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PROCIV HANDBOOKS

Reference Guide for Evacuation Planning in case of Tsunami

NATIONAL AUTHORITY
FOR EMERGENCY AND CIVIL PROTECTION
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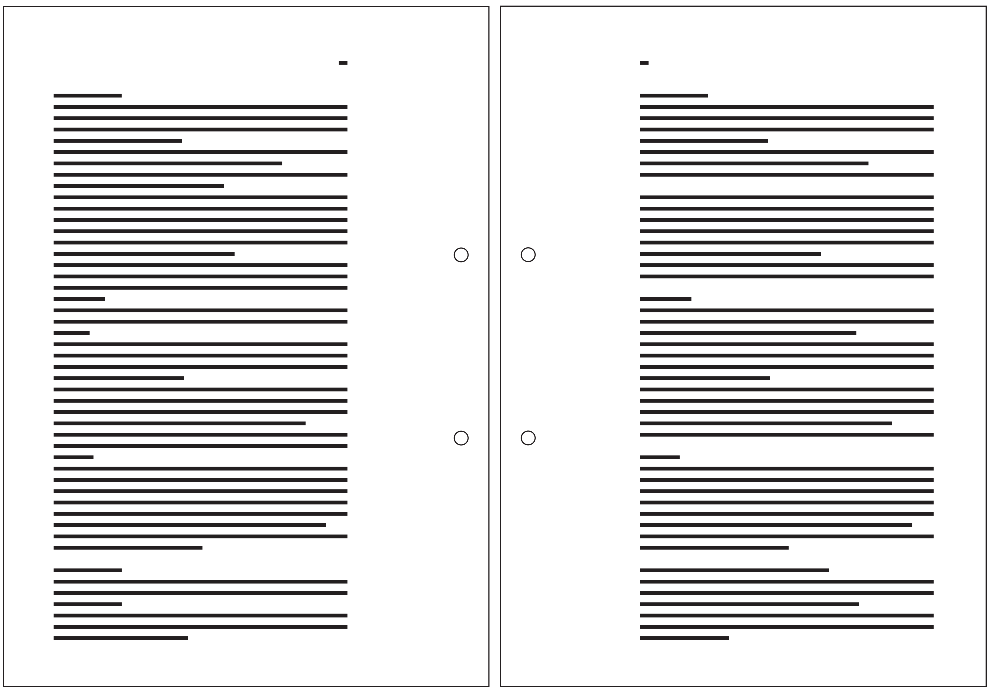
CONTENTS



Before printing this handbook think carefully if it is even necessary; save electricity, toner and paper.

If you choose to print, this notebook was prepared to be used both sides from the same sheet during the printing.

What is the Reference Guide for Evacuation Planning in case of Tsunami?

It is a document that aims to assist in the preparation of evacuation plans for areas potentially threatened by a tsunami, while also contributing to improve public perception and public awareness of this risk.

The instructions contained in this Guide were based on national and international doctrine, namely the UNESCO Intergovernmental Oceanographic Commission (IOC) working groups, as well as guidelines arising from the experience of other countries with recognised progress in this area, namely Chile, Indonesia, Italy and Japan.

What is the target audience?

All entities with authority in the area of civil protection, namely Municipal Civil Protection Services, as well as all other entities whose duty it is to collaborate on civil protection objectives, and particularly those with responsibility for action on the coastline, namely the maritime port administrations and managers of marinas and similar spaces.

What is the content of this handbook?

The Guide is divided into five chapters:

- Chapter 1: sets out the national and international framework that led to the preparation of this Guide;
- Chapter 2: characterises the phenomenon and the potential damage arising from it, and describes the susceptibility of mainland Portugal to tsunami risk;
- Chapter 3: mentions the Tsunami Early Warning System, in particular the National Tsunami Warning Centre, and illustrates the notification procedures implemented and the warning systems provided to the population;
- Chapter 4: describes the stages in the preparation of an Evacuation Plan, including definition of the potentially threatened areas, the identification of the meeting points and definition of the evacuation routes;
- Chapter 5: addresses the topic of awareness-raising and the importance of conducting regular training exercises involving the population.

DEFINITIONS

For the purpose of this Guide, the following definitions shall apply:

Early Warning

Communication usually issued by the National Warning Centre indicating the possibility of a tsunami (UNESCO, IOC, 2019).

Tsunami warning

Communication issued by civil protection authorities, when there is imminent risk of tsunami. The period during which a tsunami warning is issued can vary in length, depending on the evolution of the phenomenon.

Horizontal evacuation

The action of moving to an area in the safe zone.

Vertical evacuation

The action of ascending to the upper floors of buildings that provide safety in structural terms.

Elevated shelter

A type of meeting point which corresponds to a common space or easily accessible building located above the area potentially threatened by tsunami.

