

An Egyptian Tsunami Contingency Plan

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Abstract Tsunami is one of the most destructive natural hazards that threatens coastal communities worldwide. Until the famous 2004 tsunami, the phenomenon has rarely been regarded as an essential issue facing coastal communities, following the incident that resulted in over 400 thousand human casualties and left over 750000 homeless people after completely demolishing their homes. The world's consciousness has changed regarding the real threat that tsunami imposes on the existence of coastal communities around the world. The UNESCO's initiated a program, Northeast Atlantic Mediterranean Tsunami Warning System NEAMTWS, to raise all the required mitigation measures to ensure that residents of coastal communities know the kind and degree of threats they are exposed to and how to deal with them. The project identified Egypt's Mediterranean coast as an area of high vulnerability when exposed to tsunami hazards. Although the project was set to achieve its objective by 2011, none of its objectives have been achieved. There is a total ignorance among the local community, authorities, and planners regarding the imposed threat. There is an urgent need for an innovative approach that could mitigate the impact and threats of tsunamis and increase the resilience of coastal communities facing them. The paper aims to innovate a contingency plan for the Egyptian coastal communities as an effective tool for increasing the resilience of coastal communities against tsunamis hazards. A contingency plan is to be proposed based on profound theoretical and analytical analysis of the literature review. Furthermore, based on the findings of an empirical study, the most effective knowledge transfer tool of the proposed plan is to be tested targeting the local community participants. Finally, the paper is to induct an 'Egyptian Tsunami Contingency Plan' (ETCP) that can be applied within the context and limitations of Egyptian coastal

communities' conditions.

Keywords Coastal Contingency Planning, Tsunami and Mediterranean Coasts, Egyptian Tsunami Contingency Plan

1. Introduction

Tsunami is considered one of the most devastating disasters, despite its low incidence in the short term, due to the short time available for the appropriate evacuation and housing decisions for this type of event [1].

The awareness of coastal communities about the dangers of this disaster increased after the Indian Ocean tsunami in 2004 [2], resulting from the enormity of the disaster, which resulted in about 400,000 deaths in South Asia and East Africa [3]. The recurrence of these waves has increased since the twenty-first century, which led to countries' attention to studying the mechanism of this phenomenon [4]. Measures, especially physical measures, are necessary to reduce the risks of the tsunami. Recently, several studies have concluded that the Egyptian coasts are highly vulnerable to the tsunami disaster, especially the city of Alexandria; that is through analyzing the history of the Egyptian coasts with the tsunami, in addition to the presence of many sources of tsunamis near the Egyptian coasts.

The danger of being exposed to the disaster is not only the tsunami, but the unpreparedness of society and people to face those risks. Therefore, it was essential to reach an appropriate strategy that would be commensurate with the current social conditions of the Egyptian coastal cities in

general, for preparation to face potential risks.

2. Objectives

This research aims to compose an 'Egyptian Tsunami Contingency Plan' (ETCP) that can be applied within the context and limitations of the Egyptian coastal communities, to increase the ability of the resilience of these communities against tsunami threats.

3. Methods

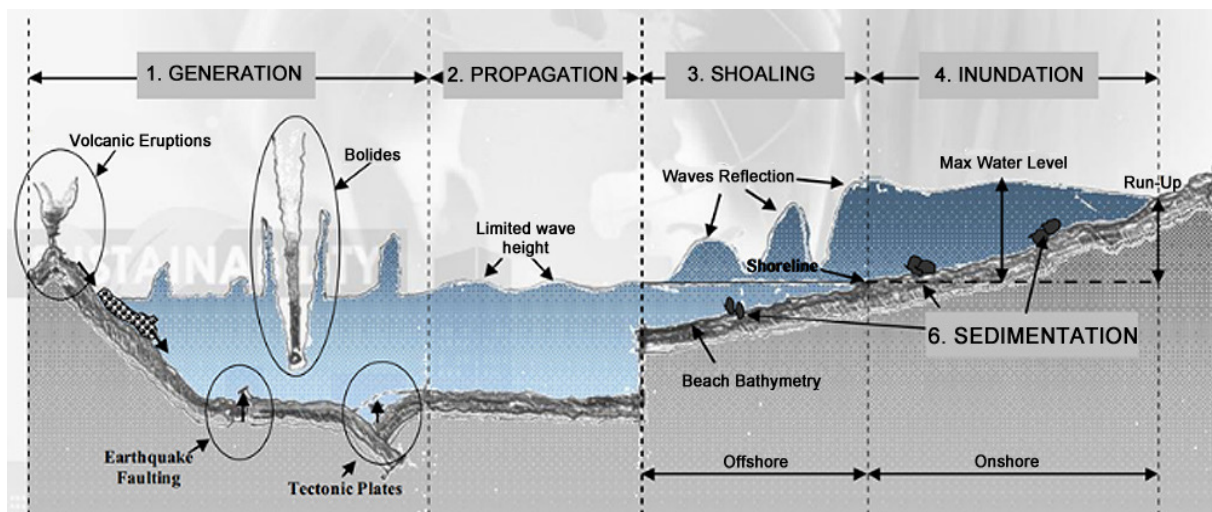
A contingency plan will be proposed for Egyptian coastal communities based on profound literature review analysis and studies. Regarding the current conditions of the Egyptian coastal cities, the research presents the social vulnerability of Alexandria city, as it is one of the largest coastal cities in terms of area and population and the most important in terms of economy and tourism. The research based on the results of a comparative analytical study for most effective approaches that are implemented to mitigate tsunami risks identified the contingency planning as the most appropriate approach to be applied in the Egyptian coastal context. The research also analyses a number of international case studies that apply the contingency planning approach to identify the obstacles and to further study and investigate the components of the contingency plan. Transfer of knowledge is the way for getting attention and participation of coastal communities, identified as the cornerstone for the success of any contingency plan. These tools and channels have been identified and tested through an empirical study, of a random stratified sample of

Egyptian coastal communities questionnaires. The results were analyzed statistically using SPSS to identify its suitability for Egyptian coastal communities inhabitants regarding age, and educational qualification. Findings were included in the final deducted proposed Egyptian tsunami contingency plan.

4. Tsunami and Egyptian Coasts

Tsunamis are centripetal force water waves in the ocean, which can be generated by seismic activities in subduction zones, landslides, and volcanic eruptions. Tsunami waves are very long and have relatively small amplitudes in the open ocean. Therefore, waves do not interrupt or dissipate any part of their energy during their travel for several kilometers. That causes catastrophic casualties for communities thousands of miles away from the generating points [5]. Analyzing the geological footprints and sediments makes it possible to ascertain the recurrence of tsunamis throughout history, which were also recorded by historical documents [4]. Figure 1 shows the stages of the tsunami process, starting from the cause (the source of the waves) until the waves return to the water again.

The Mediterranean is regarded as an active seismic basin encountering around 10% of the tsunamis that occurred worldwide since the 90s [5]- [6]. Documented historical events show that the tsunami waves struck the city of Alexandria twice, causing the city's destruction. Where nearly 5,000 people died and 50,000 homes collapsed in the year 365 due to an earthquake near the coast of Greece. The waves reached eastern Sicily, the Egyptian coasts, and the entire coastal areas.



Source: [5, p. 787]

Figure 1. The stages of the tsunami process

In 1303, an earthquake caused a tsunami, destroyed Crete island and reached the Egyptian coast (Alexandria), where a large part of the city wall and many houses collapsed, resulting in many deaths. At this time, the Lighthouse of Alexandria was destroyed [7].

This event and its impact on the city of Alexandria were mentioned in the books of the Roman historian Ammianus Marcellinus, where he said that the solidity of the earth shook and trembled and the sea rushed away. However, the massive mass of water unexpectedly returned time, causing several thousand deaths by drowning. Ships were thrown 3 kilometers from their positions, and others rushed over the rooftops. To avoid such accidents, it is necessary to understand the phenomenon and its possible dangers [8].

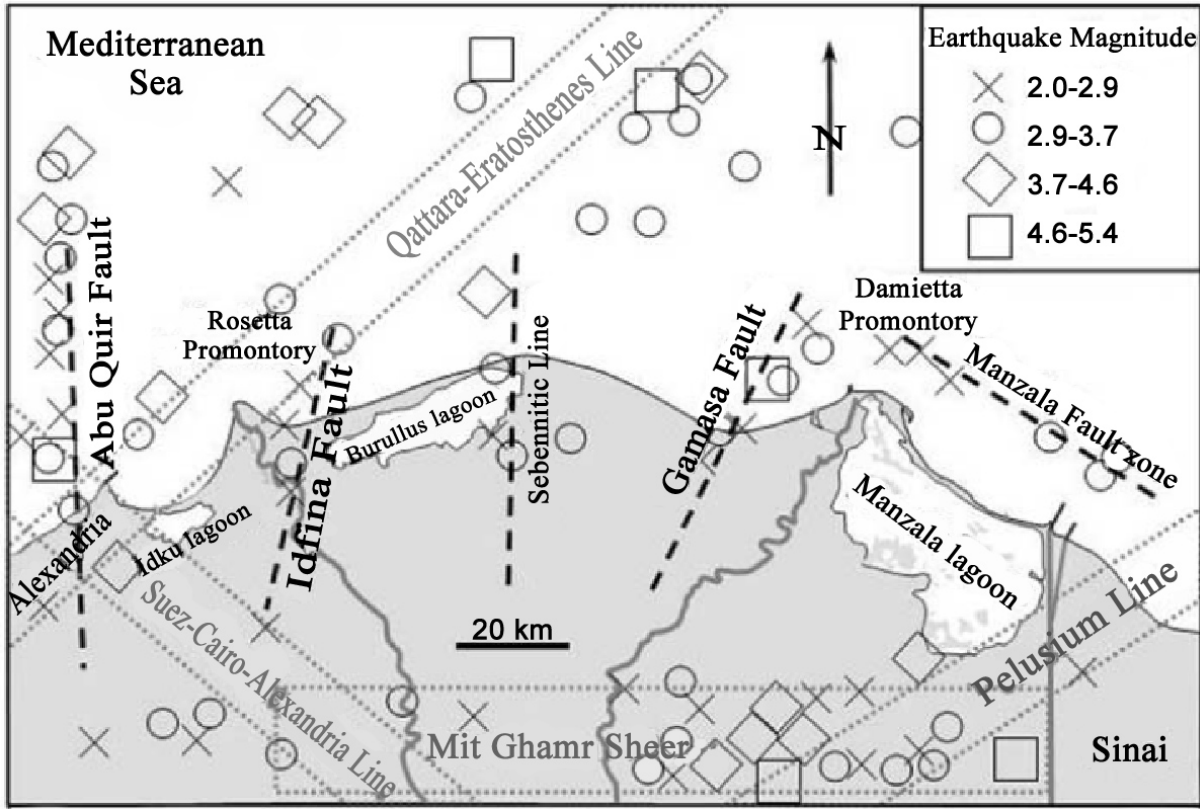
Many researchers have recently concluded that a large part of the Egyptian coastal cities on the Mediterranean Sea are exposed to the potential risk of tsunami waves, with different research results on the height of tsunami waves. However, many papers have concluded that the city of Alexandria is most probably exposed to not only that, but some of them identified the places of vulnerability and degrees of danger to specific zones [9]-[7]- [5]- [10]- [11].

