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COMPARATIVE STUDY REGARDING THE RISK PERCEPTION OF TSUNAMIS FROM EFORIE NORD (ROMANIA) AND NICE (FRANCE) COMMUNITIES

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ABSTRACT. The goal of this paper is to present a comparative study of the people perception from two different sites from Romania and France, regarding the tsunami risk in the Black and Mediterranean Seas communities. These two surveys over residents' and tourists' perception and preparedness of tsunami hazard were carried out for both towns, Eforie Nord(Romania) and Nice (France), in the frame of the ASTARTE project – „Assessment, Strategy And Risk reduction for Tsunamis in Europe" (EC Programme FP7).Data were collected by tsunami questionnaire developed in the project and translated in Romanian and French languages, and the questions are referring to: interviewee's relation to Eforie Nord and Nice sites, information about interviewed people, tsunami hazard knowledge/risk perception, evacuation issue, awareness of the existing warning system, information, and communication. A total of 256 subjects participated at surveys from both sites situated along coasts of Black and Mediterranean seas.The results of the survey showed a moderate level of tsunami preparedness and perception of people living in, working in, or visiting Eforie Nord and Nice sites, our respondents mentioned the tsunami as third rank in both sites, coming after

earthquakes and storms/pollution.Whatever the respondent's status (i.e. local population, or tourists), earthquakes and sea withdrawal are cited as tsunami warning signs by 62% and 60% of the respondents from Eforie Nord and by 30% and 31% of the respondents from Nice, respectively.When considering a future tsunami being generated in Eforie Nord, 36,3% of the respondents think that the place could be affected by a tsunami and the waves could reach more than 2-5 meters (heights cited by approx. 14% of respondents) or even more than 5-10 meters (values cited by 15% of interviewed people). Regarding the Nice site, 78% of the respondents think that the place could be affected by a tsunami in the future. With such a negative perception of tsunamis, it is not surprising that more than 29% of the respondents from Nice site expect waves of more than 10 m high. This study provided evidence that tsunamis recently occurred in the world have a significant impact on people's preparedness and perception.

Key words: *earthquake, tsunami hazard, tsunami warning system, resilience*

INTRODUCTION

The continuous development of the worldwide coastal areas have lead to the increase of the risk due to different types of hazards, natural or anthropic, permanent or episodic, which might endanger the health and stability of ecosystems and communities from these areas. Thus, even if tsunami is a relatively rare phenomenon comparing to other natural events, it represents a major natural danger involving a significant flooding risk in lower areas near the shorelines. The recent worldwide earthquakes from 26th of December 2004 in Sumatra and 11th of March 2011 in Japan, which triggered tsunami waves up to few tens of meters, have shown how devastating the consequences of such events can be. These events reveal the necessity of developing different actions used in the future for the reduction of damages and destructions caused by tsunamis in coastal area, became quite obvious. Therefore, increasing the tsunami resilience within

the communities in areas exposed to risk is of critical importance in order to minimize the damages and to prevent human losses. According to the ADPC guide (2007), the resilience of the coastal communities represents the capacity of a community to adapt to and to influence the course of environmental, social and economic change. Coastal community resilience assessment studies can be useful to characterize the resilience status and trends at the community level and can identify strengths, weakness, and gaps in resilience capacity (ADPC, 2007). These points raise awareness and broadly assess community capacity and vulnerability to coastal hazards and develop mitigation measures (ADPC, 2007).

The main purpose of this study is to present in a comparative way the perception and preparedness of people from two sites from two different countries, Romania and France to natural hazards, with particular attention to tsunami in the Black and Mediterranean Seas. The investigations were carried out in the Eforie Nord and Nice sites (figure 1). In the days dedicated to the surveys, the investigators from both institutions (National Institute for Earth Physics - NIEP and Le Centre National de la Recherche Scientifique - CNRS) have conducted their activity with interviews with shop owners, employees, local population, people representing authorities and tourists from both sites. The questionnaire used for survey contains 51 questions (Constantin et al., 2017). Also by using this questionnaire we collected useful data on awareness of the warning system by the interviewed people, on information and communication regarding this topic (17 questions). At the end of 2015, both institutions finished the field work (questionnaires), processed and interpreted the data for each test site. The total number of questionnaires at the end of the surveys has reached 256 for both test sites (table 1).