Evacuation plan

A set of procedures to be implemented by the authorities and the population to carry out the appropriate evacuation of the zone potentially threatened by a tsunami, should the need arise. It includes a map of a coastal or estuarine area, highlighting the area potentially at risk of tsunami, the evacuation routes and the location of orientation signage and meeting points and any recognised geographical references.

Meeting point

The place to which the population should head immediately after the warning is issued. The meeting point may be an open space (known as a "safe location") or a building (known as a "elevated shelter").

Tsunami risk

The combination of the probability of a tsunami occurrence and the estimated consequences on people, property and the environment.

Evacuation sub-area

A sector in an area potentially threatened by a tsunami, intended to facilitate the evacuation process by providing a specific meeting point (or more adjacent points) and evacuation routes leading to it/them. It will be delimited by the area from which people should move towards the same meeting point (or points).

Tsunami
Also known as a tidal wave, it is a series of waves of long length and duration that occur following a sudden deformation of the ocean floor, which can reach land and affect coastal areas, beaches, harbours, residential, commercial and industrial areas as well as leisure and other areas located nearby, for a period of several hours.

Evacuation route
The path to follow from a point in the area potentially threatened by a tsunami to a meeting point.

Safe location
A type of meeting point which is an open space located above the zone potentially threatened by a tsunami.

Safe zone / safe area
Zone/area located outside the zone potentially threatened by a tsunami.

Zones potentially threatened by a tsunami
Area exposed to the risk of flooding due to the occurrence of tsunami.

1. INTRODUCTION

The United Nations Sendai Framework for Disaster Risk Reduction 2015-2030, establishes, among its guiding principles, that the reduction and management of disaster risk relies on coordination mechanisms between all sectors involved and requires the full participation of public institutions, in executive and legislative matters at national and local level, together with the combined expertise of public and private sectors, including technical and scientific research services and institutions and other active members of civil society, to ensure interaction and complementarity of functions for risk reduction.

At the same time, the National Strategy for Preventive Civil Protection 2030 (approved by Resolution of the Council of Ministers nº. 112/2021 of August 11) seeks to apply this international framework on a national scale, with one of its strategic objectives being the improvement of preparedness in the face of risk. Thus, the intention is to emphasize the "need to strengthen the actions of preparation that enable awareness of serious events to be obtained in advance, to trigger response operations and to ensure the timely warning of the population".

From this context, and amongst the operational objectives outlined by the National Strategy, within the framework of the priority area of "Emergency Planning", emerged the objective to "Prepare a reference guide for evacuation planning in the event of a tsunami". Hence the publication of this document, which is intended to be a guide that will enable coastal or estuarine municipalities to plan and/or assess future and/or current mechanisms for evacuation following a tsunami and facilitate the uniform implementation at national level of evacuation planning. Some examples of evacuation plans existing in Portugal will be mentioned in the course of the document.

The preparation and implementation, dissemination and putting into practice of evacuation plans all constitute an important step towards building and consolidating a culture of prevention, which in its turn makes communities more resilient.

2. CHARACTERISATION

Tsunamis are natural events that result in coastal flooding and/or erosion, and can affect the safety of people, property and the environment (Figure 1).

Figure 1 – Indonesia 2004 (Source: ANEPC).

A tsunami is a series of waves of extremely long length and duration generated by sudden deformations of the ocean floor. The most common cause is an underwater, high-magnitude earthquake, although they can also be caused by landslides, volcanic eruptions and meteorite impacts, which change the morphology of the area of the ocean floor near the source. Although infrequent compared to other natural events, tsunamis have enormous destructive potential (Baptista, 2010).

In deep ocean, a tsunami can go unnoticed due to the reduce slope of the seabed. However, as the tsunami approaches the shore, the waves' energy is compressed over a much shorter distance, creating highly destructive waves. This is because the wave height, often only tens of centimetres, increases rapidly in shallow water.

The speed at which tsunami waves travel can be over 700 km/h, but as they enter shallow coastal waters, they slow down and reduce in length, causing an increase in wave height. Upon impact on the shore, waves can reach several metres in height (Figure 2).

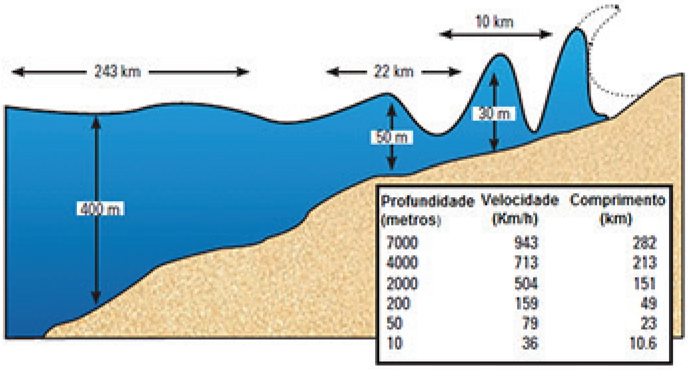


Figure 2 – Tsunami impact on the coast: effect of water depth ("profundidade") on wave height ("comprimento") and propagation speed ("velocidade") (Source: IOC, 2009).

