A BRIEF REVIEW OF TSUNAMI CHARACTERISTICS

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ABSTRACT:
The purpose of this study is to correlate some important characteristics of tsunamis. To this end different events were considered and some parameters, such as source to site distance, magnitude of the earthquake causing Tsunami and maximum wave height were summarized. A Statistical approach was used in order to estimate the relation ship between the parameters. The results of this study show that there are some correlations between these parameters

KEYWORDS:
tsunami, earthquake, characteristics

١. INTRODUCTION

As we know, a tsunami is a series of waves created when a body of water, such as an ocean, is rapidly displaced. It may be caused by an earthquake, mass movements above or below water, volcanic eruptions or other under water explosions, land slides, under water earthquakes large asteroid impacts and testing nuclear weapons at sea. All of this have the potential of generating a tsunami. The term (tsunami) which comes from the Japanese words "tsu" meaning harbor and "nami" which is the term for wave, and now this is the common international term for this phenomenon.

A tsunami can occur at any state of the tide and even at low tide. It will inundate coastal areas if the incoming waves surge high enough. A tsunami can not be prevented and precisely predicted, even if the right magnitude of earthquake occurs in the right location. Geologists, Oceanographers and seismologists analyze each earthquake, and based upon many factors may decide to issue a tsunami warning. How ever, there are some warning signs of an impending tsunami, and there are many systems developed for reducing the damage caused by it.The overlaying pressure of a tsunami be expressed as $p = \rho gh$ Where "p" is the overlying pressure, in newtons per square meters,"ρ" The density of the sea water, which is equal to $1.1 \times 10^3\ \mathrm{kg/m^3}$,"g" is the gravitational acceleration which is equal to $9.8\,\mathrm{m/s^2}$ and "h" is the height of the water column in meters. As an example for a column of water ٥،٠٠٠ m high the overlying pressure is equal to ٥,٧million tones per meter square.

٢. PRESENT STUDY

The current data base of tsunamis includes a listing of historical tsunami source events and run up locations throughout the world. The listing from ٢٠٠٠ B.C. to the present. The events have been gathered from scientific and scholary sources, regional and world wide catalogs, tide gauge reports, individual event reports, and unpublished works

٢،١. MAJOR TSUNAMIS

Table ١ Some of the world's largest tsunamis include:

Date	Location	cause	Casualty
٦٥ million years ago	Chicxulub crater	Meteoroid impact	Unknown
١٤٩٠ B.C	Greece (Aegean Sea)	Collapse of the volcano of Santorini	Unknown
January ٢٦, ١٧٠٠	Japan (Pacific Ocean)	Earthquake of magnitude ٩,٠	Unknown
August ٢٦, ١٨٨٣	Indonesia	Collapse of the volcano Krakatoa	٤٠،٠٠٠
June ١٥, ١٨٩٦	Honshu, Japan	Unkown	٢٨،٠٠٠
November ١٨, ١٩٢٩	Canada (Atlantic Ocean)	Offshore earthquake of magnitude ٧,٢	٢٧
April ١, ١٩٤٦	Alaska (Pacific Ocean)	Earthquake of magnitude ٧,٨	Over ١٧٠
November ٤, ١٩٥٢	Russia (Pacific Ocean)	Earthquake of magnitude ٨,٢	No lives lost
March ٩, ١٩٥٧	Alaska (Pacific Ocean)	Earthquake of magnitude ٨,٣	No lives lost
July ٩, ١٩٥٨	Lituya Bay, Alaska	Landslide	Unknown
May ٢٢, ١٩٦٠	Chile (Pacific Ocean)	Earthquake of magnitude ٨,٣	Up to ٢،٢٩٠
March ٢٨, ١٩٦٤	Alaska (Pacific Ocean)	Earthquake of magnitude ٨,٤	١٢٢
November ٢٩, ١٩٧٥	Hawaii (Pacific Ocean)	Earthquake of magnitude ٧,٢	٢
September ١, ١٧, ١٩٩٢	Nicaragua (Pacific Ocean)	Effshore earthquake of magnitude ٧,٠	٢٠٠
July ١٧, ١٩٩٨	Papua-New Guinea	Underwater landslide	Thousands of people
December ٢٦, ٢٠٠٤	Indonesia, W Thailand	Earthquake of magnitude ٩,٠	About ١٥٠،٠٠٠

