Prep-1: Easily understood tsunami evacuation maps are approved.

Dr. Matthieu Péroche
University of Montpellier Paul-Valéry

UNESCO-IOC EU DG ECHO CoastWAVE 2.0 Project
UNESCO-IOC Regional Tsunami Ready Recognition Programme (TRRP) Workshop
Online, January 14-15, 2024

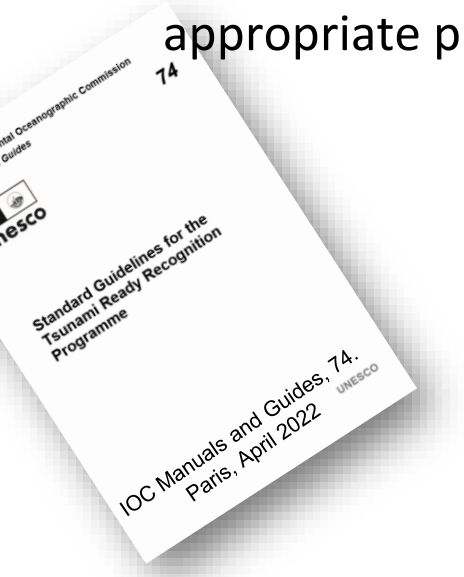
unesco
Intergovernmental Oceanographic Commission

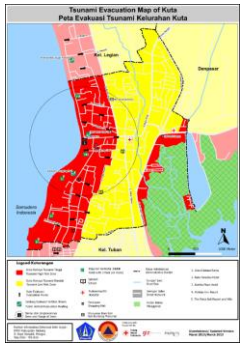
Funded by European Union Humanitarian Aid

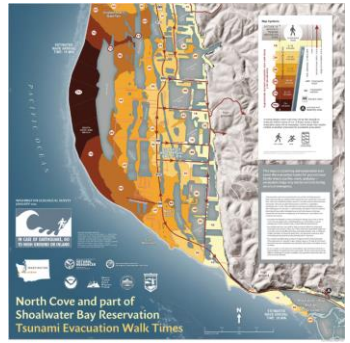
2021 2030 United Nations Decade of Ocean Science for Sustainable Development

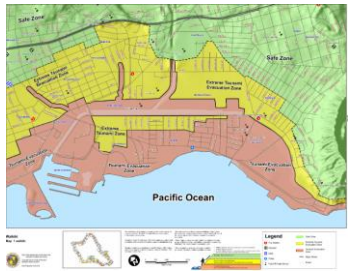
IOC-UNESCO Tsunami Ready Recognition Programme (TRRP) Workshop

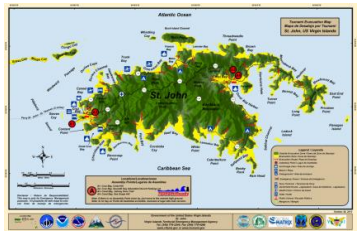
"Tsunami evacuation maps should depict tsunami evacuation routes and assembly areas. Maps should be based on tsunami hazard zone mapping and in accordance with the community's TRP. Maps should be made available via appropriate print and/or digital media"

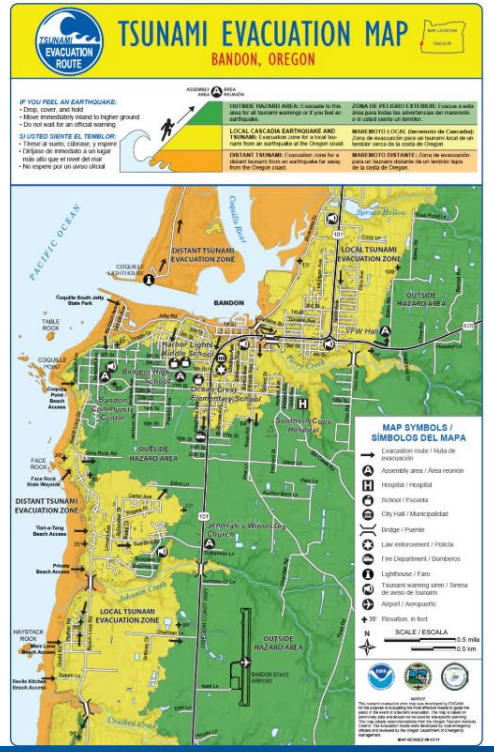


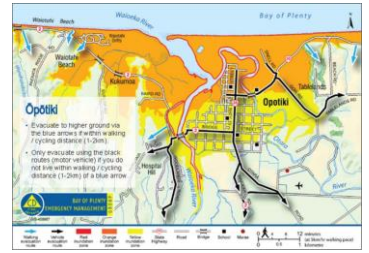












IOC-UNESCO Tsunami Ready Recognition Programme (TRRP) Workshop

Scientific Knowledge (e.g., tsunami hazard zones, inundation modeling).

A tool for dialogue and discussion (e.g., their development helps engage stakeholders and the community).

Community Safety (e.g., evacuation routes, assembly points).

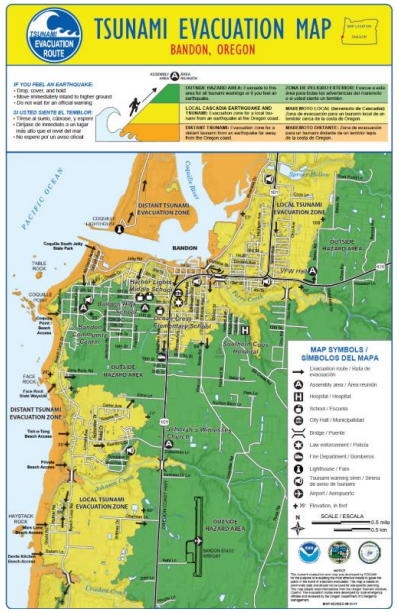
Risk Awareness (e.g., public understanding, tsunami warnings).

