How can we defend ourselves from the hazard of Nature in the modern society?

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Natural Hazards
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Member of the Editorial Board of *Natural Hazards and Earth System Sciences* (NHESS)

Involved in tsunami research since ’70s

Author of over 240 publications, with more than 150 papers in scientific journals and books of international interest

Research Lines:
Basic Questions

- What are Natural Hazards?
- Are they unavoidable?
- Is the XXI century society (or societies) more vulnerable?
- What are the best strategies to mitigate the effects?
- What is the possible contribution of scientists and of teachers?
What are Natural Hazards?

A basic definition

Natural Hazards are “those elements of the physical environment, harmful to man and caused by forces extraneous to him.” (1)

(1) I. Burton, R.W. Kates and G.F. White
The Environment as Hazard (New York: Oxford University Press, 1978)
An extension of the definition

“Natural Hazard” refers to all atmospheric, hydrologic, geologic (especially seismic and volcanic), and wildfire phenomena that, because of their location, severity, and frequency, have the potential to affect humans, their structures, and their activities adversely.

By saying "natural" one eliminates manmade phenomena as war, pollution, and chemical contamination.

Though infectious diseases can be viewed as a natural phenomenon usually they are excluded from consideration when treating natural hazards.
Two Elements

“Natural Hazards” involve always two elements

Nature and Society

A natural phenomenon that occurs in a populated area is a hazardous event. And if it causes a large numbers of fatalities and/or great property damage is a Natural Disaster.
Classification of Potentially Hazardous Natural Phenomena

Atmosphere

Storms, Hailstorms, Windstorms, Hurricanes
Lightning, Tornadoes, Tropical storms

Earth

Earthquakes, Ground fissures, Ground shaking, Soil liquefaction, Debris avalanches, Landslides, Rockfalls, Subsidence

Volcanic eruptions, Tephra (ash, cinders, lapilli), Projectiles and lateral blasts, Gas emissions, Pyroclastic flows, Mudflow and Lahar
Classification of Potentially Hazardous Natural Phenomena (2)

Sea and Ocean

Wave storms, Rogue waves, Seiches, Storm surges, Tsunamis, Coastal flooding, Salinization, Erosion and sedimentation

Hydrology

River flooding, Erosion and Sedimentation, Drought Desertification, Snow avalanches

Wildfire

Forest fires, Grass fires, Savannah fires, Brush fires
The total number of deaths in the decennium was more than 1 million. In 2011 slightly less than 30000 with most of the victims attributable to the 11 March 2011 Tohoku tsunami, affecting Japan. Tsunamis are included in the category of the earthquakes.

<table>
<thead>
<tr>
<th>Disaster Type</th>
<th>Average 2001-2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Earthquake (including tsunami)</td>
<td>20,943</td>
<td>68,015</td>
</tr>
<tr>
<td>Extreme temperature</td>
<td>231</td>
<td></td>
</tr>
<tr>
<td>Flood</td>
<td>5,202</td>
<td>5,641</td>
</tr>
<tr>
<td>Mass mov. dry</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Mass mov. wet</td>
<td>314</td>
<td>1,002</td>
</tr>
<tr>
<td>Storm</td>
<td>3,076</td>
<td></td>
</tr>
<tr>
<td>Volcano</td>
<td>3,56</td>
<td></td>
</tr>
<tr>
<td>Wild fires</td>
<td>13</td>
<td>72</td>
</tr>
<tr>
<td>Total</td>
<td>29,782</td>
<td>106,887</td>
</tr>
</tbody>
</table>

Are Natural Hazards Unavoidable?

The occurrence of potentially hazardous phenomena is inevitable. Disasters are not inevitable.

Hazards are inevitable.}

BREAKING THE LINK

- Risk assessment
- Sustainable development
- Prevention
- Preparedness
- Emergency response
Is the XXI century society more vulnerable?

Global population growth

Concentration in the plains and along the coast

Urbanization and megacities

Increased society dependence on lifelines and critical structures and infrastructures
Global Population Growth

After Wikipedia

World Population in the last 13000 yrs

<table>
<thead>
<tr>
<th>Years Passed</th>
<th>Year</th>
<th>Billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>1800</td>
<td>1</td>
</tr>
<tr>
<td>127</td>
<td>1927</td>
<td>2</td>
</tr>
<tr>
<td>33</td>
<td>1960</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>1974</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>1987</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>1999</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>2011</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>2025*</td>
<td>8</td>
</tr>
<tr>
<td>18</td>
<td>2043*</td>
<td>9</td>
</tr>
<tr>
<td>40</td>
<td>2083*</td>
<td>10</td>
</tr>
</tbody>
</table>

* UNFPA
United Nations Population Fund
estimate 31.10.2011
Global Population Growth

After the CIA World Factbook (2011 estimate).  