Table 1. *Number of questionnaires per site*

Test site	No. of questionnaires	No. of field trips	Investigating institution	No. of investigators
Eforie N	84	2	NIEP	3 researchers
Nice	172	1	CNRS	4 researchers

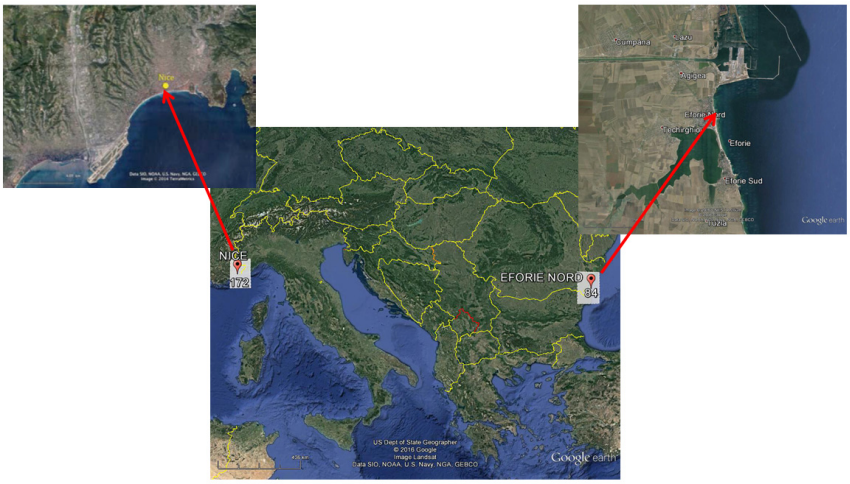

Fig. 1. *The studied areas and number of questionnaires for each site*

Background information

Eforie Nord is considered the second touristic city from the Romanian shoreline. In 2011, the population of the city was accounted as 5188 people, but during the summer time, between June and September of each year, an increase of 4 times the population was recorded (figure 2). Also, the existence in the area of many touristic and important infrastructures (Agigea port near) is very important in this respect. The Eforie Nord city is highly exposed to many possible sources of natural hazard such as earthquakes, land instability, flooding, extreme meteorological phenomena, gas hydrates activity,seashore erosion, submarine landslides and tsunami waves.

Tsunamis affecting Romanian Black Sea shore have all been rather small, causing no damage. Geological research since the late 1990's suggests that the Western coast of Black Sea has been impacted by palaeo tsunami (Ranguelov and Gospodinov, 1995; Dotsenko, 1995; Panin, 1996, 1997). In fact, this part of the Black Sea shore was hit in the past by three tsunami triggered by strong earthquakes generated in Shabla area, North-Eastern Bulgaria. First occurred on 1st Century BC, which damaged the city of Bizone, nowadays Kavarna (Nikonov, 1997). In 544/545 AC, another

earthquake triggered 6 km of flooded land in south Dobrogea (today Bulgarian shore) (Ranguelov, 1998). The last strong earthquake (M 7.2) occurred on 31st of March 1901, in the same seismic zone, inducing few km landslides and a subsidence of approximately 3 m(Partheniu et al., 2014; Partheniu et al., 2015). The recent event occurred in 2007 was reported as being associated to a submarine landslide generated in the Bulgarian area of the Black Sea (Papadopoulos et al., 2011).

Fig. 2. *Aerial photo of the Eforie Nord site and super crowded beach in the summer*

The coastal city of *Nice* is characterized by high population density, with more than 340,000 inhabitants in 2009 and one third of the 4 millions of tourists frequenting the Riviera and other touristic and industrial infrastructures (airport and cruise port). The beach of Nice is highly frequented and characterized by an important vulnerability to tsunamis (figure 3).In the area, sources of tsunami hazard can originate by earthquakes from the North-African faults and by submarine landslides or local coastal landslides (Lavigne et al., 2014). Also, The Nice area is directly exposed to the Ligure fault, expecting a tsunami wave striking about 10 minutes after the earthquake. Seismic and tsunami catalogues account in the past three tsunamis concerned Nice in 1564, 1887 and 2003. 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. Other tsunami struck the coast near Nice, on October 16, 1979 being triggered by a submarine landslide. Now, the city itself is not directly exposed to the tsunami hazard, since it is protected by a 5 meters dike. Then, no tsunami wave striking buildings and streets is expected, but the beach, is directly exposed (Fressard et al., 2017).Despite a low extent phenomenon compared to the events of Indonesia in 2004 and in Japan in 2011, the risk in Nice is actual.