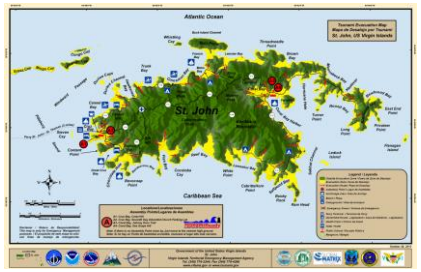
Signage Planning (e.g., directional signs, ISO symbols)

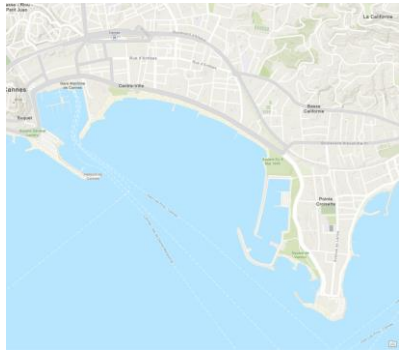
Important considerations

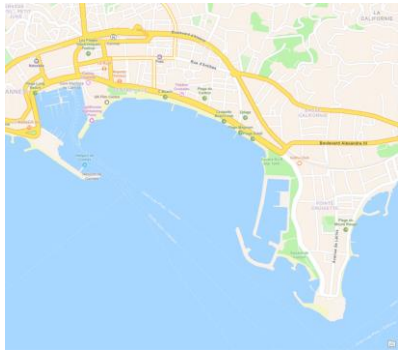
Evacuation maps should be simple and easy to read and should include essential information only.

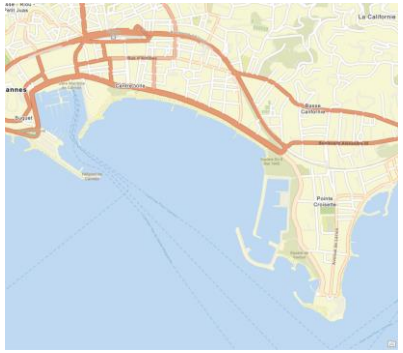
- choosing the right **base map** and the right **scale**











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- **Evacuation Zone**: areas threatened by tsunami inundation ;

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- **Evacuation Zone**: areas threatened by tsunami inundation ;
- **Evacuation Sites and assembly areas**: location of designated assembly locations or areas, and/or vertical evacuation structures, where people should go to in case of an imminent tsunami ;
- **Recommended evacuation routes to the safe place** for people to follow. These are normally indicated as arrows, or by other significant information such as local landmarks or past run-up levels, that identify locations.

Key points for defining Tsunami Evacuation Zones

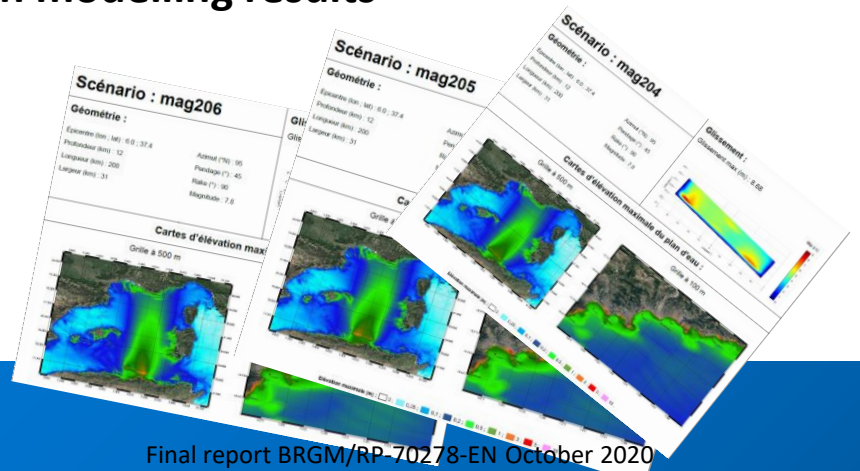
Definition

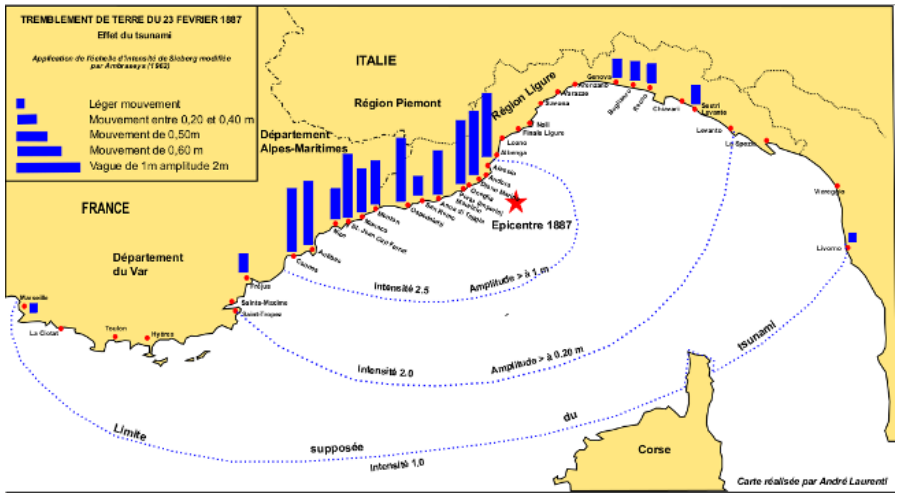
Evacuation zones are **based on the expected maximum tsunami inundation areas**. They consider **geographical features** and the **area of responsibility** of emergency management organizations.

These zones represent areas where **damage is expected**, and therefore where **residents must evacuate from** during a tsunami warning.

- Evacuation zones are primarily based on:
  - **Historical tsunami records**
  - **Tsunami inundation modelling results**

See RESP1.





