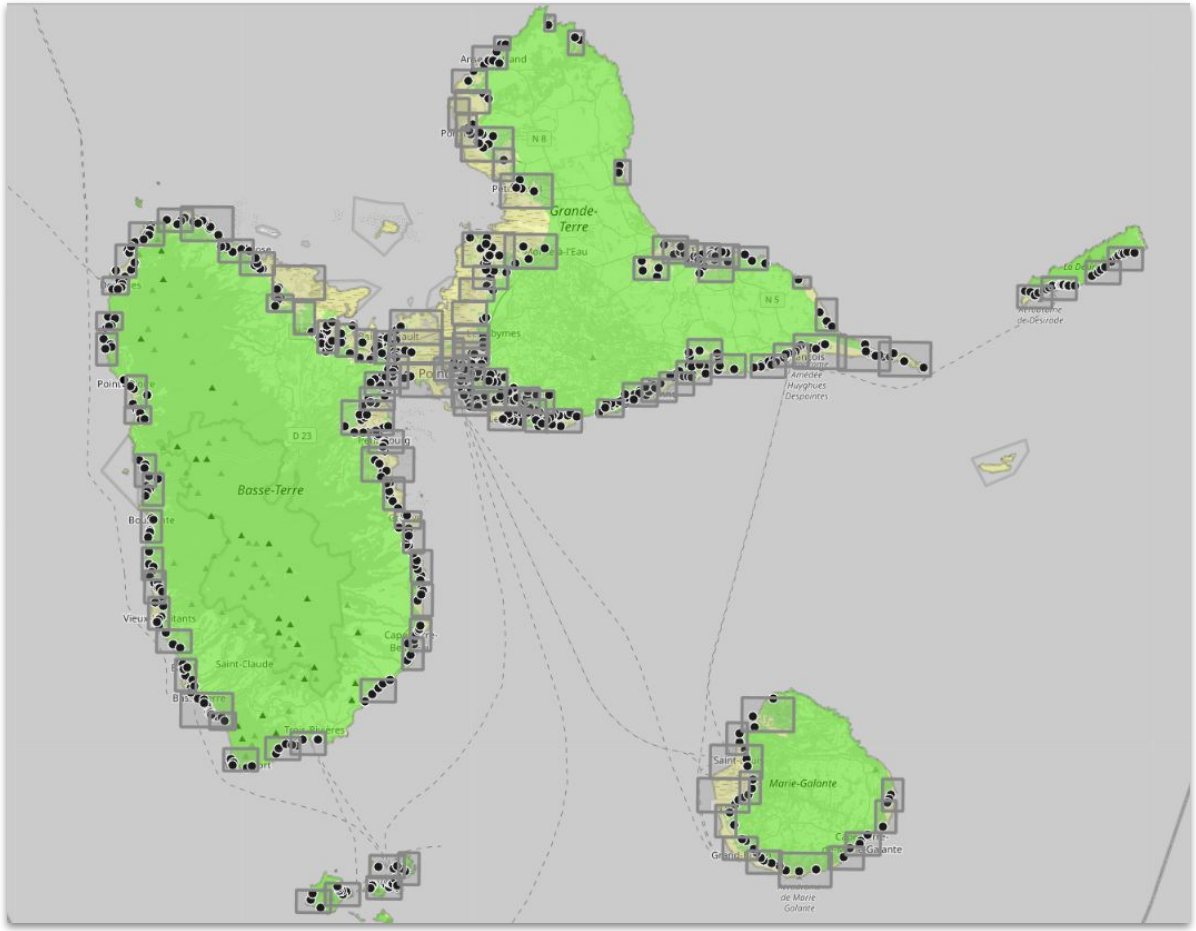
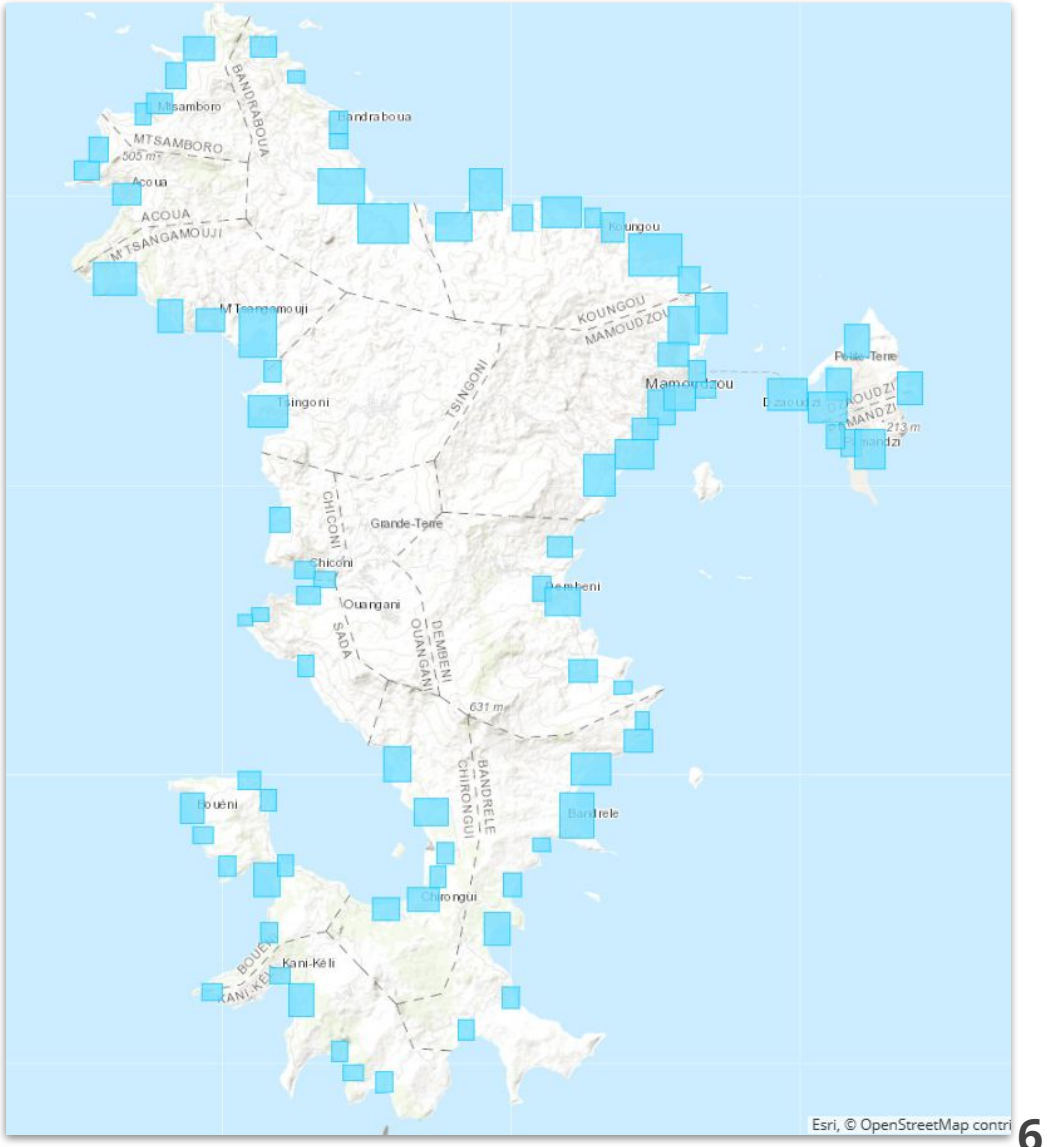
Information displayed on evacuation map

From a scientific research project, the **EXPLOIT project** (2016-2018) in the French West Indies proposed a cartographic chart for evacuation plans which, a decade later, has become a standard in France.



EXPLOIT

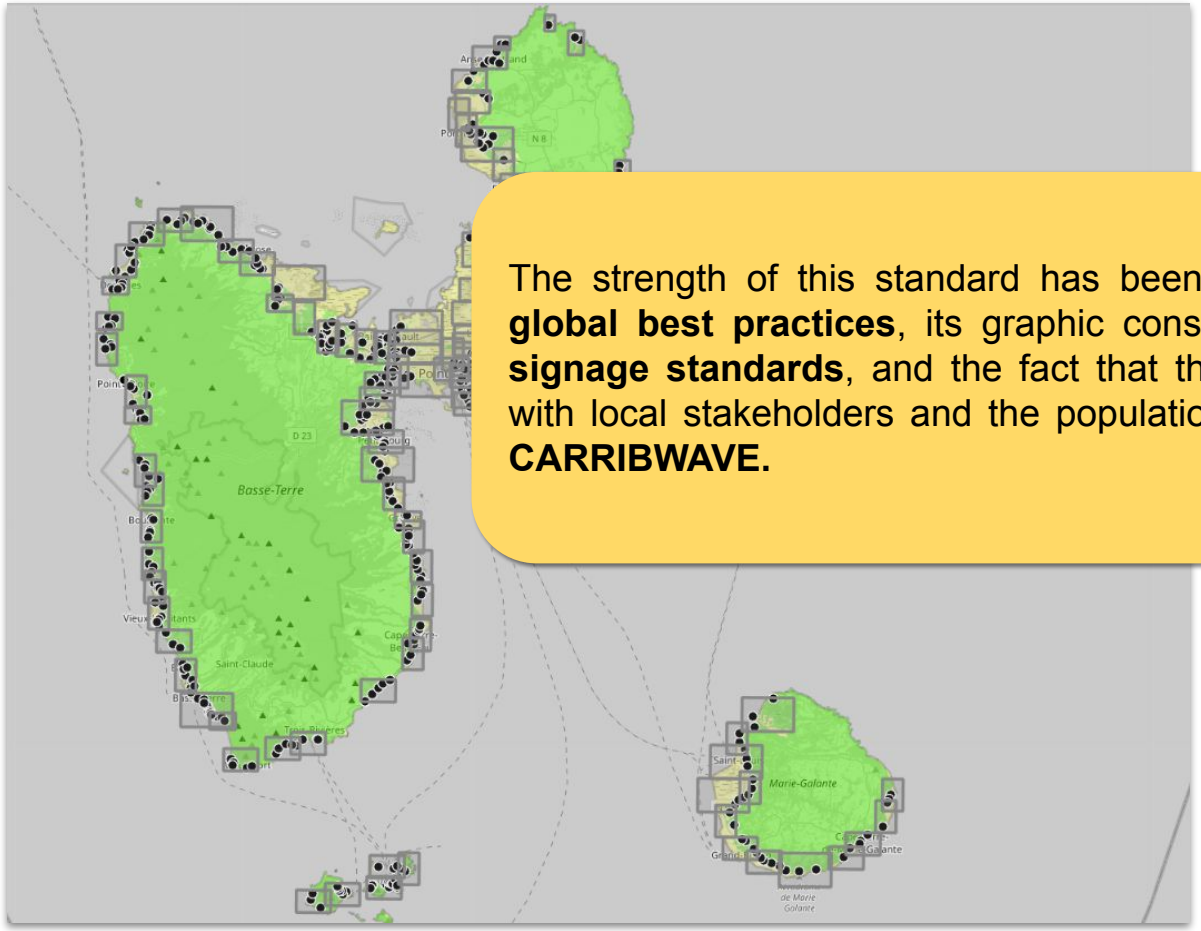
EVACTSU Mayotte



Graphical semiology and map layout

Information displayed on evacuation map

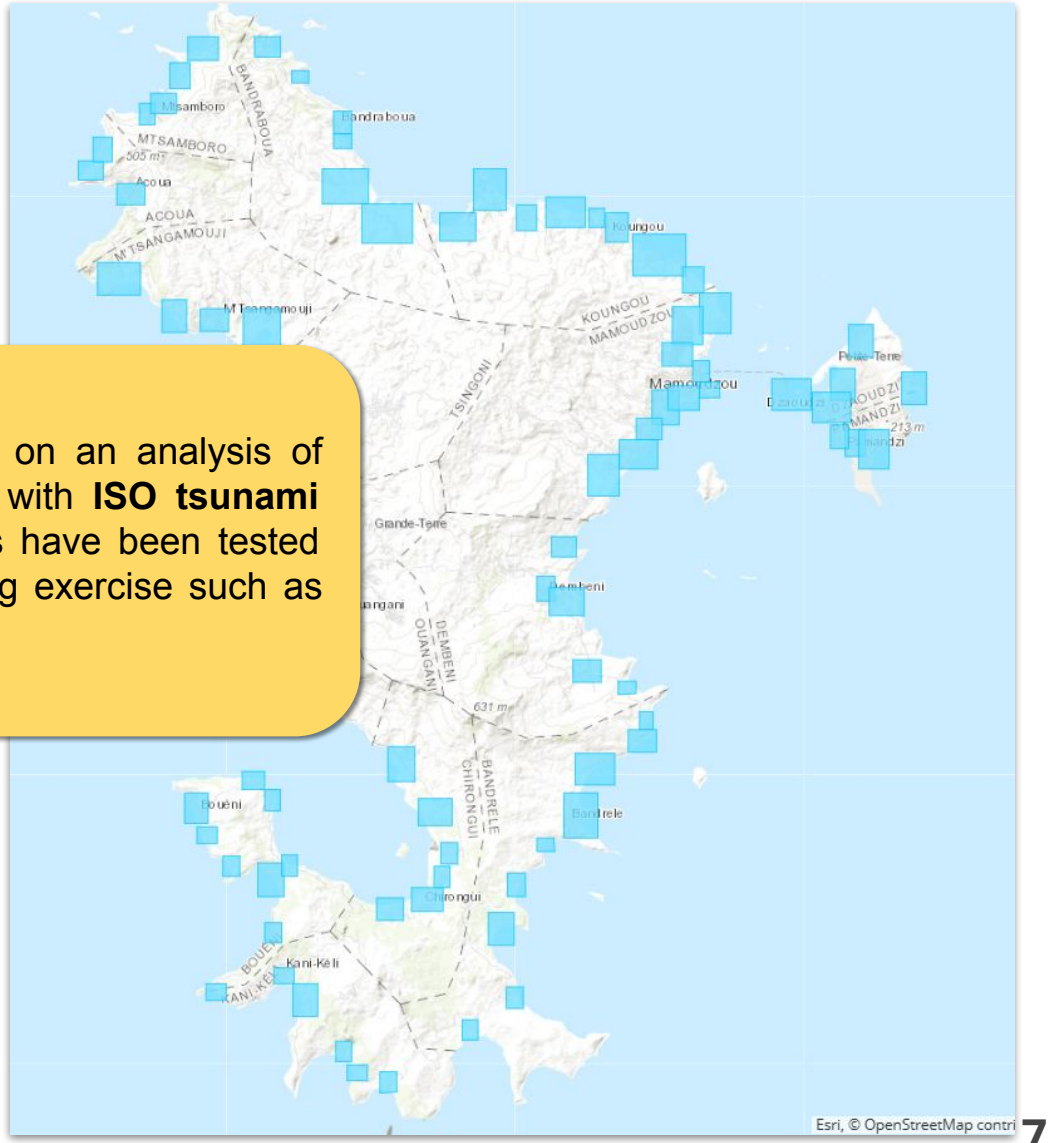
From a scientific research project, the **EXPLOIT project** (2016-2018) in the French West Indies proposed a cartographic chart for evacuation plans which, a decade later, has become a standard in France.



EXPLOIT

The strength of this standard has been based on an analysis of **global best practices**, its graphic consistency with **ISO tsunami signage standards**, and the fact that the plans have been tested with local stakeholders and the population during exercise such as **CARRIBWAVE.**

EVACTSU Mayotte



Graphical semiology and map layout

Information displayed on evacuation map

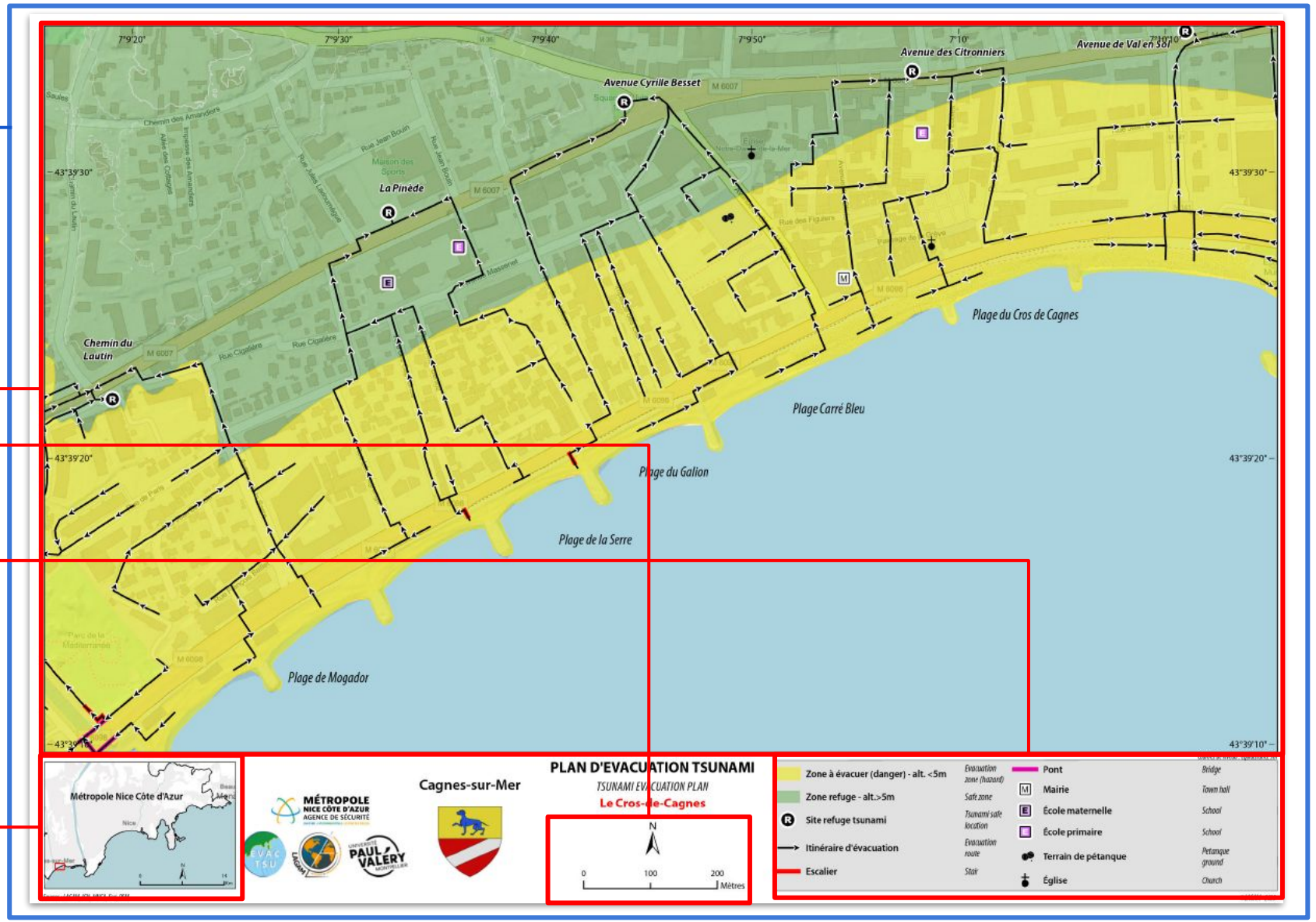
Layout

Map Canvas

Scale bar & north arrow

Legend

Overview map



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Graphical semiology and map layout

Information displayed on evacuation map

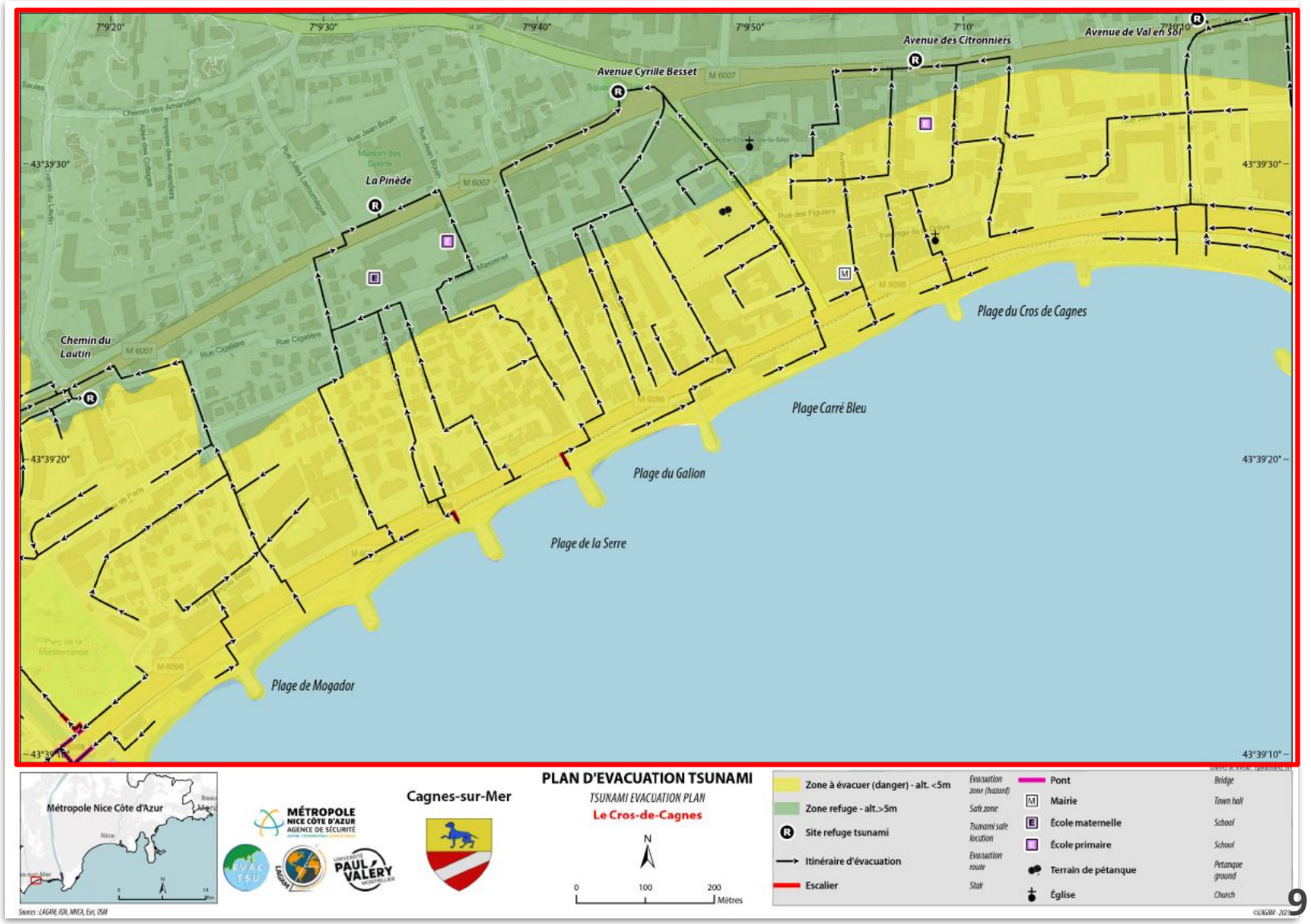
Map produced by the LAGAM (*Montpellier's geography and urban planning laboratory)* include :

Graphical infomations

- Safe zone
- Evacuation zone
- Evacuation routes
- Assembly points
- POI

Textual informations

- Assembly points names
- Toponymy



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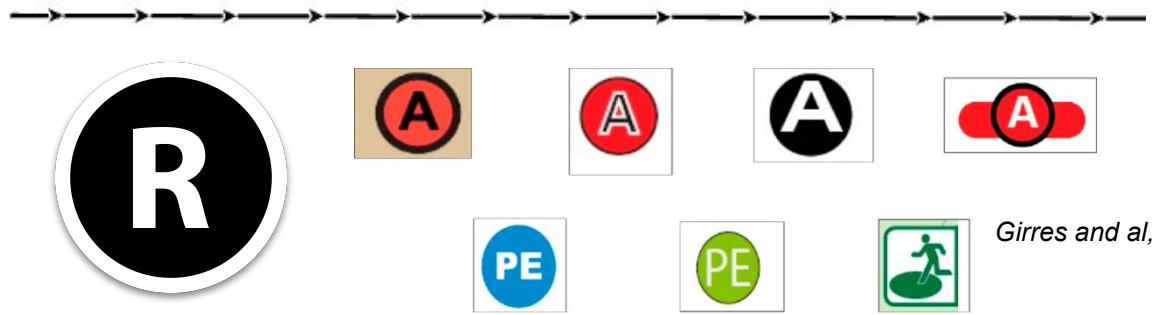
Symbolisation

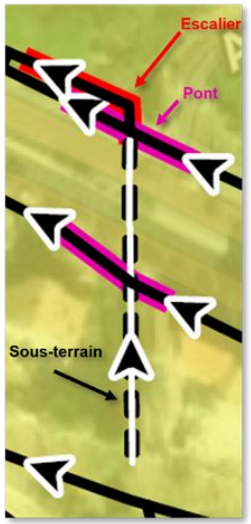
Graphic choices for symbols must allow for a **clear and quick understanding** of the map information.

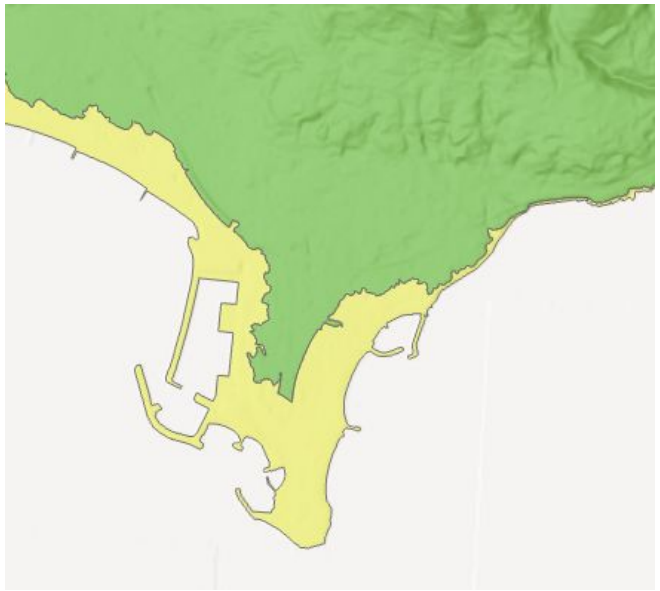
- **Simplicity** and **explicitness** are key in symbols choices, especially for the evacuation related information displayed on a map.
- For symbols with multiples colors, they should be chosen with a **high contrast level.**
- High-contrast color choices must take into account the superimposition of other (surface) symbols.
- Transparency use is limited to evacuation zone and safe zone in order to display the **basemap with elevation shading.**



Girres and al, 2016

For Nice's metropol, multiple variations of the symbol evacuation route were proposed to represent **underground sections**, **bridges** and **staircases;**



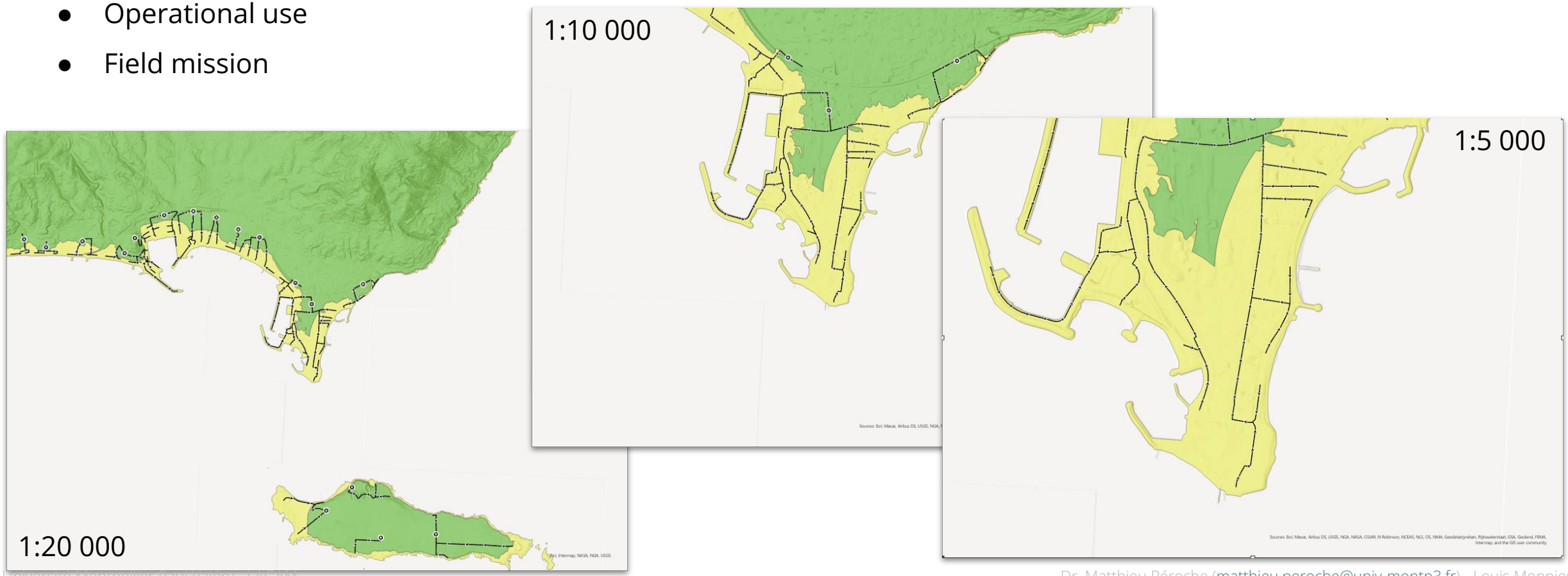


Graphical semiology and map layout

Map scale

Scale must be chosen accordingly to match data's accuracy and the purpose of the map :

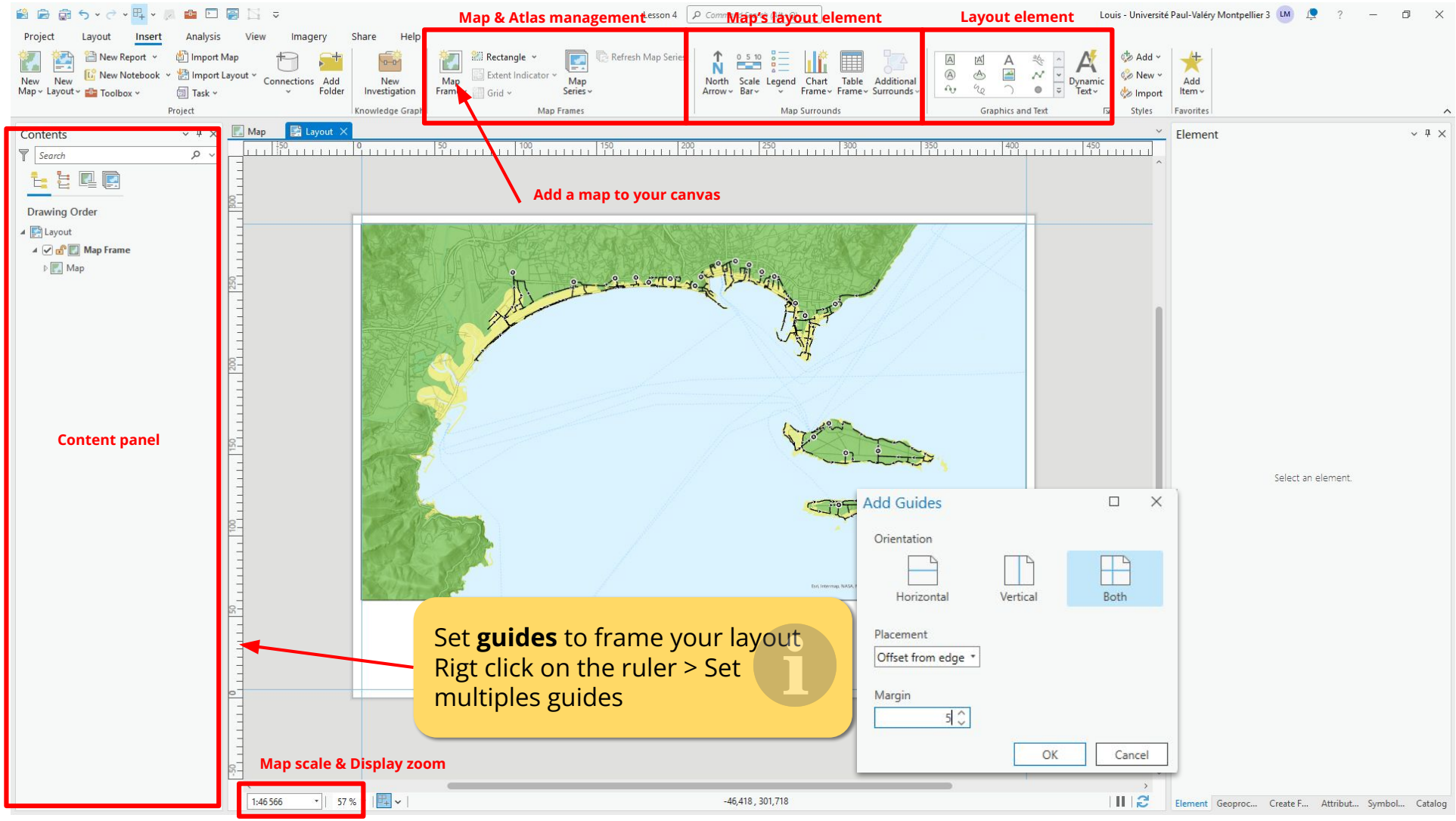
- Information / sensibilisation map
- Decision making support
- Operational use
- Field mission



Graphical semiology and map layout

Arcgis pro's layout composer

Go to **Top Ribbon** > **Insert** > **New Layout** and select a page size (A3 landscape)



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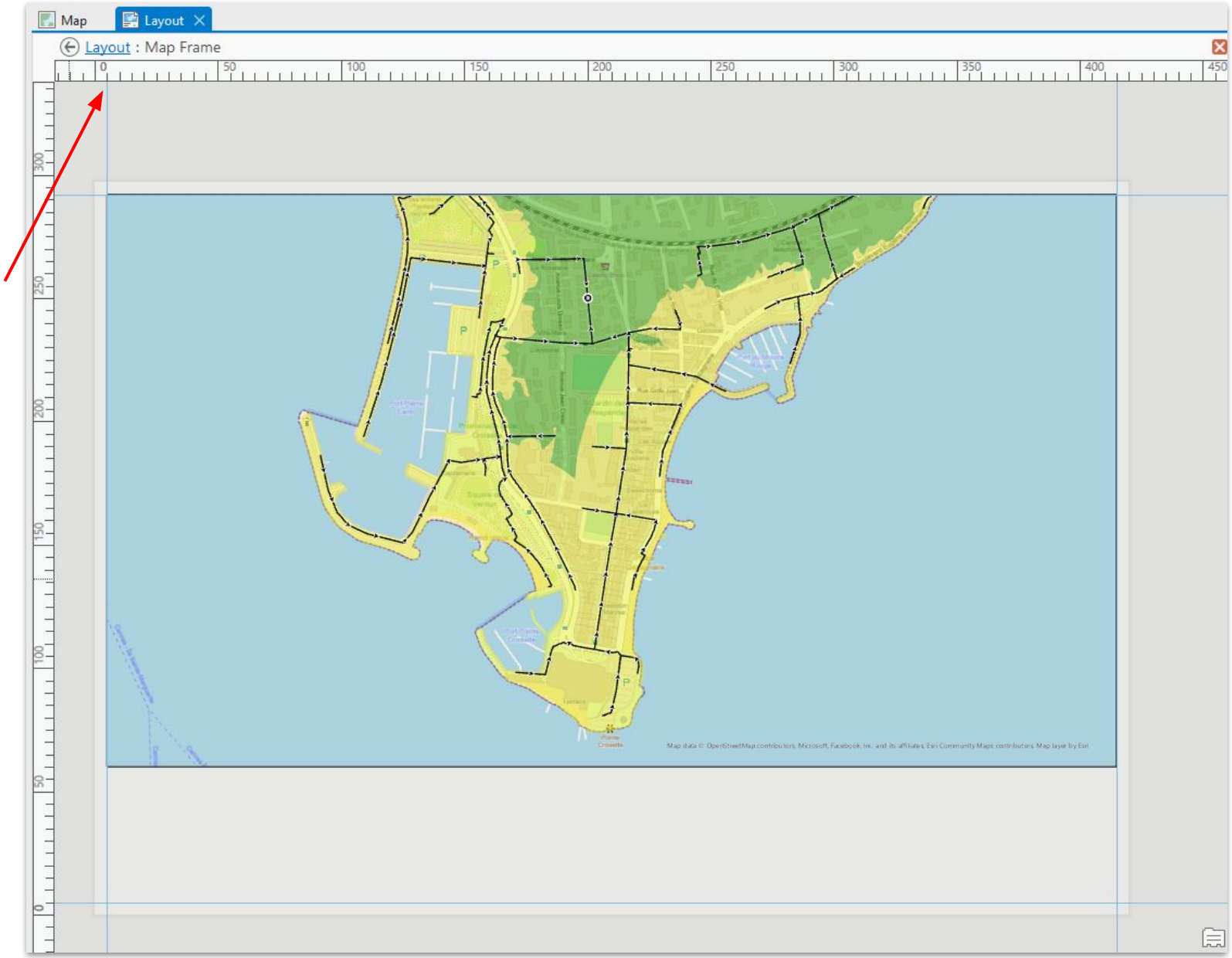
Arcgis pro's layout composer

Set your map canvas extent :

1. Right click on your map > **Activate** (Q)
2. **Pan** and **set the scale** with mouse wheel or with the bottom ribbon.
3. Click on **Layout** to return to layout edition

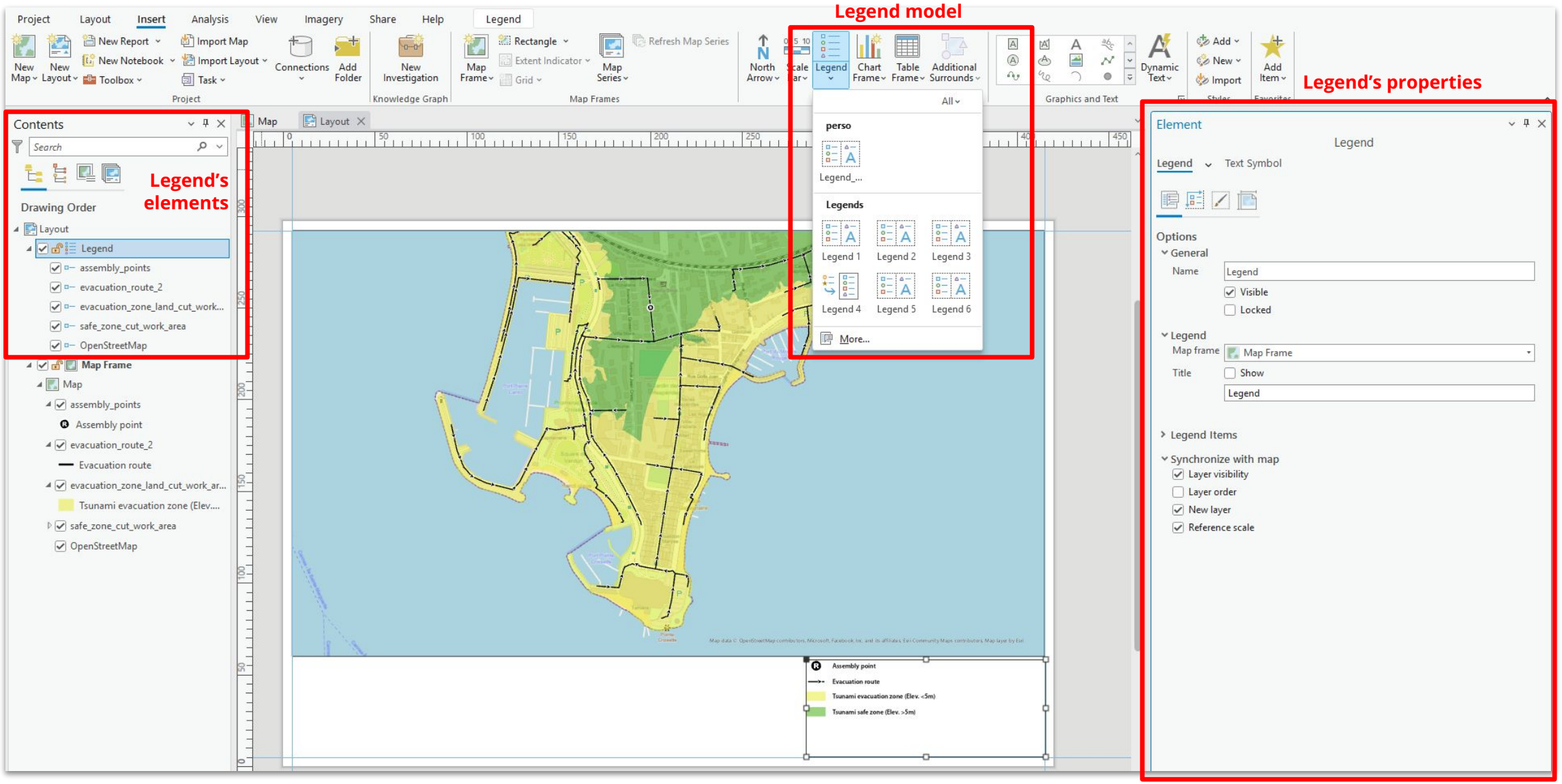
Make sure that all the the evacuation routes pointing to an assembly point are visible in the map extent.



Graphical semiology and map layout

Single map layout

- Add the map's legend



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Single map layout

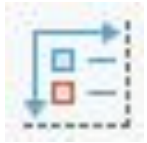
You can customize legend's behavior and legend's appearance either at a global level or at element's level.

Access the **legend's properties panel** directly in the layout or in the Contents panel through 4 menus :

Right click > Properties

General text symbol (font type, size, color, decoration ....)

