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Helpdesk Research Report

Assessing seismic risk in Kenya

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Question

Identify data on, or ways to assess, seismic risk in Kenya. Where possible, identify what the data suggests about the absolute levels of risk, the relative levels of risk compared to other countries, and which populations are particularly vulnerable.

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1. Overview

This report identifies literature that assesses seismic risk in Kenya. In this report seismic risk, as a concept, is understood to be the product of seismic hazard (the probability of harmful seismic phenomena) and seismic vulnerability (the degree of loss from seismic phenomena).

In terms of **overall seismic risk**, the presence of part of the East African Rift, which runs through the west of Kenya and the Davie fracture just south of the Mombasa, means that Kenya is vulnerable to seismic activity and related natural disasters: earthquakes, volcanic eruption and tsunamis.

Kenya faces a relatively low **earthquake hazard** in comparison to neighbouring countries with hazard levels highest in the north-west and south-west regions. There have been tremors in the past, but no significant damage or loss of life despite public alarm. The cities with the greatest degree of hazard are Nakuru, Eldoret, Kisumu and Kakamega which have a medium degree of seismic hazard (see WHO 2010 for the hazard scale). Nairobi faces a low degree of hazard and Mombasa very low.

Mombasa and the rest of the Kenyan coast have a modest degree of **tsunami hazard**. Kenya has only experienced one recorded tsunami, that arising from the Indian Ocean Earthquake of 2004, the impact of

which was relatively minor. According to assessments, the coast is vulnerable to 2 metre high waves and water reaching 500 metres inland. It has not been possible to estimate **volcanic hazard** in this helpdesk report.

In terms of **overall vulnerability**, an earthquake in Kenya is likely to result in more economic loss than in neighbouring Somalia, but at similar levels to other neighbouring countries. In this helpdesk report it has not been possible to obtain sub-national data or finite estimates of loss resulting from seismic activity.

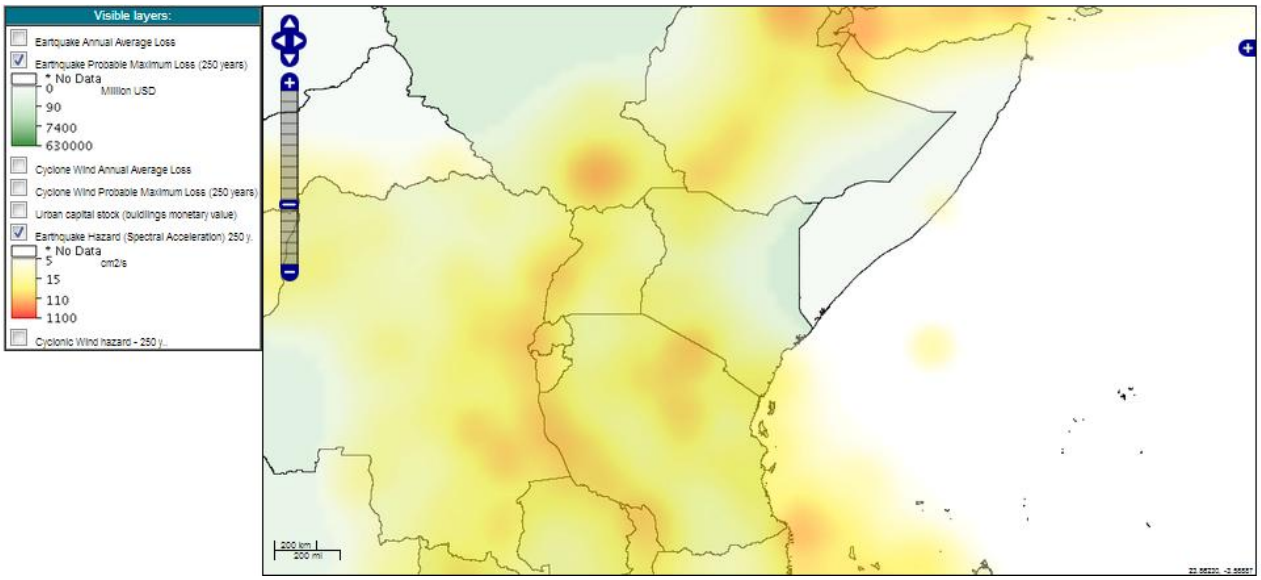
Most key vulnerability analyses do not cite seismic activity and subsequent natural hazards as a significant concern in Kenya. These vulnerability analyses do not estimate the **vulnerability of different populations** to seismic-related hazards but do identify populations vulnerable to hazardous factors and humanitarian risk in general. It may be that these vulnerable groups – primarily refugees, internally displaced persons (IDPs), and those working in agriculture – are more vulnerable to seismic hazards. Those vulnerable to conflict; flooding; and water, sanitation and hygiene-related diseases may also be more vulnerable to seismic risks.