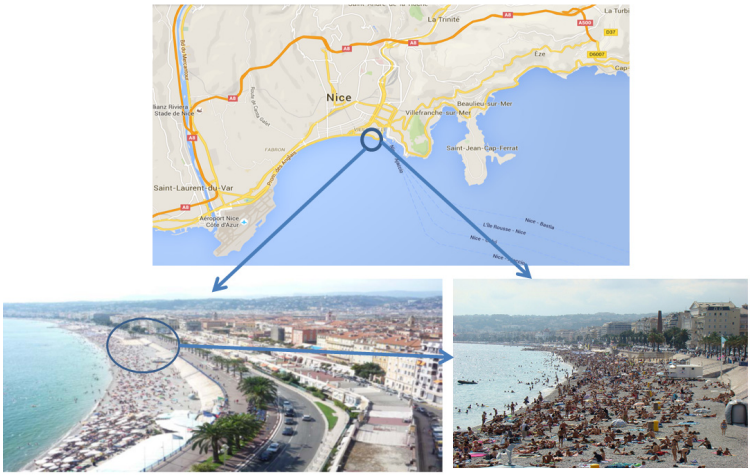

Fig. 3. *The Nice seafront, viewed from the Bellanda Tower (photo by J. Lopes, 19/08/2009) and crowded beach (photo by Plamen Dragozov)*

For such reasons and similarities of costal shapes of both sites, in the areas of Eforie Nord and Nice and their surroundings, many aspects of tsunami hazard, vulnerability and risk were investigated along the coasts of Western part of Black Sea and Mediterranean Sea.

PROFILE OF RESPONDENTS FROM EFORIE NORD AND NICE

In terms of the respondents, we questioned in the survey a large proportion of women 51.17% compared to 48.83% male (table 2), majority of them are adults aged 20-65 (82.8%) and few people aged over 65 (14.5%)

(figure 4). A total of 256 subjects participated at surveys from both sites situated along coasts of Black and Mediterranean seas.

Table 2. *Profile of interviewed people from Eforie Nord and Nice*

Gender balanced	Mean age	Education level	Status	Nationality
51,17% female 48,83% male	46	85% University degree	48% residents/ workers, 52% tourists	91,8 % nationals, 8,2% foreigners 10 nationalities

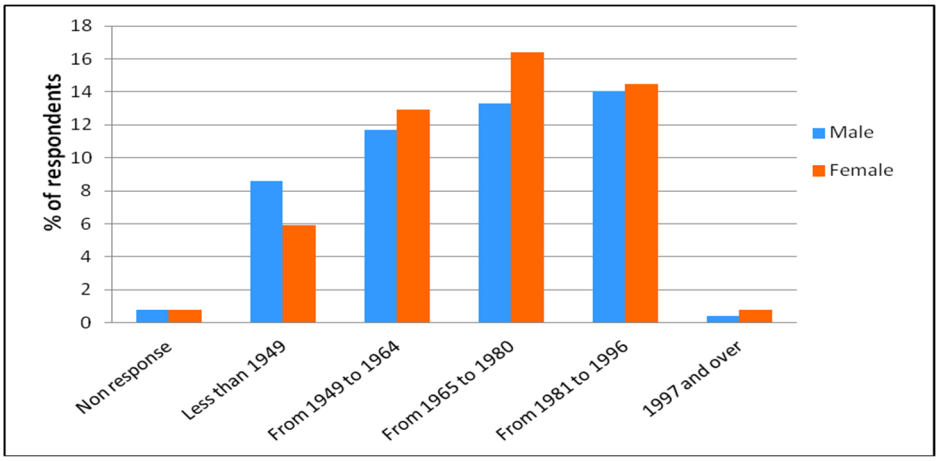

Fig. 4. *Proportion (%) of individuals from Eforie Nord and Nice by year of birth and sex*

Tsunami hazard knowledge and risk perception in Eforie Nord and Nice

The data was collected by tsunami questionnaire developed in the ASTARTE project and translated in Romanian and French languages, and the questions are referring to: interviewee's relation to Eforie Nord and Nice sites, information about interviewed people, tsunami hazard knowledge/risk perception, evacuation issue, awareness of the existing warning system, information and communication.

