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MAPPING OF FUTURE UNINTENTIONAL RISKS

Examples of risk and community vulnerability

François Grünewald, Blanche Renaudin, Camille Raillon, Hugues Maury, Jean Gadrey, Karine Hettrich

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MAPPING OF FUTURE UNINTENTIONAL RISKS

Examples of risk and community vulnerability

François Grünewald, Blanche Renaudin,
Camille Raillon, Hugues Maury,
Jean Gadrey, Karine Hettrich



urgence
réhabilitation
développement



September 2010

This research study is dedicated to Jean Arsène Constant, Haitian pioneer in disaster management, who died during the earthquake of 12 January in Port-au-Prince



Groupe URD (Urgence – Réhabilitation – Développement)

provides support to the humanitarian and post-crisis sector. It aims to improve humanitarian practice in favour of communities affected by crises via a number of activities including operational research, programme evaluation, designing methodological tools, providing institutional support and training, both in France and abroad.

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The opinions expressed in this report are those of the authors alone.

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ACRONYMS

BRIC	Brasil-India-China
CNRS	<i>Centre National de la Recherche Scientifique</i>
CRED	The Center for Research on the Epidemiology of Disasters
DAS	The French Ministry of Defence's Strategic Affairs Directorate
FAO	United Nations Food and Agriculture Organisation
GDP	Gross Domestic Product
GMO	Genetically Modified Organism
GOARN	Global Outbreak Alert and Response Network
HDI	Human Development Index
IMF	International Monetary Fund
IPCC	Inter-governmental Panel on Climate Change
NATO	North Atlantic Treaty Organisation
NGO	Non-governmental Organisation
ORSEC	<i>Organisation de la Réponse de Sécurité Civile</i> (French disaster response plan)
PPRT	<i>Plan de Prévention des risques Technologiques</i> (Technological risk prevention plan)
SARS	Severe Acute Respiratory Syndrome
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFPA	United Nations Population Fund
UN Habitat	United Nations Human Settlements Programme
USAID	United States Agency for International Development
USSR	Union of Soviet Socialist Republics
WHO	World Health Organisation
WMO	World Meteorological Organisation

Introduction

Though recent decades have been marked by armed conflict within and between states, the end of the 90s and the first decade of the 21st century has seen a large number of major natural disasters, an increase in the number of technological incidents and the emergence of pandemics.

- In the last five years there has been a sharp increase in the number of major disasters: the tsunami in South Asia, earthquakes in Pakistan, Indonesia, Haiti, Chile and China, floods in Pakistan, China and Europe, drought in the Sahel, China, Russia, cyclones in the USA, the Philippines, the Caribbean, etc.
- There is growing collective awareness of health risks, with the emergence of new pandemics and the return of old diseases that we thought were under control, but which have reappeared, stronger and more resistant to established forms of treatment (multi-drug resistant forms of tuberculosis, etc.),
- Increased risk due to demographic growth, increased population density and sensitive technological and industrial infrastructure¹ in high-risk areas are receiving more and more attention in the analysis and monitoring of risk in developed and developing countries.

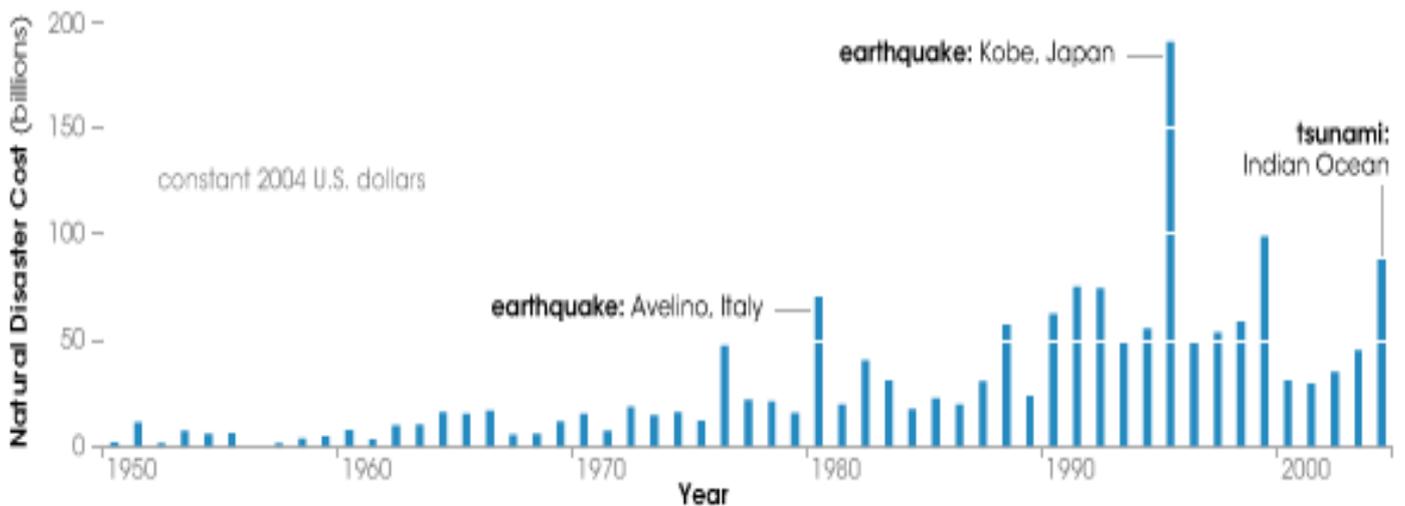
The interaction between natural, technological and health risk factors create contexts in which people are exposed to risk of alarming proportions with the emergence of increasingly complex multiple risk synergies. **These catastrophic events, which are not the result of a state or group's intention to do harm for political ends are defined in this document as "unintentional risks".**

If this trend continues, hundreds of thousands of lives will be lost each year, while the cost of these disasters will be more than 300 billion US dollars per year. Though disasters have become less lethal due to the actions of the international community in terms of both preparedness and response to disasters, their impact on development is increasingly negative. The damage done to infrastructure by recent earthquakes such as those in Iran (Bam - 2003), in Kashmir (2005), in Indonesia (Yogyakarta - 2006 and Padang - 2009) and in Haiti (Port-au-Prince - 2010) or by major floods (India, Pakistan, Bangladesh, Eastern Europe) has been enormous, incurring considerable losses.

¹NATO, 2007-a. According to NATO, sensitive infrastructure is infrastructure which provides energy, communication or security in a country.

² Riebek H, 2005

Figure 1. The cost of natural disasters from 1950 to 2005



Source : Riebek H, 2005

Mechanisms for managing natural and technological disasters and epidemics and pandemics (adaptation, mitigation, prevention, preparedness) are increasingly present in governmental, humanitarian and community strategies for reasons of survival and also for economic³, security⁴ and political reasons.

The fact that these disasters appear to be getting more serious and risks appear to be increasing is not simply the result of improved information systems. No region in the world is spared these phenomena and the frequency with which they take place is spread out reasonably evenly between all the continents⁵. All risk factors are multiplied by demographic growth, the acceleration of mobility and economic phenomena linked to globalization. There is an increased probability that disasters will take place simply due to the increased “contact” between people and risks.

A certain number of factors increase both the probability that disasters will happen and people’s vulnerability to them, but also the resilience of States and communities. By focusing on these factors, we can develop a strategic analysis of unintentional risks. This provides an essential tool to anticipate risks.

Disaster management involves **operational, geo-strategic and geopolitical challenges** at different levels:

- **international** – providing governments, who often struggle to cope, with support;
- **national** - each sovereign state is responsible for the protection of its citizens;
- **local** – the participation of communities is essential if any progress is to be made.

³ CRED, 2010

⁴ Bouveret P. and Mampaey L., 2008

⁵ European Commission, 2008

How are these unintentional risks going to evolve over the next 30 years? We must first decide what model we are going to use to make our predictions. A natural disaster is the combination of a catastrophic natural phenomenon and human societies and activities. For a long time these were **considered apolitical events**, but it is now clear that they are very closely linked to issues of governance. This explains the term “**socio-natural disasters**” which is used in Latin America. The Nobel Prize winner, Amartya Sen⁶, developed his ideas about the political economy of disasters in terms of the interaction between governance and disasters. Viewed in this way, disasters are at the heart of both national and international political questions.

Many researchers⁷, like Fernand Braudel, and aid institutions like the World Bank or the UK's Department for International Development⁸ have concluded that **natural, technological and health disasters are a major risk not only for sustainable development but also for security**⁹. History is full of cases where disasters have had a major political impact.

"There is a difference in nature between threats to security which result from hostile action and those where there is no malevolent intention, such as natural disasters. But the need for anticipation, preparedness and speed of reaction is the same for our fellow citizens in both cases. Defence and security strategies in these cases, need to respond to different problems (...). Responses themselves must be global, bringing together all the means available to the public authorities and civil society at national, European and international levels".

Livre blanc sur la défense et la sécurité nationale, Paris, 2008

Faced with these critical issues, our approach to anticipation needs to be revised. Anticipating major change¹⁰ and discontinuity is an essential strategic objective. In order to do so, we need to visualise risks and how they combine and analyse them both in spatial terms and in terms of probability.

The idea of risk mapping is currently evolving between the drawing up of a “**general atlas of hazards**” (causes of risks) and a more detailed focus on “**impact risks**” per zone. This is leading towards the **mapping of multi-risk synergy** or the **mapping of vulnerabilities** in terms of **socio-economic vulnerability** (population density, community location, food security, etc.) and **infrastructure vulnerabilities** (industrial, energy, urban and communication infrastructure, sensitive installations and resilience capacity of infrastructure, etc.). This report includes original maps which have been produced using information from a wide variety of databases.

Half-way through the study, the terrible earthquake which took place in Haiti on 12 January 2010 led to the decision by Groupe URD and the Strategic Affairs Delegation (DAS) to modify the work schedule so that a complementary piece of work could be carried out including a case study on Haiti¹¹. Groupe URD researchers also visited Bangladesh and Kalimantan (Indonesia), two areas in which there is extreme vulnerability to future unintentional risks. This work done in the field brought a useful and practical perspective to the study.

This report presents an initial analysis of the different issues involved in anticipating unintentional risks and looks at the mechanics of States' and communities' resilience in the face of these risks.

It is organised as follows:

⁶ Sen A. 1982

⁷ Tadjbakash S. & al, 2006

⁸ Abbot C. 2006

⁹ Dyer G., 2008

¹⁰ Papon, 2010

¹¹ http://www.urd.org/IMG/pdf/rapport_DASHaiti.pdf

Chapter I presents a typology of unintentional risks, their synergies and the interface between these risks and existing vulnerabilities.

Chapter II presents an operational typology of future unintentional risks and explores issues raised when these are combined.

Chapter III looks in detail at issues of vulnerability and resilience depending on different analysis models.

Chapter IV discusses the mapping of combined risks at the global level and for certain particularly sensitive areas of the planet.

Chapter V attempts to identify the main trends caused by the existence and evolution of these future unintentional risks.

Chapter I

Future unintentional risks – some definitions

I.1 Future unintentional risks: a danger for the planet

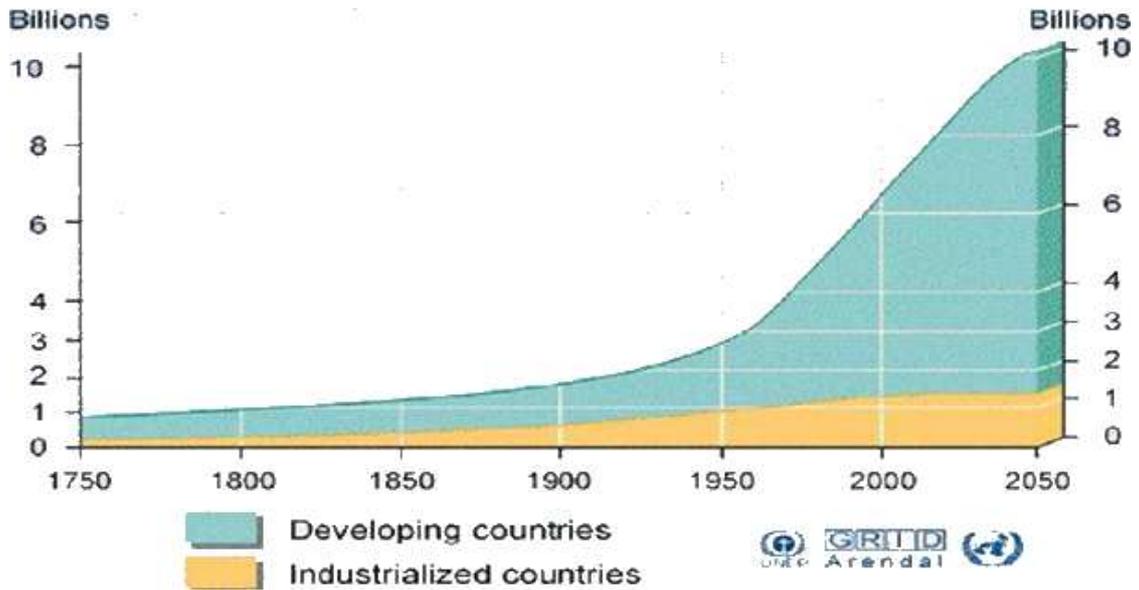
Nowhere on the planet can claim to be immune to risk, neither developed countries, poor countries like Niger and Haiti, nor intermediary countries like Indonesia, Chile or India. Though each country's disaster prevention, preparedness and response capacity varies depending on its economic level, every country is subject to the "sword of Damocles" of future unintentional risks, whether these are linked to natural phenomena, technological choices, economic or planning policies or epidemiological developments.

