

Natural Disasters: Hurricanes, Earthquakes, Tsunamis Forecast for Israel and the World

We have grown accustomed to hearing world players discussing international politics, big business and various forms of power interaction and control in the international arena. But the fundamental weakness of humankind comes to the fore every time a new natural disaster strikes and the formidable force of nature topples the strongest of men. At best, human response is evacuation, rescue, rehabilitation and reconstruction – at worst, hundreds of thousands of casualties. What does science know about the dynamics of natural disasters? Do these events only seem to be more frequent, powerful and disastrous, or are they, in fact, more catastrophic than in the past? Two experts at the Open University give us a look at some of the disasters of the past year and an explanation of the background, dynamics and prospects for the future: Dr. Yoav Yair, who teaches astronomy and meteorology at the Open University and who headed the Israeli research project in cooperation with NASA, and Prof. Shlomo Shoval, geologist, involved with international research in cooperation with France. Together they sort out weather phenomena from geological phenomena and clear up the cloudy, gloomy picture.

Earthquakes and Tsunamis: Causes, Impact, Likelihood, Prediction

In the past 20 years, there have been 95,000 pronounced earthquakes on planet Earth. The most intense earthquake on record, with a magnitude of 9.5, occurred in Chile in 1960, and was disastrous. In 1964 an earthquake of magnitude 8.5 in Alaska, in a barely-populated area, was not fatal at all. The most fatalities in recent years resulted from the disastrous earthquake and tsunami that struck Asia last year on December 26, 2004. What determines how catastrophic these natural disasters will be? When is an earthquake accompanied by a tsunami? Can we expect severe earthquakes in Israel? Where else in the world can a tsunami be expected? Can these disasters be predicted? Can their devastating impact on lives, homes and livelihood be diminished? Geologist Shlomo Shoval paints a picture of the nature of earthquakes and what the consequences are for the people of this planet.

Earthquakes

The earthquake in Asia last year, which was accompanied by a huge tsunami, is the most intense earthquake that planet Earth has witnessed in the past 40 years, with a magnitude measured at 8.9. Explains Prof. Shoval, the cause of earthquakes is the movement and collision of the earth's huge, massive plates. These plates either converge upon each other, pull apart or move past each other. They are in ongoing movement, usually at the pace of a few centimeters per year. These plates touch, releasing energy, sometimes causing minor disorders and sometime wreaking havoc. Most of the earth's quakes have occurred at the boundaries between these plates.





*The Hellenistic City of Bet Shean was totally destroyed by an earthquake.
Photo: Prof. Shlomo Shoval*

Tsunamis

A tsunami (in Japanese, “port waves”) can ensue when the violent movement of the earth’s plates occurs in the ocean lithosphere. The violent movement sends a wave of tremendous intensity which can reach speeds of 720 kilometers (the speed of a jet plane) over a distance of 160 kilometers from crest to crest. Yet in the deep water of the open ocean the height of the tsunami above sea level is less than one or two meters, barely discernible from above, picking up speed as it proceeds, and reducing speed as it nears coastal waters. When the tsunami nears the shallow waters of the coast, the friction with the ocean floor slows its course, and it grows in height with masses of water lunging towards the shore. By the time it reaches the shore, it is a massive flood wave 15 to 30 meters high. Its impact at that speed and mass is tremendous and virtually nothing can stand in its way. The damage is compounded by the contamination of water sources and spread of disease, total disruption of food supplies, the inaccessibility of the injured, and the complexity of rescue procedures and caring for so many who need immediate help.

The tremendous number of casualties from the Asian tsunami last year (reported to be about 250,000) made it one of the largest single natural disasters in history. Tsunamis have also been known to be caused by the eruption of volcanoes, as in the case of the island of Santorini in the year 1628 BC, when tsunami flood waves washed over the Cyclade Islands and wiped out the Minoan population which flourished there. Tsunamis are also said to have been caused by meteors or asteroids plunging into the ocean. Such an occurrence at the shores of Mexico is said to have caused world-wide darkness. Some say this caused the

extinction of plant life and dinosaurs millions of years ago.

The tsunami phenomenon is characteristic of the Pacific Ocean and has hit the shores of Japan repeatedly, but with less intensity than last year's tsunami. The Pacific Ocean off the coast of California is also a likely candidate for earthquakes and there are systems to warn the population about the approach of a tsunami, but nobody can infallibly chart the path of a natural disaster anywhere in the world and deliver a reliable system of protection. Much like the hurricanes in the Caribbean and the southern regions of the United States, evacuation can save lives. Due to the time that elapses from the occurrence of an earthquake until its manifestation as a tsunami flood wave, warning stations that call for evacuation could save lives.

Quakes and Tsunamis in Israel?

Can it happen in Israel? According to Prof. Shoval, although a tsunami did, in fact, hit Israel in Acre in the year 1033, a tsunami is not likely to hit Israel because the Mediterranean Sea does not behave like the open oceans. However, explains Prof. Shoval, an earthquake in Israel is more than likely – it is almost a certainty.