Accordingly, it is recommended to follow a disaster risk reduction approach followed by an analytical study of the international approaches to identify the most appropriate path in regarding the community under study, and this requires knowledge of the degree of vulnerability to societal vulnerability, which is one of the most critical factors influencing and reducing the risk of natural disasters. Accordingly, the current societal conditions of the city of Alexandria will be studied, as it is considered the second capital and one of the biggest coastal cities and it has a variety of economic and social characteristics, in addition to the possibility of being exposed to tsunami waves to a large extent, as previously mentioned.

5. Current Social Conditions of Coastal Communities (Egypt, Alexandria)

The 2004 Indian Ocean tsunami proved that tsunami waves could harm thousands of people in coastal areas around the world. Scientists have made a lot of efforts to understand the process of tsunami generation, the mechanism of its spread and wave height, and how to implement and operate early warning systems. In the Mediterranean region, there is a tsunami early warning system that is composed of the following: a local system (warning units at the municipal level or district level), at the regional system (warning units at the states level or regional level), and a global system (warning at the hall Mediterranean region). The implementation of an early warning system, which is one of the most important stages of addressing tsunami risks, requires a community that is educated and aware of tsunami risks in vulnerable coastal areas [8].

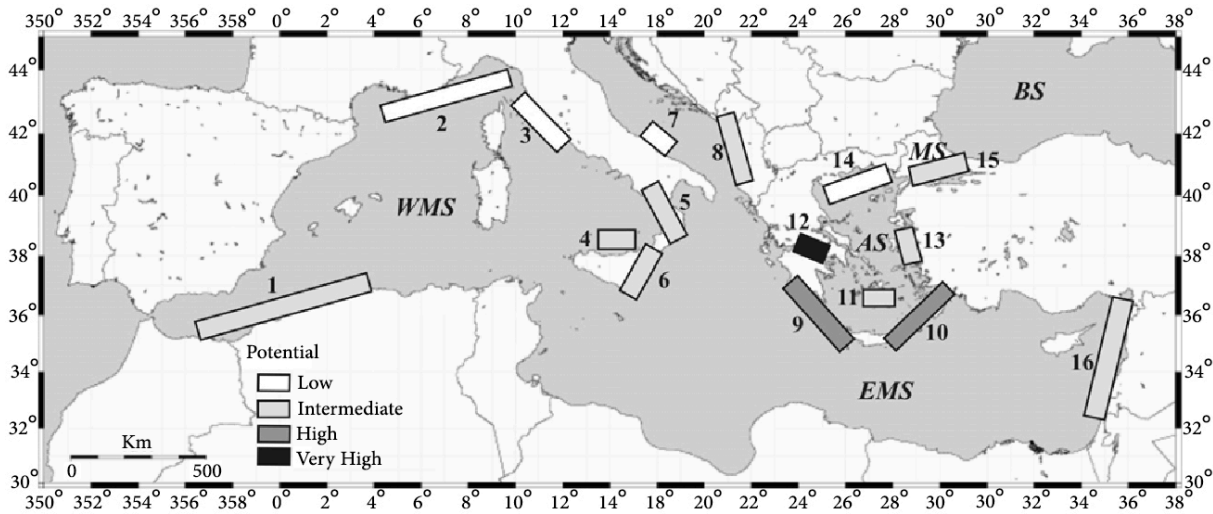
Believing that most Mediterranean citizens did not witness generating tsunamis or that they are rare, therefore no risk management strategies have been developed, which [6] demonstrates the level of awareness in the Mediterranean region. Despite the rarity of tsunami waves, their potential dangers and destructive power cannot be ignored. Several highly destructive tsunami waves were recorded in more than one site in the Mediterranean Sea, but Alexandria was affected by only a few of them that were documented historically, in addition to documenting many seismic events where two fault lines, Qattara-Eratosthenes Line and the Suez-Cairo Alexandria Line, converge on the Egyptian coast, making Alexandria a highly hazard place lying close to high potential seismic active points. (Shown in figure 2 and 3) [8].



Source: [8, p. 8]

Figure 2. Major active fault trends and the epicentral distribution of instrumental earthquakes recorded between 1900 and 1997 in the lower Nile delta

Most of the tsunami waves that affected the city of Alexandria came from the western and eastern Hellenistic arcs, which are located 500 km from the Egyptian coast. Figure 3 shows the tsunamigenic zones of the Mediterranean Sea:



Source: [6, p. 160]

EMS= East Mediterranean Sea/WMS= West Mediterranean Sea/AS = Aegean Sea/BS= Black Sea/MS= Marmara Sea,

1= Alboran Sea/2= Liguria and Cote d' Azur, /3=Tuscany, /4= Calabria, /5= Aeolian islands, /6= Messina straits, /7= Gargano promontory, /8= South-East Adriatic Sea, /9= West Hellenic arc, /10= East Hellenic arc, /11= Cyclades, /12 = Corinth Gulf, /13= East Aegean Sea, /14= North Aegean Sea, /15=Marmara Sea, /16= Levantine Sea

Figure 3. The Mediterranean Sea's tsunamigenic zones

In addition to the lack of awareness of tsunami risks present in Egyptian coastal communities, these communities are considered vulnerable to climate change, due to the direct physical impact of increasing sea levels and the potential effects of these modifications on water resources.

Alexandria is one of the coastal cities, where climatic changes could have a significant impact on its urban population. The expected impacts of climate change include an increase in coastal erosion, recurrence of heatwaves and rain, sea-level rise and tsunamis, and a number of other physical-environmental hazards such as land subsidence, and others [12]. In addition to the vulnerability caused by climate change, the unplanned sprawl of vulnerable urban communities comes to make these communities most likely to suffer from disasters with significant social, economic, and environmental consequences, according to the UN-Habitat report.

The social vulnerability of societies is due to several indicators, such as high levels of poverty, unemployment, housing inequality, and access to basic civil facilities such as sanitation and drinking water. Thus, for effective disaster planning, vulnerable high-risk areas must be identified and potential tsunami risks must be assessed, so that mitigation measures can be fully developed, proper and purposeful analysis must be conducted. The population and infrastructure in flood areas are not equal in the degree of risk, because the risk is directly related to vulnerability [12].

The results of the social vulnerability assessment are used as a tool for planning against risks, as a better understanding of the locations of vulnerabilities and the degree of vulnerability is one of the most important factors that help in selecting appropriate interventions.

The Egyptian coastal cities, facing many challenges regarding to urbanization and increasing inhabitants of unplanned areas which are characterized by general vulnerability and lack of basic services [13]. At a time

when the potential range of people affected by risks is increasing because of unplanned urbanization, vulnerability maps serve as clear and effective tools that can help identify those vulnerable areas, allowing decision-makers to provide or draw up a strategy to mitigate current challenges and mitigate future risks [14].

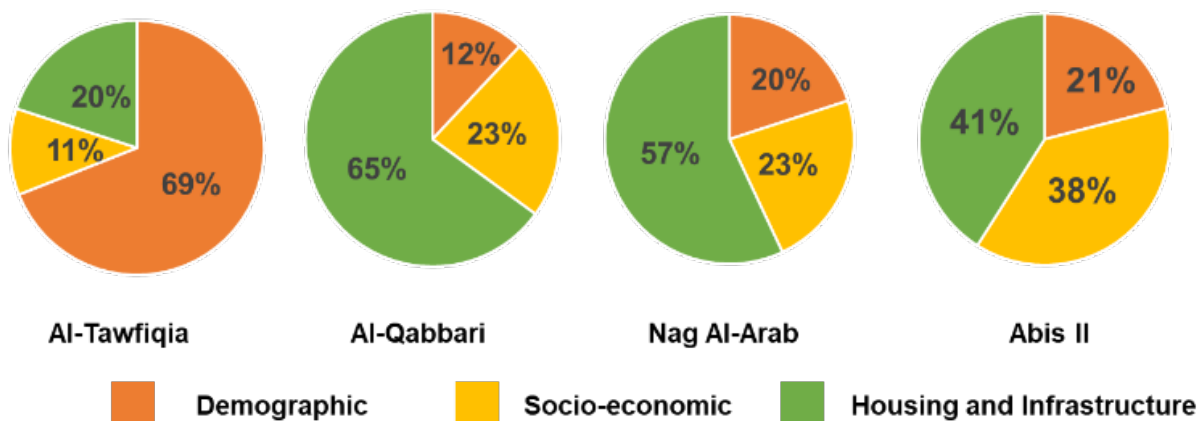
In order for decision-makers to be able to draw these strategies and implement targeted measures to mitigate risks, they must first have a clear vision of the current conditions of their countries or regions [15].

The results of a research study on social vulnerability showed that social vulnerability is unequal in different places of the same city. Alexandria was classified as suffering from social vulnerability at a moderate rate [12]. The areas were divided into (hot spots), which are highly vulnerable. Other areas are called (cold spots), which are those whose degree of vulnerability is weak. Based on the results and findings of several studies that analyze the social vulnerability of Alexandria city, the following results were concluded:

First: Concerning social vulnerability criteria in general, most of the administrative units in Alexandria could be classified as medium-vulnerability areas. Whereas in terms of infrastructure, they are only one of the most important factors of vulnerability. The more significant part of the city is considered average or very weak.