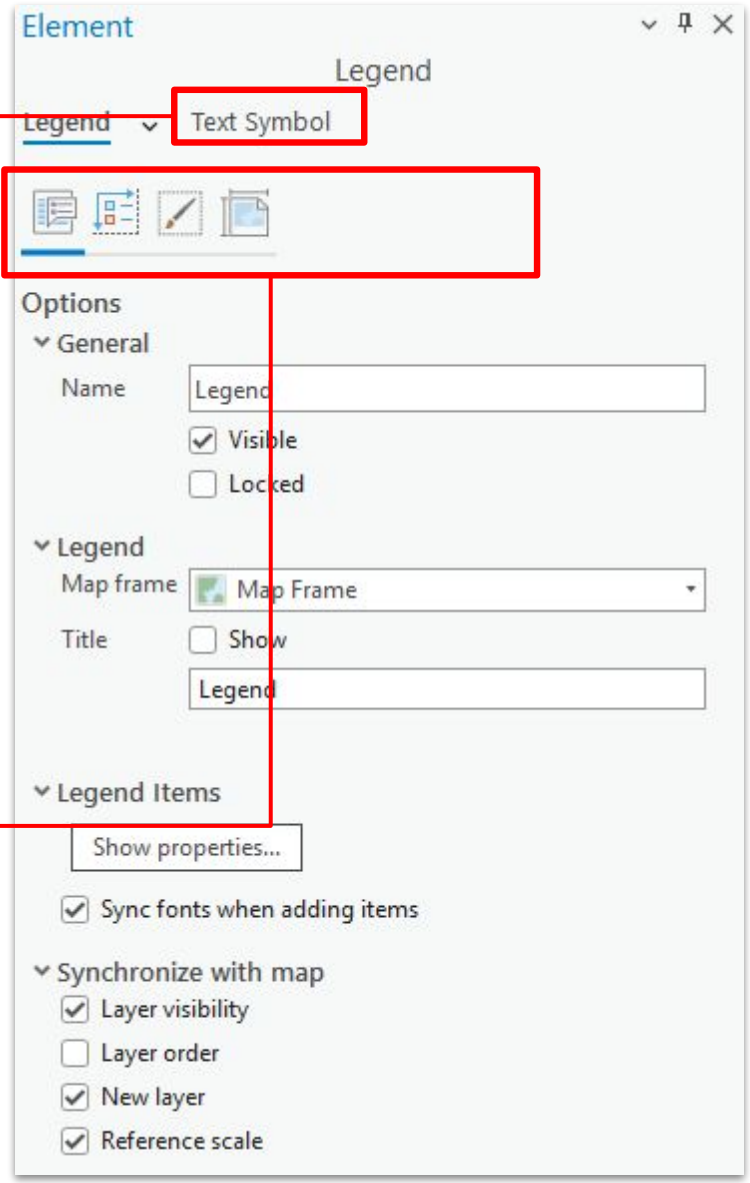
- Map connection
- Title
- Layers orders synchronisation with the map



- Automatic column and font size adjustment
- Word wrapping
- Spacing between legend elements

- Border
- Background
- Shadow

- Position



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Single map layout

Appearance can be changed for a specific elements, or multiple elements at once :

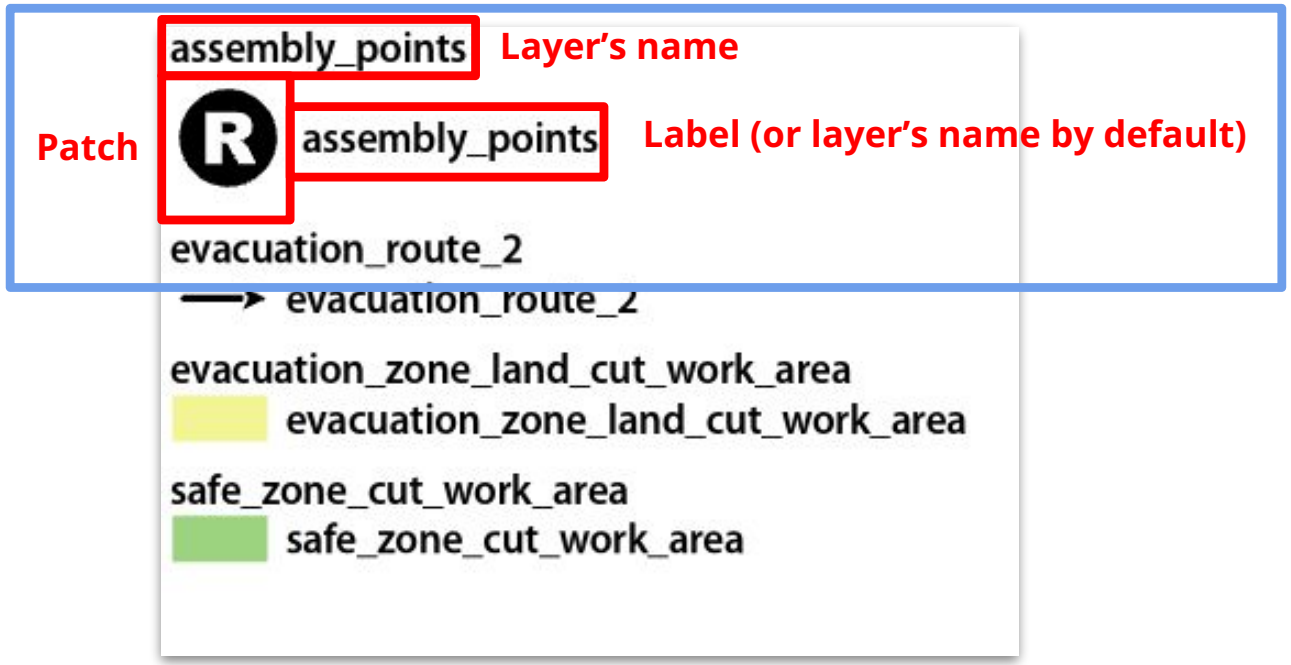
Option 1 :

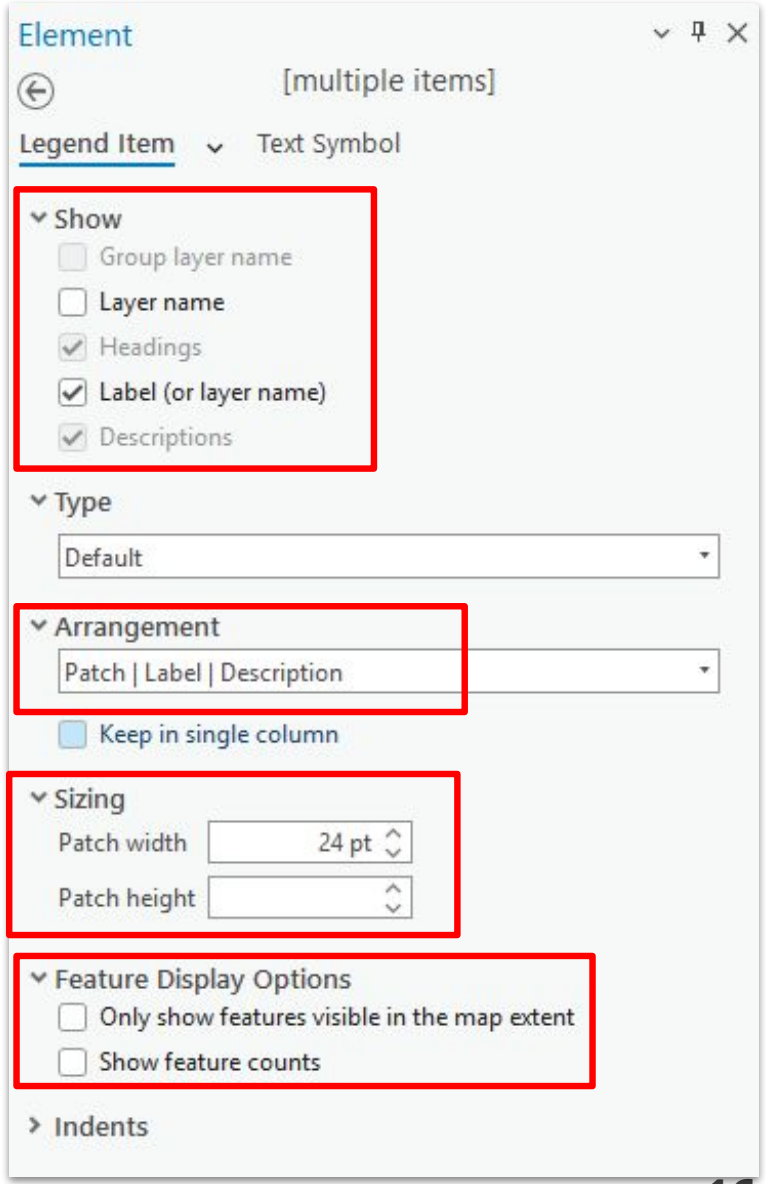
Select either one, multiple or all legend's element in content pane > **Right click** > **Properties**

Option 2 (for all legend elements)

In the **legend's properties panel** > **Legend items** > **Show properties**

Item



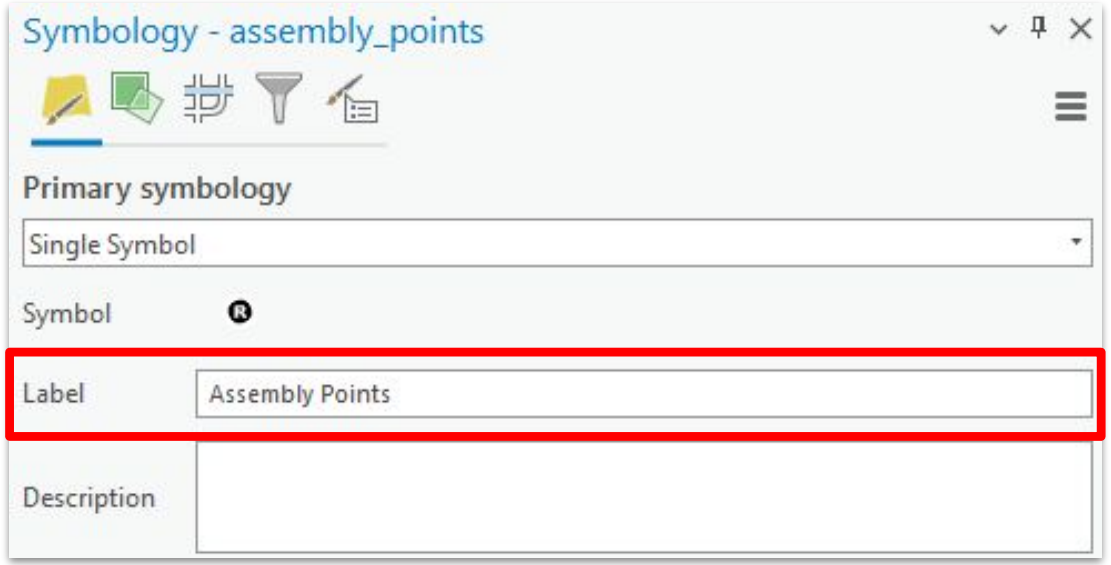


Single map layout

Element **labels** can be set in the **symbology menu** of the corresponding layer.

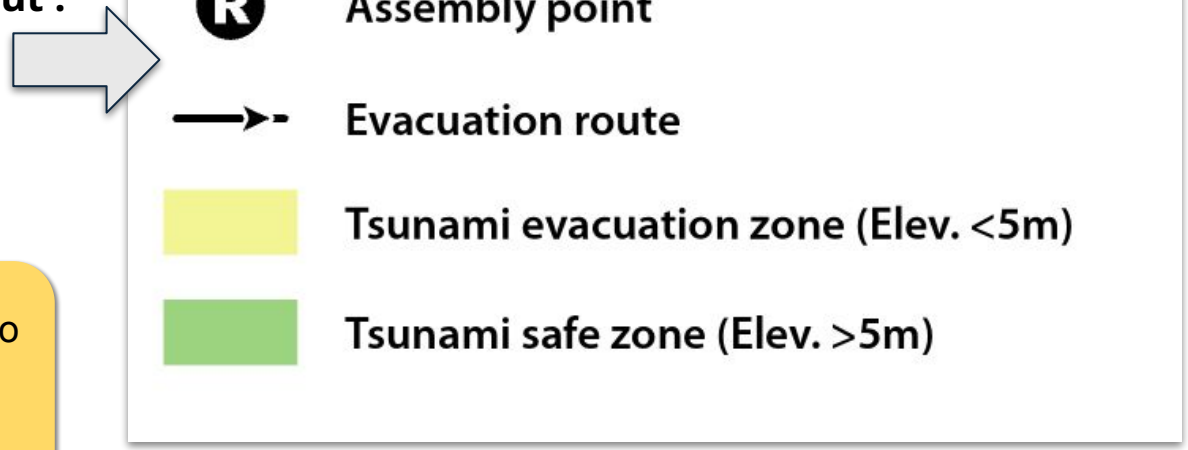
- If no label is set, the layer's name is displayer by default.
- **Description** can also be shown in the legend.

Contents panel > **Map Frame** > **Right click** on the layer > **Symbology**



Change the appearance of your legend in order to match this layout :

1. Set the label for each layer
2. Set a bigger patch size for every legend's elements
3. Set the legend's spacing



You can save your legend's style or any element's style to use it in another project or to use it by default :

Contents panel > **Right click** on Legend > **Save to style**

Single map layout

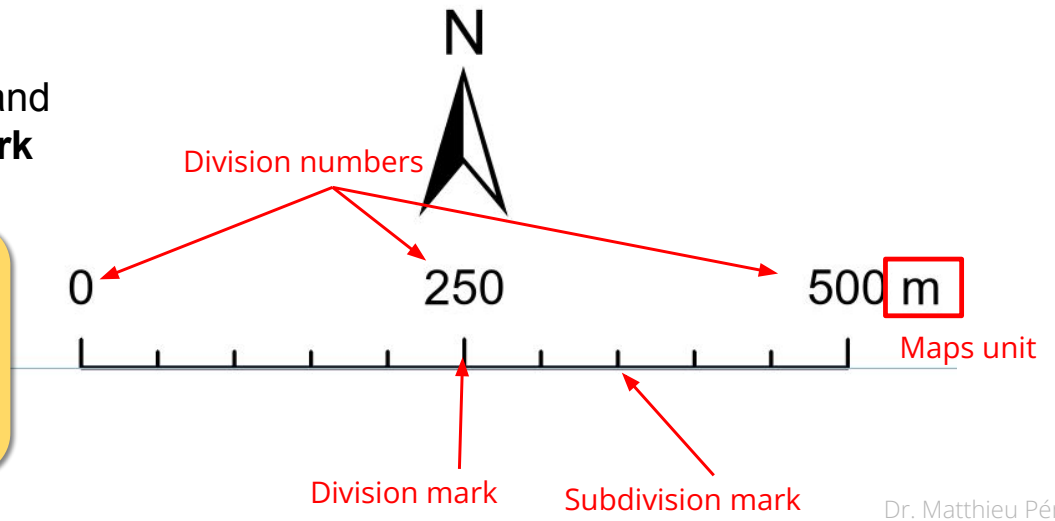
Like the legend, the north arrow and scale bar are **connected to a map frame**. They adapt dynamically to changes in the map's scale or orientation, and **fitting strategies** can therefore be used to determine how these elements respond to changes.

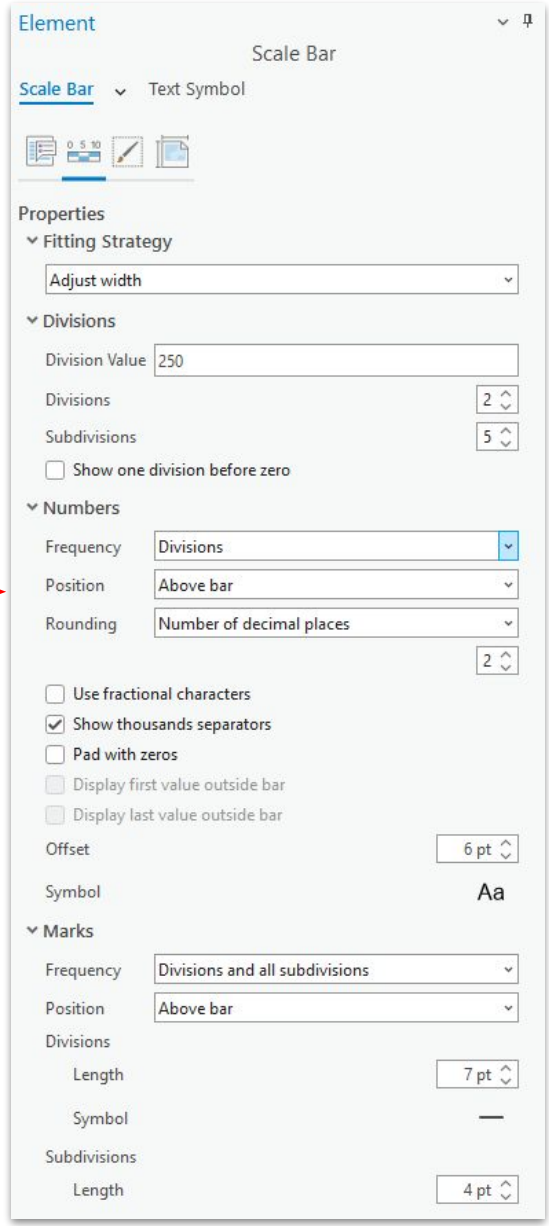
Numerical scale can be added via **Top Ribbon > Dynamic text**

Add the north arrow and scale bar to the layout to match the layout below. Align these two elements with each other and the page.

1. **In the Scale Bar Properties panel**, set the map unit in meter and change the label position
2. Set the **division value** to 250
3. Change **marks frequency** and reduce the **subdivision's mark height**

Try out the different fitting strategies available and adjust the map scale to see how the scale bar reacts.



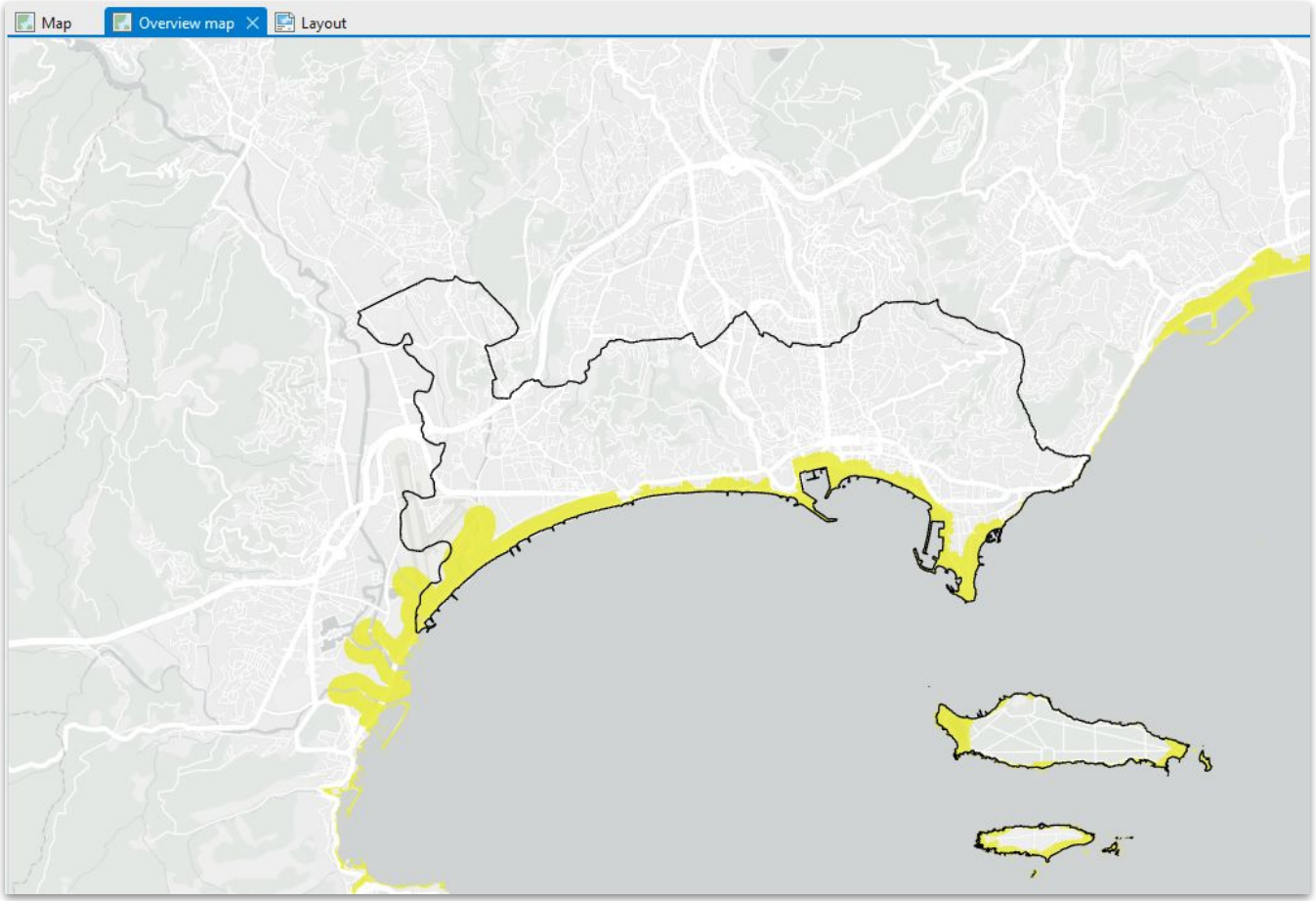


Single map layout

Overview map are used to display **main map's context**. The main map's extent is often shown with a shape marker.

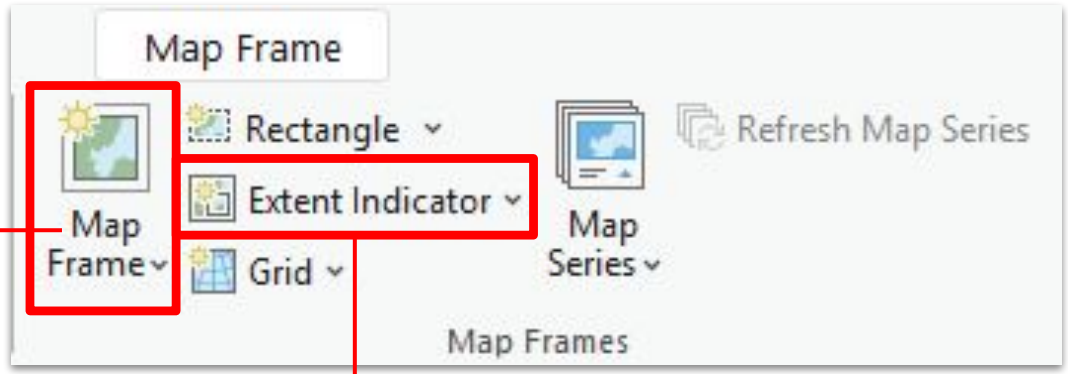
Since the overview map's frame is smaller, we need to create a map with less layers in order to ensure readability

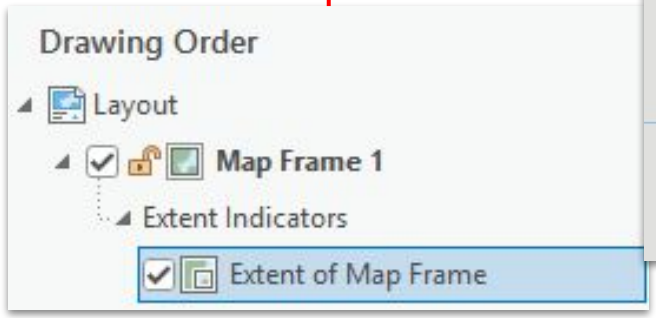
1. **Top ribbon** > **New Map**
2. Rename it in *Overview map* in the **Contents** panel
3. Choose a minimalistic basemap : **Top ribbon** > **Map > Basemap**
4. **Add** Cannes administrative boundaries and the evacuation zone layers



Single map layout

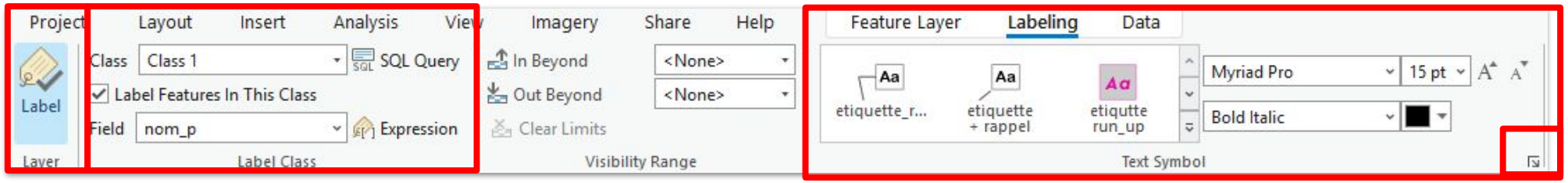
1. Go back to the **Layout** tab
2. Click on **Map Frame** and choose the overview map
3. Add it to your layout
4. In the **Extent indicator** option, choose **Map Frame**
5. Set the overview map extent and scale
6. In the **Contents** panel, select the **Extent Indicators** > right click > Properties
7. Customize the extent indicator to make it stand out



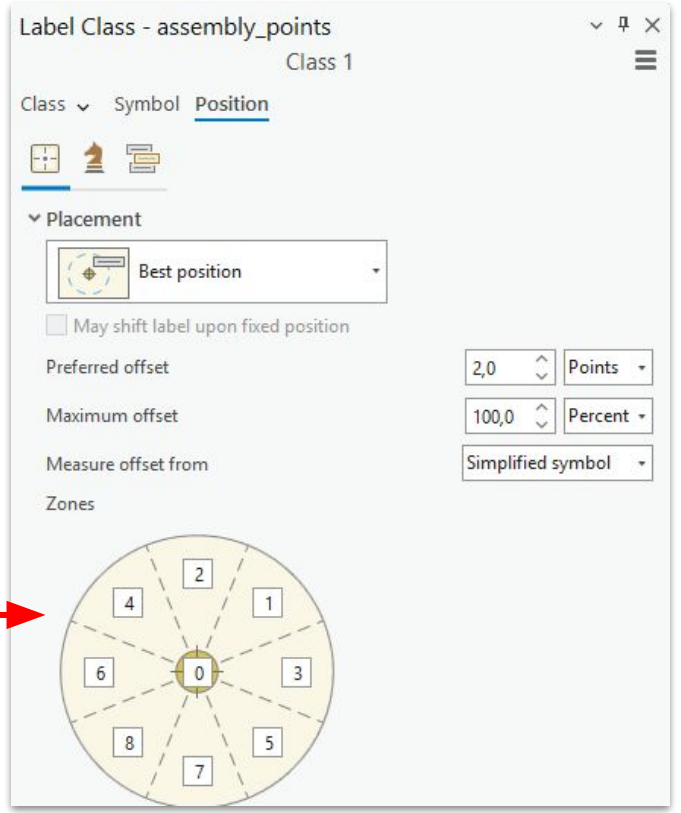


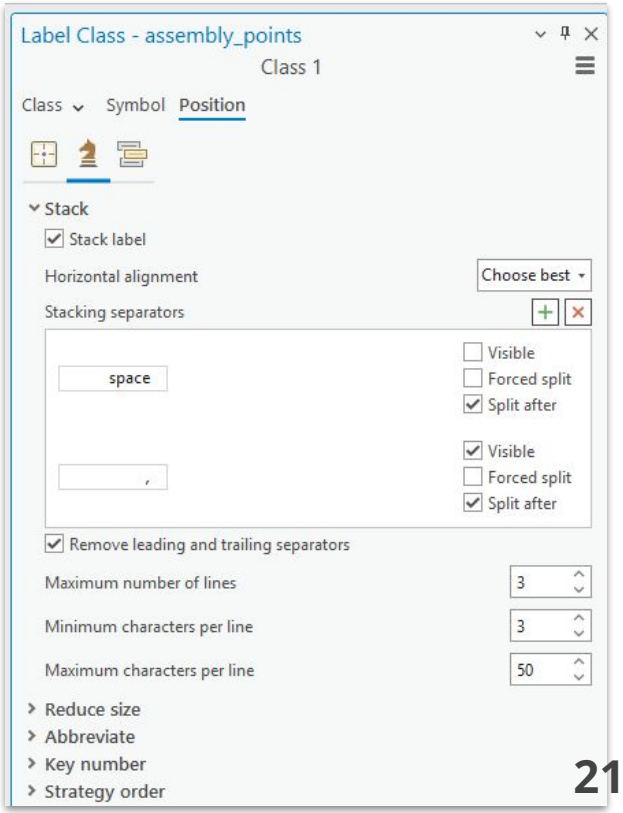
Single map layout

Labels are text elements used to display an attribute's value for each layer's feature. Assembly point name must be **labelled** on the evacuation map.



- In the **Contents** panel, select the Assembly point layer.
- **Top ribbon** > **Labelling**
- In the **Label Class** menu> **Field**, select the assembly point name's field (***nom_p***)
- Activate labelling with **Label** in the **Layer** menu
- Customize label's appearance and position by expanding the **Text Symbol** menu
- Advanced position parameters are available to set preferred placement, display order and label's fitting strategies (world wrap, abbreviation field, number of lines ….)





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Graphical semiology and map layout

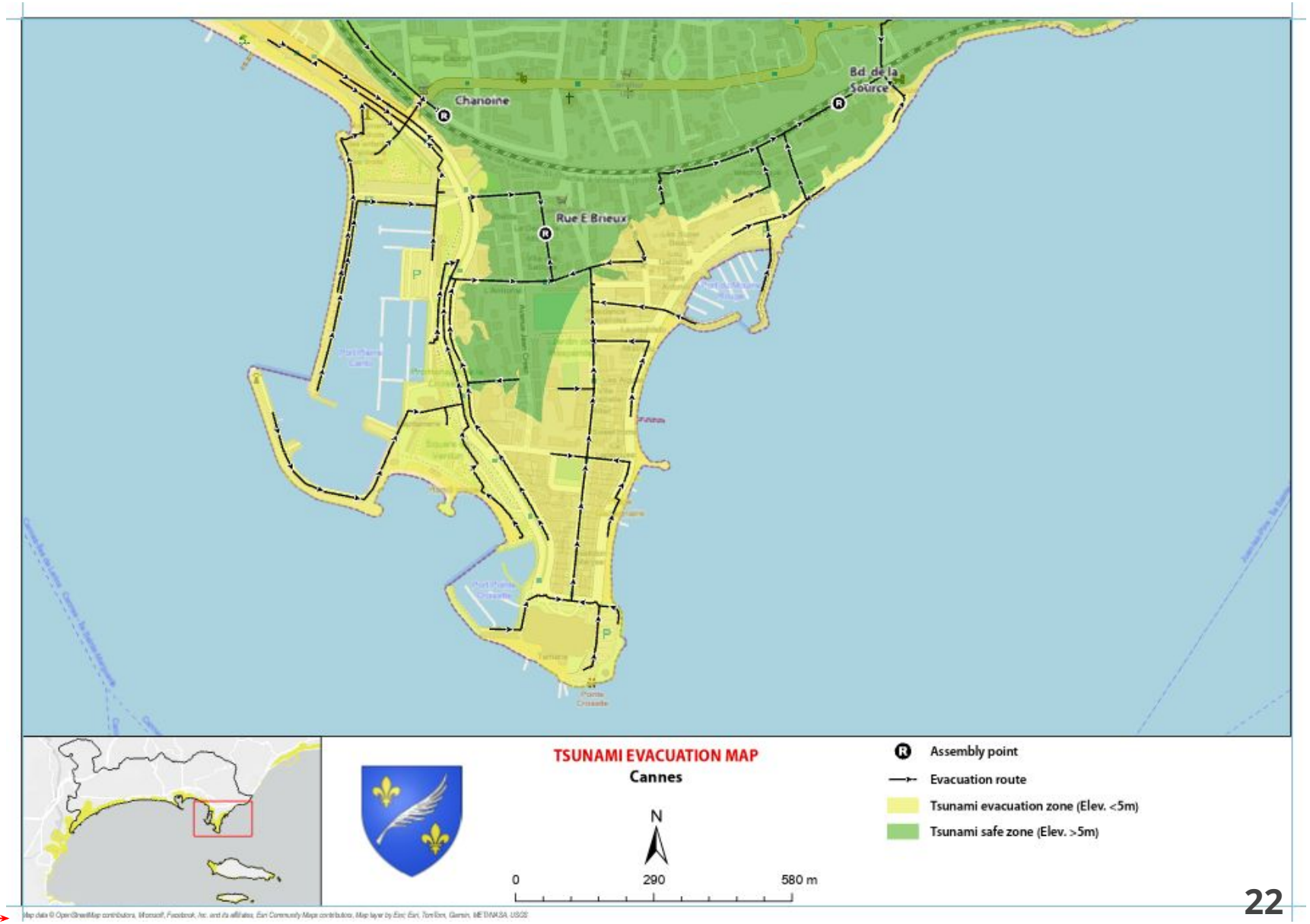
Single map layout

At this point, almost all the elements synchronized with our main map are set up.

Add a title to our map **and logo** (1_Original_data folder) in the layout's bottom ribbon

Using ESRI's basemap automatically add credits in our map frame.

Add a **Dynamic text > Service Layer Credits** in order to control their position and style



Graphical semiology and map layout

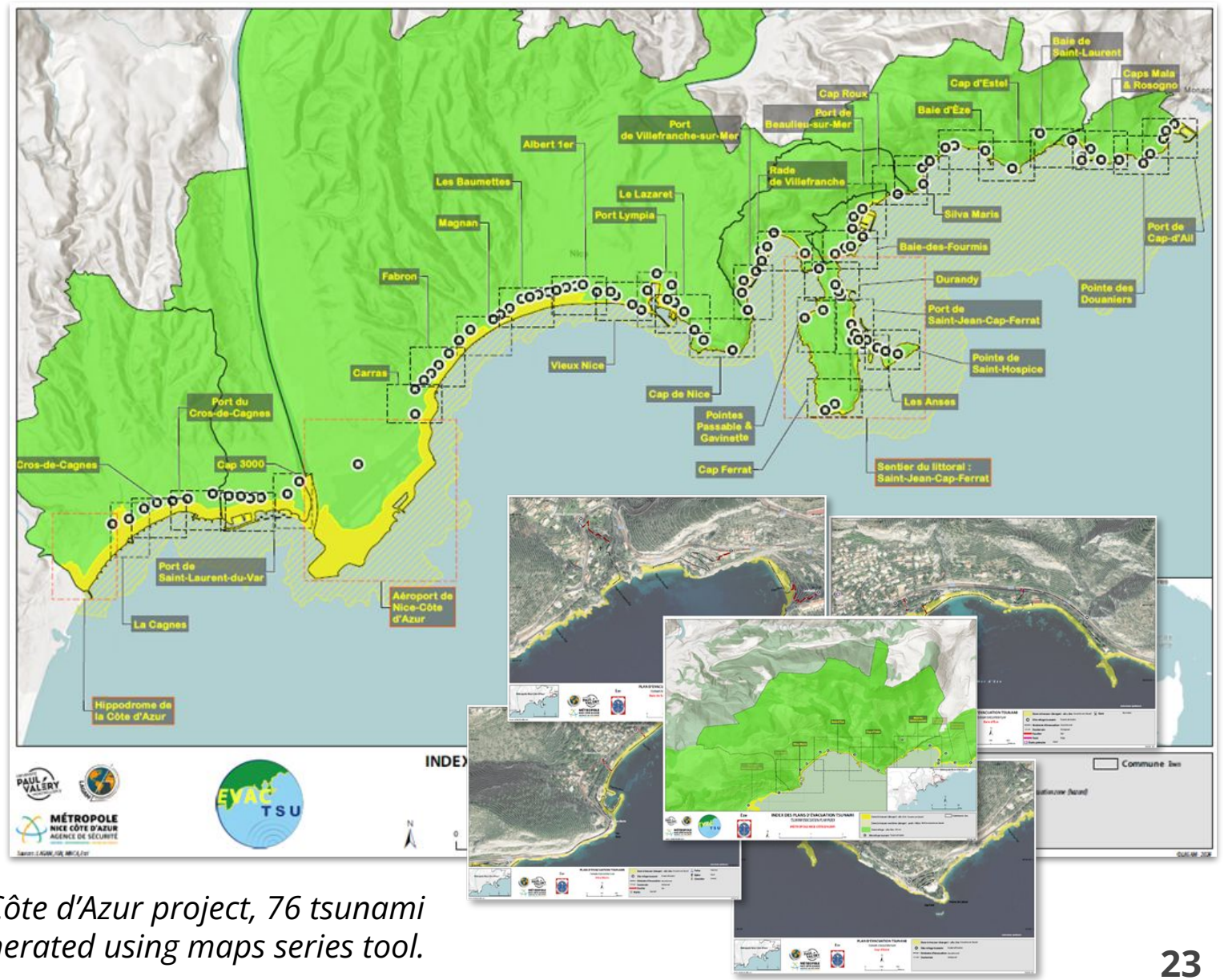
Atlas / Map series layout

Atlas (QGIS) or Map series (ArcGIS) **are automatically generated series of pages from a single layout**, with each page showing **a different extent.**

Dynamic elements such as data table, chart or dynamic text can be added to the layout and will be updated for each pages.

The map series extents can be set :

- **From layer's features geometry (spatial)**
- From bookmarks (spatial)
- From a set of layers (thematic)



As part of the EVACTSU - Nice Côte d'Azur project, 76 tsunami evacuation maps were generated using maps series tool.

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Atlas / Map series layout

Map series extents will be set up from an **index layer** : **map_series_extent** (1_Original_data) :

Using a **index layer** to set the extents allows to use fields to :

- Set a name for each extent, which can be accessed via dynamic text.
- Control the order in which the page will be generated
- Group the pages based on field's value
- *Set custom scale for each extent*

This layer can be built manually or automatically generated with build-in tools when working on larger area :

- **Grid Index Features** (Creates a grid to cover an extent)
- **Strip Map Index Features** (Creates polygons along a linear features e.g : coastline)

Atlas / Map series layout

Index layer's fields

Each entity must be named after a known location

- Neighborhood
- Landmark (airport, plaza)
- Natural feature (cap, island)

A numerical field can be added to set the map scale for each extent.

When working with multiple municipalities, a dedicated field should be added to group the map series pages on municipalities name.

maps_series_extent

Field: Add Calculate | Selection: Select By Attributes Zoom To Switch Clear Delete Copy

	FID	Shape *	Id	Nom	NomIndex
1	0	Polygon	0	de la Gare de marchandises	Gare de marchandises
2	1	Polygon	0	de l'Aéroport de Cannes Mandelieu	Aéroport de Cannes Mandelieu
3	2	Polygon	0	du Vieux port	Vieux port
4	3	Polygon	0	de la Croisette	La Croisette
5	4	Polygon	0	de la Pointe de la Croisette	La Pointe de la Croisette
6	5	Polygon	0	de l'île Saint-Honorat	L'île Saint-Honorat
7	6	Polygon	0	de l'île Sainte-Marguerite - Partie Ouest	L'île Sainte-Marguerite - Partie Ou...
8	7	Polygon	0	de l'île Sainte-Marguerite - Partie Est	L'île Sainte-Marguerite - Partie Est
9	8	Polygon	0	du boulevard du Midi Est	Boulevard du Midi Est
	Click to add new row.				

Atlas / Map series layout

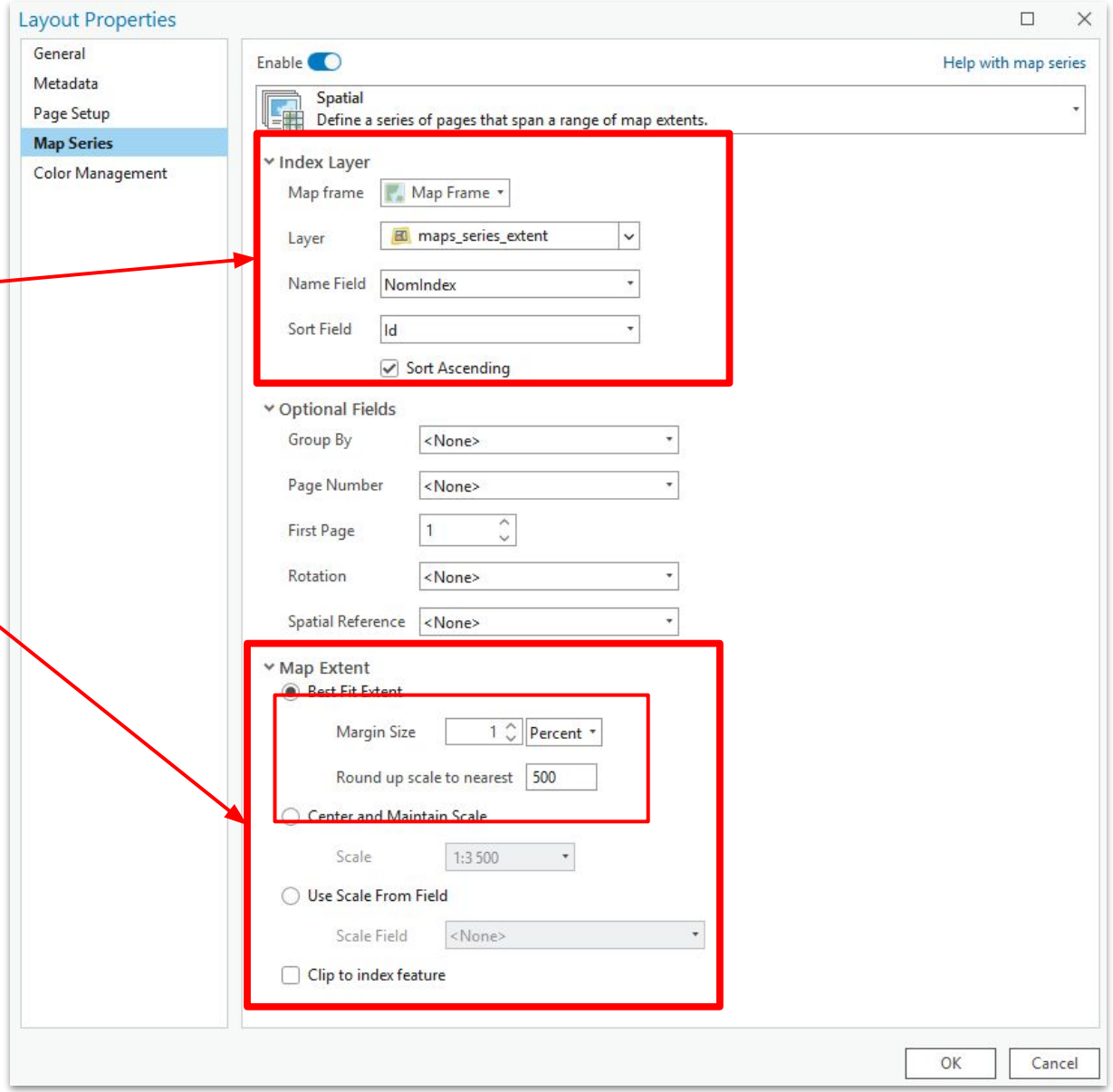
Activate **Map Series** from the **Layout** tab or **Layout's** properties in the content panel.

