

Earthquake Risk in Africa

A school's guide

By

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1.EARTHQUAKE DISASTER AWARENESS: UNDERSTAND THE THREAT

1.1 Introduction

Earthquakes have occurred for billions of years. Many stories along the history of man show the considerable impact they have had on human's lives and property. Earthquakes are the most terrifying and destructive among the other natural phenomena like rain or wind. For many of African countries, earthquake hazard constitutes a serious threat to human life and property, sometimes causing major economic losses and disruption. The environment concerns and an increased official and public awareness of earthquake hazards have, in the last decade, led to a rapid rise of interest in seismicity and, seismic hazard and risk evaluations in the African countries.

Because earthquakes are a natural phenomenon, their occurrence cannot be avoided, due to our limited knowledge and ability at present; however, the impact of such events on people's lives and their properties can be considerably reduced. The effects of all destructive earthquakes which have occurred in the past could have been significantly reduced if pre-, during and post-disaster measures were adopted and implemented. The whole community through schools could have its awareness risen and be more active in taking initiatives by better understanding of the earthquake threat in the continent and the possible effects on human lives, housing, lifelines and other systems.

This booklet is written to help you as a school's guide, to understand better the complex earthquake phenomenon and its impact on our lives and properties.

Do you know?

A moderate or major earthquake in a densely populated area could cause a considerable number of deaths and injuries and millions or billions of dollars in property losses. It also could severely impact transportation, water, electrical and other lifeline systems.

1.2 Definition of an earthquake

An earthquake is a natural phenomenon like wind and rain. It is a sudden, rapid shaking of the earth caused by the release of energy stored in rocks. This is a brief definition which children of all ages can master.

1.3 Understanding the causes of earthquakes

a. Earthquakes and geological times

An earthquake may last only a few seconds, but the processes that cause earthquakes have operated within the Earth for millions and millions of years. The development, during the last four decades of plate tectonic theory, has led to a better understanding of earthquake phenomenon causes.

Centuries before, and until seismology became formalized, the supernatural, in one form or another, was often accepted as the cause of earthquake events. Earthquakes have

occurred throughout history and all over the world. As human societies have created larger settlements, the loss and damage from earthquakes has increased.

Do you know?

There are about 3,500,000 earthquakes occurring in the world every year. There are only about 1,000,000 of them are recorded. And only about 34,000 earthquakes are felt by humans every year.

Each year, around 800 moderate earthquakes (Magnitudes 5.0 - 5.9) that cause slight damage and about 120 strong earthquakes (6.0 - 6.9) that cause serious damage. There are about 18 major earthquakes (7.0 - 7.9) that potentially destructive. Once every 10 - 20 years, there is a great earthquake (8.0 - 8.9) that can be devastating.

b. Earthquake legends

Until very recently, the cause of earthquakes was an unsolved mystery. It was the subject of fanciful folklore.

Legends are traditional narrative explanations of natural phenomena, which prevail when scientific explanation is not available. From ancient times, legends (myths) were established to explain what we did not understand.

In North Africa, old people explained earthquakes by saying that the world was perched on the horns of a bull that tossed his head when tired to change the position of the world from one horn to another. In Mozambique, it was accepted that the earth is a living creature, and it has the same kinds of problems people have. Sometimes it gets sick, with fever and chills, and we can feel its shaking. In West Africa, a giant carries the earth on his head. All the plants that grow on the earth are his hair, and people and animals are the insects that crawl through his hair. He usually sits and faces the east, but once in a while he turns to the west (the direction earthquakes come from West Africa), and then back to the east, with a jolt that is felt as an earthquake. In East Africa, A giant fish carries a stone on his back. A cow stands on the stone, balancing the Earth on one of her horns. From time to time her neck begins to ache, and she tosses the globe from one horn to the other.

But our society has modern myths about earthquakes. As in Algeria, people were saying that the El-Asnam earthquake of 10 October 1980 happened because people were eating couscous (national meal) with wine and Allah punished them. Still some people and unfortunately some of government officials believe that disasters are act of God. "All of sudden there are so many earthquakes in the world as between 1999 and 2004. These are all legends. Although we have long-range predictions, no one can make short-term predictions yet about when an earthquake will strike. Modern myths cloud our vision of what we must do to protect ourselves. Let's reject these legends or myths; it is time to look at reality and learn how to be prepared to reduce the effects of earthquakes.

c. The layers of the earth

Although our earth feels solid as we walk along its surface, it is really only partly so. The earth is subdivided into three main layers that can be visualized by taking a hard-

boiled egg as a model. There is a hard outer surface, a softer middle layer, and a central core. Figure 1: Illustrating the layers of the earth and the types of the faults. The easiest way of describing the earth's layers is to compare the globe to hard-boiled egg. It has a crust which may be considered as the shell, a middle layer, or mantle, which is like the white, and a core that is something like the yolk. The crust and the upper portion of the mantle are often referred to together as the lithosphere, or rock sphere. Scientists differentiate the core into the inner core and the outer core. The outermost layer of the earth is broken into irregular pieces, called plates, which make the earth look as a spherical jigsaw puzzle. These plates are in very slow but constant movement. Plates movement is generally of three kinds: spreading, colliding, or sliding; but kinds of boundaries. Earthquakes release the energy stored in rocks by any one or a combination of these three kinds of movement.

Do you know?

Earthquakes result from the build-up and release of energy stored in the rocks. Students may be surprised that we speak of rocks and rock layers, because in many places the rock material of the earth's crust is covered by accumulations of sand and soil. Remind them that even beneath the sediment in river valleys, plains, and beach areas, some kind of rock is always present.

d. Crust and lithosphere

The earth's crust varies in thickness from about 65 km on the continents to only about 10 km on the ocean floors. Even at its thickest, the crust is not closely as thick in respect to the whole bulk of the earth as the shell of an egg is to the egg. This is obvious when we compare 65 km to the radius of the globe, 6,370 km. The lithosphere is the outer solid portion of earth that includes the crust and the uppermost part of the mantle. The lithosphere has an average depth of 100 km.

e. Lower mantle and core

Directly under the lithosphere is the asthenosphere, a zone of the mantle with a plastic, semi-solid consistency, which may reach to about 200 km under the surface. The mantle continues to a depth of 2,900 km. The liquid outer core, which might be compared to the outer two-thirds of an egg's yolk, reaches from 2,900 km to a depth about 5,100 km. The solid metallic inner core goes the rest of the way to the centre of the earth. Both are composed primarily of iron and nickel. The oldest rocks of the crust have been dated by radioactive decay at about 4.0 billion years old; We do not know when the lithosphere began to form, but we assume that it broke into plates at this time.

Do you know?

In the mid-1960s, many scientific observations and explanations of earthquakes occurrence came together in the theory of plate tectonics.

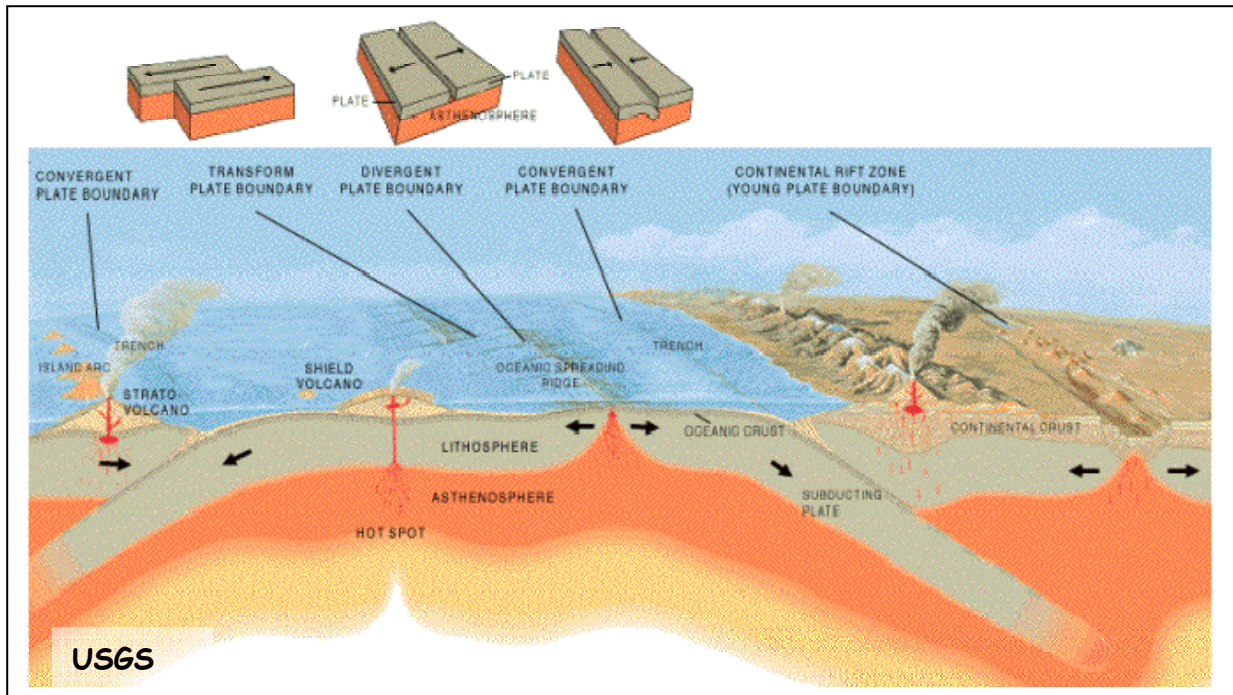


Figure 1: Illustrating the layers of the earth and types of faults

1.4 General theory of earth movements: Plate tectonics

Tectonic Plate Theory gives us today a scientific explanation of the cause of earthquakes. This theory of plate tectonics, introduced in 1968, assumes that the mantle, or upper crust, of the earth is in constant movement as segments of its lithosphere, technically referred to as "plates" slowly, continuously, and individually slide over the earth's interior (Map 1). Originally, the crust of the earth was assumed to be a single mass, one supercontinent without the existence of any ocean basins. About 200 million years ago, this supercontinent started to gradually broke apart and drift into plates of landmasses and oceans which we are observing today. A total of twenty-three plates are said to make up this system of the upper mantle. These plates meet in "convergent zones" and are pushed apart in "divergent zones" as shown in Figure 1). In the zones of divergence, molten rock from beneath the crust fill in the resulting rift and forms a ridge. As these ridges are made, pressures from their build up are said to be responsible for the creation of spreading plate boundaries shown in Figure 1. This phenomenon has been observed at mid-ocean locations illustrated by the mid-Atlantic Ridge and the Mid-pacific Rise. The Red Sea is often cited as an example of a young spreading ridge, as it separates Africa from the Arabian Peninsula. At convergence zones, subduction occurs as one plate slides under the other, forming a trench (figures 2a and 2b) as it returns material from the leading edge of the lower plate to the earth's interior. The Aleutian Trench is an example of a subduction zone. Plates can also slide past each other laterally, as well as rotate, as they are pressed against each other as one or both plates may move relatively to one another. The Pacific Plate, bordering on the West Coast of the United States, may illustrate this phenomenon as it moves - easterly past the North American Plate along the San Andreas Fault in California.