The global distribution of these events is ٧١٪ in the Pacific Ocean, ١١٪ in the Mediterranean Sea, ٩٪ in the Atlantic Ocean and Caribbean sea, ٦٪ in the Indian ocean, and ٣٪ in the Black sea. There are over ٩،٦٠٠ run up locations where tsunami effects were observed. The global distribution of these locations is ٨٢٪ in the Pacific Ocean, ٦٪ in the Atlantic Ocean and Caribbean Sea, ٣٪ in the Mediterranean, ٩٪ in the Indian Ocean and less than ١٪ in the Red and Black seas.Tsunamis have been responsible for at least ٧٤٥ fatalities and over ٢٠٠ million dollars in property damage in the United States and its territories alone. Major tsunamis occur in the Pacific Ocean region only at a rate of about per decade.

Therefore, it is important to learn as much as possible from the relatively short history available .Tsunamis have been reported since ancient times. The first recorded tsunami occurred off the coast of Syria in ٢٠٠٠ B.C. since ١٩٠٠ (The beginning of instrumentally located earthquakes),most tsunamis have been generated in Japan ,Peru, Chile, New guinea and the Solomon Islands. However, the only regions that have generated remote source tsunamis, affecting the entire Pacific basin, are the Kamchatka peninsula, the Aleutian islands, the Gulf of Alaska, and the coast of south America tsunamis. Hawaii, because of its location in the center of the Pacific basin ,has experienced tsunamis generated in all parts of the Pacific.

Our knowledge of tsunami generation is incomplete, because the generation phenomenon has not been observed nor measured directly. Tsunami intensity, is defined (Soloviev and Go, ١٩٧٤) as $I = \log_2\left(2^{\frac{1}{2}} \times H\right)$, with H as the maximum run up height of the wave. The velocity "V" of a tsunami in the open ocean is expressed as the product of the square root of the depth of the water,"d", and the gravitational acceleration $V = (dg)^{\frac{1}{2}}$ .That is why speed of the tsunami depends on the depth of the ocean basin and the waves decreased speed, as they reach shallower waters.If a tsunami encounters a coastal scrap, the height of its waves will increase. Approximately ١٥٪ of all damaging tsunamis were triggered by strike-slip earthquakes. This type of earthquake is less likely to trigger a tsunami than one with vertical motion. Tsunami travel approximately ٤٧٥ mph in ١٥،٠٠٠ feet of water .In ١٠٠ feet of water the velocity drops to about ٤٠ mph.

٤. CHARACTERISTICS OF TSUNAMIS

The following items are the major characteristics tsunamis:

١. Travel speed of up to ٤٠٠-٥٠٠ miles per hour.
٢. In deep waters, tsunamis are low and wide, often less than three feet high.
٣. There is as much as ٩٥ miles between the crest of one wave and that of the next.
٤. In shallow waters, they get more deadly.
٥. They can reach heights up to ١٠٠ feet or more and crash at inlands.

A wave becomes a shallow-water wave when the ratio between the water depth and its wave length becomes very small. Since a tsunami has a large wave length, it act as a shallow-water wave, even in deep oceanic waters. Shallow water waves move at speed equal to the square root of the product of the acceleration of gravity $\left(9.8\,m/s^2\right)$ and the water depth. For example, in the Pacific Ocean, where typical water depth is about ٤٠٠٠ m ,a tsunami travels at about $200\,m/s$, with little energy loss ,even for far distances, while at a water depth of ٤٠ m ,the speed is $20\,m/s$ much slower ,but still difficult to out turn.

Tsunami are characterized as shallow-water waves that usually have a period (A time between two successive waves) of five to twenty seconds and a wave length of about ٣٣٠ to ٦٦٠ feet ,Figure ١.