Second: The areas that are called hot spots because of their extreme vulnerability are Al-Tawfiqia in the western region, Al-Qabbari, Nag Al-Arab and Abis 2 in the eastern region.

Figure 4, shows the reasons and percentages of vulnerability. Among the city vulnerability parameters are demographic characteristics, socio-economic, housing, and infrastructure indicators, and housing and the built environment, in addition to the high rates of poverty, unemployment, illiteracy and low quality of life [12].



Source: [12, p. 1070]

Figure 4. The vulnerability domains' Percentage in every hot spot

Demographics: This term is used directly or along with other factors to refer to the size, distribution and composition of different population groups, such as age and gender [16].

Socio-economic: It means the financial situation of individuals, and the factors must include one of those indicators as minimum, such as employment, poverty, individual income and education [17].

Housing and Infrastructure: The state of the infrastructure and type of housing are the main factors for assessing societal vulnerability, so this field includes indicators such as the percentage of congestion, water and electricity supply. Often the homes of vulnerable residents are mobile, lacked of services or poorly constructed [18].

Third: Although those four areas have a common characteristic, they do not have the same reasons for vulnerability.

Fourth: Most of the areas classified as vulnerable to social vulnerability are located in areas classified as vulnerable to physical vulnerability with a high to medium rate. This is evident that vulnerability assessment is an essential tool that can identify areas of vulnerability and degrees of risk to mitigate risks and vulnerabilities [12].

Many researchers have recommended several priorities for developing such vulnerable areas, which include increasing the community adaptation ability, improving risk knowledge, paying attention to the most affected population groups, and infrastructure upgrading [12].

The current situation of the city of Alexandria has shown the extent of the fragility of society in areas, which emphasizes the need to develop a comprehensive and proactive approach to minimize the risk of natural disasters by focusing on the participation and development of vulnerable communities, cooperation and coordination between different levels and agencies, and those gaps that often exist in some approaches in dealing with disaster risks and hazards.

6. Approaches for Tsunami Mitigation

Since the forties, risk management has been widely applied in engineering, financial and industrial sectors after realizing its importance. Risk management has helped to establish a systematic procedure for examining risks and thus making decisions based on them [19]. This concept is still unfamiliar to most countries, especially developing countries.

Taking a comprehensive approach to mitigate the risks of natural disasters is a development challenge, and a development issue that needs to be set as a priority.

In this section, we will review some of the most important global approaches used for tsunami mitigation.

a. Managing urban land use for mitigating disaster risk

Land use planning is a vital instrument in reducing the risk of tsunami. Determining land uses affects infrastructure, population vulnerabilities, and potential risks, so it can be used to mitigate disaster risks [20].

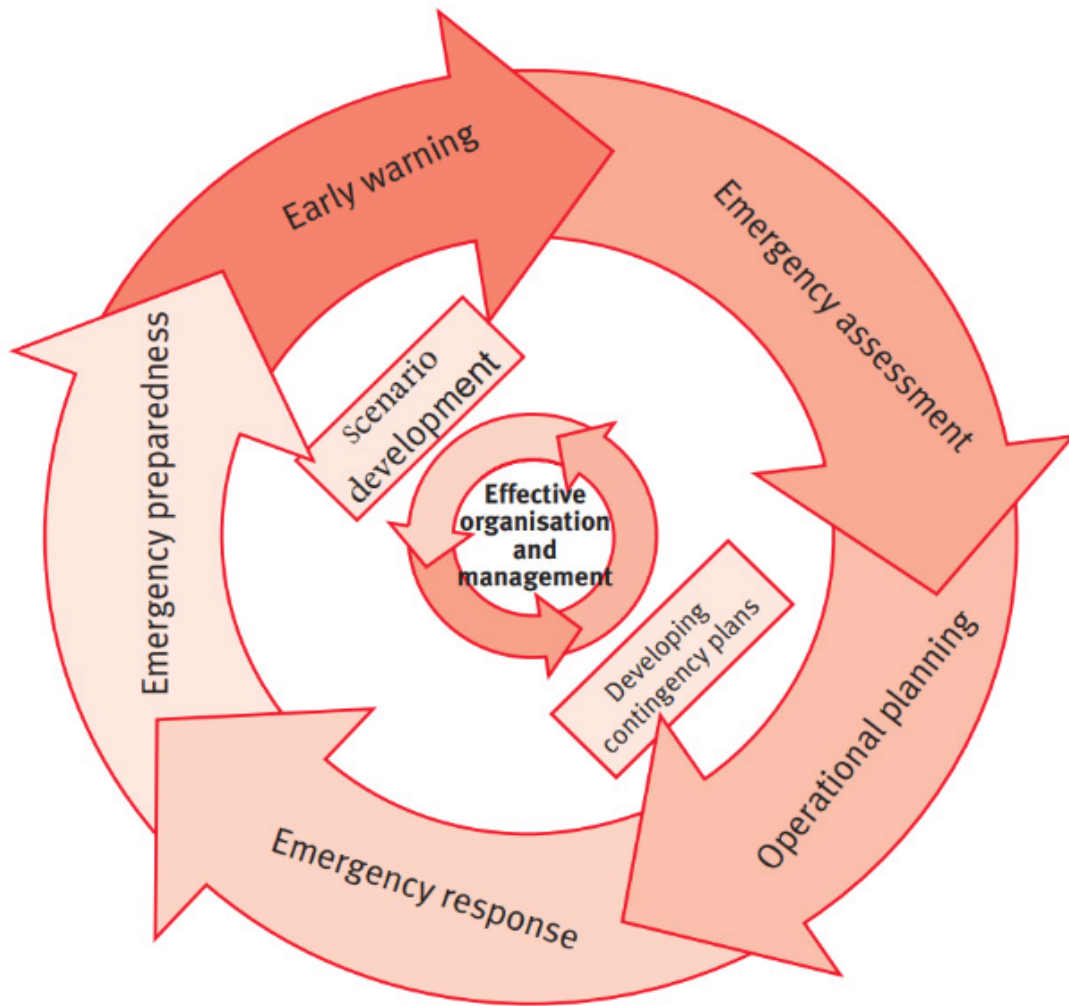
As urban land use management processes provide opportunities to understand the interaction of risks with urban growth patterns, whether current or future, measures (policies, investments and capabilities) can be deduced that lead to the development with lower risks [21]. It can be said that the goal of land use planning for disaster risk management is to achieve the use of resources and land in a way that makes them adapt to local conditions and needs, taking into account the risks of natural disasters.

b. Contingency planning

“A management process that analyzes disaster risks and establish arrangements in advance to enable timely, effective and appropriate responses.” [22].

This approach results in well-defined, structured courses of action, coordinated institutional resources, and operational arrangements for duty bearers. It is an essential part of an integrated security plan that defines different responses to different categories of risks.

There is often some confusion between disaster responses and contingency plans. Disaster response planning is preliminary and does not address specific disaster scenarios. A disaster response plan outlines risks, response strategies, actions, and capacities in a multi-hazard context. In contrast, a contingency plan builds on the disaster response plan. It is based on specific events or known risks at local, national, regional or even global levels (e.g. earthquakes, floods or disease outbreaks) [21]. The Preparation phase and the first step of the Analysis phase of this guidance could be associated with elaborating a response plan. The Development and Implementation phases could be considered as feeding the contingency plan. The initial phases (Preparation and first step of Analysis) must be carried out before the elaboration of any contingency plan (planning on a specific scenario) [23]. Figure 5 shows a simple conception of the contingency planning process.



Source : [24, p. 10]

Figure 5. A simple conception of the contingency planning process

c. Coastal defense strategy (sea fences)

Approximately 43% of Japan's 34,360 km coastline is equipped with coastal defense, consisting mainly of seawalls and breakwaters. Because Japan is a developed society and one of the most vulnerable to frequent large tsunamis and storms, its spending on physical coastal defenses is unparalleled worldwide. Although one of the main strategies was building seawalls and other strong defenses around its coasts, breakwaters are still a significant tsunami measure. One of the most extensive sea walls can be found on the coast of Taro District in Miyako City in Iwate Prefecture. Its construction began in 1933, Figure (6) and (7) shows the seawall before and after tsunami.

It became a priority during the 1960s and 1970s when coastal engineers recognized the need to create national coastal defense design and construction [25].

The scale of the disaster problem and its impact at all levels and development continues an obstacle to existing approaches, strategies, and mechanisms for disaster risk mitigation and response. A recent disaster management

enhances an inclusive approach that includes all stages of the disaster risk management cycle, but the reality is that the focus is on responding and implementing fewer activities on risk prevention, so this challenge still exists until now.



Source: [25, p. 3]

Figure 6. The seawall of Taro before the tsunami 2011



Source: [25, p. 3]

Figure 7. The seawall of Taro after the tsunami 2011

There are other prevention and mitigation strategies for tsunamis, such as building codes and coastal infrastructure construction. Table (1), defines the most currently adopted approaches.

From table 1, contingency planning is built basically on good communication between the participating institutions and stakeholders, and depends on the success of knowledge transfer, which is an essential step within each stage of the contingency planning process. Also, contingency planning is one of the least expensive and easy to implement approaches. In addition, contingency planning is applied through strategic planning [32]. Accordingly, many researches of risk mitigation approaches recommend adopting contingency plan approach for countries facing natural risks.

Therefore, the utilized contingency planning as the most appropriate approach to mitigate the risks of the tsunami on the Egyptian coast.

