



# Global Disaster Outlook: A Conservation Perspective

Common interests in survival



*From the devastation  
of natural disasters  
can spring hope  
for the reduction  
of future vulnerability.*



At World Wildlife Fund we understand that natural disasters have to be factored into the conservation equation, just as other global forces like climate change, agricultural expansion, and deforestation.

We understand, too, that in order to effectively manage natural disasters, conservation and humanitarian organizations can achieve more by working together.

In this report, WWF analyzes the global disaster risk facing select WWF priority conservation areas.

Between 1996 and 2005 over 6,400 natural and man-made disasters occurred globally, affecting over 2.5 billion people—and representing a 60 percent increase from the previous two decades.<sup>1</sup>

**In the days and weeks after a natural disaster, years of conservation achievements can be wiped out by the hurried rush of recovery efforts, which only adds to an already tragic situation. Disaster recovery provides an opportunity for conservation professionals to advance green reconstruction and support disaster risk reduction.**

Natural disasters affect conservation work in three ways. First, they contribute to environmental degradation when they occur, often threatening major conservation investments. Second, they displace entire populations, whose desperate pursuit of food and shelter may contribute to deforestation, loss of biodiversity and other environment degrading forces. Finally, they set the stage for large-scale rebuilding efforts which, if carried out in an unsustainable fashion, involve the extraction of massive quantities of raw materials and resources such as timber, sand and clay, threatening already stressed ecosystems or displacing those threats to other places.

The more conservationists can help to exert a positive influence on disaster scenarios—from preparedness and response to recovery and mitigation—the more we can advance the interests of conservation. This is particularly relevant in places where WWF has made the protection of species, the preservation of habitats and ecosystem services, and harmonization of human needs with nature our first prerogative.

## **The effects of recent disasters will be felt for years**

News coverage of major natural disasters often focuses on short-term human suffering, but the long-term consequences of those disasters—both for humans, and for biodiversity—are still felt years after the news teams and TV cameras have moved to the next big story.

**The 2004 Indian Ocean tsunami**, for example, impacted 10 countries, resulted in over 220,000 lives lost, and damaged or destroyed over 400,000 homes, spawning a 5 to 10 year reconstruction effort. The replacement of infrastructure is estimated to require over one million cubic meters of sawn timber in Indonesia alone. Given that Indonesia contains 10 percent of the

world's remaining tropical forests, and that the biggest threat to the forests of Sumatra and Borneo is from land conversion, the added logging pressure from reconstruction represents a significant threat to natural resources and the people who depend on them for food, shelter, and livelihoods.

**The combined effects of Hurricanes Katrina and Rita**, in 2005, resulted in the largest single forestry disaster on record in the United States, including the destruction or damage of roughly 320 million trees in Mississippi and Louisiana.<sup>2</sup> The loss of forest on such a wide scale not only contributes to biodiversity loss, but also results in a significant contribution of greenhouse gas emissions. The amount of carbon that will be released in the atmosphere as a result of tree decomposition is estimated at 100 million tons—equal to the amount that all live trees in the U.S. take out of the atmosphere in a single year.

In May 2008, the 8.0 magnitude **Sichuan earthquake** severely impacted the Sichuan Province in the WWF Priority Place Yangtze, home to the giant panda and the internationally renowned Wolong Nature Reserve. The earthquake claimed over 69,000 lives and seriously damaged over 5 million houses. The amount of earthquake debris requiring disposal has been estimated at over 8 million cubic meters, enough to fill the primary Olympic stadium in Beijing almost 16 times. The earthquake also impacted 86 out of 110 WWF-run projects in nature reserves and local communities in the area. At this writing the reconstruction process is not yet underway, but in such a delicate and critical ecosystem, the environmental impact of reestablishing livelihoods and rebuilding houses and water systems is expected to be enormous.

In addition to such major headline-grabbing events, WWF staff and conservation activities are affected by smaller-scale disasters almost every day: landslides in Indonesia, oil spills in the Galapagos and the Philippines, flooding in Vietnam, displaced communities in the Congo, and glacial melt in the Himalayas.

When we examine the impact of these recent and ongoing disasters and recovery efforts, along with human population growth, environmental degradation, and climate change, it is easy to see that disasters will increase in frequency and severity, well into the future.

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2 Chambers, J et al. (2007) Hurricane Katrina's Carbon Footprint on U.S. Gulf Coast Forests. *Science*. Vol. 318 (5853): 1107.



The 19 areas selected by WWF-US as priority conservation places occupy more than 10 percent of the Earth's surface, making the chance of one of these high conservation value areas being impacted by a major disaster nearly certain.

Humans are not only victims of natural disasters; we are also contributing to their occurrence. According to the Millennium Ecosystem Assessment, the impact of human activities on the global environment is causing an increase in natural disasters. The Assessment estimates that approximately 60 percent of the world's ecosystems are being degraded or used unsustainably and notes that "changes to ecosystems have contributed to a significant rise in the number of floods and major wildfires on all continents since the 1940s."<sup>4</sup>

### Humankind's relationship to disasters

Disasters destroy life, damage property and devastate ecosystems. From 1995 to 2005 more than 2.5 billion people were affected by over 6,400 natural and technological disasters globally. The economic losses incurred as a result of natural and man-made disasters average \$63 billion a year.<sup>3</sup> In 2006 alone, international relief and reconstruction donor agencies raised over \$7 billion to rebuild disaster-affected communities, and the rebuilding of many devastated areas is still incomplete.

While environmental degradation is increasing the frequency of disasters, climate change is predicted to increase their severity. The Intergovernmental Panel on Climate Change has found that extreme weather events, such as droughts and cyclones, will become more severe in the future as the climate system continues to become warmer.<sup>5</sup>



The Indonesian Red Cross Society handing out supplies in Banda Aceh, Indonesia following the 2004 Indian Ocean Tsunami. | ©Bonnie Gillespie/American Red Cross