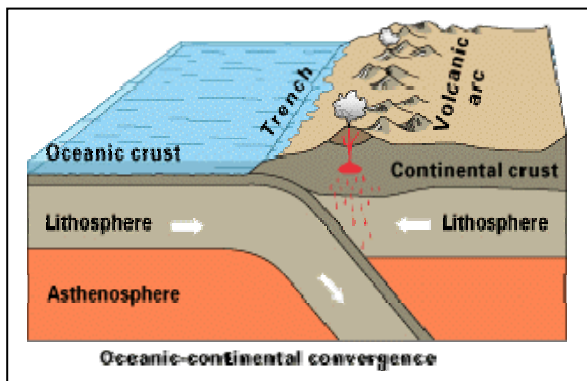


Figure 2a: Shows Oceanic-Continental Convergence

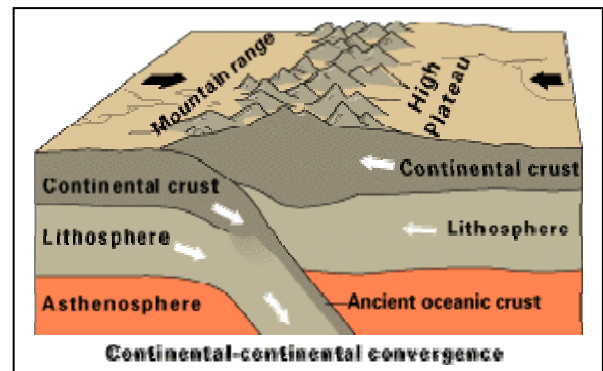


Figure 2b: Shows Continental-Continental Convergence

Do you know?

The plates scrape and slip past each other in opposite direction. As the plates are in motion, friction prevents the movement, but eventually enough energy builds up that it overcomes the friction and is released along a fault line: An earthquake

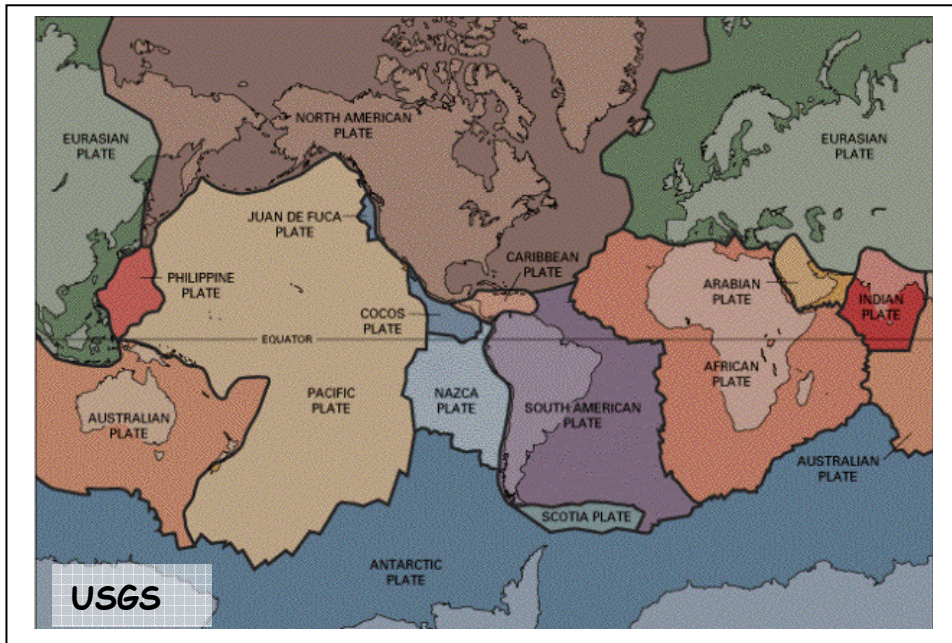
The earth's plates move at about the same rate that our fingernails grow - The fastest slipping faults move a rate of between 2mm and 8 cm per year.

a. Earthquakes at plate boundaries and within plates

Ninety five percent of all earthquakes occur in the vicinity of the borders of the tectonic plates. Where tectonic plates push into each other and/or one plate slides past the other, shallow earthquakes are common. The other five percent of earthquakes occur at faults located within plates (intraplate). They are much less frequent than those at plate boundaries.

Do you know?

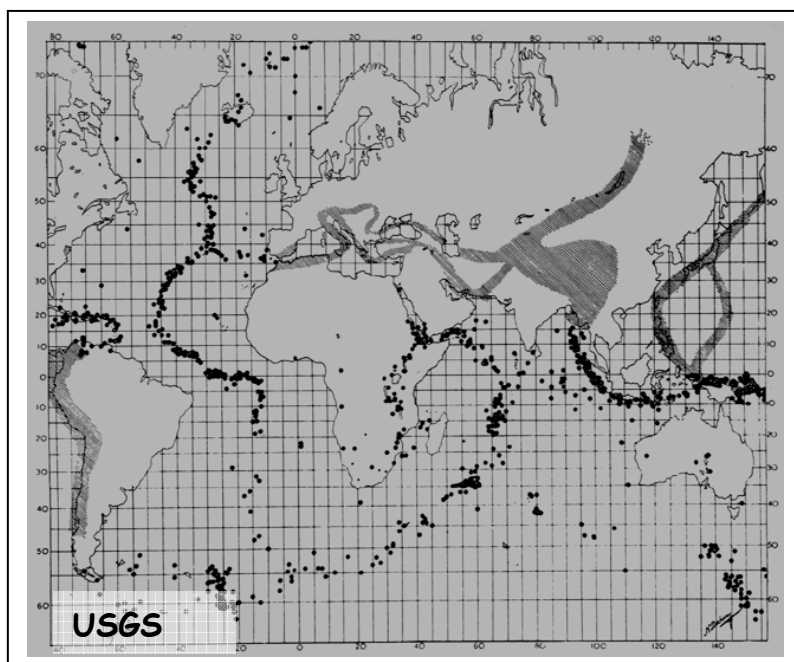
Before an earthquake, the tectonic forces that make the plates move cause the rock in the vicinity of a fault to deform and bend. Energy is stored in the rock as it deforms, in much the same way, as energy is stored in a rubber band as it is stretched. This energy is called elastic energy. When the forces exceed the resistance of the rock along the fault, the fault suddenly slips, just as the stretched rubber band snaps back to its original form when it is let go.



Map 1: Illustrates the various tectonic plates

1.5 Global seismicity

The present geographical distribution of earthquakes over the globe has been known since early 20th century. This result was the first to flow from the establishment of a worldwide system of seismographic stations. An illustration of the present earthquake catalogue for the main significant event is given in Map 2.



Map 2: Shows the main seismicity in the globe

1.6 Earthquakes in Africa

The seismicity of Africa is mainly concentrated in two main regions: North Africa and southeast Africa (Map 3). Since hundred million years ago, the same tectonic process marked by a relative motion alternating between left and right lateral along the border of the African and Eurasian plates. In North Africa, Algeria, Morocco and Tunisia, have a relatively moderate seismicity despite the apparent tectonic activity of that thrust zone of 2,300 km long and 400 km wide. This region, which comprises the Atlas ranges bordering the western Mediterranean Sea and the southern Iberic peninsula, has experienced, since hundred million years ago, a common tectonic evolution characterized by a relative motion between the left and right lateral along the African and Eurasian plates. Most of the seismic activity in North Africa is concentrated along the Atlas Mountains, mainly along the Mediterranean coast. Libya and Egypt have a low seismic activity. The seismic activity in Libya is concentrated in the northern part of the country particularly in the Hun graben and Al Jabal Al Akhdar regions. Whereas in Egypt, it is well observed around the Nile Valley and Nile Delta. There are four major seismic zones in Egypt which are known as Northern Red Sea-Gulf of Suez-Cairo-Alexandria trending NW-SE, Gulf of Aqaba-Levant Fault, NNE-SSW, Eastern Mediterranean-Cairo-Faiyum, NE-SW and Egypt-Mediterranean Coast, E-W.

Do you know?

That the average uplift rate was computed at 1.76 mm/year and the shortening rate as 1.48 mm/year for the whole Atlas ranges.

The south-eastern African region covers a region which is prone to a significant level of seismic hazard due to the presence of the East African rift system. The whole region is crossed by a tectonically active rift system within a stable African shield known as the East African Rift System (EARS). The east African Rift trends largely north-south, following the great lakes: Albert, Edward, Kivu, Tanganyika and Nyasa. An active branch on the opposite side of Lake Victoria follows the Rift Valley of Kenya, through Lake Rudolf into Ethiopia. In Ethiopia, seismic activities follow narrow zones associated with structures of the Afar depression and the main Ethiopian rift. Kenya rift is almost devoid of seismic activity although micro-earthquake studies in the Kenya rift have shown that the rift floor is seismically active. Another highly active region on the Eastern branch is northern Tanzania. The area shows diffuse seismicity that starts close to Lake Victoria and stretches southeastwards to the Indian Ocean. The Western branch is more seismically active than the Eastern branch. In the northern end, seismicity dies out abruptly in southern Sudan as the rift encounters the Aswa Shear zone. West of Lakes Edward, Kivu and Tanganyika in Zaire and Zambia, the seismicity is diffuse. The southern extension of the Western branch is well defined by a seismicity belt running through Malawi to southern Mozambique. Kariba is the most seismically active area in this part of the region. Most significant earthquakes for the African continent are listed in Table 1.