Tsunami generated by the Ligurian earthquake of 23 February 1887, its amplitude and intensity(Map by André Laurenti)

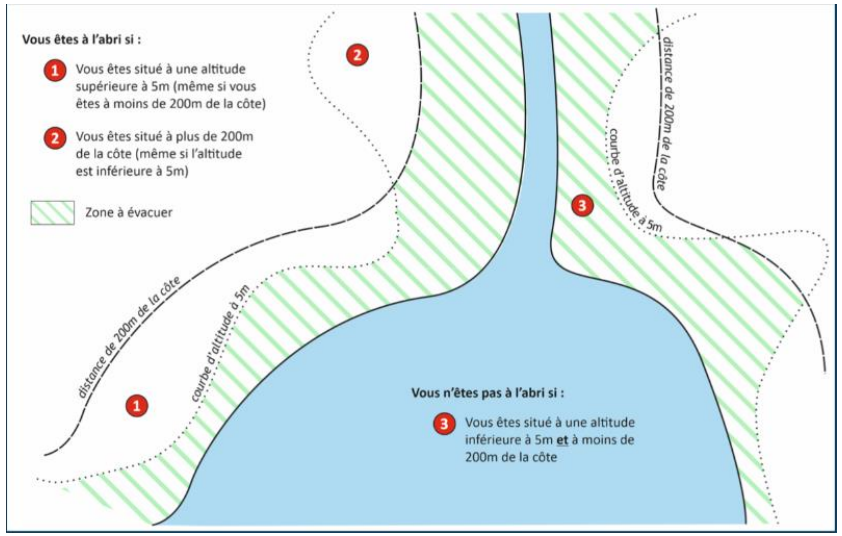
Should we use one or multiple evacuation zones?

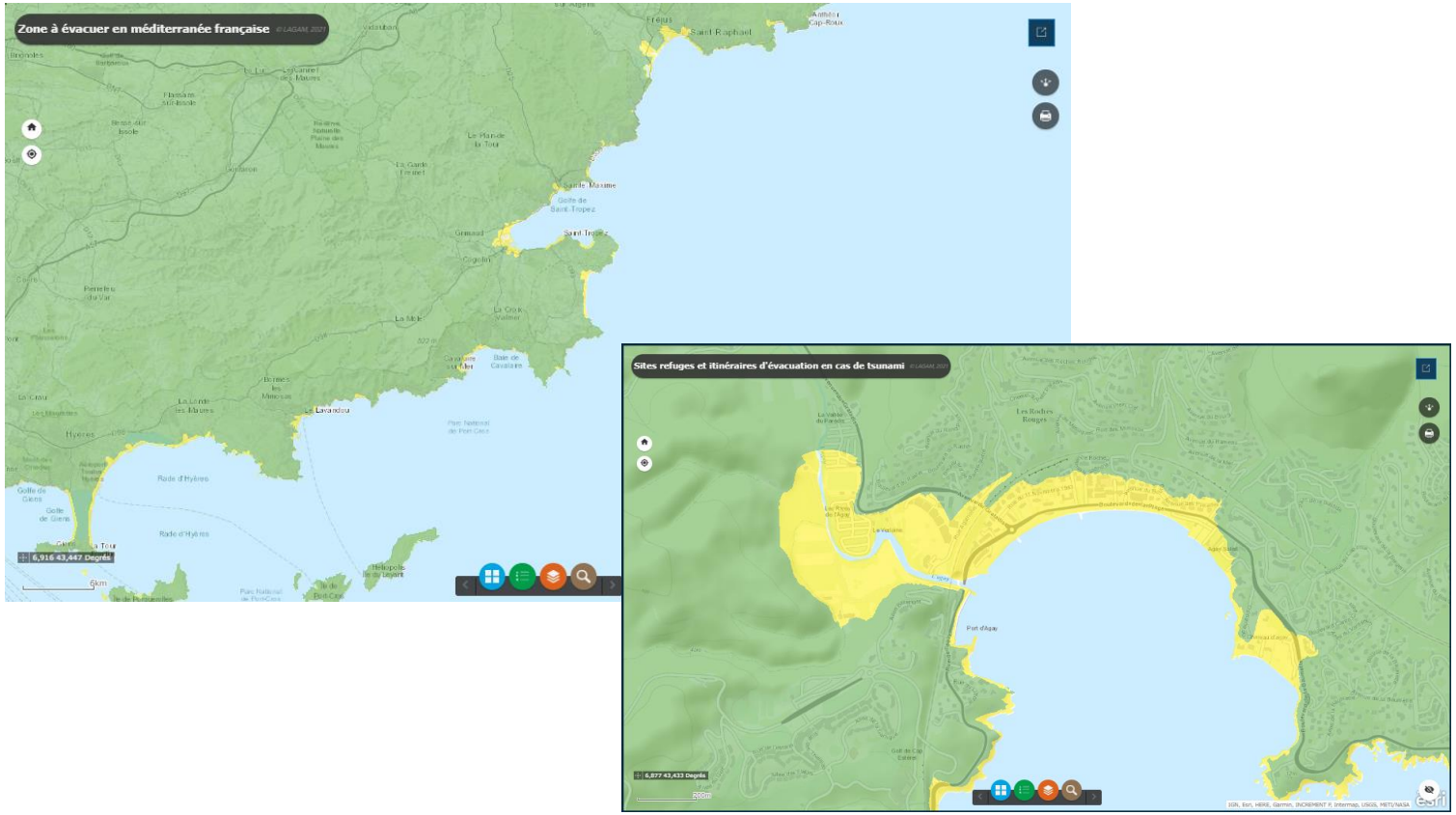
- **Single Zone:**
  - Simple to communicate and understand.
  - Risk of **over-evacuation** for smaller events.