Table 1. Most important tsunami mitigation approaches

Strategy	Managing Response to disasters Requires preparedness or reactivity [19].		Managing risks and the underlying conditions that lead to disasters Requires, among others, risk assessment, vulnerability reduction, and capacity enhancement [19]	
Approaches	Coastal defense (sea wall)	Developmental relief approach	Contingency planning	Land-use planning
Methodology	<p>The working methodology that must be followed before designing.</p> <ul style="list-style-type: none"> • First, the situation is analyzed to assess whether there is a risk of flooding or erosion. • Second, studying whether coastal soft defense methods (mitigation measures) use ecosystems and create sand dunes. • Third, identify important habitat areas and the presence of threatened organisms. • Fourth, determine the appropriate construction dates to avoid the breeding seasons of organisms. • Fifth, reduce the negative effects of infrastructure on ecosystems. • Sixth, determine the material cost and potential losses. • Seventh, prioritizing work and delaying some work until after the tourist season. • Eighth, maintenance, and continuous updating [26]. 	<p>This approach relies on the people affected and considers them able to reduce harm despite the effects of the disaster.</p> <ul style="list-style-type: none"> • This approach first entails an analysis of the capacities and vulnerabilities of the affected communities. • Determining the nature of the assistance needed and the manner in which it should be provided, by analyzing the social, economic, and demographic composition of the community and its infrastructure. • Then, the requirements for relief and recovery are determined and provided to people with the participation of people. 	<p>The main elements of the methodology of this approach are:</p> <ul style="list-style-type: none"> • Prepare • Analyze • Develop • Implement • Review • Recovery <p>Note: Some steps may overlap a little, as some of them may be re-updated based on other steps, depending on the state of the community. Therefore, it is not required to arrange the steps as mentioned.</p>	<ol style="list-style-type: none"> 1. Preparation 2. Definition of work plan, approach and objectives 3. Involve the actors 4. focus on actors for risk management and risks 5. Analysis 6. spatial 7. socio-economic 8. environmental 9. risk analysis and consideration of sector studies 10. Plan formulation 11. Land-use plan with the characterization of risk areas; 12. Implementation 13. 5. Monitoring and Control
Features/advantages	<ul style="list-style-type: none"> • Japan's coastal defenses effectiveness is more mixed. The American Society of Civil Engineering (ASCEEERI) Subcommittee on Tsunami Loads and Effects reported that although 90% of unprotected areas were completely 	<ul style="list-style-type: none"> • The participation of the affected people increases their sense of responsibility toward others and toward their community, thus making it easier to save a larger 	<ul style="list-style-type: none"> • Continuity of the planning process and updating of data makes it suitable for societies in the long term. • Achieving community participation and increasing. 	<ul style="list-style-type: none"> • This approach is very effective in future cities and creates cities with less risk of natural disasters if all types of risks are taken into account during planning.

Table 1. Continued

Approaches	Coastal defense (sea wall)	Developmental relief approach	Contingency planning	Land-use planning
Features/advantages	<p>destroyed by the tsunami, the damage behind seawalls was somewhat localized.</p> <ul style="list-style-type: none"> • “Coastal marine defenses, although bypassed, helped slow the tsunami and mitigate the extent of its impact” [27]. The lack of knowledge and a false sense of security may have reduced the chance of people evacuating on time [25]. • It may be effective in the short term, depending on the life span of the building. 	<p>number and spreading better awareness.</p> <ul style="list-style-type: none"> • This approach is a very important stage within the integrated strategy to mitigate disaster risks, but it is not suitable as a single approach to addressing disaster risks. 	<p>people's awareness of risks.</p> <ul style="list-style-type: none"> • Ease of implementation and low cost makes it suitable for different societies. • They can be used for various types of risks. 	
Challenges/Difficulties	<ul style="list-style-type: none"> • The presence of compounds that are toxic to living organisms and the high surface pH makes it an unsuitable solution for marine environments. • Some objects may grow on the concrete, causing the surface of the material to deteriorate. • Most of the existing structures were built decades ago with methodologies that are not compatible with modern engineering standards [28]- [29]- [30]. • Most developments in this type of solution are not proactive but rather reactive and sometimes ineffective. • Sea-level rise causes waves to exceed protective structures, shown previously in figure (7) [30]. • The cost is very high, so this type of approach is not suitable for poor and developing countries. 	<ul style="list-style-type: none"> • In the case of an error during the identification of priority needs, it leads to the provision of inappropriate aid, which causes increased vulnerability and more social crises. • This approach may work for some disasters, while others require more analysis and prior actions, meaning that it is not suitable for all different circumstances. 	<ul style="list-style-type: none"> • If the coordination between the various authorities and departments is not done correctly, a defect may occur in the plan. • The difficulty of sustaining disaster management training. Insufficient human resources and infrastructure facilities. 	<ul style="list-style-type: none"> • Land use planning contributes to disaster risk management in the prevention and mitigation of risks in the first place, but it is not effective in all types of risks. • The awareness of the need to consider current risks and consequences of land use patterns and knowledge of disaster risk is not achieved in high-risk areas. • Establishing management that combines disaster risk management and land use planning is an important challenge that requires technical cooperation at a high level.

Source: Researchers based on [31]- [19]- [26]- [20]

7. Components of Contingency Planning

Contingency planning is one of the most flexible and applicable approaches to different societies, whether developing or developed, in addition to the possibility of using it to mitigate most natural disasters impact, not only tsunami's impacts, contingency plan contains several components, (shown in figure 8) that may differ from time to time depending on each scenario which includes:

- 1- Partners and stakeholders: There should be a list of the names and roles of each responsible person within the system, and also a backup copy in case of someone's disappearance or absence. This list should clarify the leadership structure to prevent overlapping roles and responsibilities and to avoid confusion over decision-making authority.
- 2- Sharing knowledge: Strategies and communication tools for transferring information to all parties (responsible - respondents - stakeholders and others). Find identification of alternative ways of communication in case of interruption of primary channels due to the crisis
- 3- Built-in strategies: Procedures and protocols based on the risk assessment with which to respond to the identified, prioritized risks.
- 4- Preparing all available resources and determining how to obtain additional materials in case of need.
- 5- Logistics management plan, including identification of elements that may need an increase in capacity

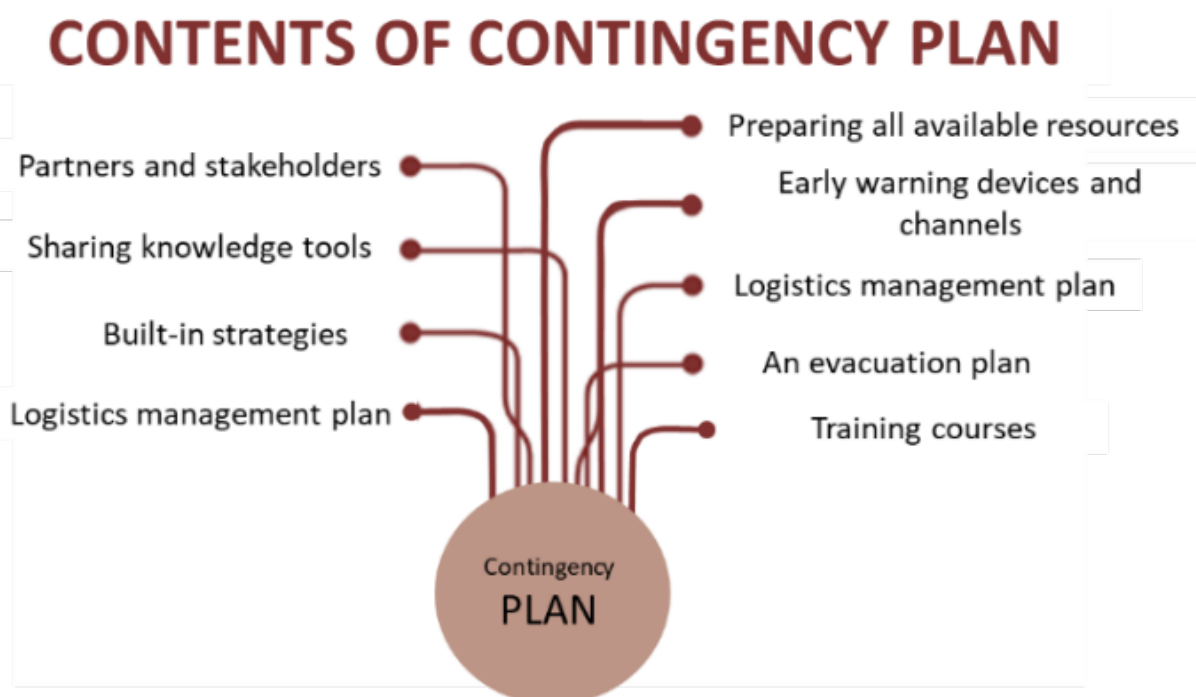
(equipment requirements - human resources - financing - etc.).

6- Early warning devices, means and channels.

7- An evacuation plan that specifies gathering points, meeting points, and escape routes during a disaster. [33]

Many disaster protection organizations such as (UNDRR - IFRC - Sendai framework) suggested (recommended) several elements that should be included in the disaster contingency plan, such as allocating funding to deal with natural disasters - including laws and legislation on natural disasters within the state constitution and imposing the consequences in if it is not followed - Involvement of individuals and affected persons in developing the plan - Continuous development of early warning devices - Constant updating of the plan - continuous, and effective and coordinating communication between authorities, officials and respondents. [34] [23] [35]

Hyogo Framework for Action also suggested mobilizing resources through countries and international and regional organizations, including (providing material support to developing countries and integrating procedures into multilateral development assistance programs), and mentioned several important considerations, including enhancing continuous, effective coordinating communication between entities, officials and responders - implementation by various stakeholders and civil society participation (NGOs, CBOs and volunteers), the scientific community and the private sector is also essential.



Source: Researchers based [33, p. 7]

Figure 8. Shows contingency planning contents

Table 2. The main elements of contingency plan

Elements	Built in Strategies	Appropriate strategies are so important. Weak strategies, disruption of procedures, or the absence of either of them can cause a significant additional danger to the lives of citizens and public order.
	laws and regulation	Successful implementation of decision-making guidelines requires facilitation by governments through new or amended laws and regulations.
	Sharing knowledge tools	Tools differ from one society to another, depending on the culture of the population and the capabilities of the government, and also differ from one population group to another within the same state. It is considered one of the most important elements of the plan, and in the case of the absence or ineffectiveness of the tools, the contingency plan will often fail.
	Finance	Governments are mainly responsible for providing risk prevention funding.
	Partners and Stakeholders	Response to the needs of a stricken population usually depends on coordinated action by the government, local authorities, (NGOs) and the communities themselves. Therefore, the plan should involve various defined stakeholders.