1. Choose the **map's frame to which the map series will apply.**
2. Select the **Index layer**
3. Select the **name** and **sort** fields

The **map extent** can be set in a variety of ways :

- By setting a margin around index feature's geometries.
- With constant scale for all map series pages.
- Dynamically from each feature using a scale field

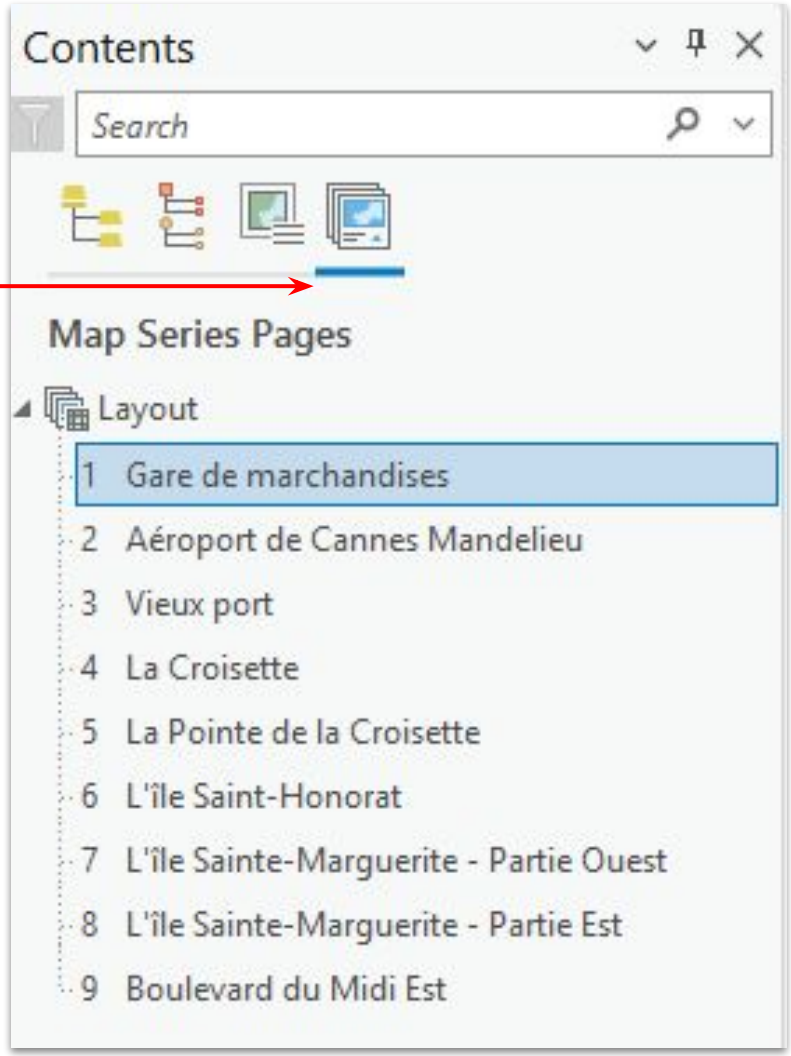
Since the polygons of the index layers are not all the same size, a dynamic map extent setting must be chosen.



Atlas / Map series layout

Once a map series is activated, you can select wich page will be displayed on your the page's layout.

Contents panel > Select **List Map Series Pages**



The index layer doesn't require to be displayed in order for the map series to be activated

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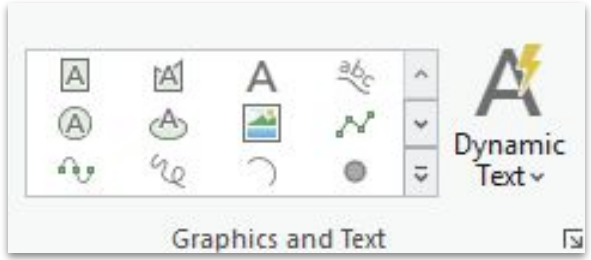
Atlas / Map series layout

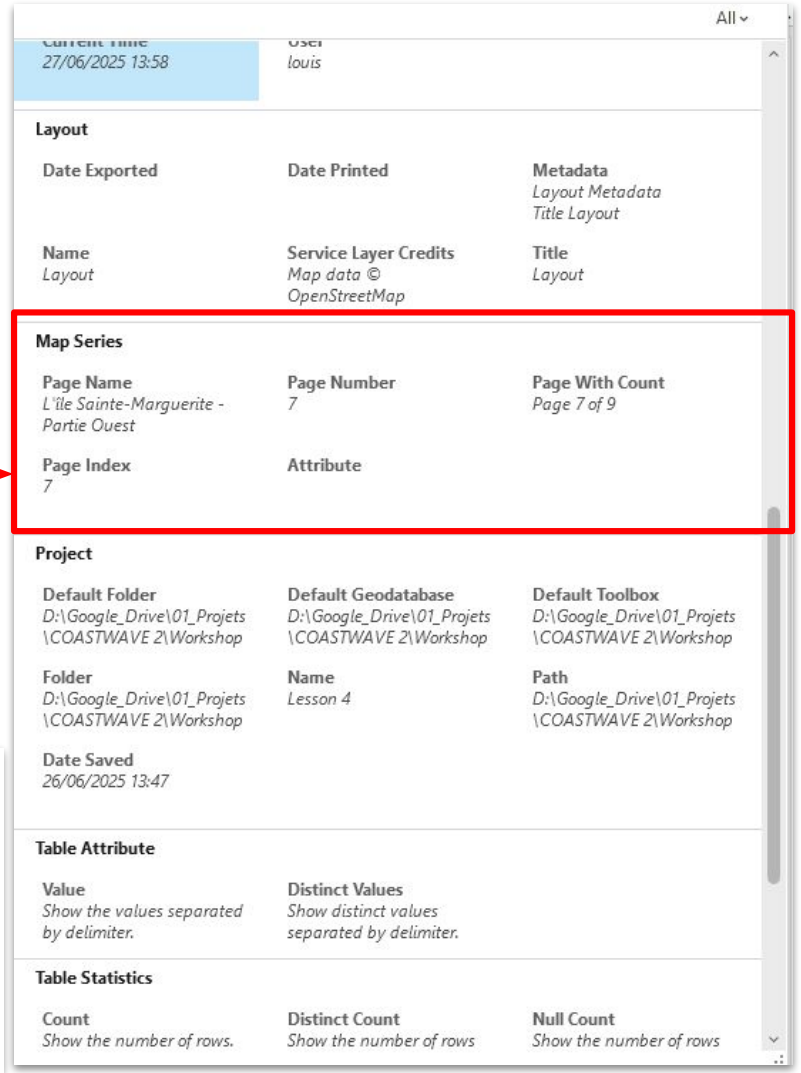
Map series allow to set up **dynamic text elements** to display layer, project or layout's specific information, i.g :

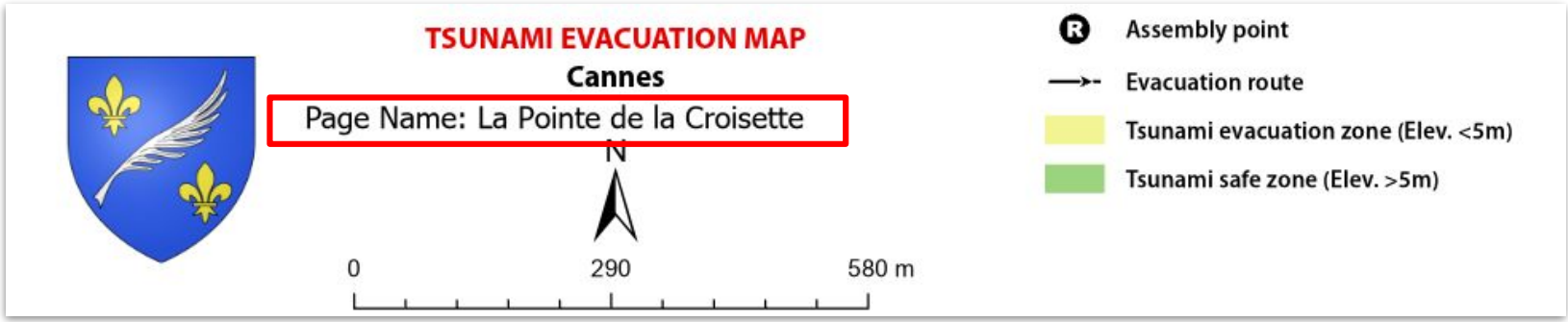
- Attribute table
- Field value
- Author / Date / Metadata
- Scale

To insert Dynamic text :

Layout tab > **Top ribbon** > **Dynamic Text**







Add the page name on your layout :

Atlas / Map series layout

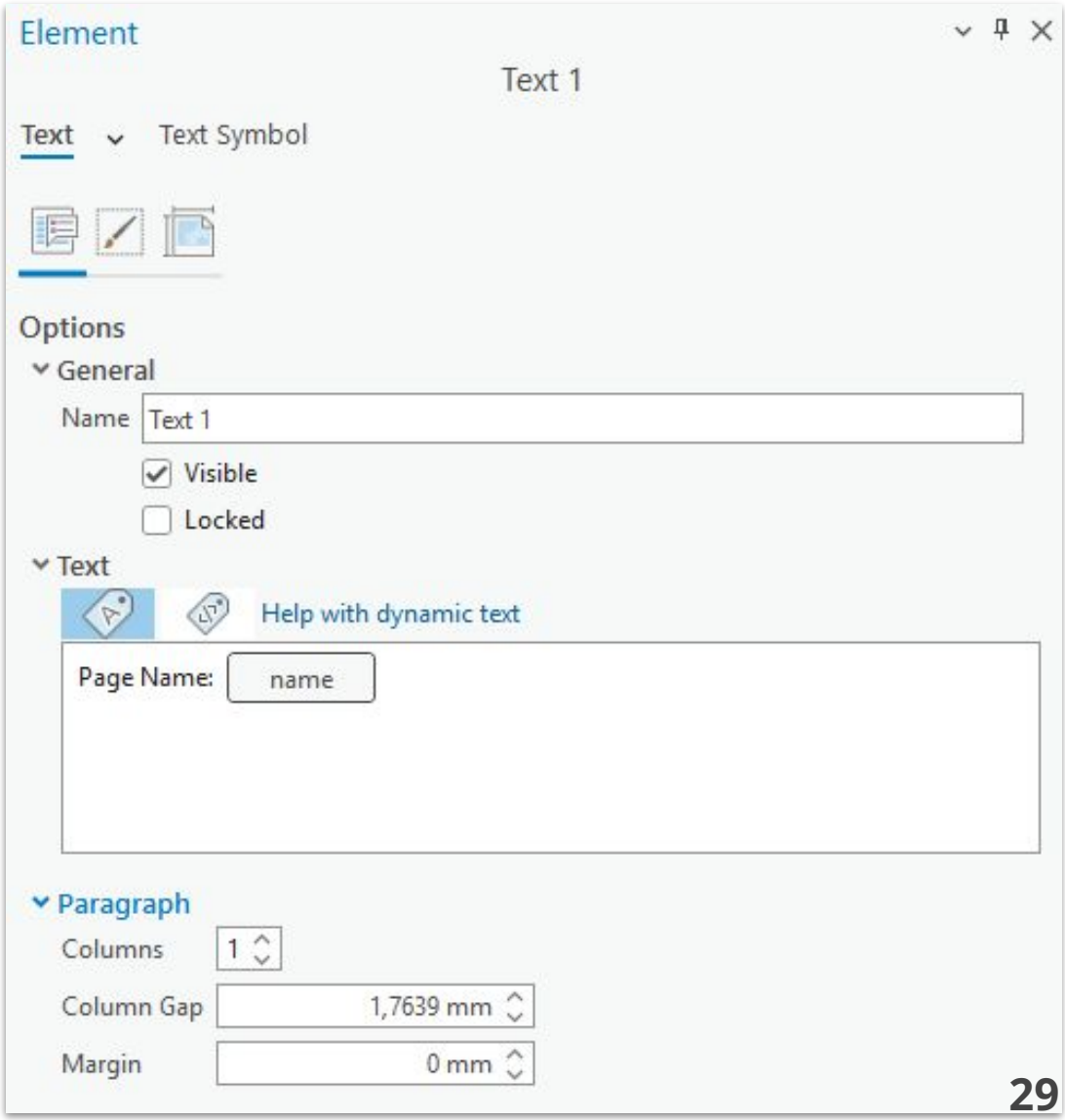
You can **combine static and dynamic text** within one text element.

Dynamic Text preset can be edited :

Select your dynamic text element > **Right click** > **Properties**

1. Remove the static text **“Page Name:”** and keep only the “name” tag
2. Choose another pertinent dynamic text element to add to your layout

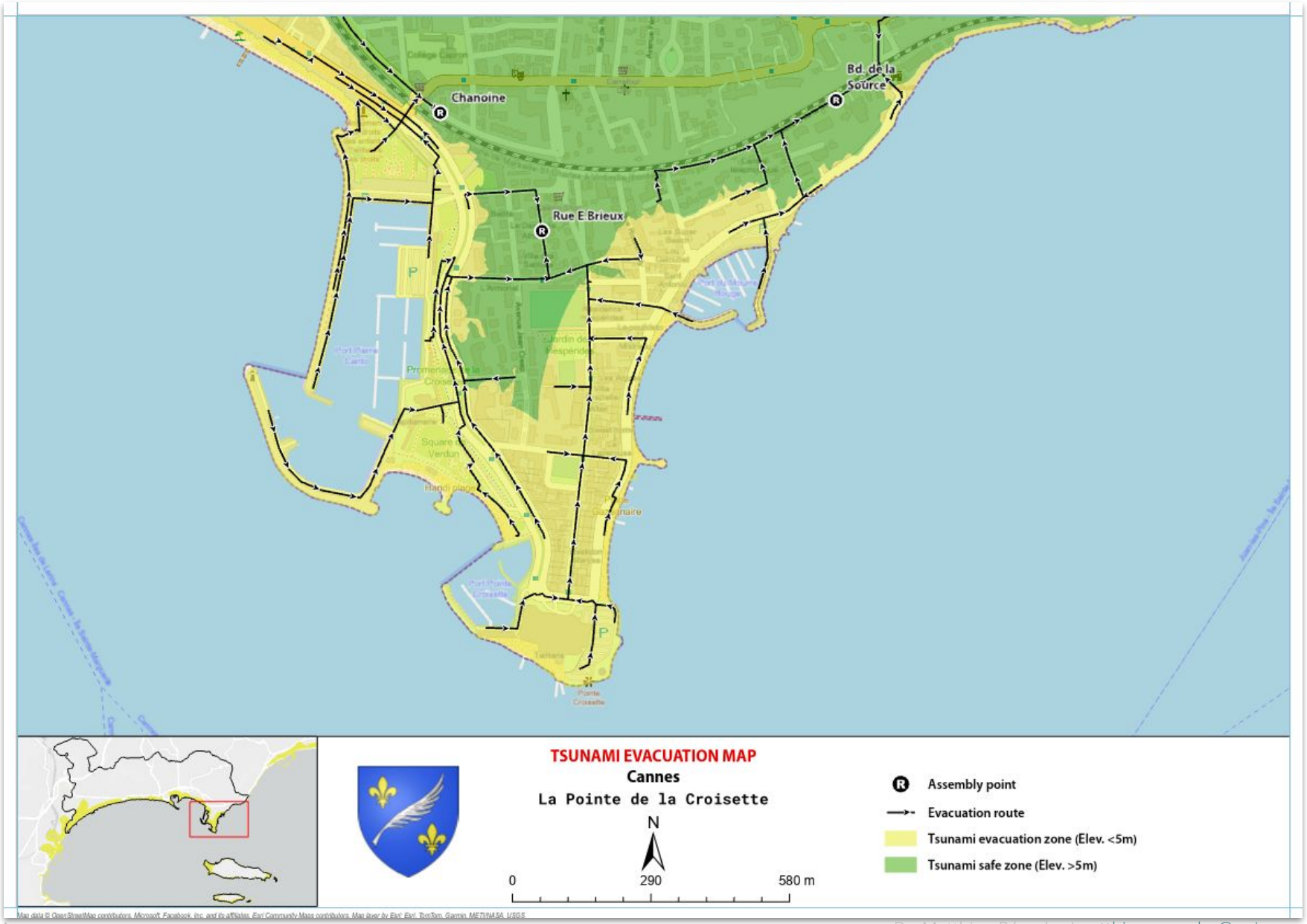
The size of the dynamic text element **will be adjusted** based on the length of the page name, which may result in it **overlapping** with other layout elements.



Graphical semiology and map layout

Atlas / Map series layout

Result :



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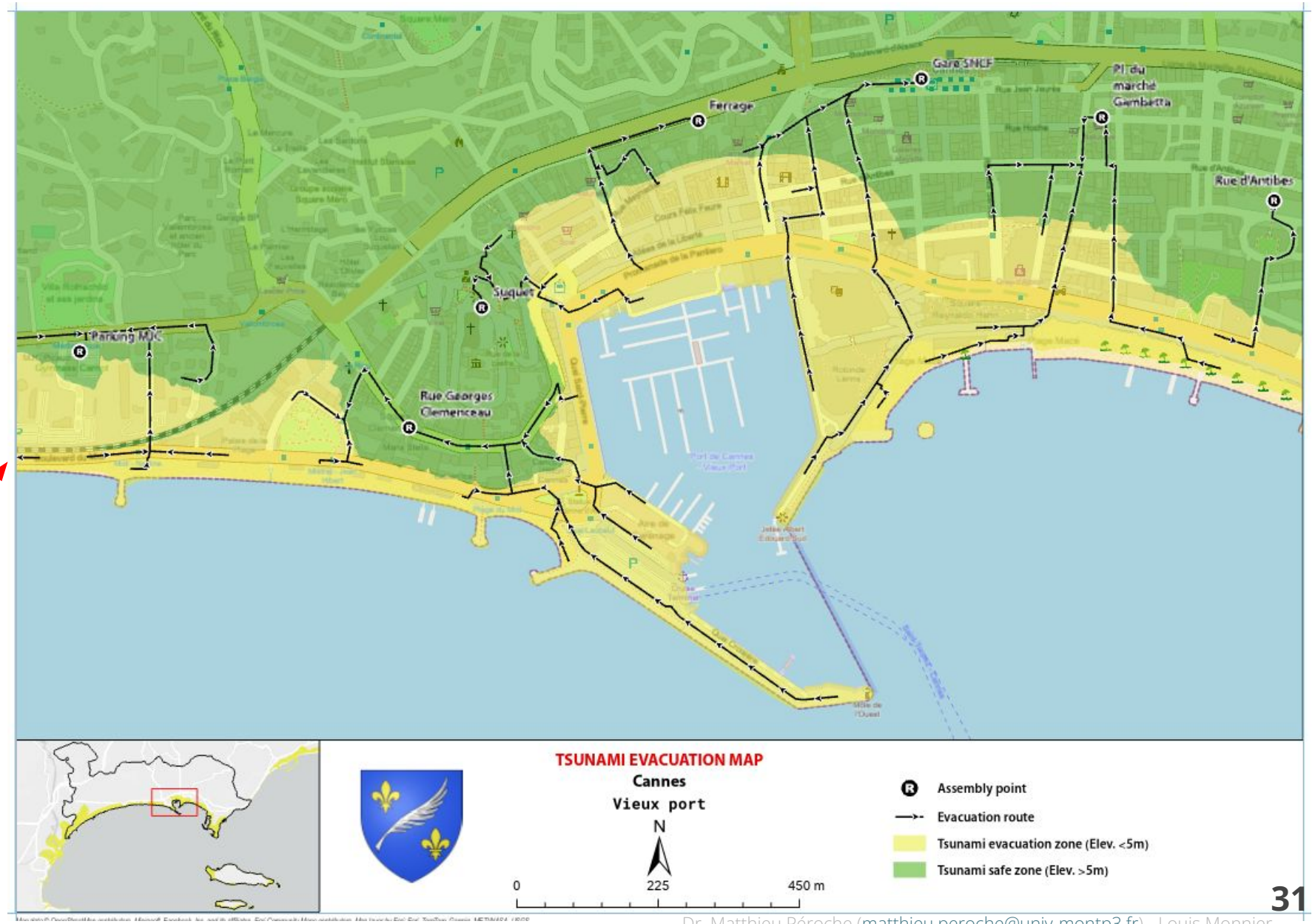
Graphical semiology and map layout

Atlas / Map series layout

In many cases, basemaps provided by ESRI doesn't display all the information needed.

⇒ **Cultural / Political / Administrative basemap** doesn't include terrain information

Basemap : OpenStreetMap



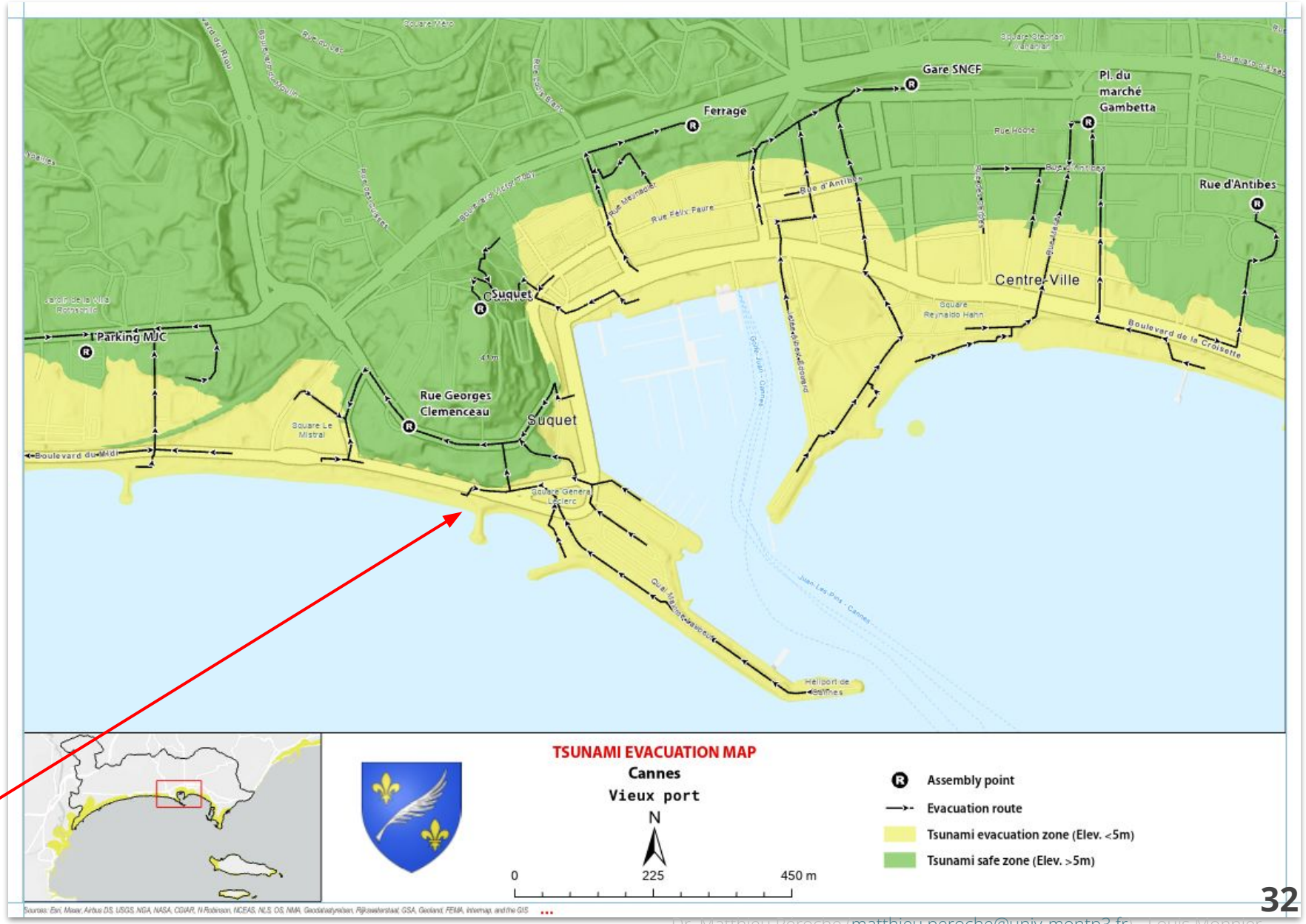
Graphical semiology and map layout

Atlas / Map series layout

In many cases, basemap provided by ESRI doesn't provide all the information needed.

⇒ **Terrain basemap** doesn't include buildings or landmark. At the scale of our evacuation plans, only the most important sections of the road network are displayed.

Basemap : Terrain with labels



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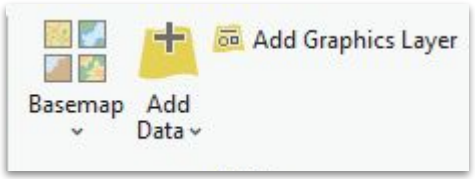
Atlas / Map series layout

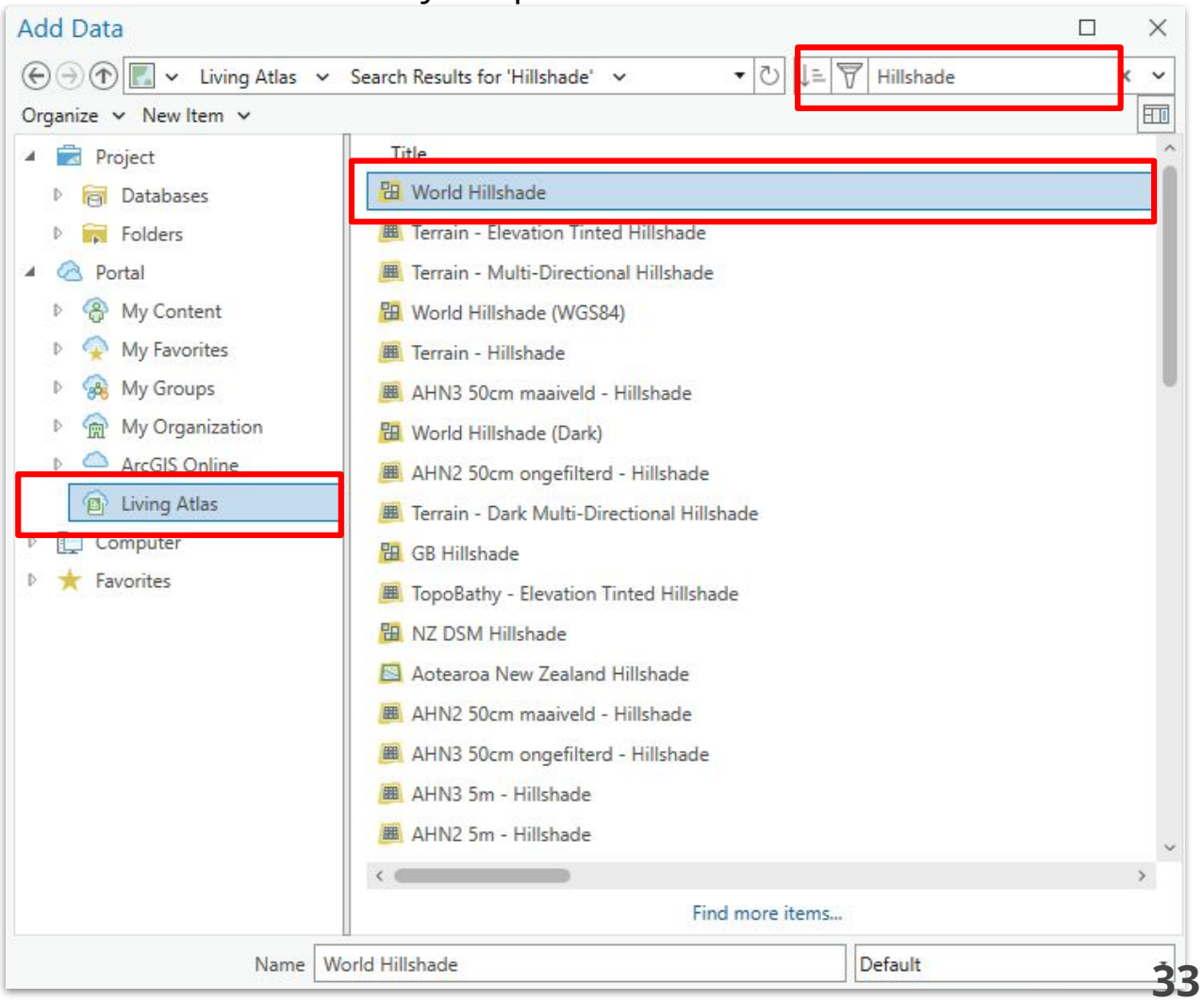
Terrain elevation must be displayed on tsunami evacuation map. The most commons ways to provide this information are **contour lines** and **hillshade.**

Arcgis don't allow to add multiple basemap on a single map, but the **tiles** or **imagery** layers used in the basemaps can be imported as standalone layer, allowing to compose your own basemap.

In your **map's tab** > **Top ribbon** > **Map** > Add **Data** > **Data**



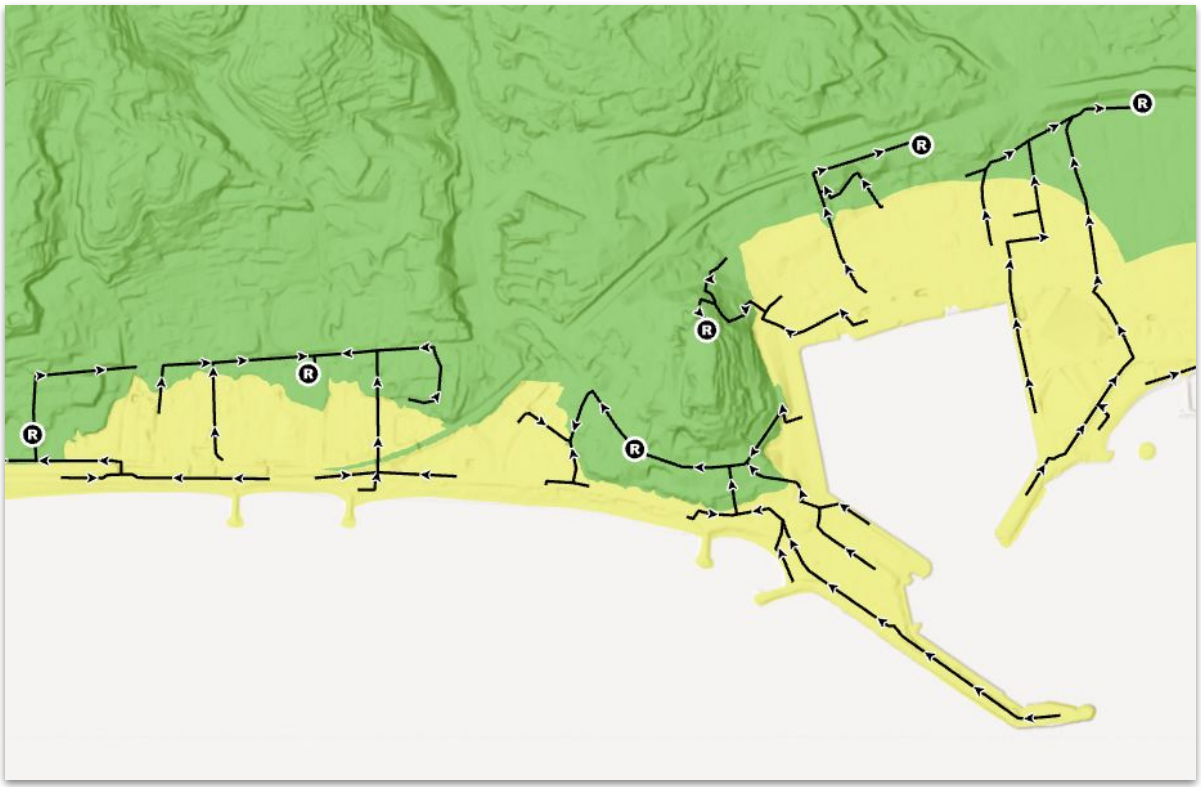
In the **Add Data** window, select **Living atlas** and search for "**Hillshade**"

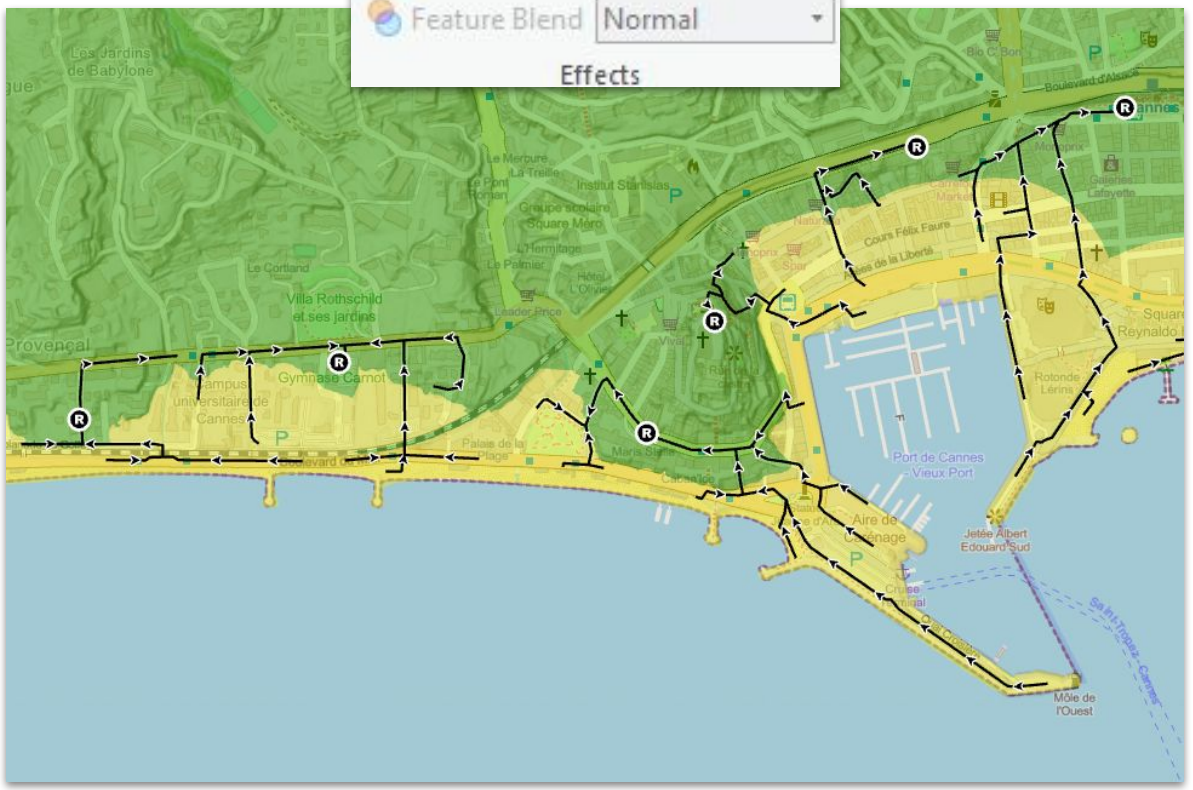


Atlas / Map series layout

In order to display both **OpenstreetMap** basemap and the **World Hillshade** tile layer, **transparency** and / or **blending mode** should be adjusted.

Select the World Hillshade layer > **Top ribbon** > **Tile Layer** > **Effects**





Atlas / Map series layout

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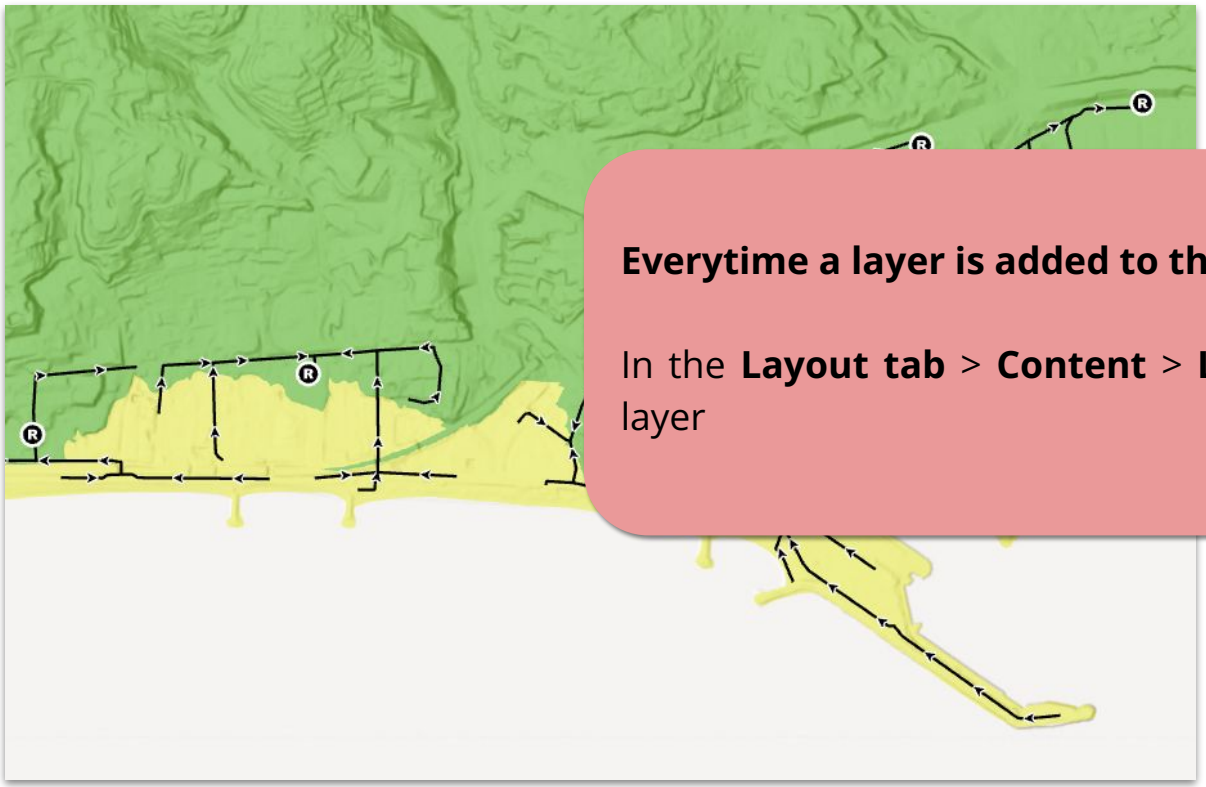
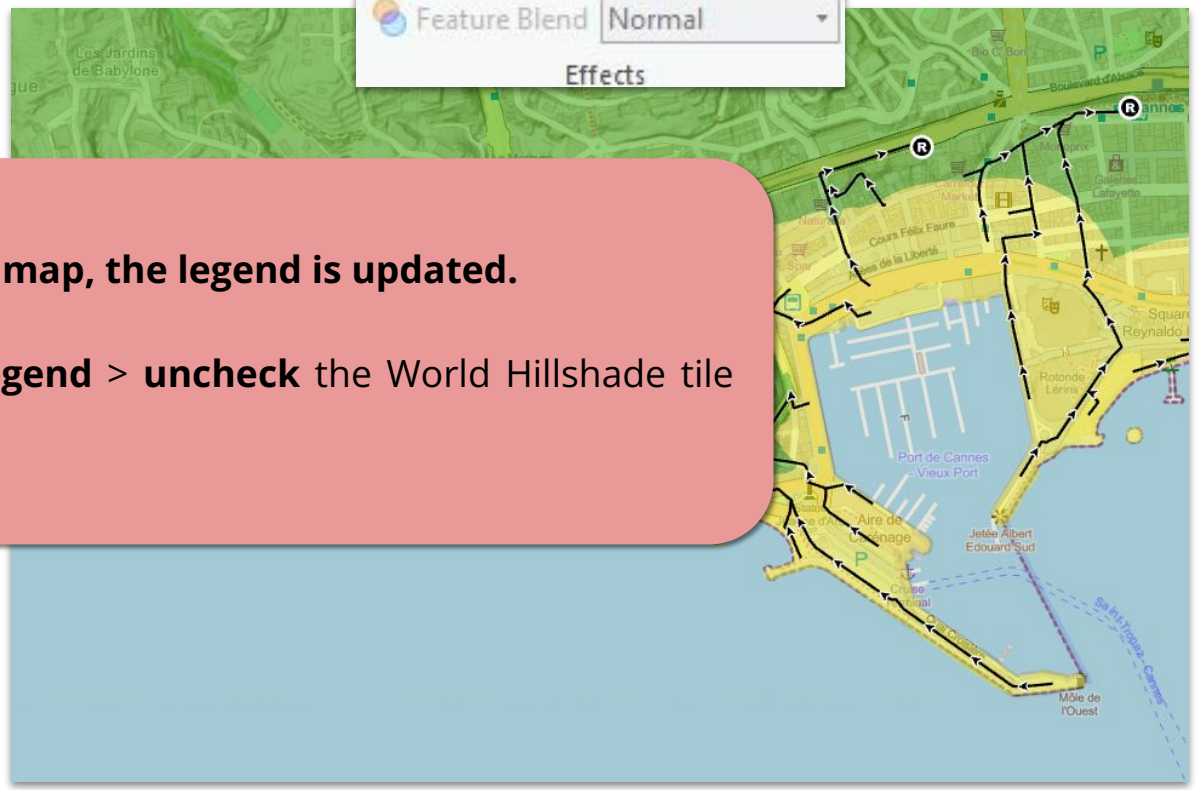




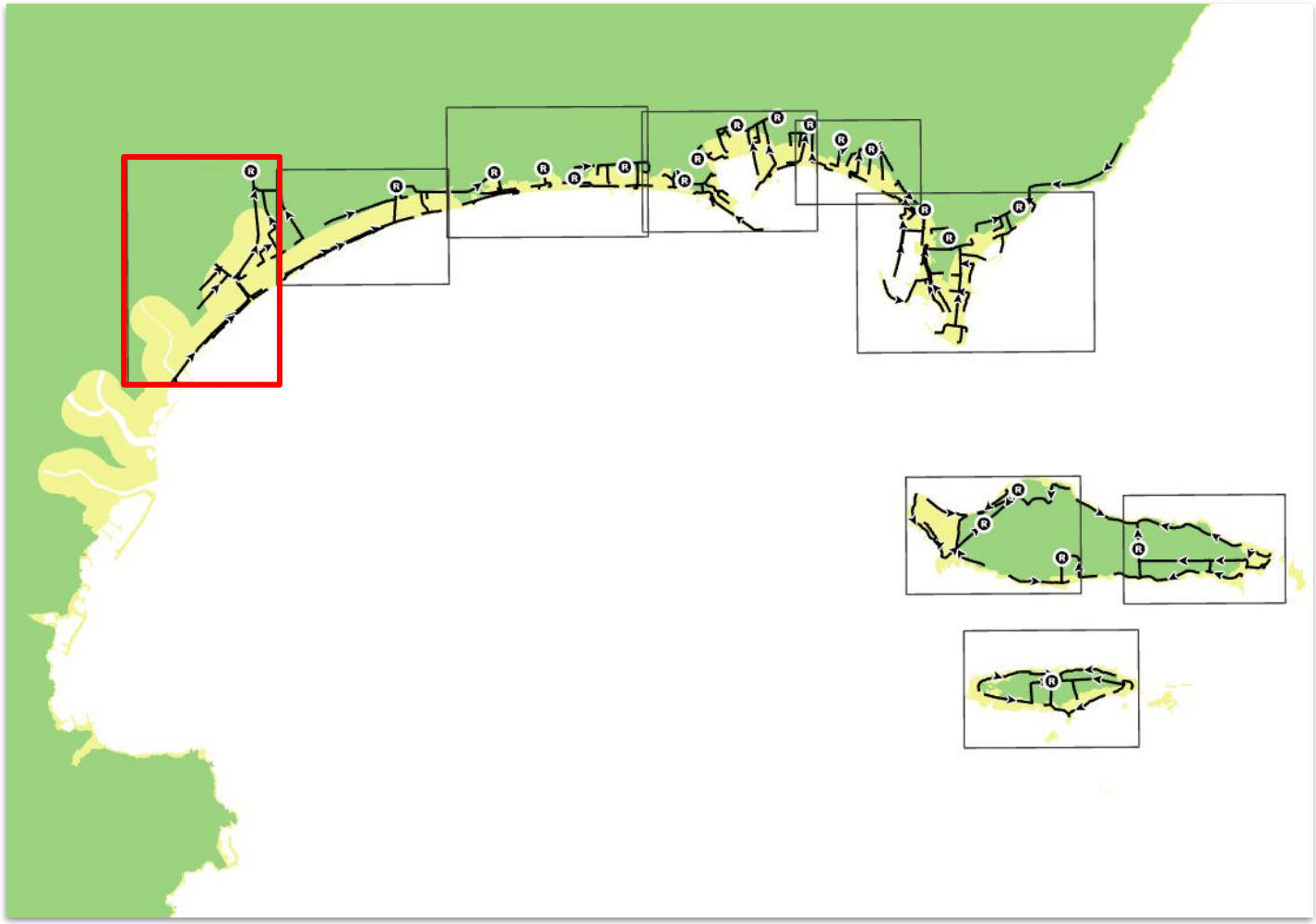
Everytime a layer is added to the map, the legend is updated.

