COMPARATIVE RISK ANALYSIS

SUMMARY

This document summarises the relative risks of natural hazards to Haiti in the coming months, in order to inform the shelter cluster contingency planning strategy.

Three main risk categories have been identified:

- Earthquakes
- Hurricanes (wind and rain/flooding risk)
- Flooding

On the basis of each event's likelihood, the most significant risk to Haiti in the coming months remains that of flooding caused either by heavy downpours during the rainy season, or by rain caused by tropical storms during the hurricane season. Extensive deforestation exacerbates the effects of heavy rainfall, frequently resulting in flash flooding and landslide.

1. EARTHQUAKE RISK

Earthquake related risks can be largely divided into two categories: risk of aftershocks, and risk of further significantly large earthquakes.

1.1 Aftershocks

Based on the characteristics of the observed aftershock sequence between January 12th and February 23rd, the United States Geological Society (USGS) issued an update to their published estimate of aftershock probability (Table 1).

Aftershock magnitude (M)	30-day period	90-day period	1-year period
M 5 or greater	55%	80%	95%
M 6 or greater	7%	15%	25%
M 7 or greater	1%	2%	3%

Table 1. Estimate of Aftershock probability (USGS)

"The aftershock activity will continue for many months, although the frequency of events should diminish with time. Nevertheless, the threat of additional damaging earthquakes within the sequence remains."

1.2 Further significant earthquakes

Whilst predicting future significant earthquakes remains a very inexact science, the USGS has produced the following summary of ongoing earthquake risk in Haiti:

"The geologic fault that caused the Port-au-Prince earthquake is part of a seismically active zone between the North American and Caribbean tectonic plates. The earthquake undoubtedly relieved some stress on the fault segment that ruptured during the event, but the extent of rupture along the fault is unclear at this time. Fault slip models, preliminary radar surface deformation measurements, and examination of satellite and airborne imagery for surface rupture suggest that the segment of the Enriquillo fault to the east of the January-12 epicenter and directly adjacent to Port-au-Prince did not slip appreciably in the earthquake. This implies that the Enriquillo fault zone near Port-au-Prince still stores sufficient strain to be released as a large, damaging earthquake during the lifetime of structures built during the reconstruction effort. In historic times, Haiti has experienced multiple large earthquakes,

apparently on adjacent faults. Field studies and ground observations of fault offsets during this earthquake and in past events are essential to evaluate the potential for future earthquakes in proximity to Port-au-Prince."

See Reference section for link to the full report from the USGS.

2. HURRICANE/TROPICAL STORM RISK

The Caribbean is one of the world's most active hurricane regions. The North Atlantic hurricane season begins in June and ends in November, peaking during the months of August September and October. The risk from hurricanes can be both in terms of wind speed causing damage to structures, and from heavy rainfall associated with such tropical storms.

2.1 Historical Hurricane Data

Haiti has been particularly badly affected by hurricanes in recent years. In 2004, Hurricane Jeanne caused major damage resulting in deadly flash-floods and mudslides. Over 3,000 people died and roughly 200,000 were left homeless. In 2008, four storms - Fay, Gustav, Hanna, and Ike - dumped heavy rains, killing 793 (a further 310 reported missing), destroying 22,702 homes and damaged another 84,625. The flood also wiped out 70% of Haiti's crops, resulting in dozens of deaths of children due to malnutrition in the months following the storms. Figure 1 shows tropical storm/hurricane tracks near Haiti since 1950.