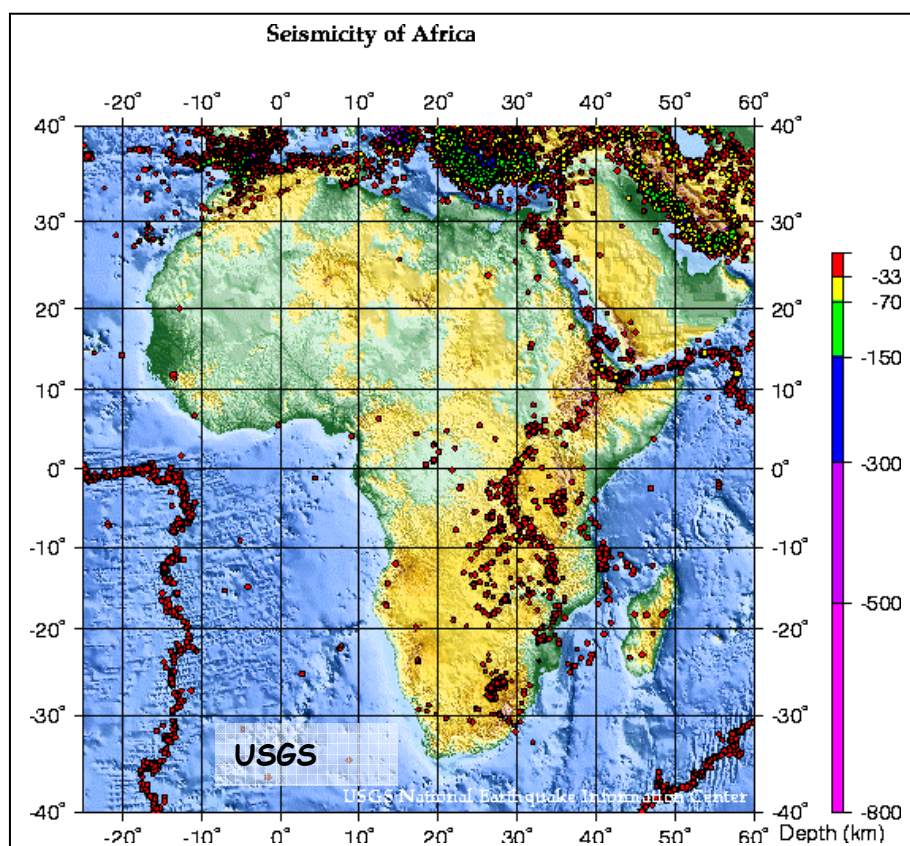
Table 1: Most important earthquakes in Africa

Date	Epicentre	Int or Mag.	Comment
600 B.C.	Thebes, Egypt	6.1	
28 B.C.	Thebes, Egypt	6.1	
262	E. Mediterranean, Libya	XII	Cyrene and cities destroyed.
320	Alexandria, Egypt	6.0	
365	E. Mediterranean, Libya	XII	Cyrene and cities destroyed.
704	Murzq (Sebha), Libya	XII	Towns and Sabha destroyed.
956 Jan 01	Alexandria, Egypt	6.0	
1183	Northern Libya, Libya	XI	20,000 killed.
1365	Algiers, Algeria	X	Several dead
1716 Feb. 03	Mitidja Atlas, Algeria	7.5	20,000 dead
1758 Jan	Constantine and Tunis		Several dead
1790, Oct. 09	Oran, Algeria	7.0	2,000 dead
1811	Libyan-Egyptian boarder	VIII	
1825, Mar. 2	Blida, Algeria	6.5	7,000 dead
1867, Jan. 2	Blida, Algeria	7.5	100 dead
1891 Jan. 15	Gouraya, Algeria	6.5	38 dead
1906 Aug. 25	Central Ethiopia	6.8	
1910 Jun. 24	Aumale, Algeria	6.6	81 dead
1910 Dec. 13	Lake Tanganyika	7.1	
1912 Jul. 9	N. Uganda	6.7	
1915 May. 8	Mozambique Channel	6.8	
1915 Jul. 11	Tunis, Tunisia	6.2	
1915 Sep. 23	Coast of Eritrea	6.7	
1919 Jul. 8	W. Tanzania	6.7	
1928 Jan. 6	Mt. Kenya	7.0	
1932 Dec. 31	Coast of Natal	6.7	
1935 Apr. 19	Al-Qadahia, Libya	6.0	
1939 Jun. 22	Ghana	6.5	16 dead
1941 Dec. 27	Tunis, Tunisia	6.8	
1942 Oct. 9	Lake Nyasa	6.7	
1945 Mar. 18	Masaka, Uganda	6.0	5 dead
1954 Sep. 9	El-Asnam, Algeria	6.8	1,409 dead
1955 Sep. 12	Alexandria, Egypt	6.0	
1960	Awasa, Ethiopia	6.1	Several dead
1961 Jun. 1	Kara-Kore, Ethiopia	6.7	160 dead
1966 Mar. 20	Mt. Ruwenzori, Uganda	6.1	4 dead
1969 Mar. 31	Alexandria, Egypt	6.1	
1969	Serdo, Ethiopia	6.3	
1980 Oct. 10	El-Asnam, Algeria	7.4	3,000 dead
1989 Mar. 10	Salima, Malawi	6.1	8 dead

1989	Dobi Graben, Ethiopia	6.5	
1994 Feb. 5	Kismoro, Uganda	6.0	9 dead
1994 Aug. 18	Mascara, Algeria	6.0	171 dead
1992 Oct. 12	Cairo, Egypt	7.0	541 dead
2003, May 21	Boumerdes, Algeria	6.8	2,278 dead
2004, Feb. 24	El-Hoceima, Morocco	6.2	600 dead

Do you Know?

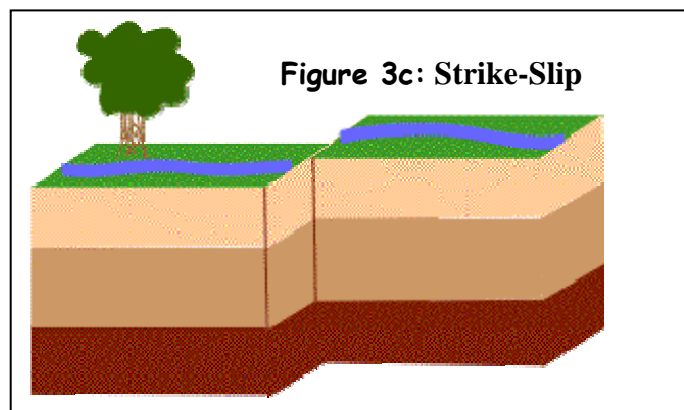
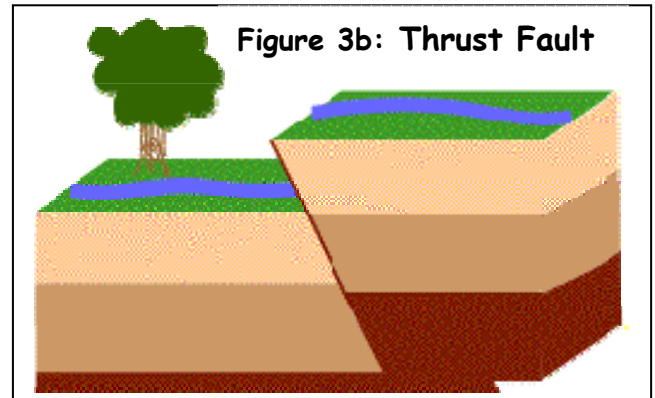
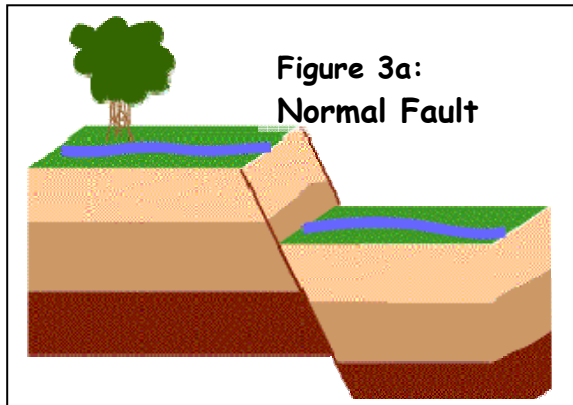
Africa (North Africa not included) and Arabia contains active rift zones responsible for about 0.1% of the world's total seismicity.



Map 3: Shows the seismicity of Africa

Types of earthquake faults

A fault is a crack in rock or soil along which earthquake movement has taken place. There are various types of earthquake faults around the world. Displacement along these fault zones during an earthquake may result in various offsets: vertical, horizontal, or a combination of the two. Figures 3a, b, c indicate the various types of earthquake faults, simply classified by the configuration and direction of offset, or slip, as shown by the respective drawings.



Figures 3a, b, c : showing the main types fault types

Do you know?

When the fault slips, the elastic energy stored in the rock is released as seismic energy in the form of seismic waves, or earthquake waves. These waves spread outward from the fault. Close to the earthquake fault, the seismic waves can be strong enough to knock people to the ground. They are weaker the farther one is from the earthquake fault. Consequently, shaking is greatest near the source of the earthquake.

Foreshocks.

Foreshocks are relatively smaller earthquakes that occur before the largest shock in a series, which is termed the mainshock. Not all mainshocks have foreshocks.

Mainshock.

The largest shock, sometimes preceded by one or more foreshocks, and almost always followed by a series of aftershocks.

Aftershocks.

Aftershocks are earthquakes that follow the mainshock. They are smaller than the mainshock and occurring within an area of radius equal to or less than half fault length of the mainshock fault. Aftershocks can continue over a period of weeks, months, or years. In general, the larger the mainshock, the larger and more numerous the aftershocks, and the longer they will continue.

Seismicity.

The geographic and historical distribution of earthquakes.

Duration of shaking

Depending on the size (magnitude) of the earthquake, the shaking may last from 10 seconds to 90 seconds.

Do you know?

The longer buildings shake the greater the damage may be.