This situation is made worse by what is known as « surface phenomena » whereby the greater the contact between risk factors, the greater the probability that these phenomena will take place. Thus, demographic growth and increased population density in certain high-risk areas (large deltas, coastal areas, regions which are fertile but are subject to earthquakes) increase the possibility of future unintentional risks. Figure 2 presents a hypothesis of demographic growth which is widely accepted in specialized circles, such as by UNFPA. This hypothesis will be used as the time reference throughout the study.

It shows how significant losses have become from so-called natural disasters in the last decades and how badly they have held back socio-economic development.

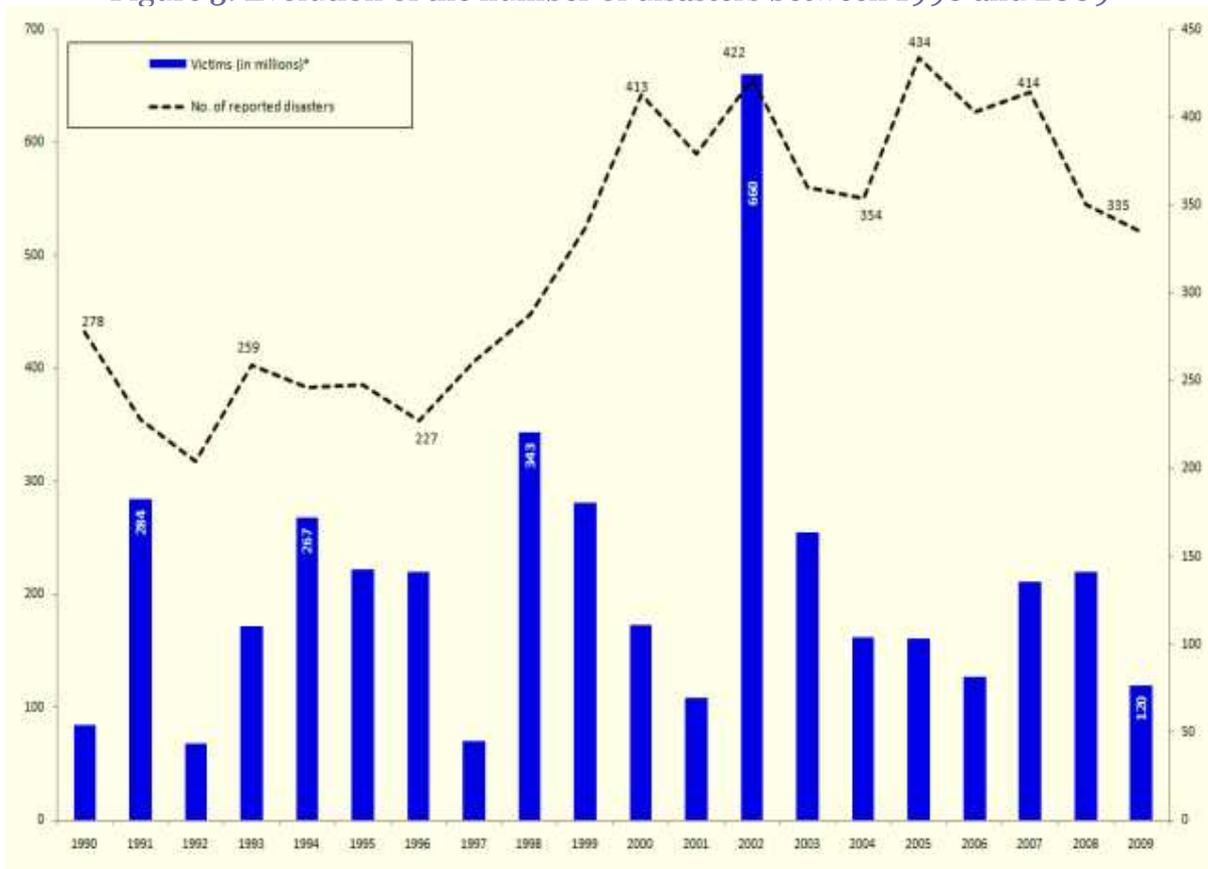
In 2008, the Centre for Research on the Epidemiology of Disasters (CRED) recorded more than 300 disasters in the world which killed more than **240 000** people and affected **214 million** people (cf. figure 3), causing economic damage of **181 billion dollars**. The CRED also recorded a significant rise in the number of hydro-meteorological disasters and earthquakes, with all the social distress that these events cause: damage to communities, infrastructure, ecosystems and national economies. Though the relative drop in the number of major disasters in 2009 brings the average for the decade down a little, the first months of 2010, with the earthquake in Haiti and the major floods in India, Pakistan and China show that there is still an upwards trend.

Figure 2. Global Population Growth



Source : www.treehugger.com/files/2009/02/when-population-growth-resource-availability-collide.php

Figure 3. Evolution of the number of disasters between 1990 and 2009



Source : CRED, Report 2009

I.2 A typology of future unintentional risks

The phenomena referred to in this report as “future unintentional risks” represent a considerable danger for humanity, as much for the well-being of communities as for international security.

The first step of this study was to determine what risks exist, what their underlying roots are and what factors cause them to take place. A typology was developed in reference to work previously carried out by Groupe URD (see Table 1: Operational typology of risks)¹². The yellow boxes represent natural disasters; the blue boxes represent disasters caused by errors in risk management or inappropriate economic policies; technological disasters are in red; and the specific case of new epidemics and pandemics like Severe Acute Respiratory Syndrome (SARS) or Avian influenza or the development of uncontrolled resistance to known endemic diseases are coloured orange.

These risks are classified into several categories and are analysed in the following order in this chapter:

- Risks linked to natural hazards (paragraph 2.1)
 - Climatic risks (paragraph 2.1.1)
 - Tectonic risks (paragraph 2.1.2)
- Health-related risks (paragraph 2.2)
- Technological risks (paragraph 2.3)
- Economic risks (paragraph 2.4).

Map 1 shows the main areas of earthquake and climatic risks in relation to geographic density. This allows us to see the intensity of exposure in relation to population distribution.

¹² Grünewald F., 2001 and 2007

Table 1: Operational typology of unintentional risks ¹³

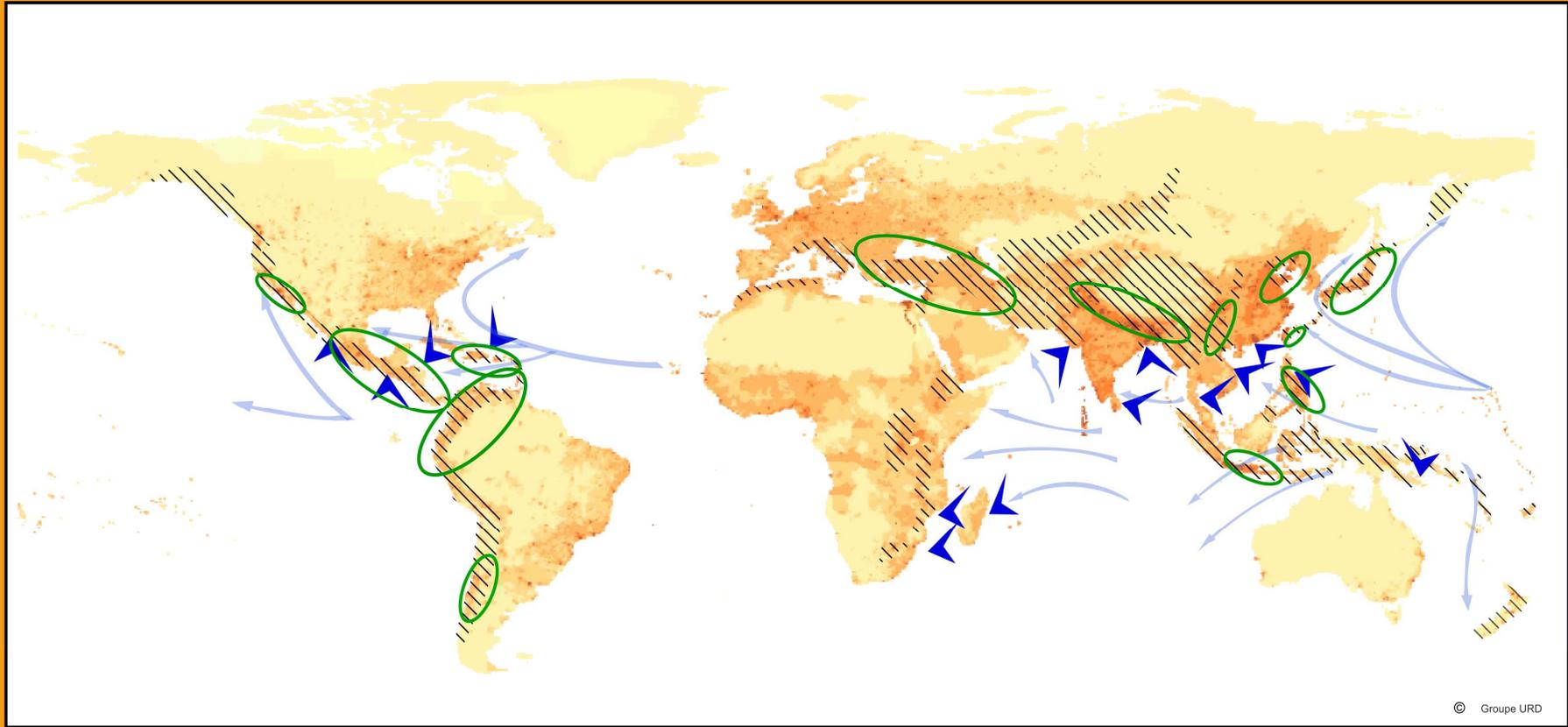
Type	Description	Predictive indicators	Descriptive indicators	Means of verification	Remarks	
Socio-natural disasters	Geological risks	Volcanic eruptions	Tectonic indicators Behaviour of fauna	Seismological; Agro-ecological; Socio-economic	Geo-tectonic monitoring; Observation of fauna; Satellite imagery	There are premonitory signs before a volcano eruption
		Earthquakes	Tectonic and seismic indicators Behaviour of fauna	Seismological; Agro-ecological; Socio-economic	Geo-tectonic monitoring; Observation of fauna; Satellite imagery	Most of the time, large-scale earthquakes take place without any premonitory warning signs
		Tsunami	Tectonic and seismic indicators Behaviour of fauna	Climatic; Nutritional and behavioural	Geo-tectonic monitoring; Observation of fauna; Satellite imagery	Seismological and sea level indicators are essential warning signs
	Climatic and biological risks	Drought	Climatic indicators; Behavioural indicators;	Climatic, Nutritional and behavioural; Socio-economic	Climatic data; Data about vegetation; Satellite imagery	For the majority of these types of disasters, frequent analysis of climatic or factual data, when it exists, as well as of the history of repercussions of previous disasters, often allows a powerful analysis of dynamics and risks to be established.
		Floods	Climatic indicators	Climatic; Nutritional and behavioural	Climatic data; Satellite imagery	
		Hurricanes and cyclones	Climatic indicators		Climatic data; Satellite imagery	El Niño is a perfect example of a potentially disastrous type of phenomenon which is perfectly predictable with known warning signs.
		Locust plague	Climatic indicators; Locust population dynamics	Agro-ecological, Climatic; Nutritional and behavioural	Climatic data; Satellite imagery; Ecological studies; Monitoring of vegetation canopy	
		Landslides	Climatic indicators; Tectonic indicators; Topological analysis	Climatic ; Agro-ecological ; Behavioural	Mapping of slopes; Climatic data; Satellite imagery; Ecological studies; Monitoring of vegetation canopy	
		Forest fires	Climatic indicators; Monitoring of vegetation canopy; Signs of fire	Climatic ; Agro-ecological ; Behavioural	Climatic data; Satellite imagery; Ecological studies; Monitoring of vegetation canopy	

¹³ Grünewald F., 2001

Type	Description	Predictive indicators	Descriptive indicators	Means of verification	Remarks
Inappropriate policies	Results of the influx of refugees	Demographic; Ecological; Socio-economic;	Security; Surgical, Socio-economic and nutritional	Geopolitical analysis; Economic analysis; Historical analysis	Often the consequence of one or two of the preceding phenomena (multi-causality)
	Failure of economic or planning policies	Geopolitical and historical Economic Demographic	MDG and human development; Socio-economic; Nutritional	Geopolitical analysis; Economic analysis; Historical analysis	Here too, analysis of historical, political and social factors is essential.
Technological disasters	Technological disasters	Analysis of location of high-risk areas; Climatic indicators; Seismic indicators	Climatic and agro-ecological, Epidemiological; Analysis of water; Behavioural;	Analysis of technological risks, Mapping of risks; Environmental studies; Epidemiological studies	Linked to old or badly located technology.
Pandemics	Emergence of new pandemics	Mortality and morbidity, Monitoring of population movements	Mortality and morbidity, Resistance to treatment	Epidemiological monitoring;	
	Renewed outbreaks of old epidemics	Mortality and morbidity, Monitoring of population movements	Mortality and morbidity, Resistance to treatment	Epidemiological monitoring;	

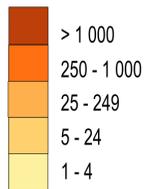
MAP 1

POPULATION DENSITY AND AREAS WITH MAJOR EARTHQUAKE AND CYCLONE ACTIVITY

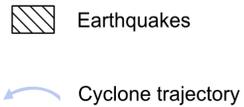


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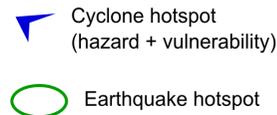
Number of inhabitants per km²



Areas affected by natural hazards



Risk hotspots



Map base: <http://finder.geocommons.com/overlays/18457/>;
Smoothnig with MapShaper.

Population density: ESIN Columbia University. SEDAC, GPWv3, Population density Grid. Data 2010.

Cyclones: Maplecroft/CARE Cyclone Risk Hotspots, World, 2008. La Documentation française, Les zones d'aléas sismiques, volcaniques et cycloniques dans le monde en 2001.