Respondents from both test sites (Eforie Nord and Nice) have mentioned from natural and anthropic types of hazards, the tsunami as third rank, coming after earthquakes and storms/pollution (table 3 and figure 5).

Table 3. *Natural and anthropic hazards in Eforie Nord and Nice*

	Natural and anthropic hazard							
Ranking	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Eforie Nord	Earth quake 39%	Storm 37%	***Tsunami 22%***	Flood 16%	Land-slide 11%	Tornado 6%	Erosion 3%	Fires 2.5%
Nice	Earthqu ake 34%	Pollu-tion 19%	***Tsunami 13%***	Storm 12%	Flood 10%	Incivility 5%	None 3%	

"In your opinion what are the main hazards that could affect this area?"

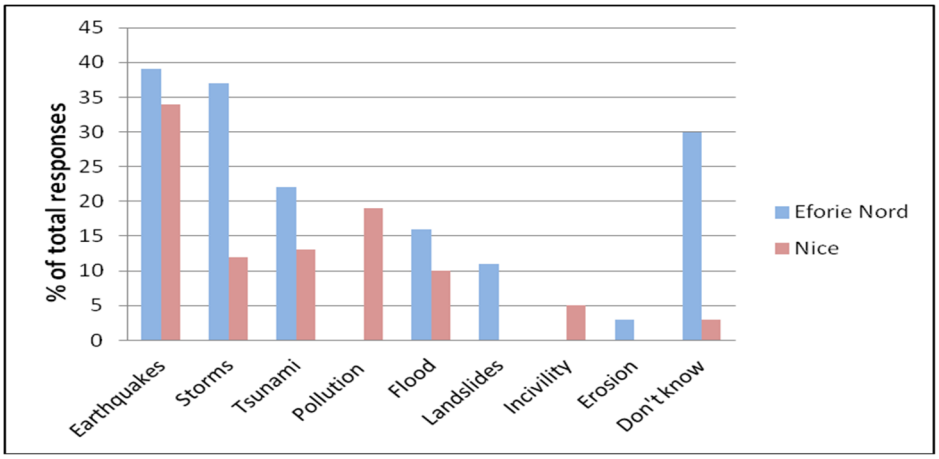

Fig. 5. *Possible natural and anthropic hazards that could affect Eforie Nord and Nice (in %)*

Regarding the above question, TV and media coverage of big and recent events (tsunami from 2004 in Sumatra and the one from Japan 2011) have been the main opportunity to learn the word tsunami for the respondents from both sites. Also, the internet and education are more efficient in Eforie Nord than Nice (figure 6).

"Where did you hear or learn the word Tsunami?"

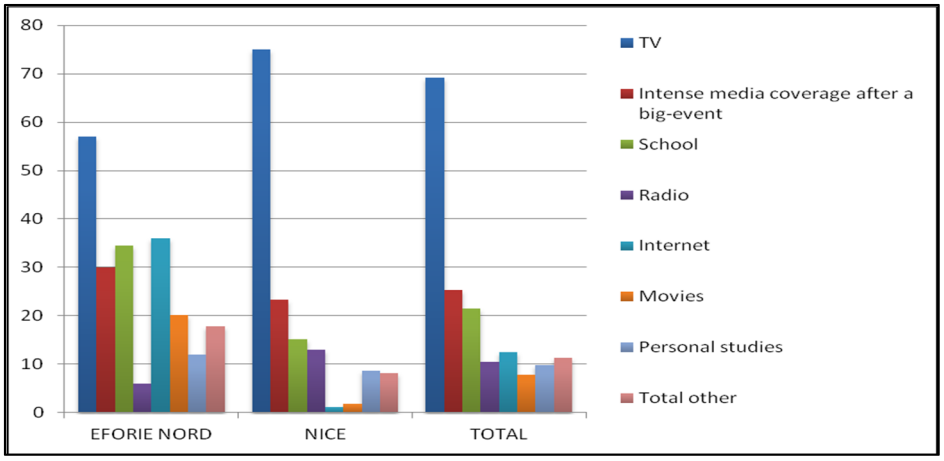

Fig. 6. *Knowledge about the word „tsunami" (in %)*

"In your opinion this area could be affected by a tsunami?"