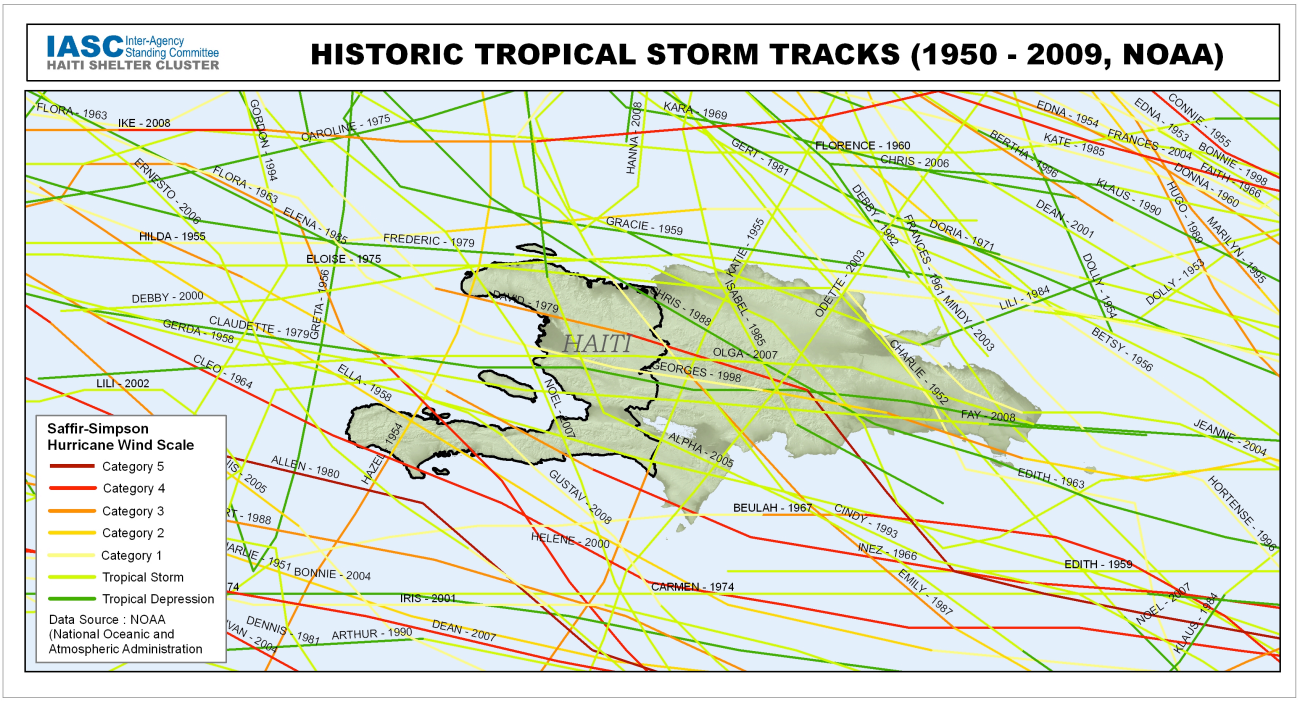

Figure 1. Historic Tropical Storm tracks near Hispaniola – 1950 to 2009 (NOAA)

Though hurricanes and tropical storms are classified by wind speed to determine the intensity of the storm, damage from high winds present less of a threat to the population than heavy rains. Historically, more deaths have been caused by flash flooding associated with tropical storms than by the effects of high winds.

Relative to the rest of the Caribbean, Haiti is not significantly more likely to be hit by a hurricane or tropical storm – however, severe deforestation has made the country extremely vulnerable, leaving bare

mountain slopes that rainwater washes down unimpeded. The 1987 Category 3 Hurricane Emily caused no loss of life; at that time, Haiti still had 25% of its forests. By 2004, only 1.4% of Haiti's forests remained, and the tropical storms Jeanne and Gordon resulted in flooding that killed thousands.

2.2 Predictions for 2010 Hurricane season

There is currently a lack of overall consensus regarding the upcoming North Atlantic hurricane season.

The TSR (Tropical Storm Risk) April forecast update for Atlantic hurricane activity in 2010 anticipates an active hurricane season based on current and projected climate signals. Atlantic basin tropical cyclone activity for 2010 is forecast to be about 60% above the 1950-2009's norm. It also predicts a high likelihood (77%) that activity will be in the top one-third of years historically. TSR's two predictors are the forecast July-September 2010 trade wind speed over the Caribbean and tropical North Atlantic, and the forecast August-September 2010 sea surface temperature in the tropical North Atlantic. (Benfield Hazard Institute)