- **Multiple Zones (local, regional, distant tsunamis) :**
  - More precise for different risk levels.
  - Complex to implement and communicate.

Definition of the tsunami evacuation zone in France – (Mediterranean coast)

« The area to be evacuated corresponds to the territory with an altitude of less than 5 metres and a distance of less than 200 m from the sea. Along river entrances, this distance is extended to 500 m from the river mouth. »





Extract from the dynamic map of the tsunami evacuation zone for the Mediterranean coast of France (TASOMA project - University of Montpellier Paul Valérie 2021)

- > https://arcg.is/0ifqmH

Key points to determine evacuation sites

Definition :

A **tsunami refuge site** is a **secure location** situated **outside the inundation zone**, where people can **seek shelter** in case of a tsunami warning.

These sites must meet the following criteria:

- Be **easily accessible** from at-risk areas.
- Have the capacity to **safely and efficiently accommodate** a large number of people.
- Be **recognized and identifiable** by the local population.
- Remain **available at all times**, without risk of **closure or obstruction**.
- Serve as a **rallying point** to **facilitate emergency coordination**.

Identify potential vertical evacuation sites only if evacuation inland is not possible and under certain conditions of building resistance, consistency of earthquake/tsunami instructions and 24/7 reception capacities.

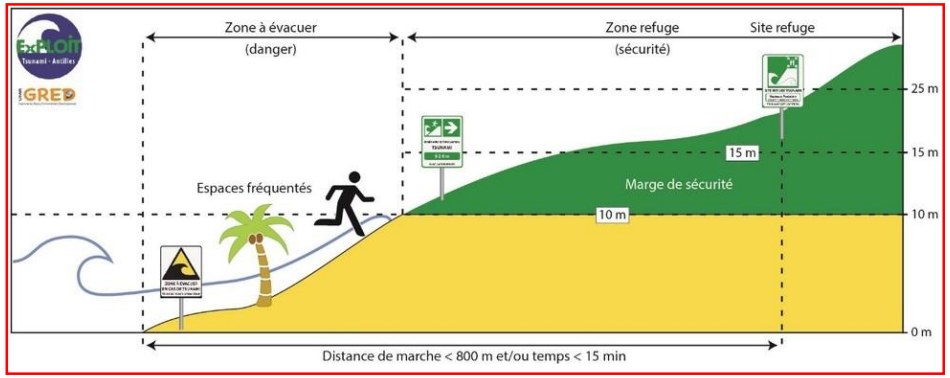
EXPLOIT project (2016 – 2018), M. Peroche - LAGAM

Key Criteria for Selecting horizontal Tsunami Refuge Sites in France

1. **Sufficient Elevation or Distance:** Located **far enough from the evacuation zone** to ensure a **safety buffer** and avoid **congestion on evacuation routes**.

2. **Quick Access on Foot:** Reachable within **15 minutes or 800 meters**, including by vulnerable populations.

3. **Sufficient Capacity:** Must accommodate all evacuees based on estimated maximum numbers.
4. **Safety:** Offers **adequate protection**, **proximity to rescue centers**, and allows movement to **higher ground** if needed.
5. **Availability:** Accessible **24/7** without risk of **closure** or **repurposing**.
6. **Local Recognition:** Must be **known and accepted** by the community, avoiding inappropriate sites like cemeteries or waste areas.



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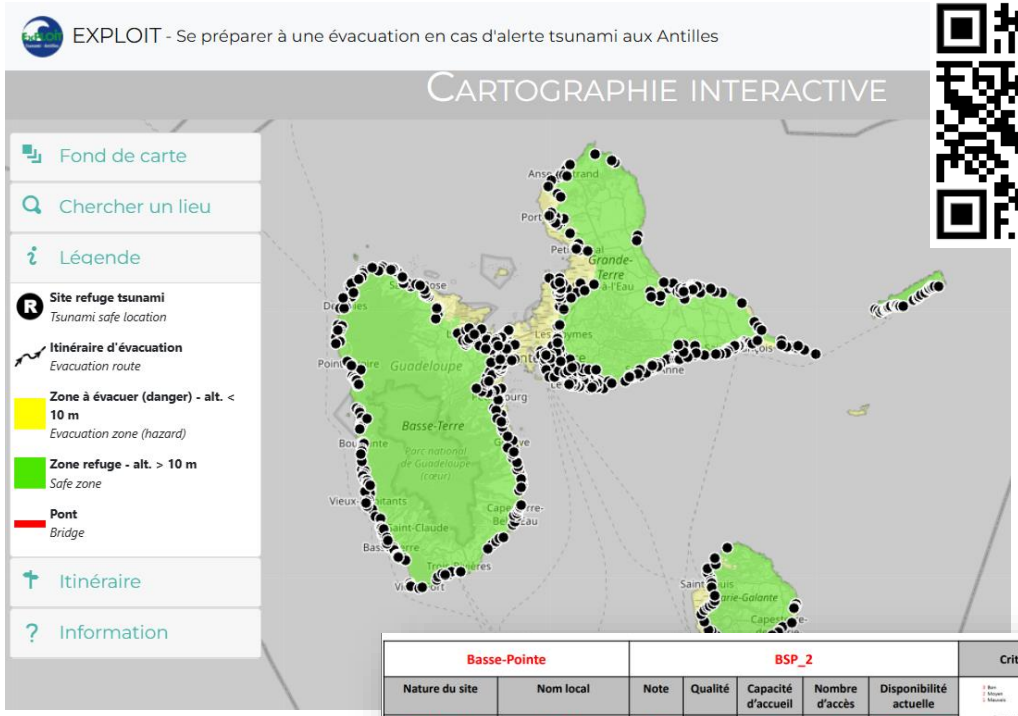
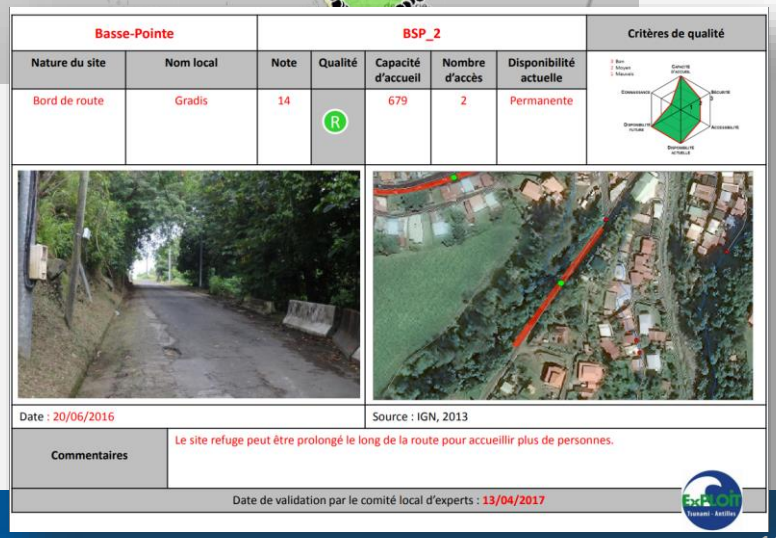