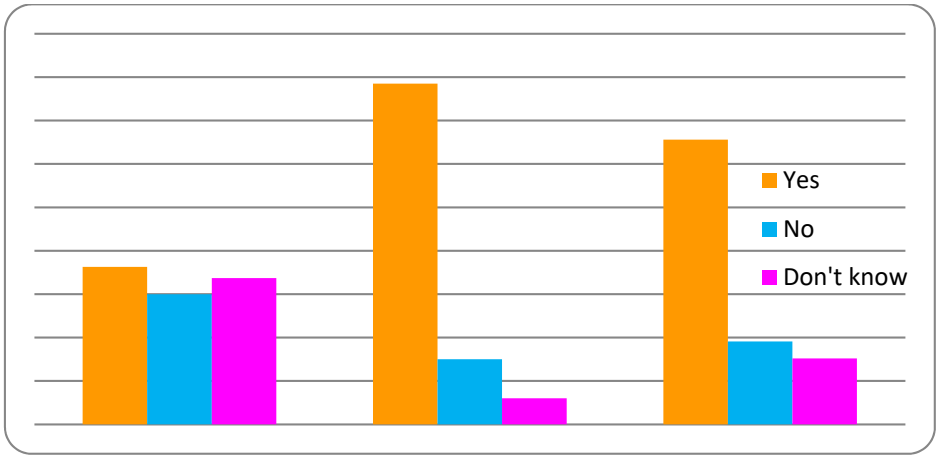

Fig. 7. *Possibility of a tsunami event in the future (%)*

When considering a future tsunami being generated in Eforie Nord, 36,3% of the respondents think that the place could be affected by a tsunami (figure7) and the waves could reach more than 2-5 m (heights cited by approx. 14% of respondents) or even more than 5-10 m (values cited by 15% of interviewed people) (figure 8). Regarding the Nice site, 78% of the respondents

think that the place could be affected by a tsunami in the future. With such a negative perception of tsunamis, it is not surprising that more than 29% of the respondents from Nice site expect waves of more than 10 m high (figure 8).

"In your opinion what could the maximum tsunami wave height be in this area?"

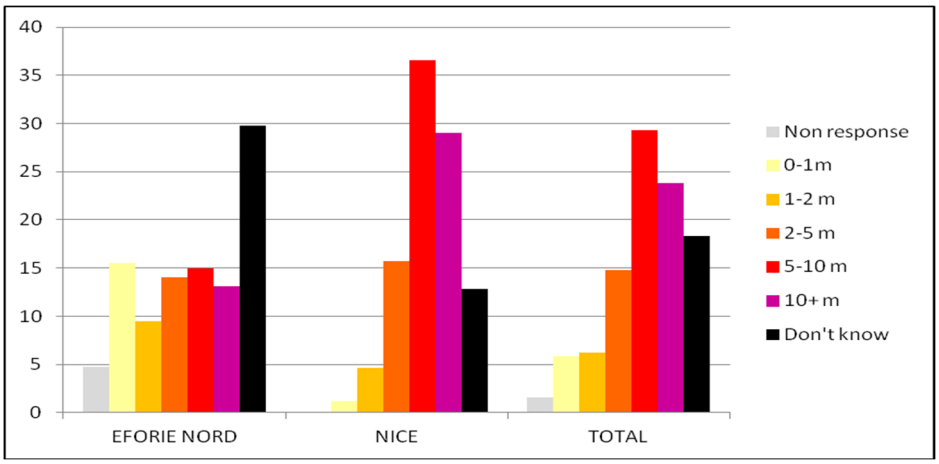

Fig. 8. *Supposed wave heights in case of a tsunami (%)*

Very light difference regarding the answers given by respondents from both sites with respect the predicted maximum tsunami waves height of 2-5 m. But, a high procentage of population from Nice consider that tsunami waves could reach up to 5-10m and even more than 10 m. We can conclude that in Nice is an overestimation of tsunami hazard. It's seems that media coverage of big and recent events had a major role in this overestimation. Nevertheless, only in Eforie Nord a significant procentage of respondents have estimated maximum tsunami wave height between 0 - 1 m, this value being much closer to the (tsunami) model results obtained for this site. It's seems that romanian people are more realistic (figure 8).