Earthquakes: CIESIN Columbia University. SEDAC, GPWv3, Global Earthquake Hazard Distribution, 2005. La Documentation française, Les zones d'aléas sismiques, volcaniques et cycloniques dans le monde en 2001.

Produced by: Groupe URD, 2010

<http://www.urd.org/>

World_PopDensitySismCyclons_carte-v7_A4LC

1.2.1 Socio-natural risks

1.2.1.1 Risks linked to climatic events

Climate-related risks have always been at the centre of societies' adaptation strategies. Glacial and periglacial periods have led to major changes in the world's vegetation and in societies' organisation. There have already been major variations in temperature in recent history.

Nevertheless, in the last 30 years there has been a considerable rise in the number of climate-related disasters¹⁴. Insurers, whose role it is to manage risk, recognise that there has been a rise in the number of climatic disasters. These have led to huge economic losses internationally and have considerably reduced the profitability of the insurance sector.



*Floods in Bangladesh in 2009
(Source : Groupe URD)*

One of the principle explanations for this increase in the number of climate-related disasters is linked to changes to the climate¹⁵ which are taking place as a consequence of the steady increase in global average temperatures since the middle of the 20th century. According to some, this increase in temperature¹⁶ is itself the result of increasing emissions of greenhouse gases into the atmosphere produced by industrial activities since the beginning of the industrial revolution and particularly since the 1950s. Map 2 shows how these factors have evolved and how they are distributed geographically.

According to the 4th report of the Intergovernmental Panel on Climate Change (IPCC)¹⁷, “it is likely that climate change will affect the frequency, intensity and duration of extreme weather events whether rapid onset (cyclones, floods) or slow onset (droughts)”. The impact of the disasters it causes will depend to a great extent on the human factor and the way in which we anticipate and manage these crises.

Though there continues to be debate in specialist circles, the IPCC's assessment of global warming is that **temperatures will rise** both in the atmosphere and in the oceans, and there will be **large-scale melting of the earth's ice cover** (glaciers and polar ice caps), **rising sea levels and the disruption**

¹⁴ Dunlop S. 2007

¹⁵ Buffet C., 2008-a et 2008-b

¹⁶ OTAN, 2007-b

¹⁷ The Intergovernmental Panel on Climate Change was established in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP). Since its creation it has produced a series of evaluation reports which have become references for decision-makers, scientists and experts.

of thermohaline circulation¹⁸ and increasingly extreme weather events (cyclones/tornados, droughts and floods). This will have an impact on natural systems and on the human environment. The effects of this warming on global thermal flows are potentially disastrous. If the macro circulation of air flow and marine currents is modified the earth as we know it will be fundamentally altered. Changes in the trajectory or intensity of the Gulf Stream or Jet Stream, for example, will have significant, long-term effects on the climate in Europe, the United States and Africa.

Changes in the thermal profile of the seas and oceans, linked for example to the melting of the polar ice caps can lead to considerable changes in the climate. The circulation of water in the oceans, caused by differences in temperature and salinity between water masses, appears to be going through major changes. These changes in thermal flows in the seas and oceans of the Southern hemisphere will accentuate El Niño and la Niña¹⁹ and will have potentially catastrophic repercussions in South and Central America as well as in Asia. Furthermore, developments in recent years seem to indicate that changes in thermohaline circulation are beginning to have repercussions in new areas such as temperate regions of the Northern hemisphere and Africa. (cf. Carte 3)

The consequences of climate change need to be anticipated in order to minimize their socio-economic impacts. The Stern report stipulates that investing 1% of global GDP per year in reducing greenhouse gas emissions will make it possible to avoid a loss of between 5% and 20% of global GDP each year.

Box 1. Climate change, the IPCC's projections

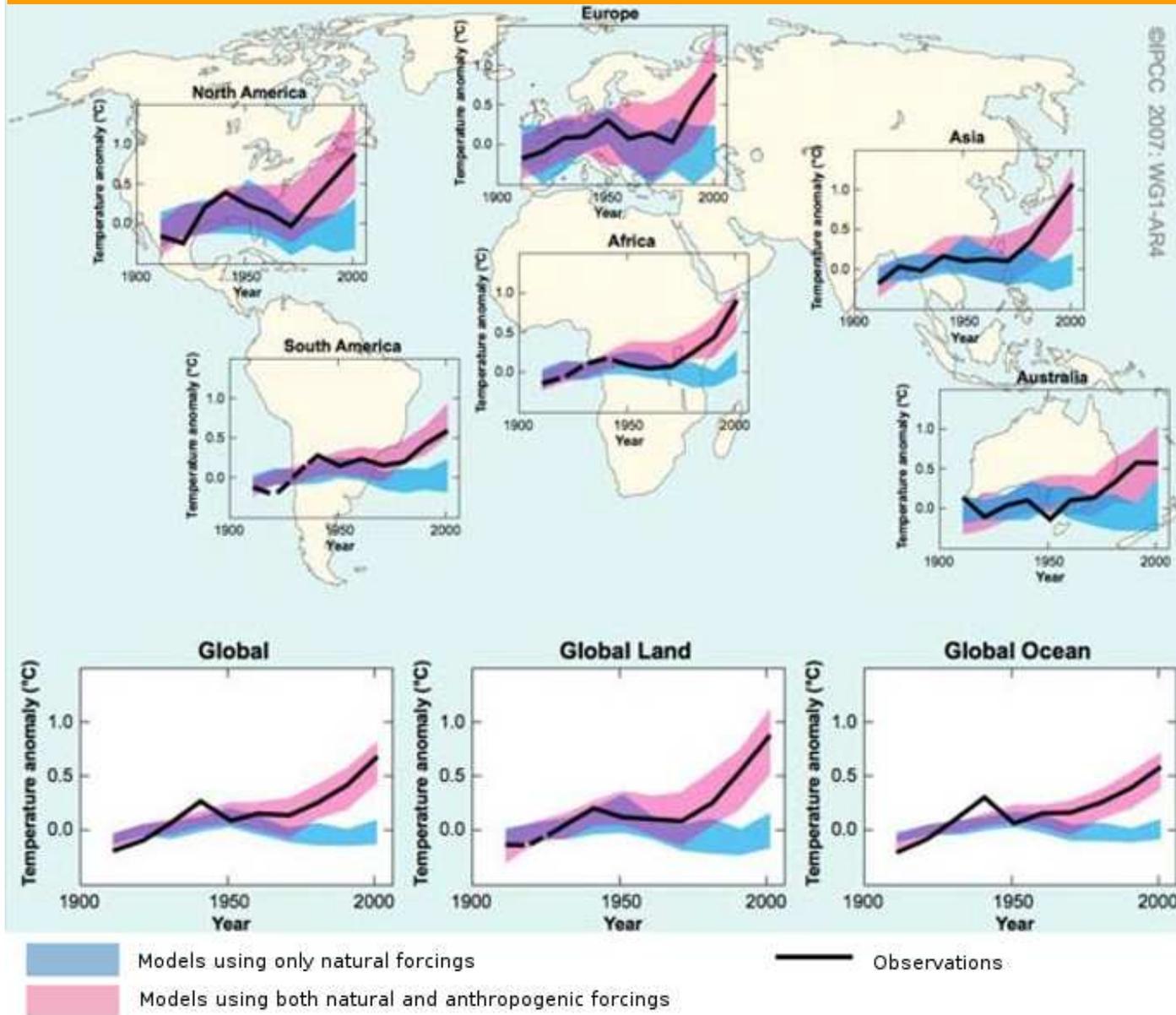
The increase in average temperature since 1906 is 0.74°C, the increase having accelerated since 1980. This change, which may seem anodyne, is in fact unprecedented in the last thousand years. It is estimated that it takes a hundred years for CO₂ to be released from the atmosphere. Thus, the CO₂ emitted today will contribute to the greenhouse effect until 2108. Despite mitigation measures, sea levels and temperatures will continue to rise. It is particularly these retroactive effects which make reducing greenhouse gas emissions so urgent in order to avoid runaway climate change. The scientists of the IPCC estimate that there are tipping points beyond which the climate is likely to change in an abrupt and irreversible manner. Is it already too late? To underline how urgent the situation was, a British think tank, the New Economics Foundation, launched a campaign in August 2008 called "100 months to save the planet", which estimated that we would reach the tipping point in 2016.

As mitigation policies remain unambitious, **global emissions of greenhouse gases will continue to rise** in the following decades, which will accentuate global warming and extreme weather events in areas where the population is already very vulnerable. This change in frequency and intensity of extreme weather events added to the rising sea level will have harmful effects on natural and human systems. It seems unavoidable that there will be further humanitarian crises and that their effects on economies and development will continue to get worse.

¹⁸ Salinity and temperature affect the density of sea water. When water cools and increases in salinity it sinks in the high latitudes (Norway, Greenland, etc.) and moves South at depths of between 1 and 3 km. It is then reheated in the Tropics and returns to the surface where it cools again and so on via currents with a high latitudinal content.

¹⁹ El Niño changes the meteorological structure of the planet, causing abnormally heavy rainfall and drought.

MAP 2. GLOBAL AND CONTINENTAL TEMPERATURE CHANGE



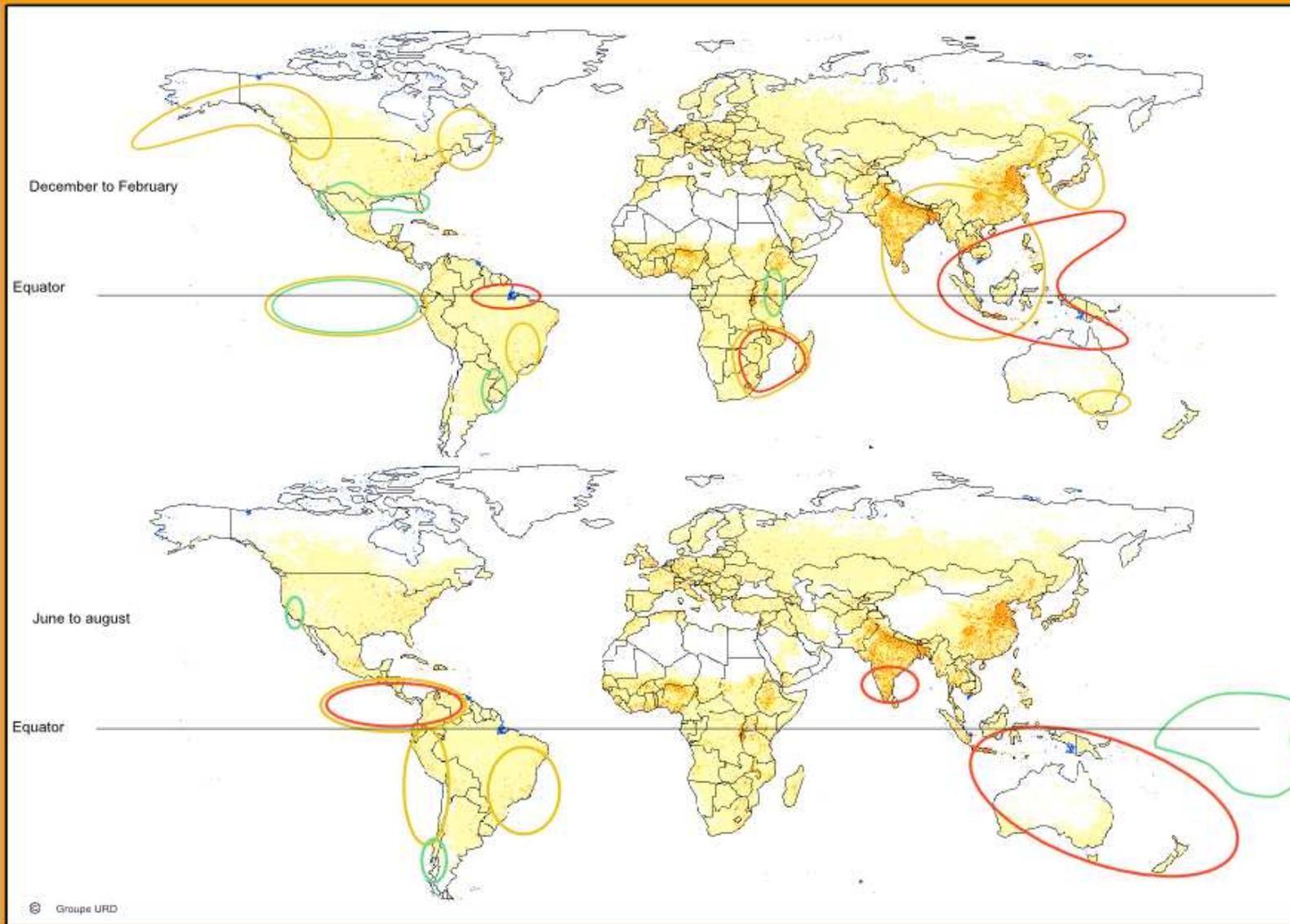
IPCC 2007: WG1-AR4

“Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906-2005 (black line) plotted against the centre of the decade and relative to the corresponding average for the period 1901-1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5 to 95% range for 19 simulations from five climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5 to 95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings”.

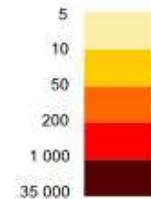
Source: IPCC Fourth Assessment Report: Climate Change 2007

MAP 3

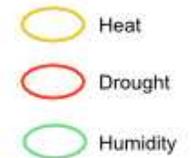
CLIMATIC VULNERABILITY AND EL NINO



Vulnerability of communities to drought in 2007 (no. of people/year)



Areas where El Niño has an impact



Prediction of sea level in 2100



© Groupe URD

Map base: <http://finder.geocommons.com/overlays/18457>; smoothing with MapShaper.
 Drought: UNEP/DEWA/GRID-Europe; Physical exposition to droughts events 1980-2001; dataset ref. 2009.
 Rising sea level scenario: <https://www.cresis.ku.edu/data/sea-level-rise-maps>.
 The effects of el Niño: MCT, El Niño effects; 2009

Produced by: Groupe URD, 2010
<http://www.urd.org/>

World_ClimateChangeElNiño_centriv1_A4L.C



*Delta in
Bangladesh,
2010 (Source :
Groupe URD)*



*Forest fire in
Indonesian
Kalimantan,
2010
(Source :
Groupe URD)*

Climate change will have many significant consequences:

- **Loss of island systems, coastal areas and increased risk in delta regions** where two thirds of the world's population lives.