Colorado State University is also predicting a more active season that usual, citing a 69% risk of communities along the Atlantic and Gulf coasts being buffeted by a major storm in the coming months. This is based on a weakening of El Nino conditions combined with abnormally strong warming of the tropical Atlantic waters. Researchers said eight hurricanes and 15 named tropical storms are likely to form in the Atlantic basin during the 2010 hurricane season, which begins June 1 and extends through Nov. 30. Four of the storms are expected to develop into major hurricanes with sustained winds of 111 mph or greater. The team bases its predictions on historical data. The 2010 season shows similarities to conditions preceding the very active 1958, 1966, 1969, 1998 and 2005 hurricane seasons. (See Annex 3)

However, the World Meteorological Organization says the El Nino effect may persist through midyear, halfway through the region's March-November hurricane season. The U.N. weather agency says the ongoing El Nino weather system could lessen the strength of hurricanes in the North Atlantic.

3. FLOOD RISK

3.1 Average rainfall

The following is an extract from the US Army Corps of Engineers, 1997, Water Resources Assessment of Haiti.

> *The quantity and regional distribution of rainfall is extremely variable because of the orientation of the mountain chains and intervening lowlands with respect to rain-bearing northeast trade winds. Haiti lies in the rain shadow of the Dominican Republic. Rainfall produced by trade winds is stopped by the mountain ridge dividing the two countries. Northern and windward slopes of mountainous areas commonly receive two to three times as much precipitation as leeward slopes.*
>
> *Average annual precipitation in mountainous areas commonly exceeds 1,200 mm and can be as much as 2,700 mm. April through November is generally the wet season, though many areas will have a lull between June and August. In these areas, the first wet season is from April to June and the second from September to November. The lull is not a dry period, but there is a marked decrease in precipitation.*
>
> *At Port-au-Prince, the wettest period is from May to November, while at Gonaïves, the wettest period is from June to September.*

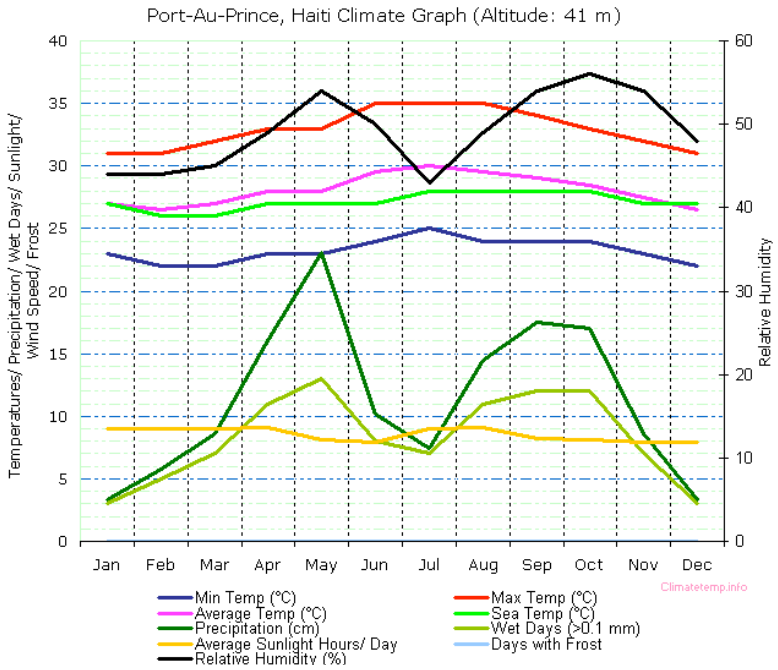

Figure 2. Average rainfall for Haiti (http://www.climatetemp.info/haiti/)

3.2 Risk of flood events

It doesn't necessarily take a tropical storm to devastate Haiti; flash flooding occurs often during the wet season, but flooding can occur at any time of the year. On 18-25 May 2004, a low-pressure system originating from Central America brought exceptionally heavy showers and thunderstorms to Haiti and the Dominican Republic. Rainfall amounts exceeded 500 mm (19.7 inches) across the border areas of Haiti and the Dominican Republic. More than 18 inches of rain in the mountains triggered floods that killed over 2600 people.