Focus (Hypocenter)

The focus is the place where an earthquake starts. The rupture begins at a point called focus or hypocenter, usually kilometres below the earth's surface. Straight up above it is the epicentre. It may be classified as deep, medium, or shallow.

Do you know?

Earthquakes with focal depths from the surface to about 70 kilometres are classified as shallow. Earthquakes with focal depths from 70 to 300 kilometres are classified as intermediate. The focus of deep earthquakes may reach depths of more than 700 kilometres

Do you know?

Following an earthquake the energy dissipates as it travels, so a shallower earthquake will cause more damage on the surface.

Epicentre

The epicentre is the point on the Earth's surface directly above the focus. The location of an earthquake is commonly described by the geographic position of its epicentre and by its focal depth.

Type of soil

Shaking is increased in soft, thick, wet soils. In certain soils the ground surface may settle or slide.

Plate tectonics: A theory, accepted today, which explain scientifically the cause of earthquakes.

Plates

Large, nearly rigid, but still mobile segments of blocks involved in plate tectonics, that include both crust and some part of the upper mantle.

Soil liquefaction

Soil liquefaction is likely to occur when a loose sand is in saturated and undrained conditions and shaken by a strong earthquake.

Do you know?

Sand blows or "volcanoes", is an indication of soil liquefaction. Soil liquefaction was reported in Orléansville (Algeria) 1954, Agadir (Morocco) 1960, El Asnam (Algeria) 1980 and Boumerdes (Algeria) 2003 earthquakes.

Tsunamis

Tsunamis are the water waves produced impulsively by earthquakes through tectonic displacement, submarine slides or landslides and Rockfall into deep water. Tsunamis merit great attention because of the loss of life, damage to the man-made structures and the alteration of the landscape that they may cause when they hit the land. Many earthquakes had their epicentres offshore in the Mediterranean Sea or the ocean, but because of their small magnitudes they do not produce any noticeable water waves.

Do you know?

No evidence was found of tsunamis causing any concern in the Africa. The speed of a tsunami (seismic sea water) may reach 800Km/hour in deep ocean. However, several sailors described a sea wave during the main shock of Chenoua-Tipaza 1989 earthquake and in the port of Tipaza, the sea was reported to have retreated by more than one meter, but no permanent changes in sea level were reported along the coast of the affected zone. Also, during the Boumerdes 2003 earthquake, it was reported that the sea retreated by more than two hundred meters and caused damage in southern Spain.

Earthquake waves

The release of energy generates earthquake waves. Earthquake waves are of two kinds, body waves and surface waves.

Body waves: Body waves that travel through the Earth are either P- (for Primary) or S - (for Secondary) waves. P- waves travel faster than S- waves. The two types together are called body waves because they travel through the body of the earth. Body waves are important because they allow us to locate the epicentres of the earthquakes. Figures 4a and 4b show the P-waves and the S-Waves forms respectively.

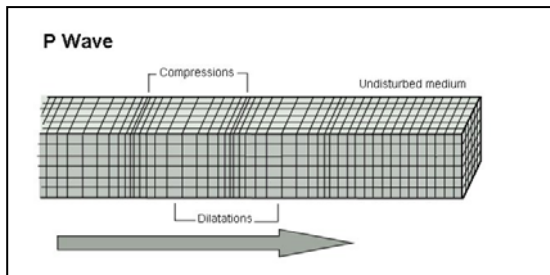


Figure 4a: Shows the P-wave form

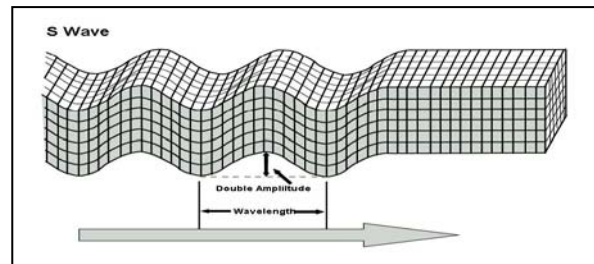


Figure 4b: Shows the S-wave form

Surface waves: Earthquake waves that travel at or near the surface of the Earth are called surface waves. They are primarily responsible for the shaking of the ground and damage to buildings. There are two types of surface waves: Love and Raleigh waves. Figures 5a and 5b show the Love and Raleigh waves respectively.

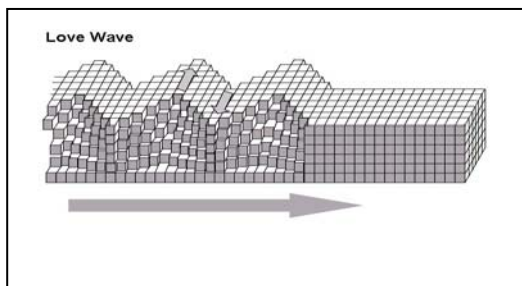


Figure 5a: Shows the Love wave form

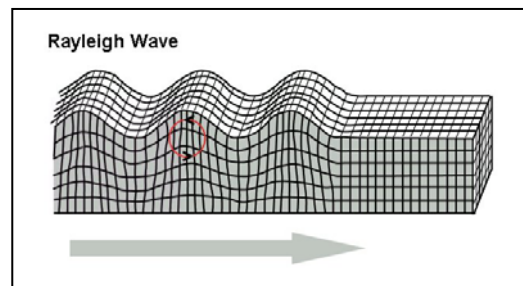


Figure 5b: Shows the Raleigh wave form

Do you know?

P-waves travel about 4.8 to 8.0 km/sec, while S-waves travel about 3.2 to 4.8 km/sec.

Surface waves: Surface waves are slower still and can cause even more damage due to their greater duration.

Measuring earthquakes

Only two methods exist today to measure the earthquakes. The first one is used for measuring the size or "magnitude" of an earthquake, and the second for measuring the effect, or "intensity" of an earthquake. It is interesting to note that the two methods measure different characteristics of an earthquake. **Magnitude** is a measure of the amplitude of the earthquake waves; it does not depend on space or time. The magnitude is proportional to the energy released. The magnitude does not give an idea of the physical effects (life loss, damage, etc.) of an earthquake on buildings. **Intensity** is a measure of the effects that the earthquake had on natural and human-made structures, which depends on several parameters as the soil, the state of the construction, the topography, etc.

Do you Know?

The larger the magnitude, the further the energy will travel and the larger the area that will be affected. Each earthquake has a single magnitude and a range of intensities.

Magnitude scale

First used in 1935, the Richter magnitude scale was named after its inventor, Professor Charles Richter of the Californian Institute of Technology in Pasadena (USA). The Richter scale reading is said to be an abstract number because it has no direct physical meaning, but rather "is intended to be a rating of a given earthquake independent of its place of observation". Because of the abstract nature of the Richter scale, earthquakes of similar Richter magnitudes may differ greatly from each other in the physical effects (Intensity) produced on the built environment because of the immense variety of local geological conditions. List 1 shows the severity of the earthquakes.

Do you know?

The volume of the small 63 mm sphere is assumed to be the equivalent of Richter magnitude 1. A magnitude 2 earthquake would be a sphere 38 mm in diameter; a magnitude 3 about 127 mm in diameter; the 6.4 magnitude would be a sphere of 30480 mm in diameter, and the 8.3 magnitude a sphere of 286464 mm. A correlation between the Richter scale and the amount of total energy released has been derived, with one-unit increase in magnitude approximating a 30 fold in energy. Thus, a three-unit increase in magnitude, from 5 to 8 for example, renders approximately a 30 x 30x 30, or a 27,000-fold increase in energy released. An example is given in Figure 6. Although it has an open-ended scale with no upper limit, the largest known earthquakes have been those approaching a Richter 9.0.

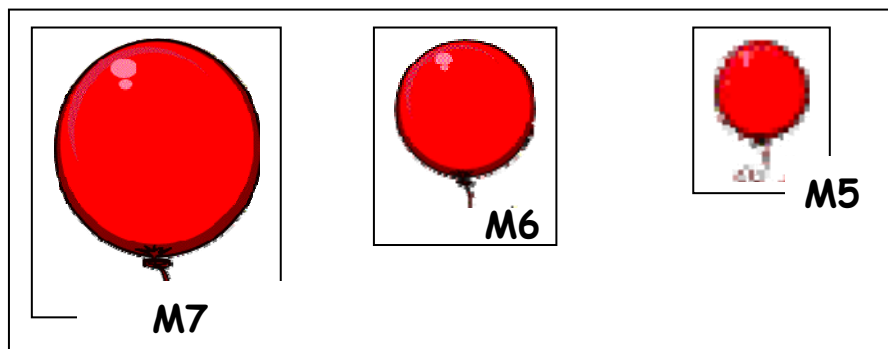


Figure 6: Shows an example of sizes from M5 to M7

List 1 shows the severity of the earthquakes.

Magnitude	Earthquake Impact	Estimation Number per year Worldwide
1.0 - 3.0	Generally not felt but recorded.	3,000,000
3.1 - 4.0	Often felt, but only minor	50,000

	damage.	
4.1 - 6.0	Slight damage to buildings.	15,000
6.1 - 6.9	Can destructive in places where people live.	120
7.0 - 7.9	Major earthquake. Causes serious damage.	20
8.0 or greater	Great earthquake. Total destruction to nearby communities.	1

Intensity scale

The intensity scale measures local damage to structures and facilities. In order to obtain a more complete picture of the earthquake's size, and physical impact on buildings and facilities in the stricken area, both scales must be used.

Although a number of scales have been developed to describe the effects of ground shaking on the performance of buildings at a given location, the modified Mercalli intensity scale (MMI) is the most widely used. In contrast with the Richter magnitude scale, which uses Arabic numerals, the MMI utilizes Roman numerals, ranging from MMI-I to MMI-XII. This also to avoid confusion in distinguishing between the two scales: an Arabic numeral means we are dealing with the Richter magnitude scale, and a Roman numeral indicates the use of the Intensity scale as a measure of the relative amount of damage incurred. A shortened descriptions of each intensity, from I to XII, used in the Modified Mercalli intensity scale (MMI) is given in Table 2.

Do you know?