Basse-Pointe		BSP_2					Critères de qualité
Nature du site	Nom local	Note	Qualité	Capacité d'accueil	Nombre d'accès	Disponibilité actuelle	
Bord de route	Gradis	14	R	679	2	Permanente	

Date : 20/06/2016 | Source : IGN, 2013

Commentaires: Le site refuge peut être prolongé le long de la route pour accueillir plus de personnes.

Date de validation par le comité local d'experts : 13/04/2017

Participatory Validation of Tsunami Refuge Sites – Mayotte (Indian Ocean) 16 coastal municipalities concerned

- **Local Committees Composition:**

The validation process involved **researchers from the University de Monptellier Paul-Valéry** , representatives from the **Prefecture**, the **Departmental Council**, and the **fire department**, as well as **local elected officials**, **municipal police**, and **municipal technical services**

- **Validation Sessions**

Context Presentation: Explanation of tsunami risks, local issues, and evacuation strategies.
Q&A Session: Clarification of technical points.
Practical Exercises: Using **digital maps**, followed by **on-site visits** to verify the selected sites.

- **Validation Objectives:**
  - ✓ **Confirm the relevance of the identified sites.**
  - ✓ **Adjust, relocate, or remove sites** if necessary.
  - ✓ **Test evacuation routes** linked to each site.
  - ✓ **Propose improvements** (e.g., signage, access).
  - ✓ **Name and officially validate** the refuge sites.
  - ✓ **Improving local ownership of results**

- **Results and Involvement:**

90 people participated in the process.

Evactsu Mayotte project (2019 – 2021), F. Leone 2021 - LAGAM

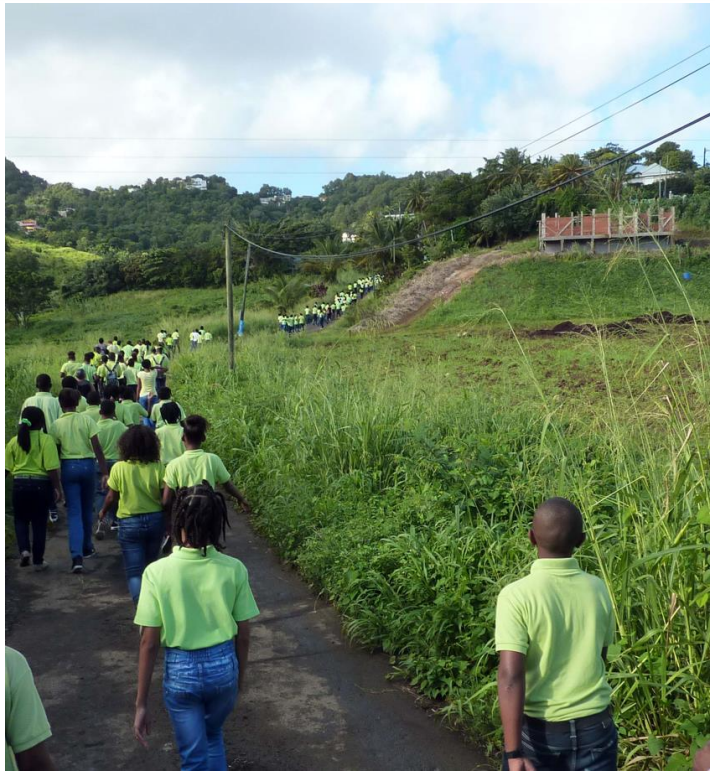
Key points to identify evacuation routes

Definition :

Evacuation routes guide people **out of the risk zone quickly**, following **paths that run perpendicularly to the coast**. These routes must be **safe, fast, and accessible** during any tsunami scenario (local, regional, distant).

Key criteria:

- **Prioritize short, safe paths:** Select routes that evacuees can follow **quickly on foot**, avoiding traffic congestion and damaged roads.
- **Bypass risky areas:** Avoid **bridges**, **fragile buildings**, **power lines**, and **landslide-prone zones**.
- **Ensure accessibility:** Routes should be **wide and practical**, including for **people with reduced mobility**.
- **Plan alternatives:** Prepare **backup routes** in case the main paths are blocked by debris or infrastructure damage.
- **Routes should avoid areas identified as at risk of flooding**: stay outside the inundation zone



EXPLOIT project (2016 – 2018), M. Peroche - LAGAM

Evacuation Mode ? Should Evacuation Be on Foot or by Vehicle?

On Foot:

Ideal to avoid road congestion.
Faster and more predictable.