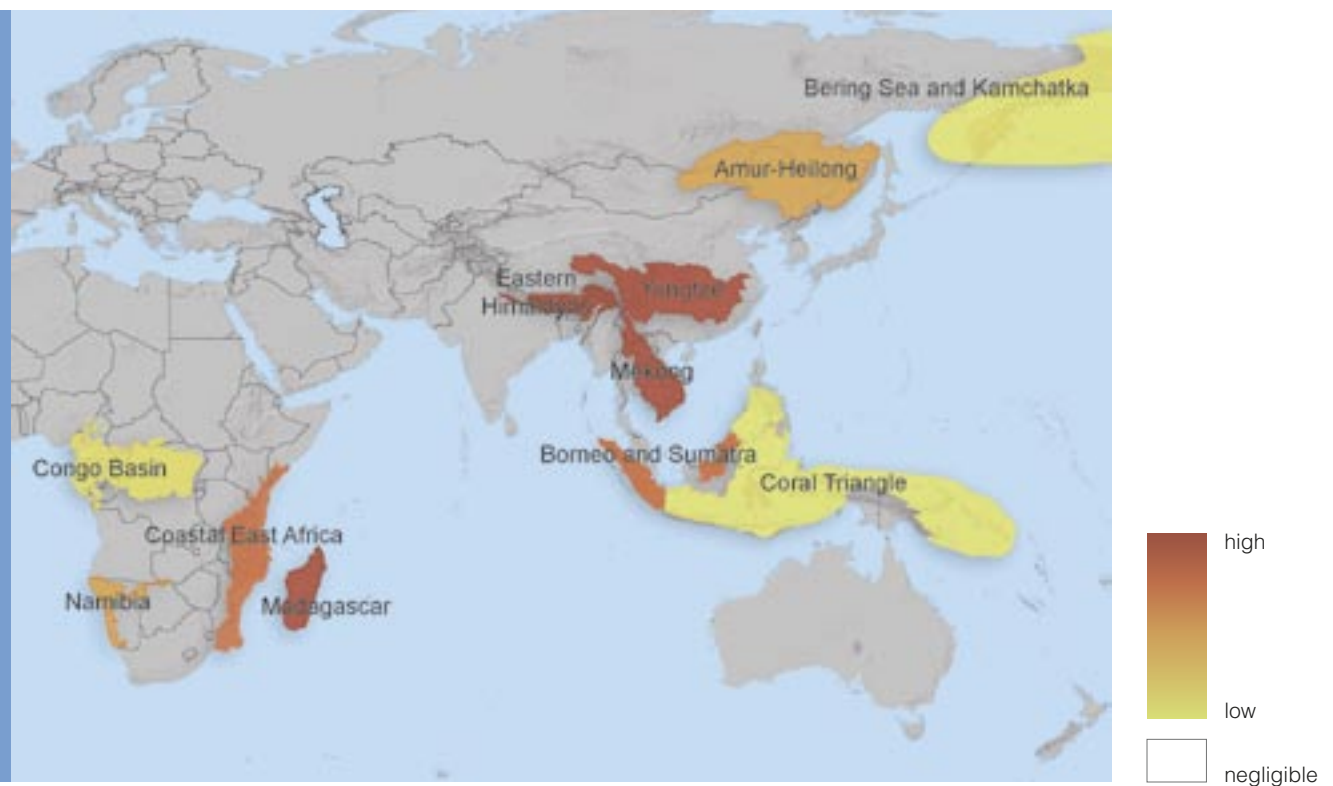
3 International Federation of Red Cross and Red Crescent Societies (2006); World Disasters Report 2006: Focus on Neglected Crises, Geneva.

4 Millennium Ecosystem Assessment (2005); Ecosystems and Human Well-being: Synthesis, Island Press, Washington, DC, USA.

5 Intergovernmental Panel on Climate Change (2007); Climate Change Impacts, Adaptation and Vulnerability: Summary for Policymakers, Working Group II Contribution to the IPCC Fourth Assessment Report: Climate Change.

### Map 1: Combined Risk of Natural Disasters to WWF Priority Places

Based on Percentage of Area Exposed to Hazards from Cyclones, Drought, Earthquakes, Floods, Landslides and Volcanoes



## A risk assessment of WWF's Priority Places

To better understand the global risk that natural disasters pose to Earth's areas of greatest biodiversity, WWF prepared a natural hazard risk assessment of its Priority Places: 19 critical regions selected by WWF-US on the basis of the wealth and diversity of life they support, the destructive challenges they face, and humankind's ability to impact them within the next decade. These 19 Priority Places occupy roughly 10.4 percent of the Earth's land surface.

To determine the disaster risk posed to these 19 Priority Places, WWF analyzed the natural hazard datasets produced by the World Bank and Columbia University for the publication, *Natural Disaster Hotspots—A Global Risk Analysis*.<sup>6</sup>

- The hazard dataset includes the hazard frequency and distribution of six types of natural disasters: cyclones, droughts, earthquakes, floods, landslides and volcanoes.
- It also includes data on the human dimensions of disaster risk, including human population distribution within the at-risk area, risk of mortality from the hazard, and risk of total and proportional economic loss based on gross domestic product of the affected areas.

The natural hazard dataset is based on actual occurrences of natural hazards and does not incorporate climate change modeling predictions. As high resolution data on the predicted impacts of climate change to

**Table 1: Combined Risk to WWF Priority Places as Percentage of Area Exposed to Hazard**

RANK	NAME
1	Mekong
2	Madagascar
3	Eastern Himalayas
4	Yangtze
5	Northern Great Plains
6	Mesoamerican Reef
7	Southern Chile
8	Chihuahuan Desert
9	Gulf of California
10	Coastal East Africa
11	Borneo and Sumatra
12	US Southeast Rivers and Streams
13	Amur-Heilong
14	Namibia
15	Coral Triangle
16	Amazon
17	Congo Basin
18	Bering Sea and Kamchatka
-	Galapagos

natural hazard severity and frequency become available, the analysis will be updated accordingly. Datasets on migration and conflict were not included in this analysis, but will be included in future updates.

6 World Bank. (Dilley, Maxx; Robert S. Chen, Uwe Deichmann, Arthur L. Lerner-Lam, and Margaret Arnold, with Jonathan Agwe, Piet Buys, Oddvar Kjekstad, Bradfield Lyon, and Gregory Yetman). 2005. *Natural Disaster Hotspots: A Global Risk Analysis*. Washington, D.C.: World Bank.

### Terminology: What is a disaster?<sup>1</sup>

**Natural hazard:** any natural process that poses a threat to human life or property. The event itself is not a hazard; rather, a process becomes a hazard when it threatens human interests.

**Natural disaster:** the effect of the hazard on society, usually as an event that occurs over a limited time span in a defined geographic area. The term "disaster" is used when the interaction between humans and a natural process results in significant property damage, injuries, or loss of life. As an example, a cyclone is a natural hazard that only becomes a natural disaster once it causes damage.

**Catastrophe:** a massive disaster requiring significant expenditure of time and money for recovery.

**Disaster risk:** in its simplest form, defined as the probability that a hazard will impact a given area, multiplied by the consequences should it occur. Within the disaster risk reduction community, it is more specifically defined by the following equation: **Disaster Risk = (Hazard x Vulnerability) / Resilience**, where: "Hazard" is described by the probability of the occurrence, the magnitude and spatial distribution of the hazard; "vulnerability" is described by the susceptibility and degree of exposure of vulnerable elements (population, economy, physical regions affected) to a hazard (i.e., extent of damage); and "resilience" is described as the likelihood of being able to respond (coping) or being able to successfully recover from the disastrous impact of a hazard.

1 Keller and Blodgett (2006) *Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes*. Pearson Education, Inc. New Jersey.