The difference between the two scales is that while the Richter scale is open-ended with no theoretical upper limit, the intensity scale is a closed-ended measure, with the maximum intensity of XII used to indicate "damage nearly total, the ultimate catastrophe". At the other end of the scale, an area of damage that has been assigned intensity I is described as "earthquake shaking not felt. But people may observe marginal effects of large distance earthquakes without identifying these effects as earthquake caused. Among them: trees, structures, liquids, bodies of water sway slowly, or doors swing slowly."

Table 2: Illustrates the Intensity Value and shortened description on Modified Mercalli Scale

Intensity	Description
I	Only instruments detect it.
II	May be felt only by people lying down.
III	People on upper floors of buildings will feel it, but may not know it is an earthquake.
IV	People indoors will probably feel it, but those outside may not.
V	Nearly everyone feels it and wakes up if they are sleeping.
VI	Everyone feels it. It is hard to walk.

VII	It is hard to stand.
VIII	People will not be able to drive cars. Poorly built buildings may collapse; chimneys may fall.
IX	Most foundations are damaged. The ground cracks.
X	Most buildings are destroyed. Water is thrown out of rivers and lakes.
XI	Rails are bent. Bridges and underground pipelines are put out of service.
XII	Most things are levelled. Large objects may be thrown into the air.

Do you know?

We have successively used the intensity scales of Rossi-Forel (1874, 10 degrees, damages starting from degree VIII), of Mercalli (1888, 12 degrees, damage starting from degree VII), of Mercalli modified by Cancani (1917, 12 degrees, damage from VI). The initial Mercalli scale is included in the scale MSK (1964), which specifies the damage for each type of construction. From 1998, a new scale came to practice, the European Macroseismic Scale (EMS) which is used actually in Europe.

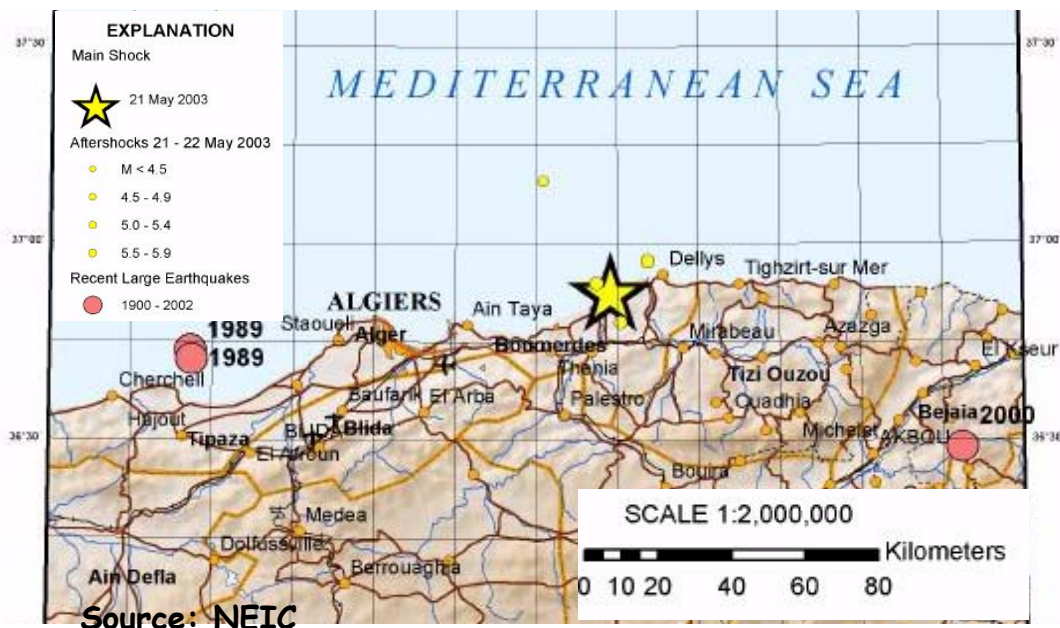
Isoseismal map

When a damaging earthquake occurs, trained engineers are sent into the field to assess damage at various buildings in various locations in the zone affected. They attribute intensity levels according to their evaluation of the damage that has been observed in accordance with the descriptions of damage states listed in the Modified Mercalli Scale in Table 2. Based on these field observations of damage after a destructive earthquake, an isoseismal map is prepared to indicate intensity degrees of damage attributed to the zone affected. The isoseismal map is constructed by drawing a line that connects points of equal intensity of damage observed in buildings and facilities located in the area affected.

Example of Earthquake Disaster in an African Country: Boumerdes (Algeria) Earthquake of May 21st, 2003

On Wednesday 21 May 2003, at 19h 44m 2s (18h 44m 2s UTC), a destructive earthquake occurred in the Boumerdes-Algiers region affecting a rather densely populated and industrialized region of about 3,500,000 people. It is one of the strongest recorded seismic events in North Africa. The depth of the focus was about 10 km. The magnitude of the earthquake was calculated at $M = 6.8$. The main shock, which lasted about 40 sec, and the two largest aftershocks (both reached $M 5.8$ on 27 and 29 May 2003) caused the loss of 2,278 lives, injuring more than 11,450, making 1,240 missing and 182,000 homeless; they destroyed or seriously damaged at least 200,000 housing units and about 6,000 public buildings in five wilayas (provinces). The extent of the socio-economic impacts of these events confirmed that Algerian buildings are highly vulnerable to the recurrence of destructive earthquakes. Estimates put the economic cost of the earthquake as high as US\$ 5 billion. Maximum acceleration was recorded at 0.58g at about 20 km and 0.34g at about 60 km from the epicentre. Maximum intensity reached is re-evaluated at $I_0 = X$ (MSK) scale at

Zemmouri, Boumerdes, Bordj-El-Bahri and Dellys. The Wilaya of Boumerdes, including the coastal city of Boumerdes and the eastern part of the capital city of Algiers were most affected by the earthquake. Damage was observed in most cities and villages along the coast in from Algiers to Dellys, a distance of about 150 km long and 40 km wide. The epicentre was located at 36.89N-3.78E, about 10km offshore from the locality of Zemmouri in the Wilaya of Boumerdes which is about 50 km east of the capital city of Algiers (See Map 4). This earthquake had large socio-economic and psychological impacts on the region. Widespread liquefaction, rock falls, landslides, ground cracking and lateral spreading were reported in the region of Zemmouri. The earthquake triggered a tsunami, which was observed on Southern coast of the Balearic islands (Spain). It was reported a retreat of seawaters in coastal zones of Algiers and Boumerdes of about 200 meters. Fishermen in the port of Zemmouri-El-Bahri in the epicentral region reported that the water depth in the port dropped to less than one meter and several fishing boats ended up on the bottom of the seabed before the water came back to its original position.



Map 4: Showing the epicentre location of the Boumerdes earthquake of May 21st, 2003

Inhabitants report that, in the most affected city of Boumerdes, the civil protection teams started joining the zone affected for search and rescue operations in about 6 hours after the earthquake. However, initial efforts to search for victims and to rescue them out of the damaged and collapsed structures were first done by the local population. Several countries have sent rescue and first aid teams immediately after the earthquake and were able to join in the efforts of finding survivals within 24 after the earthquake. The Algerian Red Crescent supported by several international

humanitarian assistance organizations started the process of providing food, water, sanitation and health care to the victims in about 12 hours after the earthquake.

Civil protection Algerian Red Crescent, the Armed forces and foreign NGO's started the process of establishing official "tent-camps" about a week after the earthquake. The victims refused at the beginning to move into the government supplied tents. Families displaced from damaged multi-story buildings preferred to stay in camps but in close proximity to the buildings in fear of looters. They also preferred to remain within their neighbourhoods where they could support each other. However, families have slowly moved to the campsites where conditions are better than the makeshift camps. Schools and educational institutions were closed in the province of Boumerdes and Eastern part of Algiers, and in the western towns and villages of the province of Tizi Ouzou. The University of Science and Technology of Algiers, the largest university of the country, located in the district of Bab-Ezzouar in the eastern part of Algiers was also temporarily closed for security, damage assessment and repairs.

2. EARTHQUAKE HAZARD, VULNERABILITY AND RISK

As the notions of earthquake hazard, vulnerability and capacity constitute the basis for an efficient strategy of earthquake risk reduction and the operational base for a culture of prevention. It is of interest to define the main terms we are using in this booklet.

The **Earthquake Hazard** is defined as a destructive earthquake, which may cause the loss of life or injury, property damage, social and economical disruption or environmental degradation. The earthquake hazard is taken as the "punch of nature" or "external forces".

Do you know?

There are no such things as natural disasters, but there are natural hazards or natural phenomena. It is the combination of these natural phenomena with the built environment that may lead to disasters.

Each earthquake hazard is characterized by its location, intensity and chance of occurrence. Depending on the degree of vulnerability of the construction, an earthquake may or may not cause loss of life and damage to property.

Do you know?

As the popular adage concerning the earthquakes is "Earthquakes do not kill, buildings do".

The **Earthquake Vulnerability** is known as a set of conditions and practice resulting from physical, social, economical and environmental factors, which enhance the susceptibility of a community to the effects of earthquake hazards.

Do you know?

Reducing the vulnerability of the African people to natural disasters is mentioned as a requirement to achieve the poverty reduction goals of the Millennium Declaration.

The following factors that affect the vulnerability could be summarized as follows:

- * **Engineering and constructions measures** (Strengthening structures, control structures, good workmanship, etc.)
- * **Physical planning measures** (Land use planning)
- * **Economic measures** (legislation, tax, insurance, etc.)
- * **Management and institutional measures** (Building capacity, expertise, education, training, etc.)
- * **Social measures** (Awareness, public information and involvement, preparedness, etc.)

For instance, a construction which had been built according to the seismic building code is less vulnerable to earthquakes than the one where the code was not respected. A building defined as vulnerable to earthquake loads, owing its type of construction and its configuration. In simple words, vulnerability is the weakness or strength of the structure to resist earthquake loads. The combination of the earthquake hazard and the vulnerability may lead to life losses and to damage to the property which is known as **Earthquake Risk**.

Do you know?

An earthquake which occurs in the desert, or in remote area where few people live will cause much less damage than if the same size earthquake strikes a city. Thus, human is directly involved in the value of the element exposed to risk. Damage or losses are interconnected to the density of population, and the concentration of economic and natural resources.

