ASTARTE

Assessment, STrategy And Risk Reduction for Tsunamis in Europe

Grant Agreement no: 603839
Organisation name of lead contractor: IPMA
Coordinator: Maria Ana Baptista

Deliverable 9.7
Report on preparedness skills, resources and attitudes within the communities

Due date of deliverable:	M12
Actual submission date to PC:	M12
Start date of the project:	01/11/2013
Duration:	36 months

Work Package:	9 "Building Tsunami Resilient Societies"
Lead beneficiary of this deliverable:	CNRS
Author(s):	**Leading Authors:** Franck Lavigne **Contributors:** - F. Lavigne, L. Goeldner-Gianella, D. Grancher, B. Anselme, A. Liotard, J. Lopes, C. Charpentier, J. Lenouvel, C. Buchet-Couzy, D. Provitolo, S. Combe, T. Lohrer, A. Cengil, T. Bucourt (CNRS); - N. Dogulu, N. Karanci, S. Kalaycioglu, S. Duzgun, A. C. Yalciner, U. Kanoglu (METU) - A. Papageorgiou, C. Tsimi, K. Orfanogiannaki, G.A.Papadopoulos (NOA) - M.-A. Baptista, R. Omira, M. Wronna (IPMA); - C. Bonnevie Harbitz (NGI) - O. Robertsen (Inst. of Psychology, Arctic University of Norway);
Version:	V1.0

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)	
Dissemination Level	
PU Public	
PP Restricted to other programme participants (including the Commission Services)	X
RE Restricted to a group specified by the consortium (including the Commission Services)	
CO Confidential, only for members of the consortium (including the Commission Services)	

TABLE OF CONTENT

EXECUTIVE SUMMARY

This report focuses on preparedness skills, resources and attitudes within the communities of the ASTARTE test sites. It presents the main results achieved in the Task 9.2 of the WP9. The aim of this task is to assess the preparedness skills, including risk perception and attitudes of the tsunami risk among inhabitants. The risk perception of local stakeholders will be held in the Task 9.3.
Based on a single questionnaire for all the test sites, such assessment allowed us: (1) to estimate how people consider the tsunami risk (multi-risk approach), how they are aware of the tsunamis recurrence and sources (links with WP2 and 3), and would people react in the future facing a tsunami threat; (2) estimate the needed level of customization and their modalities for awareness and preparedness material in each studied community; and to (3) provide data for agent-based evacuation modeling (age, reactivity, admissibility of an evacuation, etc…).

The results of this report are based on a similar questionnaire which has been translated in 9 different languages. It is divided in 5 topics (see Methods section p. 5).

The results of each test site are presented in a 4-pages individual report. These reports have been gathered together for the D9.7 deliverable. A comparative study is in process.

DOCUMENT INFORMATION

Project Number	FP7 - 603839	**Acronym**	ASTARTE
Full Title	Assessment, STrategy And Risk Reduction forTsunamis in Europe		
Project URL	http://www.astarte-project.eu/		
Document URL	http://www.astarte-project.eu/index.php/deliverables.html		
EU Project Officer	Denis Peter		

Deliverable	**Number**	D9.7	**Title**	Report on preparedness skills, resources and attitudes within the communities
Work Package	**Number**	WP9	**Title**	Building Tsunami Resilient Societies

Date of Delivery	**Contractual**	M12	**Actual**	M12
Status	Version 1.0 (V1.0)		☐ final	
Nature	☐ prototype ☑ report ☐ dissemination			
Dissemination level	☐ public ☑ consortium			

Authors (Partner)	CNRS			
Responsible Author	**Name**	Franck Lavigne	**E-mail**	Franck.lavigne@univ-paris1.fr
	Partner	CNRS	**Phone**	+33 6 26 53 02 27

Abstract (for dissemination)	This report focuses on preparedness skills, resources and attitudes within the communities of the ASTARTE test sites. It presents the main results achieved in the Task 9.2 of the WP9. The aim of this task is to assess the preparedness skills, including risk perception and attitudes of the tsunami risk among inhabitants. The risk perception of local stakeholders will be held in the Task 9.3. Based on a single questionnaire for all the test sites, such assessment allowed us: (1) to estimate how people consider the tsunami risk (multi-risk approach), how they are aware of the tsunamis recurrence and sources (links with WP2 and 3), and would people react in the future facing a tsunami threat; (2) estimate the needed level of customization and their modalities for awareness and preparedness material in each studied community; and to (3) provide data for agent-based evacuation modeling (age, reactivity, admissibility of an evacuation, etc…). The results of this report are based on a similar questionnaire which has been translated in 9 different languages. It is divided in 5 topics (see Methods section p. 5). The results of each test site are presented in a 4-pages individual report. These reports have been gathered together for the D9.7 deliverable. A comparative study is in process.
Keywords	Tsunami, resilience, preparedness, risk perception, tsunami awareness.

Version Log			
Issue Date	**Rev. No.**	**Author**	**Change**
28.10.2014	V1.0	F. Lavigne	

METHODS

Our database is based on a single questionnaire for all the test sites. In addition, specific questions have been added for each test site.

The questionnaire is divided in 5 topics:

- Interviewee's relation to the site (7 questions)
- Information on interviewed people (12 questions)
- Hazard knowledge/risk perception (10 questions)
- Evacuation issue (5 questions)
- Awareness of warning system, information, communication (17 questions)

This questionnaire has been translated in 5 languages: English, French, Portuguese, Spanish, Greek, Turkish, Norvegian, Italian and Russian, and will be soon translated in Romanian for a comparative study.

Table 1. Number of questionnaires per test site

Achieved

In process

Postponed

Field works have been carried out in Haydarpasa in summer 2014. Results are still in process. They will be delivered before the end of this year.
For diplomatic reasons, field works using questionnaires in Tangier and Syracusa were not possible in 2014. They are postponed in 2015 if the conditions are fulfilled.

Test site	Questionnaires
Tangier	
Sines	133
Colonia Sant Jordi	175
Nice	400
Syracusa	
Heraklion	113
Haydarpasa	112
Gulluk Bay	237
Lyngen	101

ASTARTE Project - Deliverable 9.7 - LYNGEN / NORWAY/ 2014

Report on preparedness skills, resources and attitudes within the communities

Test site leader: Carl Bonnevie Harbitz (NGI)
End-user of the test- site: R. Elvenes (NNFO)
Scientific team: B. Anselme, L. Goeldner-Gianella, D. Grancher, F. Lavigne (CNRS); O. Robertsen (Inst. of Psychology, Arctic University of Norway).

Local partners: Lyngen municipality
Local collaboration: J.A. Terum (Institute of Societal Safety, Arctic University of Norway, Tromsø), H.C. Vangberg (University Hospital of Northern Norway).

1. Context

1.1. Location

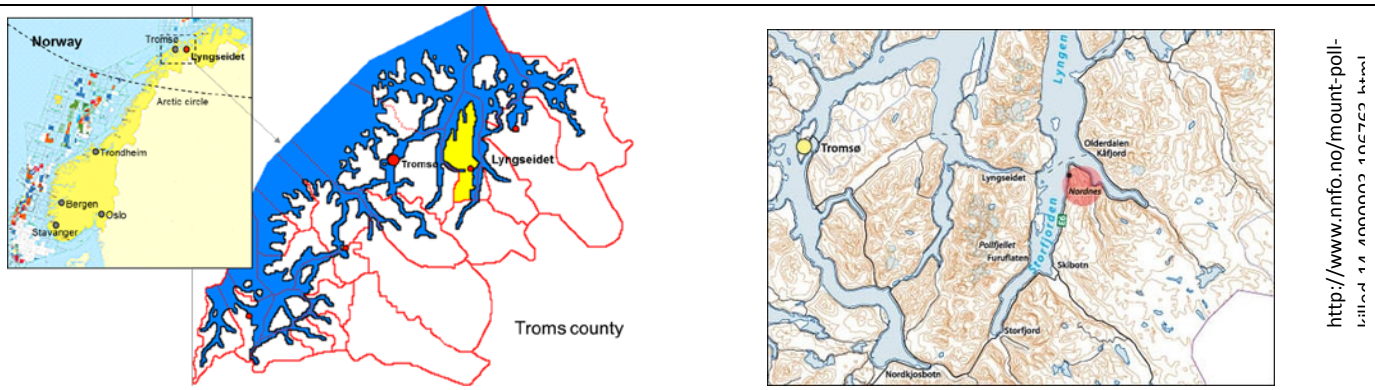


Fig. 1. Location maps of the study area

Fig. 2. The Lyngen fjord, looking west from the Nordnes Mountain.
In the foreground, instrumentation of the rock slope (F. Lavigne, 27/05/14)

1.2. Socio-economic context

In 2014, the Lyngen municipality (Fig. 1) encompasses 3000 inhabitants occupying a number of villages (Lyngseidet, Furuflaten, and other settlements along the fjord, Figs. 1-2). Only 19% of the land is cultivated along the fjord (1130 hectares). Other activities are fishing, fish processing, tourism and light industry (mainly at Furuflaten, Fig. 3). The level of education in Lyngen is lower than the mean national level (43% have not attended high school; for the whole of Norway this number is 27%). 30% of the people have a rather low yearly income less than 250,000 NOK (~30,000 €).

Fig. 3. Furuflaten industrial complex built on an alluvial fan
(F. Lavigne, 29/05/14)

1.3. Risk assessment

1.3.1. Rockslide-triggered tsunami hazard

On the 30th of June 1810, one of the largest rockslides in Norway since the ice age fell into the sea from the 1213-metres high Mount Poll (Fig. 4), situated a few km to the south of the Nordnes Mountain, on the opposite side of the Lyngen fjord (Fig. 2). It triggered a tsunami characterized by three separate waves that killed 14 people and swept away several farms, boats, and farm animals at Furuflaten. Effects of the tsunami were reported 20 km away, where the wave height ranged from 1.5 to 2 m. A number of other large rockslides have been mapped in this county, some of them leaving huge rockslide deposits in the fjords. Many of the large rockslides were released about 11,500 – 10,500 years ago, i.e. shortly after the last glacial period.

Fig. 4. Mount Poll with the scarp of the 1810 tsunamigenic rockslide, Furuflaten/Lyngen (L. Goeldner, 02/06/14)

1.3.2. Risk exposure

Although the permanent population of Lyngen is quite limited, most of them live within the tsunami hazardous area that has been modelled by NGI (maximum run-up height 33 m at Lyngseidet). Despite a negative natural balance, the net population is growing due to positive migratory balance.

Most of the administrative buildings (e.g. the city hall) are located in the exposed low lands of Lyngseidet. The industrial area of Furuflaten is also located in a very low-lying area. Initially specialized in the building industry based on sand mining after the 2nd World War, the industrial production has been progressively diversified towards production of plastic and steel, and more recently portable toilets (Ecotech).

1.4. Risk management

The rock-slope monitoring involves high-tech instrumentation such as lasers, crackmeters, tiltmeters, extensometers, GPS network, and instrumented boreholes. A series of numerical tsunami simulations were performed for various scenarios. Initial land-use and evacuation planning for rockslide tsunamis in Lyngen is now performed by Troms County, the local municipalities, and the preparedness centre Nordnorsk Fjellovervåking (NNFO). Based on the ASTARTE survey among one hundred people, the local population is informed about the tsunami hazard, even though some people would like to receive more information.

1.5. Crisis management

A permanent Early Warning System is based on an operational cell phone warning starting at least 72 hours before the occurrence of a predicted rockslide. In 2013, the Barents Rescue international emergency exercise simulated a destructive rockslide from the Nordnes Mountain. Under the umbrella of the Norwegian Directorate for Civil Protection, the exercise promoted cooperation between various authorities in the Barents Region, in addition to authorities at national and international levels.

2. Profile of the interviewed people

Number of questionnaires	Place of interviews	Sex ratio	Mean age	Geographical origin
101 	- 62.5% in Lyngseidet- 20.8% on the ferry boat - 16.8% in other villages	- 47% male - 53% female	44	- 27.5% of tourists or occasional residents (14.9% coming from foreign countries: Finland, France, Switzerland…) - 81.7% of residents (including 57.6% of people living more than 10 years in Lyngen commune)

3. People's knowledge of tsunami hazard

The three main hazards that could affect Lyngen (open question) are tsunamis (or "flodbølge" in Norwegian) induced by a rockslide from the Nordnes Mountain (47.7%), avalanches (39.8%), and rockslides (13.6%) (Fig. 5). For 9% of the interviewed people, there is no hazard in Lyngen.