2. Risk

Kenya is traversed by the seismically active Great African Rift Valley, one of the most earthquake prone areas of the world (MSSP n.d.). Consequently the area of the Great Rift Valley within Kenya and parts of the Nyanza basin are prone to earthquake and volcanic activity. However, casualties resulting from earthquakes have been low (MSSP n.d.). In July 2007, for example there were earth tremors that emanated from Mount Oldoinyo Lengai in Northern Tanzania but were felt in Nairobi, Mombassa, and Nakuru causing public scare (MSSP and NDOC 2009).

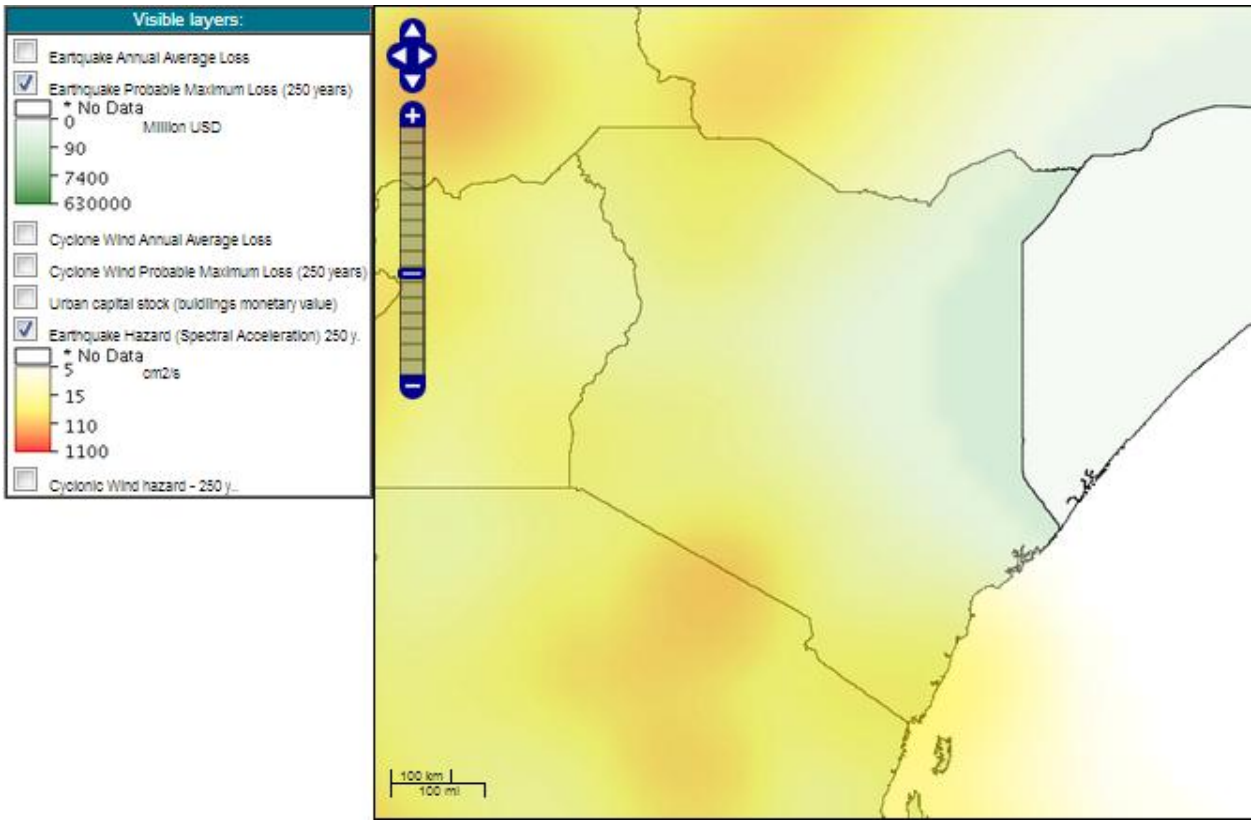
Based on data from the Global Assessment Report on Disaster Risk Reduction 2013, figure 1 illustrates the level of earthquake risk in Kenya and surrounding countries. Figure 2 focuses closer on Kenya. In these maps the green represents the degree of vulnerability to earthquake loss with darker green meaning more significant loss. The yellow to red colour represents the degree of earthquake hazard with red being the most significant and yellow being less significant.