When a tsunami wave inundates a coastal area, it creates strong onshore currents that exert potentially destructive forces in its path, sweeping away all kinds of objects and sometimes, people. Some of the most direct effects of tsunami include:

- Loss of life;
- Damage or destruction to buildings, vehicles, vessels and coastal infrastructure;
- Retreat of the coastline;
- Large amounts of debris washed ashore.

However, other effects with long-term consequences can also occur:

- Contamination of water and soils;
- Failure in the supply of drinking water due to contamination of surface water and aquifers (by salt water and other pollutants, some of them toxic);
- Outbreaks of disease;
- Interruption of economic activities;
- Limitation or restriction of access to some areas due to loss of control over hazardous materials (radioactive sources, explosives, chemical products, among others);
- Disruption of services.

In Portugal

The determination of tsunami risk presupposes knowledge of its sources and its behaviour. The scientific progress achieved in this area currently allows us to conclude that the tsunamis felt on the Portuguese coast are of seismic origin, with 6 tsunamigenic regions capable of generating seismic tsunamis considered to be of significant size in this country (Figure 3): (i) the region of the Glória Fault, (ii) the region of the Gorringe Bank, (iii) the Horseshoe region, (iv) the Algarve region, (v) the Gibraltar-Alboran region and (vi) the Tagus Valley region (Baptista et al, 2008).

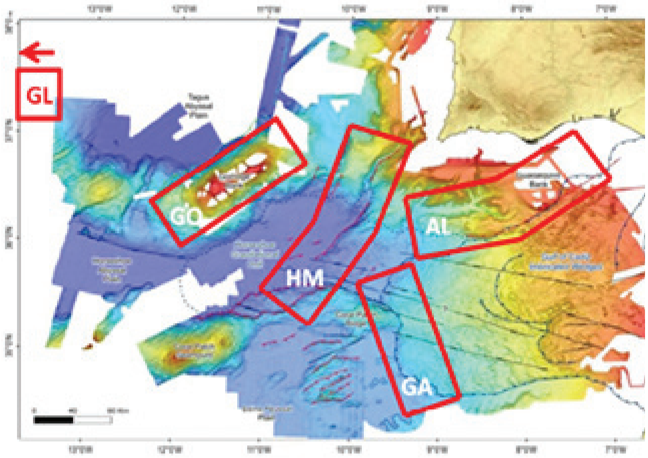


Figure 3 – Source Regions: GL(Glória); GO (Gorringe); HM (Horseshoe and Marques de Pombal); AL (Algarve); GA (Gibraltar-Alboran). (Baptista et al, 2008).

The list of tsunamis occurring on the Portuguese coast includes reliable events since 60 BC, 14 of them generated by earthquakes. A group of 5 events can be considered regional or pan-Atlantic in scope, having generated enormous damage: 60 BC, 382, 1755, 1761 and 1929 (Baptista et al, 2008).

The most destructive one to hit the coast was in 1755, originating from an earthquake with epicentre southwest of Cape Saint Vincent, and which struck a large part of the Portuguese coast with great intensity. This tsunami blasted through some estuaries, such as the Tagus estuary, where there was critical damage (human and material).

In mainland Portugal, the region's most susceptible to tsunamis are distributed along the entire southern and western coast between Cape Saint Vincent and Peniche. The estuarine and lagoon areas along these coastlines are also classified as areas of high susceptibility according to the "National Risk Assessment, 2019".

Among the most exposed zones, located in areas of high susceptibility to tsunamis, are the main urban settlements of the Algarve and Alentejo coasts and the Sado and Tagus estuaries, as well as the ports and marinas located south of Peniche. The extensive summer holiday areas potentially affected mean that in addition to the resident population there is also a high susceptibility of the seasonal population, including foreign citizens.

With regard to the environmental elements exposed in high susceptibility areas, the coastal lagoon and estuarine areas deserve special mention.

3. MONITORING, ALERT AND WARNING

In most situations, it is possible to forecast a tsunami on the basis of information on the origin of the earthquakes that cause them. Each situation is evaluated, considering seismic information and sea level data, which are obtained through seismic and sea level monitoring networks and tide gauges along the coast.

In the North Atlantic region, where ocean stations do not yet exist, the confirmation of occurrence of a tsunami is only made after the arrival of the first wave at a coastal tide gauge station or by direct observation. Therefore, the assessment of the potential for tsunami generation is based on the characteristics of the earthquake, considering that an event with an underwater epicentre of magnitude greater than 6.5 or 7 (depending on the regions) and whose focus is less than 30 km from the surface, has the potential to generate a tsunami (Baptista 2010).