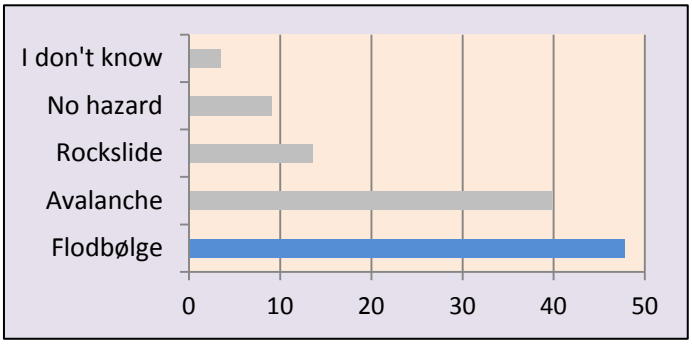


Fig. 5. Possible hazards that could affect Lyngen. Opened question, in %, ASTARTE survey, 101 answers

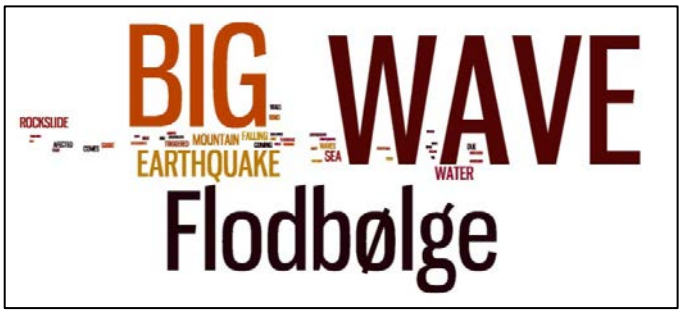


Fig. 6. Word cloud resulting from the question: *"According to you, what is a "tsunami"*?
ASTARTE survey, 101 answers

It must be noticed that no foreigners spontaneously mention the flodbølge hazard, whereas 40% of the local people know that a flodbølge has already affected Lyngen - in particular in 1810. This good knowledge of tsunamis is also apparent in the spontaneous descriptions of such an event (Fig. 6).

Even if the local flodbølge risk is well known, the knowledge of tsunamis comes to a large extent from TV (73.2%) and media coverage of big events (10.3%), e.g. the Indian Ocean and Japan tsunamis of 2004 or 2011. Only 13.4% of the respondents learnt the word tsunami at school. According to the interviewees, the possible origins of a flodbølge are rockslides (more than 58%) or earthquakes (more than 25%). However, 48.5% of the respondents consider that there are no precursor signs for them. Only 17.4% and 7.4% mention sea withdrawals and earthquake, respectively. 9.6% mention an unusual roaring sound related to a Nordnes rockslide.

4. Perception of a future tsunami event in Lyngen: a big, but not scary event

64.6% of the respondents think that a tsunami wave could reach more than 10 meters high (Fig. 7).

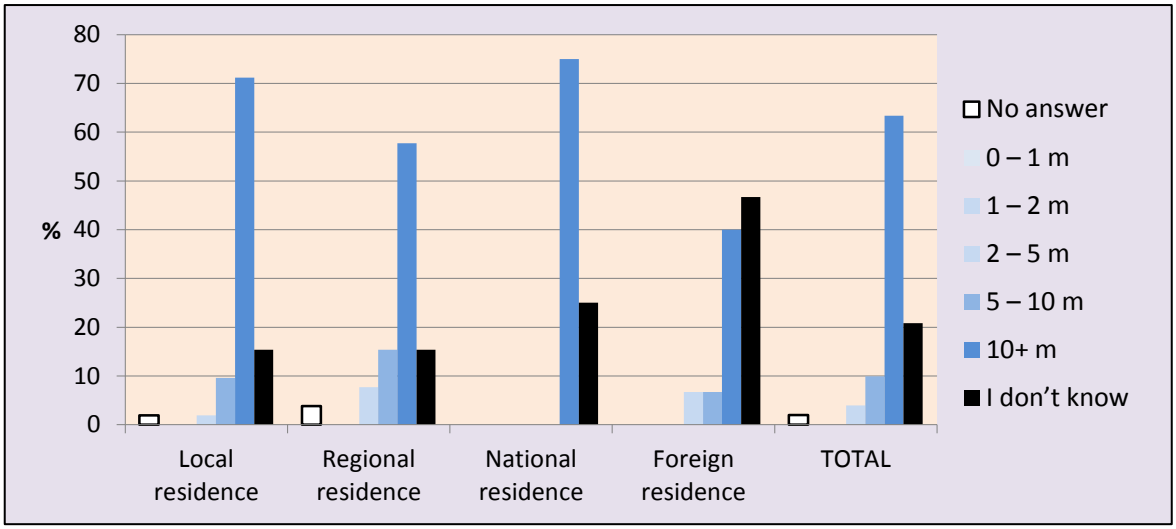


Fig. 7. Supposed wave's height in relation with people's residence. ASTARTE survey, 101 answers (in %)

Therefore, most of the respondents consider that a future tsunami could impact houses and infrastructures, and might kill people. However, 55.4% of them consider that they are not really threatened by the Nordness Mountain: 64.3% never or rarely think about the threat.

5. Trust in government's risk management

In general people are satisfied with the surveillance of the Nordnes Mountain (> 60% of them consider it as good or very good). Moreover, 40.9% of the interviewed people have a positive opinion on the quality of the Lyngen emergency plan in general. The information given by the local government about the stability of the Nordnes mountain may however be improved according to interviewees (only 31.7% of them are satisfied, whereas 15.8% are unsatisfied, 33% don't know, and 18.8% give no answer). It must nevertheless be underlined that local people have a good knowledge on the possible wave heights (more than 10m) and the time needed for evacuation (more than 24 hours, Fig. 8).

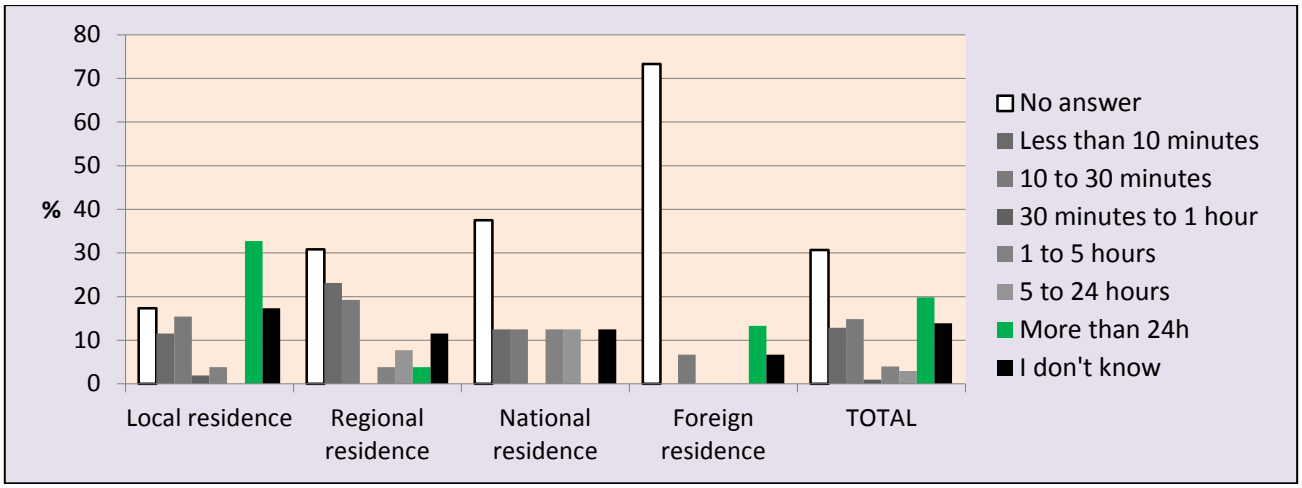


Fig. 8. Perceived evacuation time in relation with people's residence. ASTARTE survey, 101 answers (in %)

6. Local perceptions' particularities

"Jökulhlaup": an underrated hazard

The perception of hazards in Lyngen are due to either high frequency (snow avalanches) or to extensive dissemination of information (rockslide and flodbølge). However, another hazard has appeared recently due to the climate change, namely flash flood or debris flow due to glacial lake outburst, also known by the Icelandic term "*Jökulhlaup*". In the summer 2013, a large debris flow occurred in Koppangen village due to the sudden drainage of an under-glacier lake. This event was the first reported in Lyngen for at least three human generations.

The industrial complex of Furuflaten village has been built on an alluvial fan at the mouth of a river (Fig. 3).The upper part of its catchment is covered by three glacier tongues that have rapidly melted for the last decades. Therefore it is assumed that a similar or even bigger *Jökulhlaup* than the one of Koppangen is likely to occur at Furuflaten, where a school is also exposed to this hazard.

7. References

On rockslides in Norway: Furseth A., 2006. Skredulykker i Norge (Land and rock slides and avalanches in Norway), Tun forlag.

On Nordnes Mountain surveillance: http://www.nnfo.no/nordnes-mountain.188317.en.html

On the flodbølge of 1810: http://www.forskning.no/artikler/2007/august/1187941469.56; http://www.nnfo.no/mount-poll-killed-14.4990903-196763.html

On emergency plan: http://www.nnfo.no/emergency-plan.188322.en.html

On "Barents rescue exercise" 2013: http://www.dsb.no/

ASTARTE Project - Deliverable 9.7 - GULLUK BAY/ TURKEY/ 2014

Report on preparedness skills, resources and attitudes within the communities

Test site leader: Ahmet Cevdet Yalciner (METU)
End-user of the test-site: Disaster and Emergency Management Authority of Turkey (AFAD), Underwater Research Society, Republic of Turkey Ministry of Food, Agriculture and Livestock.

Scientific team: N. Dogulu, N. Karanci, S. Kalaycioglu, S. Duzgun, A. C. Yalciner, U. Kanoglu (METU).
Local partners: Governorship of Muğla
Local collaboration: Municipalities of Milas, Bodrum, and Didim

1. Context

1.1. Location

The Gulluk Bay is located in the southern part of the Aegean Sea coast off western Turkey. It lies between the headland Tekagac to the north and Yalikavak Peninsula, 21.7 kilometres to the south. The bay extends about 32.2 kilometres and is enclosed by mountains (Fig. 1). The bay is surrounded by the provinces of Aydın (in the north) and Muğla. The towns of Didim (Aydin), Yalikavak (Muğla) and Bodrum (Muğla) are popular holiday destinations.

http://www.istanbul-city-guide.com/map/mugla-map

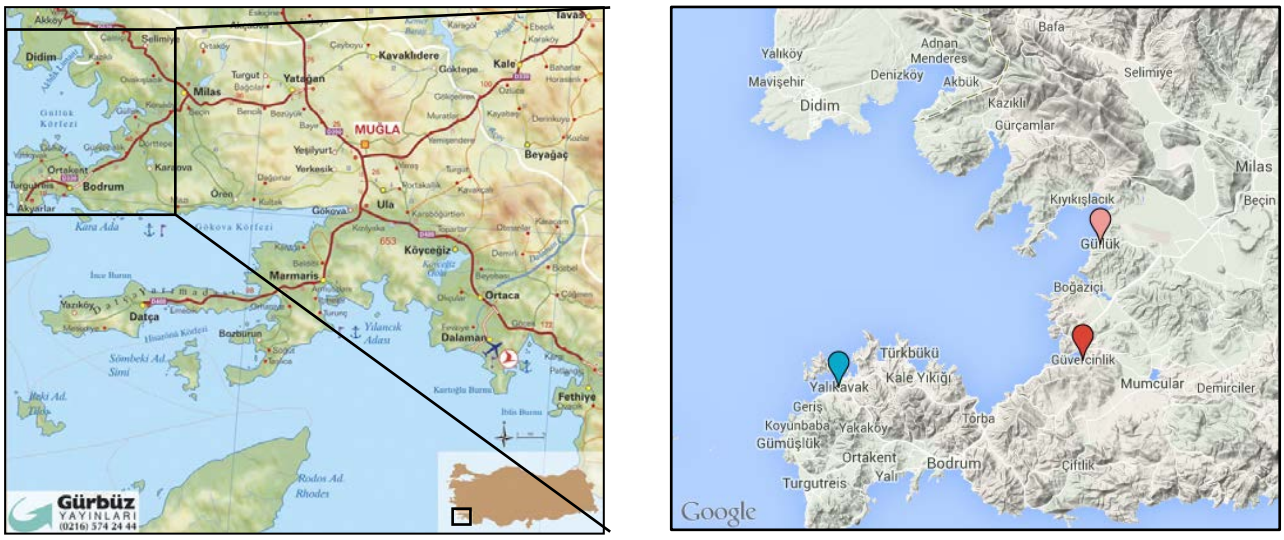


Fig. 1. The study area.(Pins show the places of interviews)

Fig. 2. Aerial photos of the Gulluk Bay.

1.2. Socio-economic context

Many villages around the Gulluk Bay have winter population of less than 2000, except the towns of Gulluk (3500) and Didim (8000). The population increases 3-4 times in the summer months, between June and September.

The bay contains one big harbor (Gulluk Harbor, Fig. 3) and two marinas (one big and one boutique). The biggest (international) airport of the region, Milas-Bodrum Airport, is also located here.


Fig. 3. Gulluk Port (left) **and the Palmarina in Yalikavak** (right)

The Gulluk Bay is also very important for fishery (Fig. 4), sea transportation, and various coastal activities among which tourism is the most prominent. The coast guard has also a small base in Gulluk Bay near Gulluk village.