Historically, this is true, it is clear that the poor seismic behaviour of buildings, leading to building collapse or severe damage has been the principal cause of loss of life. The most secure place to be during an earthquake is in an open field away from buildings and man-made objects such as telephone poles, electric-transmission lines or anything else of a significant mass which may fall. Even non-structural building elements (cladding components) have been in many cases the cause of loss of life and injuries during an earthquake.

The **Earthquake Risk** is defined as the consequences of that combination or expected losses (of lives, injuries, property, livelihoods, economic activity disrupted or environment damaged).

Do you know?

Around the globe 80 earthquakes produced economic losses of US\$ 9 billion and insured losses of about US\$ 900 million. (Source; Munich Re, 2001)

It may also be summarized as follows:

EARTHQUAKE RISK = EARTHQUAKE HAZARD * EARTHQUAKE VULNERABILITY

These consequences when they reach a certain level which cannot be supported by the community/society is called **Disaster**. A **Disaster** is known as a severe disorder of the functioning of a community or a society causing significant losses or damage which exceed the capacity of the affected community/society to deal with using its own resources. The community needs help to face and recover from such a situation.

Do you know?

The good news is that while we can do nothing about the earthquake hazard, there is a lot we can do about the earthquake risk (consequences). Earthquake risk can be considerably reduced by human action.

As the occurrence of natural hazards/phenomena cannot be avoided, at least the present state of our knowledge and ability; however, the impact of such events on human and their properties can be reduced. Earthquake Risk or damage reduction concerns all the measures taken before the next earthquake, which lead to reduce the consequences of such an event. An example for a tool to reduce the physical impacts on buildings is the seismic design code. Actions to reducing the negative impact of earthquake hazards are called **Earthquake Prevention**. Prevention measures are permanent and for long term and are implemented before the earthquake disaster.

Do you know?

Kofi Annan, IDNDR, Geneva, July 1999 declared: "Much has been learnt from the creative disaster prevention efforts of poor communities in developing countries. Prevention policy is too important to be left to governments and international agencies alone. To succeed, it must also engage civil society, the private sector and the media"

The implementation of procedures and practices to reduce earthquake vulnerabilities and damage throughout a community/ society, to avoid (prevention) or to limit (mitigation and preparedness) negative impact of earthquake hazards. These actions in which people and organizations use existing resources to face abnormal, unusual, and adverse conditions of a disaster event are known as **Disaster Management Capacity**. The capacity of a community or society to defend itself and recover from a disaster is called **Resilience**.

Do you know?

Community/society awareness is a primary and fundamental tool for earthquake risk reduction and schools can play a great role in rising the awareness.

Another tool to reduce earthquake risk is the **Early Warning**. This is to provide timely and effective information, through recognized institutions, that let individuals at risk of a disaster, to take action to avoid or reduce their risk and prepare for effective response.

Do you know?

The vital goal of hazard forecasting and early warning systems is to protect lives and reduce property damage.

3. ACTIONS BEFORE EARTHQUAKE

A. Introduction

Science today cannot precisely predict when and where an earthquake will occur. The children should be taught what to expect and how to protect themselves. Teaching the school children to recognize an earthquake and take immediate positive action can help them and those around them to come through the disaster safely. When it shakes, it is too late to think; you have to be prepared well before. You will not have time to think where you will be safe. You need to think about it ahead of time so that you can react appropriately and automatically, and immediately. Children must also learn how to prevent and reduce the effects of an earthquake disaster.

B. What Happens During an earthquake?

Most people caught in earthquakes have a feeling of helplessness. Especially if they have never experienced an earthquake before, they have no idea how long it is going to last or what will happen next. In this booklet you will take the children through several steps that will help them know what to expect and what to do if an earthquake occurs.

C. What to Expect?

The first indication of a damaging earthquake may be a gentle shaking. You may notice the swaying of hanging plants and light fixtures or hear objects sliding on shelves. Or you may be shaken first by a violent jolt (similar to a sonic boom). Or you may hear a low (and perhaps a very loud) rumbling noise. A second or two later, you will really feel the shaking, and by this time, you will find it very difficult to move from one place to another. A survivor of the 2003 Boumerdes-Algiers (Algeria) earthquake had the sensation that the Earth was moving like a deck of a ship.

It is thus important to take earthquake preventive action at the first indication of ground shaking. Do not wait until you are certain an earthquake is actually occurring. As the ground shaking grows stronger, risk increases.

For instance: Freestanding cabinets and bookshelves are likely to overturn. Wall-mounted objects (such as clocks, maps and art work) may shake loose and fly across the room.

Suspended ceiling components may pop out, bringing light fixtures and other components down with them.

Doorframes may be twisted by moving walls and may block the doors shut. Moving walls may bend window frames, causing glass to shatter and send dangerous debris into the room.

The noise that accompanies an earthquake may cause considerable emotional stress - particularly if children are not prepared to expect the frightening noise of moving and falling objects, shattering glass, wailing fire alarms, banging doors, and creaking walls. The noise will be frightening, but a little less so if it is expected.

Do you know?

Earthquake preparedness and preventive measures are regarded as the best procedures for reducing earthquake losses and damage. Earthquakes are a risk to your lives and properties, and you should routinely take precautions to reduce your losses from them.

For instance, you wear seat belts to reduce the risk of injury during car accidents. Preparation for earthquakes is like fastening your seat belts against the threat. This is an action that most people have come to accept as a reasonable precaution.

3.1 WHAT TO DO BEFORE AN EARTHQUAKE?

Do you know?

That earthquakes do not kill or hurt but anything that can move, fall, or break or collapse as buildings do.

A. ARE YOU GETTING READY?

The moderate earthquakes, which are most frequently occurring, most injuries and fatalities occur because the ground shaking displaces loose objects in and on buildings.

Do you know?

Anything that can move, fall, or break when the ground starts to shake is an earthquake hazard if it can cause physical or emotional harm.

Classrooms, theatres, cafeterias, libraries, homes, and all other places where children spend time indoors contain objects that could cause injury or damage during an earthquake. Because children have already learned a great amount about earthquakes in the previous paragraphs, they are able to identify many of these objects themselves. They make classroom lists of the hazards in different locations and then work with teachers, parents, and other adults to eliminate or reduce as many hazards as they can.

Children can displace objects that could fall and cause injury during an earthquake. Those objects that cannot be displaced should be steadily fastened. In the classroom these may comprise wall maps, models, and wheeled items such as pianos and rolling carts. At home, bookcases, cabinets, TVs, water heater, wardrobe, and other tall furniture should be fastened to wall studs. Hanging lamps, heavy mirrors, framed pictures, and similar ornaments should be removed or permanently and firmly fastened.

There will be some hazards in the classroom, cafeteria, library, home, and community that children will not be able to get rid of. Be sure they know how to avoid those things they cannot remove.

B. EARTHQUAKE HAZARD HUNT IN CLASSROOM

The first phase to start with to learn how to reduce the risk, in your classroom, School, home, and community, is **hazard hunt** and the first place to start with is your classroom with the help of your teacher.

Procedure:

1. Children must review, with the teacher, the definition of an earthquake risk: Anything that can move, fall, or break when the ground starts to shake could constitute an earthquake risk if it can cause physical or emotional harm.

The teacher should tell the children that there will be many risks that we cannot correct, but identifying these risks will help us to anticipate them and avoid fatalities and injuries.

2. Children have to conduct, with the teacher, a hazard hunt in their classroom, cafeteria and library to identify things that might hurt them during an earthquake. Ask them to make a list of any hazard that is found in their classroom. You can use a picture with other types of earthquake risks, which may not be present in their classroom.
3. Conduct a class discussion about the hazards you have found and how they might cause harm. Ask the children to decide what they can do as a group to make the room more secure. Actions might include fastening down objects, moving hanging objects, placing objects on lower shelves, and so on. You may want to write the following action verbs on the blackboard:

Move	Anchor	Remove
Relocate	replace	Fasten
Attach	Eliminate	Secure

4. If appropriate, have the children spend time displacing things they can remove to make their room safer.
5. Have the children make a list of things that could be changed, but not without the help of an adult. These might include putting latches on cabinets, blocking wheels on the piano, and attaching cabinets to walls.

If appropriate, have the children help to make these changes. They might want to meet with the principal or work with the custodians to help make their room safer. When changes cannot be made, be sure children are aware of the remaining hazards, and know they must avoid or move away from them if an earthquake occurs.

Do you know?

The Earthquake Hazard Hunt should begin at school, with all the children and teacher participating. Imagination, and common sense are all that are needed as you look around the classroom and think about what can happen when the earth and building start shaking.

C. EARTHQUAKE HAZARD HUNT AT HOME

Procedure:

1. Tell to the children that there may be several possible earthquake hazards in their homes- objects that can slide, fall, break, spill, or cause damage or injury in other ways.
2. Guide a brainstorming session with the children and see how many home hazards they can think of. List them on the board.
3. Tell the children that they are going to conduct a hazard hunt at home to identify things that might cause damage or injury to them or their families during an earthquake. Distribute the children worksheets. Remind that this sheet does not comprise all the possible home earthquake hazards- just some of them and that they have to find out all of them.
4. Tell the children to take the worksheets home and have other children and their parents join them in looking through the home for hazards. Some hazards may exist in more than one place. Give these instructions (a) put a check in the box beneath every hazard you find in your home, (b) If you can, write the name of the room(s) in which the hazard is located, (c) On a separate sheet or on the back of the worksheet, list or draw any potential earthquake hazards that are found in your home but are not on the list, (d) Bring your completed worksheet back to class.

Tell the children to look around carefully at **the living room**. Which objects (of all sizes, large and small) could slide and fall during a strong shake? What kind of damage can these do? Cabinets, clocks, chandeliers, etc.

Now to **the kitchen**. Look around carefully. Here too there are many items that could slide or fall. Cabinet doors can be shaken open, cabinets can be overturned by the shaking, even heavy appliances can move across the floor.

Now think about **the bathroom**. Are there heavy things that could slide or fall?

Look around to **the bedrooms**. Is there wardrobes, cabinets, etc.?

Finally, make a rapid check of **the exit routes**, in the corridors and behind the doors for things that could fall and block the exits.

What have you found during your short visit to your home that can injure you and your family by sliding and falling?