After the survey, earthquake, sea withdrawal, animal behavior, and big waves were mentioned in both countries as the 4 pre-signs of a tsunami. Whatever the respondent's status (i.e. local population, or tourists), earthquakes and sea withdrawal are cited as tsunami warning signs by 62% and 60% of the respondents from Eforie Nord and by 30% and 31% of the respondents from Nice, respectively (figure 9).

"What are the indicators that a tsunami could happen soon? (precursor signs)"

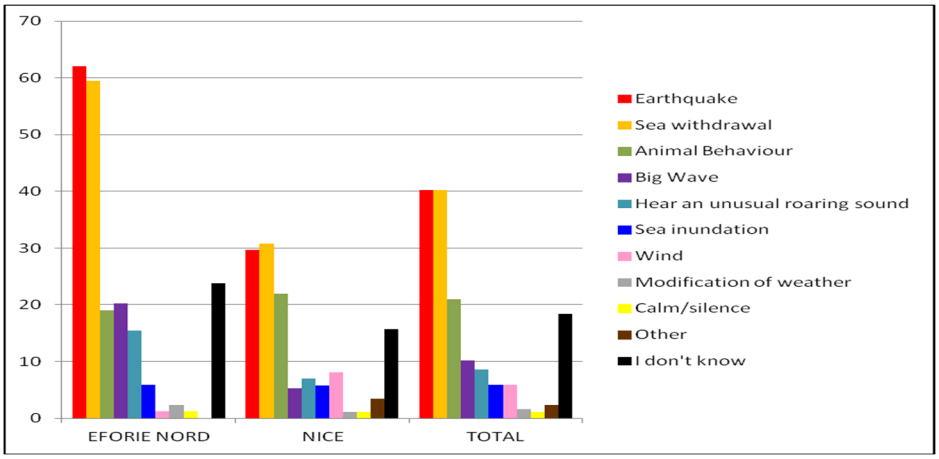

Fig. 9. *Precursor signs of a tsunami cited by the interviewees in both countries (in %)*

Behavior after an earthquake

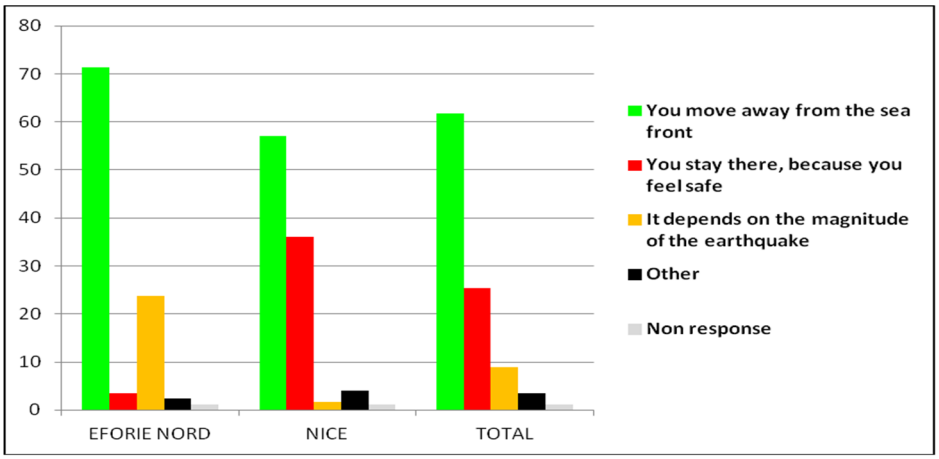

Fig. 10. *Perceived reaction in relation with people's behavior after an earthquake that might trigger a tsunami (in %)*

Very big difference between the answers given by respondents from the two sites regarding the behavior after an earthquake: in Nice a high percentage of the interviewed people (36%) answered that they would not leave the beach, because they feel safe.In Eforie Nord people are more cautious about their safety, 71% from the respondents would move away from the sea front in the case of a tsunami (figure 10).