The increase in temperatures will have unprecedented consequences: loss of land, salinification of water tables, etc. In concrete terms, thousands of people will be forced to migrate.

- **Increased economic and social disparity and risks in the agricultural sector.**

The predicted changes will affect yields and the location of production. It is likely that there will be an increase in agricultural yields in cold regions and a decrease in warm regions due to thermal stress.

The multiplication of extreme weather events in the last decade is very worrying as the practices of small farmers and general agricultural models are based on long-term observation and analysis of variations in the climate. The introduction of a large amount of uncertainty is going to make choices about practices and varieties much more difficult and is going to introduce new risk factors. Similarly, the phenomenon of parasites moving from one area to another to follow their ecosystems, which is beginning to take place in many regions, will also affect yields. Warming could modify the health and productivity of forests as well as the geographical distribution of species and will increase the risk of fires.

Phenomena directly caused by agricultural policies can create synergy with climatic changes and disastrous dynamics which will eventually lead to major "future unintentional risks". Thus, in many regions of South-East Asia, forests have been gradually replaced by industrial plantations, as was the case with the Mega Rice project in Indonesian Kalimantan in connection with transmigration policies²⁰. The failure of rice production led to the pauperization of the whole region. Forest fires, either of natural causes due to acute drought, or started intentionally to force farmers to accept contracts with oil palm plantation companies, have caused worrying levels of damage to the environment throughout the area and have increased the risk of hydro-climatic disasters.

- **Increased poverty, malnutrition and diseases linked to water and transmission vectors.**
Climatic disruption brings changes in temperature and humidity as well as changes in demographic and economic data: the mobility and distribution of people, access to means of subsistence and basic services, etc. Changes in these different parameters, which are determining factors for human health, create conditions which are favourable to major epidemiological events. Though the World Health Organisation has recently indicated that the risk of major epidemics is not systematic in post-disaster situations but is linked to specific conditions (the prior presence of vibrio cholerae, for example), numerous contexts have shown that a certain number of diseases such as malaria or dengue are becoming more common due to warming in previously temperate regions. The propagation of infectious diseases transmitted by vectors could be made easier and could lead to a change in the geographical distribution of certain pathologies. It is necessary to establish the epidemiological profile of the regions where these are likely to move from and to.
- **Reduced availability of water in certain regions²¹**
This risk is undoubtedly at the **heart of the debate** about climate change. The increase in random events which lead to aridity and the higher temperatures which accelerate evaporation will have serious repercussions both for access to water (in terms of quantity and quality) and for living conditions in these regions. It is important to note that countries which currently face major water shortages will be all the more vulnerable in years to come, with the risk of conflict to control the resource.

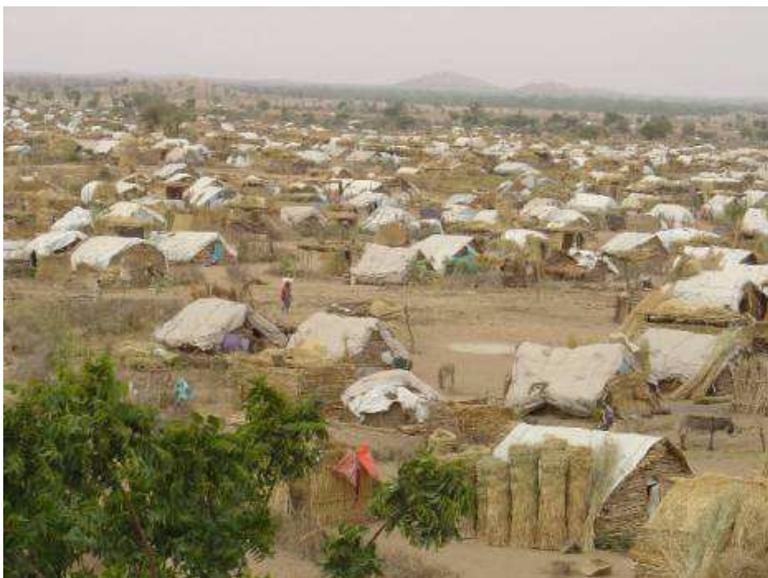
²⁰ Transmigration is a policy of the Indonesian government whereby migrants from overpopulated regions like Java are displaced to supposedly unpopulated areas. As part of this policy, large-scale rice-growing projects were created in Indonesian Kalimantan (Borneo). These projects failed both technically and socially and large industrial palm oil producing companies moved into the area to the detriment of ecosystems and small farmers.

²¹ Monnier Y., 1981

The connection between the growing scarcity of the resource and regional tensions/conflicts is analysed in chapter V.

Box 2. What part has climate change played in the conflict in Darfur? A scenario which is in danger of being repeated in other regions

There have been different reactions to the recent humanitarian emergencies in Darfur. Gareth Evans, President of the International Crisis Group, considers that it would be an exaggeration to describe Darfur as the “first climate change war” due to the complexity of the situation²². Climate change is just one factor in addition to recurring tension and the policies of the Khartoum regime towards a peripheral region which has been marginalized for a long time and to which it refuses to decentralize any power. Precipitation has fallen by a third in North Darfur in the last eighty years²³, which coincides with the increase in temperature of the Indian Ocean which has disturbed monsoons and has led to a reduction in food resources thus fuelling the conflict between farmers and nomads. Marc Lavergne, a researcher at the *Centre national de la recherche scientifique* (CNRS), stipulates that Khartoum recruits militia members from amongst “the most marginal communities in Darfur such as nomads and camel drivers who live on the edge of the Sahara and are the main victims of desertification”. The central State has not helped the population affected by the drought, but rather has instrumentalised a section of them to repress the majority and ensure its control over the region.



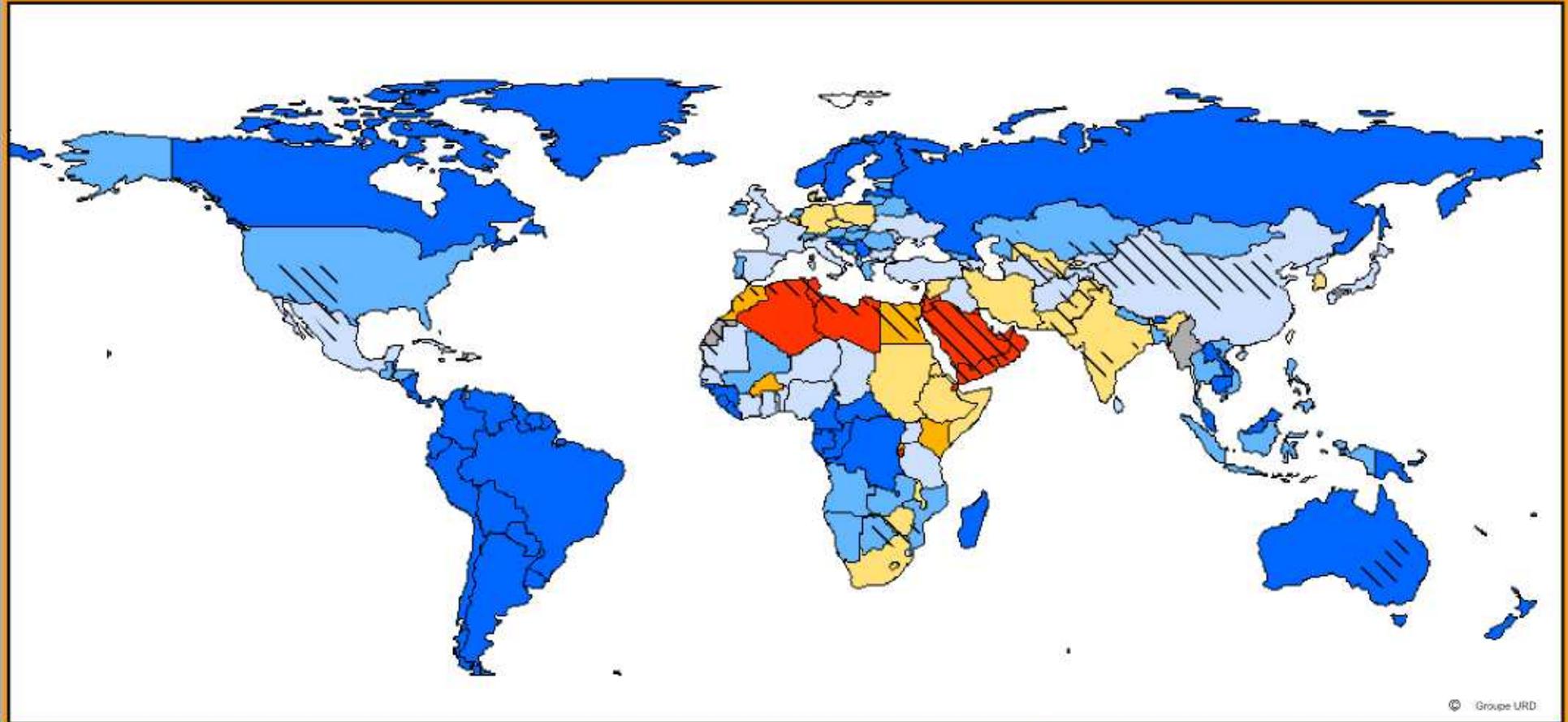
*IDP camp in Darfur,
2004
(Source : Groupe URD)*

²² “Conflict Potential in a World of Climate Change”, Gareth Evans, President, International Crisis Group, speech at the Bucerius Summer School on Global Governance 2008, Berlin, 29 August 2008

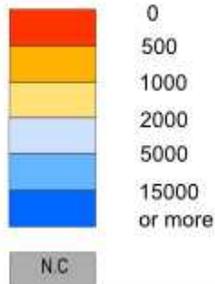
²³ “Environmental Degradation Triggering Tensions and Conflict in Sudan”, UNEP, 22 June 2007

MAP 4

RENEWABLE FRESHWATER RESOURCES



Renewable freshwater per inhabitant in 2007(M3/year)



Predicted water shortages for 2025

Available freshwater does not satisfy demand



Map base: <http://finder.geocommons.com/overlays/18457/>; Smoothing on MapShaper.

Renewable water resources: FAO AQUASTAT, "Water resources: total renewable per capita (actual) (m3/inhab/yr)". 2008; <http://www.fao.org/hr/water/aquastat/data/query/results.html>,

Prediction of water shortages for 2025: International Water Management Institute, "Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture" 2007, London.

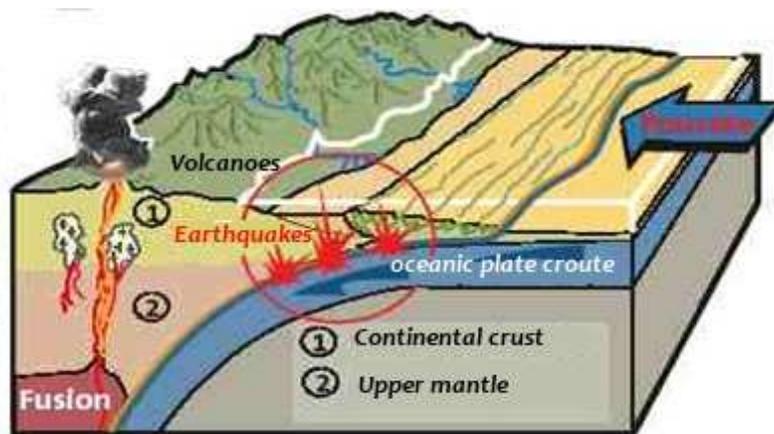
Produced by: Groupe URD, 2010. <http://www.urd.org/>

I.2.1.2 Tectonic risks (seismic and volcanologic)

The recent earthquake in Haiti and those that preceded it (Italy – 2009, China – 2008, Martinique – 2007, Pakistan – 2006 and 2004, Bam – 2003, Izmit, Boumerdes, etc.) have brought this type of risk, which is sometimes forgotten, back into the limelight. Similarly, a series of eruptions have placed the management of volcano-related events back on the agenda.

The analysis of seismic and volcanologic risks is central to the physical sciences of the earth. The analysis of the main fractures in the earth's crust and the friction points and build up of energy between tectonic plates is one of the principle ways in which these risks can be understood and the ability to anticipate them improved.

Figure 4. The principle of subduction



The movement of plates against each other as in the process of subduction, whereby oceanic plates are pushed under continental plates, cause a major build up of tension which lead to earthquakes.

Studies of the planet have provided a much better understanding of areas at risk (cf. Map 5):

- The Arakan arc which produces earthquakes in Sumatra and Java,
- The friction zone between plates which goes from the California subsistence zone (San Francisco and the risk of “the Big one”) to the Caribbean Gulf, which produced the recent earthquake in Haiti.
- The Andean arc and its regular movements,
- The major African rift and its continuation towards the volcanoes of Virunga in the Democratic Republic of Congo,
- Fracture zones around the Mediterranean, etc.

Earth physics have improved knowledge of warning signs and micro-tremors which can precede a larger earthquake. Unfortunately, as the disaster in Port-au-Prince recently demonstrated, the science of anticipation and seismic risk is far from perfect: no signal was recorded which would have made it possible to predict that an earthquake of magnitude 7 on the Richter scale was going to hit Haiti.

In the correspondence between Jean-Jacques Rousseau and Voltaire after the Lisbon earthquake of 1756, the idea emerges that “it is not the earthquake which killed people but the fact that they lived in Lisbon”.