Please complete your Earthquake Hazard Hunt list at home. Walk around with your family and list all the hazards. Discuss what you must do to mitigate each one of the hazards you listed. Decide what supplies you need and who will do what. Decide which objects are the most important. Get started and record the date that you fixed each thing.

5. Teacher should conduct a classroom discussion about the hazards that children found in their homes. Especially discuss hazards they identified that were not on the list.
6. Explain to children that now that they have identified earthquake hazards in their homes they can take action to reduce their danger. Emphasize that there are some actions they can take which cost little or no money, while other actions will cost quite a bit and will have to be done by adults.
7. Discuss the items on the list of hazard hunt brought back by the children. Determine which changes can be made easily and which will be more difficult. Again, emphasize that this list does not include everything that can be done to make home safer.
8. Have children take the list home to discuss with their parents. Parents may decide which changes could be done immediately in their homes and which ones will have to wait. Encourage children to help their parents in any way possible to make the changes that can be made. Also, remind the children that they will have to be responsible for avoiding the hazards they cannot remove.
9. Ask the children to bring back the completed checklists so they can have a follow-up discussion in class.

Do you know?

Sometimes you can reduce a risk just by moving a piece of furniture. Move your bed away from the windows. Secure large objects that could fall on your bed or block your doorway.

D. AS YOU FINISH YOUR EARTHQUAKE HAZARD HUNT IN SCHOOL AND AT HOME, PRIORITISE THE ITEMS AS FOLLOWS:

1. Secure life threatening items first (e.g. Wardrobe in bedroom, things blocking exit, etc.).
2. Secure those things that would cause significant economic loss (e.g. Computer, equipment, etc.)
3. Secure those items that will let you live more comfortably (e.g. Family heirlooms, breakables, etc.).

Continue to use the Earthquake Hazard Hunt list to check your progress in non-structural risk reduction.

E. COMMUNITY EARTHQUAKE HAZARD HUNT

Remind the children that earthquakes never cause death or injury. All deaths and injuries from earthquakes are caused by falling debris from damaged buildings.

Building damage can include:

- Toppling chimneys,
- Falling brick from walls and roof decorations, such as parapet and cornices.
- Collapsing exterior walls, falling glass from broken windows.

Damage inside the building can include:

- Falling ceiling plaster and light fixtures,
- Overturned bookcases, furniture, etc.

In the community, earthquake can cause:

- Downed power lines,
- Damage to bridges, highway, and railroad tracks,
- Flooding from dam failure, damage to reservoirs and water towers,
- Fires from spilled gasoline and other chemicals,
- Liquefaction and landslides,
- Water sloshing in ponds, pools, etc.
- Tsunami in costal zones.

3.2 THE SCHOOL DISASTER PREPAREDNESS PLAN

The school disaster preparedness plan should start with head teachers, teachers and children gathering.

A. SCHOOL GATHERING:

In preparation for a disaster, all the head teachers and teachers of the school, including school children should come together for a meeting. In this meeting, head teachers and teachers will discuss preparations prior to, during and after an earthquake disaster. This gathering could be divided into two groups. As for an evacuation plan, they should discuss (1) local maps, (2) plan of school, (3) describe school, (4) Describe setting of school: surrounding area and location of nearest emergency services, (5) Response scenarios: evacuation routes with alternatives, assembly points and their safety, refuges (churches, mosques, community centres, etc.) and routes to them, (6) Conduct evacuation drills: permanent signs (coloured arrows) to exits, (7) designate rooms for first aid, (8) Procedure for contacting parents and safely returning students to them if school closes and (9) Acquaint parents with the school's evacuation plans and inform them of where their offspring can be picked up under particular evacuation situations

B. SAFE LOCATIONS:

Spot danger areas in your school where to stay away from: in front of windows, there are large and heavy hanging light fixtures, heavy and large objects that can slide and

fall, sources of fire. Look for safer spaces where you can be protected: under a strong table, next to a strong sofa or chair, next to your bed, in a corner, or by an inside wall.

C. EXIT ROUTES:

Identify the regular exit routes and also substitute exits that you may not have thought about, through windows and back doors. Learn all the exits from your building. And school. Are all exits safe for use in all cases? If there are iron bars on an outside window or door, you should keep a heavy iron pry bar inside the building, in case you need to break these open. If there are any objects that can block the exit routes by sliding and falling, these should be removed. For example, objects which stand behind a door, i.e. rolled up carpets or vacuum cleaner.

Do you know?

During the Algiers-Boumerdes (Algeria) earthquake of 21 May, 2003 many families lost their lives because the exit routes were blocked, mainly by iron bars on and outside the windows. Electric doors were blocked by the lack of electricity and thus people could not exit and thus were killed by the collapse of the building.

D. FOOD AND WATER:

Water is essential for survival. During an earthquake you can expect that many pipes will be broken, both in the streets, and the pipes that bring water into your school. Water may be contaminated along the way by many sources. Children are to assemble an easy-to-carry kit which can be kept in the classroom for emergencies.

Essential items for the kit will include:

- Bottled water and cups (Use plastic containers to cut weight and avoid breakage),
- Class roster with students names and addresses,
- First aid checklist and supplies,
- Flashlight and spare batteries

E. TURNING OFF UTILITIES:

Following an earthquake the major threat is from fire. If there is any risk of gas leakage, these valves should be turned off first. Also, there are possible breaks in the electrical wires, and then electricity should be turned off. **Everyone should learn to turn off these utilities.**

F. ASSEMBLY PLACES:

Identify an assembly place inside your school and outside your school in the neighborhood. Family members may not be together when an earthquake occurs. You will save a lot of anxiety and worry, if parents know where to find the school children. It may take a lengthy time to get in touch with each other. This plan will save you from panicking about how to contact your parents.

First decide on a place to gather inside your school. It should be safe, central place or on the way to exit. This is where children will meet after the earthquake stops. Then decide on a safe place outside your school, away from overhead risks where you can meet if your neighbourhood is safe. This might be a park or square. This is where you will meet if your building is not safe.

You should plan for children to remain at school, whenever it is possible, until their parents or another pre-approved relative or friend arrives to pick them up after an earthquake.

3.4 DO NOT USE THE TELEPHONE UNLESS YOU HAVE A PHYSICAL EMERGENCY

Do not use the telephone **after** an earthquake unless there is a life-threatening emergency. Otherwise telephone lines will not be able to be used by those who are in need. What feels small to you may be large somewhere else.

During an earthquake telephone receivers can be removed from the hook. Replacing the telephone receivers after an earthquake will help get telephone services back to normal more quickly.

DO NOT LIGHT ANY FLAME AFTER AN EARTHQUAKE:

After an earthquake you should **never** light a flame of any kind.

3.5 EARTHQUAKE DRILL

The human brain responds to emergencies in one of three primitive ways: fight, flee, or freeze. All are form of panic. They do not work well for you now that you live in buildings and cities. You need to plan and practice our responses so that you do not panic.

You need to have earthquake drills at school, at home, at work, and at community level.

When an earthquake occurs, the solid earth will pitch and roll likes a ship for almost a minute. The shaking may start out gentle and then you may feel a sharp jolt followed by swaying or rolling. If you are near strongest ground shaking it will be impossible to move around much. Keep calm and ride it out. Your chances of getting through it safely are good if you act calmly and protect yourself from falling objects.

The rules are simple.

If you are outside:

- Stay outside
- Go to open area from hazards

If you are inside:

- Crouch under a desk or table,

- Face away from windows,
- Bend your head close to your knees,
- Use one hand to hold onto the table leg and protect your eyes with the other hand.

If no desk or table is nearby:

- Kneel against an interior wall,
- Face away from windows,
- Bend your head close to your knees,
- Clasp hands on the back of your neck.

Do you know?

Since we never know until the shaking has stopped which quakes are foreshocks or aftershocks and which is the main shock, it is essential to Drop and Cover at the first sign of an earthquake.

Practice:

DROP, COVER AND HOLD

- Find a safe place and **drop**
- **Cover** your head and neck
- **Hold** on to something secure
- Stay where you are and do not move until the shaking stops.

Drop, means get down low. **Cover** means, cover your head and neck especially. **Hold** means hold on to something stable so that you do not go sliding.

Drop, cover and hold under a strong table, next to your bed, next to a sofa, by an inside corner or wall.

How to make yourself safe? **Practice.** You should have formal earthquake drills at school or at work and the community level. You can also play this informal **Earthquake Drill Game** at home. Playing this game now may save yourself and your family from serious injury.

Rules:

1. Find the safest places in the classroom at school. Physically go to those spots and practice your positions.
2. In the days that follow this initial exercise hold surprise earthquake drills. Call "**EARTHQUAKE**". Each child should respond by moving to the nearest safe place. Stay in place for one minute. Then move towards your meeting place in the school. A minute or two later, shout "**AFTERSHOCK**" and do the same thing. When the teacher gives the instruction to **EVACUATE!** then proceed through the building evacuation route. Take along your classroom emergency kit.

3. Once a month let a child call a surprise "EARTHQUAKE" and follow through with what you have learned. Test each other. Was your choice the safest? Did you meet afterwards where you said you would? Did you do the same things during the aftershock?
4. Now you know what to do! When the shaking is over, stay close. Share the clean-up chores. Talk about what happened and be sure to let all the children say what they felt, how afraid and how brave they were.

At school, children must practice being quiet and orderly and learn to follow their teacher's instructions carefully. Tell the children that during an earthquake it is important to stay where they are and take immediate quake-safe action. After the shaking stops, children will check themselves and their neighbour; and listen quietly for instructions. Explain some of the hazards that may exist even after the major earthquake has passed, including aftershocks, fires, live electrical wires, and fumes.

3.7 CHILDREN WITH SPECIAL NEEDS

Do not excuse children with special needs from participating in earthquake drills. Children who blind, deaf, or have impaired mobility especially need experiences which build confidence in their ability to avoid and cope with dangers. Plan with other teachers and the school nurse to determine quake-safe actions for these children.

It may not be possible for children with impaired mobility to get under a desk or table. They can, however, learn to react quickly and turn away from windows; move away from light fixtures and unsecured bookcases; and use their arms or whatever is handy to protect their heads.