Figure 1. Earthquake risk for Kenya and surrounding countries (Global Assessment Report on Disaster Risk Reduction 2013)



Source: Risk Data Viewer http://risk.preventionweb.net

Figure 2. Earthquake risk for Kenya (Global Assessment Report on Disaster Risk Reduction 2013)



Source: Risk Data Viewer http://risk.preventionweb.net

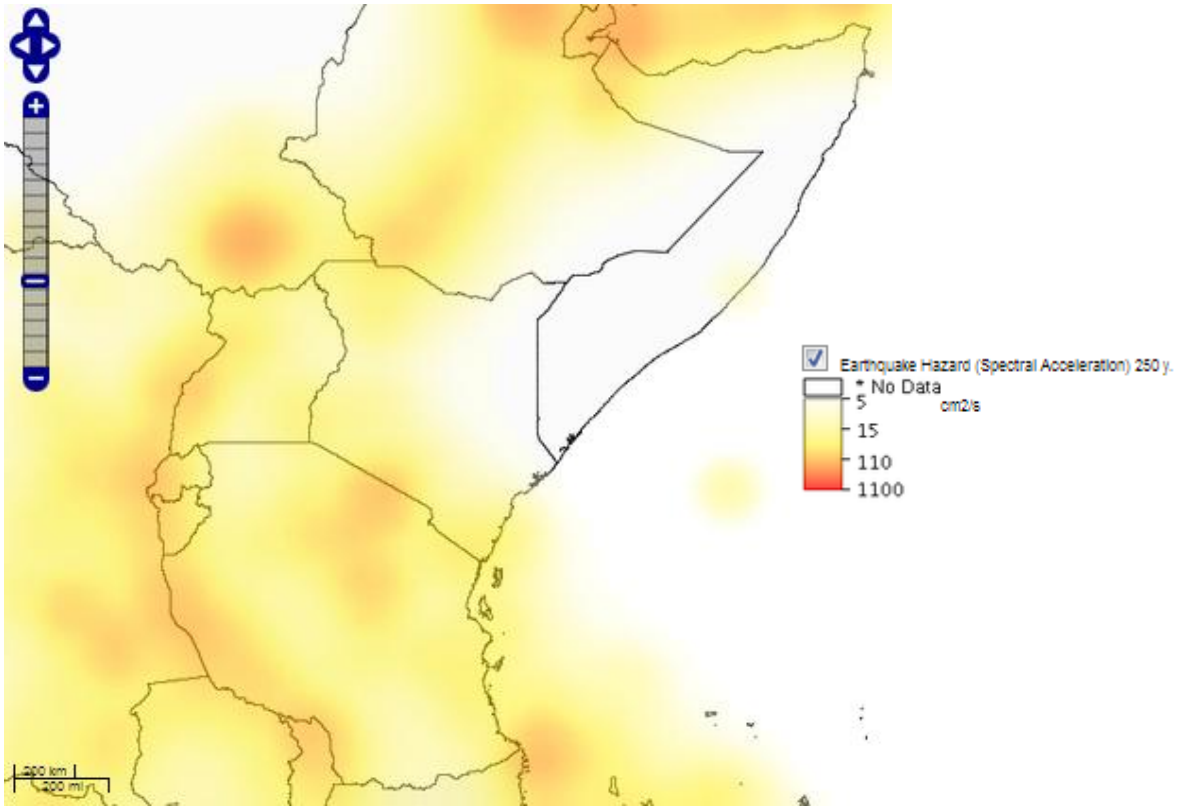
3. Hazard

The East African Rift System (EARS) is a 50km to 60km wide zone of volcanoes and faults that extend north to south in Eastern Africa for more than 3000km (1864 miles), from Ethiopia in the north to the Zambezi in the south. Kenya is located within the East African Rift System with the Rift running through the western part of Kenya and acting as the main source of seismicity in Kenya (Ngunjiri 2007). This section gives an overview of hazard in Kenya from earthquakes, tsunamis, and volcanoes.