Annual population growth rate
Population Density Distribution

Favourable Factors

- Moderate climate
- Fertile farming land
- Mineral resources - mines produce jobs, and provide raw materials for other industries
- Low land - with gentle slopes or flat ground
- Coastal areas
- Good water supply
- Wealthier areas - people move to where jobs and money can be found

Unfavourable Factors

- Extreme climate - too cold, hot, wet or dry
- Extreme relief - too high and too steep
- Extreme remoteness - places that are difficult to reach
- Infertile land - need to have extensive (very large) farms

50% (66%) of the population lives within 200 (400) km from the coast
In 1950 New York and Tokyo were the world's only megacities with over 10 million residents. By 2025 the UN predicts the number of megacities will be 37. All but eight will be in the developing world.

### The Largest 20 Megacities in the World

<table>
<thead>
<tr>
<th>Rank</th>
<th>Megacity</th>
<th>Country</th>
<th>Continent</th>
<th>Population</th>
<th>Annual Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tokyo</td>
<td>Japan</td>
<td>Asia</td>
<td>34,500,000</td>
<td>0.60%</td>
</tr>
<tr>
<td>2</td>
<td>Guangzhou</td>
<td>China</td>
<td>Asia</td>
<td>25,800,000</td>
<td>4.00%</td>
</tr>
<tr>
<td>3</td>
<td>Seoul</td>
<td>South Korea</td>
<td>Asia</td>
<td>25,600,000</td>
<td>1.40%</td>
</tr>
<tr>
<td>4</td>
<td>Jakarta</td>
<td>Indonesia</td>
<td>Asia</td>
<td>25,300,000</td>
<td>2.00%</td>
</tr>
<tr>
<td>5</td>
<td>Shanghai</td>
<td>China</td>
<td>Asia</td>
<td>25,300,000</td>
<td>2.20%</td>
</tr>
<tr>
<td>6</td>
<td>Mexico City</td>
<td>Mexico</td>
<td>North America</td>
<td>23,200,000</td>
<td>2.00%</td>
</tr>
<tr>
<td>7</td>
<td>Delhi</td>
<td>India</td>
<td>Asia</td>
<td>23,000,000</td>
<td>4.60%</td>
</tr>
<tr>
<td>8</td>
<td>New York City</td>
<td>United States</td>
<td>North America</td>
<td>21,500,000</td>
<td>0.30%</td>
</tr>
<tr>
<td>9</td>
<td>São Paulo</td>
<td>Brazil</td>
<td>South America</td>
<td>21,100,000</td>
<td>1.40%</td>
</tr>
<tr>
<td>10</td>
<td>Karachi</td>
<td>Pakistan</td>
<td>Asia</td>
<td>21,100,000</td>
<td>4.90%</td>
</tr>
<tr>
<td>11</td>
<td>Mumbai</td>
<td>India</td>
<td>Asia</td>
<td>20,800,000</td>
<td>2.90%</td>
</tr>
<tr>
<td>12</td>
<td>Manila²¹</td>
<td>Philippines</td>
<td>Asia</td>
<td>20,700,000</td>
<td>2.50%</td>
</tr>
<tr>
<td>13</td>
<td>Los Angeles</td>
<td>United States</td>
<td>North America</td>
<td>17,600,000</td>
<td>1.11%</td>
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<tr>
<td>14</td>
<td>Osaka</td>
<td>Japan</td>
<td>Asia</td>
<td>16,800,000</td>
<td>0.15%</td>
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<tr>
<td>15</td>
<td>Beijing</td>
<td>China</td>
<td>Asia</td>
<td>16,400,000</td>
<td>2.70%</td>
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<tr>
<td>16</td>
<td>Moscow</td>
<td>Russia</td>
<td>Europe</td>
<td>16,200,000</td>
<td>0.20%</td>
</tr>
<tr>
<td>17</td>
<td>Cairo</td>
<td>Egypt</td>
<td>Africa</td>
<td>15,700,000</td>
<td>2.60%</td>
</tr>
<tr>
<td>18</td>
<td>Kolkata</td>
<td>India</td>
<td>Asia</td>
<td>15,700,000</td>
<td>2.00%</td>
</tr>
<tr>
<td>19</td>
<td>Buenos Aires</td>
<td>Argentina</td>
<td>South America</td>
<td>14,300,000</td>
<td>1.00%</td>
</tr>
<tr>
<td>20</td>
<td>Dhaka</td>
<td>Bangladesh</td>
<td>Asia</td>
<td>14,000,000</td>
<td>4.10%</td>
</tr>
</tbody>
</table>

*After Brinkoff: The Principal Agglomerations of the World, 2012*
What are Lifelines?