The enormous devastation caused by the Indian Ocean tsunami on 26 December 2004 alerted global authorities, and in particular UNESCO's Intergovernmental Oceanographic Commission (IOC), to the need to implement a global tsunami warning system, as well to raise the awareness and preparedness of populations in risk zones. Portugal is part of the North-Eastern Atlantic, the Mediterranean and connected seas Tsunami Early Warning System (NEAMTWS), which is coordinated by UNESCO's Intergovernmental Oceanographic Commission. In the scope of this System, the Portuguese Institute of Sea and Atmosphere (IPMA) heads up the centre responsible for issuing tsunami warnings in the area of Portugal.

There are notification procedures in place that enable warning messages to be disseminated to the civil protection services, which in their turn disseminate warnings to the population located in areas potentially at risk of flooding by tsunami.

Among the various means that can be used to disseminate tsunami warnings, sirens are one of the most widely used at international level. Technical standards for operation of tsunami warning systems by means of sirens are published in Resolution n.º 2/2019, of September 12, and these stipulate the need to emit start and end signals, as well as, in the period between, the possibility of voice messages for the purpose of informing the population at risk about the self-protection measures to be adopted (Figure 4).

Figure 4 – Sirens installed in the municipality of Cascais (Source: ANEPC).

Even so, as Portugal has tsunamigenic sources nearby, the lead time for warning the population will always be reduced, a disadvantage that is partially compensated by the possibility of actually feeling the earthquake and seeing the possible anomalous receding of the sea. In such cases, the population should immediately adopt self-protection behaviour in the event it is located close to the coastline; events in the past have shown that damage can occur as a result of a tsunami with a wave height of 50cm, so anything above that, and until an accurate assessment of the tsunami potential can be made, people should be prepared to react.

4. EVACUATION PLANNING

In zones potentially threatened by a tsunami, strategies should be developed to systematise an essential set of actions that will achieve the safest and most effective evacuation possible, and allow people exposed to imminent danger to move to safer places. Taking as a starting point the provisions already included in the Municipal Civil Protection Emergency Plans, the municipal authorities, as the closest entities to the population, should develop evacuation plans for potentially threatened zones, notwithstanding that more detailed guidelines may have been defined for the operational response, in special emergency civil protection plans dedicated to tsunami risk.

Planning is essential to mobilise and coordinate skills and resources, and to manage the safe and timely movement of people, anticipating the needs for shelter and assistance. Such planning should incorporate a prior survey of occupied areas and the awareness, preparation and training of the population. Similarly, it should be borne in mind that a population that is well prepared and familiarised with the evacuation plan contributes to reduce the number of potential victims - which is why the participation of the citizens in its planning is so important.

There is not a single evacuation "model" that can be applied to cover all the scenarios, so any plan must be based on the geographical (physical and human) reality of the area in question; namely, whether it is a cliff or sandy coastline, and also whether it is a densely populated area or an area with low population density or even the floating population. It is also important to consider the different characteristics of the potential displaced people (with special attention to people with reduced mobility such as children, the elderly, bedridden or disabled people), which influences the population's response time. In addition, the time available for evacuation depends on the distance from the source (landslide, earthquake, volcanic eruption) and the existence of a tsunami alert and warning system, as well as having a population that is aware of and trained to adopt appropriate behaviour when faced with a tsunami.

The implementation of an evacuation plan involves adopting a set of preparatory measures, with the main objective of guiding all potentially affected people in a timely and organised manner, along the evacuation routes to the meeting points. Evacuation can be initiated spontaneously by the population (as a reaction to the warning signal) or following guidance from the competent authorities. The movement of people along the evacuation routes can be guided by teams/people selected for that purpose.

Thus, according to the UNESCO Intergovernmental Oceanographic Commission (IOC), the evacuation plan should define potentially threatened zones and identify limits beyond which people should be removed. The following elements, among others, should be represented in this document: potentially threatened zones, evacuation routes and meeting points (see appendix).

In addition to carrying out awareness-raising actions and campaigns, the placement of signage is a means of informing the public of the possibility of a tsunami occurring in a given area, as well as the self-protective behaviour to adopt. Since 2008, UNESCO's Intergovernmental Oceanographic Commission (IOC) has encouraged Member States to adopt the ISO 20712 standard tsunami signage in order to promote consistency in understanding and action at local, national and international levels.

Thus, three basic signs have been agreed upon: zone potentially threatened by tsunami, safe location and elevated shelter (see Resolution Nº. 1/2019 of September 12). However, it is important that the signage be checked periodically to ensure that it has not been destroyed or vandalised.