3.1 Earthquake hazard

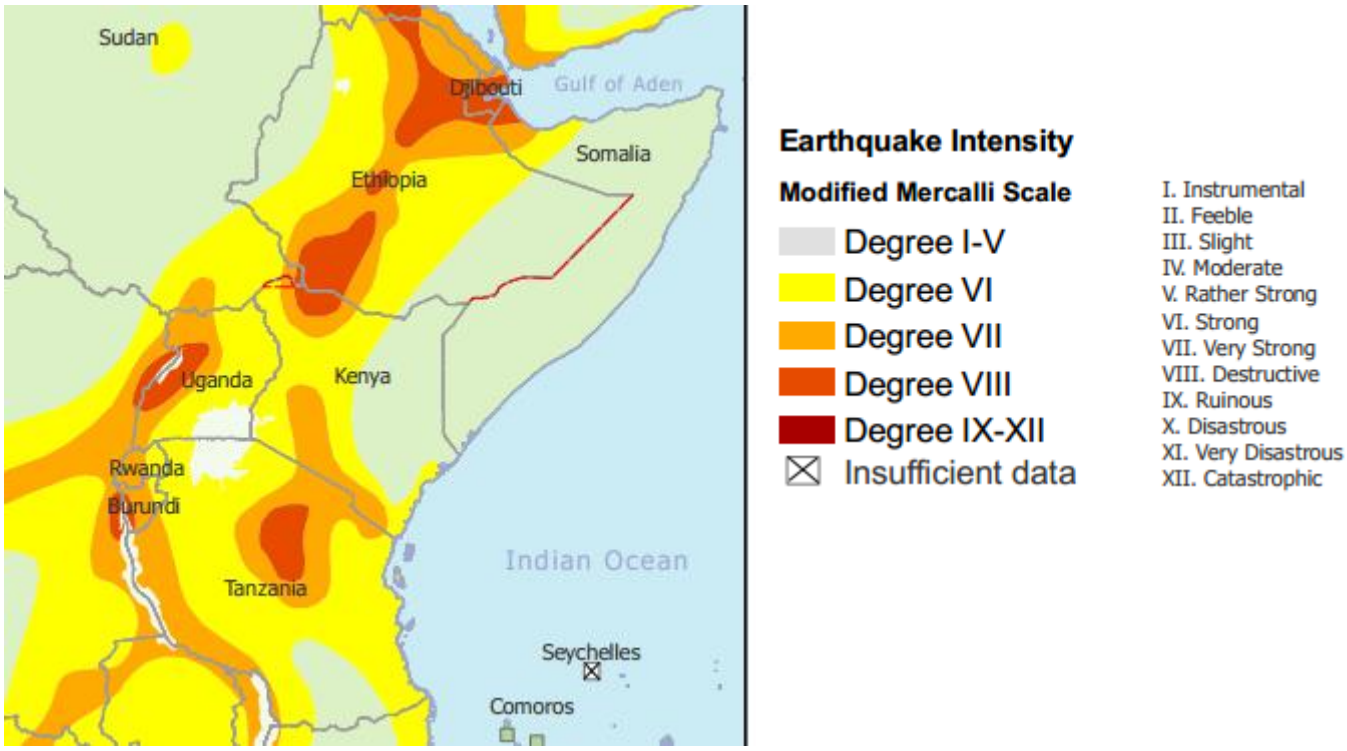
Figures 3 and 4 demonstrate how earthquake hazard and intensity is most prominent along the rift that runs from the north-west to the south-west of Kenya with particular hazard/intensity around the north-west and south-west borders. Figure 4 suggests that there are areas in Kenya where earthquake activity may be destructive although most of western Kenya faces strong and in some cases very strong earthquake intensity.