By Vehicle:

May be permissible for **distant tsunamis** with more time.
Planners must provide clear instructions.

Key Contributions of GIS at Each Stage of the Process

Community Involvement in Evacuation Planning and Map Development

Active **community engagement** ensures that evacuation maps are **practical, relevant, and widely accepted** by those who will use them. Involving **local residents, workers, and tourists** improves the accuracy of the maps and strengthens the community's **preparedness and trust** in the evacuation process.

Key actions include:

- **Public Meetings** – Engage **local stakeholders** (schools, hospitals, businesses) from the start to **present risks and draft maps**.
- **Gather Local Knowledge** – Incorporate **first-hand knowledge** from the community to identify **risk areas, safe routes, and gathering points**.
- **Create Local Working Groups** – Form **local committees** including residents, officials, and emergency services to **validate maps and organize drills**.
- **Field Visits and Exercises** – Conduct **route-walking exercises** with the community to **test and adjust evacuation maps**.
- **Community Drills** – Organize **evacuation exercises** to **practice routes** and **identify bottlenecks**.
- **Regular Updates** – **Review and update maps** over time based on **community feedback** to keep them **relevant and effective**.

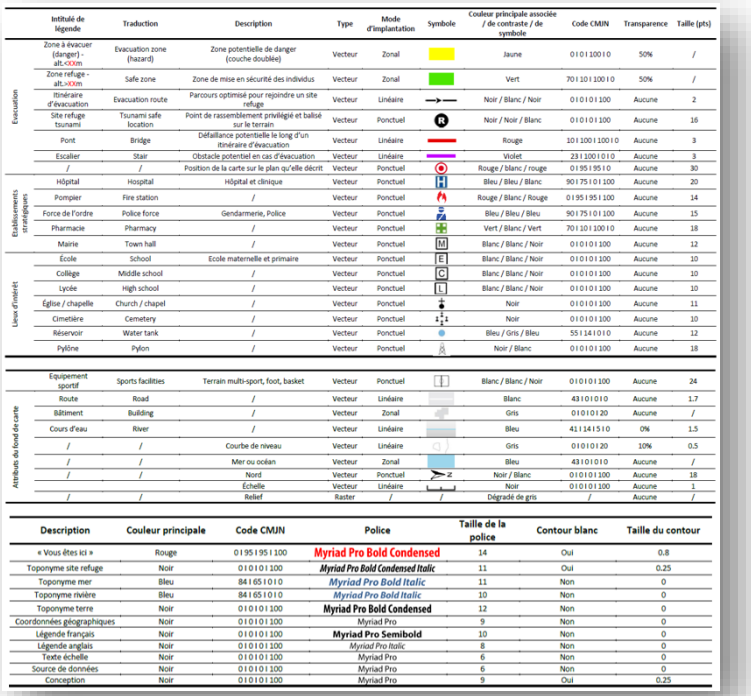
Evactsu Mayotte project (2019 – 2021), F. Leone 2021 - LAGAM

Key Points finalize the Evacuation Map

The finalization of the evacuation map is a crucial step to ensure it becomes a practical, easy-to-understand tool for the local population, workers, and tourists. This step includes not only refining the map itself but also developing accompanying signage to guide people effectively during a tsunami evacuation.

- Validate the map with local authorities – Ensure accuracy and gain official approval.
- Incorporate community feedback – Ensure the map reflects local realities and community needs.
- Standardize map elements – Use consistent colors, symbols, and legends to improve readability.

- Provide clear instructions – Indicate when to evacuate, how to evacuate, and where to go.
- Develop public procedures – Create simple guidelines to accompany the map for better understanding.
- Install signage – Place evacuation signs in key locations to guide people during an emergency.