**Table 2: Hazard Frequency Analysis of WWF Priority Places**

GLOBAL HAZARD FREQUENCY ANALYSIS								
	Baseline	Cyclone	Drought	Earthquake	Flood	Landslide	Volcano	All Hazards
Global area exposed to hazard (minimum mapping unit)	8,868,972	509,251	2,810,082	567,533	2,566,721	196,435	22,308	6,672,330
Global percentage exposed to hazard	n/a	5.74%	31.68%	6.40%	28.94%	2.21%	0.25%	75.23%
PRIORITY PLACE HAZARD FREQUENCY ANALYSIS <i>Percentage of Priority Place Area Exposed to Hazard</i>								
	Cyclone	Drought	Earthquake	Flood	Landslide	Volcano	All Hazards	
Amazon	0.00%	14.39%	3.67%	23.33%	1.84%	0.24%	43.46%	
Amur-Heilong	18.58%	57.97%	0.00%	37.98%	0.08%	0.07%	114.69%	
Bering Sea and Kamchatka	0.01%	0.01%	0.03%	0.00%	0.02%	0.00%	0.08%	
Borneo and Sumatra	0.00%	61.92%	39.25%	68.62%	20.96%	5.34%	196.10%	
Chihuahuan Desert	19.10%	39.53%	0.03%	23.36%	0.11%	0.09%	82.23%	
Coastal East Africa	21.56%	56.35%	0.00%	55.54%	0.08%	0.00%	133.53%	
Congo Basin	0.00%	18.27%	0.00%	58.48%	0.33%	0.22%	77.31%	
Coral Triangle	2.12%	11.44%	5.89%	4.64%	3.25%	1.05%	28.40%	
Eastern Himalayas	0.00%	67.11%	64.99%	62.86%	27.08%	0.00%	222.03%	
Galapagos	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Gulf of California	21.10%	31.74%	10.80%	6.35%	0.92%	0.00%	70.91%	
Madagascar	93.02%	61.96%	0.00%	72.04%	0.05%	0.00%	227.07%	
Mekong	38.21%	93.78%	11.53%	82.84%	6.83%	0.00%	233.19%	
Mesoamerican Reef	34.63%	14.85%	9.08%	35.79%	4.94%	0.08%	99.37%	
Namibia	0.00%	15.92%	0.00%	2.41%	0.00%	0.00%	18.32%	
Northern Great Plains	0.00%	67.52%	0.00%	25.75%	0.00%	0.00%	93.27%	
Southern Chile	0.00%	32.64%	52.06%	43.07%	20.08%	8.77%	156.62%	
US Southeast Rivers and Streams	82.33%	12.84%	0.06%	97.87%	0.00%	0.00%	193.10%	
Yangtze	17.84%	45.73%	16.46%	86.88%	12.16%	0.00%	179.06%	
Total Percentage of priority place exposed to hazard	8.00%	23.71%	4.97%	25.52%	2.62%	0.40%	65.22%	
COMPARISON OF RISK FOR DISASTER OCCURRENCE WITHIN PRIORITY PLACES TO RISK GLOBALLY								
	Cyclone	Drought	Earthquake	Flood	Landslide	Volcano	All Hazards	
Percentage difference in exposure likelihood for priority places	+39.27%	-25.17%	-22.34%	-11.81%	+18.31%	+60.11%	-13.31%	

Note: The "All Hazards" figure is calculated by summing the percentage exposure of a Priority Place to each hazard type. Since a specific geographic area within a Priority Place may be exposed to more than one type of hazard, the "All Hazards" figure can exceed 100 percent.



In order to display risk consistently across each type of natural hazard, and to define areas that are at greatest risk of disaster, the hazard data were divided into those areas that are in the top 30 percent of risk for a given natural hazard and those that are not. Hereafter, we identify places as “exposed to hazard” as those areas that place in the top 30 percent.

Because the Priority Places vary dramatically in size—from 56,000 square miles for the Galapagos to 2.5 million square miles for the Amazon—the percentage of total area exposed to natural hazards was determined to provide the best risk comparison among Priority Places. A separate analysis was conducted to determine the risk that natural hazards pose to Priority Places in comparison to the rest of the world.

Each of WWF’s Priority Places was ranked from high to low according to the relative risk for each type of natural hazard. The rankings were based on past occurrences of each type of hazard within each Priority Place, under the assumption that past occurrences increase the likelihood of future occurrences. A “high” ranking indicates that the natural hazard has occurred relatively frequently over a widespread area within the Priority Place in the past, signifying a high likelihood of the hazard occurring again relative to the other Priority Places. A “low” ranking indicates that instances of the hazard have occurred relatively less frequently over a smaller area of the Priority Place. A “negligible” ranking does not indicate that the natural hazard has no chance of occurring, but that there are few (or no) significant past instances of this hazard, implying that the likelihood of future occurrences is minimal.

Map 1 and Table 1 contain complete rankings of the combined risks to the 19 Priority Places. Table 2 on page 6 shows the percentage of Priority Place area exposed to each of the six hazards.

### WWF’s most at-risk places, weighted for human impact

The effect of a natural hazard on a Priority Place includes both environmental considerations and a human element. Indeed, it is this human element that defines a disaster: natural hazards become disasters when they result in significant property damage, injuries, or loss of life.

The greater the human population and economic investment in a given place, the greater the importance

**An analysis of the combined risks shows that the Mekong, Madagascar, and Eastern Himalayas regions are the three Priority Places most exposed to natural hazards.**

of ensuring that reconstructed communities are founded on sound natural resource management, taking steps to build resilience against future disasters. Areas with larger human populations and more complex infrastructures also have greater potential for post-disaster reconstruction to threaten their already stressed ecosystems.

In order to address the human element in disaster risk, WWF assessed which Priority Places are most vulnerable to natural hazards, including data on risk of mortality and the risk of total and proportional economic loss. The mortality risk dataset weights the frequency and distribution of natural hazards with the likelihood of fatalities, considering population distribution, the severity of the disaster, and the economic wealth of the region. As such, natural hazards that occur in poor and highly populated regions of the world are weighted to have more fatalities, and therefore a higher risk of disaster.

The results of the risk assessment weighted for human elements (map and corresponding table on pages 8 and 9) changes the disaster risk rankings of the 19 Priority Places:

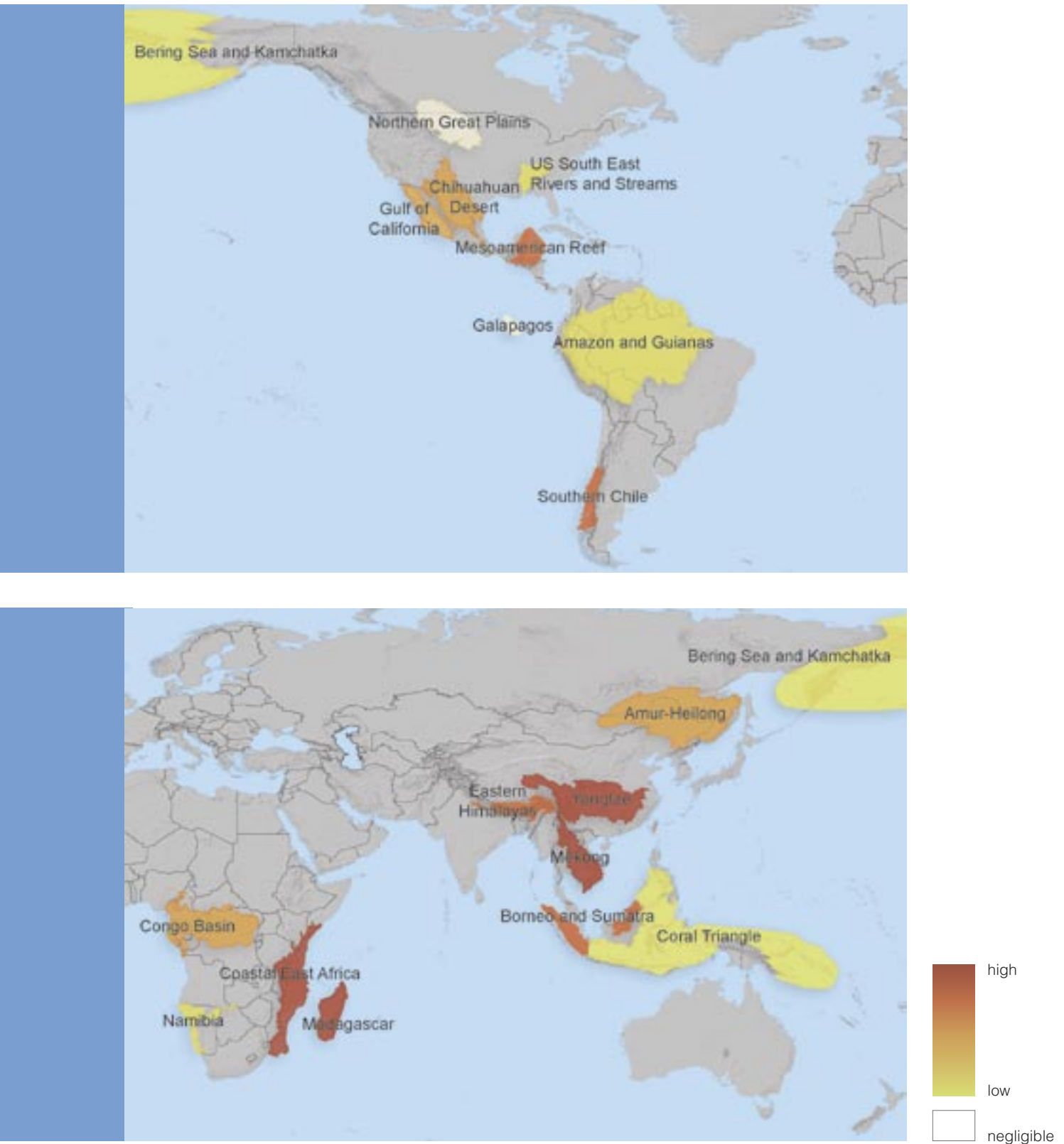
- The Yangtze ecoregion becomes the most at-risk Priority Place.
- Coastal East Africa moves from being the tenth most at-risk Priority Place to being fourth behind Yangtze, Madagascar, and Mekong.
- Borneo and Sumatra also move up in rank from the eleventh most at-risk Priority Place to sixth.
- Because of its low population density, the Northern Great Plains—which has a high susceptibility to drought—moves from the fifth position to having the lowest risk.
- The Galapagos has a negligible disaster risk for disaster when examined with and without human factors.

### Global risk and biodiversity

Compared to the rest of the world, WWF’s 19 Priority Places are more at-risk to four types of natural hazards:

## Map 2: Combined Risk of Natural Disasters to WWF Priority Places Weighted for Human Impact

Based on Percentage of Area Exposed to Hazards from Cyclones, Drought, Earthquakes, Floods, Landslides, and Volcanoes and Weighted by Human Population Distribution, Risk of Mortality from Hazard and Regional Economic Wealth



cyclones, floods, landslides, and volcanic eruption. Priority Places are less at-risk to earthquakes and substantially less at-risk to drought in comparison to the rest of the world.

One possible explanation for the fact that the Priority Places are more likely to be impacted by cyclones, floods, landslides, and volcanic eruptions, in comparison to the rest of the world, is rooted in the disturbance theory of species richness occurring at a large scale. *The disturbance theory argues that the highest diversity is maintained by intermediate levels of disturbance.*<sup>7</sup>

If natural disasters such as cyclones or floods occur often enough to create gaps or open spaces in habitats so that they allow for pioneer species to colonize and speciate, but not so often as to repeatedly prevent species from establishing in the first place, then a regular cycle of infrequent disasters may actually promote species diversity over thousands of years.

The fact that Priority Places are substantially less at-risk to drought may be explained by the fact that Priority Places are selected based on the wealth and diversity of the life they support. If an area is more susceptible to drought, it typically has less rainfall even under optimal conditions, making it less likely to support high species diversity and therefore less likely to be chosen as a Priority Place.

## The global community responds

In response to the growing threat of disasters, the General Assembly of the United Nations declared the 1990s the International Decade for Natural Disaster Reduction and created the International Strategy for Disaster Reduction. Subsequently, the institutionalization of disaster risk reduction has been adopted by more than 178 countries through the UN's Agenda 21, *Rio Declaration on Environment and Development*. In June 2006, the World Bank created the Global Facility on Disaster Reduction and Recovery, which called for reducing disaster risk in development and promoting "environmentally sustainable disaster reduction and recovery practices."

At WWF we share the international community's recognition of the extent to which humanitarian priorities are intertwined with conservation prerogatives. Humans need to take action now to help reduce natural disasters, improve the preparedness of vulnerable communities, understand the

**Table 3: Combined Risk to WWF Priority Places as Percentage of Area Exposed to Hazard and Weighted for Human Impact**

RANK	NAME
1	Yangtze
2	Madagascar
3	Mekong
4	Coastal East Africa
5	Eastern Himalayas
6	Borneo and Sumatra
7	Mesoamerican Reef
8	Southern Chile
9	Amur-Heilong
10	Chihuahuan Desert
11	Congo Basin
12	Gulf of California
13	Coral Triangle
14	Namibia
15	Amazon
16	US Southeast Rivers and Streams
17	Bering Sea and Kamchatka
-	Galapagos
-	Northern Great Plains

conservation consequences of disasters, and advance the adoption of sustainable reconstruction practices.

Humans cannot eliminate natural disasters. But we can develop and implement mitigation and response strategies to reduce both human suffering and environmental degradation. In the long run the disaster recovery plan that preserves precious natural resources will help both people and biodiversity survive.

**Now more than ever, governments and multilateral institutions are mobilizing to address global disaster risk and invest in disaster prevention for sustainable development. Conservationists can play a critical role in reducing future disaster risk and vulnerability to both humans and the environment.**

<sup>7</sup> Connell, J.H. (1978) Diversity in tropical rainforests and coral reefs. *Science*, 199, 1302-1310.