At this question the respondents from both test sites have an accurate behaviour, but a high percentage of respondents (70%) from Eforie Nord answered that they will look first for a higher site. Also, 61% of the respondents from Nice, answered that they will move away from the beach (figure 11).

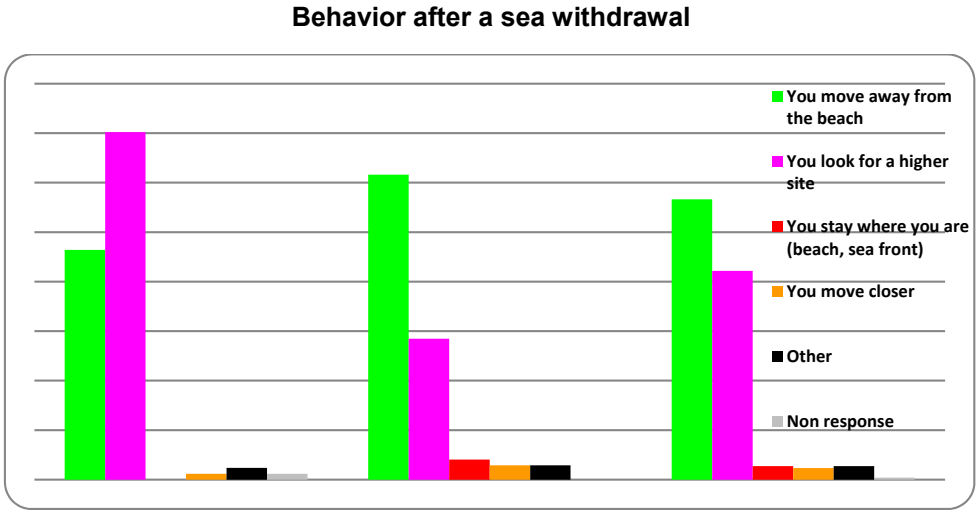

Fig. 11. *Perceived reaction in relation with people's behavior after a sea withdrawal (in %)*

CONCLUSIONS

From all the data collected through these two surveys performed in order to find out the level of knowledge, resources, and attitude of the Romanian and French population regarding the tsunami phenomenon on the Black and Mediterranean Seas, it appears that the preparedness level is average, and in general, in Europe a low attention is paid to tsunami risk, maybe due to their relative infrequency and, also their smaller scale.Our respondents from both sites mentioned the tsunami as third rank in both sites, coming after earthquakes and storms/pollution. Following this study, one may conclude that part of the interviewed people from Romania are well documented (through school and internet) and are aware of the phenomenon, meanwhile others,french people especialy, know about tsunami only from TV. Important to emphasize is the fact that people are aware (65%) that a tsunami might happen in the future (reported in both test sites), they have a fairly good knowledge of precursor signs (more

than 40% cited earthquakes and sea withdrawal), and in a case of tsunami over 60% of the respondents will evacuate the beach. One of the weak point in Nice is the overestimation of the tsunami height compared with the tsunami model results developed for that area: 37% of the people expect a wave height in excess of 5 m and 29% up to 10 m, whereas the modeled heights are less than 4 m for the worst cases (Lavigne et al., 2017). This overestimation is mainly due to extensive media coverage of the disasters caused by the major tsunamis trigerred by the earthquakes from December 26, 2004 in Sumatra and March 11, 2011 in Japan.

When you associate low to moderate levels of risk perception and hazard knowledge with innapropriate expected attitudes of the people (locals and/or tourists), a disaster is imminent althought only small tsunami waves (with heights less than 2 m) might occur during the day in full summer season (in July and August).

The main conclusion that we can underline is the need of education which is considered a key instrument for the increase of the resilience for any type of hazard, natural or anthropic. For that purpose, the results of this study illustrate the necessity of education and training of the coastal communities about the tsunami hazard.

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