Fig. 4. One of the fish farm areas in Gulluk Bay (The coves especially on the eastern part of the bay are occupied by fish farms) (N. Dogulu, 07/08/14)

The increasing population density as well as urban development and industrial & agricultural practices along the bay coastline intensifies the problem of environmental and sea pollution. The municipal structure in Turkey has changed after municipal elections on March 30, 2014. Previously, the local authority in Gulluk Bay was shared by local municipalities Yalikavak, Gulluk and Didim – each having their own budget. In the new structure, the responsibility areas of nearby municipalities has been expanded and parts of Gulluk Bay are merged to Bodrum and Milas municipalities.

1.3. Risk assessment

1.3.1. Tsunami hazard

The Aegean coasts were affected by a number of tsunamis during the second part of the 19th century, most of which are earthquake-triggered. The largest tsunami event of the 20th century occurred following the Amorgos, Greece earthquake in 1956. Okal et al. (2004) reported the maximum run-up of 2.1 m in the town of Yalikavak. The Santorini Eruption in 1630 BC also caused a tsunami, which might have affected the Eastern Mediterranean coasts of Turkey.

1.3.2. Risk exposure

According to modeling studies carried out for the Gulluk Bay, one of the tsunami scenario indicates that the main infrastructures, i.e., the ore mine area near Gulluk Port, and marinas in Didim and Yalikavak, and small parking basins for fishery crafts, and airport at the North East tip of the bay are under risk when the tsunami inundates Gulluk Bay.

1.4. Risk management

The Tsunami Forecast Point in Bodrum-Milas (Muğla) region is located in south of Bodrum Peninsula. The arrival times and nearshore amplitudes of any expected tsunamis are automatically computed by Tsunami Warning Center of Turkey operated by KOERI. This operation is also documented in NEAM (Interim Operational Users Guide for NEAMTWS, version 2.0) by KOERI. Numerical tsunami simulations were performed for selected tsunami scenarios based on seismic sources. During questionnaire surveys, small meetings with residents have been performed to understand the level of awareness. Based on the interviews conducted by the ASTARTE team, the local population is informed about the tsunami hazard, even though some people would like to receive more information.

1.5. Crisis management

In Turkey, the National Tsunami Warning Center (NTWC-TR) covers the Eastern Mediterranean, Aegean, Marmara and Black seas. KOERI assesses the tsunamigenic potential of an earthquake and informs the civil protection authority (CPA) by issuing a message and updating it based on sea-level measurements and/or refined calculations where appropriate. A next generation Decision Support System in Natural Crisis Management (i.e. TRIDEC) is also in use.

2. Community survey of tsunami perceptions

Number of questionnaires	Place of interviews	Sex ratio	Mean age	Geographical origin
237 	- 22.4% Guvercinlik - 38.4% Gulluk - 39.2% Yalikavak	- 30 % female - 70 % male	43.5 (with a standard deviation of 15.9 years)	- 48.9% of local residents (including 41.8% of people living more than 10 years in the Gulluk Bay region) - 37.6% are on holiday. - 4.6% of foreigners (mostly English, also Belgian, Irish, and Australian)

3. People's knowledge of tsunami hazard

The three main hazards reported by participants that could affect Gulluk Bay are earthquakes (24.2%), fires (10.8%), and sea pollution (7.7%) (Fig.5). Tsunami is ranked only at the seventh position indicating relatively low risk compared to earthquakes. Although the word cloud resulting from participants' description of tsunami reveals that there is appropriate tsunami knowledge (Fig. 6), tsunamis are not considered as a major hazard for Gulluk Bay. On the other hand local problems such as fire, sea and environmental pollution, which the people directly suffer from, are potentially considered as more pronounced hazards.

Fig. 6. Word cloud resulting from the question: *"According to you, what is a "tsunami"*? (ASTARTE survey, open question, 237 questionnaires, 229 answers)

Despite the low priority assignment to tsunami at the local scale, the interviewed people are aware of tsunamis in the world. Their tsunami hazard knowledge is gained largely from TV (31.7%) and intense media coverage after a big event (33.8%), e.g. the Indian Ocean and Japan tsunamis

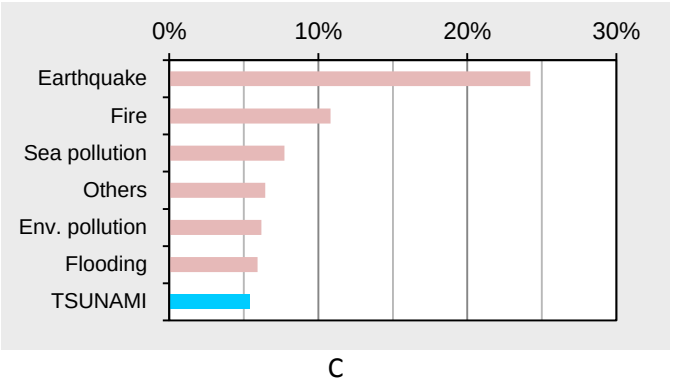


Fig. 5. Possible hazards that could affect Gulluk Bay region
Open question, in %, ASTARTE survey, 101 answers (ASTARTE survey, open question, 237 questionnaires, 388 answers)

of 2004 and 2011, respectively. It is important to note that only 16.9% of the people heard or learned the word tsunami at the school.

Majority of the interviewees (86.9%) think that Gulluk Bay would be affected by a locally generated tsunami in the Aegean Sea, which is particularly attributed to seismicity of the region (6.8%).Consistently, 29.3% of the respondents consider earthquakes as an indicator that a tsunami could happen soon. The other precursor signs mentioned were sea withdrawal and animal behavior (both 15.9%).

4. Perception of a future tsunami event in Gulluk Bay: few lessons learned but high anticipation

Low priority assignment to tsunamis (explained in Part 3) is consistent with the people's poor knowledge on the past tsunamis that occurred in the region: only 12.2% of the all participants think that Gulluk Bay has already been affected by a tsunami – in particular the 1956 earthquake and tsunami in Amorgos, Greece. It is important to mention that although more than 60% of the local people don't think that a tsunami occurred in the past, 48.5% of them think that the region could be affected by a tsunami in the future. While 28.3% of the all respondents predict the maximum tsunami wave height to be 5 – 10 meters, a lesser majority (18.1%) thinks that a tsunami wave could reach more than 10 meters. It should be noted that local residents' estimations much closer to the (tsunami) model results, i.e. a higher percentage for wave height of 2-5 meters compared to that of non-local (regional, national, foreign) residents (Fig. 7).

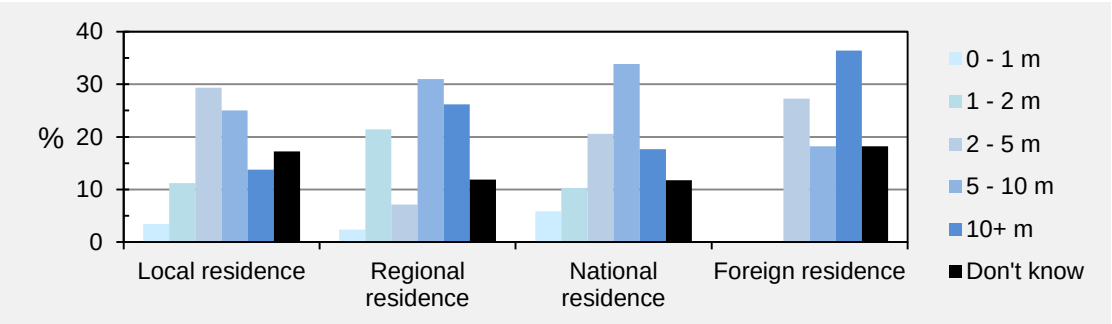


Fig. 7.Tsunami wave height estimates in relation to people's residence. ASTARTE survey, 237 answers (in %).

Death and injury of people (10.7%), impact on coastal tourism (9.9%), impacts on beaches (9.6%), and damage and destruction to houses and building (9.3) stand out among the effects that a tsunami would have in Gulluk Bay.

5. Trust in government's risk management

While 71.7% of the interviewed people think that the preparedness measures for any natural hazard is not satisfactory, this ratio becomes even higher (87.8%) for tsunamis. There is indeed no particular preparedness measure for tsunamis, e.g. inundation (and evacuation) maps or warning signs. Such high percentage can be also explained by the significant majority (76.8%) of the survey participants not knowing that there is a tsunami warning point in Gulluk Bay region. Such situation emphasizes the need for informing the community about the existence of such a system. It is key to know that people positively believe that education/training (29.1%) and media curricula (22.3%) could play a major role in improving the preparedness in general. The expected evacuation time among local residents is less than 10 minutes (42%, Fig. 8). However, such a short duration would not be enough considering not only the narrow streets/roads and traffic but also the panic situation. Overall, this points out the significance of a good quality early warning system for the towns in Gulluk Bay.

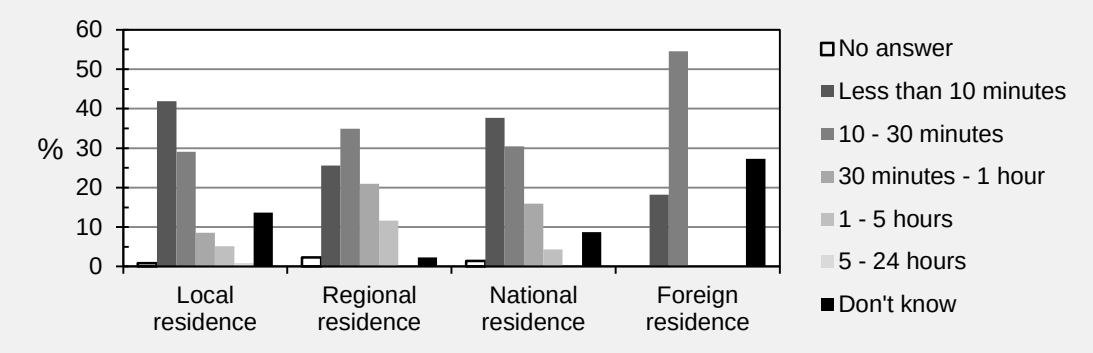


Fig. 8.Expectedevacuation time in relation with people's residence.ASTARTE survey, 237 answers (in %)

6. Local perceptions' particularities

6.1 Tsunami: a low priority hazard

In Gulluk Bay, the perception of hazard focuses more on the local problems. The most prominent problems identified by the survey participants are: fire, sea & environment pollution, insufficient infrastructure, traffic, and unplanned urbanization. Unlike these hazards, tsunami is a rare natural phenomenon, and is not been experienced in the region very often. This situation makes tsunami a low priority hazard for the community in the Gulluk Bay.

6.2 The need for education

In Gulluk Bay, there has to be a very successful strategy for building knowledge among people to increase tsunami awareness and foster preparedness. In this direction, establishment of educational programs and provision of effective knowledge dissemination, especially through media, are indispensable.

7. References

- https://www.coastguidetr.com/en/gulf/1001/gulluk-gulf
- Altinok, Y., &Ersoy, Ş. (2000). Tsunamis observed on and near the Turkish coast. *Natural Hazards, 21*(2-3), 185-205.
- Soloviev, S. L., Solovieva, O. N., Go, C. N., Kim, K. S., & Shchetnikov, N. A. (2000). Tsunamis in the Mediterranean Sea 2000 BC-2000 AD (Vol. 237). J. Bonnin, B. W. Levin, S. Tinti, & G. A. Papadopoulos (Eds.). Dordrecht: Kluwer Academic Publishers.
- Ozel, N. M., Necmioglu, O., Yalciner, A. C., Kalafat, D., Yilmazer, M., Comoglu, M., ... &Erdik, M. (2012, June). Tsunami Early Warning in the Eastern Mediterranean, Aegean and Black Sea. In *The 22nd International Offshore and Polar Engineering Conference, Rhodes (Rodos), Greece* (pp. 17-22).
- Okal, E. A., Synolakis, C. E., Uslu, B., Kalligeris, N., &Voukouvalas, E. (2009). The 1956 earthquake and tsunami in Amorgos, Greece. *Geophysical Journal International, 178*(3), 1533-1554.

ASTARTE Project - Deliverable 9.7 - NICE / FRANCE / 2014

Report on preparedness skills, resources and attitudes within the communities

Test site leader: Anne Loevenbruck (CEA).
Scientific team: D. Grancher (CNRS), L. Goeldner-Gianella, F. Lavigne, J. Lopes, C. Charpentier, J. Lenouvel, C. Buchet-Couzy (UP1).
Local partners: D. Provitolo (Géo-Azur).
Local collaboration: Eco-Vallée.

End-user of the test-site: Chambre de Commerce et d'Industrie (CCI) Côte d'Azur; Nice Municipality, Communauté urbaine Nice-Côte d'Azur, Préfecture des Alpes Maritimes, Sapeurs-pompiers des Alpes Maritimes (Firemen organization), Etablissement Public d'Aménagement "Plaine du Var".