Source: Researchers based [32]- [35]- [36]- [5]- [23]- [33]- [26]

Table 2 reports on the main elements for any contingency plan. Some variations may appear regarding the uniqueness of each case.

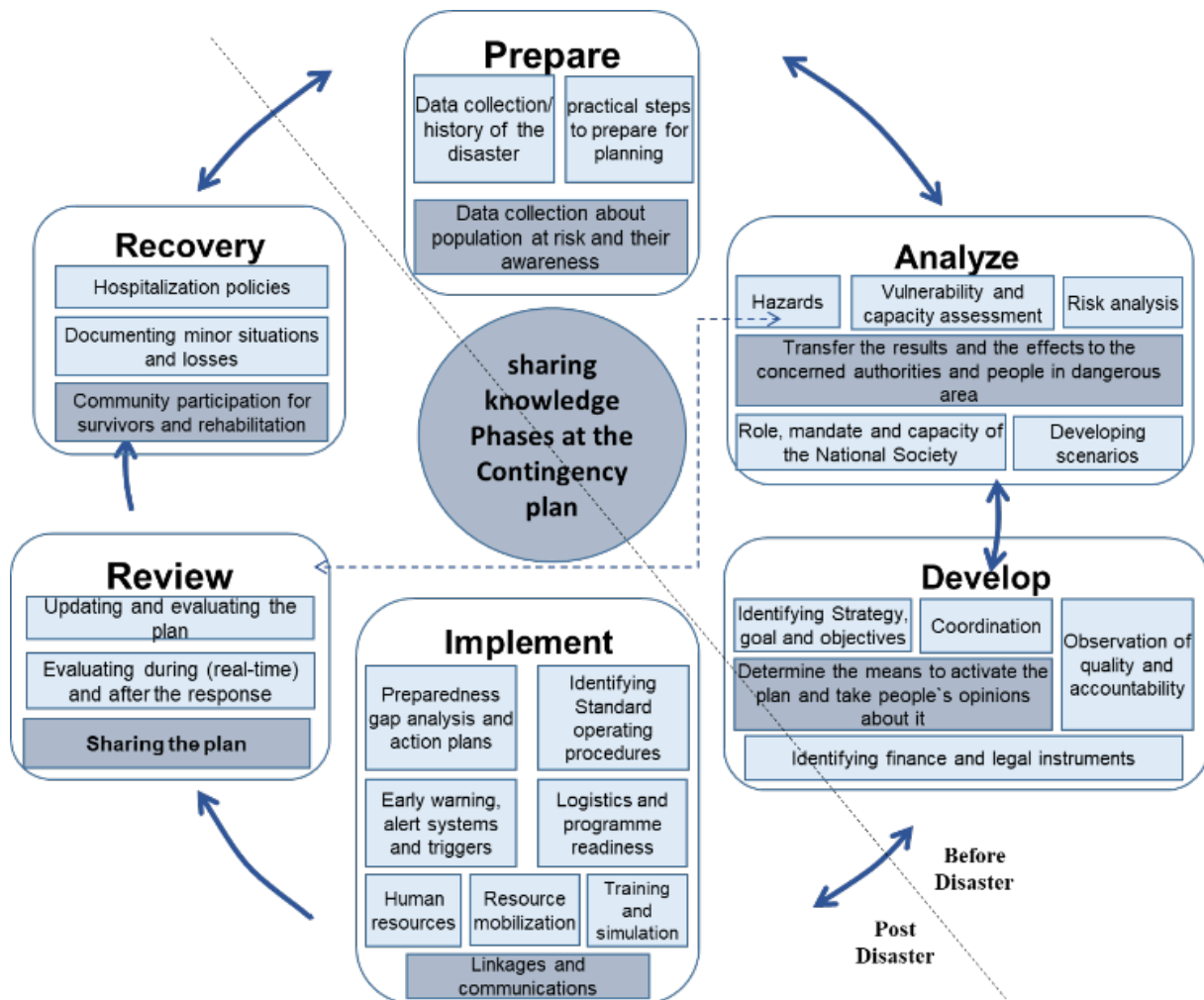
8. Contingency Planning and Transferring Knowledge

All planning models could be traced back to one of the three basic roots: rational/empirical, force/coercive, and normative/re-educational [37]. All models share the idea that planning is a logical sequential process that can be applied to solve all kinds of problems. The normative root/re-education is based on education and interpersonal communication skills [32]. Contingency theory is based on roots but relies on the normative root/re-education more, which makes it somewhat complex, as it reflects the current state of society. Therefore, it can be considered a more appropriate descriptive model that emphasizes increased community communication, and deals with how

to work while directing people to action planning and examining the link between knowledge and action [32].

In the forties of the last century, the concept of knowledge referred to facts only, and then it shifted in the eighties to refer to both facts and values.

Therefore, contingency plan (CP)'s success depends on good information delivery, effective coordination, and learning and communication strategy (IEC), at the sharing knowledge stage, in line with the other stages of the process taking into account a number of factors such as population vulnerability, potential for disaster, potential sources of donor support in addition to receiving and coordinating national, regional and global inputs as well as community capacity and government plans to respond to disasters [35], which requires community cooperation according to its acceptance and understanding of the project and its objectives. Figure 9, shows the stages of the contingency planning process and its continuity, including the role of knowledge in each stage and how to link knowledge and make decisions.



Source: Researchers based on [32]- [35]- [36]- [5]

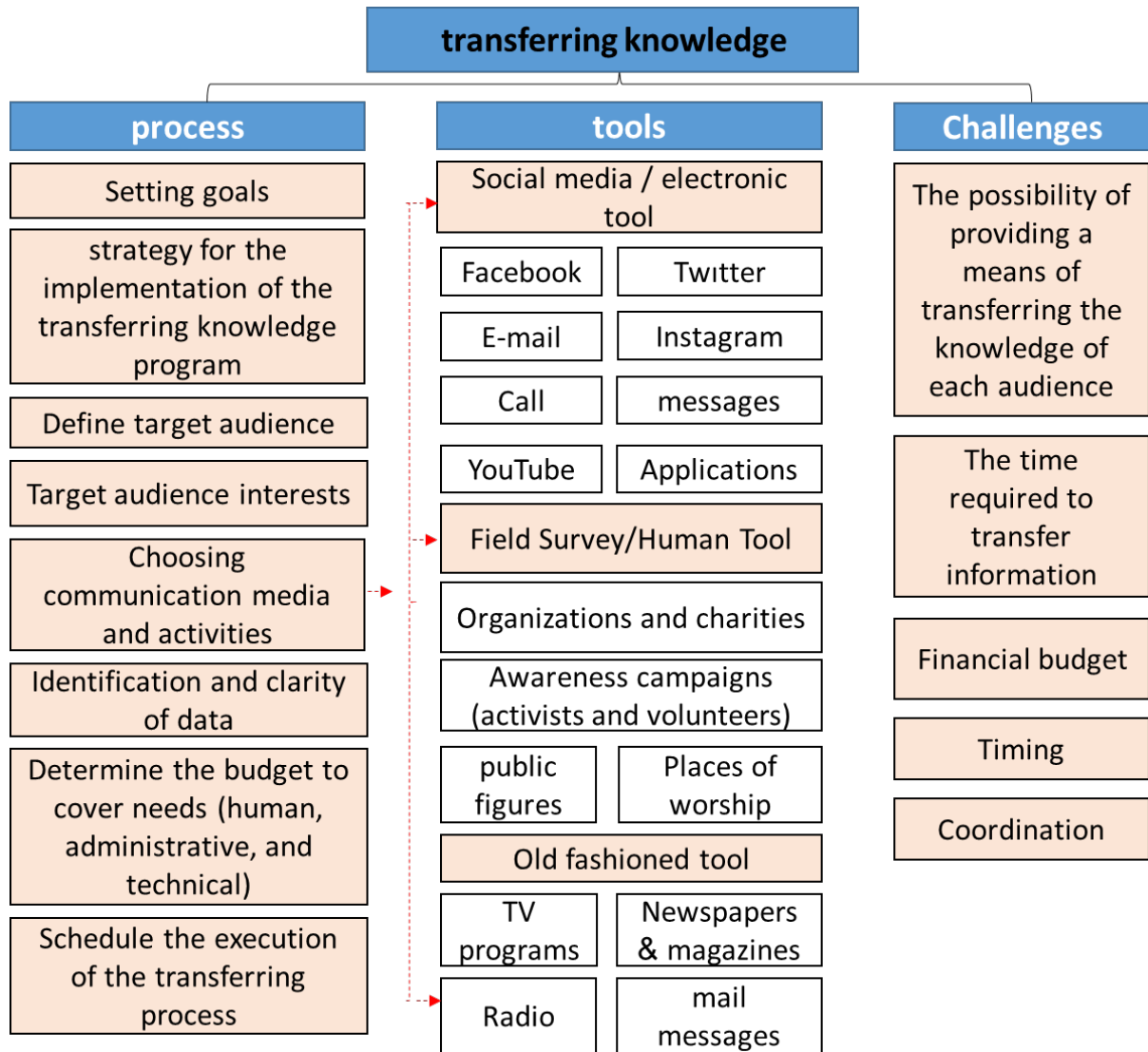
Figure 9. Shows the theoretical framework for contingency planning process and the role of knowledge in each stage

This strategy (IEC) includes planning and implementing various activities such as the distribution of leaflets, the development of user-friendly audio-visual materials electronic media, banners, and billboards, organizing competitions in schools and taking over, public meetings, organizing street plays, discussions (especially in schools), parties, etc. In addition to a website, it presents key information on the current situation, including cost, financial and institutional arrangements, and safeguard reports such as resettlement plans.

Sharing information with local community representatives and other agencies is important, especially

during emergencies. Therefore, the plan must include a mechanism and means of communication such as fax, radio, telephone, people, etc., [35] as shown in figure 10.

A member within the National Societies, in addition to the Public Relations Officers, should be responsible for the participation of teachers with the media and local communities, and must have the necessary expertise and ability to communicate with the government and organizations in order to ensure the consistency of external communications. In addition, team members must be trained on how to communicate information effectively [35].