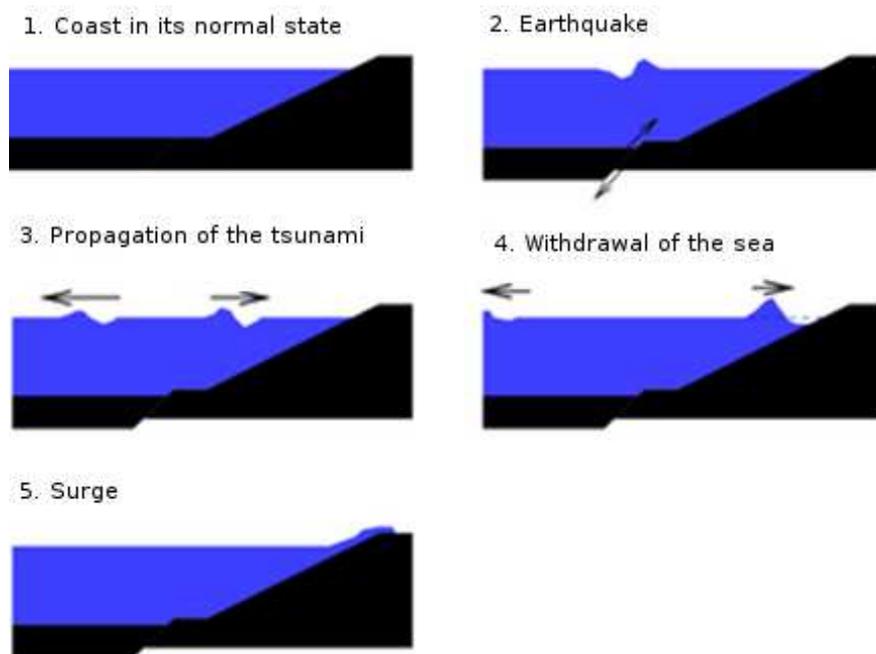
“Without leaving the subject of Lisbon, imagine, for example, that nature had not gathered twenty thousand houses there with six or seven floors, and if the inhabitants of this big city had been spread out more evenly, and less densely housed, the damage would have been much lighter, or maybe even nil. How many unfortunate people perished in this disaster because they wanted to fetch their clothes, their papers or their money?”

Jean-Jacques Rousseau, *Lettre sur la providence* (18 August 1756)

But the fact is that volcanic areas often have very fertile soil which has been enriched by the volcanic ash and that societies have often chosen the productivity of the soil despite the risk.

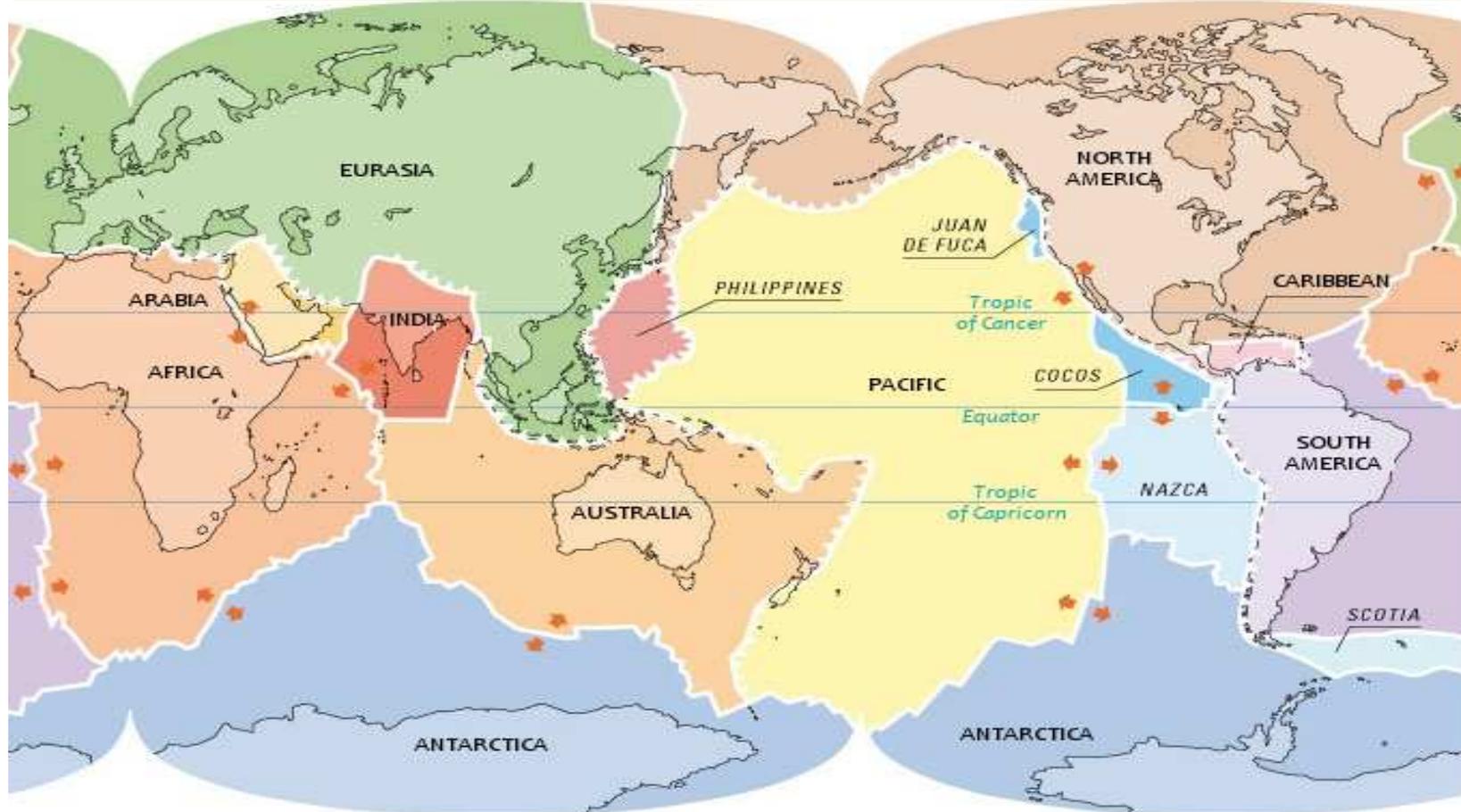
Linked to seismic phenomena is the major risk of tsunamis. The movements of the earth’s crust have a direct impact on the mass of water which cover it. The larger and more sudden the movement (a high magnitude earthquake), the more brutal the effect on the water. In many coastal regions the risk of tsunamis needs to be monitored along with the risk of earthquakes.

Figure 5. Tsunami generation, propagation and surge



Source : Régis Lachaume

MAP 5 TECTONIC AND SEISMIC RISK IN THE WORLD



Lithospheric plates:

-  Divergent boundary (rift)
-  Convergent boundary (subduction zone)

NAZCA Name of plate

-  Intense seismic activity
-  Other regions subject to earthquakes

Gall projection of the earth
(correction of poles by J. Bertin, 1950)

Sources :

- US Geological Survey ;
<http://earthquake.usgs.gov/regional/world/historical.php/>
- Encyclopaedia universalis, Paris : Albin Michel, 1989

Roberto GIMENO and Patrice MITRANO, April 2006

© La Documentation française

Source : Questions internationales n°19, May-June 2006

1.2.2 Sanitary risks (epidemics and pandemics)

1.2.2.1 Epidemics and pandemics: thoughts on sanitary risk

Major pandemics are not a new phenomenon. Some of them form part of the collective memory of humanity such as the plague, cholera and Spanish influenza, which ravaged Europe at various times in the past. The history of these major epidemics is closely linked to the increase in mobility of goods and people: diseases transported by explorers (tuberculosis, syphilis, measles, etc.) which had a devastating effect on native populations. The demographic impact of these epidemics on entire regions like Latin America and the Caribbean has shaped history.

Box 3. The plague in Europe

During the Middle Ages, the plague, which had spread throughout Europe, disappeared both in the West and in the East. In 1346, having disappeared for six centuries, it re-appeared in the region of the Black Sea. The battle between the Mongols and the Genovese in Constantinople led to the contamination of communities who fled, thus spreading *Yersinia pestis* to Messina, then Marseille via the galleys which landed there in November 1347. The plague reached Paris in June 1348, then England and Flanders. From the Muslim world to Western Europe, the plague decimated populations and weakened social structures. In a few months, the plague wiped out between one third and a half of the population of Europe. It is difficult to make a more precise estimation. We can only get an idea of the scale of the disaster from registers of baptisms and burials. But all calculations reach a figure of at least 40% of deaths in each village. The economic consequences of the plague were also huge. Lack of labour led to the disruption of production. Fields remained uncultivated and entire villages were abandoned. It was not until the second half of the 15th century that the impact of the epidemic was partially repaired.

It is highly probable that in the decades ahead, epidemics will spread faster because of increased and accelerated social and geographical mobility. This was the case with the most recent pandemics.

“National” epidemics become cross-border epidemics and sometimes move from the “epidemic” stage to the “pandemic” alert stage. They could have major economic and security-related impacts. For these reasons, health issues should be an integral part of geopolitical analysis.

1.2.2.2 Old infectious agents which present new risks

Though old, the influenza virus remains a potentially significant source of mortality. The Spanish influenza virus, which hit Europe immediately after the First World War, was much more deadly than the conflict itself. This virus modifies itself regularly. Certain changes are due to human activity, such as intensive poultry or livestock farming which favours hybrids and the emergence of new viruses. These can be relatively benign, even if they are very contagious (swine flu H1N1) or less contagious but very dangerous (avian flu H5N1, SARS). (cf. Map 6)

The development of self-medication systems, the increased and uncontrolled use of antibiotics and the presence of medicinal products of questionable quality on the markets of numerous countries of the South produce resistance to known treatment methods which is increasingly worrying. Thus, *streptococcus pneumoniae* and the tuberculosis bacillus (Koch bacillus) which were very sensitive to antibiotics fifty years ago have developed a worrying level of resistance to them in recent decades: people are now being killed by simple streptococcus bacteria. Not only are viruses more and more resistant but human beings' immune systems are becoming more and more fragile because they do not come into contact with these viruses regularly.

A study published in the August 2010 issue of *The Lancet* sounded the alarm following the appearance and rapid spreading of multi-resistant bacteria via **medical tourism patients** to South Asia and which are also present in Europe, the United States and Canada.

Box 4. The appearance of new multi-resistant pathogenic agents

Bacteria are more and more resistant to conventional antibiotics. 10 years ago, the main concern was Gram⁺ bacteria such as staphylococcus aureus which are resistant to meticillin and enterococci which are resistant to vancomycin. It is now being recognized that the multi resistance of Gram⁻ bacteria also poses a major risk to public health. Not only does resistance spread much more rapidly with Gram⁻ bacteria than with Gram⁺, but there are also far fewer new antibiotics available or being developed for this range of bacteria. The increased resistance of Gram⁻ bacteria is linked to the high level of mobility of genes which can be disseminated by the plasmids in the bacterial population. The increased mobility of human beings via air travel and migration means that bacteria and plasmids are rapidly transported from one country or continent to the other. This dissemination can not be detected as the resistant clones travel within human bacterial flora and only become apparent when they are a source of infection. The appearance of Gram⁻ enterobacteriaceae, transferred by the New Delhi metallo-beta-lactamase (NDM-1) gene, which is resistant to the majority of antibiotics, is a major global health problem.

It is fundamentally important that systems are put in place to monitor these new forms of resistance and dissemination. At the same time, decisions to sound the alarm should be based on the highest ethical standards.

The case of the H1N1 virus (cf. box 5) raises questions about the problem of States or international institutions not having their own experts who are independent of lobbies. Furthermore, if the alarm is raised frequently in situations which turn out to be unjustified, there is a risk that the whole early warning and rapid reaction system will lose credibility.

There are very few antiviral medicines, therefore preserving their effectiveness should be a priority. It is regrettable that the French Ministry of Health issued injunctions to doctors to treat all cases of the flu with the antiviral drug Tamiflu. Apart from the fact that its effectiveness is scientifically questionable, it is certain that its overuse will ensure that the product becomes ineffective due to the resistance this creates.