Systems or networks that provide for the circulation of people, goods, services and information

They are vital for the health, safety and economic activity of the community

Platt, 1991
Typical Lifelines and Key Structures

Lifelines
- Transport
- Water
- Power
- Sewerage
- Telecommunications
- Fuel pipelines
- Informatic networks

Key Structures and Facilities
- Police
- Fire brigade
- Ambulances
- Emergency coordination centres
- Hospitals
- General medical care
- Food distribution networks
- Schools
- Emergency shelters

After Britton, 1997
# Vulnerability of Lifelines to Natural Hazards

<table>
<thead>
<tr>
<th></th>
<th>Earthquakes</th>
<th>Landslides</th>
<th>Storms</th>
<th>Floods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>● ● ●</td>
<td>●</td>
<td>● ● ●</td>
<td>●</td>
</tr>
<tr>
<td>Water</td>
<td>● ● ●</td>
<td>●</td>
<td>●</td>
<td>● ● ●</td>
</tr>
<tr>
<td>Sewer</td>
<td>● ● ●</td>
<td>●</td>
<td>●</td>
<td>● ● ●</td>
</tr>
<tr>
<td>Telecom</td>
<td>● ● ●</td>
<td>●</td>
<td>● ● ●</td>
<td>●</td>
</tr>
<tr>
<td>Roads</td>
<td>● ●</td>
<td>● ● ●</td>
<td>● ●</td>
<td>● ● ●</td>
</tr>
<tr>
<td>Rail</td>
<td>● ● ●</td>
<td>● ● ●</td>
<td>● ●</td>
<td>● ●</td>
</tr>
<tr>
<td>Bridges</td>
<td>● ● ●</td>
<td>●</td>
<td>●</td>
<td>● ●</td>
</tr>
<tr>
<td>Airports</td>
<td>● ●</td>
<td>●</td>
<td>● ●</td>
<td>● ●</td>
</tr>
<tr>
<td>Ports</td>
<td>● ● ●</td>
<td>●</td>
<td>● ●</td>
<td>●</td>
</tr>
</tbody>
</table>
## Lifelines Interdependency

<table>
<thead>
<tr>
<th>Failure of</th>
<th>Power</th>
<th>Water</th>
<th>Sewerage</th>
<th>Telecom</th>
<th>Roads</th>
<th>Rail</th>
<th>Bridges</th>
<th>Airports</th>
<th>Ports</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power</strong></td>
<td></td>
<td>3***</td>
<td>3***</td>
<td>3***</td>
<td>-</td>
<td>3***</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td>1</td>
<td></td>
<td>3***</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td><strong>Sewerage</strong></td>
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<td>3***</td>
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</tr>
<tr>
<td><strong>Telecom</strong></td>
<td>3***</td>
<td>3***</td>
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<td>-</td>
<td>3***</td>
<td>3***</td>
<td>3***</td>
</tr>
<tr>
<td><strong>Roads</strong></td>
<td>1</td>
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<tr>
<td><strong>Rails</strong></td>
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<td>1</td>
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</tr>
<tr>
<td><strong>Bridges</strong></td>
<td>3***</td>
<td>3***</td>
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</tr>
<tr>
<td><strong>Airports</strong></td>
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</tr>
<tr>
<td><strong>Ports</strong></td>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
What are the best strategies to mitigate the effects?

- **Knowledge of the physical phenomena**
  - Geoscientists

- **Knowledge of the society assets and dynamics**
  - Engineers
  - Social scientists

- **Programmes implementation**
  - Politicians
  - Decision makers

- **Plans development**

- **Emergency (short term)**

- **Prevention (long term)**

*Stefano Tinti*
What are the best strategies to mitigate the effects? (2)

Hazard Assessment

Vulnerability and Risk Assessment

Mitigation Plans

Politicians

Decision makers

Geoscientists

Engineers

Social scientists
What is the possible contribution of scientists?

- To provide knowledge-based hazard-to-risk assessment
- To develop short-term mitigation plans including monitoring, forecast, warning systems
- To develop long-term prevention plans including sustainable development concepts

Geoscientists and Engineers and Social scientists need to speak with each other.

Stefano Tinti
What is the possible contribution of teachers?

to cooperate with authorities to disseminate information on emergency plans

to stimulate the development of and to participate in drills programmes involving schools

to develop educational plans in natural hazards on prevention issues

to fill a cultural gap to increase the awareness that natural disasters are not inevitable and that the main strategy we have is a sustainable development

Stefano Tinti
Thank you

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