Figure 3. Earthquake hazard for Kenya and neighbouring countries (Global Assessment Report on Disaster Risk Reduction 2013)



Source: Risk Data Viewer http://risk.preventionweb.net

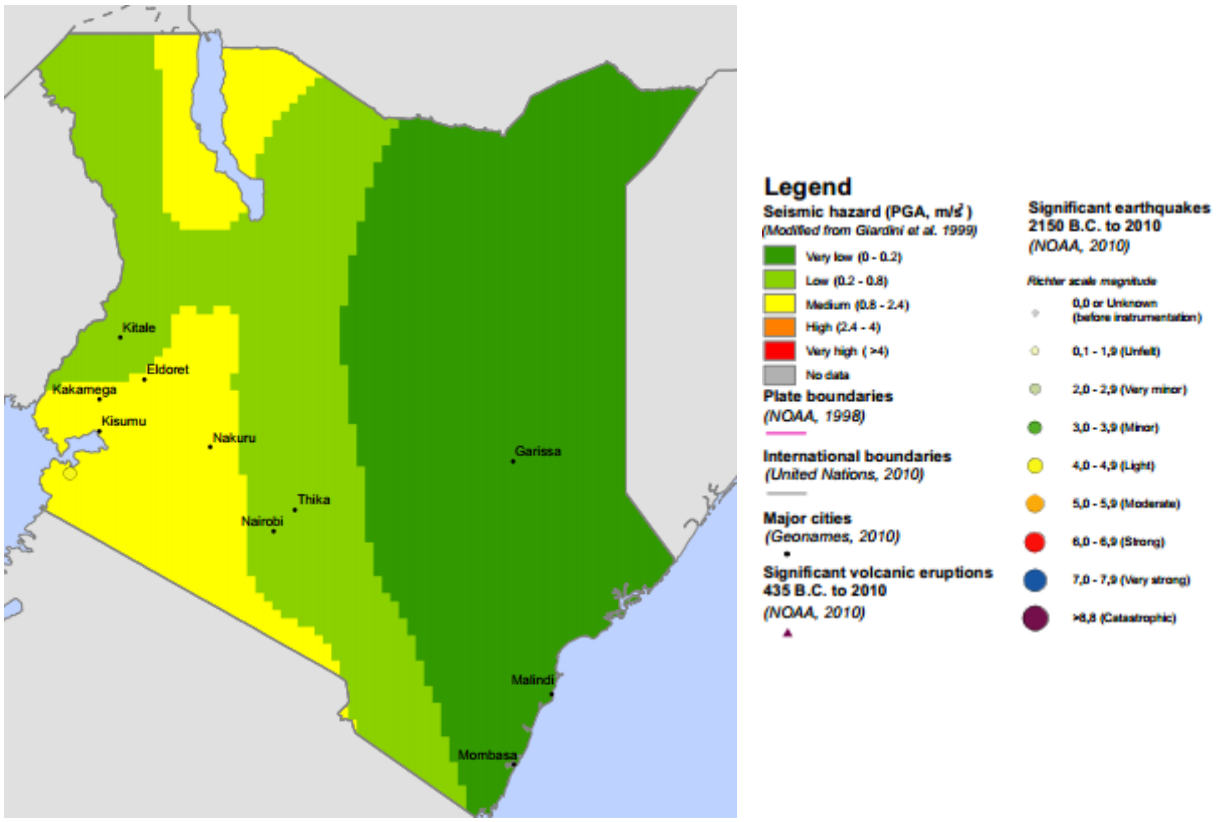
Figure 4. Earthquake hazard for Kenya and surrounding countries (OCHA)



Source: OCHA 2007

Figure 5 shows the major cities in relation to seismic hazard. Of note is that the most populous cities Nairobi and Mombasa are in areas with low and very low seismic hazard. Nakuru, Eldoret and Kisumu, with populations of over 200,000, are based in an area of medium seismic hazard.

Figure 5. Seismic Distribution Map (WHO)



Source: WHO 2010

Although Mombasa is located away from the East African ridge it is located near to a seismically active area of the Davie fracture, a tectonic plate fracture zone, which runs from Kenya due south towards Madagascar and Mombasa's population is to some extent at risk from this (Keima expert comments).