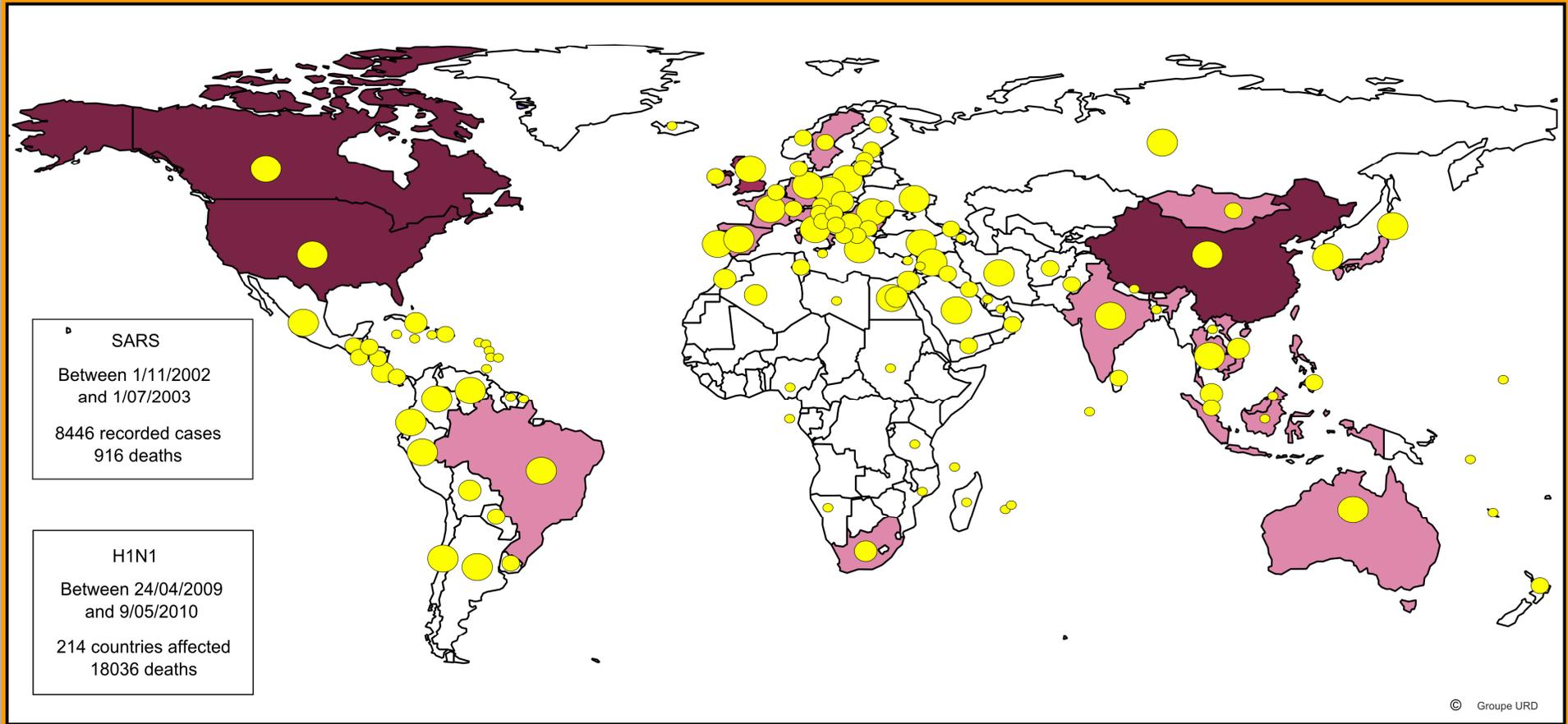
Box 5. The difficulty of managing the new pandemics

In June 2009 the WHO announced that there was a pandemic of the H1N1 virus. The President of the Council of Europe's Health Commission, Wolfgang Wodarg, a German doctor and epidemiologist, asked for an investigation to be carried out into the role of pharmaceutical firms in the way the influenza A virus was managed by the WHO and individual States: *"We are faced with a failure of the great national institutions charged with alerting us to the risks and responding to them should a pandemic arise. In April, when the first alarm came from Mexico, I was very surprised by the figures the World Health Organization²⁴ was advancing to justify the proclamation of a pandemic. I had suspicions immediately: the figures were quite weak and the level of alarm very elevated. There weren't even a thousand sick people before there was already talk of the pandemic of the century. (...) In reality, nothing justified sounding the alarm at that level. That was only possible because the WHO changed its definition of pandemic at the beginning of May. Before that date, it was not only necessary that the illness break out in several countries at once, but also that it have very serious consequences, with a number of mortalities in excess of the usual averages. That aspect was erased from the new definition, while the only criterion retained was that of the rate of the illness's diffusion..."* Experts linked to pharmaceutical firms are suspected to have had a major influence on decisions at the level of the WHO and national governments. A considerable amount of alarmist information was then sent out and vaccination campaigns began at considerable and no doubt disproportionate cost for health systems: around 700 million Euros in Germany, almost 800 million in France... All this to contain an influenza epidemic which by January 2010 had "only" claimed the lives of 300 people, compared to between 5000 and 10 000 people who die from "normal" seasonal influenza. (Source: <http://grippe-a-h1n1.over-blog.com>)

24 « WHO failing in its duty of transparency » ; Leading edge, The Lancet of infectious diseases Vol 10; August 2010

MAP 6

SOURCES OF EPIDEMICS AND PROPAGATION OF THE H1N1 AND SARS VIRUSES



Number of deaths linked to the H1N1 virus since April 2009

- 1 - 10
- 11 - 50
- 51 - 100
- 101 or more

Sources of SARS development

- Local transmission (contamination within a country)
- No local transmission (contamination outside national borders)

Map base: <http://finder.geocommons.com/overlays/18457/>;
ISmoothing with MapShaper.

Number of H1N1 deaths: OMS Map Production, "Pandemic H1N1 2009. Countries, territories and areas with lab confirmed cases and number of deaths as reported to WHO". Status as of 9 May 2010.

Sources of SARS development: OMS Map Production, "SARS, cumulative number of reported probable cases" Status as of 29 April 2003.

Data: OMS

Produced by: Groupe URD, 2010
<http://www.urd.org/>

I.2.2.3 New infectious agents

With social changes and the probability of mutations transforming harmless biological entities into potentially very effective vectors of mortality, humanity remains confronted with new sanitary risks.

The AIDS (HIV) virus is a “new” atypical virus. It is contagious exclusively via sexual activity and blood contamination, it targets specific population groups on the basis of behaviour, develops slowly and moves almost inexorably towards death predominantly amongst the young. This virus revealed particular weaknesses in the societies of the North and the South. To this, one must add the incompetence and inappropriateness of health systems as well as their lack of means. The violent rejection of victims by society and the resulting exclusion (for example, in the USA, people who are HIV positive cannot take out insurance or travel²⁵...) disrupts the whole of society in certain African countries where almost one in two young adults dies of or has the disease. This has major repercussions socially, economically and in terms of security:

- Entire areas of Malawi and Zimbabwe are no longer self-sufficient and cannot provide cities in the region with agricultural produce because there is a shortage of workers;
- Feeling that they have no future, AIDS victims adopt desperate behaviour which ranges from pillaging to sexual assaults on a massive scale.

Other new agents which have appeared in recent decades such as the **Ebola virus**, which migrated to humans, and the **Marburg virus**, combine high mortality with a currently weak propensity for major epidemics. The contamination area remains limited in size: epidemics die out very quickly as the virus kills too quickly for contamination to expand: it stops as soon as the population available for contamination falls below a certain size, thus preventing the virus from being transmitted or reproduced. The epidemic stops, but the survival of the virus is generally not compromised. It has recently been discovered that certain animals can transmit the virus directly to humans (bats). This reactivates the process.

As understanding of this domain has improved, new dangers have been identified. Prions are a new form of infectious and contagious agent²⁶ (neither a bacteria, virus, fungus or parasite, they are composed primarily of protein), against which little can currently be done. “Mad cow disease” is an example. Probably caused by an inappropriate method of feeding animals, it provoked a massive health and commercial crisis. The economic and social impact of this type of epidemic is still contained for the time being as the areas affected were located in countries with the legal, regulatory and logistical means to face up to and control the phenomenon.

Looking ahead, there is no reason why new pathogenic agents of varying contagiousness, rapidity and dangerousness will not appear from time to time in either the animal, human or inter-species domains.

²⁵ http://www.gnpna.org/docs/US_HIV_Travel_Immigration_Ban_Fact_Sheet.pdf

²⁶ This term was first used in 1982. The first description of Creutzfeldt-Jakob disease dates back to 1920.

I.2.2.4 Sanitary problems and security issues

Sanitary risks have a number of common characteristics: newness, external origin (how it develops), potentially high impact, disruptive to society and its values and a socio-economic impact which creates the need for more regulation. Sanitary risks are related to three types of insecurity:

- **Biological insecurity**, linked to the risk of transmittable infections. This is the type of insecurity which is recorded most frequently and it is becoming an increasingly globalised phenomenon. It brings the possibility of exclusion and confrontation between healthy and sick individuals and between countries which have been affected and those which have not. This is all the more true as demand for antibiotic and retroviral treatment and the supply of uncontrolled medicine grow. Anticipation of this growing risk is extremely important (cf. H1N1 flu).
- **Food insecurity**, in the sanitary sense (safety). Situations where there is food insecurity such as the “Mad Cow” crisis, and their major economic repercussions (with destabilization of markets, protectionism, embargoes, etc.), could be a significant source of vulnerability in relation to supply and commerce. Another form of insecurity could be the battle over Genetically Modified Organisms (GMOs), which has similarities to a biological war. GMO products used in agricultural production can have a significant effect in terms of genetic pollution if wild species of the same plant exist in the ecosystem (the case of GMO colza and the numerous self-propagating plants from the Cruciferae family present in the area where it is cultivated). Transmission by pollinating insects and linked to proto-viral (prion) forms of genome transfer, whose fundamental importance we are gradually coming to learn, are making the dissemination of modified characteristics similar to contamination.
- **Environmental insecurity**, the vaguest of the three. The environment is increasingly at the source of certain pathologies, such as those produced by problems linked to nuclear power stations, incinerators, chemical factories, products like asbestos and electromagnetic waves. The issue of environmental security can also lead to the questioning of certain practices such as intensive livestock farming or certain industries (nano-technologies) with the unmonitored multiplication of their components (e.g. relay antennas for mobile phones). In addition, the deterioration of air quality in cities, which is essentially linked to road transport and industries (high concentration of ozone and micro-particles), is already causing an increase in the frequency of cardio-respiratory diseases which raise questions about urbanism and transport.

Faced with these different global risks, the response is still often national or even local (for urbanism and transport) and can vary from one country to the next. The risk of conflict within a country and between countries is something which has emerged in recent years. This poses a major problem in terms of establishing international health strategies to deal with the challenges facing humanity in the decades to come.

To conclude, the links between health security and public security are numerous and take many forms. There is a great deal of controversy about causes and responsibilities. Many voices have been raised challenging social behaviour and international relations.

1.2.3 Technological risks

1.2.3.1 Industrial and technological risks

The Bhopal disaster in India in 1984 was the first major non-nuclear industrial incident of the modern age. Nevertheless, industrial accidents, such as in foundries and mines, (firedamp explosions, etc.), have been taking place for a long time. The acceleration of urbanization (houses increasingly close to dangerous industrial installations), the multiplication of sites and the transportation of potentially dangerous products increase the risk of disasters despite technical progress. These risks come from chemical-based industries like the pharmaceutical industry, the food industry and consumer products manufacturers, the petrochemical industry (stocks of petroleum derivatives) or in the production of electricity (the collapse of a hydro-electrical dam, etc.).

The types of accidents which are likely to take place in these contexts are:

- **fires**, which start when dangerous substances are being loaded, unloaded or transferred or when electrical equipment is being handled. Fires can also be caused if flammable substances are inappropriately stored (inappropriate combinations, exposure to light or air, etc.);
- **explosions**, which are caused during the fabrication, use or storage of flammable liquids, gases or solid explosives. Explosions create rapid and violent shockwaves and are extremely destructive (broken windows, collapsed buildings, injuries to eardrums and lungs, etc.);
- **the dispersal of toxic substances**, following an explosion, a leak, a chemical reaction or a fire. A toxic substance, generally in the form of a gas, spreads into the atmosphere bringing the risk of deadly or irreversible intoxication in a perimeter of several kilometres. Oil slicks are a well-known example of this kind of risk. These can involve different types of oil, which are spilled into the sea in greater or lesser quantities and can lead to major pollution of deep waters and coastal areas.

All major industrial accidents have an impact on communities which are directly or indirectly exposed to them and on the environment (destruction of fauna and flora, long-term contamination of air, water and soil). They can be all the more dangerous in that a single accident can have multiple effects and can cause collateral damage on neighbouring facilities (the domino effect).

The European Council's Seveso II Directive aims to prevent industrial disasters and limit their effects by fixing strict security and safety procedures for all sites where there is an industrial risk. However, these norms (and other similar norms) are only applied in certain countries. As such, there are high-risk areas in all the countries which are trying to develop their industries and particularly in the chemical and petro-chemical sectors.

The increased number of deep sea oil drilling platforms has created a more acute form of risk, because, as the recent oil slick in the Gulf of Mexico has shown, managing technical incidents is much more complex in deep water.

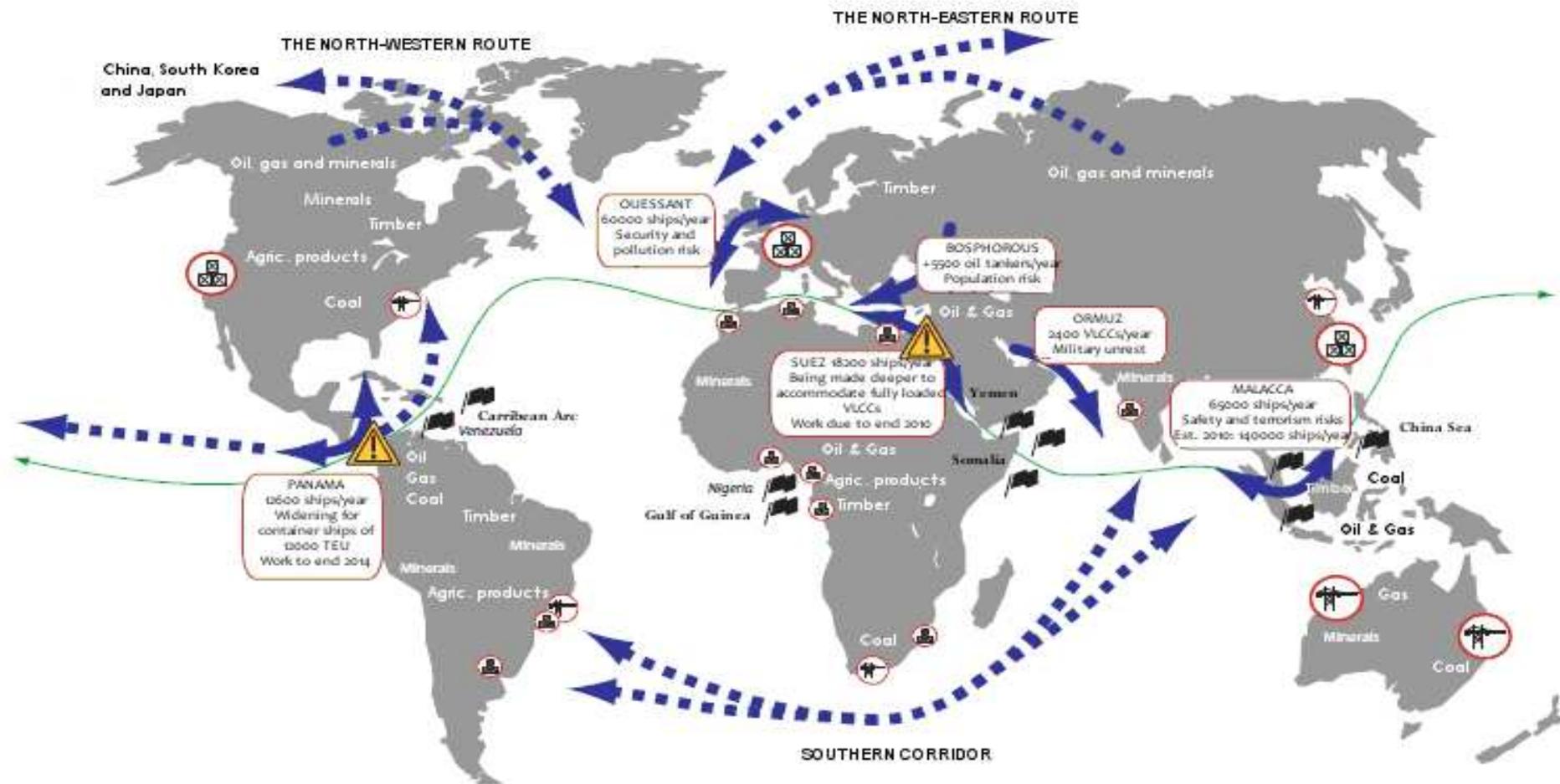
I.2.3.2 Risks related to the development of international transport