“In Israel, earthquakes takes place every day – usually too low in intensity to be felt, but all measurable. Most of them are minor, and this is a positive and constructive scenario, because it allows for the ongoing release of small amounts of energy before they reach devastating intensity. Israel is located along the Dead Sea rift and is a prime candidate for earthquakes. As long as there are minor earthquakes that release the pressure, Israel is safer from the threat of a pressure build-up that will result in disaster,” says Prof. Shoval.



Biblical references in the Book of Kings record terrifying descriptions of earthquakes in Israel – great and powerful winds, mountains and boulders shattering, tremendous noise and fire – followed by the sound of silence. Joseph Ben Mattityahu records a famous earthquake in the year 31 BC. In the year 749, the largest Hellenistic

city, Bet Shean, was totally destroyed by an earthquake. Archaeological remains show the collapse of temples, homes destroyed and the marketplace in shambles.

On the average, about every 100 years, Israel suffers a disastrous earthquake, says Prof. Shoval. In the year 1202, the



cities of Safed, Acre and Nablus were totally destroyed and thousands were killed. In 1546, the cities devastated were Jerusalem, Hebron, Nablus, Ramle, Haifa and Gaza. In 1837 an earthquake in which 3,000 perished struck northern Israel. Most of the houses in the ancient city of Safed, perched high on a mountain and built

on a steep incline, were destroyed. In 1840, 20,000 people were reported to have been killed in an earthquake in Lebanon. The same earthquake hit Tiberias, Acre, Sidon, and the area between the Hula Valley and Lake Tiberias. In 1927, a disastrous earthquake hit the central, populated area of Israel. Nablus, Ramle and

Tiberias were hit again. Lod, Hebron and Jerusalem also sustained heavy damage. 300 people were killed and about 1,000 homes were destroyed. Rock slides stopped the flow of the Jordan River for a day. And in 1995, the Sinai Peninsula and Eilat were damaged. In most cases, the magnitude was in the range of about 6.5 and several hundred people were killed; in many cases there was considerable damage to homes – and hundreds of years ago, whole towns were wiped out.

Given this persistent history of earthquakes, the minor, ongoing quakes that release pressure are a blessing, says Prof. Shoval. The southern region of Israel shows a relaxation of pressure, while in some northern regions of Israel there are still indications of a pressure build-up.

Prediction and Prevention

Are earthquakes and other geological disasters more catastrophic today than in the past? Says Prof. Shoval, it is unlikely that there has been a significant change during our lifetime in the frequency and intensity of earthquakes. The greater impact and damage is a function of more densely populated and built up areas hit by these disasters today.

There is no way to predict an earthquake with accuracy. Pre-shocks and the release of radon gas are indicators, but they are not conclusive. More indicative is the history of earthquakes. Areas that have had earthquakes in the past will, most likely, have them again. And in those areas investment and construction which will withstand earthquakes is imperative. Tall buildings must be constructed with flexibility to enable them to withstand quakes without shattering. May all our quakes be small ones, he concludes.

Natural Disasters: Hurricanes and Tornadoes: Natural Violence

The recent hurricane season has been one of the most disastrous in history. The storms wreaked havoc and destruction in the southern United States, Mexico and the Caribbean, as well as in Southeast Asia and will impact the damaged infrastructures, finances and social services of many states and countries for years to come – not to mention the shattered lives of tens of thousands of people. Dr. Yoav Yair, meteorologist and international expert on climate, looks at the inordinate increase in the number of hurricanes – yet another monstrous natural climatic disaster – as well as the ugly face of their mean sister the tornado in the American mid-West – and discusses possible causes, impact and forecasts for the future.

Hurricanes

In the space of three months, 23 hurricanes struck the same region of the Caribbean, Mexico and the southern regions of the United States. More intense than in the past and certainly more frequent, more devastating and damaging, is this only a function of the increased density of populations clamoring to live on the shoreline, or are the rules of nature changing? Dr. Yoav Yair shares his insight on environmental and atmospheric changes, extreme weather events and how they affect the intensity of natural disasters.

Hurricanes develop above warm tropical waters between latitudes 8° and 20° – which are characterized by warm water above 26.5°C (79.7°F), high humidity and mild winds. Unstable atmospheric pressure, added to this configuration, creates thunderstorm clouds which amass large quantities of water and heat the atmosphere. The heat causes a barometric drop and convergence of winds into a small low pressure system. The drop in pressure in the eye of the storm strengthens the storm which reaches a circumference of 500-750 kms (310-465 miles) and becomes a hurricane. Hurricanes are characterized by extremely strong winds, lightning, hail and tremendous amounts of rain, and in the Atlantic Ocean, are steered by winds from east to west. The eye of the storm is a shaft of clean area in the center of the surrounding clouds. This area of low pressure makes the ocean water bulge to a height of 6-8 meters (20-26 ft). Billowing winds create waves as high as 10 meters (33 ft).

Hurricanes are fueled by the water they ride on and lose their intensity and power as they reach the shore and go over land.