3.2 Tsunami hazard

Tsunami hazard assessment has shown that the Kenyan coast is vulnerable to tsunamis that are generated in Indian or Pacific oceans (Amollo 2007). Simulations have shown that the region can experience tsunami wave heights of up to 2m high and inundation extent is greatest in the unprotected areas reaching about 500m inland. However, Kenya has only recorded one tsunami in its history, that of the 2004 Indian Ocean tsunami.

Kenya has a 600km long coastline, with Mombasa as the principal Kenyan seaport and a number of settled communities and establishments based on the coast. The coastal region is low-lying and is characterized by a fossil reef that lies a few meters above sea level. Kenyan mangrove forests, which have served as a defence against strong waves, have been over-exploited, and in some cases completely destroyed with the areas converted to other uses such as for salt ponds. This has left vast areas bare leading to coastal erosion and lack of protection against storm surges and tidal waves (MSSP n.d.).

The 2004 Indian Ocean tsunami reached Kenya and is the first recorded tsunami in Kenya (Ngunjiri 2007). It came at low tide and was consequently less damaging than to other countries, especially those closer to the epicentre of the earthquake. One person was reported dead and there was property destruction of varying magnitudes along the entire coastline, especially to the fishing industry. Malindi Bay and Lamu

were most affected by destruction of fishing gear, boats and lost man-hours, which was due to these areas being wide, shallow and open (MSSP n.d.).

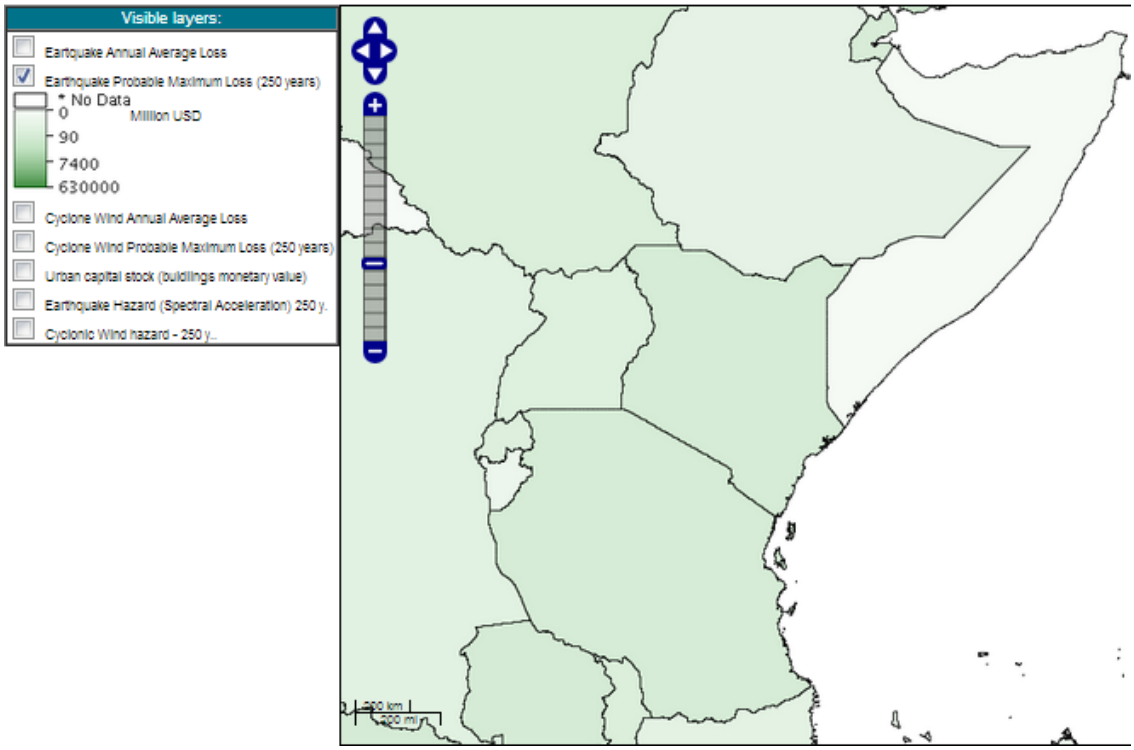
3.3 Volcanic hazard

The volcanoes within Kenya are extinct and dormant running from North to South and East to West (MSSP 2009). In this study it was not possible to identify data that illustrates volcanic hazard.