The transportation of toxic, flammable, explosive or polluting substances represents a major risk for communities and the environment. Accidents can be caused by vehicle failure, containment problems, meteorological hazards (fog, black ice, etc.) or human error. The most common accidents are caused when flammable substances catch fire or when vehicles have accidents leading to leaks or toxic clouds. This creates the risk of air, water or soil contamination and the danger that toxic substances they might be inhaled, ingested or may come into contact with skin. The areas most at risk from such accidents are those where traffic is the most intense, such as around motorways, and chemical and petrochemical factories.

In order to limit these risks, each type of transport (road, sea, etc.) is subject to its own regulations with specific rules for circulation and, in theory, drivers are obliged to receive special training with refresher courses every five years. But precautions of this kind do not prevent disasters: most accidents involving the transportation of dangerous substances on the road are caused when there is a collision with another vehicle.

Thus, there are major risk factors on the principle **aerial, maritime, rail and road routes** (cf. Map 7). The transportation of humans and goods has also led to the dissemination of species which have rapidly become a danger for ecosystems: predators, viruses and bacteria are disruptive travellers whose dissemination alongside the growing freedom of movement of human beings and goods could prove to be one of the biggest challenges for humanity. This unintentional risk, which often comes as a result of human error or fraud, is rarely noticed. And yet, how many ecosystems are put in danger in this way: rabbits introduced on islands, insects carrying diseases or killer bees, the list will continue to grow.

MAP 7. ISEMAR MAP / THE SATURATION OF GLOBAL MARITIME ROUTES



Sources : ISEMAR Nantes saint Nazaire, IFL, Belmas, Lloyd Shipping Economist, Lloyd List Journal, Journal de la Marine-Marchande, Le Marin.

Conception et réalisation : Renaud Larochette, ISEMAR, 2007.

Present and future maritime routes

- The major containerized East-West route
- New maritime routes being planned or developed.
- Gaz: The main exported raw materials

Sensitive areas

- Key maritime passageways
- Maritime channels being made bigger
- Areas where there is piracy

Needs in terms of facilities and infrastructure

- Saturation of container terminals
- Saturation of the surroundings of bulk carrier terminals

TEU : twenty-foot equivalent unit, or 5M
 Standard length of a container (transportation capacity of 25 tonnes or 22 cubic metres).
 VLCC: Very Large Crude Carrier: Supertanker of 160 000 tonnes or more (transportation capacity of 2 million barrels).

I.2.3.3 The risk of dam failure

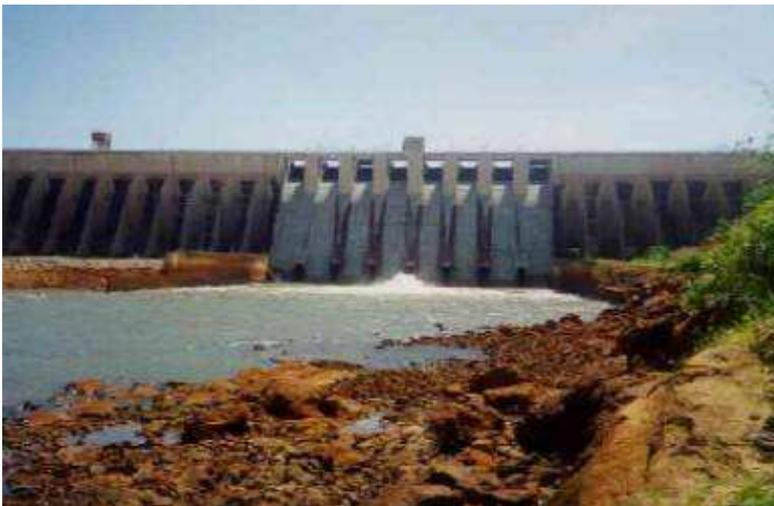
Dams play a number of roles such as regulating water flow, irrigating fields, supplying cities and villages with water, producing energy and putting out fires. Industrialisation, increased energy needs and the intensification of agriculture have led to a major increase in the number of dams in the last fifty years. There are now more than 45 000 large dams in the world, with more than 22 000 in China.

- **Dam failure:** There are two kinds of dams: arch dams (built out of concrete) and gravity dams (built out of concrete or earthfill). Earthfill dams have twice the failure rate of those made out of concrete. Water circulation can lead to external erosion of the crest of the structure and/or internal erosion due to water circulation within the structure which increases due to the erosion and eventually causes it to collapse. This is most common when the water is in full spate, a long time after the structure has begun to be used. Failure of concrete dams generally happens very suddenly: the displacement of vertical blocks can lead to the partial or complete rupture of the structure. This leads to the formation of a gigantic wave which sweeps down below the dam (submersion wave) in a similar way to a tidal wave. The cause of failure can be human (shortcomings in prior studies, mistakes during operation, monitoring or maintenance, even acts of sabotage), technical (design fault, its construction or the quality of the materials used) or natural (landslides, etc.)
- **The risk of failure:** Failure has considerable human, economic and environmental consequences. The water and materials which sweep down from the dam can cause serious flooding and damage to people, structures (houses, buildings, companies, bridges, roads, etc.), crops and livestock and can paralyse public services. Disasters of this kind can also sweep away cultivable land, can deposit waste, debris and sludge, can cause different forms of pollution and even technological accidents due to the presence of factories in the valley (toxic waste, explosions caused by the reaction with water, etc.).

Though rare, the risk of dam failure should not be taken lightly. No dam is completely safe from a violent natural event such as an earthquake, torrential rain, exceptionally high water levels or a landslide. When a section of mountain fell into the Vajont dam in Italy in 1963, a wave of over 150 metres swept away several villages and killed more than 2000 people. In Europe, the exceptionally high water levels in the last twenty years have caused the failure of two dams, one in Romania and the other in Spain. The debates in China about the risks related to the Three Gorges Dam show how important this subject is: if it were to break, there would be hundreds of thousands of victims. Dams need to be kept under constant surveillance, with frequent inspection and measurement of displacement, cracks, settling and water pressure. This should be carried out at the project phase, during construction, when they are being filled and when they are in operation and can be carried out at the national level (France and USA) or at the local level (Canada).



The Three Gorges Dam in China
(Source : www.chine-informations.com)



Manantali Dam in Mali, on the Senegal River
(Source : *Organisation for the Development of the Senegal River*)

In numerous countries dam design, construction, monitoring and maintenance are subject to strict regulations. Unfortunately, these are not always respected.

It is a key strategy of many countries to develop hydraulic energy as a complement or partial alternative to fossil fuels. However, this involves very specific technical norms which lead to high costs. Consequently, there is a possibility that corners will be cut to save money or of corruption in the process of attributing contracts and monitoring work carried out, which can create significant risks. Areas in China (the Three Gorges Dam) and South-East Asia (on the Mekong and the main rivers of Asia) need to be monitored with great care.

I.2.3.4 Nuclear risks

The disasters of Three Mile Island (United States, 28 March 1979) and Chernobyl (Ukraine, 26 April 1986), showed how dangerous nuclear accidents could be. Thus, despite nuclear energy's useful civil applications (energy, medicine, chemistry, biology, archaeology, industry, defence, etc.), it brings risks. Radioactive rays are particularly dangerous and can have damaging consequences for humans and for the environment. The accidental release of radioactive elements can contaminate the air, soil, water, living beings and even objects. The wind can also carry radioactive elements over very long distances. Humans suffer internal contamination if they inhale radioactive particles or eat contaminated food.

In industry or in medical radiotherapy units, the most common accidents are caused by instruments for controlling soldering (gammagraphy). When the radioactive source is removed from its protective container to control the soldering, ill-informed staff can be seriously exposed to radiation. But the most serious risk comes from **industrial nuclear installations**, and more specifically nuclear power stations. A major risk is the possibility that the cooling circuit in the heart of the reactor breaks leading to a rise in temperature which could then cause the fusion of the heart and the release of highly radioactive particles inside the reactor. It is the type of technology used which allows this kind of risk to be reduced (cf. differences between RBMK type reactors developed in the ex-USSR and those developed in France, for example, which use pressurized water) and fortunately nowadays power stations in developed countries are equipped with containment systems which allow this kind of accident to be prevented. Furthermore, many units which could not be modernized have been shut down. And there has been a focus on the quality of staff and staff training. But experience has shown that these measures do not remove all risk. Privatisation and increased subcontracting have, on the contrary, led to less well trained personnel and a number of incidents²⁷. Even very minor incidents which take place regularly show that risk is still there²⁸. Risk therefore remains serious and is growing as the number of power stations increases in countries where norms are less strict. (cf. Map n°8).

A major risk is the **transportation of raw materials and waste**. Questions remain about the (very) long-term storage of more or less highly radioactive nuclear waste, the durability of storage areas, their stability, how they will age and how the location of storage sites can be maintained in the collective memory over time. Nuclear waste has been produced and stored throughout Europe for 50 years. At a time when around fifty power stations are being decommissioned and Europe is expanding, production is naturally going to increase. European directives²⁹ which link storage and recycling of waste have brought in stricter regulations for the European Union. But due to the cost and the strictness of European storage regulations, there is also greater risk of illegal storage activities and particularly of waste being exported to countries where regulations are less restrictive. Risks are therefore being moved to areas which are sometimes very populated (South Asia) or where there are no regulations (Africa).

In order to limit risks, each type of transportation is subject to its own regulations and specific circulation rules and drivers are given special training. But taking precautions in this way does not prevent disasters from happening, particularly due to the long distances that this waste can cover, the fact that they may have to cross high-risk areas and that norms vary considerably between the different areas that are covered.

²⁷ CRIIRAD, 2009-a

²⁸ CRIIRAD, 2009-b

²⁹ Directive n° 75/442/EEC of 15/07/75 on waste, Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel. Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations.

1.2.4 Economic risks

Economic crises have left their mark on the history of humanity. Even when they had unintended causes (e.g. climatic events leading to hunger-related riots), they have often brought significant changes.

Following the crisis of 1929 and its dramatic indirect repercussions on WWII, for example, the world experienced a 30-year period of stability and economic growth. Since then, the economic sphere has been affected by regular crises, such as the oil crisis of 1973, the economic crisis of 1997 (Asia) and the more recent subprimes crisis (2008). The crisis of 2008-9, which has had a very serious effect on economies throughout the world, was caused by the improper and uncontrolled use of complex financial tools which provide a great deal of leverage. If encouraged by liberal policies and in the absence of regulatory mechanisms, stock market speculation on shortages³⁰, which are sometimes themselves the result of speculation, can create potentially systemic, but unintentional crises. These can have major repercussions. They highlight three important points:

- the interdependence of global economies;
- specific relations of dependence between certain economies which bring a series of risk factors for specific industries or sectors, and which can have disastrous repercussions if they have a domino effect;
- the choices made by a small number of economic and political actors can have a massive and potentially dramatic impact on hundreds of millions of people.

Certain crisis-related dynamics, such as the recent trend of **dramatic fluctuations in the price of food and fuel** which have a major impact on hunger and poverty in the world, are largely predictable. These crises are linked to known and well-analysed factors, even though the way these risks are interpreted can vary a great deal. There is also a lack of political will to take them into account:

- reduction of the availability and amount of fossil fuels. This reduction can be temporary (speculation, cold weather, technical incidents or conflict in production areas) or structural (technological problems which cause bottlenecks in oil refineries as in Iran, a real drop in availability due to resource depletion). There is great debate about “peak oil” due to the fact that the variables involved in calculating this peak are very dependent on estimates of global resources based on an acceptable extraction price. This leads as much to speculation as it does to the encouragement of energy diversification. It is important to note the industrial sector’s extraordinary ability to innovate: in a few years, it has gone from rejecting electric vehicles to launching a large number of electric cars.
- demographic growth which places increased pressure on limited resources such as water, land, pasture, trees, etc.;
- increase in the urban population in relation to rural workers. Changes in global behaviour and consumption place added pressure on resources;
- increased meat consumption due to the establishment of middle classes in countries like India and China;
- Climatic events which affect production (poor harvests);
- Market speculation based on the possibility of a drop in availability of a product which leads to it being bought, stored and resold. This was, for example, the cause of the 2005 famine in Niger and the food riots in Egypt.