	Intitulé de légende	Traduction	Description	Type	Mode d'implantation	Symbole	Couleur principale associée / de contraste / de symbole	Code CMJN	Transparence	Taille (pts)
Évacuation	Zone à évacuer (danger) - alt.<0m	Evacuation zone (hazard)	Zone potentielle de danger (couche doublée)	Vecteur	Zonal		Jaune	0 1 0 1 100 1 0	50%	/
	Zone refuge - alt.>0m	Safe zone	Zone de mise en sécurité des individus	Vecteur	Zonal		Vert	70 1 10 1 100 1 0	50%	/
	Itinéraire d'évacuation	Evacuation route	Parcours optimisé pour rejoindre un site refuge	Vecteur	Linéaire		Noir / Blanc / Noir	0 1 0 1 0 1 100	Aucune	2
	Site refuge tsunami	Tsunami safe location	Point de rassemblement privilégié et balisé sur le terrain	Vecteur	Ponctuel	R	Noir / Noir / Blanc	0 1 0 1 0 1 100	Aucune	16
	Pont	Bridge	Défaillance potentielle le long d'un itinéraire d'évacuation	Vecteur	Linéaire		Rouge	10 1 100 1 100 1 0	Aucune	3
	Escalier	Stair	Obstacle potentiel en cas d'évacuation	Vecteur	Linéaire		Violet	23 1 100 1 0 1 0	Aucune	3
	/	/	Position de la carte sur le plan qu'elle décrit	Vecteur	Ponctuel		Rouge / Blanc / rouge	0 1 95 1 95 1 0	Aucune	30
Établissements stratégiques	Hôpital	Hospital	Hôpital et clinique	Vecteur	Ponctuel	H	Bleu / Bleu / Blanc	90 1 75 1 0 1 100	Aucune	20
	Pompier	Fire station	/	Vecteur	Ponctuel		Rouge / Blanc / Rouge	0 1 95 1 95 1 100	Aucune	14
	Force de l'ordre	Police force	Gendarmerie, Police	Vecteur	Ponctuel		Bleu / Bleu / Bleu	90 1 75 1 0 1 100	Aucune	15
	Pharmacie	Pharmacy	/	Vecteur	Ponctuel		Vert / Blanc / Vert	70 1 10 1 100 1 0	Aucune	18
	Mairie	Town hall	/	Vecteur	Ponctuel	M	Blanc / Blanc / Noir	0 1 0 1 0 1 100	Aucune	12
Lieux d'intérêt	École	School	Ecole maternelle et primaire	Vecteur	Ponctuel	E	Blanc / Blanc / Noir	0 1 0 1 0 1 100	Aucune	10
	Collège	Middle school	/	Vecteur	Ponctuel	C	Blanc / Blanc / Noir	0 1 0 1 0 1 100	Aucune	10
	Lycée	High school	/	Vecteur	Ponctuel	L	Blanc / Blanc / Noir	0 1 0 1 0 1 100	Aucune	10
	Église / chapelle	Church / chapel	/	Vecteur	Ponctuel		Noir	0 1 0 1 0 1 100	Aucune	11
	Cimetière	Cemetery	/	Vecteur	Ponctuel		Noir	0 1 0 1 0 1 100	Aucune	10
	Réservoir	Water tank	/	Vecteur	Ponctuel		Bleu / Gris / Bleu	55 1 14 1 0 1 0	Aucune	12
	Pylône	Pylon	/	Vecteur	Ponctuel		Noir / Blanc	0 1 0 1 0 1 100	Aucune	18
	Equipement sportif	Sports facilities	Terrain multi-sport, foot, basket	Vecteur	Ponctuel		Blanc / Blanc / Noir	0 1 0 1 0 1 100	Aucune	24
Attributs du fond de carte	Route	Road	/	Vecteur	Linéaire		Blanc	43 1 0 1 0 1 0	Aucune	1.7
	Bâtiment	Building	/	Vecteur	Zonal		Gris	0 1 0 1 0 1 20	Aucune	/
	Cours d'eau	River	/	Vecteur	Linéaire		Bleu	41 1 14 1 5 1 0	0%	1.5
	/	/	Courbe de niveau	Vecteur	Linéaire		Gris	0 1 0 1 0 1 20	10%	0.5
	/	/	Mer ou océan	Vecteur	Zonal		Bleu	43 1 0 1 0 1 0	Aucune	/
	/	/	Nord	Vecteur	Ponctuel	N	Noir / Blanc	0 1 0 1 0 1 100	Aucune	18
			Échelle	Vecteur	Linéaire		Noir	0 1 0 1 0 1 100	Aucune	1
	/	/	Relief	Raster	/	/	Dégradé de gris	/	Aucune	/

Description	Couleur principale	Code CMJN	Police	Taille de la police	Contour blanc	Taille du contour
« Vous êtes ici »	Rouge	0 1 95 1 95 1 100	Myriad Pro Bold Condensed	14	Oui	0.8
Toponyme site refuge	Noir	0 1 0 1 0 1 100	*Myriad Pro Bold Condensed Italic*	11	Oui	0.25
Toponyme mer	Bleu	84 1 65 1 0 1 0	*Myriad Pro Bold Italic*	11	Non	0
Toponyme rivière	Bleu	84 1 65 1 0 1 0	*Myriad Pro Bold Italic*	10	Non	0
Toponyme terre	Noir	0 1 0 1 0 1 100	Myriad Pro Bold Condensed	12	Non	0
Coordonnées géographiques	Noir	0 1 0 1 0 1 100	Myriad Pro	9	Non	0
Légende français	Noir	0 1 0 1 0 1 100	Myriad Pro Semibold	10	Non	0
Légende anglais	Noir	0 1 0 1 0 1 100	*Myriad Pro Italic*	8	Non	0
Texte échelle	Noir	0 1 0 1 0 1 100	Myriad Pro	6	Non	0
Source de données	Noir	0 1 0 1 0 1 100	Myriad Pro	6	Non	0
Conception	Noir	0 1 0 1 0 1 100	Myriad Pro	9	Oui	0.25

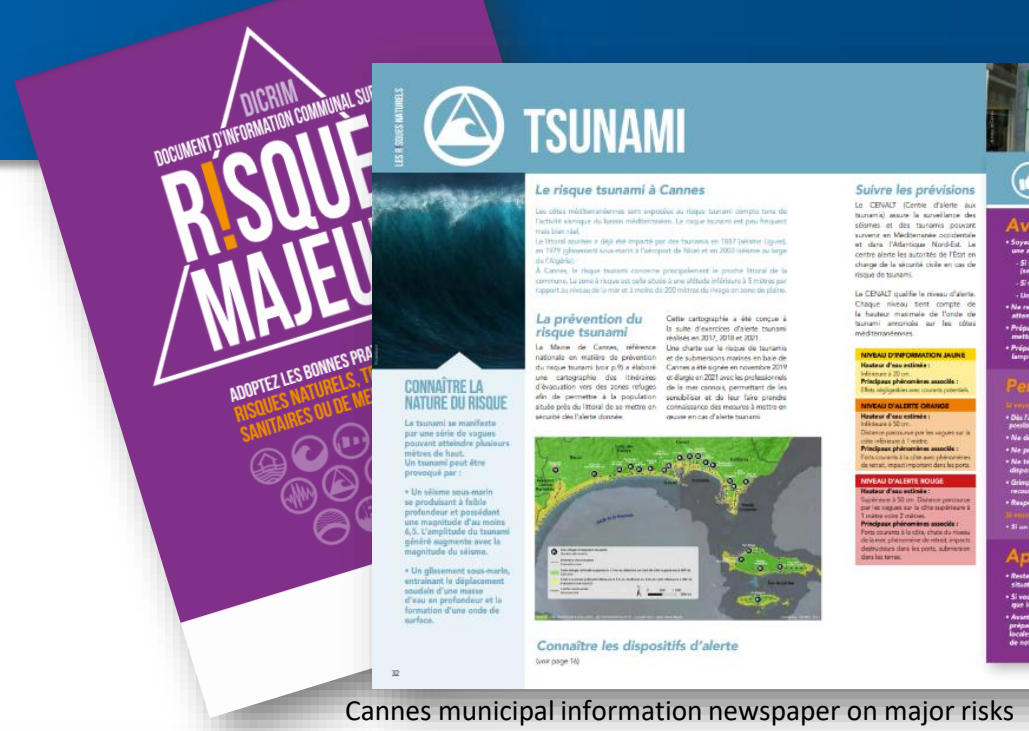
Extract from the cartographic chart of the tsunami evacuation plans for the EXPLOIT project (Leone et al, 2018)

Cartographic chart used in Cannes

Key Points for evacuation plan dissemination !