1. Context

1.1. Location

Google Earth

Fig. 1. Location maps of the study area

Fig. 2. The Nice seafront, viewed from the Bellanda Tower (J. Lopes, 19/08/09)**.**

1.2. Socio-economic context

Thanks to its international transport infrastructures (airport and cruise port), Nice has become the second most visited city in France, especially for its well-known *"Promenade des Anglais"* - which was built by the first overwintering English community (fig. 5) at the beginning of the 19th century - and its annual Carnival, which welcomes about one million tourists each year. With more than 340,000 inhabitants in 2009 and one third of the 4 millions of tourists frequenting the Riviera, the coastal city of Nice presents a major human, economical, functional and territorial vulnerability.

1.3. Risk assessment

1.3.1. A tsunami hazard from various origins

Tsunamis can originate here by earthquakes from the North-African faults and by submarine landslides or local coastal landslides. On 16 October 1979, a part of a new harbor built along Nice airport collapsed (Fig. 3), situated a few km to the west of the Baie des Anges. It triggered a tsunami that killed 1 person and swept away several boats at Antibes. Effects of the tsunami were reported along 120 km of the coastline between the Levant Islands and Menton. According to the historical archives, three other tsunamis from seismic origins concerned already Nice (fig. 4) in 1564, 1887 and 2003 (see test-site "Colonia de St Jordi"). In 1887, waves reached 2 m at Cannes and Antibes, submerging most of the beaches. The last one impacted in the night eight French harbors.

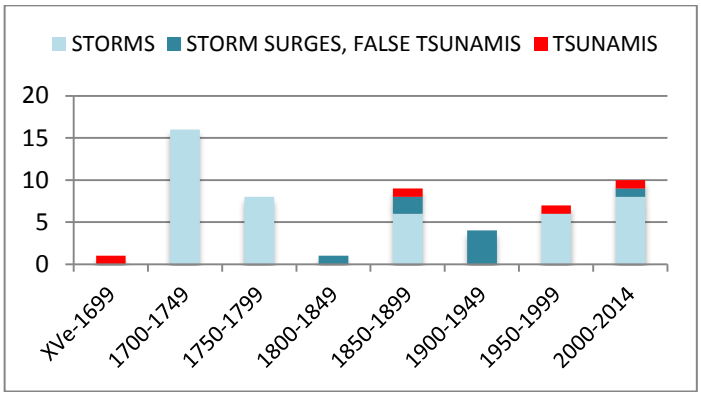


Fig. 4. Extreme marine events on the coast of Nice since the 16th century (CADAM, BD tsunamis. C. Charpentier, 2014)

1.3.2. Risk exposure

In spite of a quite low tsunami hazard in this area, exposure is very high, because of the extreme urban density of the coastline during the touristic season (fig. 2) or during the annual Nice Carnival. The coastline has become more and more exposed to coastal risks with an increasing presence of swimmers, sunbathers, walkers and vehicles - still relatively rare 150 years ago (fig. 5).

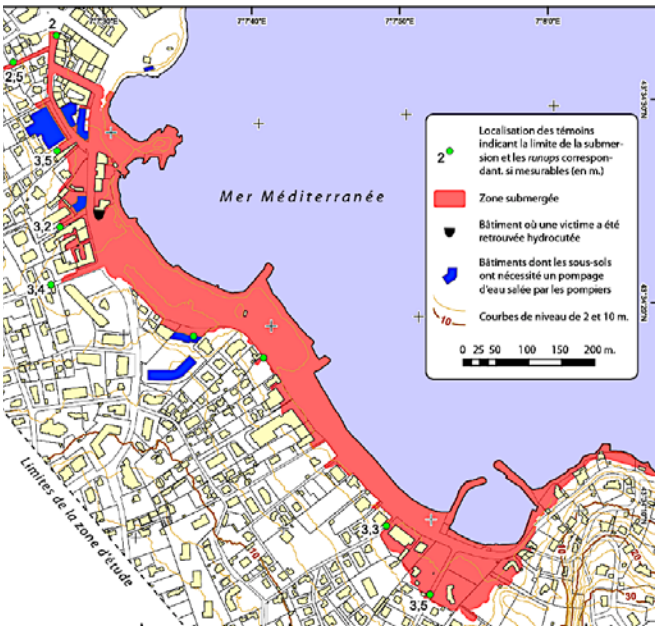


Fig. 3. Flooded area in Antibes due to the 1979 landslide-generated tsunami (Sahal & Lemahieu, 2011)

Fig. 5. Charles Negre, *Promenade des Anglais en 1865*, Archives départementales des Alpes Maritimes

1.4. Risk and crisis management

Neither land use nor evacuation plan related to tsunamis are presently underway in Nice. The ASTARTE program aims to provide the end-users with information helping them to define the best evacuation system and its procedure.

2. Profile of the interviewed people in Nice and adjacent towns

Number of questionnaires	Place of interviews in spring and summer 2014	Sex ratio	Mean age	Geographical origins of the interviewed people
400	- 172 questionnaires in Nice - 146 questionnaires in Saint-Laurent-du Var - 82 questionnaires in Villefranche-Sur-Mer	- 51% female - 49% male	48	- 44.1% of tourists or occasional residents in visit or in holidays (13% coming from foreign countries, e.g. UK, Switzerland, etc. - 58.8% of local or regional residents (including 53.1% of people living more than 1 year in the communes of the study)

3. People's knowledge of tsunami hazard

The main hazard which could affect Nice and its surrounding areas, spontaneously cited by one third of the interviewed people, is "earthquake" (fig. 6), as it can logically be expected in this region. Other possible hazards are either man-made, like pollution (19.2%) and incivility - which merges robbery, violence, insecurity (5.1%) - and natural - like storms or floods. Even if 15% of the interviewed people don't know which hazard could affect Nice, the tsunami hazard ranks 4, with 11.6% of the answers. It is important to notice that French residents and French tourists know relatively well this hazard, whereas it isn't evoked by foreigners. Local French residents are the best informed, certainly because of the landslide-generated tsunami of 1979 and the information frequently provided by the local medias.

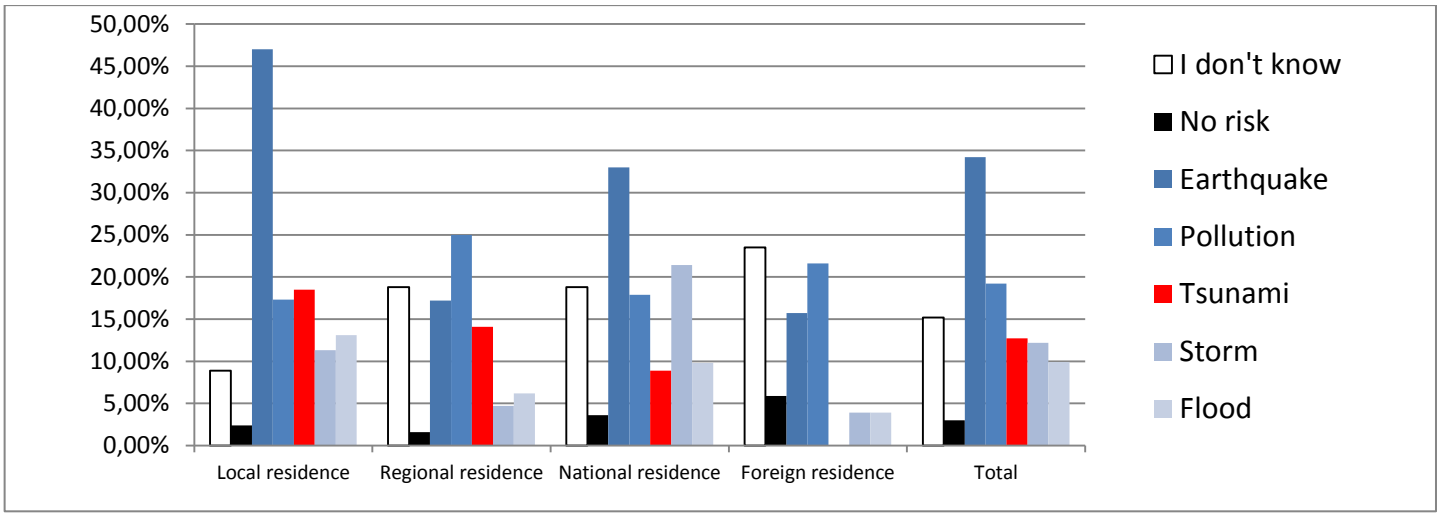


Fig. 6. Spontaneously evoked hazards that could affect Nice. (Open question, 400 answers)

Fig. 7. Word cloud resulting from the question: *"According to you, what is a tsunami?"* (Open question).

As elsewhere, people assimilate this hazard mostly to "big" "waves", but also to "earthquakes" (fig. 7). Therefore, the majority of the respondents think that precursor signs could be such earthquakes (41.5%), but also sea withdrawal (30.4%) and animal behaviour (22.6%). As elsewhere, this relatively good knowledge comes in a large part from TV (76.8%) and media coverage of big events (33.5%) - e.g. the Indonesian and Japanese tsunamis of 2004 and 2011 -, but more rarely from school (15.5%).

4. Awareness and perception of a future tsunami event in Nice

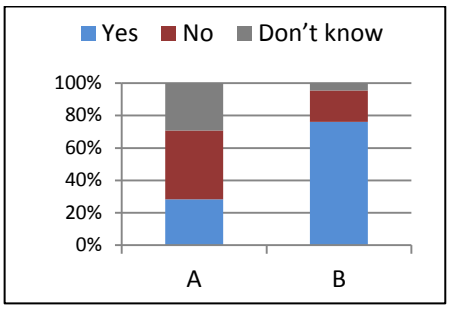


Fig. 8. "Has this coastal zone already been affected by a tsunami?" (A) and "could it be affected by a tsunami?" (B) (n=400).

If 28.3% of the people know that the local coastal zone has already been affected by a tsunami, they generally don't remember the exact date of 1979 or 2003. However, people are in a large part aware that it could happen in the future. Therefore, most of them consider that a tsunami could once impact houses and buildings (80%) and even injure or kill people (71%). The impact on beaches and coastal tourism may also be important (for respectively 70.4% and 65.2% of the people). 12.3% of them even imagine a destruction of the region. With such a negative perception of tsunamis, it is not surprising that more than 40% of the respondents expect waves of more than 10 m high. This percentage reaches even 70% for local and national French residents, who seem relatively pessimistic.

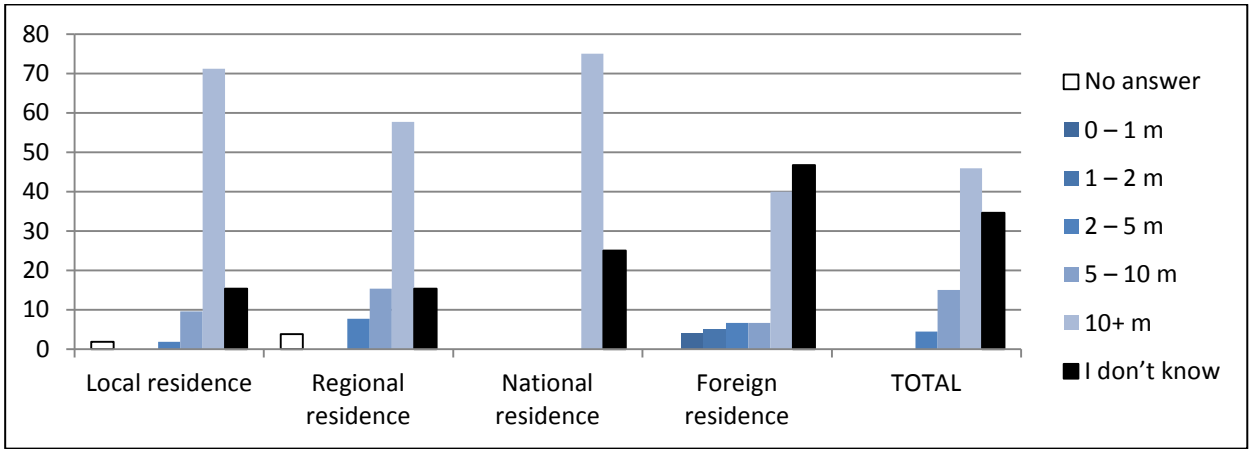


Fig. 9. Supposed wave heights in case of a tsunami (400 answers).

5. Perception of risk management and people evacuation

If 58.4% of the respondants ignore if there is a tsunami alert system for Nice and surrounding areas, 21.3 % are sure that there aren't - what is currently true if speaking about a system alerting directly residents and tourists. Among people thinking that there is no warning system, 70 % think that the best one is a sirene - for instance according to French respondents the national sirene concerning fires or accidents which is tested each first Wednesday of the month. Apparently a large part of the interviewed people (45%) would evacuate immediately after receiving such an alert, but communication on it has still to be improved because half of the people don't know what to answer to this question - and perhaps "what to do". Local and national French residents seem the most hesitant (50 to 60%).