Child on Juani Island, part of the Mafia Marine Park, which was created  
with the support of WWF Tanzania. | © Roger HOOPER/WWF-Canon



## Anatomy of Natural Hazards

In the following section we explore each of the six types of natural disasters by providing a focus map depicting the specific disaster risk to one of WWF's Priority Places, a detailed description of each disaster and a photo illustrating the environmental and/or human impact of the disaster. The focus maps and photos we have chosen to represent each disaster are not always the highest ranked in risk. This is because we wanted to showcase a diversity of geographic areas with the realization that even a mid or low grade cyclone, drought, earthquake, flood, landslide, or volcano can have lasting impacts on ecosystems, infrastructure and human life.





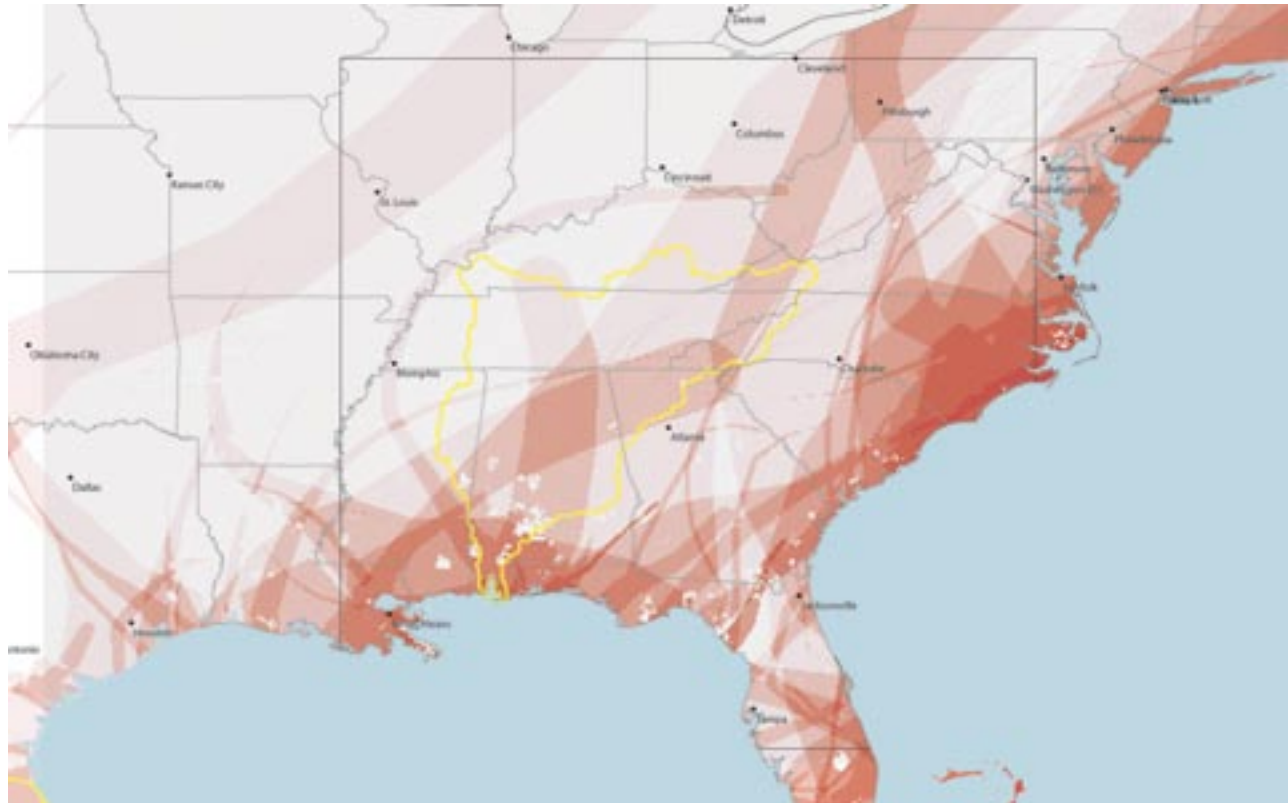
**Cyclones:** large thunderstorm complexes, rotating around an area of low pressure that have formed over warm tropical or subtropical ocean water. Low-intensity cyclones are called tropical depressions and tropical storms. High-intensity cyclones go by the names typhoon, tropical cyclone, or cyclonic storms in the Indian Ocean and most of the Pacific Ocean, while in the Atlantic Ocean and northeastern Pacific Ocean they are known as hurricanes. Cyclones are ranked according to the

Saffir-Simpson Scale from Category 1, the lowest, to Category 5, the highest, depending on the intensity of the storm. Category 1 is characterized by wind speeds 119 to 153 km (74 to 95 mi.) per hour and storm surge generally 1.2 to 1.5 m (4 to 5 ft.) above normal. Category 5 is characterized by wind speeds greater than 249 km (155 mi.) per hour and storm surge generally greater than 5.5 m (18 ft.) above normal.<sup>8</sup>

<sup>8</sup> Definitions on pages 12–22 are based on Keller and Blodgett (2006) *Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes*. Pearson Education, Inc. New Jersey.

### Map 3: Cyclone Risk to WWF Priority Place US Southeast Rivers and Streams

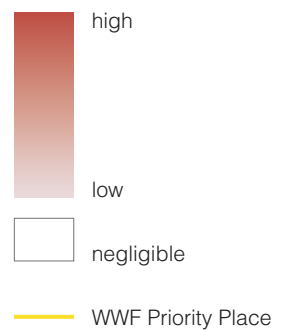
Based on Percentage of Area Exposed



#### Rank of Cyclone Risk to WWF's Priority Places

Based on Percentage of Area Exposed

- |                                    |                       |
|------------------------------------|-----------------------|
| 1. Madagascar                      | NEGLIGIBLE RISK       |
| 2. Mesoamerican Reef               | Namibia               |
| 3. Coastal East Africa             | Eastern Himalayas     |
| 4. Mekong                          | Galapagos             |
| 5. US Southeast Rivers and Streams | Northern Great Plains |
| 6. Yangtze                         | Congo Basin           |
| 7. Amur-Heilong                    | Amazon                |
| 8. Coral Triangle                  | Borneo and Sumatra    |
| 9. Gulf of California              | Southern Chile        |
| 10. Chihuahuan Desert              |                       |
| 11. Bering Sea and Kamchatka       |                       |