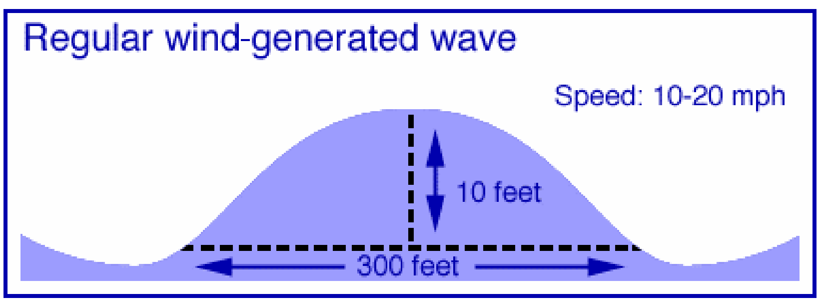

Figure١. Tsunami in shallow water

A tsunami in deep water can have a wave length greater than ٣٠٠ miles and a period of about an hour, Figure ٢.

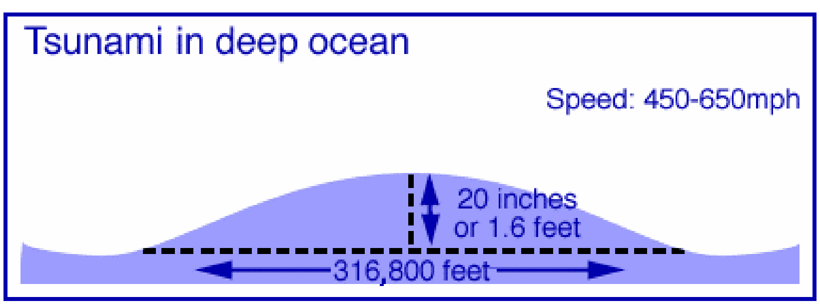

Figure٢. Tsunami in deep water

٥. CURRENT AND FUTURE RESEARCH

One of the more recent changes, in tsunami research is that, the regional centers will be taking on a greater responsibility for tsunami detection and warning procedures. This is because there have been occasions when the warning from Hawaii came after the tsunami hit the area .This can occur with local and regional tsunamis that tend to be smaller in their area of effect. Some seismically active areas need to have the warning system and equipment closer than Hawaii if they are to protect their citizens. For example, the Aleutian Islands near Alaska have two to three moderate earthquakes per week. As of many ١٩٩٥, centers located in Palmar, Alaska, have assumed a larger role in the management of tsunami warning. In terms of the basic research, one of the biggest areas of investigation is the calculation of return rates.Return rates, or recurrence intravels, are the predicted frequency with which tsunamis will occur in a given area and are useful information, especially for highly sensitive buildings such as nuclear power stations, offshore oil drilling platforms, and hospitals. A geologist in Halifax suggests that the ١٩٢٩ tsunami left a sedimentary record that is evidence in the soil profile, and that such records can be dated and used to calculate return rates.

٦. CONCLUSIONS

In this study a series of tsunamis were considered in order to establish their common characteristics. From this data we can conclude that most tsunamis are caused by a rapid vertical movement along a break in the Earth's crust. Tsunamis are generated when large masses of earth on the bottom of the ocean drop or rise, thereby displacing the column of water directly above it. This type of displacement commonly occurs in large subduction zones, where the collision of two tectonic plates causes the oceanic plate to dip beneath the continental plate to form deep ocean trenches. Most Subduction occurs along island arcs and coastal areas of the Pacific. The notable exception being the West Coast of the United States and Canada. The movements along faults are largely strike-slip, with little vertical displacement, and thus produce few local tsunamis.

Them the present knowledge of tsunami generation appears to be incomplete, because the generation phenomena has not been observed nor measured directly. However, studies of tsunami data suggest that the size of a tsunami is directly related to the shape of the rupture zone, the rate of displacement and sense of motion of the ocean-floor in the source (epicentral) area, the amount of displacement of the rupture zone, and the depth of the water in the source area. It is also observed that long-period tsunamis are generated by large-magnitude earthquakes associated with seafloor deformation of the continental shelf; on the other hand shorter period tsunamis are generated by smaller magnitude earthquakes associated with seafloor deformation in deeper water beyond the continental shelf.

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