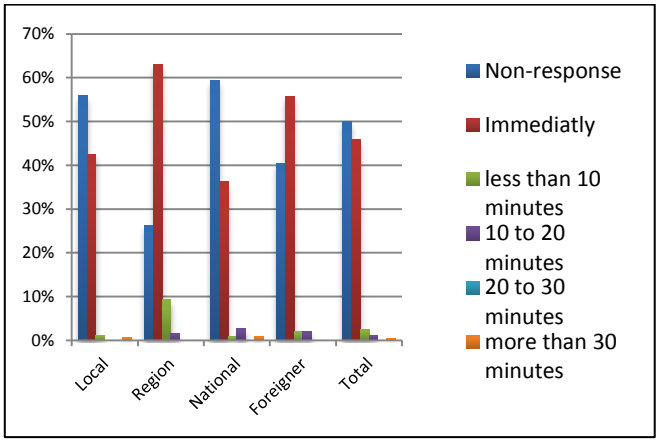


Fig. 10. Perceived evacuation time in relation with people's residence (ASTARTE survey, 400 answers)

6. Local particularities

Population of the Western Mediterranee seems quite aware of the tsunami hazard, although they have a poor knowledge of past events in this region. Even if the probability of occurrence of a tsunami in the Cote d'Azur is low, a tsunami event would have a high impact on people and territories. The mere sight of the retreat of the sea by the tourists in Summer time could generate a movement of panic among the people, who tend to overestimate the wave height of a tsunami in Nice. In order to increase the awareness of people in the French Cote d'Azur, the CENALT (National French Tsunami Warning Centre) and his permanent crisis cell launched six alerts of yellow level since mid-2012. However it is likely that the French southern coastline will one day face a more severe alert requiring people's evacuation (Damicis, 2014).

7. References

*** Scientific references:**

- CHARPENTIER C., 2014, *Perception et représentation du risque de tsunami à Nice*, Master thesis, 171 p.
- DAMICIS A., 2014, "La mise en place d'un système de surveillance des tsunamis français", *La LIREC (Lettre d'Information sur les Risques et les Crises),* n° 44, 28-31.
- LOPEZ J., 2014, *Gestion du risque de tsunami à Nice et modalités d'évacuation,* Master thesis, 107 p.
- SAHAL A., LEMAHIEU A., 2011, "The 1979 nice airport tsunami: mapping of the flood in Antibes", *Natural Hazards*, 56/3, 833-840.
- SAHAL A., 2011, *Le risque tsunami en France : contributions méthodologiques pour une évaluation intégrée par scénarios de risques,* PhD Thesis, University Paris 1. http://tel.archives-ouvertes.fr/docs/00/65/43/55/PDF/SAHAL_2011_TSUNAMIS_FRANCE.pdf

*** Web sites on local tsunamis or test-site:**

- Données de l'Observatoire du tourisme de la Côte d'Azur : http://www.cotedazur-touriscope.com/pdf/fiches/12/normal.pdf
- Site du CENALT (Centre National d'Alerte aux Tsunamis Français) : http://www.info-tsunami.fr

ASTARTE Project -Deliverable 9.7– COLONIA SANT JORDI/SPAIN/2014

Report on preparedness skills, resources and attitudes within the communities

Test site leader: M. Canals (Univ. of Barcelona).
End-user: IMEDEA ; Puertos del Estado ; Ses Salines Coastal Research Station.

Scientific team: D. Grancher, L. Goeldner-Gianella, F. Lavigne (CNRS); S. Combe, T. Lohrer.

1. Context

1.1. Location

Fig. 1. Location map of the study area (Balearic islands, Spain)

Fig. 2. City center and main beaches of Colonia de Sant Jordi (Mallorca island, Spain)

1.2. Socio-economic context

Balearic islands (fig. 1) are one of the most important tourist centers of the world. Tourism on Mallorca island started in the 19th century with some well-known visitors like Chopin and George Sand; the first luxury hotel was built there in 1903. In 1935 the island welcomed already 40,000 tourists and 50,000 visitors on cruise ships. But the nowadays massive seaside tourism has gradually grown since the construction in the sixties of an international airport near Palma and the proliferation of charter flights. In 2013, Spain welcomed 60 millions of tourists - coming overwhelmingly from Brittany, Germany and France but less from Spain itself - and was again considered as the third tourist destination in the world. Beach tourism is predominant on the Balearic islands, with in case of a Mediterranean tsunami possible impacts affecting in particular sunbathers and swimmers. Colònia de Sant Jordi test site embraces the southernmost tip of Mallorca Island, encompassing the coastal strip between Colònia de Sant Jordi (about 3000 permanents residents) and Cala Santanyí (more than 500 permanent residents), surrounding the Cape Ses Salines and Cala Llombards. The coastline consists of rocky outcrops, small cliffs and pocket beaches. As on the rest of the southern and eastern coasts of Mallorca, touristic infrastructures have expanded in Colònia de Sant Jordi and Cala Santanyí in the last decades, with the construction of hotels and leisure ports (fig. 3). Our survey was conducted in Colonia de Sant Jordi, where large sand beaches (fig. 2, 4, 5) welcome numerous tourists.

Fig. 3. The seaside hotels and the leisure harbor of Colonia de Sant Jordi (Photo T. Lohrer, 10/08/2014).

Fig. 4. The densely occupied beach of Els Dolç in August 2014 (Photo T. Lohrer, 10/08/2014).

Fig. 5. The Port Beach in August 2014
(Photo T. Lohrer, 10/08/2014).

1.3. Risk assessment

1.3.1. Tsunamis originating from North-African margin

Following the MW 6.9 "Boumerdes-Zemmouri earthquake", the 21 May 2003, some tsunami waves reached the Balearic Islands, producing damage to boats, port facilities and roads. In the test site, several boats sunk while anchored in Cala Santanyí or around the Cape. Other tsunamis originating from North-African margin have impacted Mallorca Island, in particular in 1756, 1856 and 1980. Inundations occurred in Cala Santanyí in 1756, with water entering about 5 km inland. There are also some evidences of coastal paleo-tsunami deposits, such as extensive ridges made of large imbricate blocks or sand deposits.

1.3.2. Risk exposure

Simulated worst-case scenarios yield maximum wave heights of 1 to 2 m in this test-site, with arrival times of 30 to 70 min after a seism in the North-African margin. Some wave amplifications can also be expected in the bays, the harbours and on the pocket beaches. Fortunately the 2003 tsunami occurred at dark hours in the beginning of the tourist season, thus avoiding human casualties.

1.4. Risk and crisis management

Regarding tsunami risk, no land use or evacuation planning are underway in the Balearic Islands. Local authorities are mostly unaware of this risk or tend to minimize it, while local civil protection considers that there is still little political will and support for any preventive program. This lack of risk management could have consequences on local and foreign risk perception, what our survey with 175 persons has in some way highlighted. Logically, there is no tsunami warning system in the test-site.

2. Profile of the interviewed people

Number of questionnaires	Place of interviews	Sex ratio	Mean age	Geographical origin
175	City center and main beaches of Colonia de Sant Jordi : - es Dolç, - Estanys, - Port beach	- 46.5% male - 53.5% female	42	51.4% live in Spain and 52% are foreigners, mainly coming from Germany (24%) and France (7%). 80% are occasional visitors (just presents for a few hours or days). If 34.6% of interviewed people visit the study site for the first time, 16.6% of them live or work in it.

3. People's knowledge of tsunami hazard

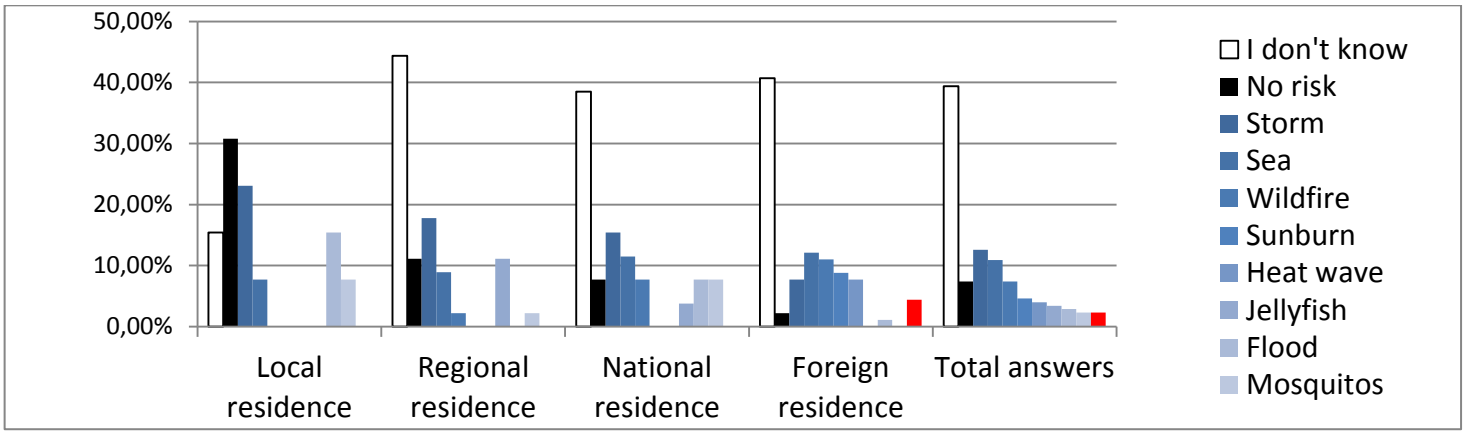


Fig. 6 "*Which hazards could affect Colonia of Sant Jordi?*" (open question, ASTARTE survey, 175 answers).

If a lot of people (40%) doesn't know what to answer to the question *"Witch hazards could affect the Colonia of Sant Jordi"(*fig. 6), most of them speak spontaneously about natural risks, especially sea- or heat-related risks (storm, sea, jellyfish, flood ; natural fire, sunburn or heat wave). However, the risk of tsunami is the ninth of the cited risks, only mentioned by some percents of the interviewed people. Furthermore, tsunamis are only cited by tourists and not at all by local or Spanish residents. This level is particularly low compared to the results obtained on some European beaches of the Astarte Program: for instance, tsunamis are ranked at the fifth place in Sines (Portugal) or Nice (France). Despite this local and more generally national ignorance, the definition of a tsunami is well known, even if incomplete (fig. 7), referring overwhelmingly to the words "earthquake" and "big wave", as elsewhere.

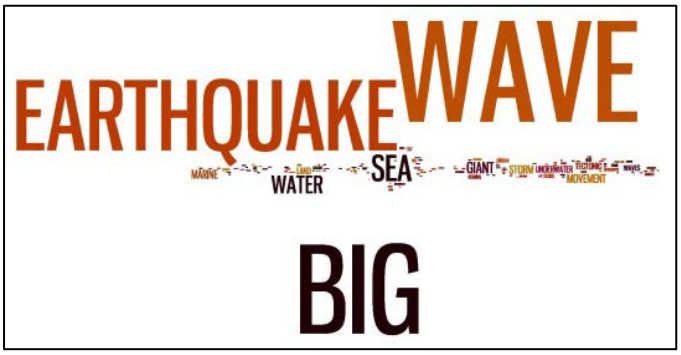


Fig. 7. Word cloud resulting from the question: *According to you, what is a "tsunami"?* Open question, ASTARTE survey, 175 answers. (D. Grancher)

This social knowledge comes in a large part from TV (63%) and media coverage of big events (61.7%) - e.g. the Indonesian and Japanese tsunamis of 2004 and 2011. Therefore, interviewed people know relatively well the precursor signs of a tsunami, such as the sea withdrawal (50%) - which is generally not often mentioned -, big waves and earthquakes (respectively one fifth of the people for each), and modified animal behavior (16%). But less than 20% of the respondents (and in particular 15.4% and 11.5% of local and Spanish people) learnt the word tsunami at school - what could partially explain why they don't spontaneously think to tsunamis.

4. Perception of a future tsunami event in Colonia de Sant Jordi

The question related to the possible height of a tsunami wave hitting Colonia de Sant Jordi (fig. 8) confirms that the Spanish people ignore for a large part this natural risk. In fact, more than 35% of local people and approximatively 20% of people living in the region or in Spain don't know what to answer to this question. Moreover like foreigners, the Spanish are numerous to think that such a wave could reach more than 5 meters (a height cited by more than 30% living in the region and the land) or even more than 10 meters (a height cited by a quarter of people living in Spain). We notice on figure 6 that local residents have a more accurate approach of reality, with 30% of the people referring to waves of 1 to 5 meters, what is perhaps linked with their perception of the tsunami of 21 May 2003 and its local waves of 1 to 2 meters. Therefore, linked to their general ignorance and surestimation, most of the respondents consider that a future tsunami could have severe impacts, like houses and infrastructures destructions (65.7%), death of people (55%) or even a total destruction of the region (38.3%).