The Dartmouth Flood observatory have archives on flood events dating back to 1985, and have records relating to at least 14 lethal events between 1986 and early 2004. These occurred both during the rainy season and the hurricane season:

- 1993 late May 20
- 1994 early November – Hurricane Gordon >1000
- 1996 mid November 18
- 1998 Late August – Hurricane Gustaf >22
- 1998 late September - Hurricane Georges >400
- 1999 late October - Hurricane Jose 4
- 2001 mid-May 15
- 2002 late May 30
- 2003 early December - Tropical Storm Odette 8
- 2003 mid-November 10
- 2004 late May >2000

The US Army Corps of Engineers, 1997 Water Resources Assessment of Haiti states the following:

> *Most of the major cities are along the coast and are surrounded by steep, often barren, hills. The combination of scarce vegetation on surrounding hillsides and lack of storm water drainage systems produces serious flooding, often resulting in significant loss of human lives and serious property damage. Between 1992 and April 1998, there were 12 serious flood events which resulted in loss of life and severe loss of property.*

Flooding contaminated the water supply, and the lack of uncontaminated water is expected to produce deadly waterborne diseases, such as cholera and dengue fever.

Within the Port-au-Prince area, uncontrolled housing construction to accommodate the growing population has resulted in the construction of large numbers of dwellings in flood plains. This situation, along with generally poor materials and construction techniques, exposes many residents to serious danger when floods occur. In addition, the overall lack of domestic waste disposal methods increases biological contamination of the waterways during flood events

Most of Haiti's streams are relatively small and less than 100 kilometers long. The Rivière de l'Artibonite, which rises in the Dominican Republic and drains westward to the Golfe de la Gonâve, is the largest stream. It has a length of about 280 kilometers and a catchment area of about 9,500 square kilometres. It is shallow, as are most other streams in the country, but has average flows ten times that of any of the other streams. This stream presents a significant flooding risk due to water descending from the mountains fanning out over the plains.

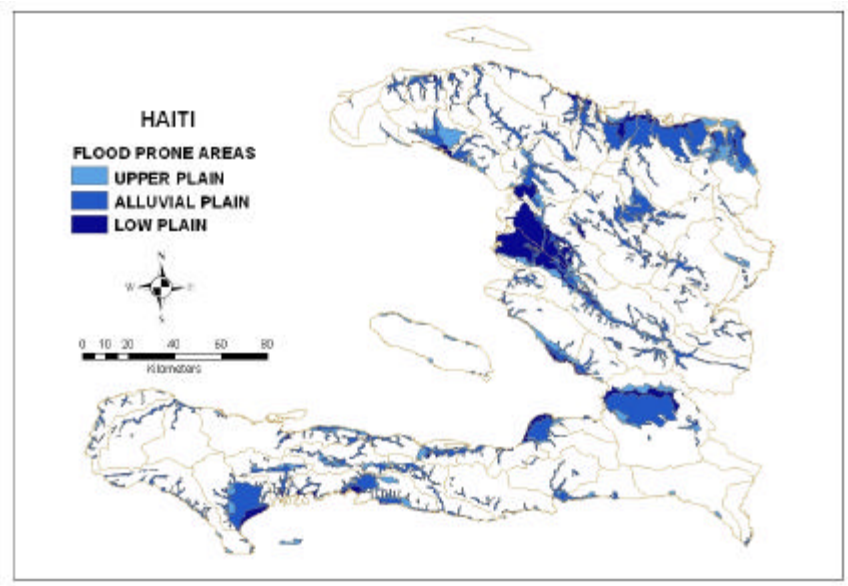

Figure. 3: Flood Prone Areas in Haiti (Guilland, 2005)

4. CONCLUSION

Whilst the risk of aftershocks remains high and could lead to the collapse of houses partially damaged by the January 12th earthquake, the most immediate and significant risk to vulnerable populations within Haiti is that of flooding.

Whilst major flooding events are more likely during the hurricane season, flash flooding can occur throughout the whole year, and is also likely during the peak of the rainy season in May.

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Professor Mark Saunders and Dr Adam Lea
Aon Benfield UCL Hazard Research Centre, UCL (University College London), UK

Extended Range Forecast of Atlantic Seasonal Hurricane Acitivity and Landfall Strike Probability for 2010 (as of 7 April 2010)
By Philip J. Klotzbach1 and William M. Gray2
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