In the **Layout tab** > **Content** > **Legend** > **uncheck** the World Hillshade tile layer

Atlas / Map series layout

One of the map extent need a layout set on **portrait** mode

How would you solve this problem ?



Atlas / Map series layout

Exporting a map series :

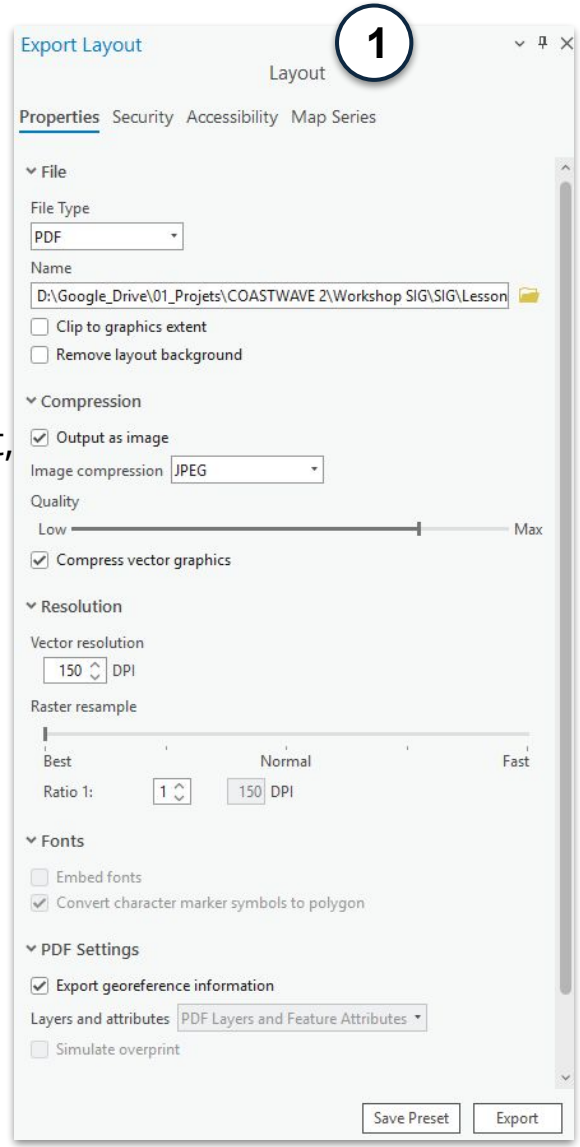
Layout tab > T**op ribbon** > **Share** > **Export Layout**

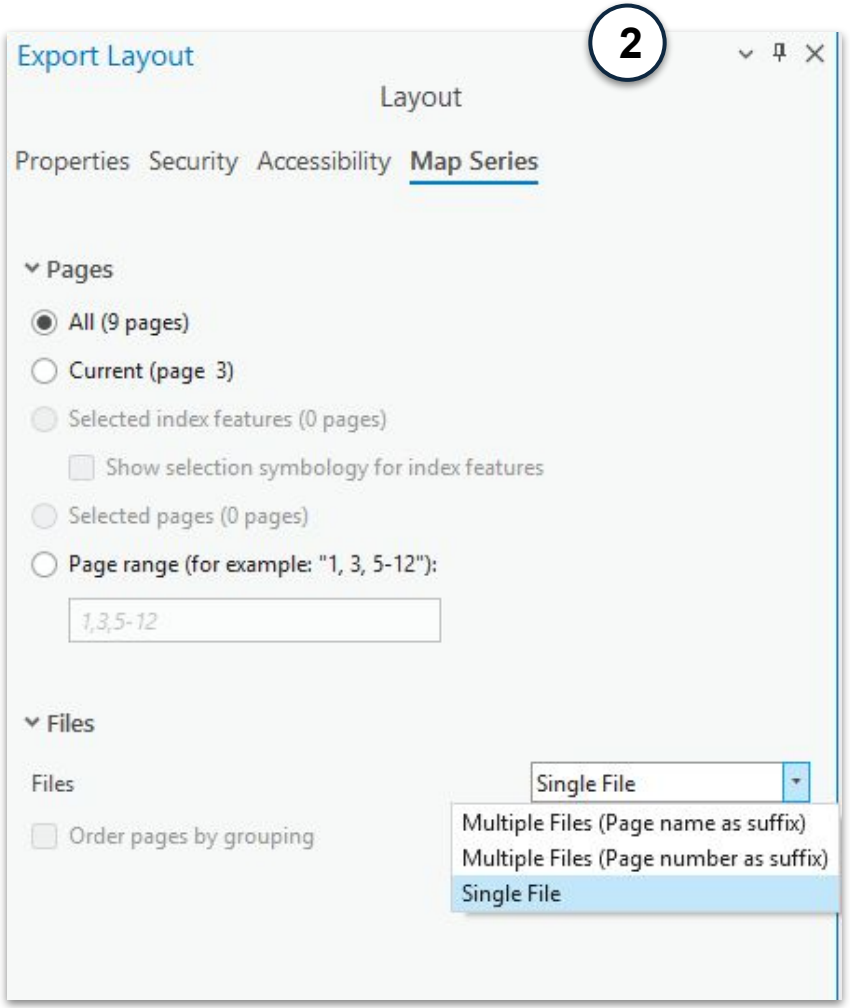
1

The **Properties menu** allows you to set the file format, export resolution and destination folder.

2

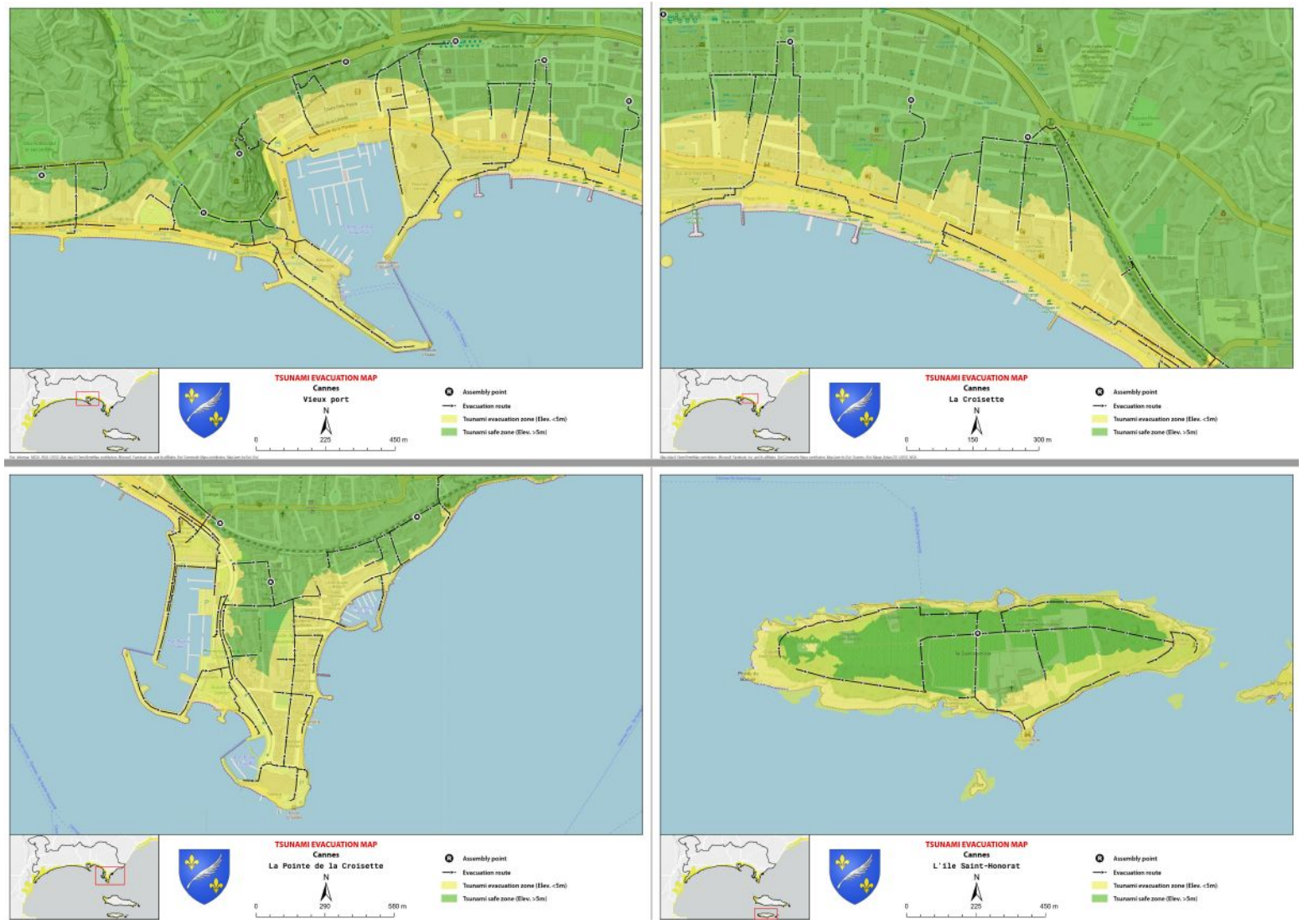
The **Map Series menu** allows you to choose which pages will be exported, and whether they will be exported as independent files or as a single file.

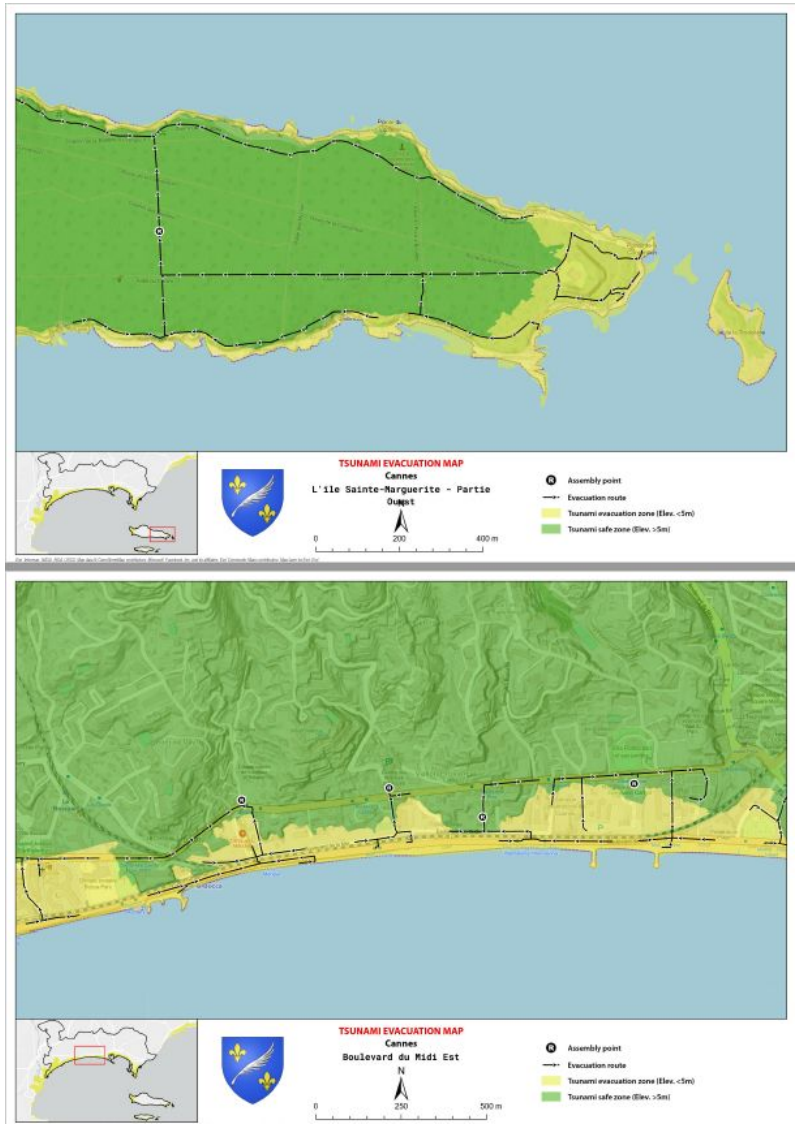




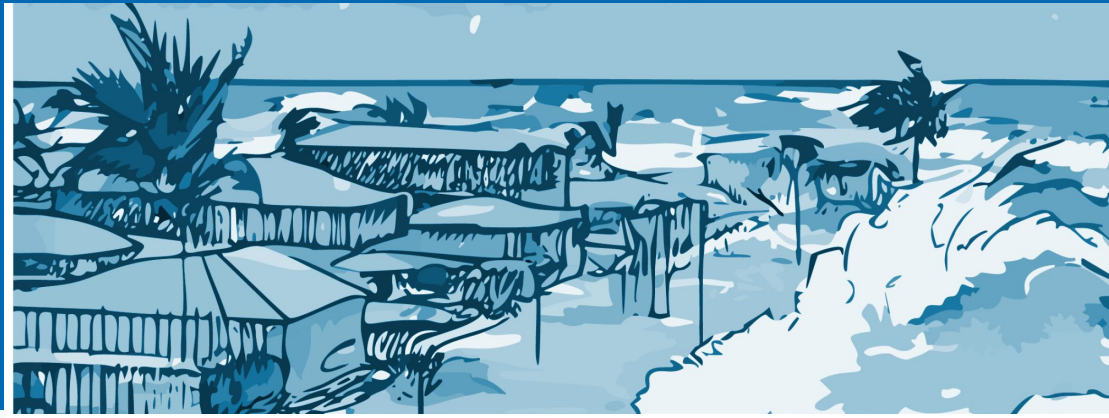
Graphical semiology and map layout

Atlas / Map series layout





Tsunami Evacuation Mapping Workshop



CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

Dr. Matthieu Péroche
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30 June – 4 July 2025

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Intergovernmental Oceanographic Commission

Funded by European Union Humanitarian Aid

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

CoastWAVE NEAMTWS

LAGAM
LABORATOIRE DE GEOGRAPHIE ET D'AMENAGEMENT DE MONTPELLIER

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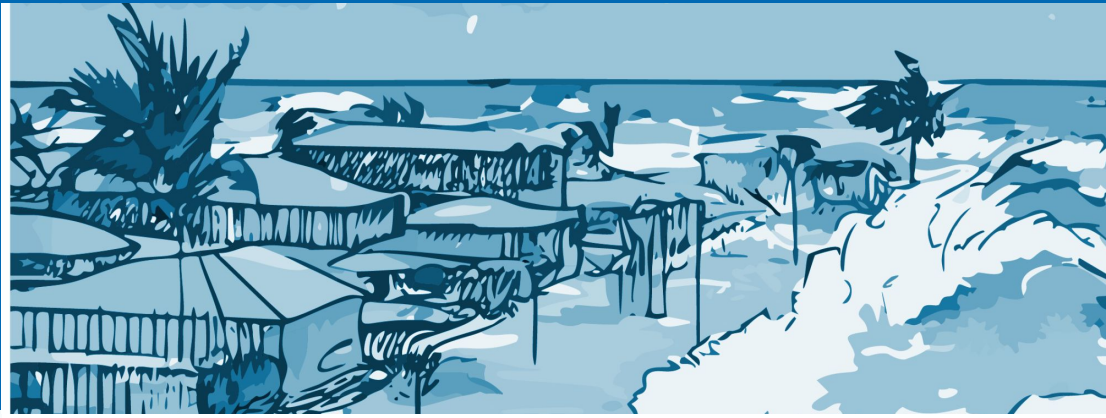
Tsunami Evacuation Mapping Workshop

30 June – 4 July 2025



CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

Dr. Matthieu Péroche
Louis Monnier

Lesson #5

Dynamic cartography Support for evacuation map diffusion

Contact : matthieu.peroche@univ-montp3.fr

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Intergovernmental Oceanographic Commission

Funded by European Union Humanitarian Aid

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

CoastWAVE NEAMTWS

LAGAM
LABORATOIRE DE GEOGRAPHIE ET D'AMENAGEMENT DE MONTPELLIER

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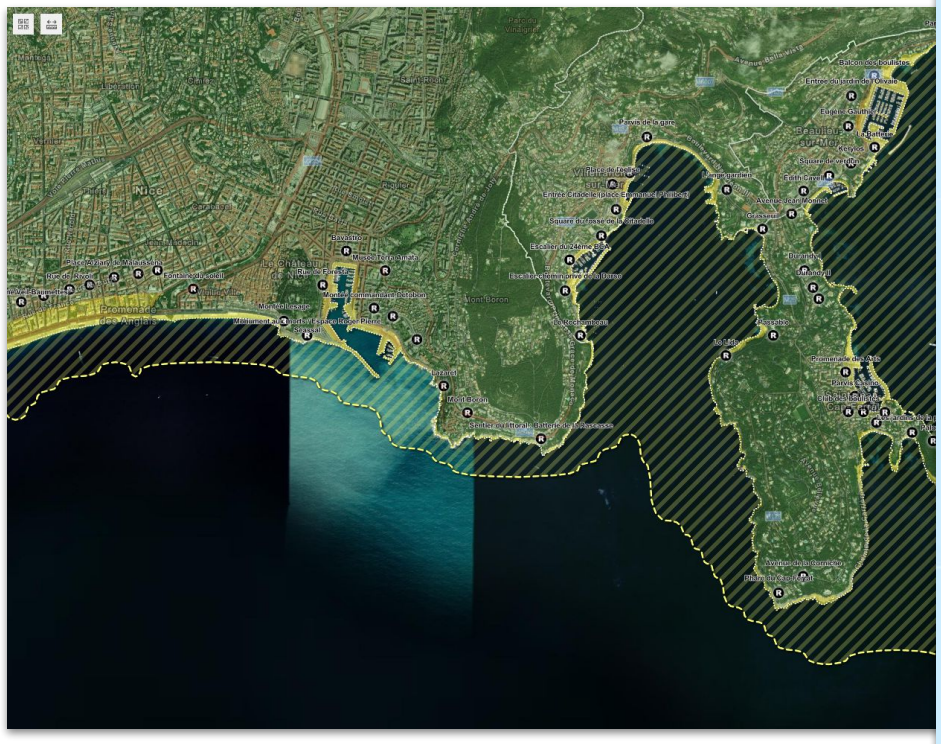
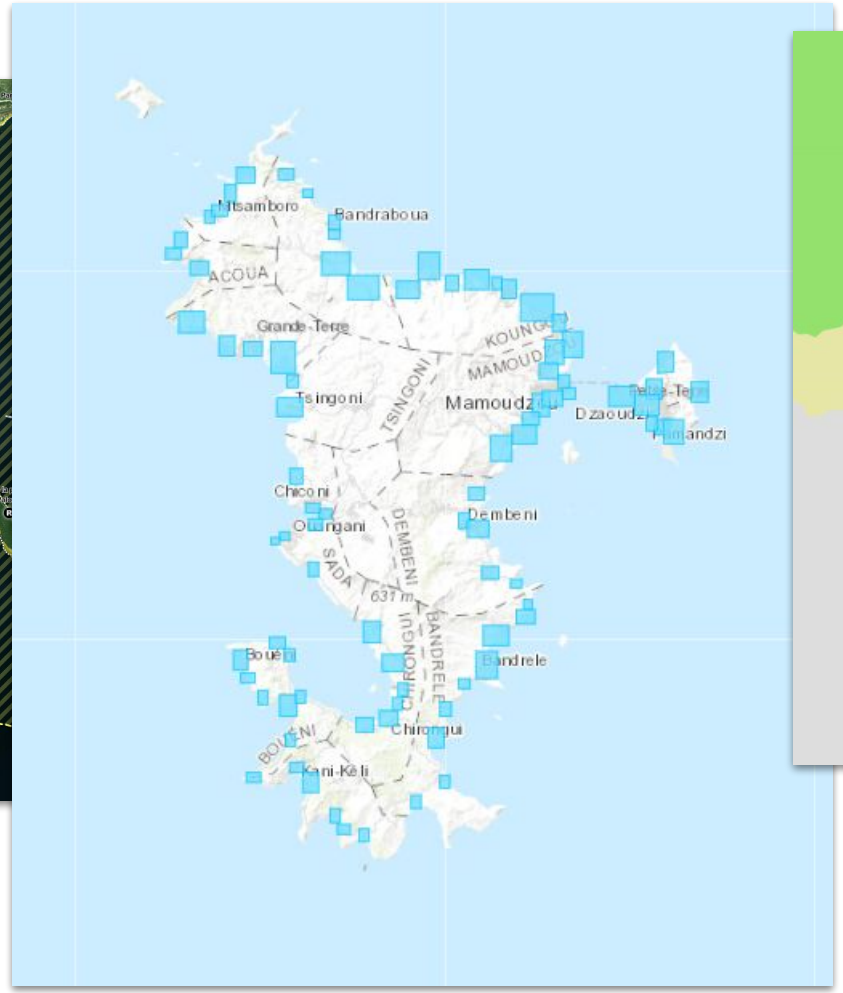
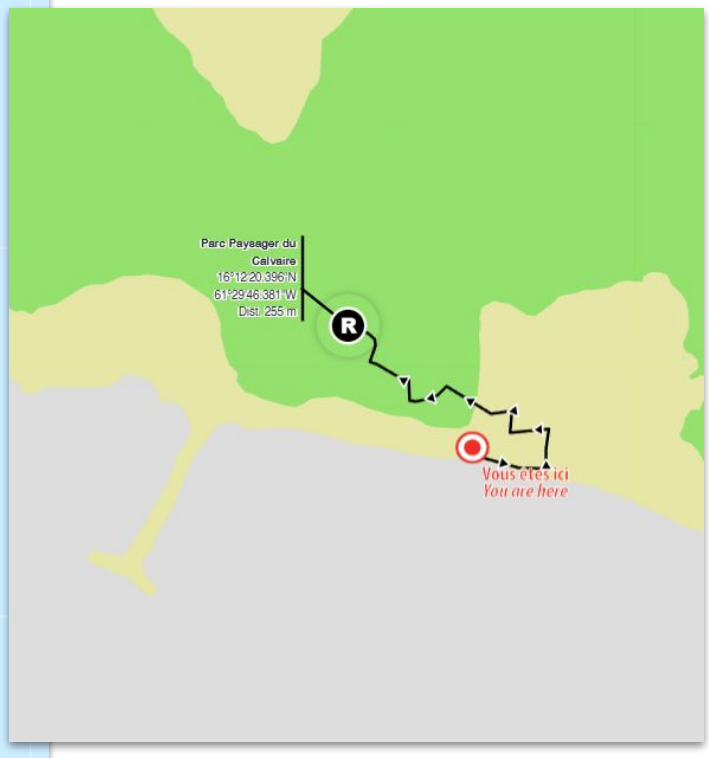
Lesson's overview

Create a web map using Arcgis online tools







Arcgis Online is **ESRI's cloud GIS platform**. It's fully integrated in ESRI's software ecosystem and provides all the necessary tools / services, from spatial analysis to content publishing :

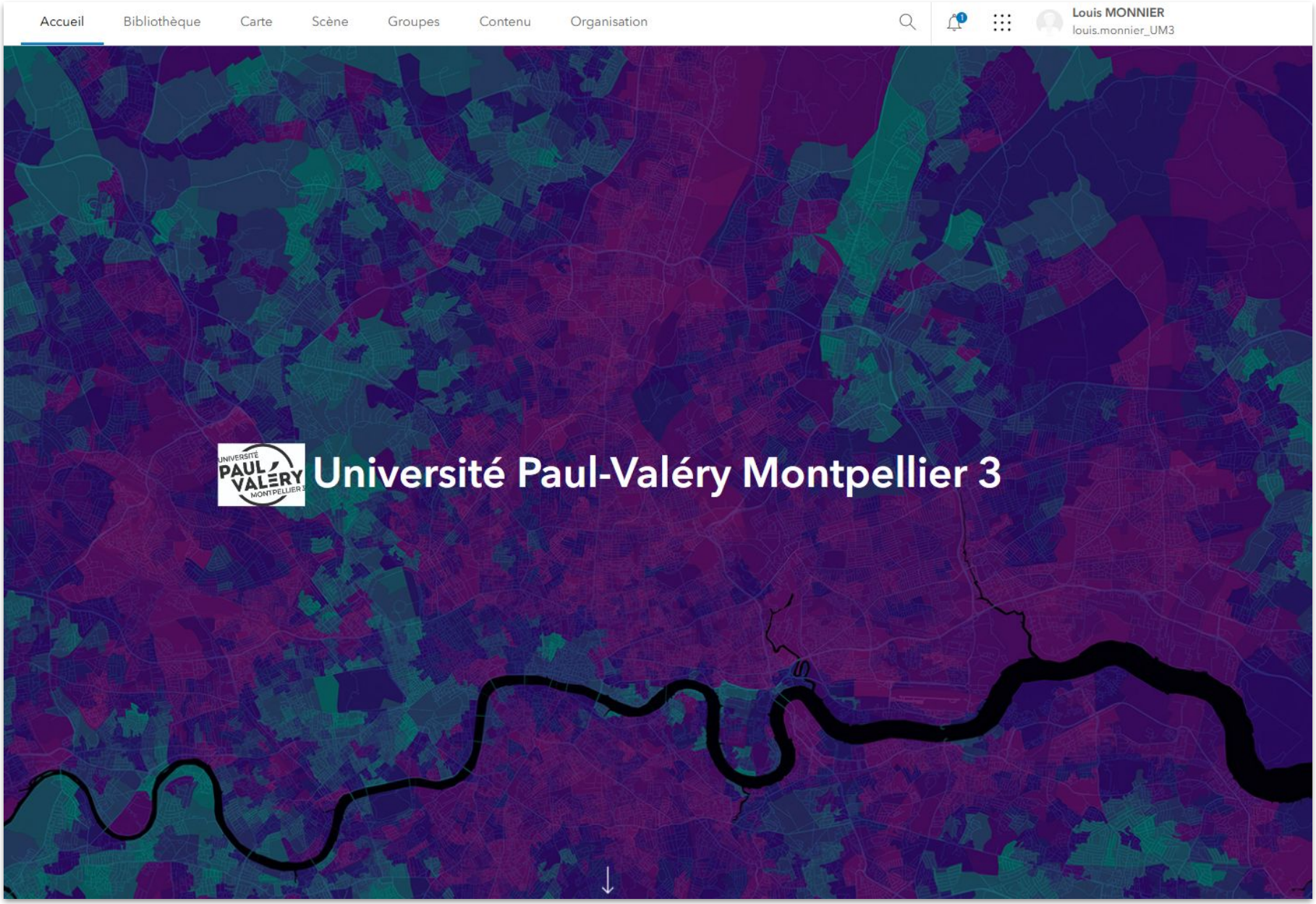
- **Upload** geospatial & non-spatial data
- **Access** to your organization's content or community's content
- **Publish** map and application
- **Perform** spatial analysis
- **Connected** with Arcgis Pro Desktop
- **Collaborative** work

Dynamic cartography - Support for evacuation map diffusion

ArcGIS Online

Web interface for :

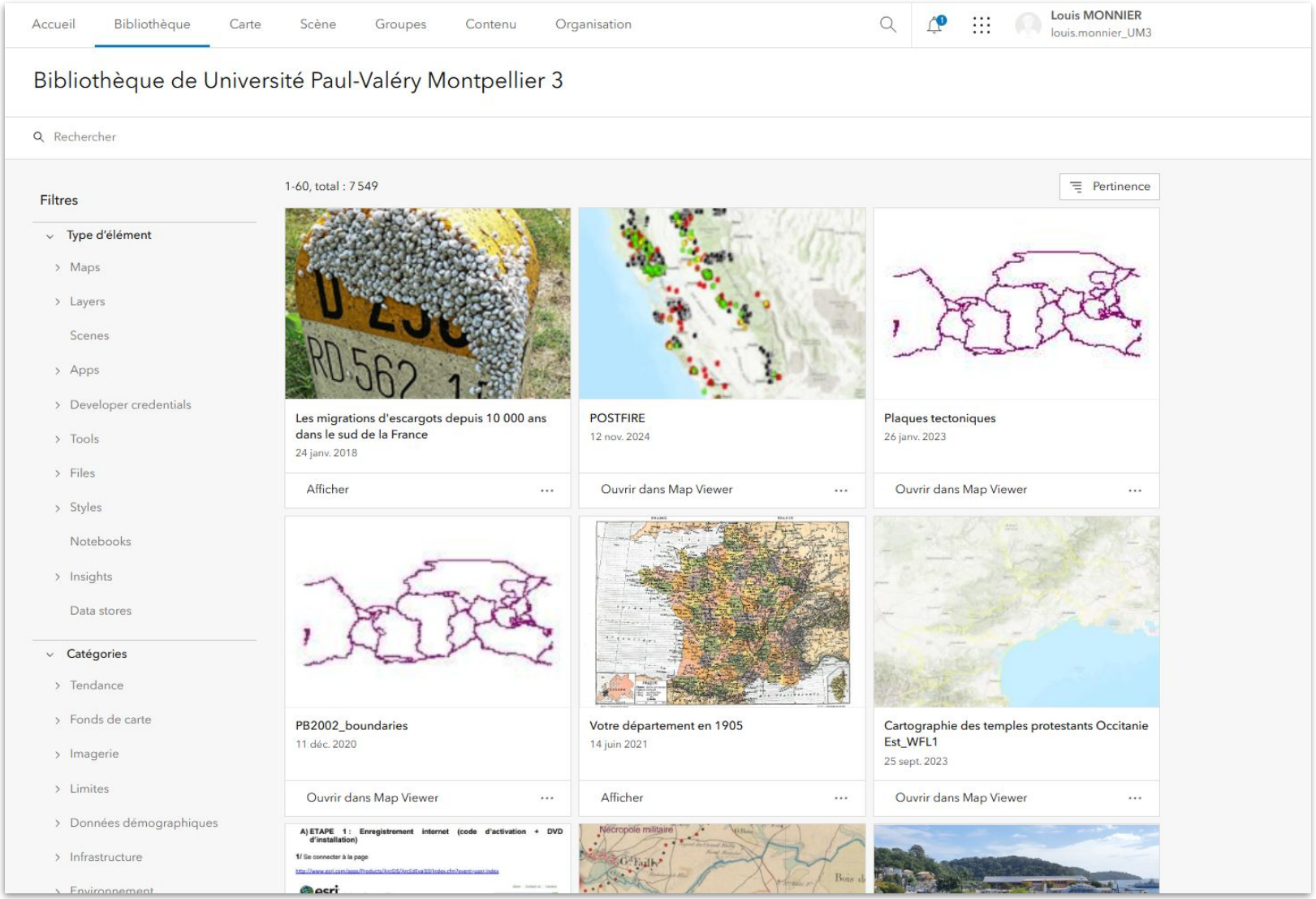
- Data's management
- Web map
- Web app
- Collaborative work



Dr. Matthieu Péroche (matthieu.peroche@univ-montp3.fr) - Louis Monnier

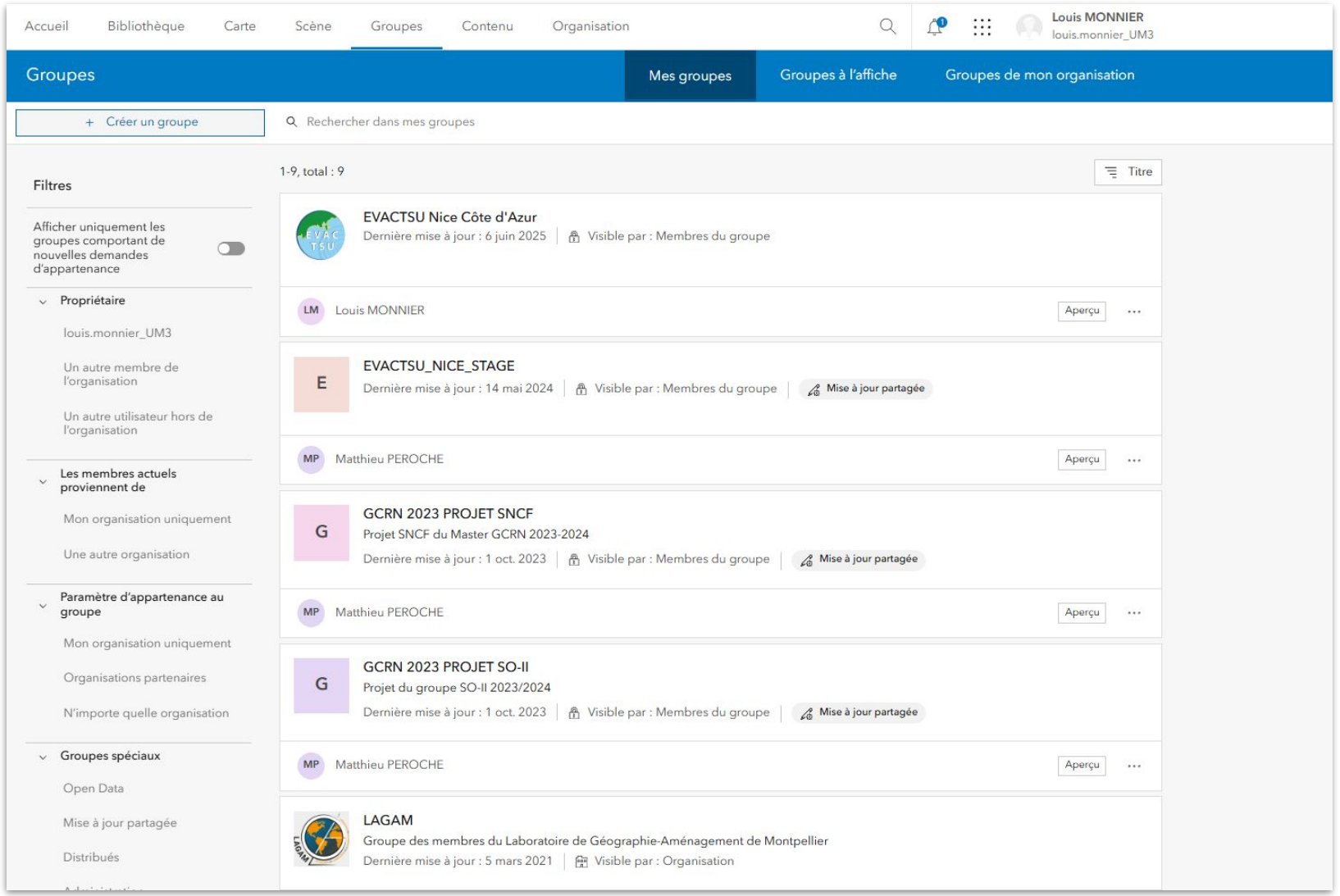
Organization's library

ArcGIS Online



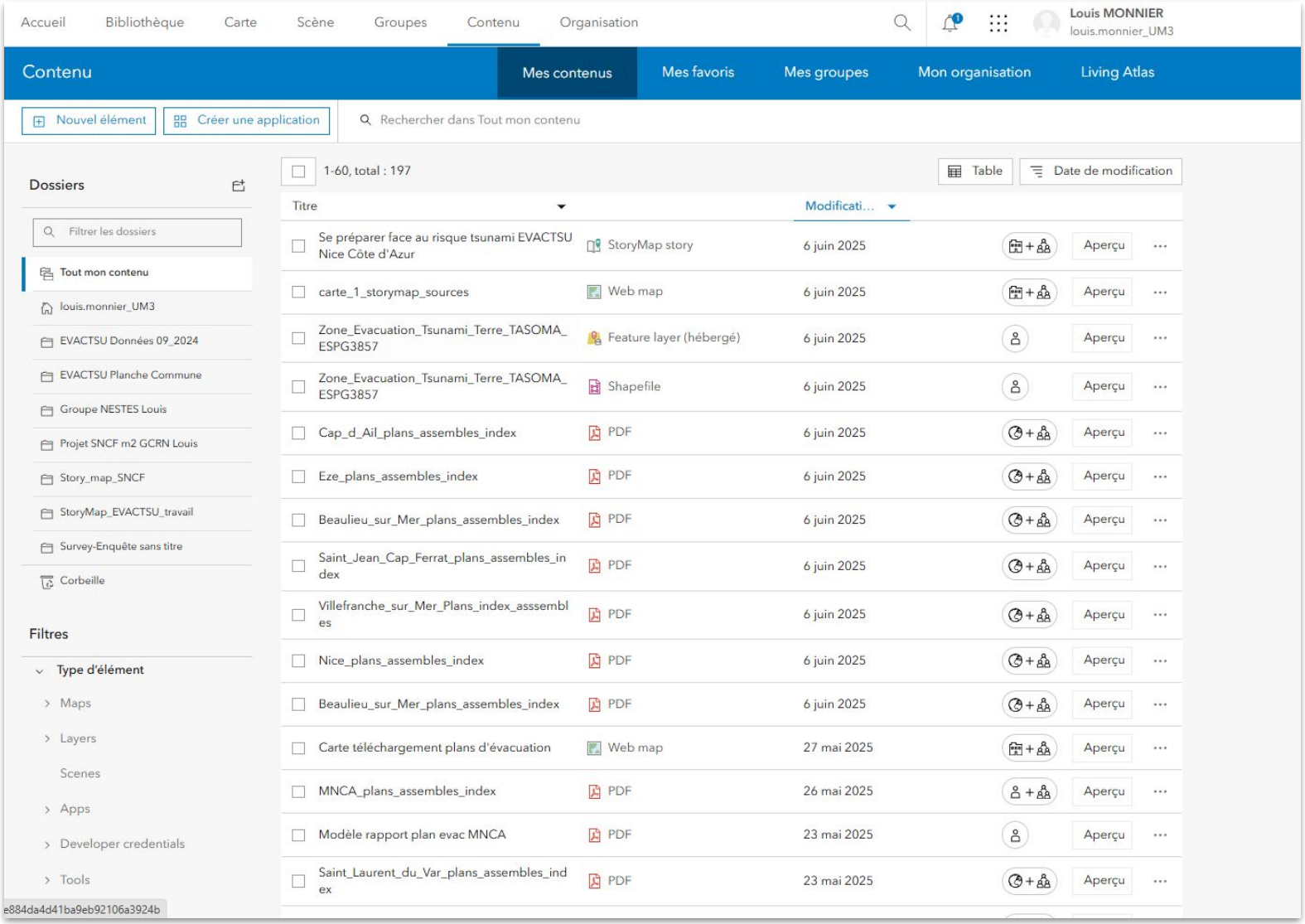
Work group management

ArcGIS Online



Upload, configuration and authorisation management for sharing.