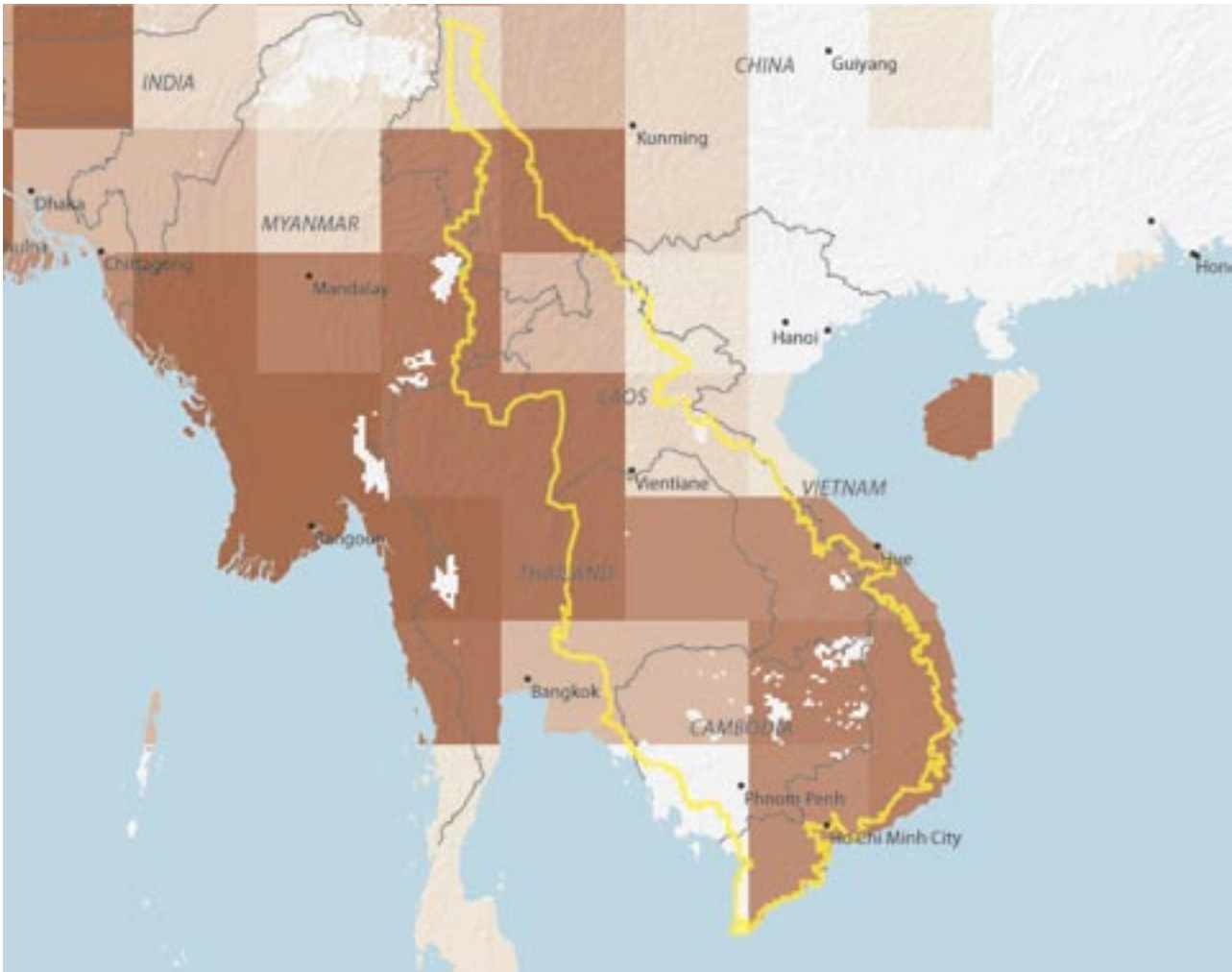




**Drought:** an extended period of unusually low precipitation that produces a temporary shortage of water for people, other animals, and plants. Over one billion people live in semiarid regions where droughts are common, and over 100 million people are threatened

with malnutrition or death if drought causes their crops to fail. As a result of climate change, more intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics.

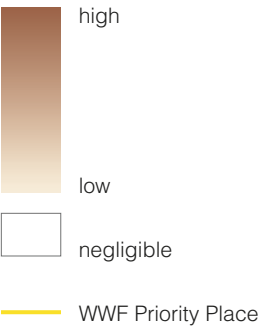
**Map 4: Drought Risk to WWF Priority Place Mekong**  
Based on Percentage of Area Exposed



**Rank of Drought Risk to WWF’s Priority Places**

Based on Percentage of Area Exposed

- |                          |                                 |
|--------------------------|---------------------------------|
| 1. Northern Great Plains | 13. Mesoamerican Reef           |
| 2. Mekong                | 14. Congo Basin                 |
| 3. Chihuahuan Desert     | 15. Amazon                      |
| 4. Gulf of California    |                                 |
| 5. Madagascar            | NEGLIGIBLE RISK                 |
| 6. Southern Chile        | Galapagos                       |
| 7. Coastal East Africa   | US Southeast Rivers and Streams |
| 8. Namibia               | Borneo and Sumatra              |
| 9. Eastern Himalayas     | Bering Sea and Kamchatka        |
| 10. Amur-Heilong         |                                 |
| 11. Yangtze              |                                 |
| 12. Coral Triangle       |                                 |





**Earthquakes:** geological disruptions that occur along planes of weakness in the Earth's crust, typically in the presence of strong tectonic forces, making their likelihood of occurrence dependent on geography. It is estimated that there are about 500,000 detectable earthquakes in the world each year, 100,000 of which

can be felt by people and 100 of which cause some form of damage. Globally, their distribution follows a series of earthquake "belts" which follow the boundaries of the Earth's tectonic plates. Local earth materials and geologic structure strongly influence the amount of ground motion.

The 2004 Indian Ocean tsunami took thousands of lives and devastated livelihoods, infrastructure and ecosystems. | ©Choo Youn-Kong/AFP/Getty Images