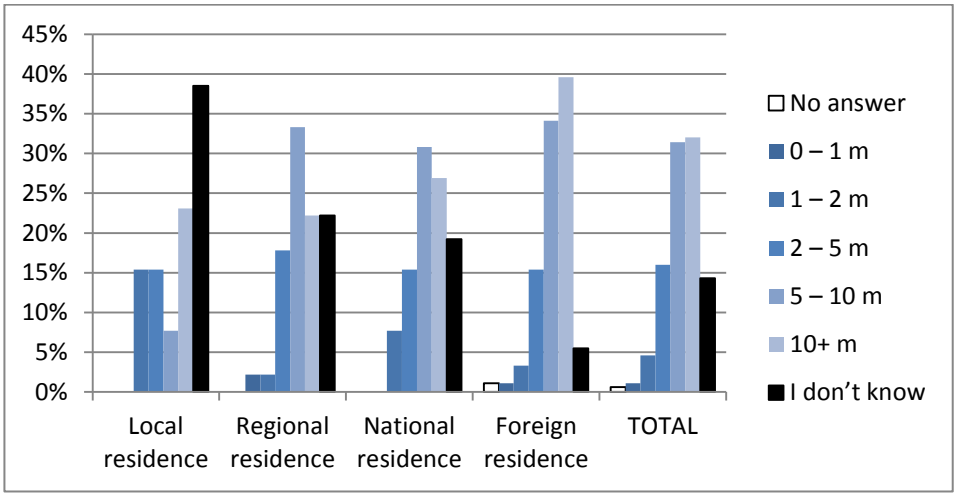
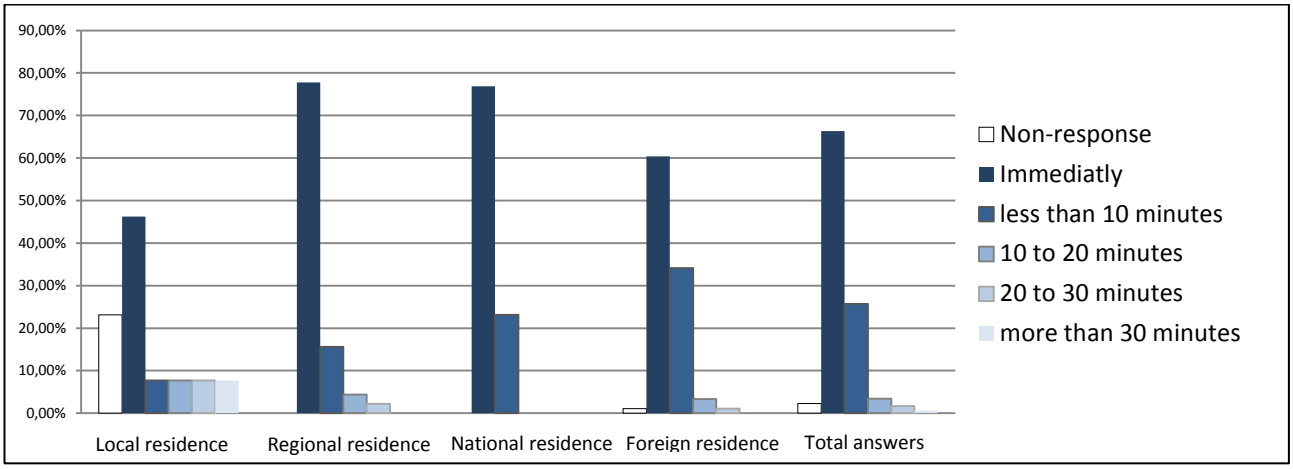


Fig. 8. Supposed wave heights in case of a tsunami in relation with people's residence. ASTARTE survey, 175 answers.

5. Spontaneous evacuation and tsunami alert

Even if 64% of the respondents don't know if there is or not a tsunami alert system, and 33.1% think it doesn't, they will mostly, whatever their origin or general ignorance, evacuate immediately the beach or the town (fig. 9).

Fig. 9. Perceived evacuation time in relation with people's residence. ASTARTE survey, 175 answers.



6. Local particularities

Despite an apparently rapid reaction when seeing a tsunami wave, most of the people would have severe difficulties to evacuate the beach of Els Dolç because of the presence of barbed wires on the whole length of the coastal dune fringing the beach and along the narrow access path.

Fig. 10. A narrow path, between barbed wires and the sea, connects the Beach of Els Dolç (in the background) to the Port beach and the city center.

Photo. T. Lohrer., 14/04/2014.

References :
- Álvarez-Gómez José A., Íñigo Aniel-Quiroga, Mauricio González, Luís Otero. Tsunami hazard in the Western Mediterranean Spanish coast from seismic sources. *Nat. Hazards Earth Syst. Sci.,* 11, 227–240, 2011.
- Lafuerza, S., Sultan, N., Canals, M., Lastras, G., Cattaneo, A., Frigola, J., Costa, S. and Berndt, C., 2012. Failure mechanisms of Ana Slide from geotechnical evidence, Eivissa Channel, Western Mediterranean Sea. *Marine Geology*, 280 (1-4): 20-39, doi: 10.1016/j.margeo.2012.02.010
This research work has been funded by the project ASTARTE : Assessment, STrategy And Risk Reduction for Tsunamis in Europe. Grant 603839 7th FP (ENV.2013.6.4-3 ENV.2013.6.4-3).

ASTARTE Project - Deliverable 9.7 - SINES / PORTUGAL / 2014

Report on preparedness skills, resources and attitudes within the communities

Test site leader: Maria Ana Baptista (IPMA)

End-user of the test-site: Autoridade Nacional de Porteção Civil (ANPC), Sines Harbour Administration, some industrial companies of the harbour.

Scientific team: A. Liotard, L. Goeldner-Gianella, D. Grancher, F. Lavigne (CNRS) ; M.-A. Baptista, R. Omira, M. Wronna (IPMA).

Local collaboration: Laboratório de Ciências do Mar (CIEMAR, Evora University) ; Município de Sines ; Centro do Arte de Sines.

1. Context

1.1. Location

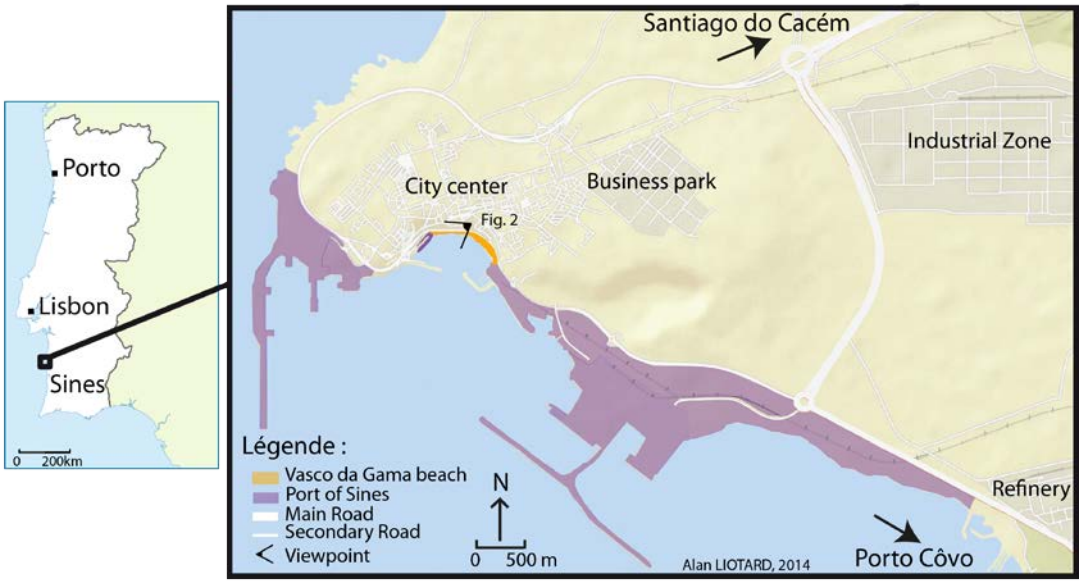


Fig. 1. Location maps of the study area

Fig. 2. Sines, view looking West, picture taken from the Castle, 30 meters above the cliff.

- In the foreground, the fishing harbour surrounded by the Vasco da Gama Avenue.

- Over the cliff, the city center of Sines.

- In the background, the Petrochemical and Liquid Bulk terminals.

(A. Liotard, 15/03/14)

1.2. Socio-economic context

As of 2011, the Sines municipality (fig. 1) encompasses about 14 000 inhabitants. The city is part of the Alentejo area but administratively belongs to the district of Setúbal. The coast of Sines was very touristic in the past. Since the 70's the landcape transformations (fig. 2 and 4) linked with the port activities have caused a reduction in the number of tourists. Now Sines is considered as one of Portugal's most important industrial ports. Situated more than 25 meters above sea level, the city center appears to be protected from tsunamis.

Fig. 3. View looking South-East, terminals of the port built on reclaimed land. (A. Liotard, 15/03/14)

1.3. Risk assessment

1.3.1. A simulation considering a 1755-like tsunami

On November 1, 1755, the well-known "Great Lisbon Earthquake" generated a tsunami. The epicentre has been located about 200 kilometres off the coast of Cape St. Vincent. It triggered tsunamis waves that reached until 30 meters height in Lagos and about 10-15 meters in Lisbon. In Sines, the priest working at that time reported that the village was *« situated so high […] that the big floods from the earthquake did not reach the city center; still, the waters reached levels never before seen ».*

Fig. 4. Sines in the 50's (unknown author, edição Correia.)

1.3.2. Risk exposure

The population of the city center is not exposed to the direct effects of tsunami waves but the beaches and the Port of Sines – partly constructed on reclaimed land – are within the tsunami risk area. The IPMA team has modeled a worst-case scenario based on a 1755-like earthquake generating tsunami waves estimated to reach 10-15 meters. Most of the Port's buildings (e.g. the liquid bulk terminal and the petrochemical terminal) are exposed low lands, and the exacerbation of the risk has to be taken into consideration. Containers or other floating objects could damage the tanks and create pollution/explosion as secondary effects - what could not only affect the efficacy of evacuations but also the population in the city center.

Fig. 5. View on the Container terminal from the Liquid gas terminal (LGT). The container transportation of the waves may damage the LGT in case of tsunamis. (A. Liotard, 27/03/14)

1.4. Risk management

A set of tsunami numerical models were created by the IPMA team for several scenarios: Marques de Pombal Fault (MPF), Horseshoe Fault (HSF), Gorringe Bank Fault (GBF), Cadiz Wedge Fault(CWF) and a combination of Marques Pombal and Horseshoe Fault (HS+MPF). The local population is informed about the tsunami hazard, even though some people do not think a tsunami could reach or has ever reached the coast of Sines. A survey seemed necessary to deepen this first impression (see below).

1.5. Crisis management

There is no tsunami warning system specifically designated by authorities in Sines. The Civil Protection and the Administration of the Port of Sines (APS) appear to be more concerned with the risk of storms, earthquakes or with industries. Several sirens exist: the civil protection established a sheltering alarm system in case something goes wrong with the industries. APS has its own alarm system: for each terminal two different alarms systems are tested every week. One means that people must evacuate and the second that people must find shelters. The Liquid Bulks and the Petrochemical terminals are the only places that are directly linked to APS in case of alert – the other terminals are under the directorship of risk managers. Considering the safety fence around each terminal, APS strategy seems relatively complex.

2. Profile of the interviewed people

Number of questionnaires	Place of interviews	Sex ratio	Mean age	Geographical origin
133	- 49% in the Port- 39% on the beaches - 12% in the city center of Sines	- 58% male - 42% female	36	- 95% of the interviewed people come from Portugal : 38% live in Sines, 13% in the region, 41% in the rest of the country ; 8% lives abroad.- Interviewed foreigners (5%) are from France, Germany and Slovenia.

3. People's knowledge of tsunami hazard

The main risk that could affect Sines (fig. 6) is Pollution (27%) due to the industries. This hazard has to be linked to the risk of explosion (18%), which is cited right after the risk of Earthquakes (19%). The risk of tsunamis is the fifth most important (10%). It must be noted that most of the people citing this risk were interviewed in the Port of Sines. This result may be due to the study carried out in the port itself by another research programme concerning risk management relating to earthquakes and tsunamis.

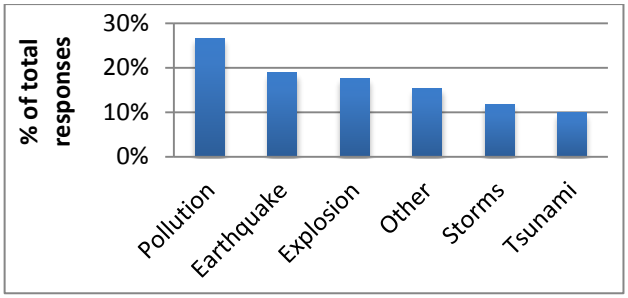


Fig. 6. Possible hazards that could affect Sines. Open question, ASTARTE survey, 133 answers.