In this planning, emphasis should also be placed on the importance of communication during the emergency, so it is essential to have teams/people to provide up-to-date information on the situation and particularly, whether the population should remain at the meeting point and until when, or when it is safe to return, thereby avoiding situations of panic and precipitous dispersal.

It is recommended that the preparation of an evacuation plan includes printed maps, digital maps or interactive web products, not forgetting that they should be accessible to all users, including people with visual and hearing impairments (https://www.inr.pt/acessibilidades). The maps should include not only the delimitation of the potential flood area, the evacuation routes and meeting point locations, but also isochronous signals with evacuation times and distances to be covered on foot to the meeting point.

It is also recommended that the written information on the maps be bilingual (Portuguese and English).

4.1. Defining the potentially threatened zones

The zones potentially threatened by tsunami are coastal and estuary areas. Thus, the entire coastline is exposed in the event of a tsunami, with greater or lesser susceptibility depending on whether it is a cliff or dune coastline. However, the impact of the waves on the coastline is not always the same, and this, combined with the route the water takes through the local topography and features such as dunes and coastal vegetation, buildings, topographical irregularities and rivers, significantly affects the location and severity of any flooding (NEAMTIC, 2012).

Conducting simulation studies of the inundation produced by a tsunami is essential to evacuation planning, since the height and length of waves are highly variable, depending, among other things, on the source and propagation. However, in the absence of detailed studies, it is considered reasonable to simplify the assessment of the elements at risk (people, environment, infrastructures and economic activities) using a prompt delimitation, on digital map at a scale of 1:25000, of zones potentially threatened by tsunami, based on two empirical scenarios, both used in guidelines produced internationally (Chile and USA, for example):

- delimitation of the affected area to the elevation of 10 metres (it is considered that the tsunami wave will be felt up to 10 metres above mean sea level – a similar scenario to the tsunami that hit the Indian Ocean region in 2004);

• delimitation of the affected area to the 30 metres elevation (it is assumed that the tsunami wave will be felt up to 30 metres above mean sea level - worst case scenario, corresponding to the maximum recorded impact of the 1755 tsunami in some areas).

The entire zone potentially threatened by tsunami should be marked (Figures 5 and 6), making known the existing danger to all those who are there.

Figure 5 – Standard sign informing that the area is in a potential tsunami risk zone.

Figure 6 – Signs in a potential threatened zone in Alvor, Portimão (Source: ANEPC).

After defining the affected areas in each of the scenarios, it will be possible to determine the:

• identification of priority evacuation zones (located on land at an altitude of less than 10 metres above sea level);
• identification of other evacuation zones (located on land with an altitude of between 10 and 30 metres above sea level);
• estimate of the area potentially flooded in each scenario;
• estimate of the population potentially present in the evacuation area(s) (including resident, occasional and seasonal population).

It is recommended to divide the potentially affected zone into evacuation sub-areas, understood as a sector of the total area to be evacuated from which people can move - by one or more evacuation routes - to the nearest elevated shelter or safe location (Figure 7).

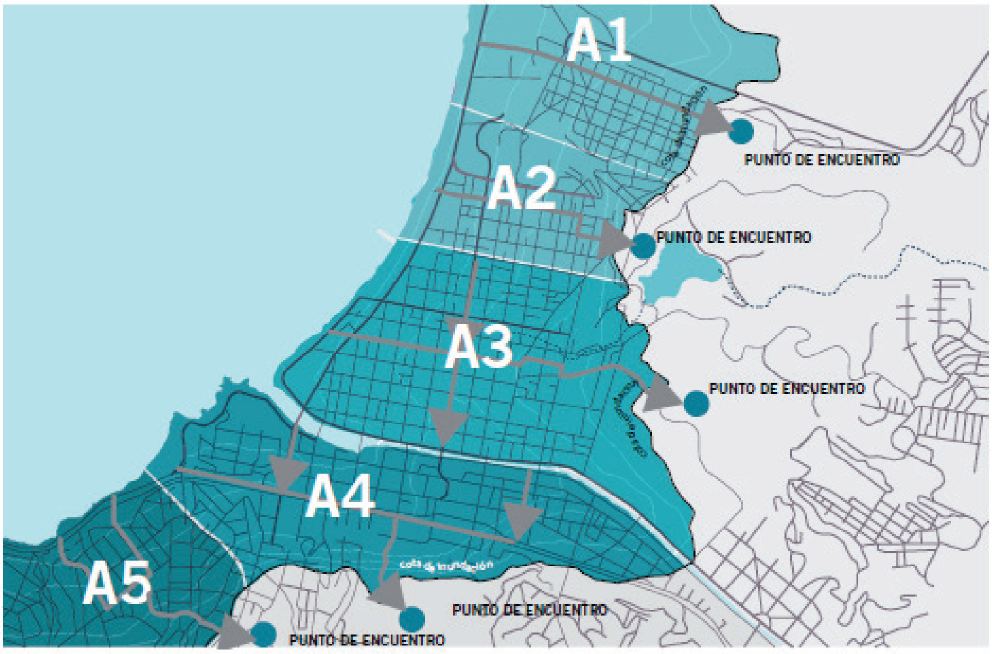


Figure 7 – Example of evacuation sub-areas (Source: Guia de Referencia para Sistemas de Evacuación Comunales por Tsunami, 2017).