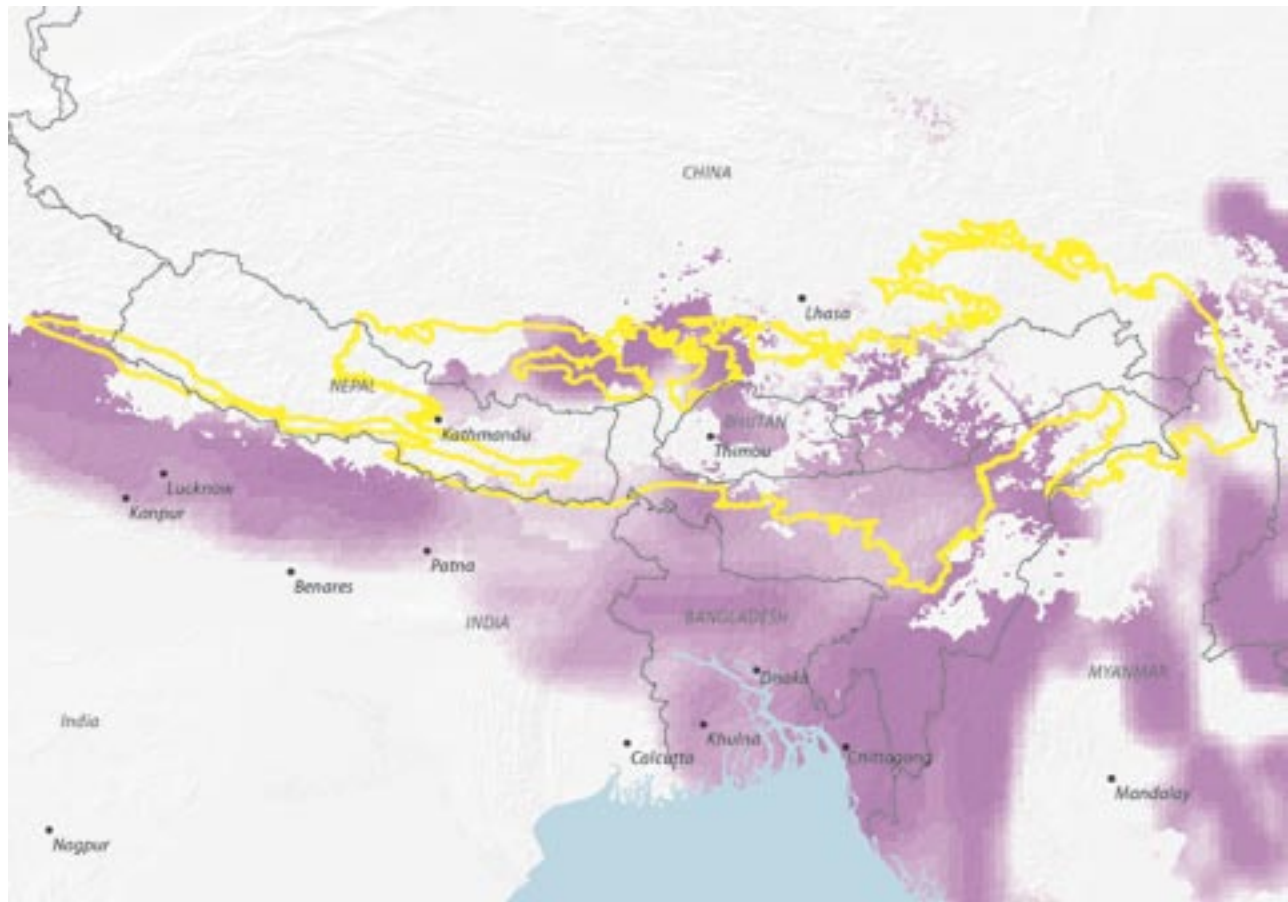
**Tsunamis:** waves or series of waves caused by vertical and/or horizontal displacement of a significant mass of ocean water. The underwater displacement can be caused by rapid uplift or subsidence of the sea floor in a large earthquake; an underwater landslide often triggered by an earthquake; collapse of the side of a volcano into the ocean; a submarine volcano explosion;

and/or the impact of an asteroid in the ocean. Tsunami waves differ from wind-driven waves, such as those created by cyclones, in that water particles flow straight ahead as the waves move forward, surging over beaches and higher areas with significant force. Water particles within wind-driven waves move in a circular motion, and wash up and down a beach without flooding higher areas.



## Map 5: Earthquake Risk to WWF Priority Place Eastern Himalayas

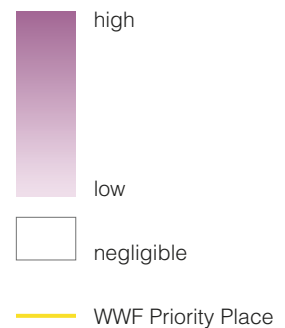
Based on Percentage of Area Exposed



### Rank of Earthquake Risk to WWF's Priority Places

Based on Percentage of Area Exposed

- |                             |                                 |
|-----------------------------|---------------------------------|
| 1. Eastern Himalayas        | NEGLIGIBLE RISK                 |
| 2. Southern Chile           | Namibia                         |
| 3. Yangtze                  | Chihuahuan Desert               |
| 4. Mekong                   | Galapagos                       |
| 5. Coral Triangle           | Northern Great Plains           |
| 6. Gulf of California       | Coastal East Africa             |
| 7. Borneo and Sumatra       | US Southeast Rivers and Streams |
| 8. Amazon                   | Madagascar                      |
| 9. Bering Sea and Kamchatka | Congo Basin                     |
| 10. Mesoamerican Reef       | Amur-Heilong                    |



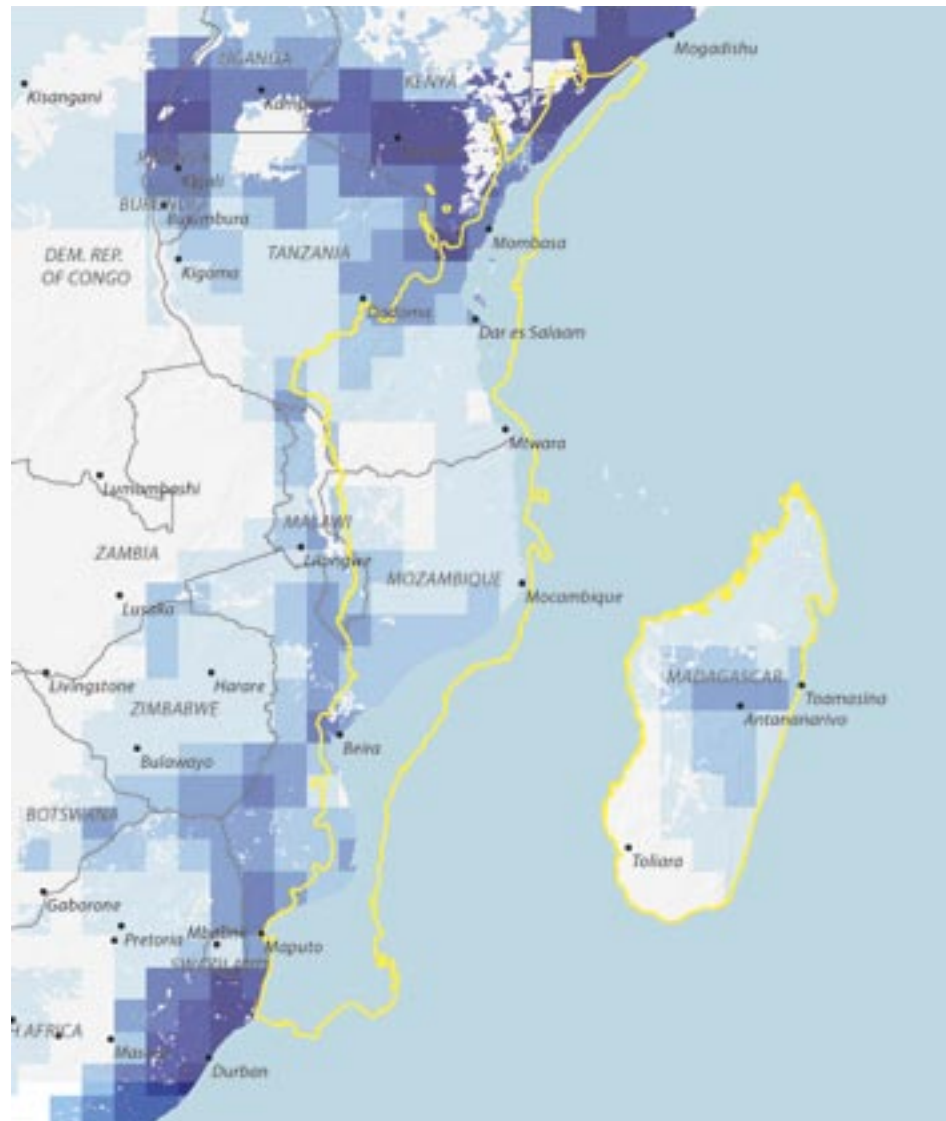


**Floods:** one of the most universally experienced natural hazards, floods are defined as the natural process of overbank flow. Any place that receives precipitation has the potential to flood, however the most disastrous flooding occurs in heavily populated areas near large bodies of water, such as the Mekong and Yangtze Rivers. Upstream floods occur in the upper parts of the drainage basins and in some small drainage basins of tributaries to a larger river. They are generally produced

by intense rainfall of short duration over a relatively small area. Floods that are sudden and of relatively high volume may be called flash floods. Downstream floods are more typically associated with cyclones and tropical storms. The amount of moisture in the soil at the time precipitation starts plays an important role in flooding because water-saturated soil cannot hold additional moisture and will cause flooding to occur.