ArcGIS Online

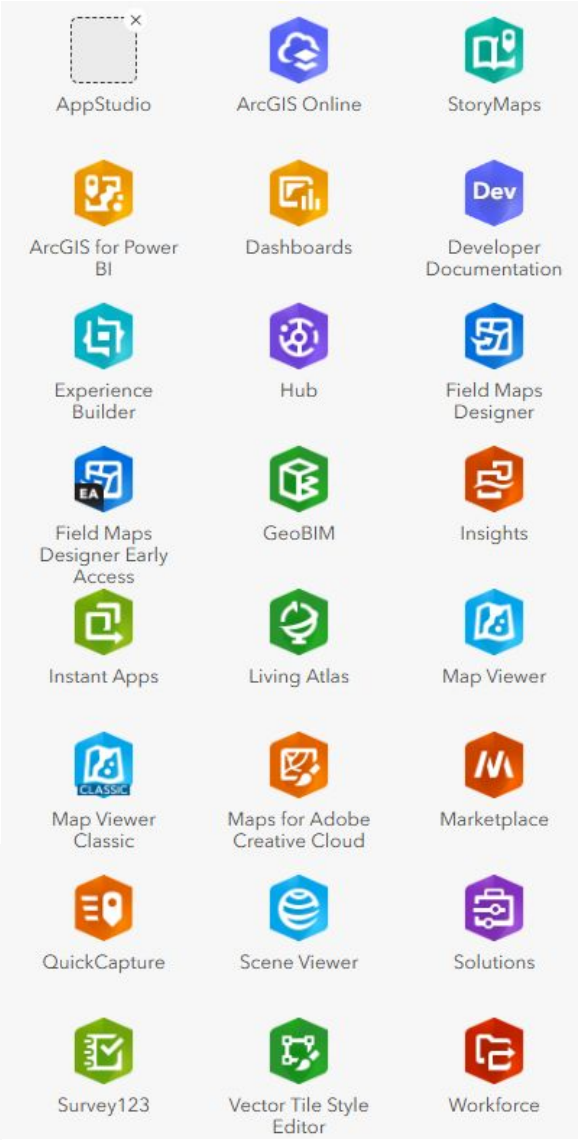


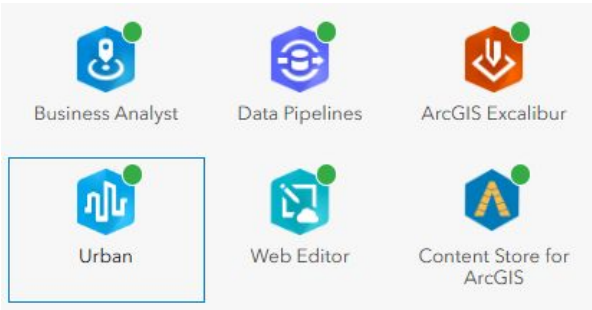
Access to a wide range of web applications :

- **Mapping** : *Map Viewer, Scene Viewer (3D), Vector style editor*
  - Create interactive 2D or 3D map
  - Custom basemaps
  - Perform spatial analysis*

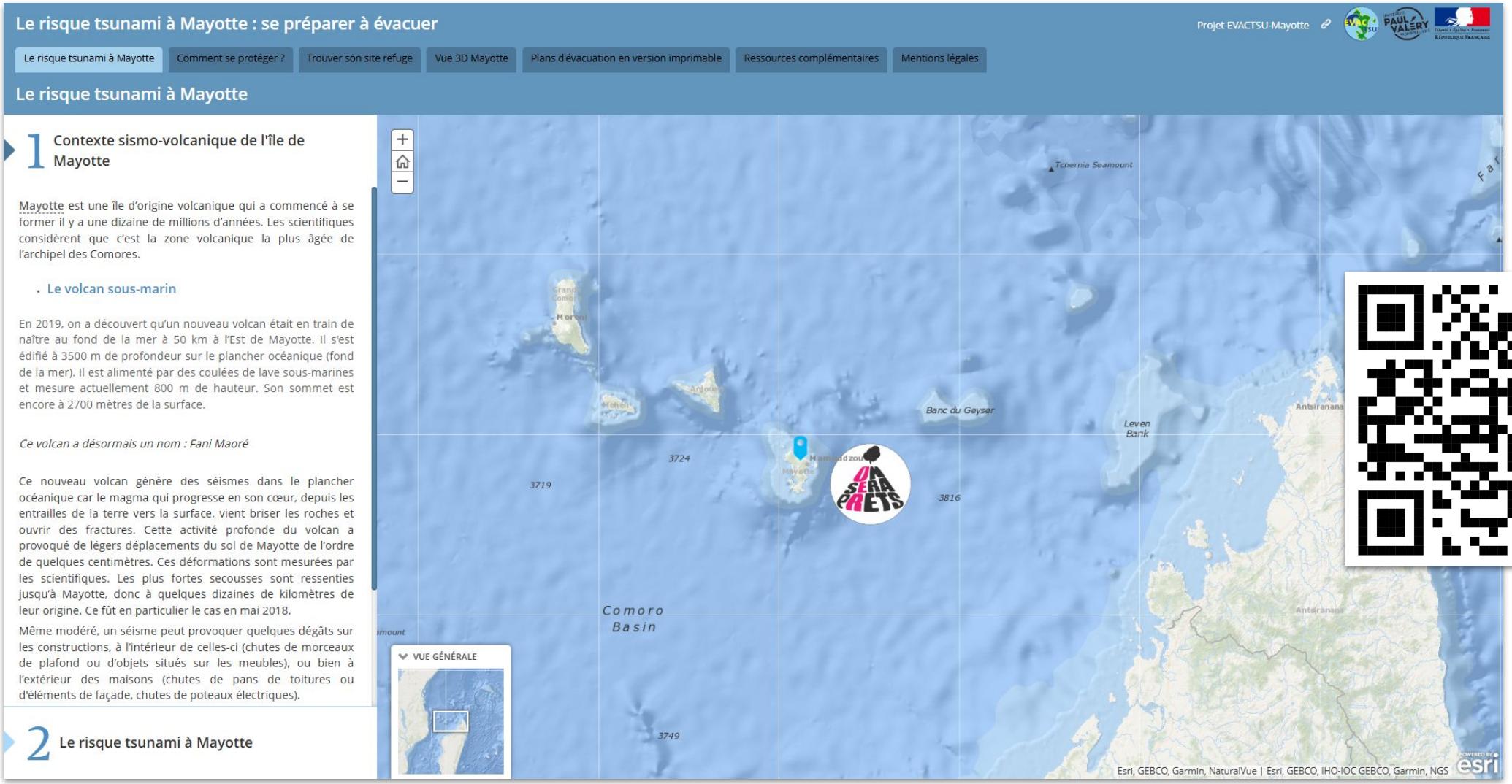
- **App creation** : *Storymap, Experience builder, Instant App*
  - WYSIWYG interface for web site creation
  - Integration of others ESRI's web app
  - User oriented application
  - Audience

- **Data collection** : *Field map designer, Survey123*
  - Conduct survey and perform result's analysis
  - Collect data on the field and cloud's synchronisation

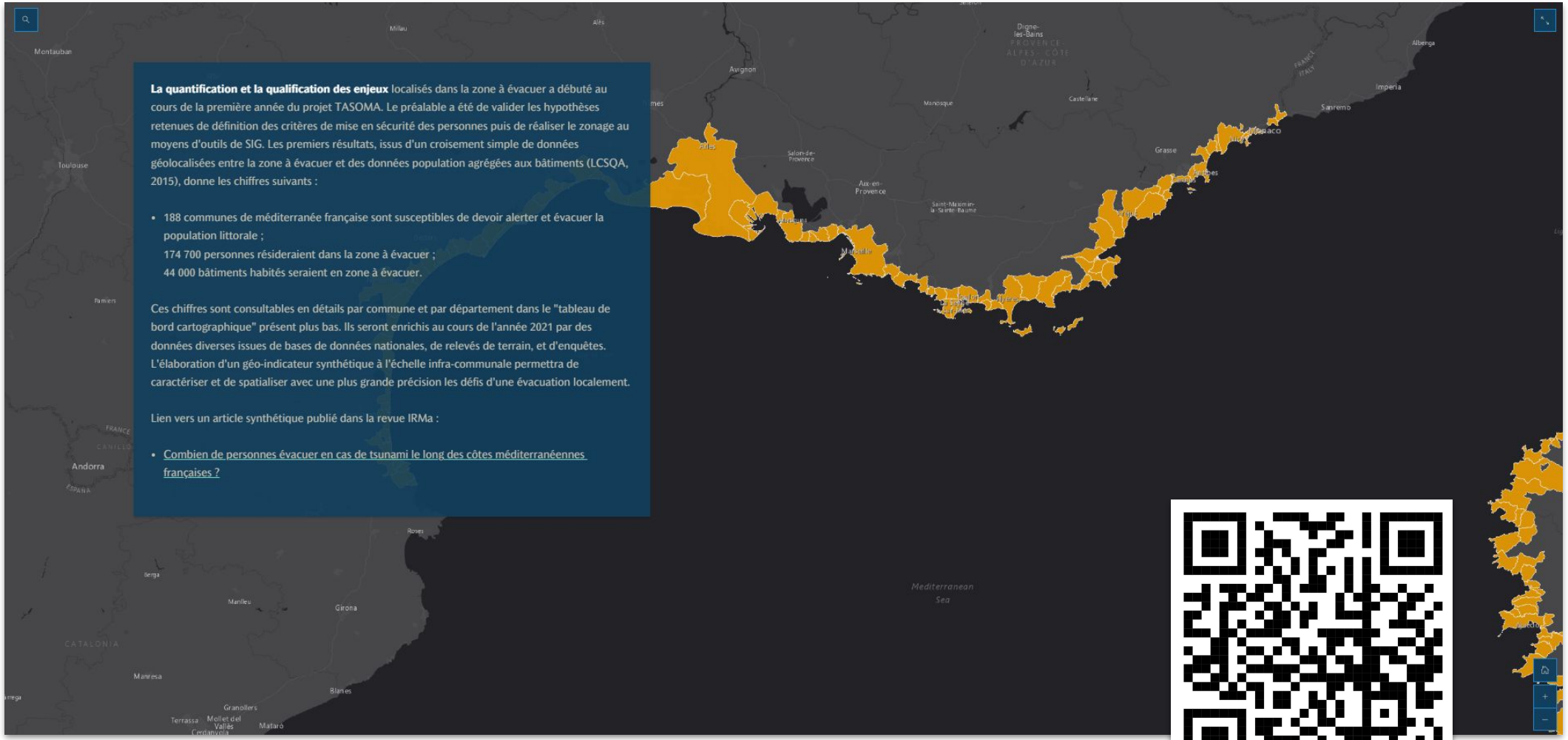




Storymap : EVACTSU Mayotte

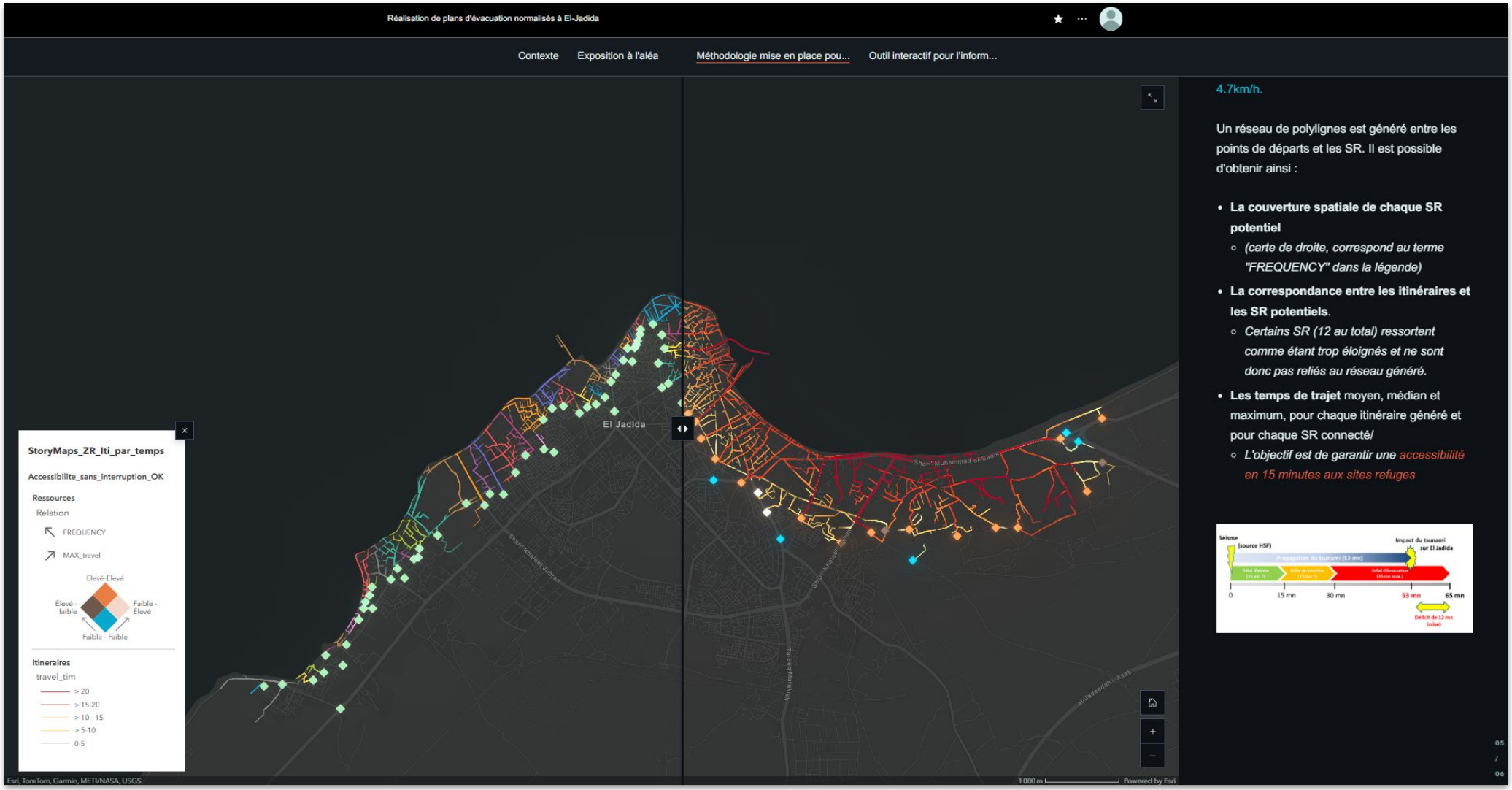


Storymap : TASOMA



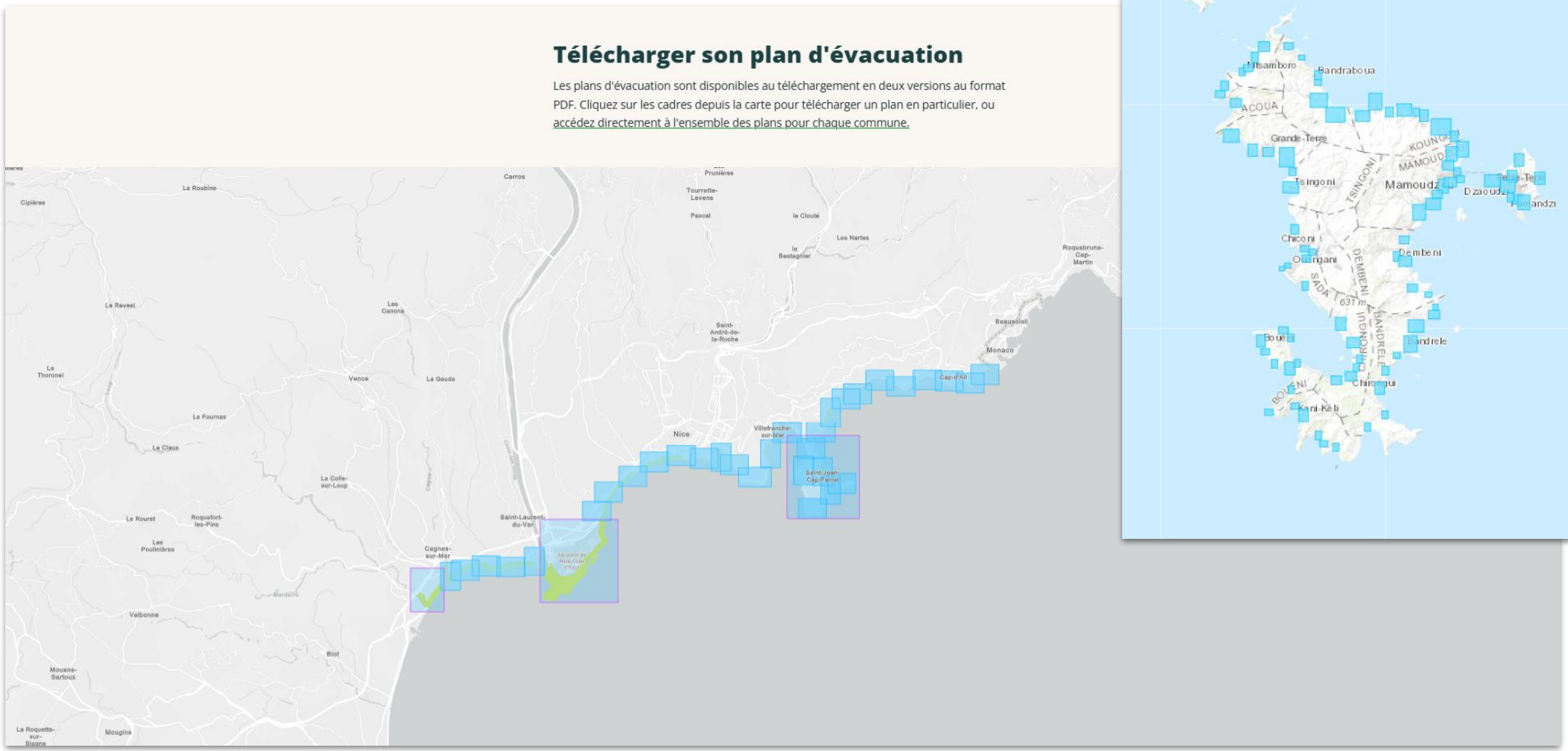
Embed geographic content with interactive elements.

StoryMaps



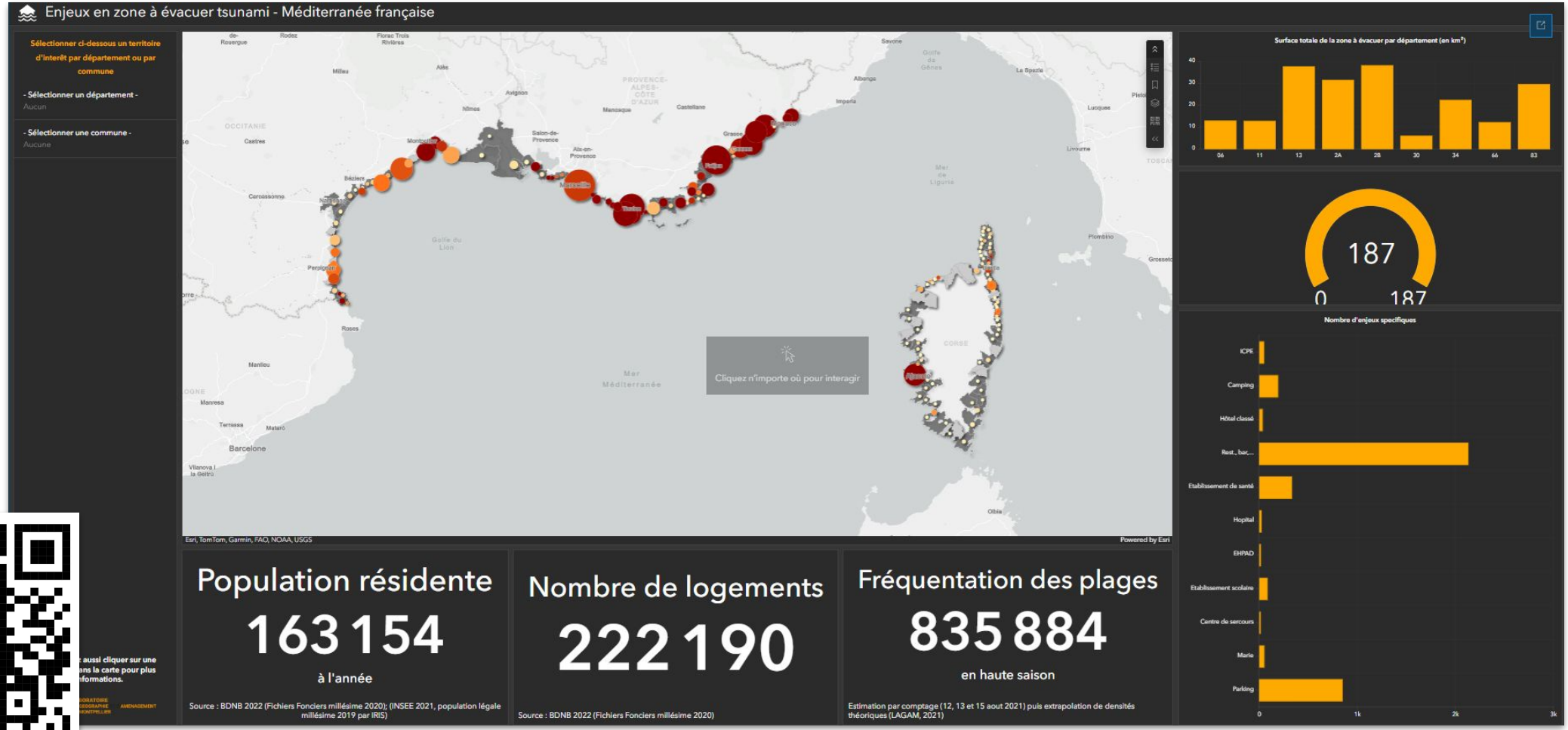
Public Access and Download of Evacuation Maps

StoryMaps



Dynamic data visualization

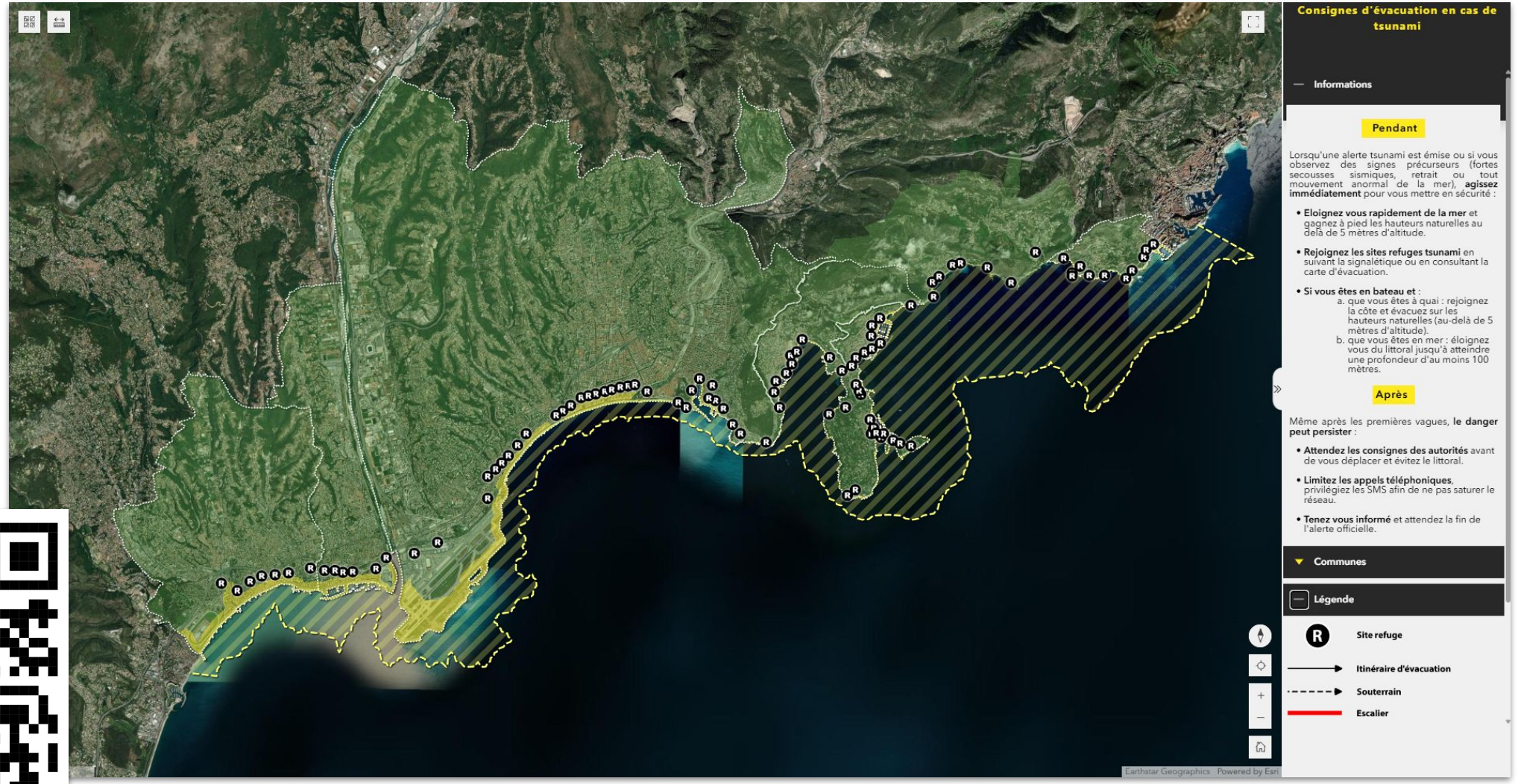
Dashboards



Dynamic cartography - Support for evacuation map diffusion

User oriented application

Experience Builder



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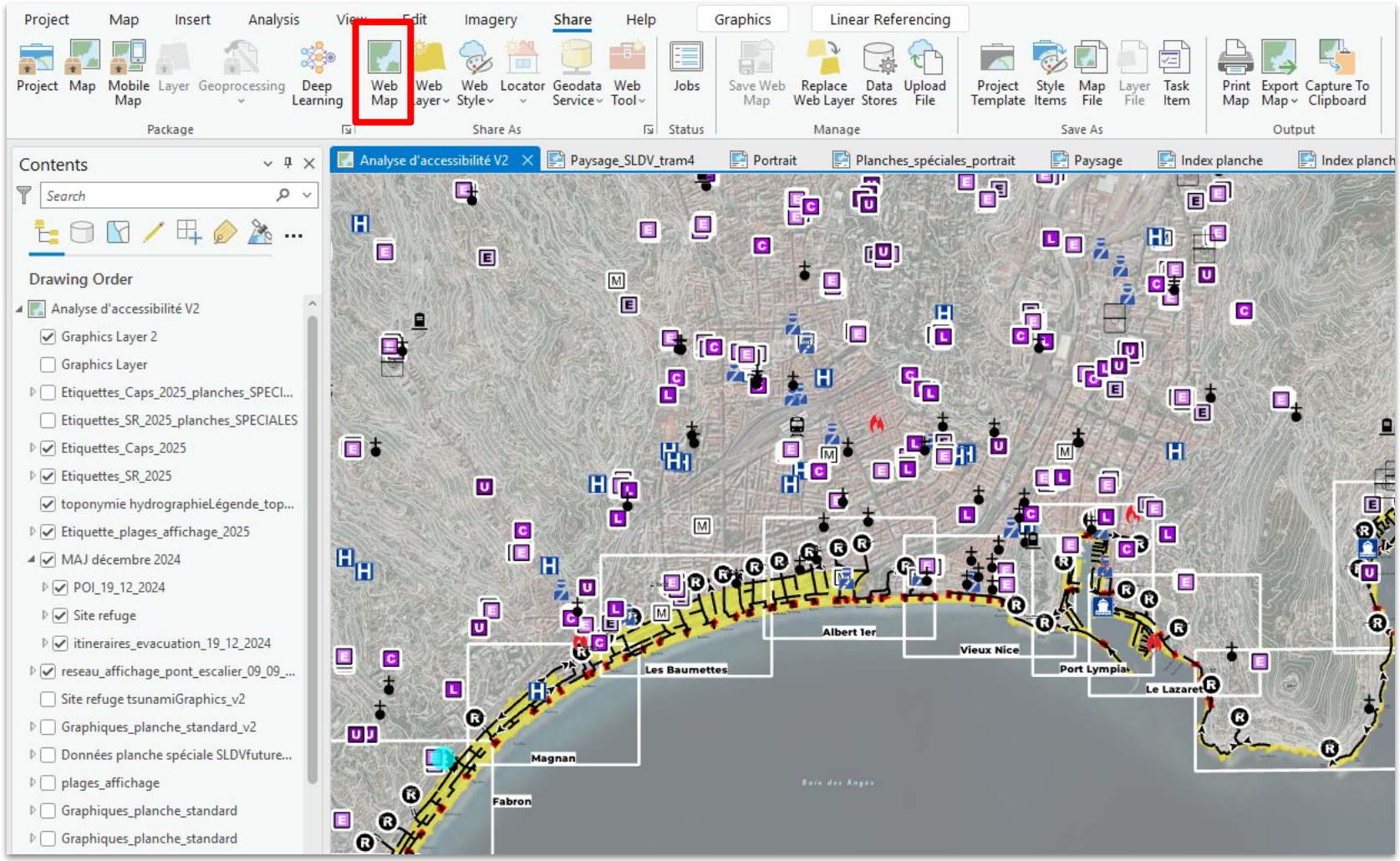
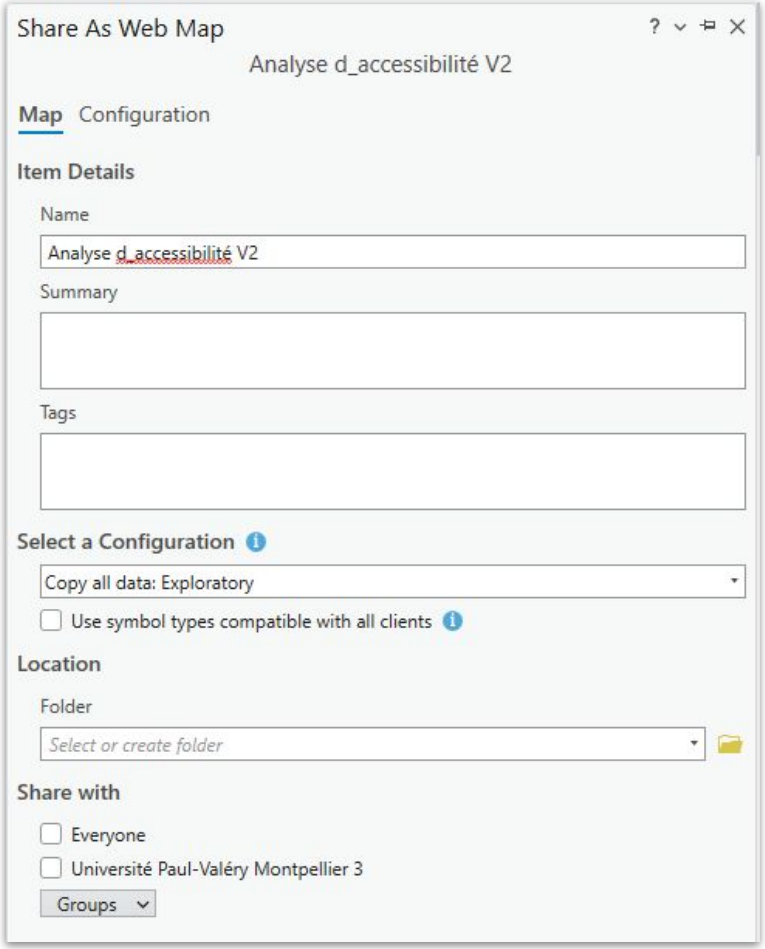
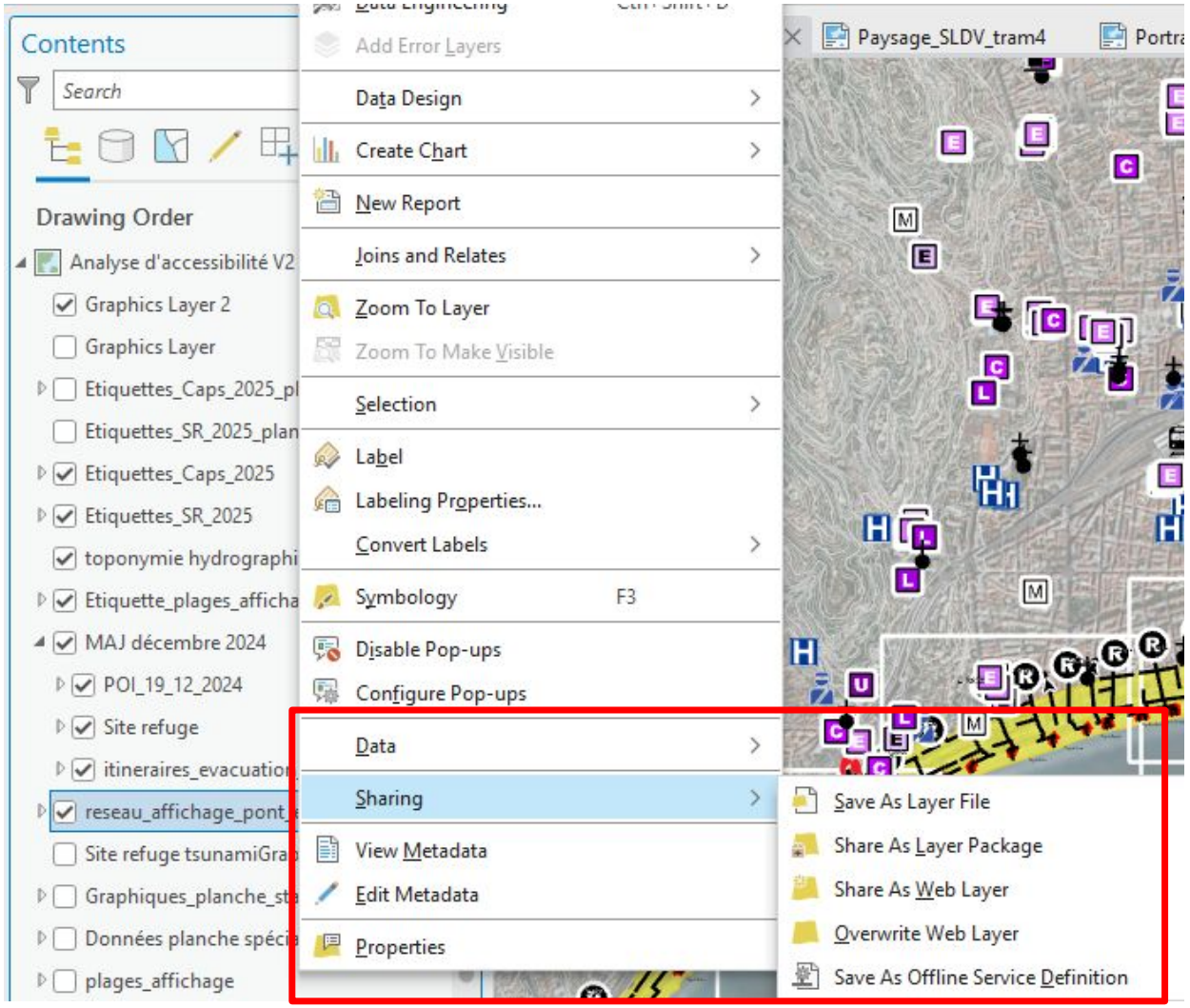
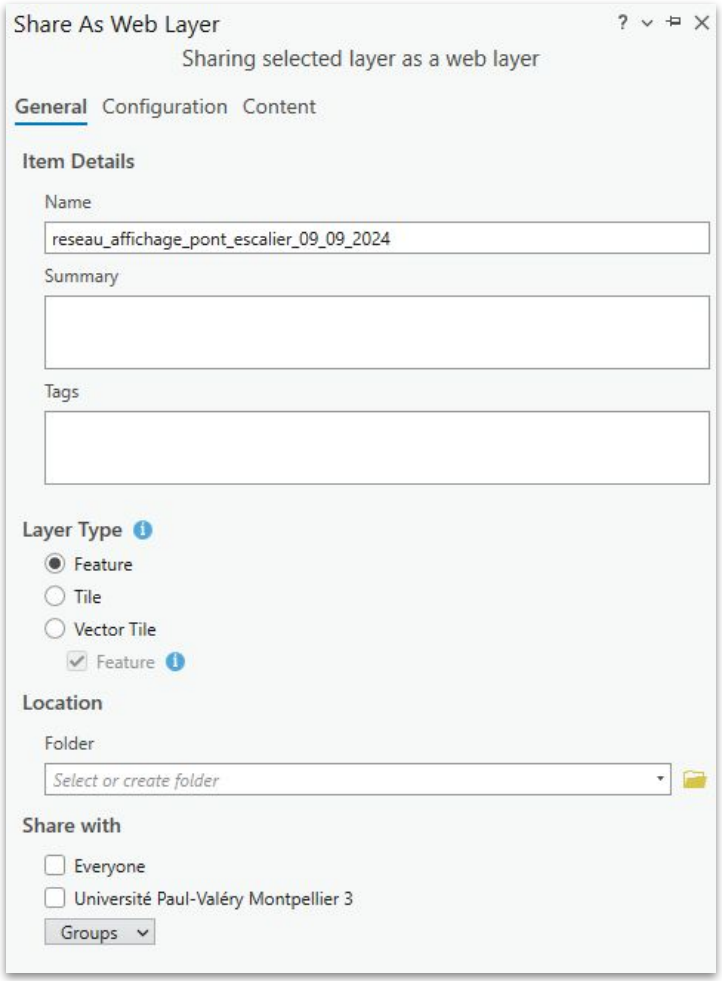
Uploading data to Arcgis Online - Option #1 (Project export)





Uploading data to Arcgis Online - Option #1 (Layer export)

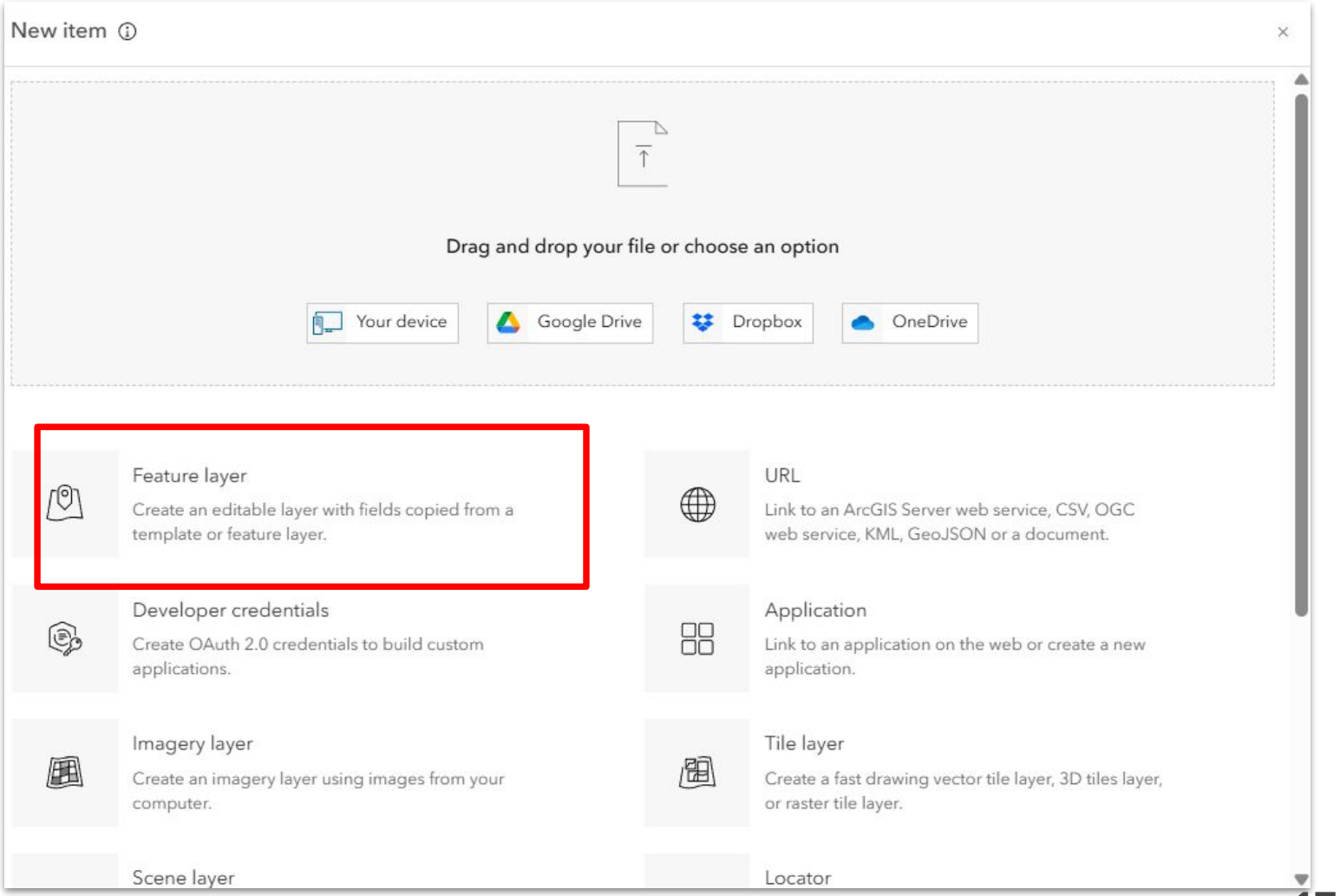




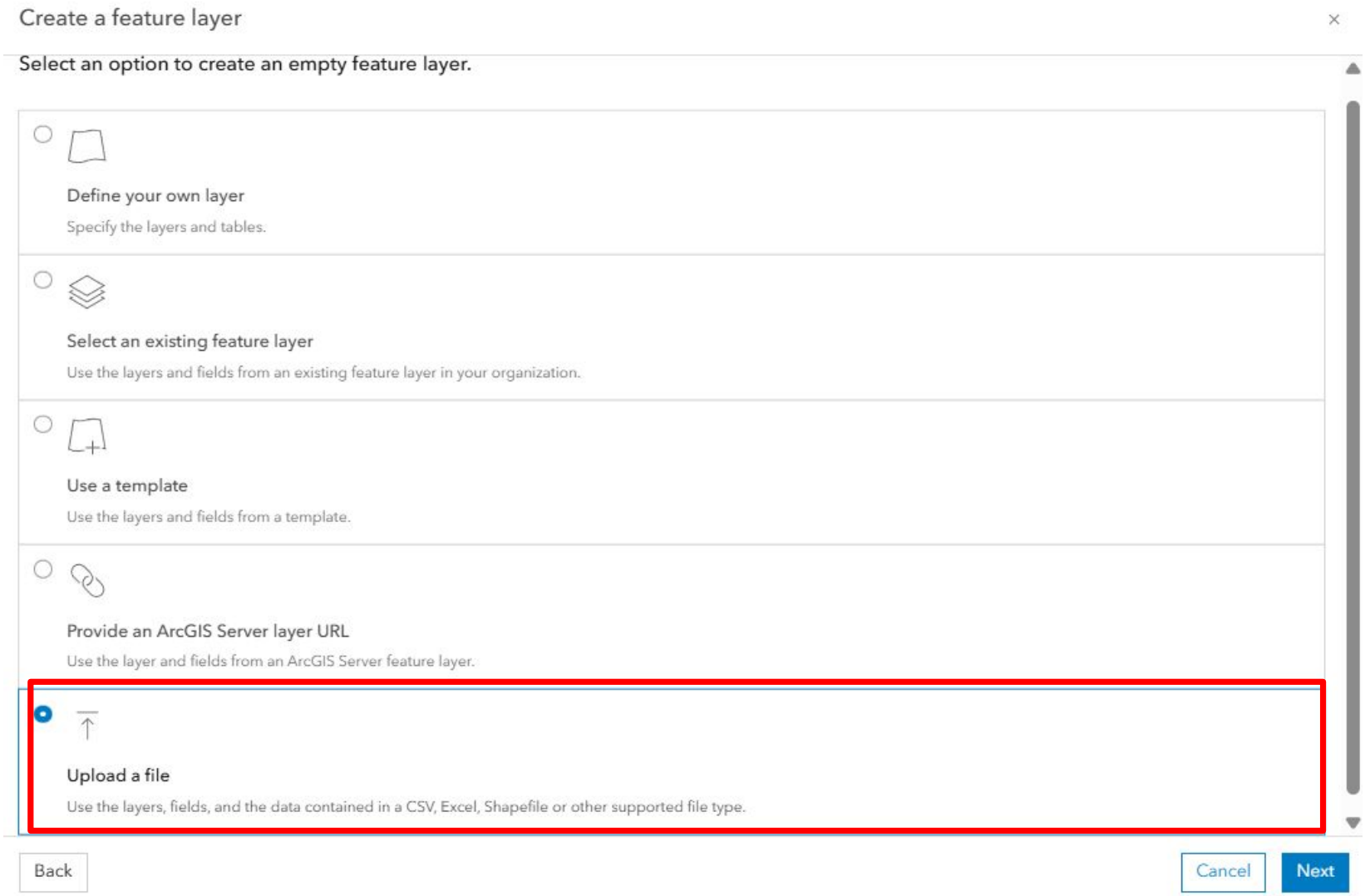
Uploading data to Arcgis Online - Option #2 (Online interface)