This division into sub-areas facilitates the estimation of occupancy and the necessary dimensions for each of the evacuation routes, in order to ensure that all people in each sub-area can move as quickly and as neatly as possible along the route towards the towards the corresponding meeting point (Figure 8).

Figure 8 – Location of safe areas for evacuation in Lagos city (Source: Trindade et al, 2014).

4.2. Identifying meeting points

The meeting points are intended to guide the direction of evacuation (both vertical and horizontal), constituting the safe place in a tsunami warning situation (Figure 9). In addition to their location, preferably outside the zone potentially threatened by tsunami, another important criterion to take into consideration for its definition is its broad accessibility, preferably by multiple routes or at a confluence point in the road network, with no obstructions in its vicinity and with capacity to hold all the present population. Ideally, we suggest considering that the distance to be travelled by a person to the meeting point should not exceed 1,000 metres.

In sprawling areas, where the distance to travel to reach a safe area is very long, the possibility of implanting structures or choosing buildings with adequate structural strength that allow vertical evacuation (displacement to the upper floors) within the flood zone can be considered. It should be ensured that these structures/buildings are earthquake resistant, can withstand the impact of waves and any debris they may carry, and at the same time have a height greater than that of the wave in the worst-case scenario.

Figure 9 – Main evacuation routes to safe locations in Cascais (Source: Cascais Municipality website).

From these meeting points, the population should be directed by the authorities to the emergency shelter [1] provided for in the General Emergency Plans[2] .
Ideally, the implementation of each meeting point should take into consideration some minimum requirements to be met, which will allow the meeting points to facilitate the permanence of the people who have come there. The following are minimum requirements, depending on the type of meeting point:

- Have at least 3 floors (i.e. 9 m high);
- Have a backup system of public lighting with a minimum autonomy of 10 to 14 hours in case of service failure;
- Be equipped with operational communication devices such as radios, megaphones, etc;

1 – See Installation and Management of Population Concentration and Support Zones, Technical Manual (PT).
2 – See Manual to Support the Elaboration and Operationalization of Civil Protection Emergency Plans (PT).

• Have fixed toilets or be equipped with conditions for the installation of temporary toilets, if necessary;
• Have potable water available;
• Be properly signposted, according to Resolution n.º 1/2019, of September 12 (Figure 10).

It is also desirable that each meeting point has protection against solar radiation and/or rain.

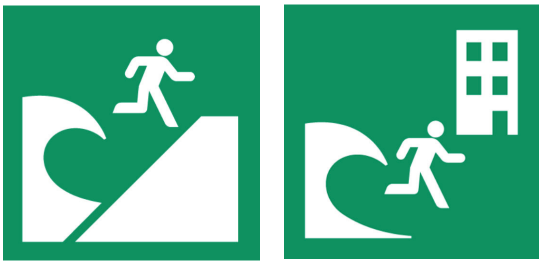


Figure 10 – Standardised signs informing about the safe location (left) and elevated shelter (right).

4.3. Identify evacuation routes

Once the best alternatives for the meeting points have been identified (on the assumption that they are located at an elevation above 30 metres in relation to the mean sea level), it is advisable to verify if the population of each sub-area will be able to move to a meeting point by the shortest possible route, or by the fastest possible route.

There are several methodologies to estimate the time necessary for evacuation, including amongst the variables, decision time (the time that elapses between the official detection of the event and when the alert is issued); the time to warn the population, the reaction or preparation time of the population and the expected time of arrival of tsunami waves (Trindade et al, 2014).

When preparing an evacuation plan, it is very important to take into consideration the mobilisation time (or preparation for evacuation). A weakness of most evacuation plans is that they do not adequately integrate the population's response capacity (Gruntfest and Huber, 1989). This issue can be overcome with strong awareness-raising action and the carrying out of regular drills, however, an average reaction time of 10 minutes can be assumed (Trindade et al, 2014).

Thus, the population, at any location within the potentially threatened zone, should be advised to:

1. Run to the nearest road or path and follow evacuation routes to the nearest elevated shelter or safe location, or
2. Remain in (and climb up) the building in the event it is among of the elevated shelter.

In the case of persons with reduced mobility, it is important be aware of the most vulnerable situations in advance and to provide escort and support teams specially trained to minimise evacuation time.

Different obstacles that may arise during the evacuation should also be taken into consideration, such as traffic, adverse weather conditions, impassable roads, downed power lines and other obstructions. Although it is not always possible to predict where obstacles may occur, it is important that evacuation route planning considers several alternative options so that evacuation is not compromised.