Source: Researchers based on [5]- [38]- [39]- [40]- [41]

Figure 10. Shows the tools and the challenges at transferring knowledge process

9. Contingency Planning Current State in Bulgaria (Case Study)

For the purpose of this research three international cases were selected and studied: Rhode Island state, Padang city in Sumatra Island and Bulgaria city. However, due to the limitation of the paper, only the Bulgarian case was included in the text as the most appropriate and similar case to the Egyptian situation.

Bulgaria is a small country situated in Southeastern Europe. Its territory covers an area of 110,994 square kilometers. In contrast, land borders with its five neighboring countries, and its coastline is 354 kilometers long. Therefore, the main objective of creating a contingency plan was to analyze and assess the risk of disaster, identify preventive measures to mitigate the adverse consequences of disasters, organize and coordinate

actions to prevent or reduce the consequences of disasters.

Bulgaria was chosen as a case study for several reasons:

- History of Bulgaria with the tsunami disaster similar to the Egyptian case, where the periods between the events of the tsunami are far apart. Also both of them have high vulnerability to the disaster.
- Bulgaria's participation with Egypt in one of the most important sources of tsunami generation, which is the Hellenic arc, as shown previously in Figure (3).

The main objective of analyzing the case study is to access the tools and channels used in implementing the contingency plan and spreading knowledge about it, as shown in table 3.

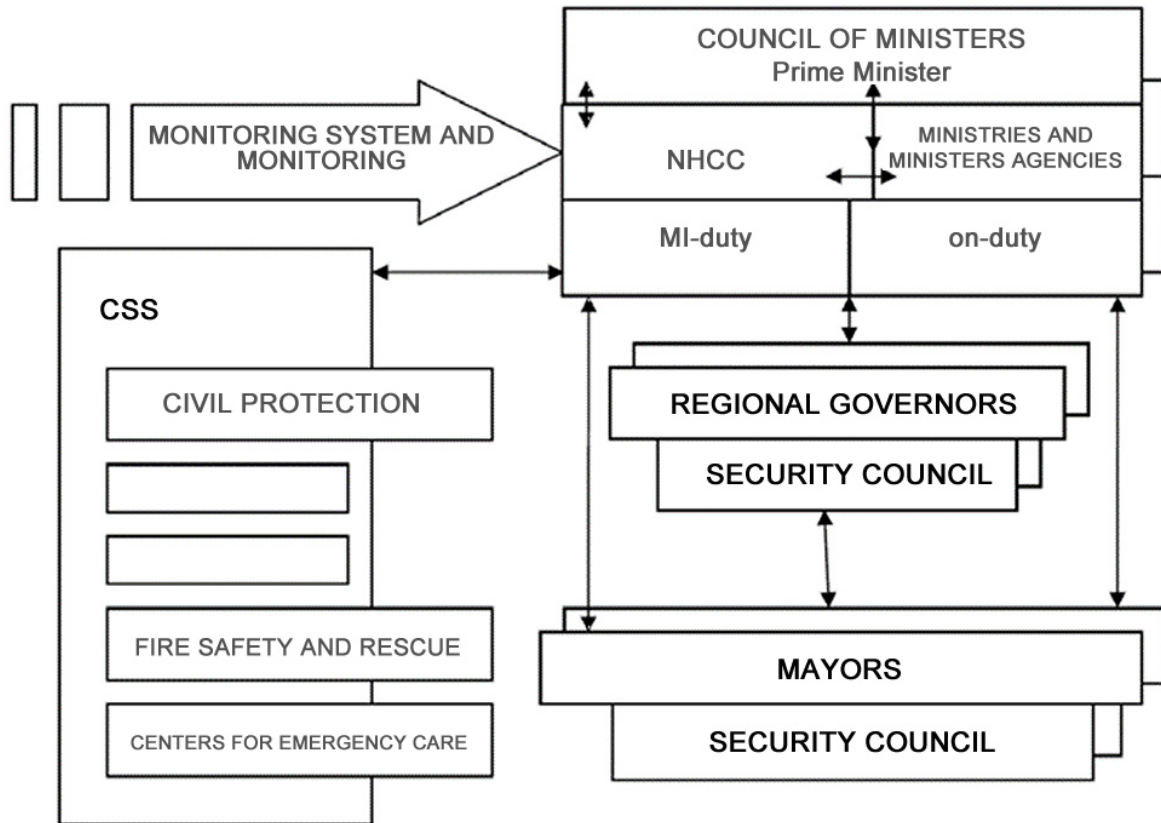
The definition of contingency planning as stated in contingency planning current state in Bulgaria is as follows:

A contingency is a situation that may or may not occur. It is a plan set for a specific time in case things go wrong. Contingency plans are often adopted by higher authorities or institutions that want to prepare for a disaster situation that might occur [36].

The purpose of contingency planning is to ensure an effective and rapid response in the event of a disaster and it

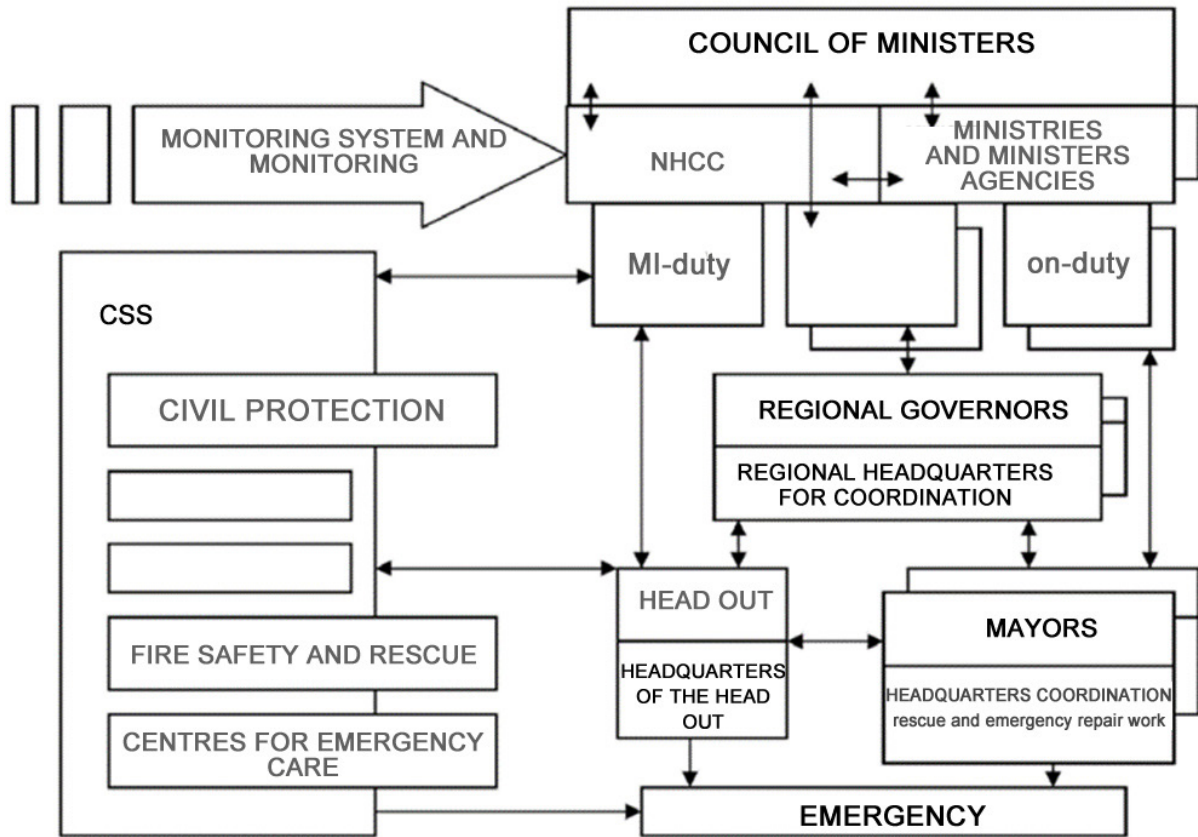
should identify the difficulties that may be encountered, find solutions to them and avoid any other difficulties before the crisis occurs.

Figures from 11 to 13 show the process of coordination and interaction between executive authorities and different institutions that deal with a disaster in different stages.



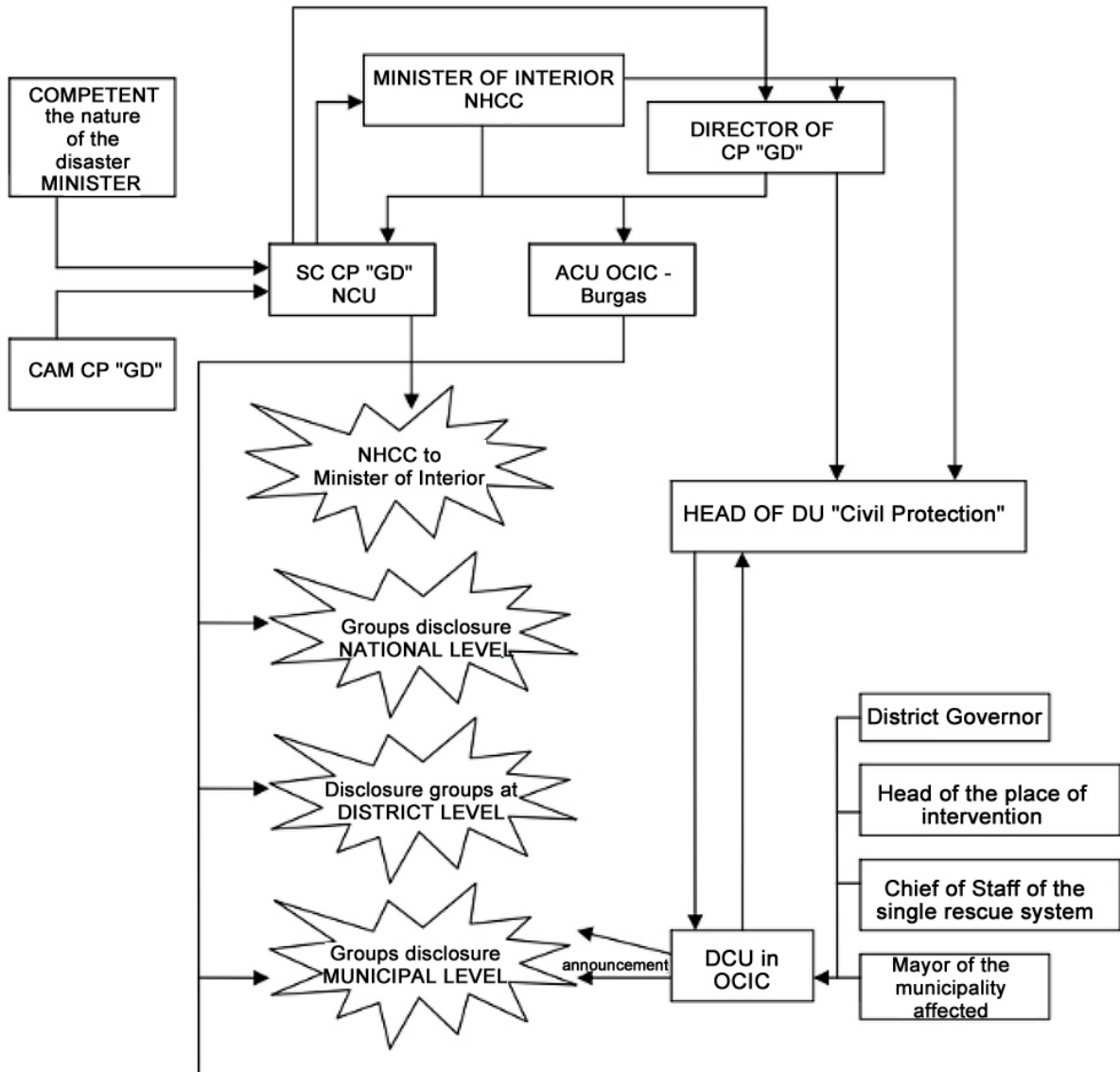
Source: [36, p. p30]