- Database connection
- Feature layer
  - Vector format
  - Geotagged pictures
- Tile imagery
- Arcgis 3D scene
- Web App
- Geocoding library
- PDF file

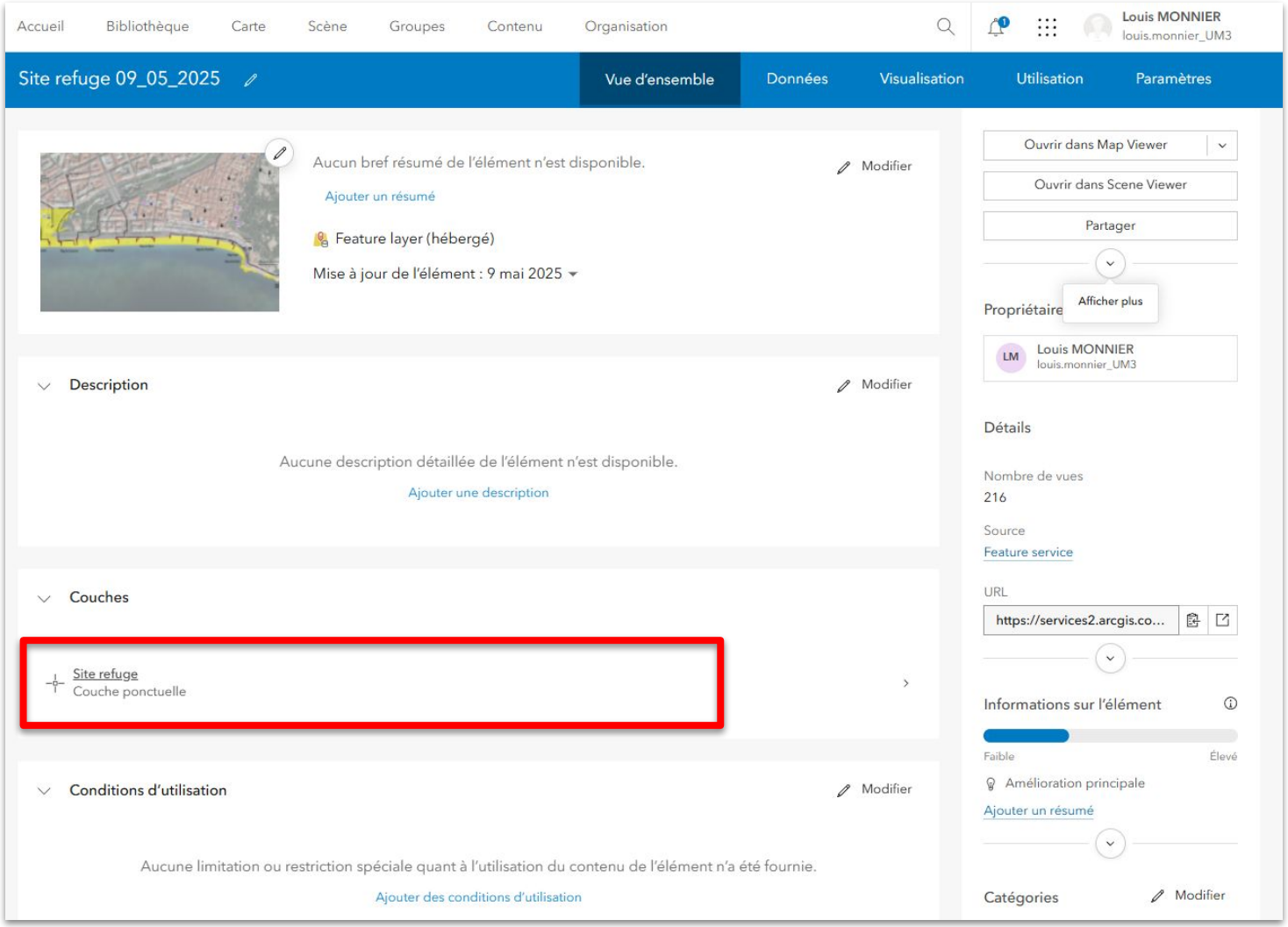
Vector data must me compressed (.zip, .7z) before import in Arcgis Online



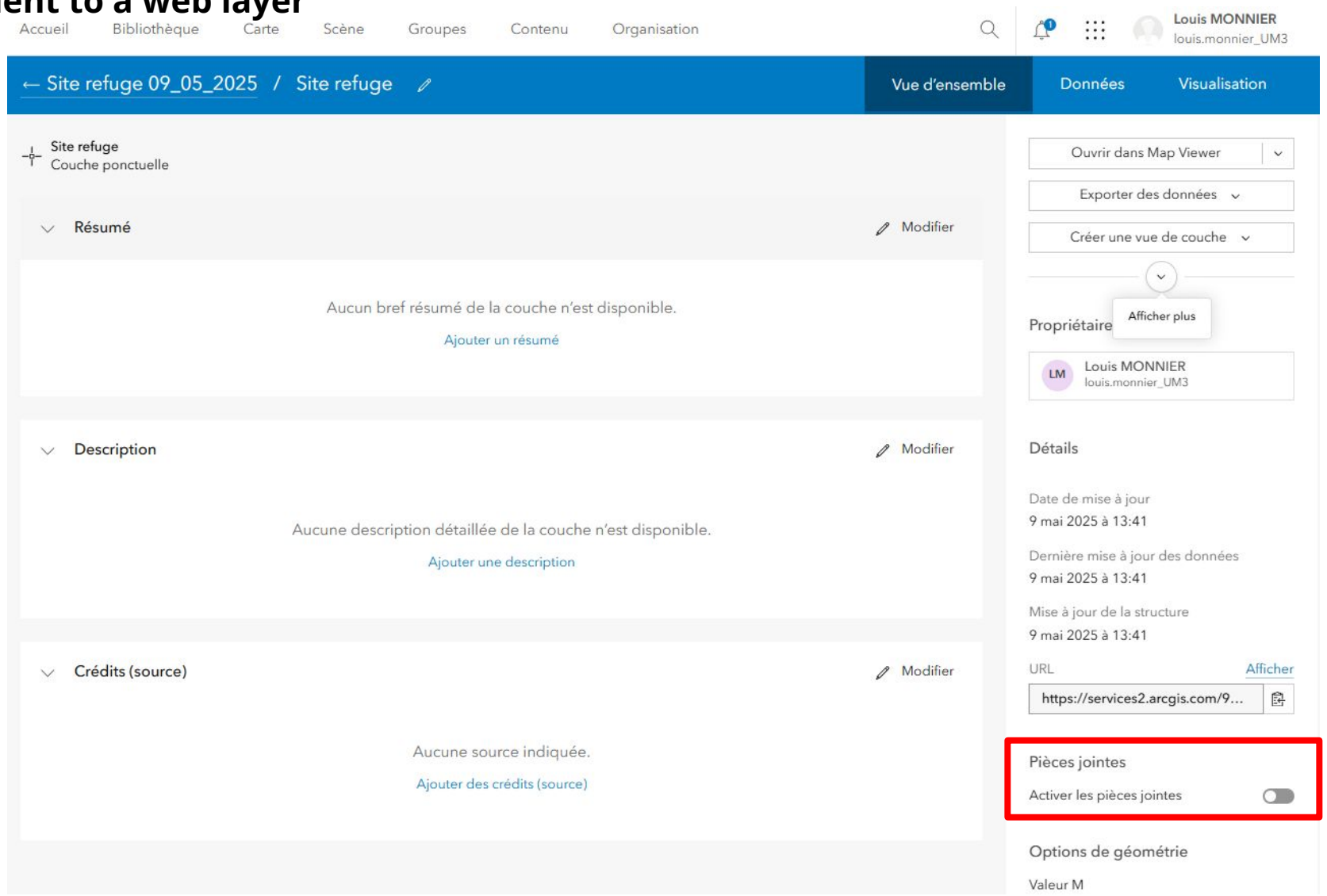
Uploading data to Arcgis Online - Option #2 (Online interface)



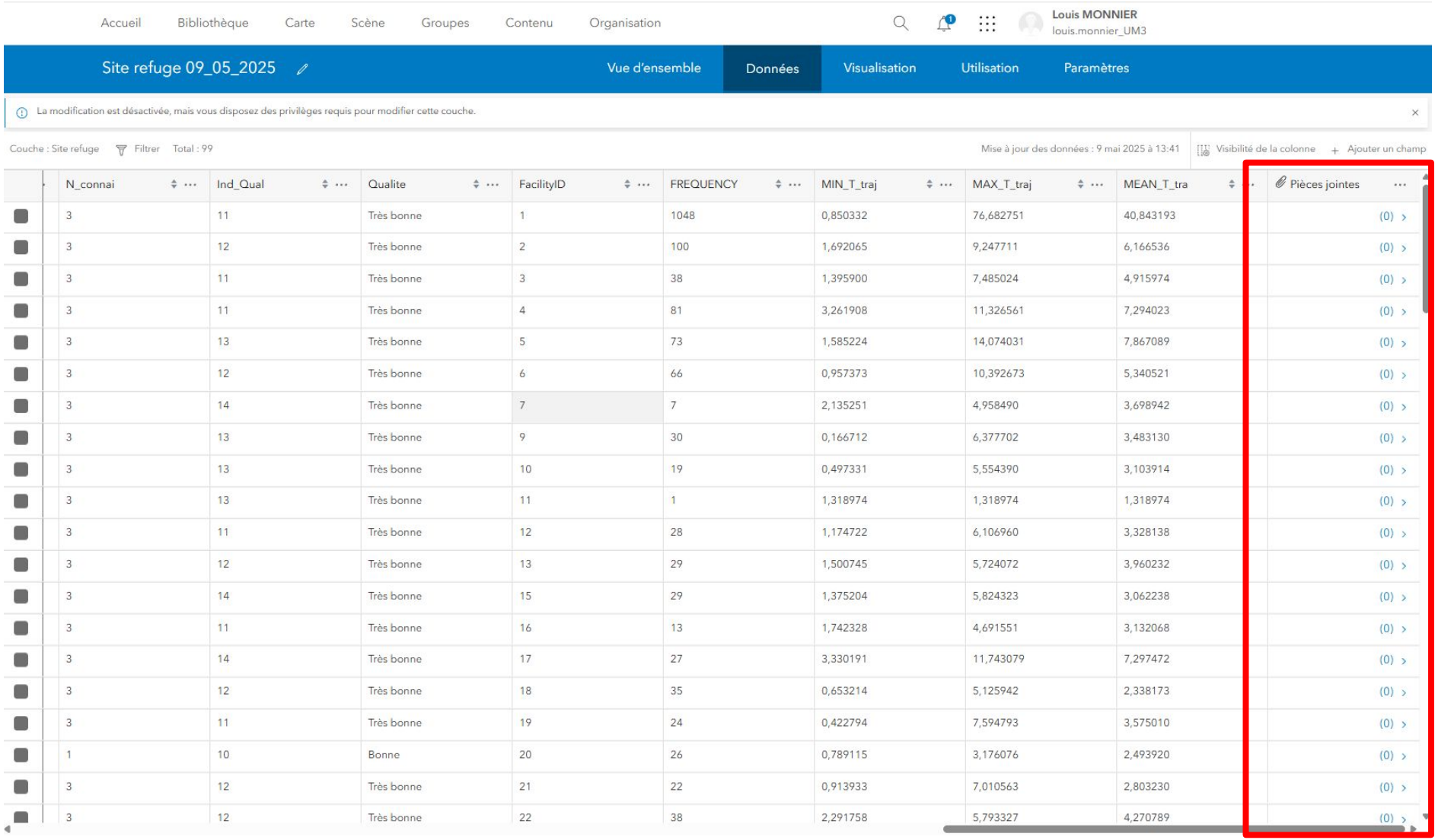
Upload attachment to a web layer



Upload attachment to a web layer

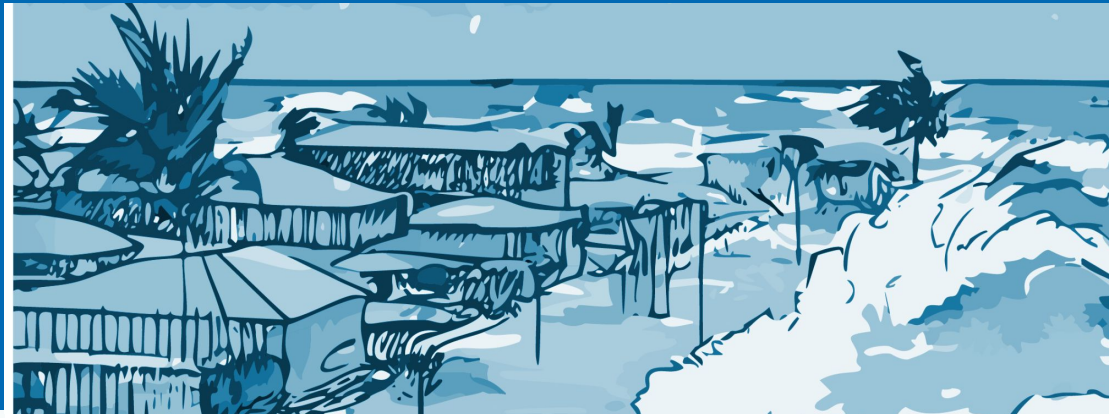


Upload attachment to a web layer



N_connai	Ind_Qual	Qualite	FacilityID	FREQUENCY	MIN_T_traj	MAX_T_traj	MEAN_T_tra	Pièces jointes
3	11	Très bonne	1	1048	0,850332	76,682751	40,843193	(0)
3	12	Très bonne	2	100	1,692065	9,247711	6,166536	(0)
3	11	Très bonne	3	38	1,395900	7,485024	4,915974	(0)
3	11	Très bonne	4	81	3,261908	11,326561	7,294023	(0)
3	13	Très bonne	5	73	1,585224	14,074031	7,867089	(0)
3	12	Très bonne	6	66	0,957373	10,392673	5,340521	(0)
3	14	Très bonne	7	7	2,135251	4,958490	3,698942	(0)
3	13	Très bonne	9	30	0,166712	6,377702	3,483130	(0)
3	13	Très bonne	10	19	0,497331	5,554390	3,103914	(0)
3	13	Très bonne	11	1	1,318974	1,318974	1,318974	(0)
3	11	Très bonne	12	28	1,174722	6,106960	3,328138	(0)
3	12	Très bonne	13	29	1,500745	5,724072	3,960232	(0)
3	14	Très bonne	15	29	1,375204	5,824323	3,062238	(0)
3	11	Très bonne	16	13	1,742328	4,691551	3,132068	(0)
3	14	Très bonne	17	27	3,330191	11,743079	7,297472	(0)
3	12	Très bonne	18	35	0,653214	5,125942	2,338173	(0)
3	11	Très bonne	19	24	0,422794	7,594793	3,575010	(0)
1	10	Bonne	20	26	0,789115	3,176076	2,493920	(0)
3	12	Très bonne	21	22	0,913933	7,010563	2,803230	(0)
3	12	Très bonne	22	38	2,291758	5,793327	4,270789	(0)

Tsunami Evacuation Mapping Workshop



CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

Dr. Matthieu Péroche
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30 June – 4 July 2025

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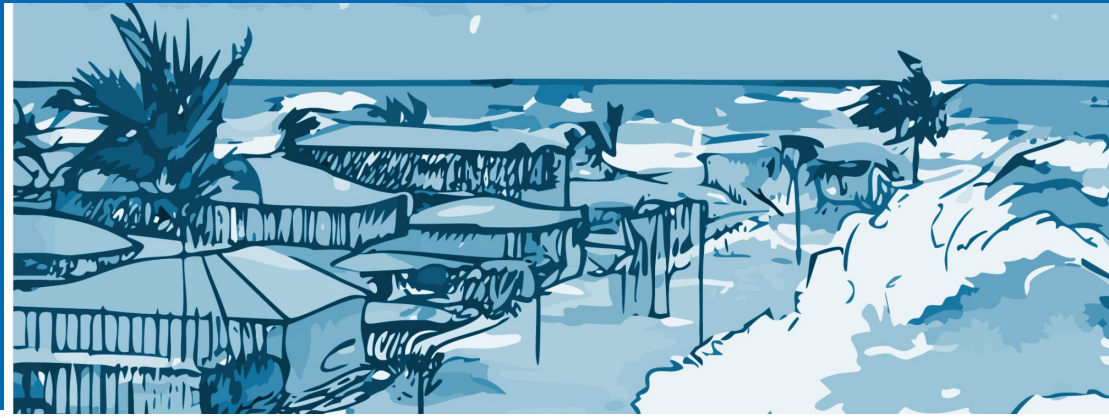

CoastWAVE 2.0 Project

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Lesson #6

Tsunami evacuation signage

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Tsunami evacuation signage

II	PREPAREDNESS (PREP)
4	**PREP-1**. Easily understood tsunami evacuation maps are approved.
5	**PREP-2**. Tsunami information including signage is publicly displayed.
6	**PREP-3**. Outreach and public awareness and education resources are available and distributed.
7	**PREP-4**. Outreach or educational activities are held at least three times a year.
8	**PREP-5**: A community tsunami exercise is conducted at least every two years.

The most visible way to educate the public about the tsunami hazard in the coastal zone is by using signboards. The tsunami signage will contribute to public awareness of the risk posed by tsunamis and better understanding of what should be done by the community in response to the event. It is critical that residents and tourists be aware of tsunami hazard zones, evacuation routes and safe zones in coastal areas.

- Signage needs to comply with national and/or international standards specifications.
- Signage must inform both the local population and international visitors.
- Local or national authorities have to define the number of signs by localities, but at a minimum, there must be signs for public education and signage for evacuation
- The adoption of a tsunami signage standard will provide a basis for a consistent set of signage and symbols nationwide.

Dr. Matthieu Péroche (matthieu.peroche@univ-montp3.fr) - Louis Monnier

Tsunami evacuation signage

In 2008, the International Organization for Standardization (ISO) approved international signage for tsunami hazard zones, evacuation areas and evacuation buildings.

ISO 20712 on water safety signs and beach safety flags provides guidance on safety signs that provide information about aquatic hazards and the action necessary to avoid those hazards, including signage for tsunami hazard areas.

Reference No : W056

Category : Warning

Registration date : 2019-07-30

Status : Active

Reference No : E062

Category : Evacuation route, location of safety equipment or safety facility, safety action

Registration date : 2019-07-30

Status : Active

Reference No : E063

Category : Evacuation route, location of safety equipment or safety facility, safety action

Registration date : 2019-07-30

Status : Active

http://itic.ioc-unesco.org/index.php?option=com_content&view=article&id=1645&Itemid=2322

https://www.iso.org/obp/ui#iso:grs:7010:E063

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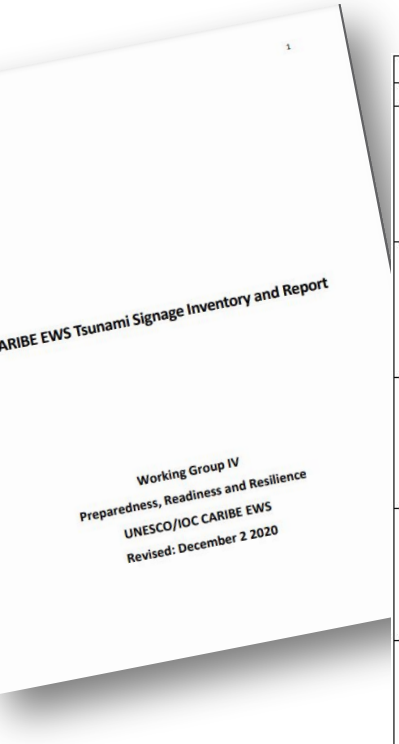
Tsunami evacuation signage

CARIBE EWS Tsunami Signage Inventory and Report



Costa Rica

Signage Art/Photo	Signage Type	General Information
 	Tsunami Hazard Zone	**Width/Height (ft.):** 90 cm x 60 cm **Materials (e.g. aluminum, plastic, or fiber glass):** Aluminum **Number of Signs Installed:** Quepos: 55 Ostional: 5
 	Entering/Leaving Tsunami Hazard Zone	**Width/Height (ft.):** **Materials (e.g. aluminum, plastic, or fiber glass):** **Number of Signs Installed:** Ostional: 13
 	Tsunami Evacuation Route	**Width/Height (ft.):** 90 cm x 60 cm **Materials (e.g. aluminum, plastic, or fiber glass):** Aluminum **Number of Signs Installed:** Quepos: 254 OOstional: 1
 	Tsunami Assembly Point	**Width/Height (ft.):** 90 cm x 60 cm **Materials (e.g. aluminum, plastic, or fiber glass):** Aluminum **Number of Signs Installed:** Quepos: 77 Ostional: 2
	Tsunami Evacuation Map	**Width/Height (ft.):** 2.2 m x 2.1 m **Materials (e.g. aluminum, plastic, or fiber glass):** Aluminum **Number of Signs Installed:** Quepos: 13
	Tsunami Ready Recognition	**Width/Height (ft.):** **Materials (e.g. aluminum, plastic, or fiber glass):** **Number of Signs Installed:**

Person Completing Survey: Silvia Chacón Berrantes (silviach@una.ac.cr)

Member State Contact Information:
NTWC: Sistema Nacional Monitoreo de Tsunami, Dr. Silvia Chacón Barrantes, Coordinator. Tel: +50683096690, +50688957414, +50622102872. E-mail: sinamot@una.cr, silviach@una.ac.cr, sinamot.cr@gmail.com

Comments: There are two communities recognized as Tsunami Ready in Costa Rica: Quepos and Ostional. Both communities use two different types of tsunami signage. Quepos signage are mainly green and yellow, meanwhile the signage of Ostional are blue.

Honduras

Signage Art/Photo	Signage Type	General Information
	Tsunami Hazards Zone	**Width/Height (ft.):** **Materials (e.g. aluminum, plastic, or fiber glass):** **Number of Signs Installed:**
	Entering/Leaving Tsunami Hazard Zone	**Width/Height (ft.):** **Materials (e.g. aluminum, plastic, or fiber glass):** **Number of Signs Installed:**
	Tsunami Evacuation Route	**Width/Height (ft.):** **Materials (e.g. aluminum, plastic, or fiber glass):** **Number of Signs Installed:**
	Tsunami Assembly Point	**Width/Height (ft.):** **Materials (e.g. aluminum, plastic, or fiber glass):** **Number of Signs Installed:**
	Tsunami Evacuation Map	**Width/Height (ft.):** **Materials (e.g. aluminum, plastic, or fiber glass):** **Number of Signs Installed:**
	Tsunami Ready Recognition	**Width/Height (ft.):** **Materials (e.g. aluminum, plastic, or fiber glass):** **Number of Signs Installed:**

Person Completing Survey:

Member state Contact Information:
NTWC & TWFP: Comisión Permanente de Contingencias,Mr. Juan José Reyes (Alerta Temprana) Tel: +50433994815 Email: martincito1968@yahoo.com
TNC: Comisión Permanente de Contingencias, Lic. Oscar Renan Mencia Irias (Director Nacional de Gestión de Preparación y Respuesta a la Emergencia) Tel: +50422290606 ext 3301 Email: oscarmencia@copeco.gob.hn

Comments: The signage belongs to the Cedeño community, located in the Pacific coast of Honduras.

(Note form CTWP):

Trinidad & Tobago

Signage Art/Photo	Signage Type	General Information
	Tsunami Hazards Zone	**Width/Height (ft.):** 24" x 24" **Materials (e.g. aluminum, plastic, or fiber glass):** Aluminum **Number of Signs Installed:** 7
	Entering/Leaving Tsunami Hazard Zone	**Width/Height (ft.):** **Materials (e.g. aluminum, plastic, or fiber glass):** **Number of Signs Installed:**
	Tsunami Evacuation Route	**Width/Height (ft.):** 36" x 36" **Materials (e.g. aluminum, plastic, or fiber glass):** Aluminum **Number of Signs Installed:** 7
	Tsunami Assembly Point	**Width/Height (ft.):** 36" x 24" **Materials (e.g. aluminum, plastic, or fiber glass):** **Number of Signs Installed:** 2
	Tsunami Evacuation Map	**Width/Height (ft.):** **Materials (e.g. aluminum, plastic, or fiber glass):** **Number of Signs Installed:**
	Tsunami Ready Recognition	**Width/Height (ft.):** 36" x 24" **Materials (e.g. aluminum, plastic, or fiber glass):** Aluminum **Number of Signs Installed:** 1

Person Completing Survey: Muhammad Anwar Baksh

Member state Contact Information:
NTWC: Office of Disaster Preparedness and Management (ODPM), Rodney Smart (Chief Executive Officer) Tel: +18686401285 Email: rsmart@mns.gov.tt , odpmalerts@mns.gov.tt
TWFP: Trinidad and Tobago Meteorological Services, Mr. Ezekiel Sampson (Director) Tel: +18686694392, +18686695465 Email: synop@metoffice.gov.tt , Seide.Shakeer@metoffice.gov.tt , dirmet@metoffice.gov.tt

Comments: The signage correspond to the community of Carenage.

(Note form CTWP):

http://itic.ioc-unesco.org/index.php?option=com_oe&task=viewDocumentRecord&docID=28111

Tsunami evacuation signage

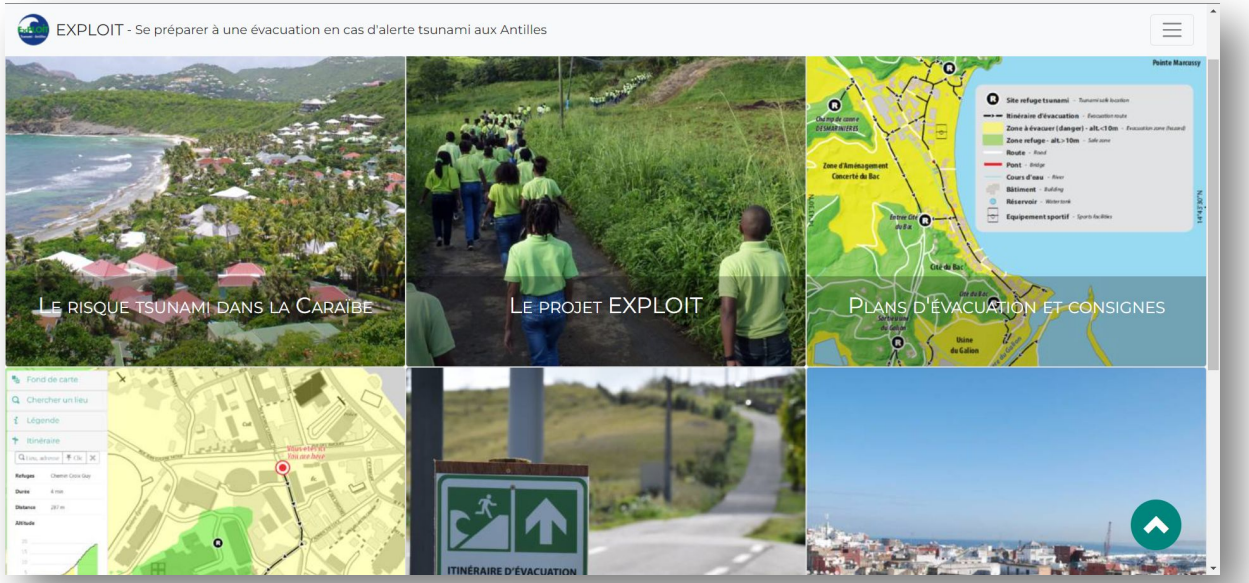
The first tsunami evacuation signs in the French West Indies (Martinique, 2013)

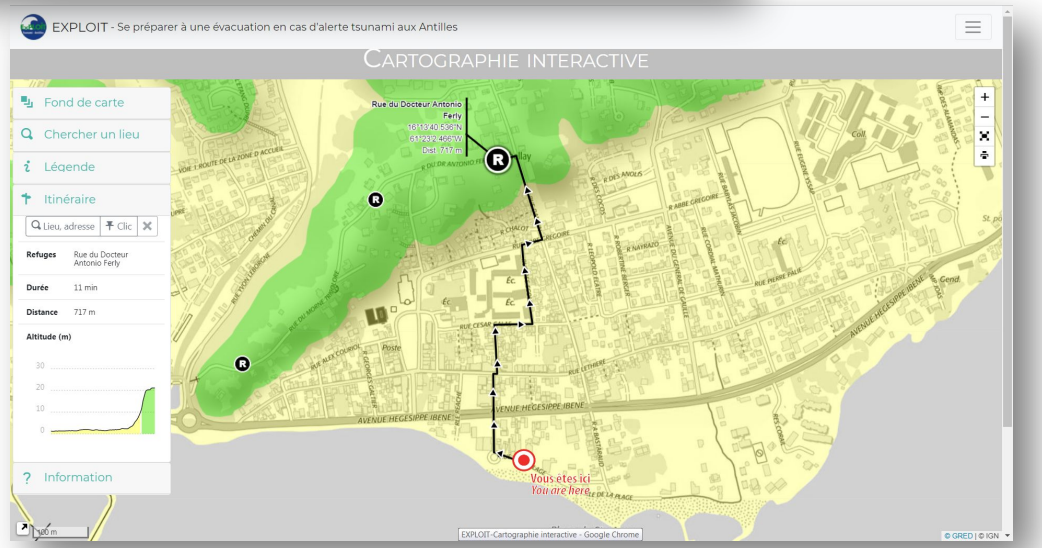
Dr. Matthieu Péroche (matthieu.peroche@univ-montp3.fr) - Louis Monnier

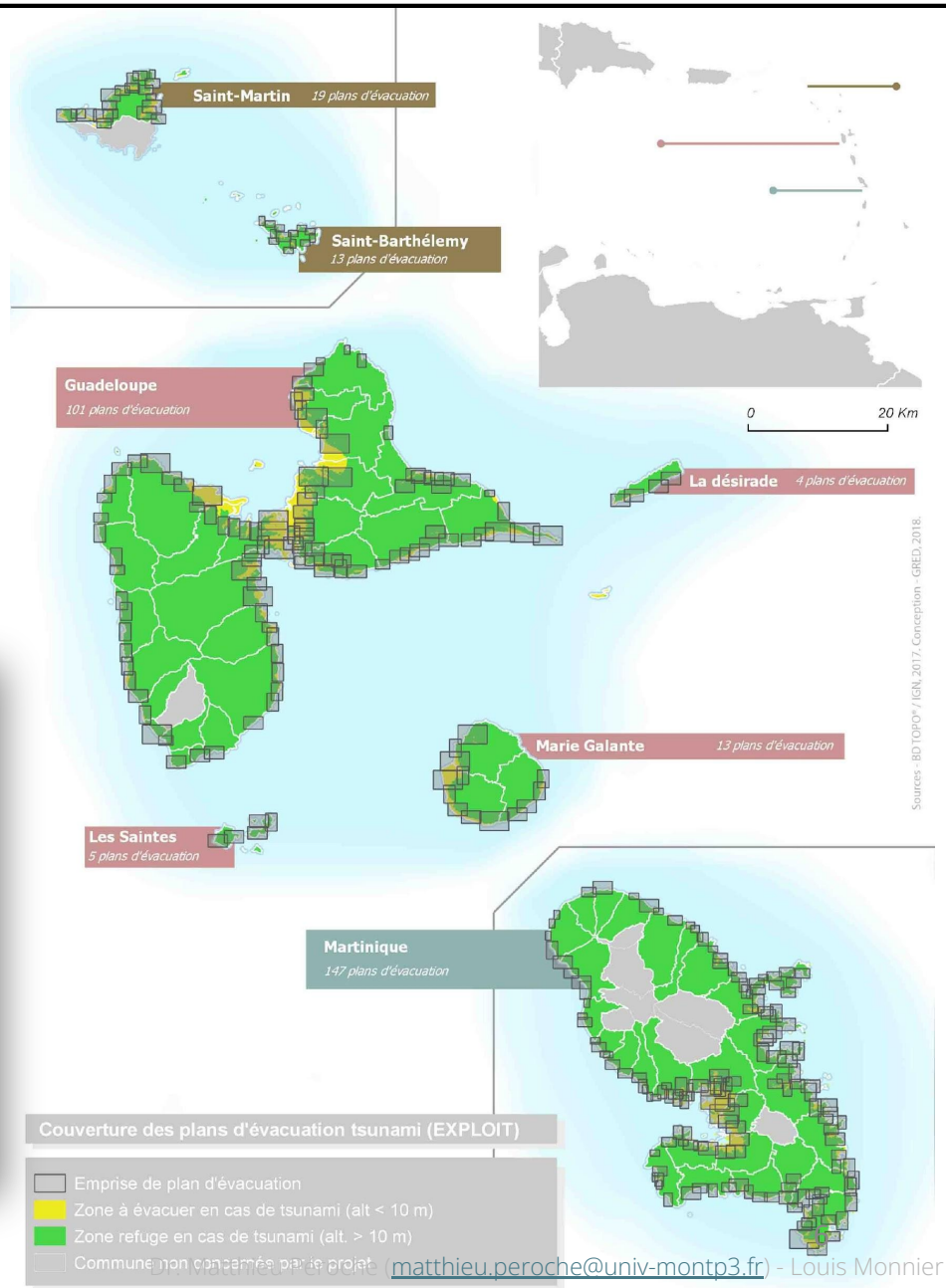
Lesson #6

Tsunami evacuation signage

Coastwave 2.0 Evacuation Mapping Workshop







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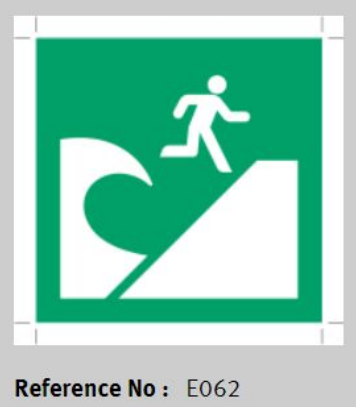
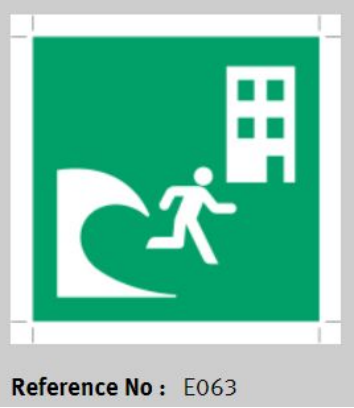
Tsunami evacuation signage

The ISO-approved signage consists of three signs :

Tsunami Hazard Zone (left) - To warn of a hazard from tsunami waves



• **Tsunami Evacuation Area (middle) -** To indicate the location of a safe place/uphill area for evacuation to in the event of a tsunami



• **Tsunami Evacuation Building (right) -** To indicate the location of a safe building for evacuation in the event of a tsunami

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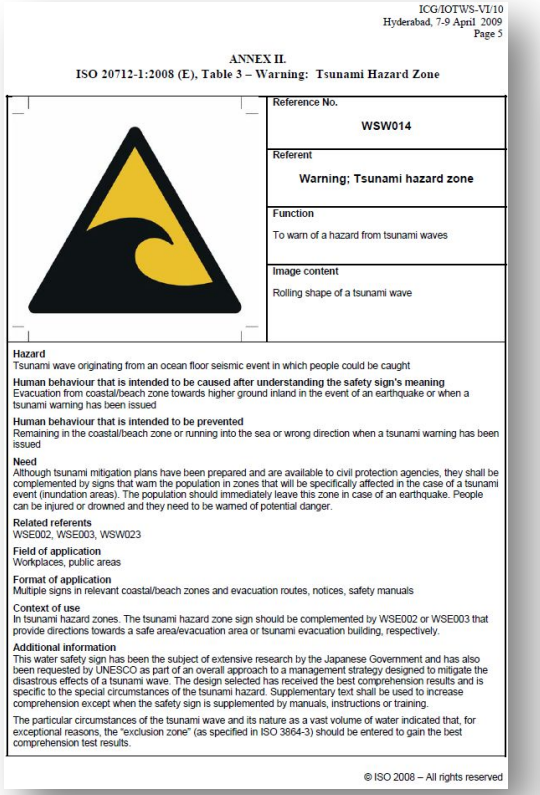
Tsunami evacuation signage

The ISO-approved signage consists of three signs :



ICG/IOTWS-VI/10
Hyderabad, 7-9 April 2009
Page 5

ANNEX II.
ISO 20712-1:2008 (E), Table 3 – Warning: Tsunami Hazard Zone

	Reference No. WSW014
	Referent: Warning; Tsunami hazard zone
	Function: To warn of a hazard from tsunami waves
	Image content: Rolling shape of a tsunami wave

Hazard
Tsunami wave originating from an ocean floor seismic event in which people could be caught

Human behaviour that is intended to be caused after understanding the safety sign's meaning
Evacuation from coastal/beach zone towards higher ground inland in the event of an earthquake or when a tsunami warning has been issued

Human behaviour that is intended to be prevented
Remaining in the coastal/beach zone or running into the sea or wrong direction when a tsunami warning has been issued

Need
Although tsunami mitigation plans have been prepared and are available to civil protection agencies, they shall be complemented by signs that warn the population in zones that will be specifically affected in the case of a tsunami event (inundation areas). The population should immediately leave this zone in case of an earthquake. People can be injured or drowned and they need to be warned of potential danger.

Related referents
WSE002, WSE003, WSW023

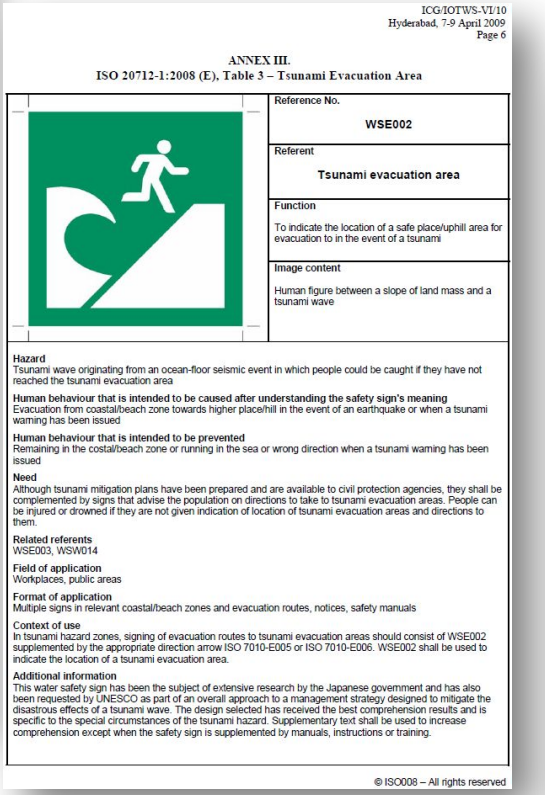
Field of application
Workplaces, public areas

Format of application
Multiple signs in relevant coastal/beach zones and evacuation routes, notices, safety manuals

Context of use
In tsunami hazard zones. The tsunami hazard zone sign should be complemented by WSE002 or WSE003 that provide directions towards a safe area/evacuation area or tsunami evacuation building, respectively.

Additional information
This water safety sign has been the subject of extensive research by the Japanese Government and has also been requested by UNESCO as part of an overall approach to a management strategy designed to mitigate the disastrous effects of a tsunami wave. The design selected has received the best comprehension results and is specific to the special circumstances of the tsunami hazard. Supplementary text shall be used to increase comprehension except when the safety sign is supplemented by manuals, instructions or training.

The particular circumstances of the tsunami wave and its nature as a vast volume of water indicated that, for exceptional reasons, the "exclusion zone" (as specified in ISO 3864-3) should be entered to gain the best comprehension test results.



ICG/IOTWS-VI/10
Hyderabad, 7-9 April 2009
Page 6

ANNEX III.
ISO 20712-1:2008 (E), Table 3 – Tsunami Evacuation Area

	Reference No. WSE002
	Referent: Tsunami evacuation area
	Function: To indicate the location of a safe place/uphill area for evacuation to in the event of a tsunami
	Image content: Human figure between a slope of land mass and a tsunami wave

Hazard
Tsunami wave originating from an ocean-floor seismic event in which people could be caught if they have not reached the tsunami evacuation area

Human behaviour that is intended to be caused after understanding the safety sign's meaning
Evacuation from coastal/beach zone towards higher place/hill in the event of an earthquake or when a tsunami warning has been issued

Human behaviour that is intended to be prevented
Remaining in the costal/beach zone or running in the sea or wrong direction when a tsunami warning has been issued

Need
Although tsunami mitigation plans have been prepared and are available to civil protection agencies, they shall be complemented by signs that advise the population on directions to take to tsunami evacuation areas. People can be injured or drowned if they are not given indication of location of tsunami evacuation areas and directions to them.