The following are considered minimum requirements for the choice of an evacuation route in order to optimise the flow of people:

- Connect to a safe area, and ideally to a meeting point, in the shortest possible distance, or in the shortest possible time;
- Be wide enough to allow the evacuation of the corresponding sub-area;
- Preferably have public lighting;
- Have pavements in good condition and adapted to facilitate the movement of people with disabilities and reduced mobility, including children, the elderly and pregnant women;
- Have slopes of no more than 12% gradient. On steep slopes, zigzag pedestrian escape routes are recommended to reduce the slope, bearing in mind that the maximum slope recommended for the circulation of people with reduced mobility is 6% (according to Decree-Law n.º 163/2006, of August 8).
- Be properly signposted, according to Resolution nº 1/2019, of September 12.
(Figure 11). Signs must also be placed within the potentially threatened areas, especially in places where many people gather, such as beaches and parks, to create a repetition effect.

Figure 11 – Standardised signs indicating evacuation direction.

The placement of this signage may include an additional sign indicating the distance to the meeting point, in order to allow the population to see the approach to the safe area (Figure 12).

Figure 12 – Signs for evacuation routes in Alvor, Portimão (Source: ANEPC).

Additionally, an evacuation route should NOT:

- Be located in or pass through areas exposed to other risk situations, according to risk characterisation carried out by the municipality;
- Be located on, or near, high and very high-voltage power lines;
- Be adjacent to buildings or constructions in poor condition, which may collapse in the event of an earthquake;
- Create the need to use special structures (bridges, viaducts or subways) which may have been damaged/cracked during the seismic event.

5. AWARENESS-RAISING

The effectiveness of warning systems is strongly conditioned by the response of the entities with responsibility for coordination in emergency situations and of the population. Thus, with the aim of encouraging countries to increase awareness of the risk of tsunami, the UN General Assembly has designated, since 2015, the 5th of November as the World Tsunami Awareness Day (https://www.un.org/en/observances/tsunami-awareness-day). This day provides a good opportunity for testing evacuation plans and other awareness-raising activities.

The success of any alert and warning system in saving lives and reducing material damage depends on the rapid dissemination of information to the potentially affected population and on how prepared they are to react. In this context, it is already a practice in some Municipalities to consider the evacuation drill as a testing exercise within the Municipal Civil Protection Emergency Plan.

Special attention should be given to the organisation of evacuation drills in buildings (both public and private) with a high concentration of people (e.g.: schools, nursing homes or day centres, hospitals, shopping centres/areas, industrial units, etc.), the organisation of workshops in the tourism sector (involving, particularly, the management of hotels, beach resorts or marinas) and information campaigns among the most vulnerable groups.

It is important to encourage people to react and recognise that the main warning of a possible arrival of a tsunami is the earthquake itself.

TSUNAMI WARNING

The first sign of an impending tsunami is the earthquake itself. So, if a strong earthquake is felt, people should plan to escape to safe areas if they are near the coast or an estuary.

A tsunami can be created immediately after an earthquake or up to about an hour later. Sometimes, the first visible sign of an approaching tsunami is an abnormal retreating of the sea from the shoreline, which is then followed by a rise in sea level.

Public information on the danger of a tsunami makes the population more prepared for the arrival of one. Citizens should be trained to recognise the warning signs of an impending tsunami, experience evacuation routes to higher ground and discuss ways to help children, the elderly and/or people with reduced mobility. In isolated areas there may be no mechanism to receive advance warning of a tsunami, therefore in such situations, public awareness about the danger signs and preparedness/reaction may be the only way to save lives.

Awareness-raising and risk information programmes, which make scientific concepts understandable and available to the public, have proven to be very effective. Several successful educational activities include (Pacific Disaster Centre, 2005):

- presentations, lectures and informal talks for the population, delivered by local experts who describe the tsunami risk, identify potentially affected areas, and recommend self-protection measures;
- distribution of leaflets (adapted for the visually and hearing impaired), encouraging people to seek further information and take steps to safeguard their property and their families (e.g. http://idl.campus.ciencias.ulisboa.pt/earthquake-and-tsunamiinfo/tsunami_poster/);
- warning signs posted in risk areas and other signs directing residents to previously established evacuation routes;
- carrying out periodic evacuation drills.

The population present in risk areas should be regularly informed and trained in a context of evacuation drills, which will also serve to evaluate the understanding of warning systems, test the means of communication and the equipment involved in the evacuation plan, assess the time needed for evacuation and the suitability of the evacuation routes and understand the levels of operational response (Figure 13).

Figure 13 – Evacuation drill (Source: Cascais Municipality website).