Figure 11. The process of interaction and coordination between the executive authorities before the disaster,



Source: [36, p. 30]

Figure 12. Executive authorities and operative interaction in case of a disaster



Source: [36, p. 31]

Figure 13. Declaration executive authorities and components of unified rescue and system's early caution

Table 3. Analyzing of Bulgaria contingency plan

levels	National	Regional	Municipality
Built-in strategies	<ul style="list-style-type: none"> • Critical Infrastructure Protection • planning and mitigation • adaptive 		
Built-in laws	<ul style="list-style-type: none"> • Law for Disaster Protection (LDP) • Law on the National Emergency Call System Using the Pan - European NO.112 • Regulation for Early Warning and Disaster Disclosure • The Law on the Ministry of Internal Affairs • The Law on the Bulgarian Red Cross 		
Main steps of the process	Analyzing hazard and risk	The risk is assessed and the hazard is identified.	
	Identifying, defining and prioritizing contingencies	Contingencies are prioritized and examined based on this initial evaluation, to focus resources and planning activities on the important contingencies.	
	Developing scenarios for the planning process	Then, scenarios of potential damage are developed for the selected contingencies.	
	Preparing a contingency plan for each selected scenario	Scenarios are used to estimate potential needs based on the underlying assumptions used. Contingency plans can be then developed based on scenarios.	
	Maintaining and updating the contingency plan.	The plan must be revised and updated to reflect changing circumstances.	
Sharing knowledge tools	National	Regional	Municipality
	<ul style="list-style-type: none"> • electronic media • social networks via the press center of the Ministry of the Interior • the web page of the Fire Safety and Civil Protection (FSCP) directorate • The online Fire Safety and Civil Protection magazine SOS 112. 	<p>The regional and municipal directorates also use regional and local mass media and interact with regional and municipal administrations. They organize meetings and discussions with different target groups to provide materials, presentations and training with the aim to raise awareness and improve population's preparedness to act.</p>	<p>Civilians are informed by information campaigns such as leaflets, banners, handbooks, videos, TV and radio spots. Children and students receive 5 school hours per year dedicated to disaster risk awareness training.</p>
variable parameters	food security situation		
	population vulnerable to potential risk		
	the impacts of previous crises		
	lessons learned of the history of disaster		
	partners and intercountry capacities		
partners	<ul style="list-style-type: none"> • The Regional Development and Public Works Minister for seismic and geological risk • The Chairman of the Nuclear Regulatory Agency for nuclear and radiation accident risks • The Environment and Water Minister for flood risk • The Agriculture, Food and Forestry Minister for the forest fires risk • the DRR Council to the Council of Ministers • The bodies of the central executive power and the constituent parts of the unified rescue system 		
Key priorities	<ul style="list-style-type: none"> • Right to protect any person • Prioritizing saving lives over protecting other activities • Sharing knowledge about disaster risks and activities of executive authorities in the disaster protection • Prioritizing protection for preventive measures • Responsibility for implementation of protection measures • phasing of forces and resources for protection 		

Table 3. Continued

faults	<ul style="list-style-type: none"> • Partial or complete duplication of concepts • The multiplicity of different powers of institutions and jobs creates duplication that negatively affects the process • The municipality lacks the necessary powers to perform all emergency rescue work.
Results	<p>The following areas require specific information management procedures as this process requires specific skills. Regional delegations, National Societies and other relevant authorities should incorporate these procedures into their disaster response plan.</p> <ol style="list-style-type: none"> 1. Public information sharing - specific to local, national and regional media. this step must be taken into account in preparedness plans and consideration of potential requirements. 2. Inter-institutional Communication - Communication within institutions and between the participating bodies of the National Federation and also with other agencies should be strengthened (as shown previously in figure 11) [35]. 3. Operational information (as shown previously in figure 12) - It must be managed by (EOC) and is necessary to make effective decisions. 4. Internal information - Which aims to ensure that all volunteers and staff have access to information on issues related to the emergency operation. 5. Reporting - The reporting process must be well thought out with continuous follow-up of updates, and the requirements must be respected and strengthened at all levels. 6. As a result of the analysis of information systems and early warning systems, (as shown previously in figure 13) it is evident that the elements of risk assessment and target areas affect some types of early warning systems [42]. <p>Emergency response organizations and stakeholders define a platform for sharing information through information systems and early warning systems, so it affects the elements of preparedness [43]. This is because if the wrong type of information sharing or early warning system is chosen without consulting all stakeholders, confusion and inability to respond during a disaster occur.</p>
Recommendations	<ul style="list-style-type: none"> • Continuous observation, and immediate evacuation people at risk of and danger are tools to avoid loss of life. • Involve survivors of past disasters and civilians at risk in the development of the plan and the selection of dissemination tools. • Establishing voluntary units within vulnerable areas and disbursing material incentives to participants and volunteers. • Continuous updating of the coordination process, follow-up of the responsible authorities and individuals, and ensuring that they keep pace with the updates. • Develop clear policies that define the roles and responsibilities of emergency organizations • Having a strategy for enhancing contingency plan education for CP elements. • Communication problems during severe weather, network breakdown, and obstacles encountered by early warning and information systems are all confirming factors for the importance of public education and knowledge sharing [44].

Source: Researchers based on (Law for Disaster Protection of Bulgaria) [44]- [36]- [35]- [42]- [43].

10. Questionnaire Investigating the Most Effective Channels for Transferring Knowledge among the Egyptian Coastal Communities

To set the appropriate Egyptian contingency plan, the researchers conducted a questionnaire divided into three sections, the first section aims to measure residents' knowledge and awareness about the Tsunami disaster, and the second section discusses the appropriate tools and

channels to transfer knowledge about Tsunami for different ages groups. The last section discusses the evacuation plan.

The researchers used a Google form to disseminate the questionnaire and reach all social strata. In addition, the researchers filled out some forms through individual interviews with inhabitants, who could not use Google form, figure 14 shows some screenshots of the questionnaire (the questionnaire link: <https://forms.gle/9hjF7TFZnyefQEfd6>)

What are the most appropriate ways to learn about the evacuation plans for safe areas and safe buildings from your point of view? (you can choose more than one answer) *



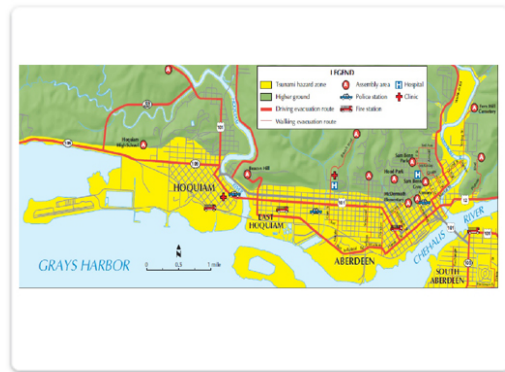
Brochure with illustrations

Progress down from here (indicating change of level).	<ol style="list-style-type: none"> 1. Suspended at head of stairs or ramp. 2. Suspended at change of level.
<ol style="list-style-type: none"> 1. Progress up to the left (indicating change of level). 2. Progress forward and across to the left from here when suspended within an open area. 	<ol style="list-style-type: none"> 1. On wall or suspended at foot of stairs or ramp. 2. On half landing wall or stairs. 3. Suspended at change of level. 4. Suspended in open areas.
Progress down to the left (indicating change of level).	<ol style="list-style-type: none"> 1. On wall or suspended at head of stairs or ramp. 2. On half landing wall or stairs. 3. Suspended at change of level.
<ol style="list-style-type: none"> 1. Progress up to the right (indicating change of level). 2. Progress forward and across to the right from here when suspended within an open area. 	<ol style="list-style-type: none"> 1. On wall or suspended at foot of stairs or ramp. 2. On half landing wall or stairs. 3. Suspended at change of level. 4. Suspended in open areas.
Progress down to the right (indicating change of level).	<ol style="list-style-type: none"> 1. On wall or suspended at head of stairs or ramp. 2. On half landing wall or stairs. 3. Suspended at change of level.

Written list of steps to be taken



Guidance signs and distinctive signs showing directions to safe roads to safe areas and buildings



Maps showing roads and escape sites

We kindly ask you to clarify how easy it is to use the previous methods, by determining the degree of importance of each of the previous methods to you? Please rate it from 1:5 where 1 is (not important) / 2 (least important) / 3 (somewhat important) / 4 (important) / 5 (very important) *

	1	2	3	4	5
Brochure with illustrations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Written list of steps to be taken	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Guidance signs and distinctive signs showing directions to safe roads to safe areas and buildings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maps showing roads and escape sites	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tsunami mobile apps	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Places of worship	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Official websites of government agencies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Source: researchers

Figure 14. Some screenshots of the questionnaire form

The sample community is the residents of the Egyptian coastal communities, and the sampling strategy is a random stratified sample.