The **dissemination of evacuation plans** ensures that **local residents, workers, and tourists** are informed and prepared for a potential tsunami. It includes various **communication channels** to make **evacuation routes, refuge sites, and safety procedures** accessible and understandable to everyone in the area.

- **Distribute printed material - Leaflets, brochures and evacuation maps.**
- **Use the local media - Inform through the local press and radio announcements.**
- **Public display - Display evacuation maps in public spaces and high-traffic areas (schools, town halls, ports).**



Cannes municipal information newspaper on major risks

Tsunami evacuation plan displayed at the reception of a beach restaurant in Cannes (M. Péroche, 2024)

Regional press article

Key Points for evacuation plan dissemination …

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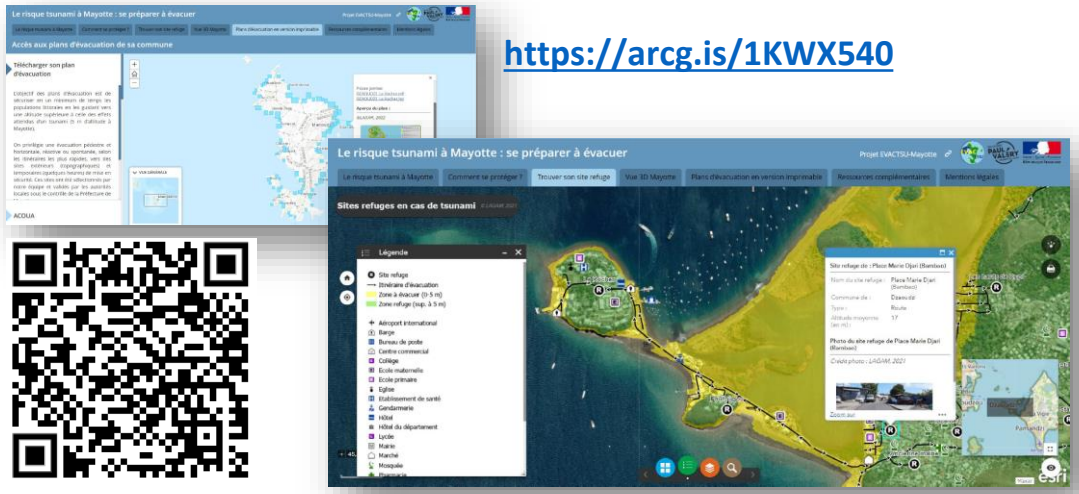
- **Dedicated websites and mapping platforms - Provide interactive evacuation maps accessible online including on mobile devices.**

➢ **Evactsu Mayotte project (Indian Ocean - 16 municipalities)**

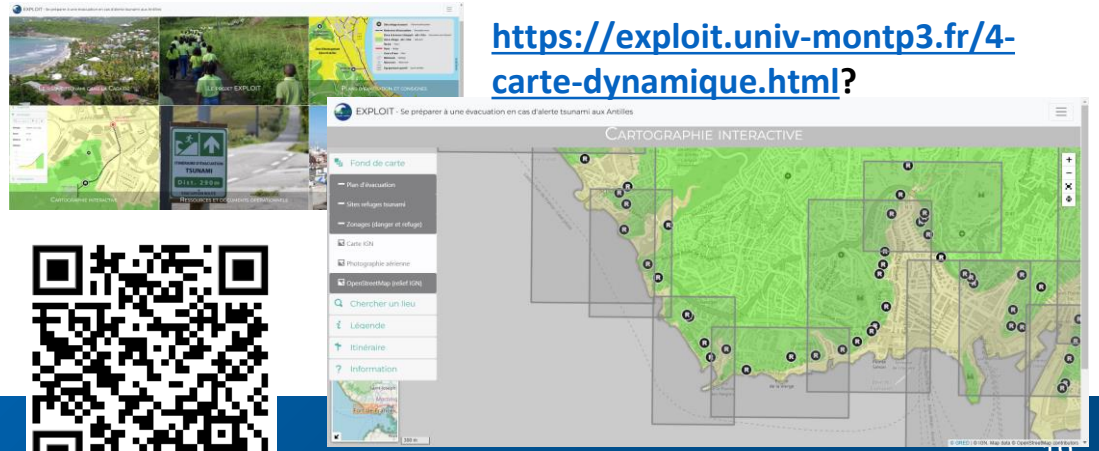
Arcgis Online solution



https://arcg.is/1KWX540

➢ **EXPLOIT project (Caribbean bassin - 60 municipalities)**

Opensource development with dynamic functionality and mobile version



https://exploit.univ-montp3.fr/4-carte-dynamique.html?

A good evacuation plan is only useful if it's kept alive: practice it!


Tsunami evacuation exercise at Le Robert secondary school in Martinique (M. Peroche, 2016)


Thank you

UNESCO
Intergovernmental Oceanographic Commission (IOC)

UNESCO-IOC DG ECHO CoastWAVE 2.0
project
Tsunami Resilience Section

unesco
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