## Map 6: Flood Risk to WWF Priority Place Coastal East Africa

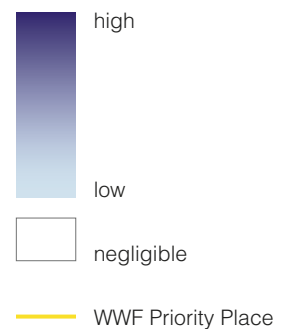
Based on Percentage of Area Exposed



### Rank of Flood Risk to WWF's Priority Places

Based on Percentage of Area Exposed

- |                                    |                          |
|------------------------------------|--------------------------|
| 1. Mekong                          | 12. Southern Chile       |
| 2. Yangtze                         | 13. Congo Basin          |
| 3. Eastern Himalayas               |                          |
| 4. Mesoamerican Reef               | NEGLIGIBLE RISK          |
| 5. Borneo and Sumatra              | Namibia                  |
| 6. US Southeast Rivers and Streams | Galapagos                |
| 7. Amazon                          | Northern Great Plains    |
| 8. Coastal East Africa             | Madagascar               |
| 9. Amur-Heilong                    | Gulf of California       |
| 10. Chihuahuan Desert              | Bering Sea and Kamchatka |
| 11. Coral Triangle                 |                          |



A village swept by a landslide at Lembah Gumanti district in Solok, West Sumatra in 2006. | © STR/AFP/Getty Images



**Landslides:** include the rapid downslope movement of rock or soil as a more or less coherent mass, as well as avalanches and earth, debris and rock flows. Driving and resisting forces on slopes are determined by the interrelationships of the type of earth materials, slope angle and topography, climate, vegetation, water and

time. Landslides are linked to other natural hazards such as earthquakes, volcanoes, storms, and fires. Human activities such as timber harvesting and urbanization can lead to increases in erosion and put pressure on slope stability, thereby increasing landslide potential.



## Map 7: Landslide Risk to WWF Priority Place Borneo and Sumatra

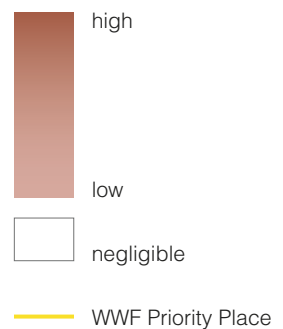
Based on Percentage of Area Exposed



### Rank of Landslide Risk to WWF's Priority Places

Based on Percentage of Area Exposed

- |                         |                                 |
|-------------------------|---------------------------------|
| 1. Eastern Himalayas    | 12. Bering Sea and Kamchatka    |
| 2. Southern Chile       | 13. Chihuahuan Desert           |
| 3. Borneo and Sumatra   |                                 |
| 4. Yangtze              | NEGLIGIBLE RISK                 |
| 5. Coral Triangle       | Namibia                         |
| 6. Mesoamerican Reef    | Galapagos                       |
| 7. Mekong               | Northern Great Plains           |
| 8. Amazon               | US Southeast Rivers and Streams |
| 9. Gulf of California   | Madagascar                      |
| 10. Congo Basin         | Amur-Heilong                    |
| 11. Coastal East Africa |                                 |





The El Lila volcano, south of Santiago, Chile, spewing lava, smoke and ashes over communities of this Andean region. | © JOSE MONSALVE/AFP/Getty Images



**Volcanoes:** caused by spreading or sinking lithospheric plates, interacting with other earth materials at plate boundaries to produce molten rock called magma, which can erupt through the Earth and cause volcanoes to form. Approximately two-thirds of all active volcanoes on Earth are located in the “Ring of Fire” that surrounds the Pacific Ocean.

## Map 8: Volcano Risk to WWF Priority Place Southern Chile

Based on Percentage of Area Exposed



### Rank of Volcano Risk to WWF's Priority Place

Based on Percentage of Area Exposed

1. Borneo and Sumatra

2. Southern Chile

3. Coral Triangle

4. Amazon

NEGLIGIBLE RISK

Namibia

Chihuahuan Desert

Eastern Himalayas

Mekong

Galapagos

Northern Great Plains

Coastal East Africa

Mesoamerican Reef

Madagascar

Congo Basin

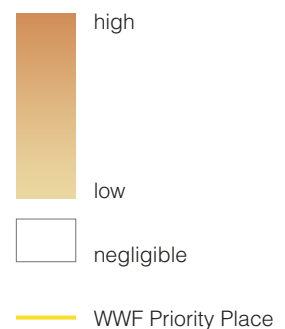
Yangtze

Amur-Heilong

Gulf of California

Bering Sea and Kamchatka

US Southeast Rivers and Streams



## What next?

- Include conflict and migration parameters in risk analysis and assessment.
- Incorporate climate change projections into risk assessment.
- Develop collaborative and integrated disaster risk reduction and disaster response among conservation, humanitarian, government, and private sectors

## A common interest in survival

If conservationists are to protect and preserve species, habitats, and natural resources in a long-term and sustainable way, then the impact disasters and disaster recovery and reconstruction activities have on ecosystems needs to be taken into account as a factor in conservation planning. Likewise, agencies and individuals who plan for and respond to disasters should include proper management of natural resources in relief, recovery and reconstruction programs.

In recent years WWF has embarked on a number of innovative partnerships with humanitarian organizations and governments to help promote sustainable practices in disaster recovery and reconstruction. In a world of rising human population, increased competition for limited resources, and intensified risk of natural disasters in many vulnerable ecoregions, we expect such partnerships to continue and expand in the near term providing a model for how our common interest in survival may be achieved.



**A healthy environment  
enhances the capacities  
of societies to reduce  
the impact of natural and  
human-induced disasters.**

UNITED NATIONS INTERNATIONAL STRATEGY  
FOR DISASTER REDUCTION



FSC LOGO COMING SOON

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Maps for this publication were created by WWF researcher Kathleen Reytar and WWF Sensory Imaging Specialist Aurelie Shapiro based on datasets provided by WWF and the World Bank and Columbia University's Natural Disaster Hotspots-A Global Risk Analysis (2005).

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