The researchers used a randomization methodology to determine the sample size, as it is difficult to determine the total population so the researcher used Google form to get the data from the population in all categories as shown in table 4.

Table 4. Categories of the research sample

	Age groups (years)	Count	Percent %
Valid	6-12 (primary education)	2	1.3
	13-18 (preparatory and secondary education)	13	8.3
	19-22 (university education)	13	8.3
	23-60	121	77.6
	Older than 60	7	4.5
Total		156	100.0

Source: researchers from SPSS

156 forms were filled by a sample of various residents of Egyptian coastal communities, including (64 from Alexandria - 35 from Damietta - 27 from Ismailia - 11 from Port Said - 10 from the North Coast - 4 from Sharm El Sheikh - 1 from Sokhna - 4 from Hurghada). The sample includes inhabitants from various coastal communities and various age groups (2 respondents at 6:12 years), (15 respondents at 13:18 years), (13 respondents at 19:22), (119 respondents at 23:60 years) and (7 respondents at older than 60) in addition, the sample is varied in terms of educational qualification and gender (58 male/98 female).

The first section of the questionnaire seeks to verify the validity of the research hypothesis that the Egyptian coastal communities do not have sufficient awareness about the tsunami disaster and are not ready to address its risks (and accordingly a contingency plan will be proposed for the Egyptian coastal communities).

The research found that a large group of society, 121 respondents equivalent to (77%) believed that they were aware of the disaster risks. And to ensure their awareness, three other questions related to the risks of the disaster were presented. It was found that (94%) of the respondents were not as knowledgeable as they thought. In comparison, only (6%) of their answers were real. This step was the beginning of sharing knowledge about the tsunami disaster and the first seed for developing a contingency plan for the coastal communities. The appropriate tools and channels used in the plan to transfer knowledge regarding disaster and evacuation plans to safe areas and how to deal with risks during the process, were identified through several questions and the analysis of their results using Gamma relations by SPSS.

11. Questionnaire Results and Discussion

11.1. Results and findings based on descriptive statistics analysis

From our sample, we deduce that although most people of age (23-60) in our sample, believed that they knew about the tsunami disaster, it turned out that they didn't acquire the correct information regarding tsunamis.

The most appropriate tools to disseminate area evacuation plans according to age groups were deducted, as shown in table 5.

Table 5. The most appropriate tools to disseminate evacuation plans

Age group (years)	Tools to receive the area Eva plan	%
6:12 (primary education)	Social media	50
	Advertising campaigns	50
13: 18 (preparatory and secondary education)	Social media	37
19: 22 (University education)	Social media	37.5
23:60	Social media	32
Older than 60	Places of public services, places of worship, and commercial shops	31.5
	Distribution to houses	26

Source: researchers

We also deduce the most appropriate ways to receive the warning of the occurrence of a tsunami according to different age groups, as shown in table 6.

Table 6. Appropriate tools for receiving tsunami warnings

Age group (years)	Tools	%
6:12 (primary education)	Social media	100
	T.V	
	Text messages on the phone	
13: 18 (preparatory and secondary education)	Social media	23.5
	T.V	23.5
	Tsunami mobile apps	23.5
19: 22 (university education)	Text messages on the phone	33.3
	Social media	30.5
23 :60	Text messages on the phone	28
	Social media	24.8
Older than 60	T.V	22.7
	Radio	18
	People knocking on doors	18

Source: researchers

11.2. Statistical Analysis by Gamma Relation

By using Gamma analysis tools¹ from SPSS, the researchers were able to conclude the following results and findings:

- There is a significant relationship between age groups and three methods for receiving knowledge about the tsunami phenomenon, which is shown in table 7.

Table 7. Gamma relationship between age groups and methods for receiving knowledge about the tsunami phenomenon

Tool	Gamma	Approx. Sig.	value	Relationship
Tsunami mobile apps		.000	-.359	Negative Intermediate
Seminars and sermons in places of worship		.006	.316	positive Intermediate
TV talk shows		.049	.254	positive week

*Sig less than 0.05 means the model is significant

Source: researchers using SPSS

- There is no significant relationship between educational level and methods of receiving knowledge about the tsunami phenomenon.
- Tsunami mobile application is the only tool to learn about the evacuation plans for safe areas and safe buildings that have a significant relationship with age groups as shown in table 8.

Table 8. Gamma relationship between age groups and the most appropriate channel learn about the evacuation plans

tool	Gamma	Approx. Sig.	value	Relationship
Tsunami mobile app		.03	-.243	Negative week

*Sig less than 0.05 means the model is significant

Source: researchers using SPSS

- There is no significant relationship between educational level and of the most appropriate ways to learn about the evacuation plans for safe areas and safe buildings.

12. Final Proposed (ETCP) Social Transferring Knowledge Tools and Participating Agencies

This plan aims to increase the resilience of Egyptian coastal communities. This plan proposes laws and legislation that Egyptian law may include to protect people in natural disasters, it also proposes methods of financing natural disasters, participating agencies, stakeholders, and their respective responsibilities during emergencies based on suggestions of UNDRR report. Also the plan identified the most appropriate tools for sharing knowledge and communication among the authorities, stakeholders and respondents or people at risk based on the empirical study conducted.

Table 9 shows the proposed Egyptian Tsunami Contingency Plan (ETCP).

¹ Gamma is the simplest measure of ordinal variables association to calculate, since it does not use information about ties in rank, it ranges from -1.00 to 1.00. A Gamma of 0.00 reflects no association; a Gamma of 1.00 reflects a positive perfect relationship between variables; a Gamma of -1.00 reflects a negative perfect relationship between those variables [49]

Table 9. The proposed Egyptian Tsunami Contingency Plan (ETCP)

Levels	National	
	Local	
Proposed Built-in strategies	<ul style="list-style-type: none"> Mitigation and Adaptation Vulnerability and Risk Assessment 	
Proposed laws and regulations to be built in the process	Gaps that required to enact legislation in the field of disaster management: <ol style="list-style-type: none"> Disaster management objectives. It is a relationship to steady and sustainable development. The responsibility of the various organizations and institutions. The authority entrusted with managing the disaster. Organizational Structure. Economic resources and financial costs. The relationship with non-governmental organizations as well as international organizations and the relationship with other countries. 	The proposed laws to be incorporated relating to natural disasters: <ol style="list-style-type: none"> Civil Defense Law Public Security Law public health law Building Code Disaster Environmental Protection Act Law of the National Society of the Egyptian Red Crescent Marine Disasters Act Energy and Mineral Resources Regulation and Management System Early warning and disaster detection system
Sharing knowledge tools	Main tools <ol style="list-style-type: none"> Tsunami mobile apps Seminars and sermons in places of worship TV talk shows 	Sub tools <ol style="list-style-type: none"> Social media Text messages on the phone People knocking on doors
Finance	Measures for increasing investment in disaster risk mitigation: <ul style="list-style-type: none"> Developing national strategies for financing disaster risk reduction and support its continuous development. (National) Adopting blended finance within specific countries to enhance disaster risk reduction financing. (National) Pursuing financial flows toward disaster risk reduction. (Regional-Global) Starting to allocate a bond for prevention/DRR targeted toward SIDS, LDCs, LLDCs. (Global) [45]. 	Partners <ul style="list-style-type: none"> Institutional investors (including pension funds) and Central/Reserve banks. Regional development Banks (including specialized) and National regulators, MDBs. Research institutes and Insurance-related organizations [45].
Partners and Stakeholders	<ul style="list-style-type: none"> National Government Inter-Governmental Organizations United Nations Disaster Risk Reduction Local Government Authorities Private Sector Civil Society Organizations Academic Researchers Children, youth and child-centered Organizations 	

Source: researchers based on [45]- [34]

13. Conclusion

There is no doubt that Egyptian coasts are highly exposed to the danger of the tsunami, and what makes the matter worse is that the current conditions do not bode well for the ability to withstand the risks. Furthermore, the necessity to implement the contingency planning strategy (one of the most important stages of which is spreading awareness and increasing the community's ability to face risks) could not be ignored.

The contingency planning strategy is distinguished

from other strategies in that one of its creators is the population, coastal communities, at risk themselves.

The focus of contingency planning should be on the planning process. A written response and/or contingency plan is much more than a paper. Responding in disaster situations will not be effective unless there were procedures and structures, and well-functioning managerial and operational systems. Planning processes develop the capacities, tools, understanding, and early action response and recovery operations that can address the social dimension of coastal communities that cannot

be ignored [23].

It must be emphasized that contingency planning is a continuous process that does not stop. The tools for its activation are variable with the change in circumstances and societies. Therefore, it is recommended to update the plan annually as a maximum.

The research has managed to identify the most appropriate tools and channels for transferring and receiving tsunami knowledge, among the Egyptian coastal areas communities (tables 5,6,7 and 8), identified as the main factor of success for any contingency plan, based on which the research main scientific contribution was composed regarding the ability to innovate, compose and promote the Egyptian Tsunami Contingency Plan (ETCP) deducted (table 9).

List of Abbreviations

Table 10. List of abbreviations

Abbreviation	Meaning
ETCP	Egyptian Tsunami Contingency Plan
CP	Contingency Plan
NEAMTWS	North East Atlantic Mediterranean Tsunami Warning System
SPSS	Statistical Package for the Social Sciences (OR) Statistical Product and Service Solutions
sig	significant
IFRC	International Federation of Red Cross
DRR	Disaster Risk Reduction
UNDRR	United Nations Disaster Risk Reduction
SIDS	Small Island Developing States
LDCs	Least Developed Countries
LLDCs	Land Locked Developing Countries
NGO	Non - Governmental Organizations
MDBs	Multilateral Development Banks
EOC	Emergency Operations Center
IEC	Information delivery, Effective coordination, and a learning and Communication
LDP	Law for Disaster Protection
FSCP	Fire Safety and Civil Protection
Gamma	a measure of association for ordinal variables

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