Tsunami is however a well-known hazard mostly defined as a "big wave" (fig. 7). The social knowledge about it comes in large part from TV (52,6%) and school (51,1%), as well from Media coverage (14,3%) - e.g. the Indonesian and Japanese tsunamis of 2004 and 2011. According to interviewed people, the major possible origins of a tsunami are earthquakes (88,7%). Only 3% of them spontaneously cited volcanoes. However a large part of people mention precursor signs, such as Sea Withdrawal (48.9%) or earthquakes (37,6%). Only 15,8% do not know any precursor signs.

Fig. 7. Word cloud resulting from the question: "According to you, what is a "tsunami"? Open question, ASTARTE survey, 133 answers. (D. Grancher)

4. Perception of a future tsunami event in Sines: a big event, likely to happen

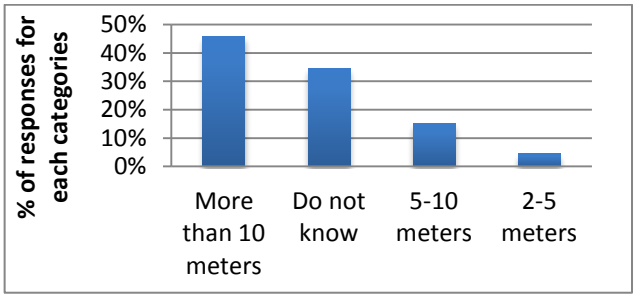


Fig. 8. Supposed wave heights in case of a tsunami. ASTARTE survey, 133 answers.

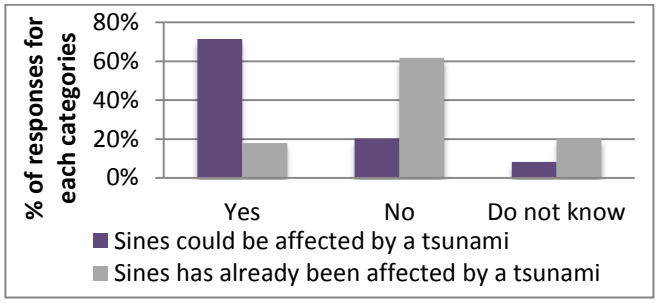


Fig. 9. Expectations about tsunamis in Sines. ASTARTE survey, 133 answers.

If 71.4% of people think that a tsunami wave could reach Sines, 61.7% think however that a tsunami has never occurred here (fig. 8) –making not necessarily a link to the 1755 tsunami (quoted by only 20 persons). 33.8% of the respondents spontaneously mention the destructions due to this hazard, considering that a future tsunami could impact houses and infrastructures, and might even kill people (fig. 9).

5. Trust in government's risk management

In general, people are not satisfied with the preparation systems in Sines, for both natural and tsunamis' hazards. The results show that the government's preparation for tsunamis seems less satisfactory than the preparation for other natural hazards (fig. 10). This can be linked to the fact that tsunamis are not the most apprehended risk in Sines (fig. 6).

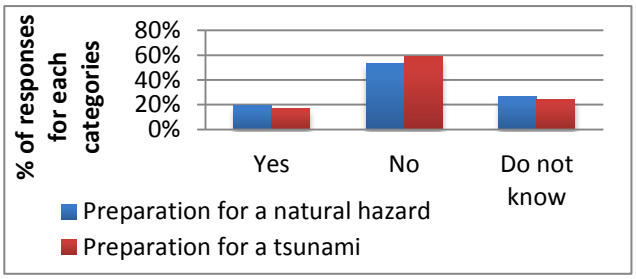


Fig. 10. Are preparation measures satisfactory? Open questions. ASTARTE survey, 133 answers.

6. Local perceptions' particularities

6.1. Influence of a "big waves' culture" on the perception of tsunamis' risk

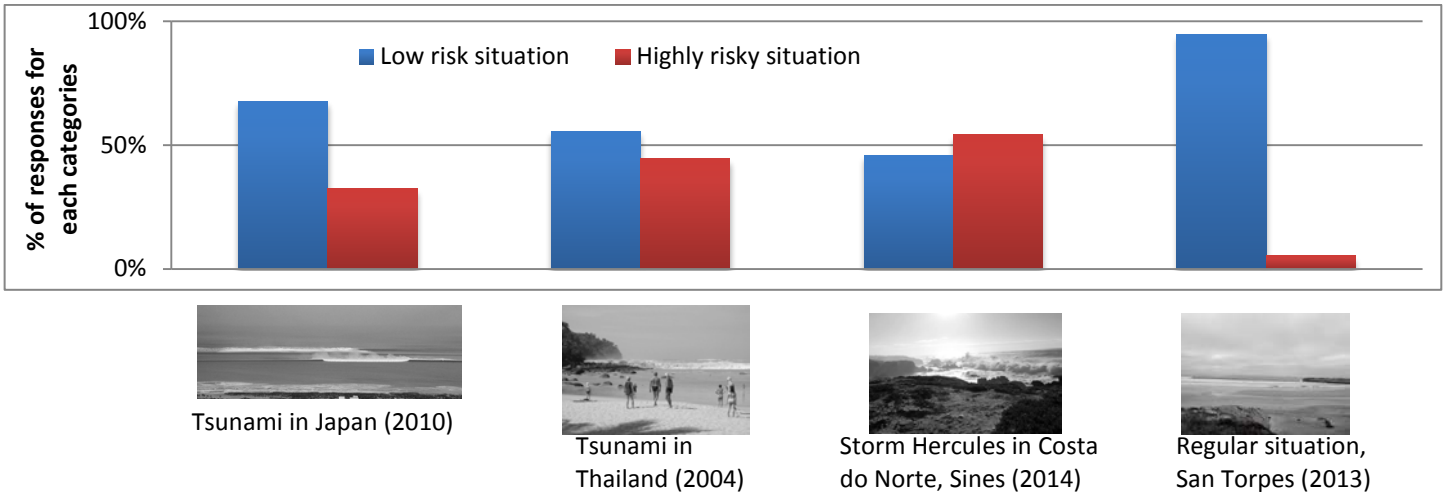


Fig. 11. Landscape approach of the risk, ASTARTE survey, 133 answers.

"Landscapes of tsunami" in Japan and Thailand (fig. 11) are underestimated by more than 50% of the interviewed people, whereas storms (landscape near Sines) are apprehended as a highly risky situation by 54% of them, as if a local « big waves' culture » would bias and reduce the risk's perception of a tsunami. As it happens, people living on the seafront often feel accustomed to big waves, as they see their every impacts in the landscape (results of some in-depth interviews).

6.2. The industrial Port city of Sines: the cumulative effects in case of tsunami

SPA has five main installations that store dangerous products, such as crude, methanol or liquefied gas. In case of tsunami, it is expected that the port infrastructures won't withstand the waves, especially considering drag forces and log-jams impacts. These products may exacerbate the risk and crisis management, right after the tsunami occurrence.

References :

- Location of the Earthquake of 1755: Baptista M.-A. *et al*. (1998). « Constraints on the source of the 1755 Lisbon tsunami inferred from numerical modeling of historical data ». *Journal of Geodynamics*, 25(2), p. 159–174.
- Population: Portal do Instituto Nacional de Estatística
- Data about the tsunami of 1755 : National Geophysical Data Center
- Report of the priest: FALCAO, J.-A. Memória Paroquial do Concelho de Sines em 1758. *Real Sociedade Arqueológica Lusitana*. Santiago do Cacém : 1987.
- Tsunami modeling: Omira, R., Baptista, M. A., Matias, L., Miranda, J. M., Catita, C., Carrilho, F., & Toto, E. (2009). « Design of a sea-level tsunami detection network for the Gulf of Cadiz ». *Natural Hazards and Earth System Science*, 9(4), p. 1327–1338.
- Crisis management in Sines : Liotard A. (2014) [Master's Thesis] « Le risque tsunami dans un espace industriel sensible : étude de la perception et de la représentation du danger dans la ville industrialo-portuaire de Sines, Portugal. »

ASTARTE Project - Deliverable 9.7 – HERAKLION / GREECE / 2014

Report on preparedness skills, resources and attitudes within the communities

Test site leader: Maria Sachpazi IG Director (NOA)
End-user of the test-site: Municipality of Heraklion, Decentralised Administration of Crete

Scientific team: A. Papageorgiou (NOA), C. Tsimi (NOA), K. Orfanogiannaki (NOA), G.A.Papadopoulos (NOA), F. Lavigne (CNRS), D. Grancher (CNRS)
Local partners: Municipality of Heraklion,
Local collaboration: Civil Protection of Heraklion

1. Context

1.1. Location

Fig.1a Heraklion city center

Fig.1b Crete island

www.wikipedia.com

Fig.2 View of Heraklion harbour

1.2. Socio-economic context

Heraklion is the largest city and the administrative capital of Crete island (Figs. 1,2). Also, it is the fourth largest city in Greece with a population of about 170,000 which, however, during the summer vacation period nearly doubles. It is located in the Northern Central part of Crete Island and it is an important shipping port and ferry dock (Fig. 3) situated at distance of about 4 km from the city centre. The international airport of Heraklion (Fig. 4) is considered to be the second busiest in Greece. Heraklion is a major tourist and holiday destination and thus, there are lots of hotel complexes, marinas, tourist attractions and crowded beaches (Fig .5) in and around the city. Moreover, the industrial region is very close to the city centre, less than 4 km away. The main occupations of the inhabitants are tourism, agriculture and commerce.

Fig.3. Old and new port next to each other

Fig. 4. International airport of Heraklion

Fig. 5. Chani Kokkini beach, 10 km from the city center

1.3. Risk assessment

1.3.1. Earthquake and volcano related tsunami hazard .

Tsunamis in the wider area of the test site Heraklion are mainly generated by earthquakes but also by volcanic processes as historical, geological and instrumental data have shown. In the past, Heraklion was hit by strong, destructive tsunamis such as the ones of AD 8 August 1303, 10 October 1650 and 9 July 1956 (Papadopoulos, 2011, Papadopoulos & Papageorgiou, 2014). The first and the third event were caused by large tectonic earthquakes associated with the eastern segment of the Hellenic Arc and with the back-arc area respectively. That of 1650 was associated with the eruption of the Columbo volcano in the Santorini volcanic complex. Bellow, Table 1 includes tsunamis that have hit Heraklion in the past (after Papadopoulos, 2011).

ID	YEAR	MONTH	DAY	SUBREGION	LAT	LONG	k	K
1	1303	08	08	East Crete/Dodecanese	35 00	27 00	5	9
2	1494	07	01	Heraklion	35 30	25 30	3	5
3	1630	03	09	Heraklion	36 00	24 00	3	5
4	1650	10	10	Thera, South Agean Sea	36 30	25 30	6	10
5	1956	07	09	Cyclades, South Aegean Sea	36 39	25 55	5	8
6	2000	04	05	Crete Is.	34 13	25 42	3	5

Table 1. Tsunamis that have hit Heraklion. k indicates tsunami intensity (in Sieberg-Ambraseys 6-grade scale) and **K** indicates tsunami intensity (in Papadopoulos-Imamura 12-grade scale)

1.3.2. Risk exposure

Heraklion is a coastal city with a population of about 170,000 which doubles during the summer vacation period. Many hotel complexes are located on the coastline and most of the beaches are very crowded during the summer with Greek and foreign tourists. Moreover, 4 km SE from the city center, there is the industrial zone of Heraklion and 4 km E from the city there is the international airport of Heraklion. In addition, the power plant unit that supplies with electricity the entire Crete is situated close to the beach at distance of c. 5 km to the west of Heraklion. Many of the administrative buildings such as Civil Protection, Police and Fire Brigade are also situated very close to the coast.

1.4. Risk management

Papadopoulos and Dermentzopoulos (1998) developed for the first time a Tsunami Risk Management Pilot Study for western Heraklion. Firstly, they collected and analysed data related to the physical planning, they made a semi-quantitative description of the potential impacts of a characteristic, extreme tsunami and then, they developed a series of approaches for taking prevention and mitigation measures. Few years later, Papathoma et al. (2003) described a new vulnerability assessment approach for the west part of Heraklion, Crete. This study incorporates multiple factors such as parameters relating to the natural and built environments and socio-demographics that contribute to tsunami vulnerability. The results were presented within a Geographic Information System (GIS). Finally, on October 2011, a large scale European civil protection exercise was held in Crete. The exercise was organized in the context of the POSEIDON project “Earthquake followed by Tsunami in the Mediterranean Sea” and it ran for two days in real-time. It involved four levels of civil protection (local, regional, national, European). More than 300 participants attended: representatives from fire brigade, Emergency Medical Services (EMS), health authorities, port authorities, police, municipalities and volunteers, along with search and rescue teams from Greece, France and Cyprus.