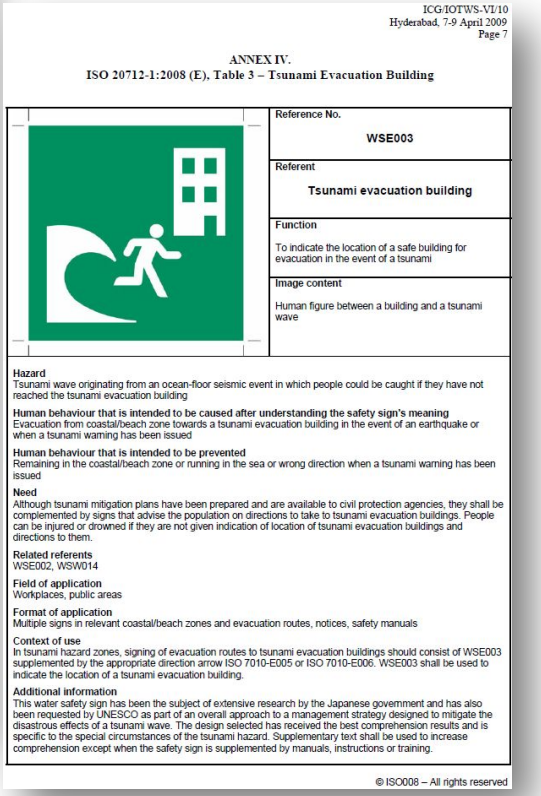
Related referents
WSE003, WSW014

Field of application
Workplaces, public areas

Format of application
Multiple signs in relevant coastal/beach zones and evacuation routes, notices, safety manuals

Context of use
In tsunami hazard zones, signing of evacuation routes to tsunami evacuation areas should consist of WSE002 supplemented by the appropriate direction arrow ISO 7010-E005 or ISO 7010-E006. WSE002 shall be used to indicate the location of a tsunami evacuation area.

Additional information
This water safety sign has been the subject of extensive research by the Japanese government and has also been requested by UNESCO as part of an overall approach to a management strategy designed to mitigate the disastrous effects of a tsunami wave. The design selected has received the best comprehension results and is specific to the special circumstances of the tsunami hazard. Supplementary text shall be used to increase comprehension except when the safety sign is supplemented by manuals, instructions or training.



ICG/IOTWS-VI/10
Hyderabad, 7-9 April 2009
Page 7

ANNEX IV.
ISO 20712-1:2008 (E), Table 3 – Tsunami Evacuation Building

	Reference No. WSE003
	Referent: Tsunami evacuation building
	Function: To indicate the location of a safe building for evacuation in the event of a tsunami
	Image content: Human figure between a building and a tsunami wave

Hazard
Tsunami wave originating from an ocean-floor seismic event in which people could be caught if they have not reached the tsunami evacuation building

Human behaviour that is intended to be caused after understanding the safety sign's meaning
Evacuation from coastal/beach zone towards a tsunami evacuation building in the event of an earthquake or when a tsunami warning has been issued

Human behaviour that is intended to be prevented
Remaining in the coastal/beach zone or running in the sea or wrong direction when a tsunami warning has been issued

Need
Although tsunami mitigation plans have been prepared and are available to civil protection agencies, they shall be complemented by signs that advise the population on directions to take to tsunami evacuation buildings. People can be injured or drowned if they are not given indication of location of tsunami evacuation buildings and directions to them.

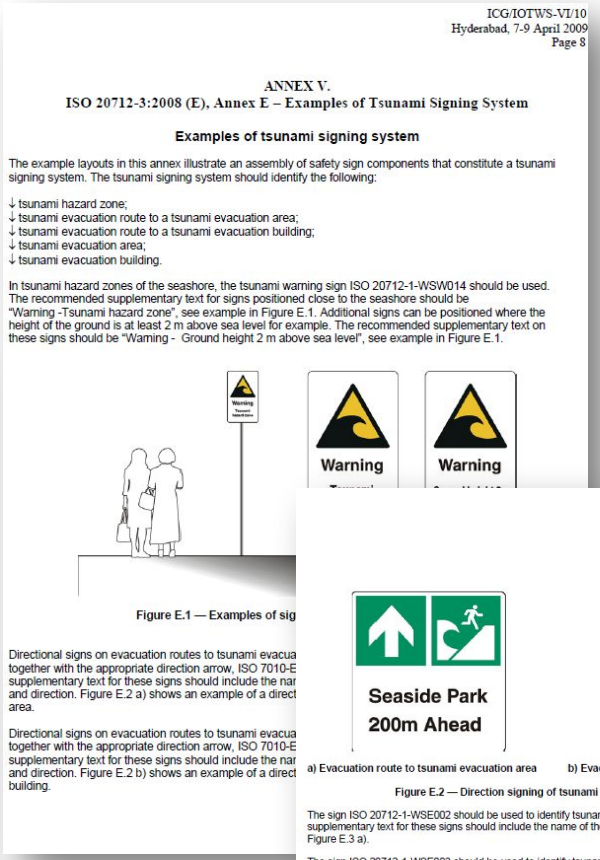
Related referents
WSE002, WSW014

Field of application
Workplaces, public areas

Format of application
Multiple signs in relevant coastal/beach zones and evacuation routes, notices, safety manuals

Context of use
In tsunami hazard zones, signing of evacuation routes to tsunami evacuation buildings should consist of WSE003 supplemented by the appropriate direction arrow ISO 7010-E005 or ISO 7010-E006. WSE003 shall be used to indicate the location of a tsunami evacuation building.

Additional information
This water safety sign has been the subject of extensive research by the Japanese government and has also been requested by UNESCO as part of an overall approach to a management strategy designed to mitigate the disastrous effects of a tsunami wave. The design selected has received the best comprehension results and is specific to the special circumstances of the tsunami hazard. Supplementary text shall be used to increase comprehension except when the safety sign is supplemented by manuals, instructions or training.



ICG/IOTWS-VI/10
Hyderabad, 7-9 April 2009
Page 8

ANNEX V.
ISO 20712-3:2008 (E), Annex E – Examples of Tsunami Signing System

Examples of tsunami signing system

The example layouts in this annex illustrate an assembly of safety sign components that constitute a tsunami signing system. The tsunami signing system should identify the following:

- tsunami hazard zone;
- tsunami evacuation route to a tsunami evacuation area;
- tsunami evacuation route to a tsunami evacuation building;
- tsunami evacuation area;
- tsunami evacuation building.

In tsunami hazard zones of the seashore, the tsunami warning sign ISO 20712-1-WSW014 should be used. The recommended supplementary text for signs positioned close to the seashore should be "Warning -Tsunami hazard zone", see example in Figure E.1. Additional signs can be positioned where the height of the ground is at least 2 m above sea level for example. The recommended supplementary text on these signs should be "Warning - Ground height 2 m above sea level", see example in Figure E.1.

Figure E.1 — Examples of sig

Directional signs on evacuation routes to tsunami evacua
together with the appropriate direction arrow, ISO 7010-E
supplementary text for these signs should include the nar
and direction. Figure E.2 a) shows an example of a direct
area.

Directional signs on evacuation routes to tsunami evacua
together with the appropriate direction arrow, ISO 7010-E
supplementary text for these signs should include the nar
and direction. Figure E.2 b) shows an example of a direct
building.

ICG/IOTWS-VI/10
Hyderabad, 7-9 April 2009
Page 9

a) Evacuation route to tsunami evacuation area b) Evacuation route to tsunami evacuation building

Figure E.2 — Direction signing of tsunami evacuation routes examples

The sign ISO 20712-1-WSE002 should be used to identify tsunami evacuation areas. The recommended supplementary text for these signs should include the name of the tsunami evacuation area, see the example in Figure E.3 a).

The sign ISO 20712-1-WSE003 should be used to identify tsunami evacuation buildings. The recommended supplementary text for these signs should include the name of the tsunami evacuation building, see the example in Figure E.3 b).

a) Tsunami evacuation area b) Tsunami evacuation building

Figure E.3 — Signing of tsunami evacuation areas and evacuation buildings examples

https://oceanexpert.org/downloadFile/6200

Tsunami evacuation signage

Adaptation of the international tsunami hazard signage (ISO 20712 standards) – TSUNAMI EVACUATION ZONE

Download link : https://exploit.univ-montp3.fr/5-ressources.html

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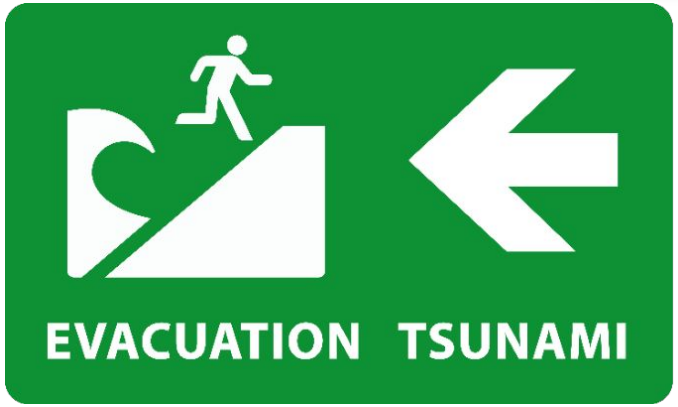
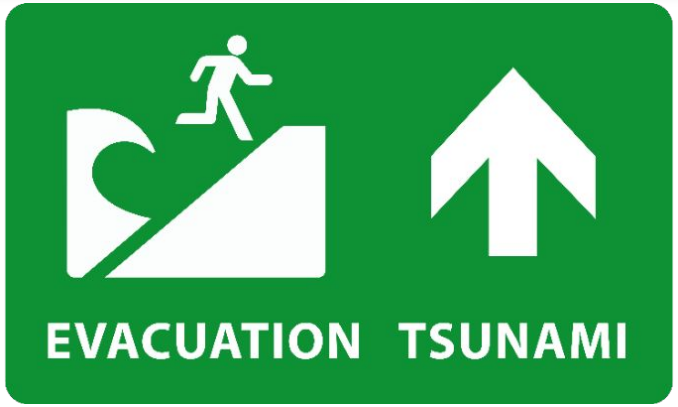
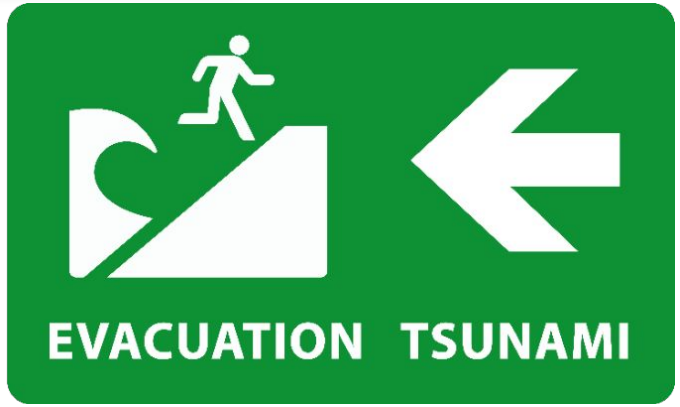
Tsunami evacuation signage

Adaptation of the international tsunami hazard signage (ISO 20712 standards) – EVACUATION ROUTE







Download link : https://exploit.univ-montp3.fr/5-ressources.html

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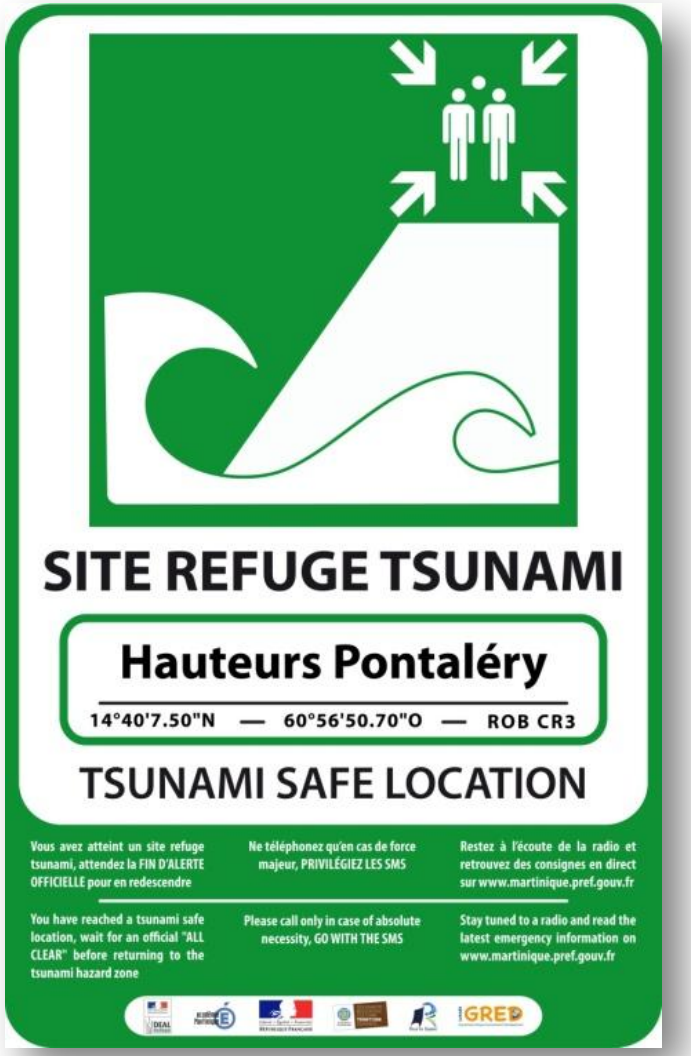
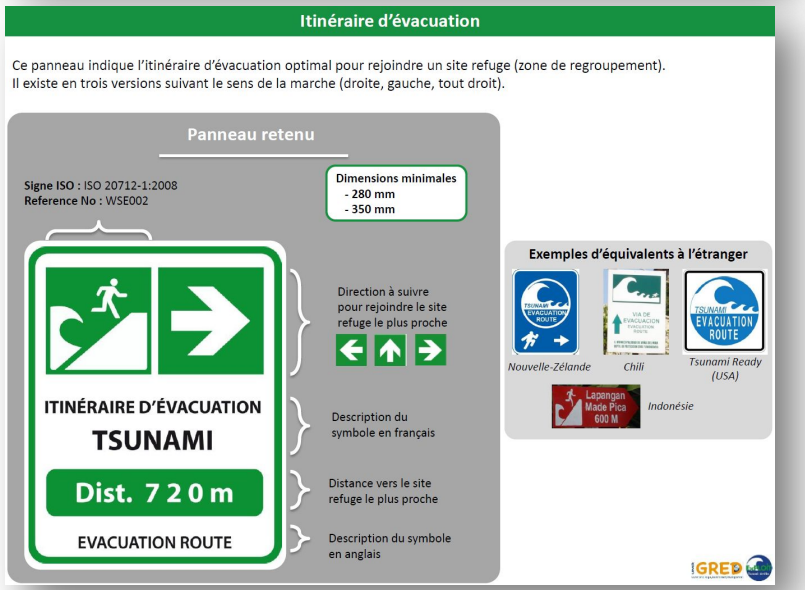
Tsunami evacuation signage

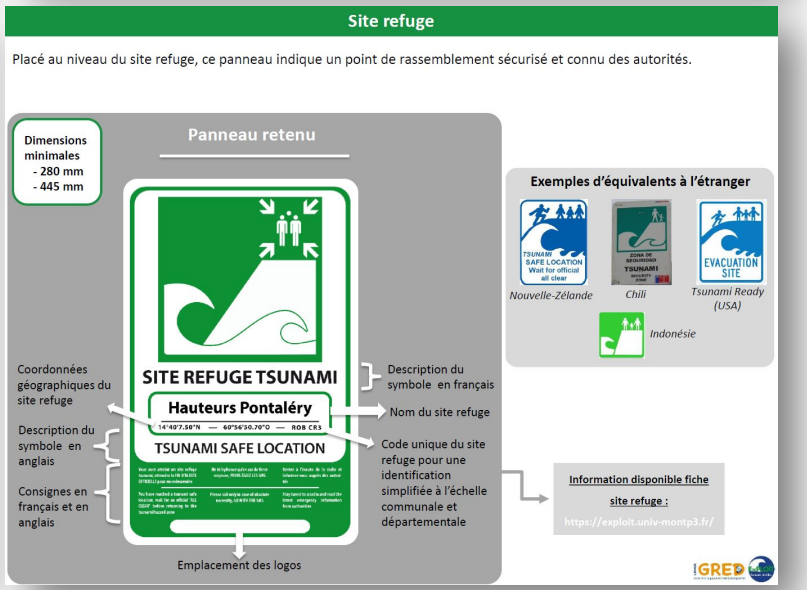
Adaptation of the international tsunami hazard signage (ISO 20712 standards) – SAFE LOCATION



Download link :
https://exploit.univ-montp3.fr/5-ressources.html

Tsunami evacuation signage





Download link :

https://exploit.univ-montp3.fr/data/RESSOURCES/Panneaux/Charte_panneaux.pdf

Tsunami evacuation signage

Tsunami evacuation exercise
Middle School of Robert 2016

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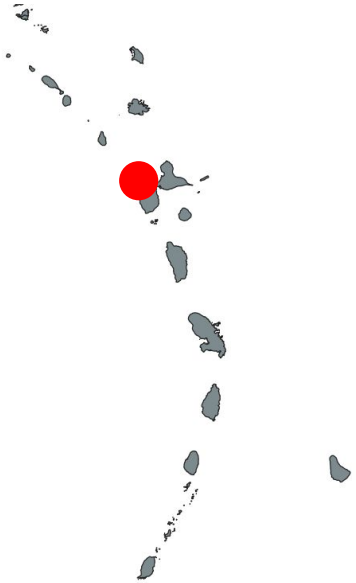
Tsunami evacuation signage

C . Jaffrézic, 2021

Present-day situation in FWI
Guadeloupe island

C. Jaffrézic, 2021



C. Jaffrézic, 2021

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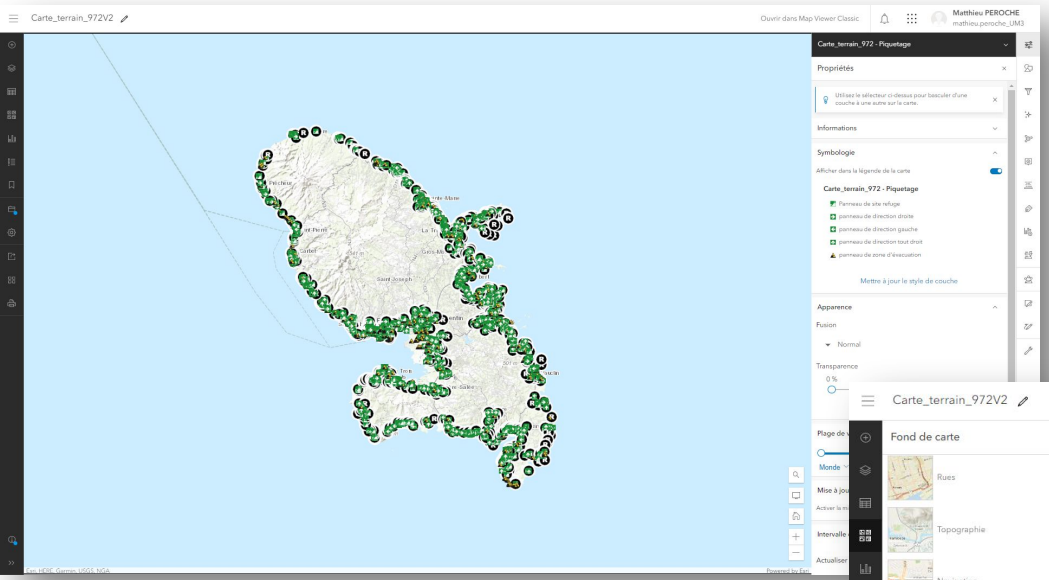
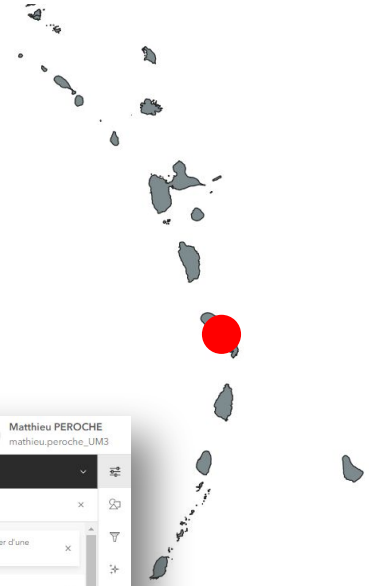
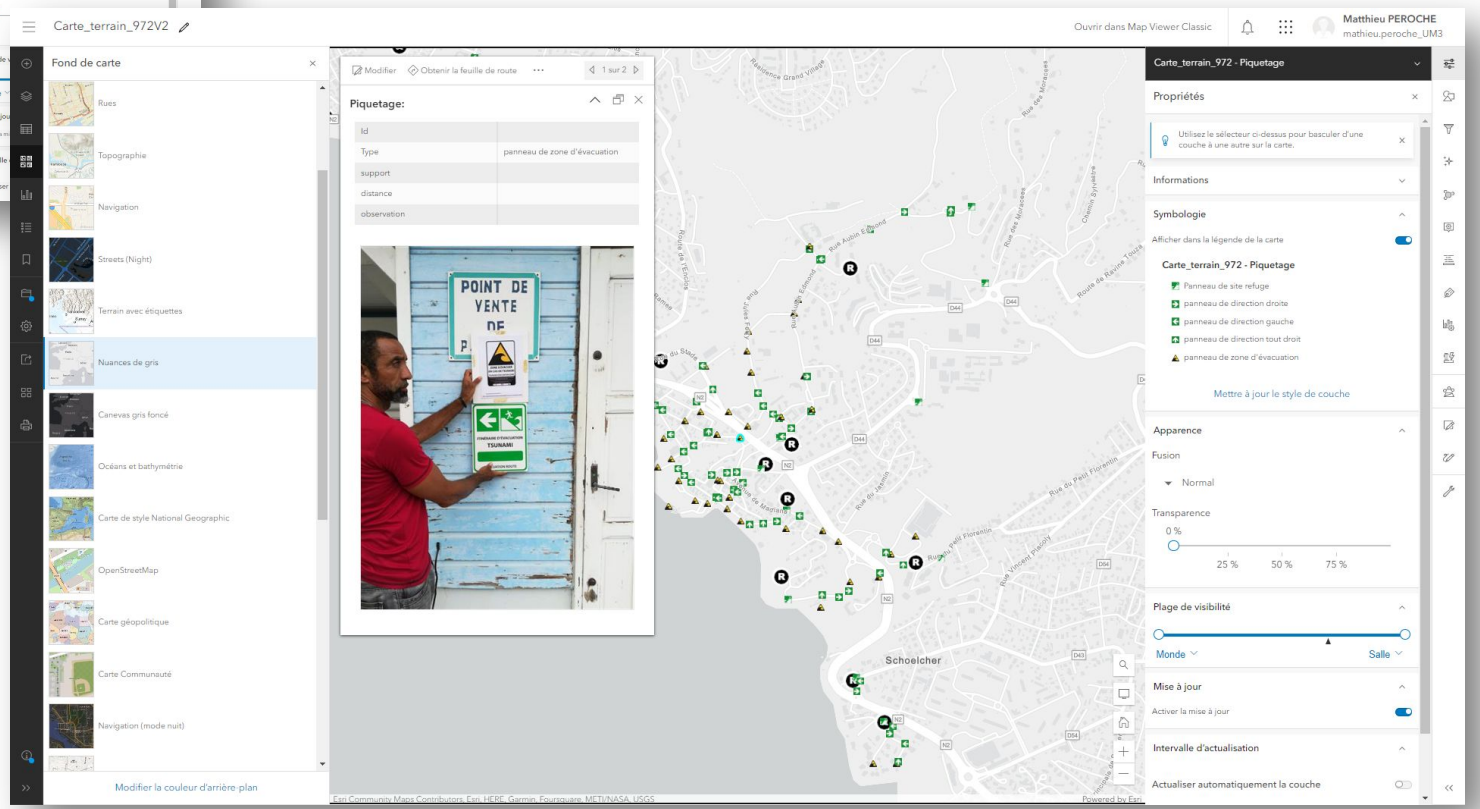
Tsunami evacuation signage





Present-day situation in FWI
Martinique island



Titre	5048
Panneau de site refuge	552
panneau de direction droite	815
panneau de direction gauche	838
panneau de direction tout droit	1058
panneau de zone d'évacuation	1785

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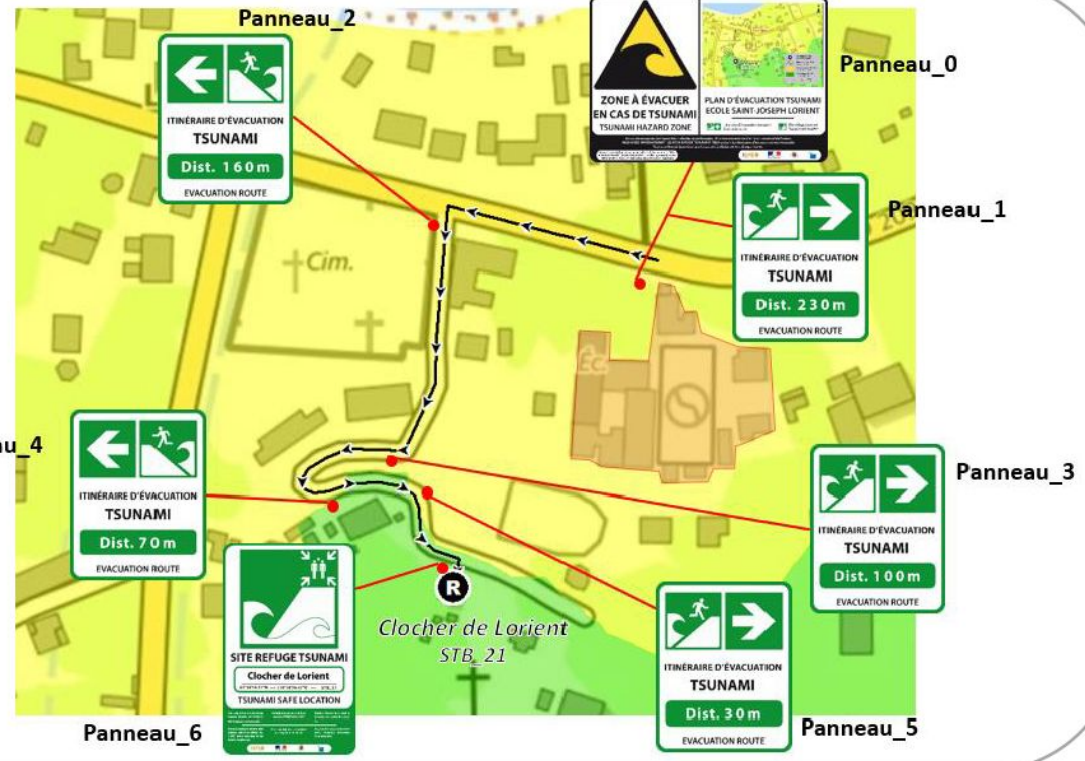
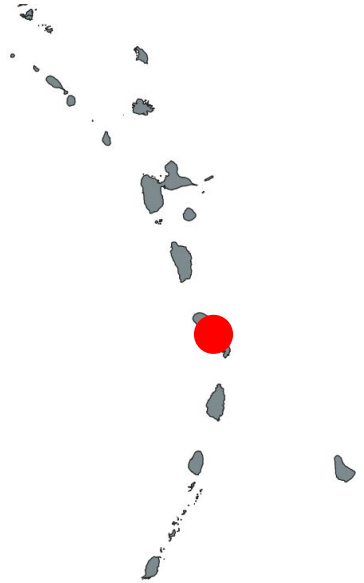
Tsunami evacuation signage

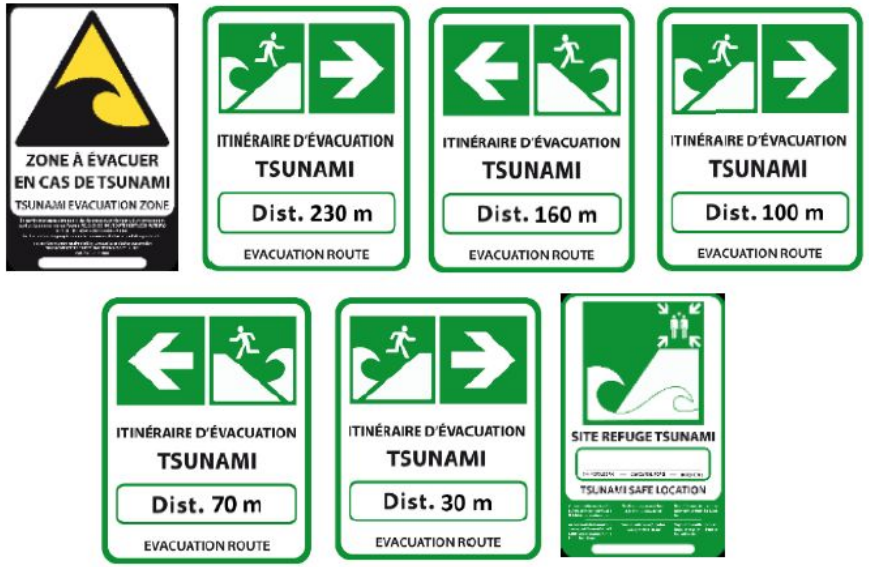
A



Present-day situation in FWI
Martinique island



B



Example of files issued to communes (A: plan of sign locations for an evacuation route; B: ready-to-print signs for an evacuation route)

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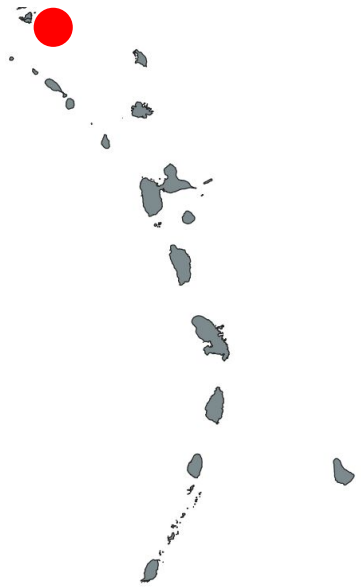
Lesson #6

Tsunami evacuation signage



Present-day situation in FWI – Saint-Barthélemy island

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Tsunami evacuation signage

New Zealand's famous "blue line" would become "green line“ in Saint Barthelemy !

Blue lines on Island Bay streets show tsunami-safe zones

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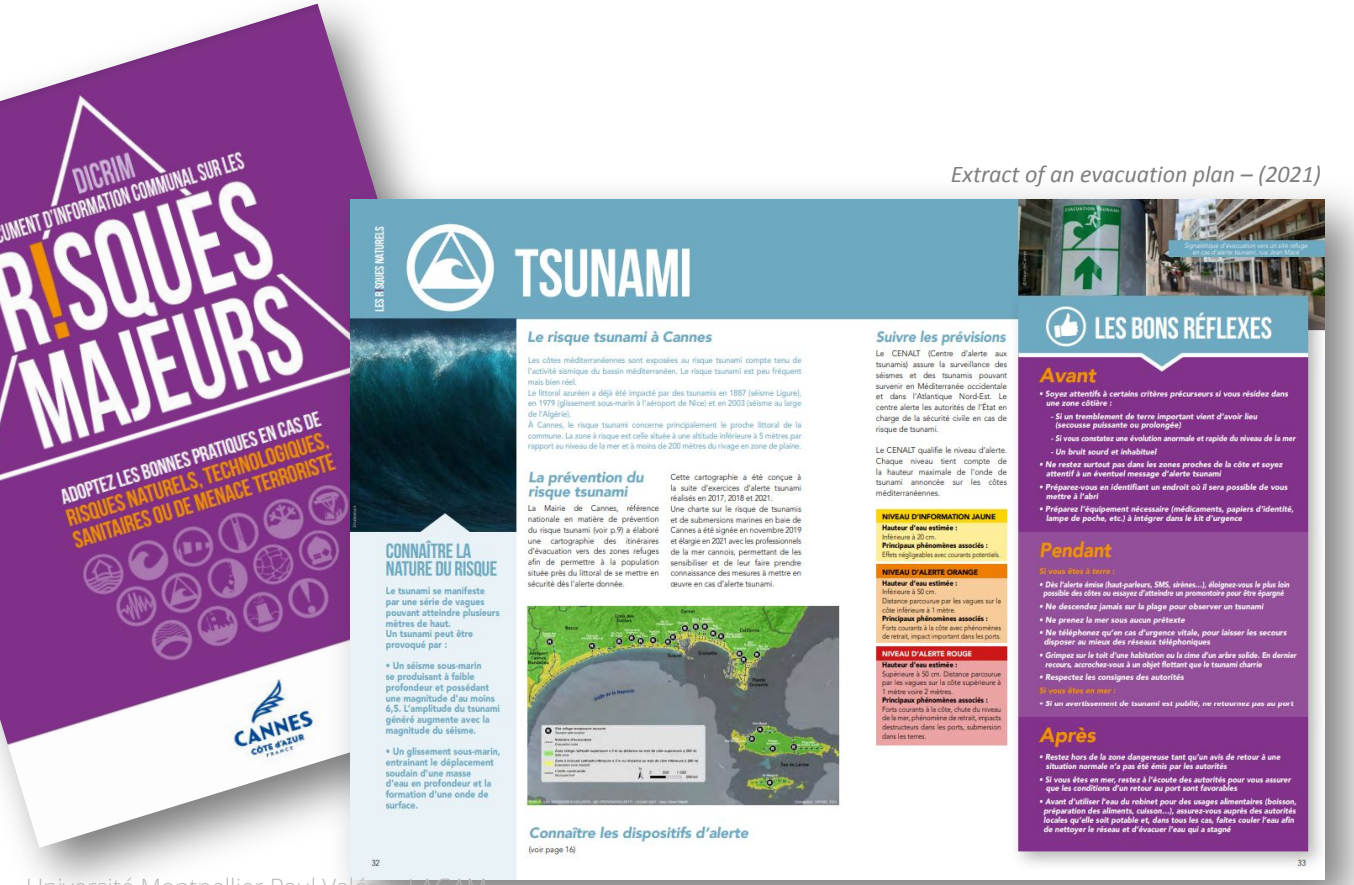
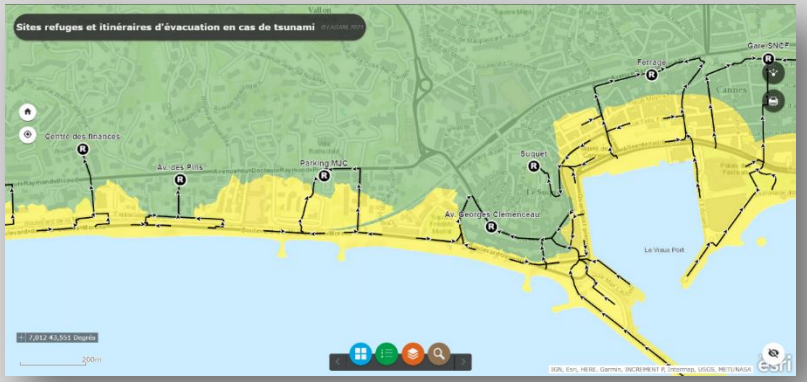
Tsunami evacuation signage

- ✔ Mapping of the area to be evacuated and quantification of the main issues in this area (population, critical infrastructures, etc.)
- ✔ Identification of horizontal refuge sites and evacuation routes according to a scientific protocol adapted from work carried out in the Caribbean
- ✔ Mapping of evacuation plans according to a standardised graphic chart



Extract of an evacuation plan – (2021)

Interactive version of evacuation plan



https://arcg.is/1jKCv50

Tsunami evacuation signage

✔ Suggested signage to be installed along evacuation routes

Tested signage (ground paint), august 2020

Information and public survey stand, august 2020

Different supports and materialss

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Lesson #6

Tsunami evacuation signage

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Tsunami evacuation signage

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Tsunami evacuation signage

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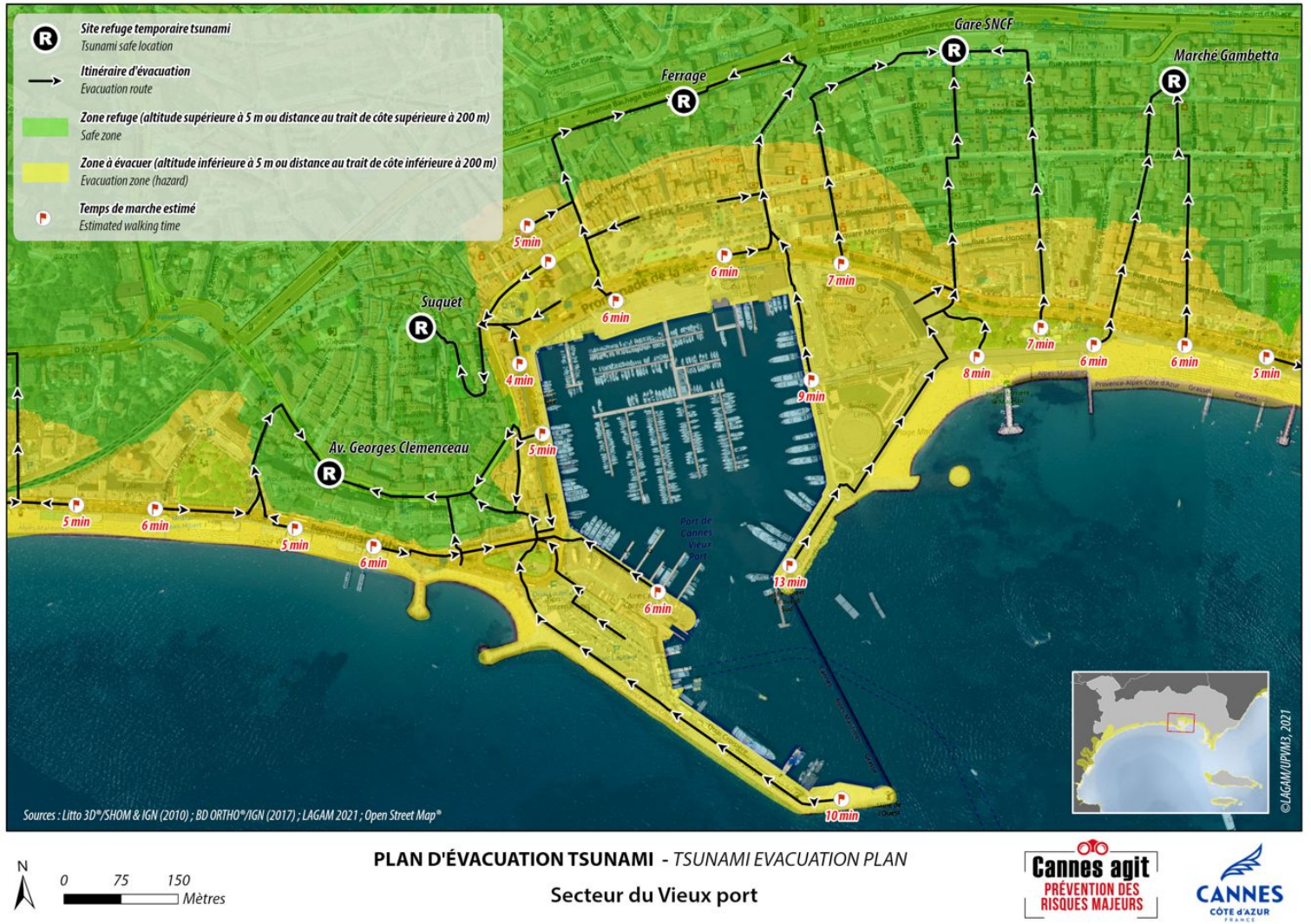
Some key steps

- Identify the location of evacuation signage based on existing evacuation plans



Some key steps

- Identify the location of evacuation signage based on existing evacuation plans
- Produce a photographic report of the signage location

Vue aérienne

Type de signalétique

Modèle de macaron	Nom du site refuge	Distance (m)
	Bd de la Source	Distance : 450 m

1

Vue Street View

Légende

Point d'implantation (Point GPS : 43.543404,7.042216)

Orientation de la flèche sur le macaron

Tsunami evacuation signage

Some key steps

- Identify the location of evacuation signage based on existing evacuation plans
- Produce a photographic report of the signage location
- Produce maps showing the signage locations

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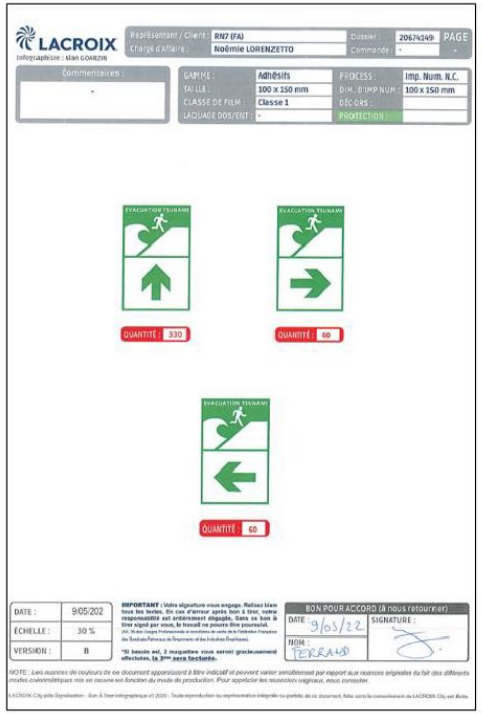
Tsunami evacuation signage

Some key steps

- Identify the location of evacuation signage based on existing evacuation plans
- Produce a photographic report of the signage location
- Produce maps showing the signage locations
- Draft the technical file / the mock-ups for the selected company.