3.8 EARTHQUAKE-SAFE CLASSROOM CHECKLIST

- 1. Replace heavy lamps on tables with light, no-breakable lamps.
- 2. Change hanging plants from heavy pots into lighter pots
- 3. Remove all heavy objects from high shelves
- 4. Remove all fragile objects from high shelves
- 5. Take glass bottles out of medicine cabinets and put them on lower shelves
- 6. Move materials that can easily catch fire so they are not close to heat sources
- 7. Attach water heater to the studs of the nearest wall.
- 8. Move heavy objects from exit routes in your classroom or school.
- 9. Block wheeled objects so they cannot move.
- 10. Attach tall furniture such as bookshelves to studs in walls.
- 11. Employ flexible connectors where gas lines meet appliances such as stoves, water heater and dryers.
- 12. Fasten heavy appliances such refrigerators to studs in walls.
- 13. Make sure heavy mirrors are well fixed firmly to walls.
- 14. Make sure heavy pictures are well fixed firmly to walls.
- 15. Make sure heavy air conditioners are well fixed firmly to walls.
- 16. Take away dead or diseased tree limbs that could fall on the school.

4. ACTIONS DURING AN EARTHQUAKE

As events progress rapidly during an earthquake, you will have little time to think. First you hear a sound, then shaking starts.

If there are others in your surroundings, shout "**EARTHQUAKE - EARTHQUAKE**" just as you practiced in your drill, to warn them to take cover. If it was just a small earthquake or a passing truck, don't be humiliated -you just had another good earthquake drill. This exercise is necessary.

4.1 WHAT YOU MUST DO DURING AN EARTHQUAKE

Children should learn how to behave during earthquakes wherever they are during the shaking.

- **Stay calm!** If you're indoors, stay inside. If you're outside, stay outside.
- **If you're indoors**, stand against a wall near the centre of the building, stand in a doorway, or crawl under heavy furniture (a desk or table). Stay away from windows and outside doors. **DROP, COVER and HOLD:**
- Find a secure place and **drop** (move away from windows and glass and away from large heavy things). **Drop** under a solid table or a similar object.
- **Cover** your head and neck. Take cover beside the inner walls, corners and doors.
- **Hold** on to something secure.
- If you are in the kitchen, move away from the refrigerator, stove, and overhead cupboards. Don't use matches, lighters, candles, or any flame. Broken gas lines and fire don't go together.
- Stay where you are and do not move until the shaking stops.
- **If you're outdoors**, stay in the open away from trees and power lines or anything that might fall. Stay away from buildings (objects might fall off the building or the building could fall on you).
- **If you're in a car**, stop the car and stay inside the car until the shaking stops. Keep away from bridges, underpasses or electric poles.
- Don't use elevators (they'll probably get stuck anyway).
- **In narrow city streets:** There are very few places outside that are secure. In fact, running out of the building may be the most hazardous thing to do.
- If you are on a **sidewalk near buildings**, go inside the doorway to protect yourself from falling bricks, glass, plaster and other objects.
- If you are in a **crowded store** or **other public place**, do **not** rush for the exit. Move away from display shelves containing objects that could fall.
- If you are in a **stadium** or **theatre**, stay in your seat and protect your head with your arms. Do not try to leave until the shaking is over. Then leave in a calm, orderly manner.
- If you are in a **wheelchair**, stay in it. Move to cover, if possible. Lock your wheels and protect your head with your arms.

4.2 WHAT YOU MUST NOT DO DURING AN EARTHQUAKE

- Do not run to the stairs or exit doors,
- Do not go out to the balcony,
- Do not jump from balconies or windows,
- Do not use the elevator.
- Do not rush toward exits.

5. ACTIONS AFTER AN EARTHQUAKE

5.1 What You Must Do After an Earthquake

- **Stay calm. Do not panic.** If you don't feel calm pretend to be calm. That will help your classmates and all others around you.
- **Check yourself, your classmates and all others around you for injuries.** Provide first aid for anyone who needs it.

INSIDE

- **Check for fire.** Take appropriate measures and precautions if possible.
- **Check water, gas, and electric lines for damage.** If any are broken, shut off the valves. Check for the smell of gas. If you smell it, open all the windows and doors, leave immediately, and report it to the authorities (use someone else's phone). Don't use matches, flashlights, appliances or electric switches.
- **If your building is damaged,** leave the building **when the shaking stops.**

OUTSIDE

- **Stay out of damaged buildings.** If your building is damaged you should not panic. You should calmly and carefully exit your building. On your way out pick up your evacuation bag and water and go to a secure place.
- Be careful around broken glass and other hazardous objects. **Be careful of chimneys** (they may fall on you).
- **Stay away from beaches.** Tsunamis and seiches sometimes hit the seashore after the ground has stopped shaking.
- **Stay away from damaged areas.**
- If you're at school, work, shop or public building, follow the emergency plan or the instructions of the person in charge.
- **Expect aftershocks.** Earthquakes come in clusters. Several aftershocks usually occur within the first hour after the main shock. Aftershocks generally occur during the following days, weeks, months and even years, but getting smaller and less frequent. During an aftershock you should behave exactly as you did during the main earthquake. **Aftershocks are natural.**

5.2 What You Must Not Do After an Earthquake

- Do not panic, scream or run.
- **Do not use telephone except to report physical emergency and fire.** You may have been seriously shaken and be well -but somewhere else someone needs help and your phone call will prevent theirs from getting through. Leave the telephones free so that neighbourhoods with real emergencies will be able to get the help they need and so that authorities and media can get information through to speed help. Make only one call to your out-of-area contact.
- **Do not light any match, lighter, candle or fire** unless in presence of an adult and when all risk of escaping gas and other flammables is gone. If you smell gas, turn it off where possible, open the windows and doors and exit immediately. If it is dark, turn on your flashlight.

5.3 EVACUATION

5.3a BUILDING EVACUATION

Building evacuation is conducted in order to make sure that everyone is secure and accounted for, and to assess damage before re-entering the building. Building evacuation should be done calmly and carefully. If **at school**, follow the instructions of your teacher and **in the community** follow the coordinator of the emergency operations.

There may be more risk outside your building than inside.

There may be no secure assembly area outside.

There may be no clear routes to get outside.

Alternative routes may need to be cleared.

5.3b AREA EVACUATION

Evacuation should never be automatic. It must be planned and checked before it can be implemented.

There are two main reasons why some areas should be evacuated:

1. Low lying areas immediately by the coast should be evacuated because the ground may be particularly unstable. Everyone should move carefully to higher stable ground away from the shore.

2. Fire or chemical risks may require people to move quickly out of the way of hazard.

However, in general, an earthquake itself is **NOT** a reason for evacuation. Before beginning an evacuation, it must be determined that there is a secure place to go and a safe way to get there.

After a severe earthquake, children in the affected area **should not be sent anywhere** on service buses, until it has been determined that the route and the destination are both safe. Instead, everyone should be prepared for children to stay at school until their safety can be assured, and until they can be released to parents or pre-designated relatives or friends.

5.4 PSYCHOLOGICAL SUPPORT

Disasters affect people and particularly children in so many ways. There is a variety of behaviour that is normal under these unusual circumstances. Children experience many different losses in an earthquake disaster. There is a natural grieving process following any loss and a disaster causes much anguish.

Some normal initial responses to disaster include:

- Fear
- Disbelief
- Disorientation and numbing
- Reluctance to abandon everything
- Need for information
- Seeking help
-

Soon after there may be other responses

- Change in appetite
- Anxiety
- Anger and suspicion
- Apathy and depression
- Crying
- Frustration and feelings of powerlessness
- Moodiness and irritability
- Increased illnesses
- Difficulty sleeping
- Headaches
- Disappointment with and rejection of outside help
- Isolating oneself from family and friends
- Guilt
- Domestic violence
- Inability to enjoy normal activities

Young children may also experience:

- Return to earlier behaviours
- Clinging to parents

- Reluctance to go to bed
- Nightmares
- Inability to concentrate
- Refusal to attend school.

6. CONCLUSION

Based on the lessons from the past disasters in Africa as well as in other countries, it is of interest to remind the African countries that they have to involve gender-sensitive regulatory and legal measures, institutional reforms, improved analytical and methodological capabilities, education, awareness, financial planning and political commitment. It is recommended the following recommendations for the African countries particularly:

Increasing awareness among public and private schools. In general, public school safety policies are more likely to focus more on school violence prevention than on natural and man-made hazard preparedness. As such, earthquake and other natural hazard preparedness issues have a tendency to be included just as a sentence or paragraph within a larger policy dealing with school violent behaviour, student attending, and order. The encouraging impact of this policy structure is that it could be used to support integrated planning, with disaster planning being one element. The negative effect is that earthquake and other natural hazard preparedness may be given inadequate attention at the private schools.

Developing comprehensive policies: from preparedness and mitigation to response. State policies typically call on schools to develop school safety plans, evacuation plans, or hazardous materials plans. While it is a subtle distinction, it bears noting that school plans are not policy. Many plans typically consist of a checklist of response actions to conduct in case of an emergency. Public and private school policies on earthquake preparedness, on the other hand, should include a vision statement and a more holistic description of school safety, including preparedness, mitigation, and response.

Ensuring greater coordination of school safety plans to create a more uniform and robust approach to school safety planning. While local education agencies are either encouraged or required to develop school safety plans, the content of those plans is largely left to local discretion. This has led to an unevenness of policies and plans across districts. As a result, some local education agencies approach school safety planning in a comprehensive manner; others develop plans that barely meet the state requirements. Even the concept of a "safety drill" may look very different from district to district.

Ensuring compliance with school safety policies. Education leaders should explore the interest and feasibility of improved monitoring with compliance school safety policies. If state education policymakers decide that enhanced monitoring is desirable, education officials may want to transfer that responsibility to the community or to the state-level emergency management structure.

Addressing the needs of disabled children and communicating with the community. It is important for governments to provide specific guidance to schools regarding the needs of children with disabilities. Schools have increasingly become the centre of community life, providing medical services, referrals to other community organizations, and evening education courses for the community. As such, they can be education vehicles for the field of earthquake preparedness as well.

In all, education policymakers and administrators in conjunction with national; regional and local disaster management structures should consider giving more explicit guidance and training in school for earthquakes and other disaster preparedness.

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