Intensity	Wind speed	Surge	Potential Damage
1	152 km/h (95 mph)	1.2-1.5 m (4-5 ft)	trees, shrubbery, mobile homes
2	176 km/h (110 mph)	1.8-2.4 m (6-8 ft)	roofs, mobile homes
3	208 km/h (130 mph)	2.7-3.6 m (9-12 ft)	trees stripped, buildings damaged
4	249 km/h (155 mph)	3.9-5.4 m (13-18 ft)	extreme: flooding, major damage
5	250+ km/h (156+ mph)	5.4+ m (19+ ft)	catastrophic: houses blown away

The intense winds alone are enough to do devastating damage. But the huge amounts of water in the torrents of rain that these huge clouds pour down, as well as the waters from the flooding of ocean water have often caused as much or more damage. Thus retaining walls or dams can attempt to prevent the surge from breaking, but if the waters are higher than the walls, the resulting damage can reach tremendous dimensions.

Hurricane Intensity

The Saffir-Simpson hurricane scale defines intensity in numbers from 1 to 5.

“Let there be no misunderstanding,” clarifies Dr. Yair, who, as coordinator of the Israeli space shuttle project with NASA, attended a workshop in 1999, held in Annapolis, Maryland, when the notorious hurricane, Floyd, hit its shores. “The hurricane’s intensity was estimated to be 3, but as it neared the shore its intensity diminished. Anyone who thinks a hurricane intensity of 1, which is defined as a tropical storm, is a walk in the park, can think again. Forget your umbrella – it’ll just tear apart and blow away. Take cover and don’t be outside or you may find yourself soaked to the bone and without control of your movements.”

Have the Number and Intensity of Hurricanes Increased?

Comparing the number and intensity of hurricanes that occurred between 1975-1989 with those during the period between 1990-2004, shows that both the number and the percentage of intense hurricanes has increased in recent years. What caused the increase in the number and intensity of hurricanes? There are differences of opinion as to whether this, too, can be attributed to global warming. Some experts say that a 20-year period in world climate research is too short to reach final conclusions. “The increased scope of damage may be a separate issue,” explains Dr. Yair, “Over the years, more and more habitation of ocean front cities, many of them at or below sea level, increases the likelihood of extensive damage to property and danger to lives in the tragic event of a natural disaster.”



Can hurricanes and tornados be predicted or prevented?

All attempts to prevent or circumvent hurricanes have failed. Measurement tools of various types enable advance warning and effective evacuation, which save lives. Property, of course, remains behind and damage is in multi-billions of dollars. Even evacuation is no small matter for the elderly, the disabled, the poor who have nowhere to go and those who are otherwise not mobile. Due to the phenomenon of hurricanes reducing their intensity as they hit the shore, the disaster reports of weather

forecasts and calls for evacuation sometimes prove exaggerated when the hurricanes become nasty tropical storms that do not require evacuation. The exact configuration and angle of encounter are hard to calculate and thus the extent to which the hurricane will be diminished on land is not always accurately predictable. Massive evacuation can also be very slow-moving and cumbersome as millions of people descend on limited highway space. So while there is effective advance notice of hurricanes, evacuation, damage prevention and subsequent rescue teams leave much to be desired.

Tornados, being short lived and chaotic, are hard to predict, however general warnings are issued when weather conditions are ripe. The exact time and location of the twister are still hard to predict, and current knowledge enables us to see them only minutes before they touch down. Future research will have to improve on early warning times in order to save more lives, concludes Dr. Yair.

Tornados

The hurricane’s little sister, the mean and violent tornado, hits the American mid-West at the rate of 1,200 storms a season, usually during the summer months. Generally they travel at a rate of 80 km an hour (50 mph) and their dimension seldom exceeds 500 meters. Winds can exceed 500 km an hour (300 mph)! A tornado usually lasts for no longer than a few minutes or an hour at most. But the destruction is total and devastating anywhere along its trail. Anything in the narrow path of the tornado will be wiped out.

The dynamic of tornados is different than hurricanes. Tornados begin at the base of cumulonimbus clouds. A change in the direction and speed of horizontal winds with altitude causes air to spin horizontally. A warm updraft from the ground lifts this spinning air into a loop. The spin of the air incorporated into the main updraft of the thunderstorm intensifies

and a twister develops and increases in intensity and speed.

“Tornado Alley” is generally located in the following states: Iowa, Minnesota, South Dakota, Nebraska, Canada, Kansas, Colorado, Oklahoma and Texas (also Alabama, Arkansas, Missouri). Most tornados take place in the spring and early summer, peaking in May and June.

Can a tornado or a hurricane occur in Israel?

There were minor twisters in the Beit Shean Valley in 1989 and in Kibbutz Leman in 1990. In the 1950s a few wind-bursts accumulated under cumulonimbus clouds on Israel’s central plain. These occurrences are rare and not intense. The particular climatic combination necessary for hurricanes – of tropical, humid heat over a large body of warm water accumulating intensity as it travels, is neither the climate nor the terrain of Israel.