4. Vulnerability

There is limited literature that documents specific vulnerability to earthquakes in Kenya. Figure 6 below provides an overview of probable maximum economic loss from an earthquake, which allows for comparison between neighbouring countries. However sub-national data did not seem to be available.

Figure 6. Earthquake Probable Maximum Loss (Global Assessment Report on Disaster Risk Reduction 2013)



Source: Risk Data Viewer http://risk.preventionweb.net

A number of key reports that examined vulnerability in Kenya along various dimensions (e.g. Oxfam 2009, Parry et al. 2012, Christiansen & Subbarao 2004) do not cite earthquakes, volcanic activity or tsunamis as a major concern although they are often listed under natural disasters that Kenyan's may face.

The most recent Emergency Humanitarian Response Plan for Kenya 2013 (Parry et al. 2012) notes that communities remain vulnerable to disasters due to factors, such as poverty, livelihood insecurity, and settlement in areas prone to seasonal flooding or with poor infrastructure and services, such as informal urban settlements. These groups are vulnerable to hazards such as droughts, floods, landslides, epidemic

outbreaks and climatic change. The report makes no specific note of seismic activity and subsequent hazards such as earthquakes and tsunami.

Based on population growth, high poverty rates (57% of Kenyans live below the poverty line), unemployment, the high prevalence of HIV/AIDS and an economy largely dependent on rain-fed agriculture the report argues that a significant proportion of the population is highly vulnerable to disasters, and any small, predisposing factor may result in emergencies of high proportion, often culminating in national disasters (Parry et al. 2012).

Parry et al. (2012) highlights the following areas as highly vulnerable disaster-affected districts: **Turkana NE, Turkana South, Turkana NW, Turkana Central, Mandera West, Mandera Central, Mandera East/North, Wajir West/North, Wajir East, Marsabit, Wajir South, Garbatulla**.

The report does not specify that these districts and groups are particularly vulnerable to seismic risk, but rather humanitarian risk in general.
Specific groups listed as vulnerable include: **refugees and internally displaced persons (IDPs) (especially refugee/IDP women and children); and agro-pastoralists, pastoralists and small-scale farmers (especially those in Arid and Semi-arid Lands)**.

Those prone to other humanitarian risks may well be more vulnerable to seismic risks than the larger population. The Kenyan water, sanitation and hygiene (WASH) sector coordination mechanism (WESCOORD) coordinates support to WASH measures in times of drought emergencies and support for preparedness, risk reduction and recovery measures after drought. The mechanism has identified a number of priority counties noting their conflict and flooding risks, as well as the likelihood of WASH-related disease outbreaks (see table 1). These **priority counties** may well be more vulnerable to other risks such as seismic risk.

Table 1. Water, sanitation and hygiene sector coordination mechanism (WESCOORD) locations

WESCOORD Priority Counties	Conflict Risks	Flooding Risks	Likelihood of WASH-related disease outbreaks
Garissa	High	High	High
Isiolo	High	Low	Low
Kilifi	High	Moderate	Moderate
Kisumu	High	High	High
Kwale	High	Moderate	Low
Laikipia	High	Low	Low
Mandera	High	Low	High
Marsabit	High	Low	Moderate
Migori	High	High	High
Narok	High	Low	Moderate
Tana River	High	High	High
Wajir	High	Moderate	High
West Pokot	High	Low	Low
Baringo	Moderate	Low	Low
Busia	Moderate	High	High
Kajiado	Moderate	Low	Low
Kitui	Moderate	Low	High
Makueni	Moderate	Low	Moderate

WESCOORD Priority Counties	Conflict Risks	Flooding Risks	Likelihood of WASH-related disease outbreaks
Samburu	Moderate	Low	Low
Taita Taveta	Moderate	Low	Low
Kitui	Moderate	Low	Low
Tharaka	Moderate	Low	Low
Turkana	Moderate	Low	Moderate
Machakos	Low	Low	High

Source: Parry et al. 2013

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Key websites

- Global Assessment Report on Disaster Risk Reduction 2013 Data Platform: http://www.preventionweb.net/english/hyogo/gar/2013/en/home/data-platform.html

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