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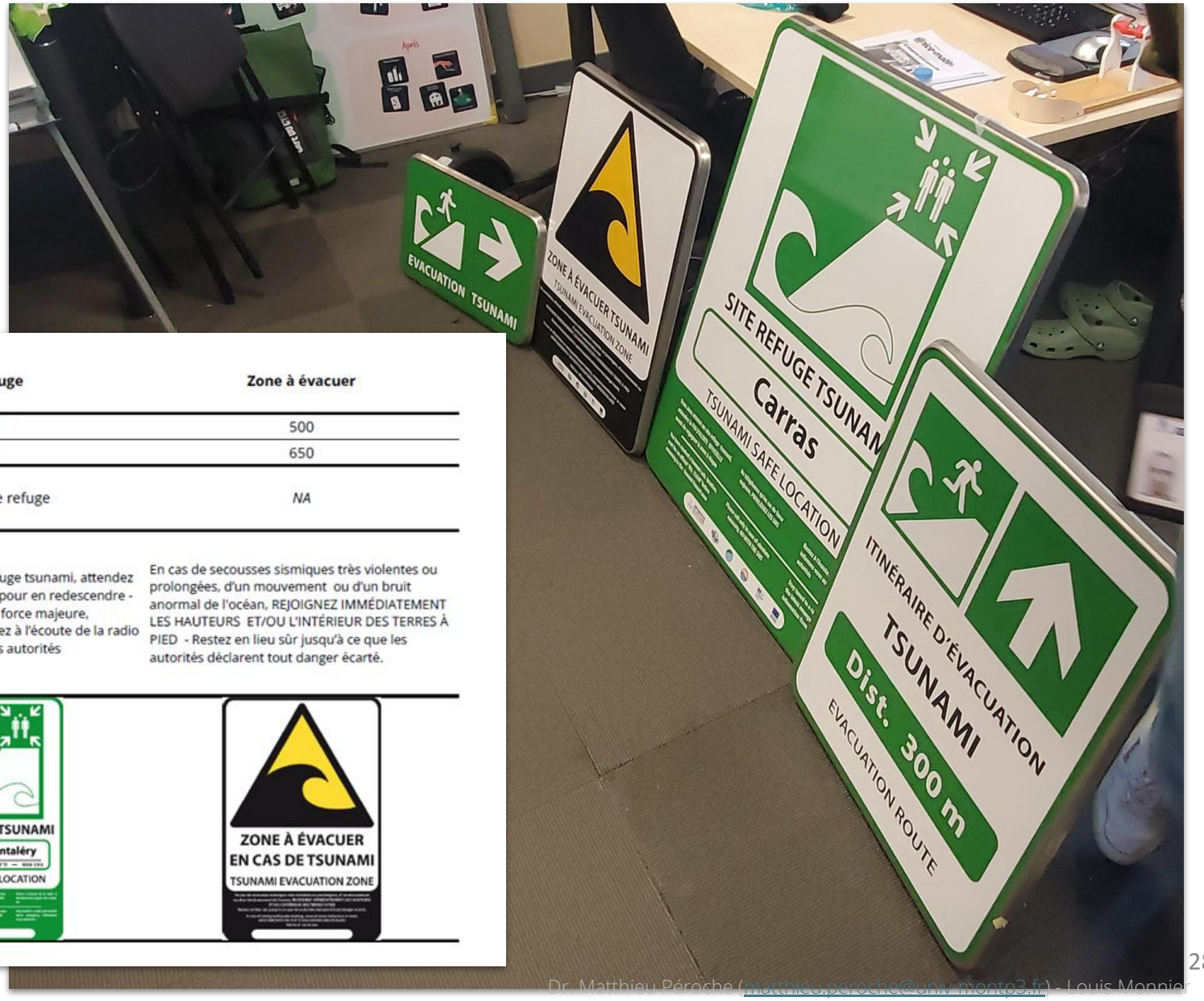
Tsunami evacuation signage

Some key steps

- The sign dimensions should be discussed with both the stakeholder and the selected company.
- Standard dimension signs cost less and are faster to produce.



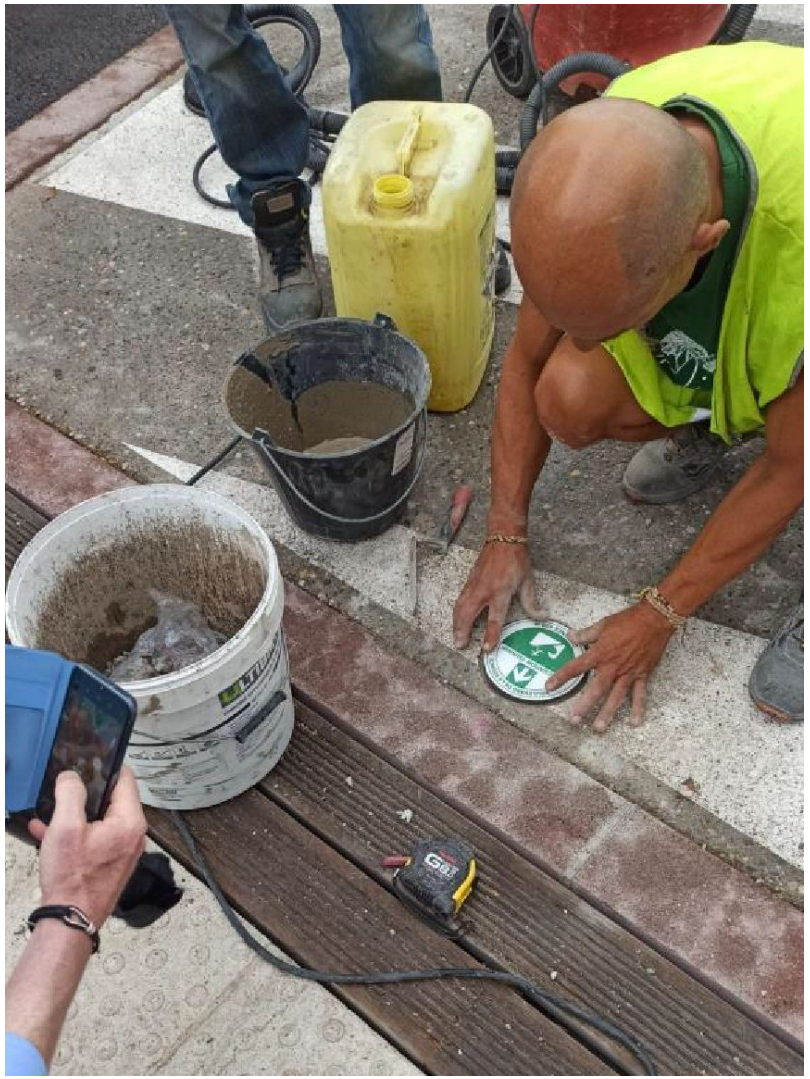
		Itinéraire d'évacuation*	Itinéraire d'évacuation (panonceau)*	Site refuge	Zone à évacuer
Dimensions	Hauteur (mm)	600	300	900	500
	Largeur (mm)	500	500	600	650
Information spécifique figurant sur le panneau		Distance restante jusqu'au site refuge	*NA*	Nom du site refuge	*NA*
Information générale figurant sur le panneau (avec traduction en anglais)		Itinéraire d'évacuation tsunami	Evacuation tsunami	Vous avez atteint un site refuge tsunami, attendez la FIN D'ALERTE OFFICIELLE pour en redescendre - Ne téléphonez qu'en cas de force majeure, PRIVILÉGIEZ LES SMS - Restez à l'écoute de la radio et informez-vous auprès des autorités	En cas de secousses sismiques très violentes ou prolongées, d'un mouvement ou d'un bruit anormal de l'océan, REJOIGNEZ IMMÉDIATEMENT LES HAUTEURS ET/OU L'INTÉRIEUR DES TERRES À PIED - Restez en lieu sûr jusqu'à ce que les autorités déclarent tout danger écarté.
Modèle					

* 3 variantes en fonction de la direction indiquée : gauche, droite et face

Tsunami evacuation signage

Some key steps

- Identify the location of evacuation signage based on existing evacuation plans
- Produce a photographic report of the signage location
- Produce maps showing the signage locations
- Draft the technical file / the mock-ups for the selected company.
- Guide the company on site for installation



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Tsunami evacuation signage

Some key steps

- Identify the location of evacuation signage based on existing evacuation plans
- Produce a photographic report of the signage location
- Produce maps showing the signage locations
- Draft the technical file / the mock-ups for the selected company.
- Guide the company on site for installation
- Map the installed signage

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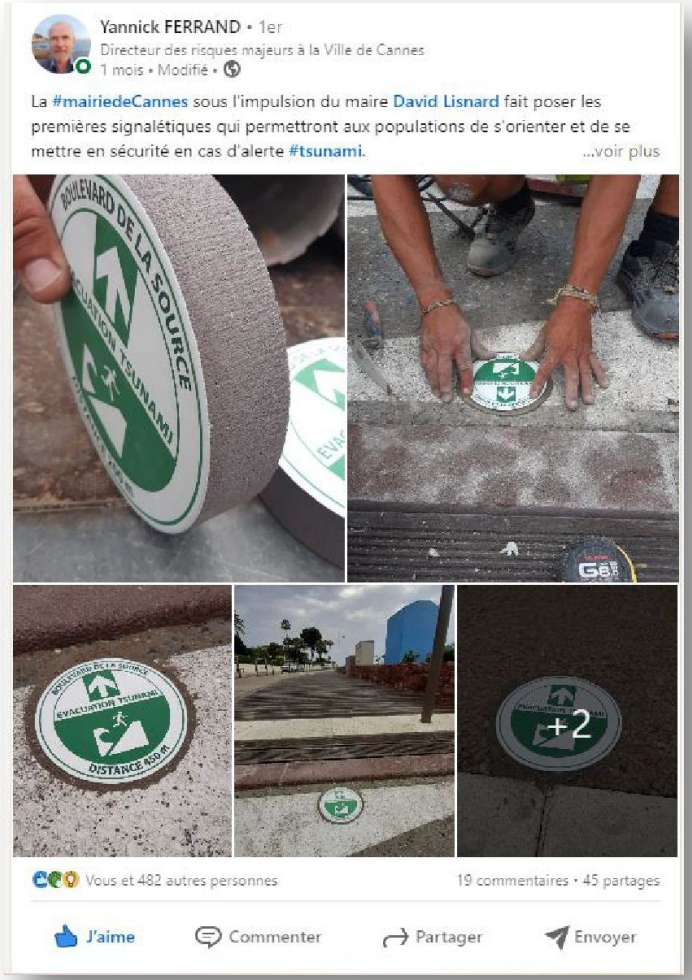
Tsunami evacuation signage

Some key steps

- Identify the location of evacuation signage based on existing evacuation plans
- Produce a photographic report of the signage location
- Produce maps showing the signage locations
- Draft the technical file / the mock-ups for the selected company.
- Guide the company on site for installation
- Map the installed signage
- Communicate to media



Dr. Matthieu Péroche (matthieu.peroche@univ-montp3.fr) - Louis Monnier

Tsunami evacuation signage

Of all the criteria to be recognized as IOC-UNESC Tsunami Ready, the installation of tsunami signage is the most difficult:

- Signage and its installation are costly
- Signage materializes the spatial extent of the risk
- Signage requires several levels of approval (administrative, financial, legal, etc.), and the process can be lengthy.

II	PREPAREDNESS (PREP)
4	**PREP-1**. Easily understood tsunami evacuation maps are approved.
5	**PREP-2**. Tsunami information including signage is publicly displayed.
6	**PREP-3**. Outreach and public awareness and education resources are available and distributed.
7	**PREP-4**. Outreach or educational activities are held at least three times a year.
8	**PREP-5**: A community tsunami exercise is conducted at least every two years.

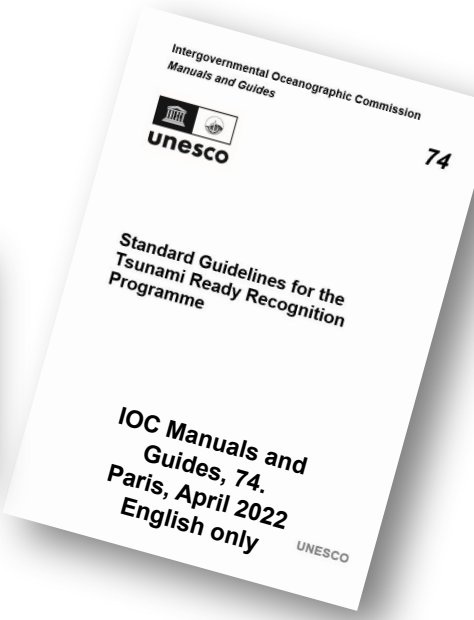
Two French experiences:

#1 Importance of following the pictograms and colors proposed by the ISO standard to create a national standard.

#2 Allow some flexibility in the choice of signage supports and materials to encourage stakeholders to adopt the system.

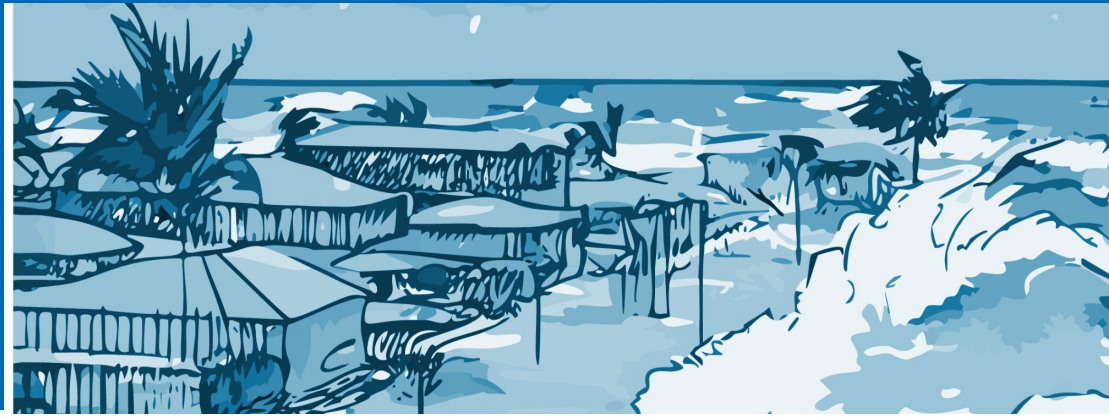
unesco
Intergovernmental Oceanographic Commission

Tsunami Ready



Dr. Matthieu Péroche (matthieu.peroche@univ-montp3.fr) - Louis Monnier

Tsunami Evacuation Mapping Workshop



CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

Dr. Matthieu Péroche
Louis Monnier

30 June – 4 July 2025

Contact : matthieu.peroche@univ-montp3.fr

unesco
Intergovernmental Oceanographic Commission

Funded by European Union Humanitarian Aid

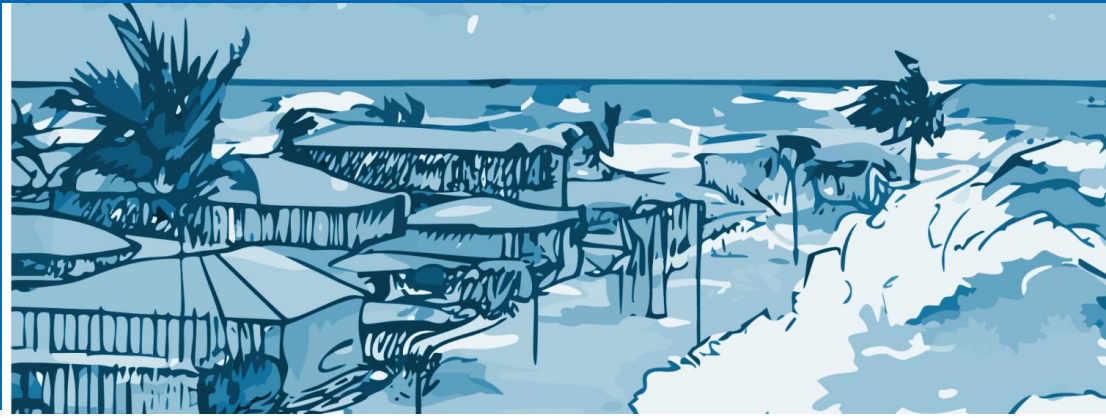
2021 2030 United Nations Decade of Ocean Science for Sustainable Development

CoastWAVE NEAMTWS

LAGAM
LABORATOIRE DE GEOGRAPHIE ET D'AMENAGEMENT DE MONTPELLIER

Université Paul Valéry Montpellier 3

Tsunami Evacuation Mapping Workshop



WELCOME to Montpellier !

CoastWAVE 2.0 Project

IOC-UNESCO (EU DG ECHO)

30 June – 4 July 2025

unesco
Intergovernmental Oceanographic Commission

Funded by European Union Humanitarian Aid

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

CoastWAVE NEAMTWS

LAGAM
LABORATOIRE DE GEOGRAPHIE ET D'AMENAGEMENT DE MONTPELLIER

UNIVERSITÉ PAUL VALERY MONTPELLIER 3

Welcome to University Montpellier Paul Valéry

Coastwave 2.0 Evacuation Mapping Workshop

ATRIUM, new Learning Center

Big changes at Route de Mende !

Discover **ATRIUM**, our brand new Learning Center — a bold architectural project in a green campus.

Founded in 1970, UMPV builds on a legacy dating back to 1289 in Montpellier.
Multiple campuses in Montpellier & Béziers
Route de Mende campus is a listed 20th-century heritage site!

At UMPV :

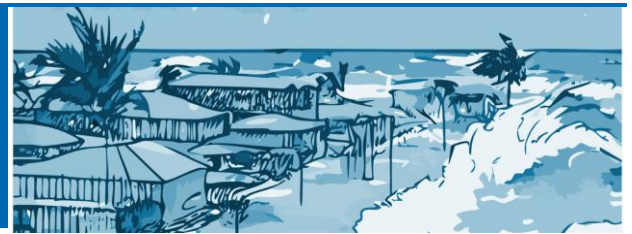
- 23,000 students
- 774 faculty & researchers
- 1,335 guest lecturers
- 654 admin & tech staff

A vibrant and diverse academic community!

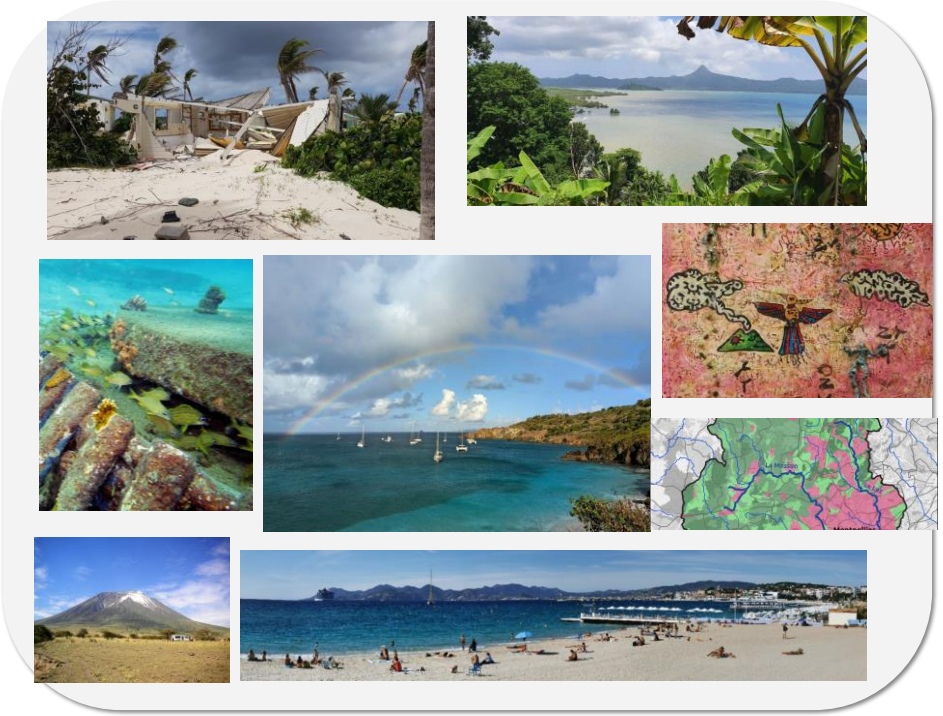
The Saint-Charles site is UMPV 's research hub in the heart of Montpellier.

21 interdisciplinary research units

A gateway between knowledge and society !



Welcom to our Research Lab : LAGAM !



Founded in **2021**, the **LAGAM – Geography and Spatial Planning Laboratory of Montpellier** – is a university research center dedicated to **applied geography**, **spatial planning**, and **risk management**. Affiliated with Paul-Valéry University Montpellier 3, it builds on over 20 years of scientific expertise.

LAGAM bridges **fundamental research and operational action**, with core skills in:

Action-research, **spatial analysis**, **cartography**, **modeling**, **geomatics**, and **drone-based aerial surveys**.

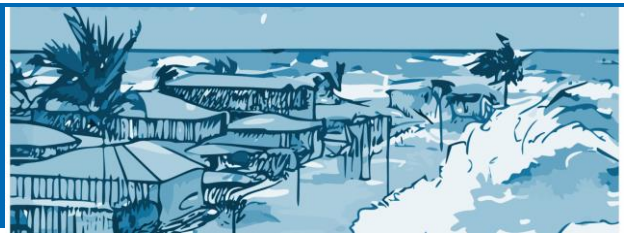
With **80 members**, including **30 PhD students** and **25 affiliated researchers**, LAGAM is a dynamic hub, closely linked to the geography degree programs at the university and internationally oriented.

Research focus areas:

- Natural hazards, crises & disasters
- Transport & mobility
- Emerging challenges in urban planning
- Spatial analysis, mapping & modeling
- Coastal & water management
- Coastal & applied geomorphology
- Health & territories
- Rural development and trajectories
- Public policy & local development in Europe

Follow our research, fieldwork, and projects!
https://lagam.xyz/

A gateway between knowledge and society !

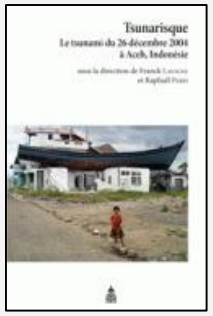


Context

History of Tsunami Risk Projects

Project name

TSUNARISQUE



Dir. Franck Lavigne / Raphaël Paris

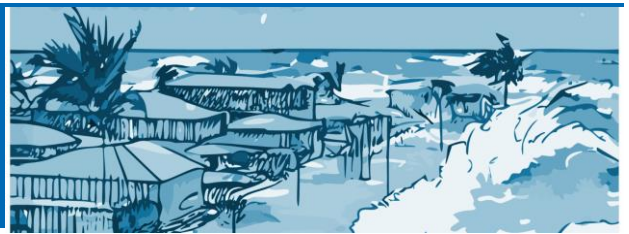
http://www.editionsdelasorbonne.fr/fr/livre/?GCOI=28405100100000

https://www.youtube.com/watch?v=4QeZA-6DB04

2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026

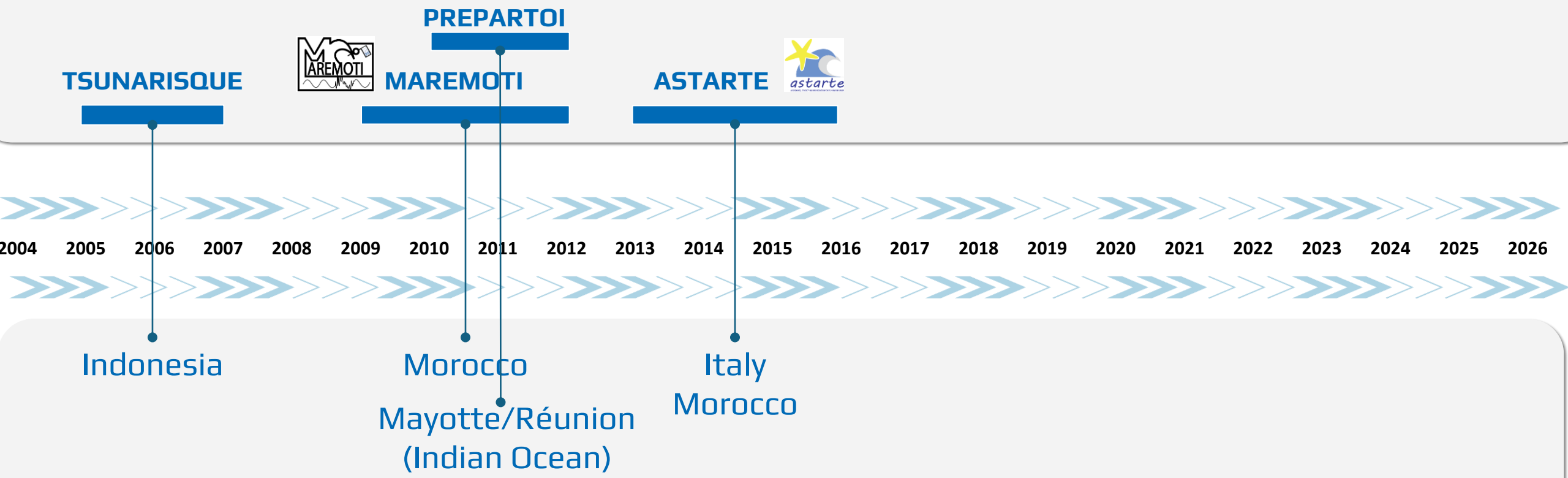
Indonesia

Areas where our team has worked

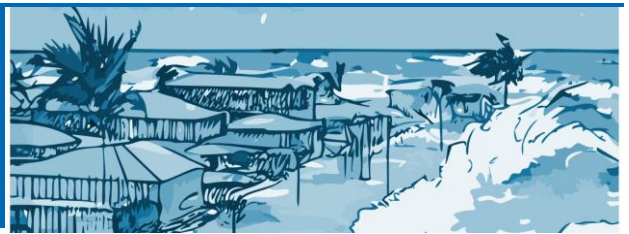


History of Tsunami Risk Projects

Project name



Areas where our team has worked



History of Tsunami Risk Projects

Project name

Péroche M., Phd

PREPARTOI

TSUNARISQUE

MAREMOTI

ASTARTE

2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026

Indonesia

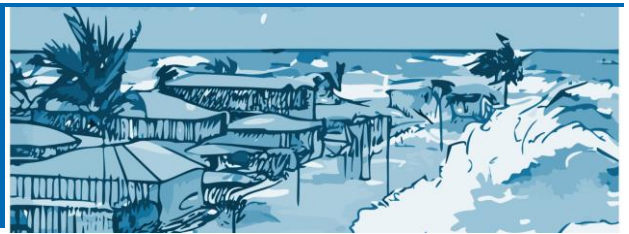
Morocco

Mayotte/Réunion
(Indian Ocean)

Italy
Morocco

Martinique (F.W.I)

Areas where our team has worked



Context

History of Tsunami Risk Projects

Project name

Péroche M., Phd

PREPARTOI

TSUNARISQUE

MAREMOTI

ASTARTE

EXPLOIT

2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026

Indonesia

Morocco

Mayotte/Réunion (Indian Ocean)

Italy

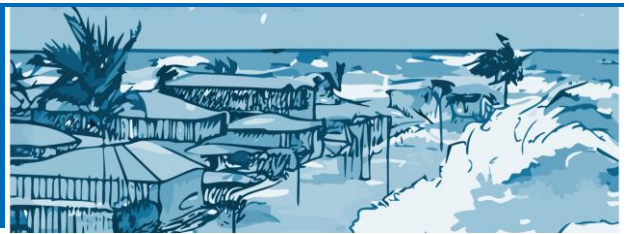
Morocco

Martinique (F.W.I)

French West Indies

Areas where our team has worked

EXPLOIT : https://exploit.univ-montp3.fr/



Context

History of Tsunami Risk Projects

Coastwave 2.0 Evacuation Mapping Workshop

Project name

Péroche M., Phd

TSUNARISQUE
PREPARTOI
MAREMOTI
ASTARTE
EXPLOIT
EVACTSU
TASOMA
EVACTSU MNCA
CoastWave 2.0

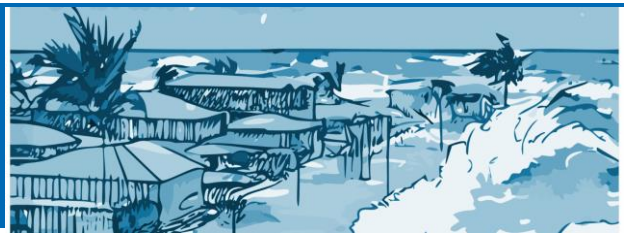
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026

Indonesia
Morocco
Mayotte/Réunion (Indian Ocean)
Martinique (F.W.I)
Italy
Morocco
French West Indies
French Mediterranean
Mayotte (Indian Ocean)
Nice Metropolis
Nice & Marseille

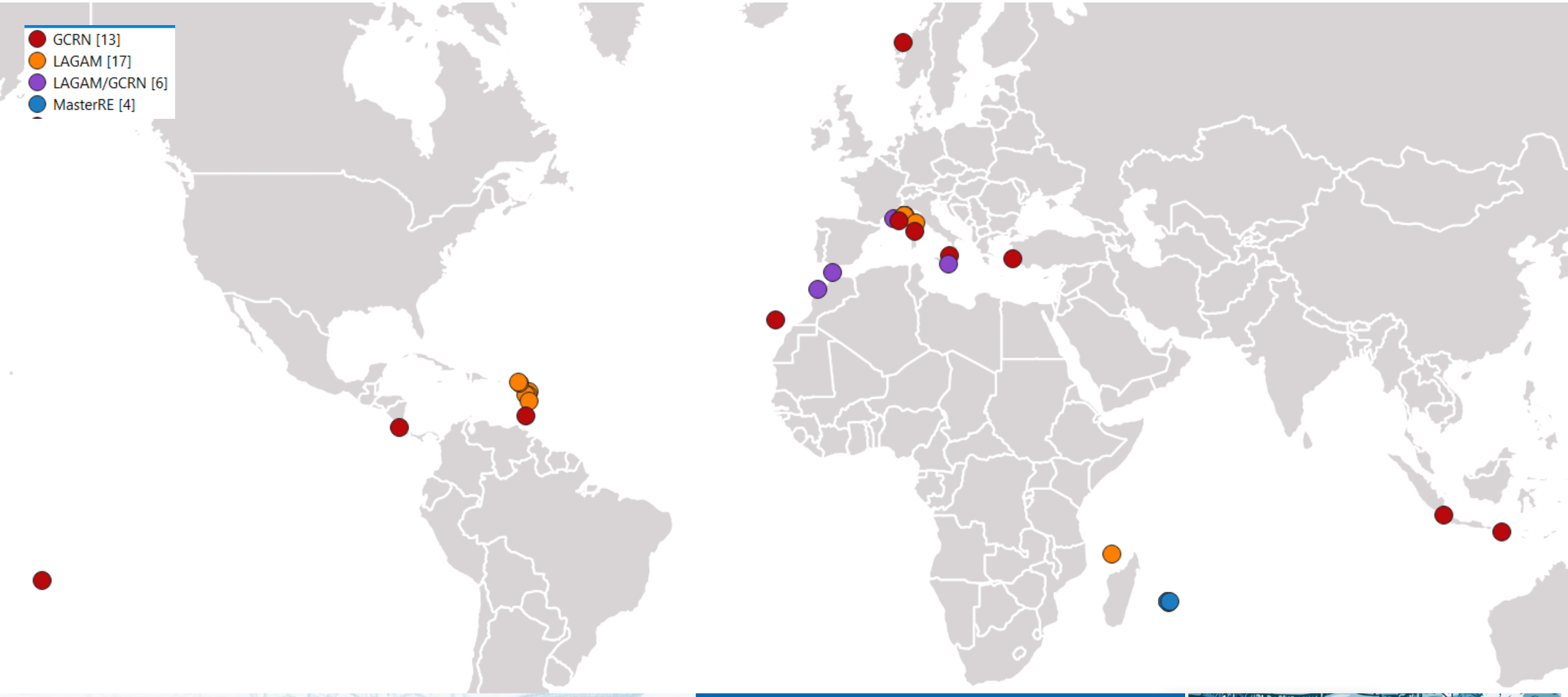
Areas where our team has worked

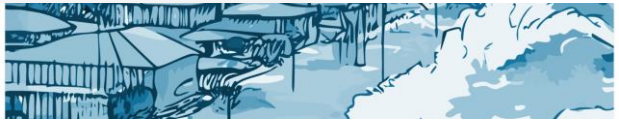
TASOMA : https://arcg.is/0ifqmH

EVACTSU Mayotte : https://arcg.is/1be4iC0



History of Tsunami Risk Projects





Context

Contribution to Tsunami Ready prog.

Deshaies municipality (Guadeloupe, F.W.I) 30 juin 2023

Cannes municipality 19 janvier 2024

Remise de la plaque Tsunami Ready à David Lisnard (c) Mairie de Cannes

20 Years of Tsunami Risk Work…

… a Perspective from Montpellier

- **A deeply formative experience** — humanly and scientifically.
- **A call to action**: risk prevention, evacuation planning, and research in action.

Time from hazard modeling to evacuation planning

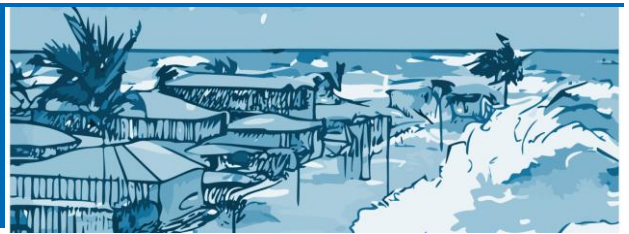
(a reality check across contexts):

- ✓ Mayotte → **8 years**
- ✓ French Antilles → **10 years**
- ✓ Cannes (France) → **18 years**

Over 20 years:

- 11 research projects (national & international)
- 5 PhD theses
- 40 master's theses (GCRN master degree)
- 80 + communities with validated tsunami evacuation plans

Scientific progress must be translated into action !



Matthieu Péroche

Researcher, LAGAM
Tsunami evacuation mapping · ICG CARIBE-EWS & NEAMTIC · Crisis planning

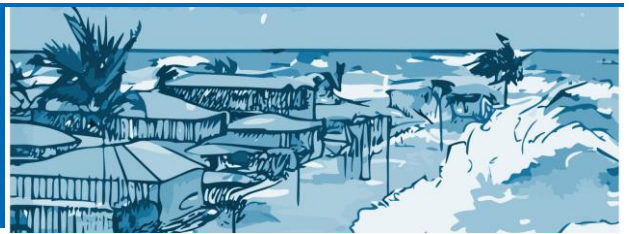
Louis Monnier
Research Engineer
GIS modeling · CoastWAVE 1 & 2 · Workshop design & facilitation

Emilie Lagahé
Research Engineer
Cartographer, scientific development and knowledge dissemination

Frédéric Leone
LAGAM Director – Professor
Post-disaster analysis · Field deployment · Scientific coordination

Monique Gherardi
Research Engineer
Stakeholder engagement · Co-construction methods · Operational tools

Lyna
Geography undergraduate student (L2)
Workshop support · Local logistics · Training immersion



Workshop Program

Day 1 – Context & Introduction
- Welcome, overview of CoastWAVE 2.0
- Tsunami hazard modelling (CEA)
- Icebreaker

Day 2 – Defining Safe Zones
- Evacuation zone mapping
- Identifying assembly points

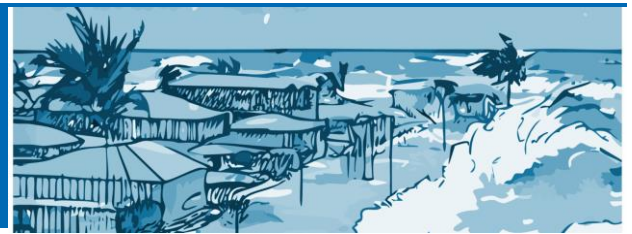
Day 3 – Evacuation Routing
- Graph-based network construction
- Time-efficient route calculation
- Start cartographic design

Day 4 – Map Production
- Graphical semiology & layout
- Static and dynamic maps

Day 5 – Applying the Method
- Tsunami signage & field application
- Group work on case studies (if time permits)
- Wrap-up

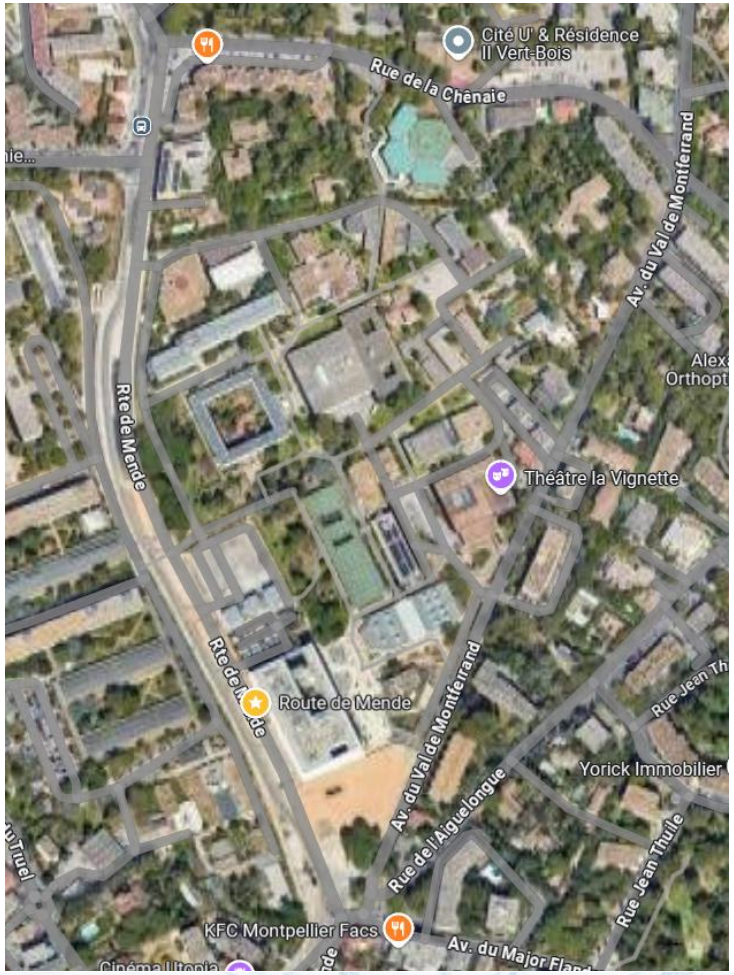
What you'll learn this week

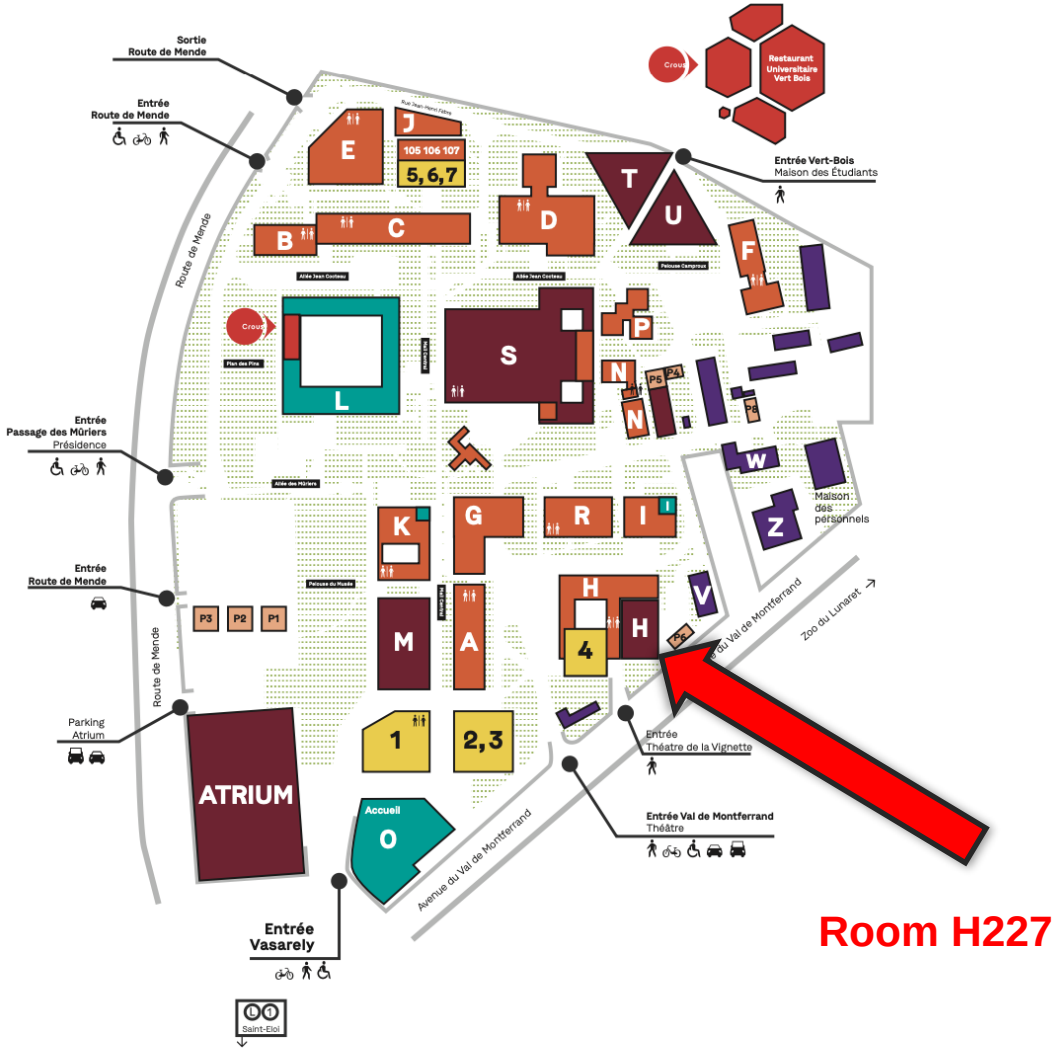
1. Delineating evacuation zones
2. Identifying assembly points
3. Building pedestrian network graphs
4. Calculating travel times & optimizing routes
5. Designing clear, accessible evacuation maps



Workshop

Location





Room H227

ADMINISTRATION

- O **Accueil - Informations**
- L Présidence
- L Direction des Études et de la Scolarité - DES (rez-de-chaussée)
- I Direction des Relations Internationales et de la Francophonie - DRIF
- I Institut universitaire d'Enseignement du Français langue Etrangère - IEFE

ÉQUIPEMENTS CULTURELS ET SERVICES COMMUNS

- ATRIUM Bibliothèque Universitaire
- R Centre de langues étrangères et régionales (2ème étage) - CLER
- T Maison des Étudiants - MDE
- M Musée des Moulages
- U Salle Charles-Camproux
- T Salle Jean-Moulin
- ATRIUM Handi-Études - Service accueil des étudiants en situation de handicap
- ATRIUM SAFCO - Service de l'Apprentissage et de la formation continue
- ATRIUM Service Commun Universitaire d'Information, d'Orientation et d'insertion Professionnelle - SCUIO-IP
- U Service Universitaire des Activités Physiques et Sportives - SUAPS
- U Service Universitaire de Médecine Préventive et de Promotion de la Santé - SUMPPS
- U Service de la vie étudiante - SVE
- H Théâtre la Vignette

ACCUEILS UFR ET SALLES DE COURS

- H UFR 1 - (1er étage) Faculté des lettres, arts, philosophie, psychanalyse
- G UFR 2 - (2ème étage) Faculté de langues et cultures étrangères et régionales
- C UFR 3 - (rez-de-chaussée) Faculté des sciences humaines et de sciences de l'environnement
- A UFR 4 - (rez-de-chaussée) Faculté des sciences sociales, des organisations et des institutions
- B UFR 5 - (2ème étage) Faculté des sciences du sujet et de la société
- B UFR 6 - (1er étage) Faculté d'éducation et des sciences pour les LLASHS
- E ITIC - (rez-de-chaussée) Institut des technosciences de l'information et de la communication
- P Pavillon informatique / accueil ENT
- N Salles des poètes (Pierre-Reverdy, Charles-Cros, Bobby-Lapointe, Valery-Larbaud)
- S Salles de cours (BUG, BUs1, BUs2)
- Pavillons d'enseignement (P1, P2, P3, P4, P5, P6, P8)
- Amphithéâtres