6. REFERENCES

Autoridade Nacional de Emergência e Proteção Civil, 2022 – "Manual de Apoio à Elaboração e Operacionalização de Planos de Emergência de Proteção Civil".

Autoridade Nacional de Emergência e Proteção Civil, 2020 – "Instalação e gestão de Zonas de Concentração e Apoio à População, Manual Técnico".

Autoridade Nacional de Emergência e Proteção Civil, 2020 – Riscos e Prevenção - Tsunamis.

Autoridade Nacional de Emergência e Proteção Civil, 2019 – "Avaliação Nacional de Risco".

Autoridade Nacional de Emergência e Proteção Civil, 2012 – "Guia para o Planeamento e Condução de Exercícios no Âmbito da Protecção Civil".

Baptista, M. A.; Miranda, J. M.; Lima, Vânia; Catalão, João; Roquette, Pedro, 2008 – "Avaliação do Risco de Tsunami na Costa do Algarve".

Baptista, Maria Ana, 2010. Tsunamis. Academia das Ciências de Lisboa.

Câmara Municipal de Cascais, 2018 – "Aviso e Alerta de Tsunamis. Cascais promove cultura de segurança".

Carrilho, F.; Costa, E.; Pires, P.; Varela, D., 2014 – "Sistemas de alerta para tsunamis" disponível em Boletim PROCIV N.º 81.

Fukutaro, K.; Daisuke, I.; Tsuyoshi, I.; Akio, O., 2020 – "An allocating method of tsunami evacuation routes and refuges for minimizing expected casualties".

Gruntfest, E.; Huber, C.,1989 – "Status Report on Flood Warning Systems in the United States. Environmental Management".

ICG/NEAMTWS Working Group 4, 2010 – "Reducing and Managing the Risk of Tsunamis".

Intergovernmental Oceanographic Commission (IOC), 2009 – "Tsunami Risk Assessment and Mitigation for the Indian Ocean: Knowing your Tsunami Risk and What to do About It".

Intergovernmental Oceanographic Commission, 2019 – "Tsunami Glossary", Fourth Edition.

Ministerio de Vivienda y Urbanismo, Ministerio del Interior y Seguridad Pública, Ministerio de Energía, Oficina Nacional de Emergencias, Centro Nacional de Investigación para la Gestión Integrada de Desastres Naturales, 2017 – "Guía de Referencia para Sistemas de Evacuación Comunales por Tsunami".

Miranda, J.M.; Baptista, M.A., 2006. "Riscos Naturais, Documento de trabalho".

NEAMTIC, UNESCO-IOC, 2012 – "Tsunami Preparedness Civil Protection - Good Practices Guide".

Norwegian Geotechnical Institute, 2006 – "Tsunami Risk Mitigation Strategy for Thailand".

Pacific Disaster Center, 2005 – "Tsunami Awareness Kit: General Tsunami Resources".

Papadoulos, G.; Imamura F., 2001 – "A proposal for a new tsunami intensity scale".

Scheer, S.; Gardi, A.; Guillande, R.; Eftichidis, G.; Varela, V.; de Vanssay, B.; Colbeau-Justin, L., 2011 – "Manual de Planificação de Evacuação por Tsunami".

Trindade, A.; Catita, C.; Omira, R.; Baptista, M. A. e Teves-Costa, P., 2014 – "Risco de tsunami em Lagos – Rotas de evacuação".

UNESCO, Intergovernmental Oceanographic Commission, s/d – Tsunami Ready Program.

7. LEGISLATION

Decree-Law n.º 45/2019, of April 1 – Organic of the National Authority for Emergency and Civil Protection

Basic Civil Protection Law (Law nº. 27/2006, of July 3, with the changes introduced by Organic Law n.º 1/2011, of November 30, and by Law n.º 80/2015, of August 3, that the republished)

Resolution n.º 1/2019, of September 12 – Guiding standard for the installation of signage in areas exposed to the risk of tsunami and respective escape routes.

Resolution n.º 2/2019, of September 12 – Technical standards for operationalization of tsunami warning systems by sirens.

Resolution of the Council of Ministers n.º 112/2021, of August 11 – National Strategy for a Preventive Civil Protection 2030.

APPENDIX

Evacuation Plan Structure Model

The model presented below is merely indicative and must be adjusted to the local reality.

- **Summary description of the situation** (include cartography, see chapter 4)
- **Intervening Entities** (see Municipal Emergency Plans): distribution of responsibilities
- **Warning procedures** that allow triggering the evacuation process
- **Evacuation procedures**
  - – Indicate the potentially threatened zone (see chapter 4.1)
  - – Define and signal the meeting points (see chapter 4.2)
  - – Define and signal evacuation routes (see chapter 4.3)
  - – Define teams/elements responsible for guiding the movement to the meeting points
  - – Define the teams/elements responsible for keeping the information up to date at the meeting points
- **Exercise program**

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