1.5. Crisis management

The National Tsunami warning Centre operated by the Institute of Geodynamics, NOA (NOAIG), which is also a candidate Tsunami Watch Centre for NEAMTWS/IOC/UNESCO, covers also the area of Crete island. As soon as a submarine earthquake of M≥5.5 has taken place, NOAIG issues a tsunami information bulletin which is directed to the General Secretary for Civil Protection (GSCP, Athens) as well as to the other candidate tsunami watch centres of NEAMTWS. Local authorities in collaboration with GSCP are primarily responsible for the crisis management.

2. Profile of the interviewed people

Number of questionnaires	Place of interviews	Sex ratio	Age	Geographical origin
113	- 65.5% city centre (cafeterias, restaurants, bars, etc) - 34.5% beach (3 different, crowded beaches next to Heraklion)	- 54% female - 46% male	Generally, age ranged from 15 to 65.	- 46% local people and residents(living in Heraklion more than 1 year) - 54% tourists (25.66% of them are foreign tourists from all over Europe)

3. People's knowledge of tsunami hazard

According to the interviewed people's opinion, the main hazards that could affect Heraklion (opened question) are Earthquakes (33%), Hydrolysis of the Syrian chemicals (8%), Fire (8%), Floods (7%) and last are tsunamis (6%). A large part of the participants (38%) didn't focus on natural hazards but selected to reply differently, like "economic crisis", "politicians" etc.

In the question: "What is a tsunami?", 46.2% gave a general answer and said that a tsunami is a big wave, 24.5% answered that it is a huge wave in the sea caused by an earthquake, 19.8% answered that it is a tidal wave and 8.5% answered that they don't know.

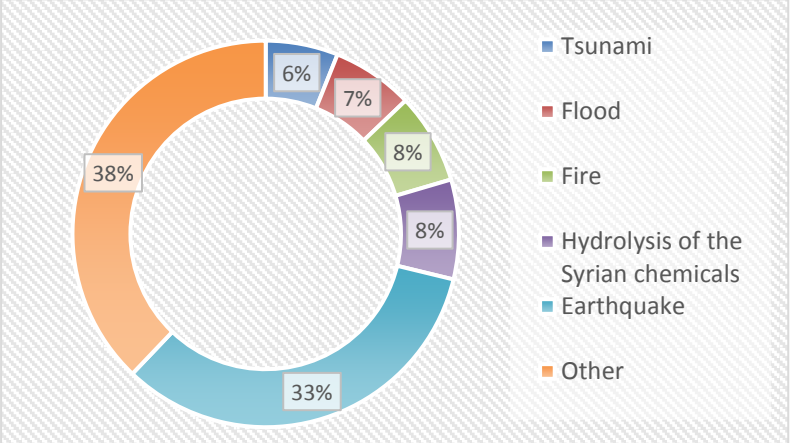


Fig. 6. Possible hazards that could affect Heraklion. Opened question, (in %, ASTARTE survey, 113 answers)

The social knowledge on tsunamis comes in a large part from TV (32.3%) and media coverage of big events (15%). Also, 12.3% of the respondents learned about tsunamis from school and 11.2% from internet. In the question "In your opinion, how is a tsunami created?" 71.7% answered "from earthquakes" and 12.4% answered "from volcanoes". In addition, most of the participants consider that earthquake and sea withdrawal are precursors of a tsunami.

4. Perception of a future tsunami event in Heraklion

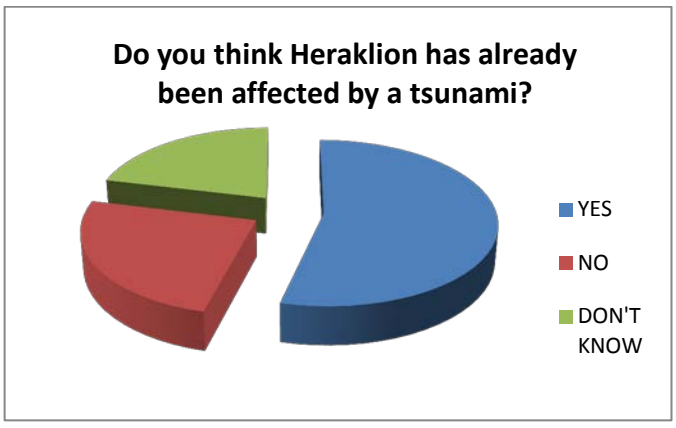


Fig. 7a. Knowledge about a tsunami event in Heraklion in the past (in %, 113 answers)

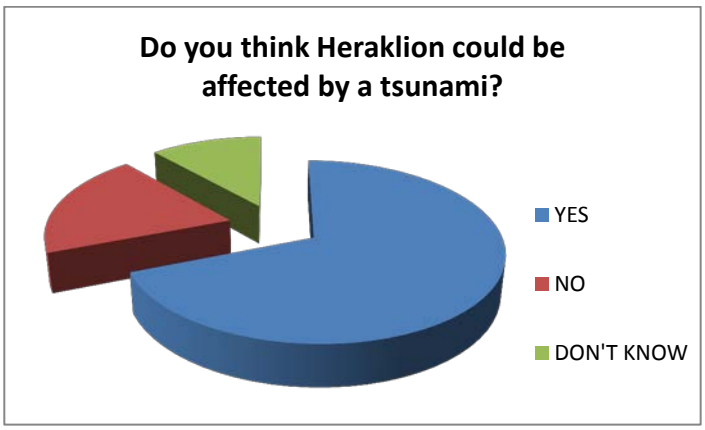


Fig. 7b. Possibility of a tsunami event in Heraklion in the future (in %, 113 answers)

Most of the respondents (54%) think that Heraklion has already been affected by a tsunami and 69% of them agree that Heraklion could be affected by a tsunami in the future. Moreover, 27.43% of the interviewed people don't know what the maximum wave height could be in case of a tsunami in Heraklion and 22.12% of them believe that the maximum wave height could be more than 10m. Concerning the local people, 37.78% of them answered that they don't know about the wave's height in case of a tsunami, whereas the majority of foreigners (29.03%) answered that the maximum wave height in the area could be more than 10m. Most Greek tourists (35.71%) believe that the wave's height could be 2-5m.

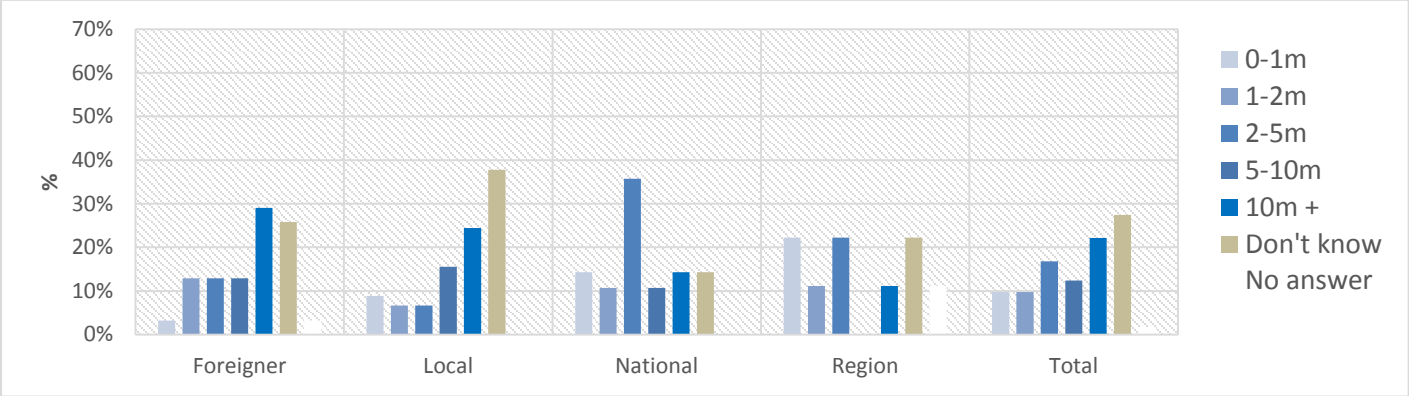


Fig. 9. Supposed wave's height in relation with people's residence (in %, 113 answers)

5. Tsunami alert-Evacuation

What is really interesting to mention is that most of the interviewed people (70.5%) don't know if there is a tsunami warning system in Heraklion and 25% answered "No". In addition, in the question: "How much time is there between a tsunami alert and the first tsunami wave", most foreigners and Greek tourists answered 10 to 30 minutes, while most local people (almost 40%) answered that they don't know.

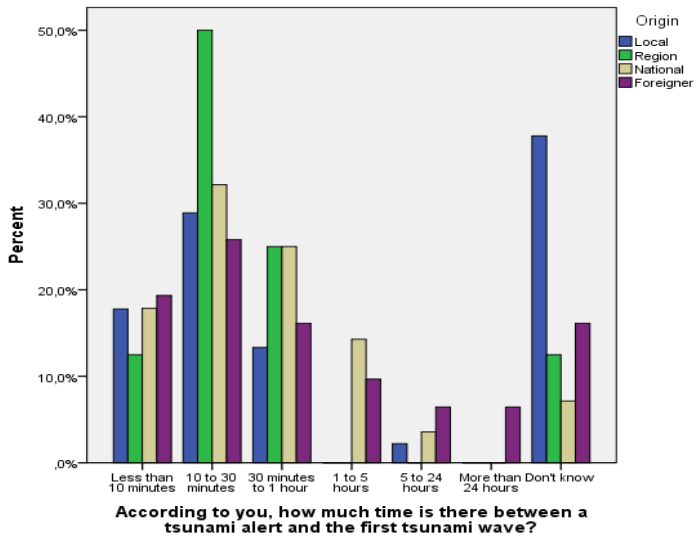


Fig. 9. Time needed between a tsunami alert and the first tsunami wave in relation to people's residence. (in %, 113 answers)

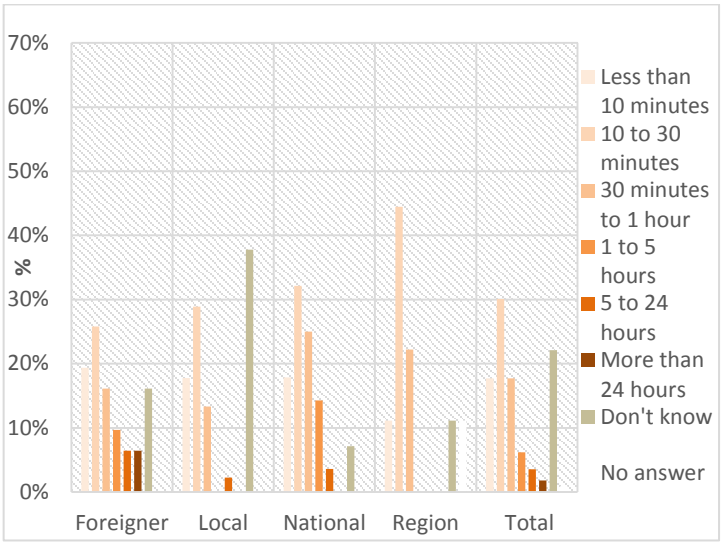


Fig. 10. Perceived evacuation time in relation with people's residence. (in%, 113 answers)

When people were asked if they would escape in case of a tsunami alert, 90.3% answered "Yes" and 28.9% of them said that nothing could prevent them from evacuating. 26.3% of the interviewed people answered that "only panic" could prevent them from evacuating and 23.7% answered "traffic" in this question.

Moreover, 25.81% of the foreign respondents and 32.14% of the Greek tourists believe that they need 10 to 30 minutes to evacuate. However, 37.78% of the local people said that they don't know how much time they need to evacuate.

6. Local perceptions' particularities

6.1. Heraklion: a city exposed to tsunamis

Heraklion is a coastal city and constitutes a densely built environment. Its Coastal Zone covers an area of about 30 km long coastline, from East to the West and 8km width from North to South. In the past, Heraklion was hit by tsunamis produced from different sources, some of which were strong and destructive. The majority of these tsunamis were caused by strong earthquakes that took place in the Hellenic Arc and Trench system which is considered to be the most seismically active region in the Mediterranean. However, of great importance was also the tsunami that occurred on 29 September 1650 which is associated with the eruption of the Columbo volcano. For these reasons, Heraklion is considered to be a city exposed to hazardous tsunamis. What is really interesting to mention is the fact that the tsunami vulnerability in Heraklion is strongly time-dependent due to tourism which nearly doubles the population during the summer period.

7. References

G.A Papadopoulos and TH. Dermentzopoulos 1998. A Tsunami Risk Management Pilot Study in Heraklion, Crete. Natural Hazards 18: 91-118.

M. Papathoma, D. Dominey-Howes, Y. Zong and D. Smith, 2003. Assessing tsunami vulnerability, an exemple from Herakleio, Crete.

G.A Papadopoulos, 2011. A seismic history of Crete, Earthquakes and Tsunamis: 2000BC-2011 AD. National Observatory of Athens, Ocelotos Publications.

G.A Papadopoulos and A. Papageorgiou, 2014. Large earthquakes and tsunamis in the Mediterranean region and its connected seas. In: Extreme Natural Hazards, Disaster Risks and Societal Implications, Cambridge University Press.