History shows how these phenomena can have a major social impact and just how explosive their security impacts can be, from the hunger riots in ancient times and during the French Revolution up to the riots in Egypt and very recently in Mozambique.

³⁰ Letrate JP. et al, 2009

Chapter II

Combined future unintentional risks

Crises rarely depend on one factor alone: alongside one risk factor there are other phenomena which contribute either to the creation of aggravating circumstances, or to interaction between risks. Analysing the combination of risks is therefore of key importance in anticipating different types of threats.

1.3 Natural risks, population density and urbanisation

One of the keys for analyzing the synergy between risk factors is **global demographic growth and increased population density in high-risk areas**, due to **urbanization**³¹ which, themselves, reinforce all risks, both in frequency and intensity.

1.3.1 How will demographics change?

In the 1990s, the United Nations Population Fund (UNFPA) estimated that there would be between 11 and 15 billion people in the world in 2100. It has now revised this forecast for the global population to peak at 9 billion in 2050³² followed by a period of stabilisation, which still represents an increase of a third in 50 years³³. One of the reasons that their forecast was revised is the very low birth rate in developed countries. The population of Europe, in particular, is aging significantly. The population of several countries is even set to fall: Germany (-4.12% by 2050), Italy (-21.64%), Hungary (-22.45%), Bulgaria (-32.05%). According to UNFPA estimates, the population of Russia is set to fall by 40 million which will take it from the 6th largest in the world to the 18th largest (cf. Tableau 2).

Other regions, by contrast, are due to experience a demographic explosion: these are essentially developing countries which are responsible for 96% of world growth. For example, the birth rate is 8 children per woman in Niger, 7.25 in Somalia and 7.2 in Angola. With a birth rate this high, Niger will multiply its population by 5 by 2050.

³¹ Day D., Grinsted A., Piquard B., 2009

³² UNFPA, 2005

³³ Even if the birthrate is falling – it is currently 2.5 children per woman – the number of people of procreative age was 1.2 billion in 2000.

Table 2. The 18 countries whose population will exceed 100 million

Rank	Country	Population in 2050 (millions)	Population in 2000 (millions)
1	India	1,531.44	1,016.94
2	China	1,395.18	1,275.21
3	United States	408.69	285
4	Pakistan	348.7	142.75
5	Indonesia	293.8	211.56
6	Nigeria	258.47	114.74
7	Bangladesh	254.6	137.95
8	Brazil	233.14	171.79
9	Ethiopia	170.98	65.6
10	Democratic Republic of Congo	151.64	48.57
11	Mexico	140.23	98.93
12	Egypt	127.4	67.78
13	Philippines	126.96	75.71
14	Vietnam	117.69	78.14
15	Japan	109.72	127.03
16	Iran	105.48	66.44
17	Uganda	103.25	23.49
18	Russia	101.46	145.61

Source: UNFPA 2004.

1.3.2 Several risk factors in the same location

Another focus for analysis is the **existence of several risk factors in the same location**. Certain contexts are more vulnerable due to the multiplication of risk factors to which they are exposed:

- **Urban development in coastal zones and deltas** (heliotropism and coastalisation) brings greater risks. Whether in Africa, in Europe, within island systems or in the Americas, higher urban density near the sea increases the impact of rapid onset disasters (cyclones, tsunami) as well as sensitivity to rising sea levels.
- **The location of certain cities in arid areas** represents, in itself, a risk for water resources and increased health risks linked to acute problems of water quality.
- **The location of major conurbations in areas where there is a high tectonic risk**, in both developed and developing countries is highly dangerous. This danger can only be reduced by establishing and imposing earthquake resistant standards in urban planning and in construction.



The town of Chalang (Indonesia) which was hit by the Tsunami of 26/12/2004 (Source : Groupe URD)



Peripheral areas around Kabul, Afghanistan (Source :Groupe URD)

1.4 The vicious circle of health risks, poverty and economic crises

When considering the issue of resilience, it is necessary to look at the interaction between economic risks and unintentional risks. Economic crises can either cause unintentional risk or can make its effects worse. In many countries (such as Somalia, Haiti, Ethiopia, Cambodia and the Philippines), people living in very fragile areas survive thanks to the transferral of funds from the diaspora. If a disaster takes place at a time when an economic crisis restricts the financial resources available from the diaspora, this has terrible consequences for the beneficiary population (this was the case in East Africa and South Asia in 2008-2009).

It has long been accepted that there is a **link between poverty and ill health**: people are ill more often when they are poor and poor health increases poverty, particularly when a population does not have access to a public health service and health insurance (cf. Map 9). The many risks described in this prospective report (e.g. climatic, seismic, etc.) seriously affect the income of a major proportion of the world population, which can lead to economic and political instability and, of course, can make the affected population more vulnerable to illness.

The difficulties experienced by the international community to achieve the Millenium Development Goals have been made worse by phenomena linked to climate change and the slow- or rapid-onset disasters that these generate³⁴. It will therefore be all the more difficult to reduce poverty as climate-related instability increases. Similarly, it is going to be all the more difficult to provide reasonable access to potable water as it is going to become increasingly rare. Furthermore, it will be all the more difficult to improve people's nutritional state as the agricultural production of whole areas will become more and more erratic due to the increased number of natural disasters.

1.5 Health risks and technological risks

Depending on economic factors and whether or not norms exist and are applied (governance issues), technological risks fall into three categories: a) small but non-negligible; b) real and pre-occupying; and c) serious, as illustrated in map 8.

In this analysis, it is important to consider synergy between risks. Alongside clear "Seveso" type phenomena there are all the other risk-related issues. Industrial infrastructure will resist to a greater or lesser degree to seismic events (e.g. oil slick in Haiti following the January 12 earthquake) or meteorological events (e.g. chemical plants and storage of dangerous products in areas susceptible to flooding in Bangladesh; dangerous installations at risk of being affected by drought-related fires in Russia). Maintenance capacity can also be affected by an epidemic or an economic crisis.

³⁴ IDDRI, 2009

It is also common for natural and technological risks to be combined. NATO's analysis of critical infrastructure³⁵ is interesting in that it looks at the interaction between natural and technological risks. Situating strategic facilities, such as an energy or communications hub, in a sensitive area is a serious error just as building a factory which produces pollution or the storage of dangerous products in unstable areas represents a major unintentional risk. This is an important issue to take into account in relation to the construction of large dams. In several countries, dams have been built which combine both weak application of technical norms and serious seismic or climate-related risk. For example, in China in 2008³⁶, an earthquake weakened hydro-electric dams on several lakes and waterways in Sichuan and neighbouring provinces.

The analysis of the location of technological risks presented in map 8 has been achieved by combing a number of maps: industrial basins, state poverty, natural risks and climate change³⁷.

It is well-known that accidents in industrial or civil nuclear plants can create health risks. On the other hand, new health risks caused by our way of living, producing or consuming still need to be investigated more. Though these have often been identified, such as the link between the rise in the number of cancers and the increased presence of chemicals in the environment, they have not yet been sufficiently documented. These risks affect more and more categories of people, such as rural populations affected by the misuse of pesticides and those who work in industries where work conditions do not respect norms. It is possible that these pathologies will increasingly weigh on already fragile health systems and will cause real economic problems with inevitable social and political repercussions. The protests which have taken place in China are a good illustration of this.

The risks related to the use of nanotechnologies are not yet known. On the other hand, the dangers of being exposed more and more to waves of different frequency (mobile phones, wifi, etc.) have been identified. Without adopting a position which resists all forms of progress, it is important that these issues, which are genuine public health issues, are actively monitored.

Alongside these risks which directly affect human beings, rivers and seas are increasingly affected by phenomena, such as the presence of alarming levels of chemicals, hormones or hormone derivatives, which have not been completely eliminated in water treatment plants. There is a risk that this will cause huge economic damage³⁸ in the coming decades.

³⁵ NATO, 2007

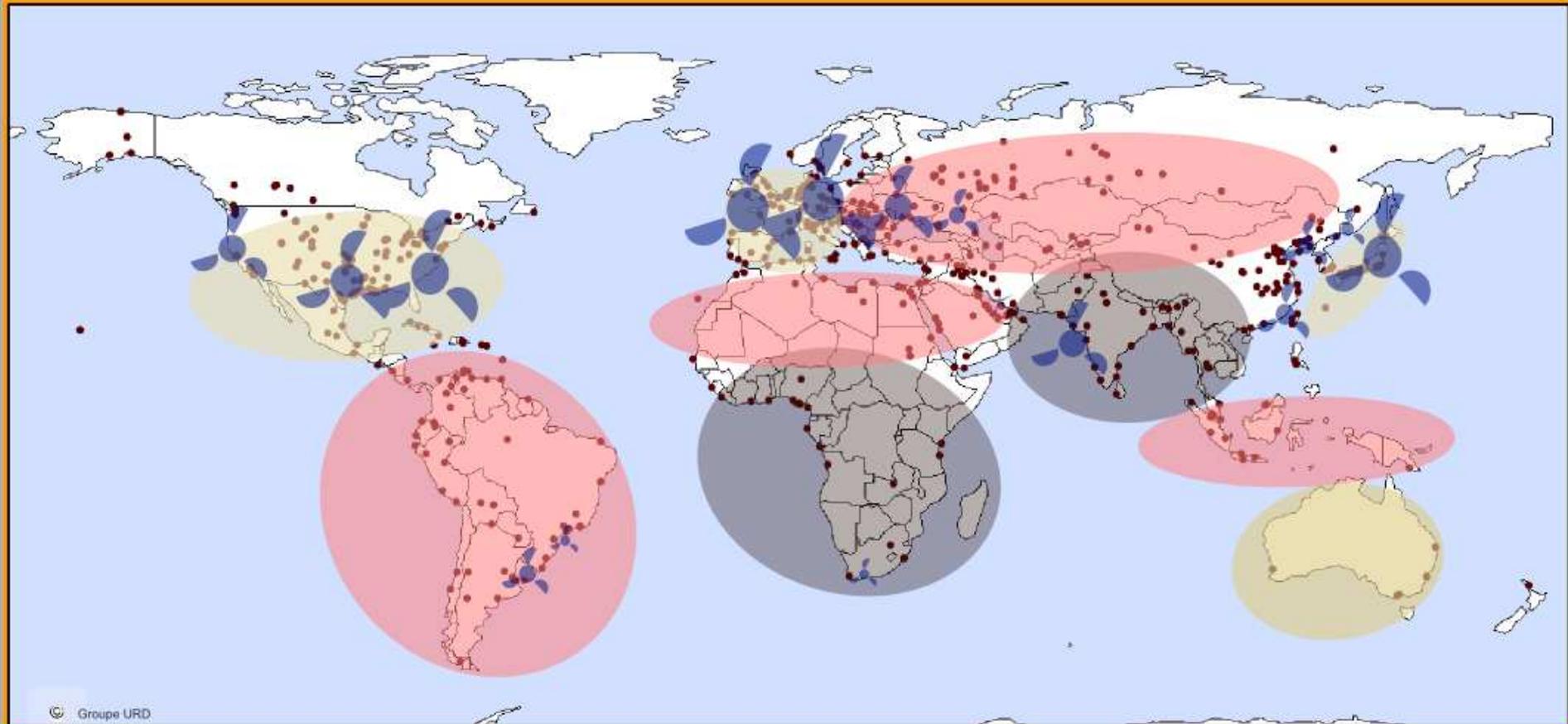
³⁶ A major earthquake hit the province of Sichuan in China on 12 May 2008. At 14 :28 local time, 6 :28 UTC (8 :28 in France), the initial tremor was of magnitude 7.9. Its epicenter was located in the district of Wenchuan. 70 000 people were killed, 18 000 were reported missing and 374 000 were injured as well as many buildings were destroyed (source Agence Chine Nouvelle)

³⁷ Garnaud and Ferret, 2010

³⁸ PETIJEAN O. 2008

MAP 8

TECHNOLOGICAL AND INDUSTRIAL RISKS



© Groupe URD

Global distribution of nuclear power stations and oil refineries



Concentration of nuclear power stations



Oil refineries

Level of risk:



Low but not negligible



Serious and worrying



Genuine

Fond de carte: <http://finder.geocommons.com/overlays/18457>;
Nuclear power stations: International Nuclear Safety Center at ANL, 2005
Oil refineries: Google map, Crude Oil Refineries 2008, fichier .kmz

Industrial and natural risk south of the Himalayas and in South East Asia, a Groupe URD map, 2010

*Industrial and natural risks around the Mediterranean, Groupe URD map, 2010

Industrial and natural risks in Central America and the Caribbean, Groupe URD map, 2010

Population density and areas with major seismic and cyclone activity, Groupe URD map, 2010

Produced by: Groupe URD, 2010
<http://www.urd.org/>

I.6 Economic risks and health risks

The structural adjustment policies of the 1980s, which were imposed by international financial institutions and theoretically aimed to stabilise the economic fundamentals (e.g. debt, inflation) of countries of the South via the restructuring of their economies, led to disastrous cuts in social sectors such as health. As a result, basic services like vaccination and pre- and post-natal care received almost no more funding and therefore were no longer provided. This had disastrous consequences for public health. Numerous publications³⁹ describe the potential risks and economic and financial consequences of these choices based on the idea that health care is costly and “unproductive” in the short term and also politically useless. It took many years before the World Bank and the International Monetary Fund (IMF) recognized that these policies had been unsuccessful. Both of these institutions have in fact revised their policies in this area to a great degree, but the consequences of the decades of structural adjustment are still being felt.

Another example is the globalisation of the flow of labour and notably the migration of health personnel which represents a form of “brain drain”. More and more healthcare professionals are leaving the South for the North where there is a shortage of qualified personnel in certain professions (doctors and nurses) and where pay is higher.

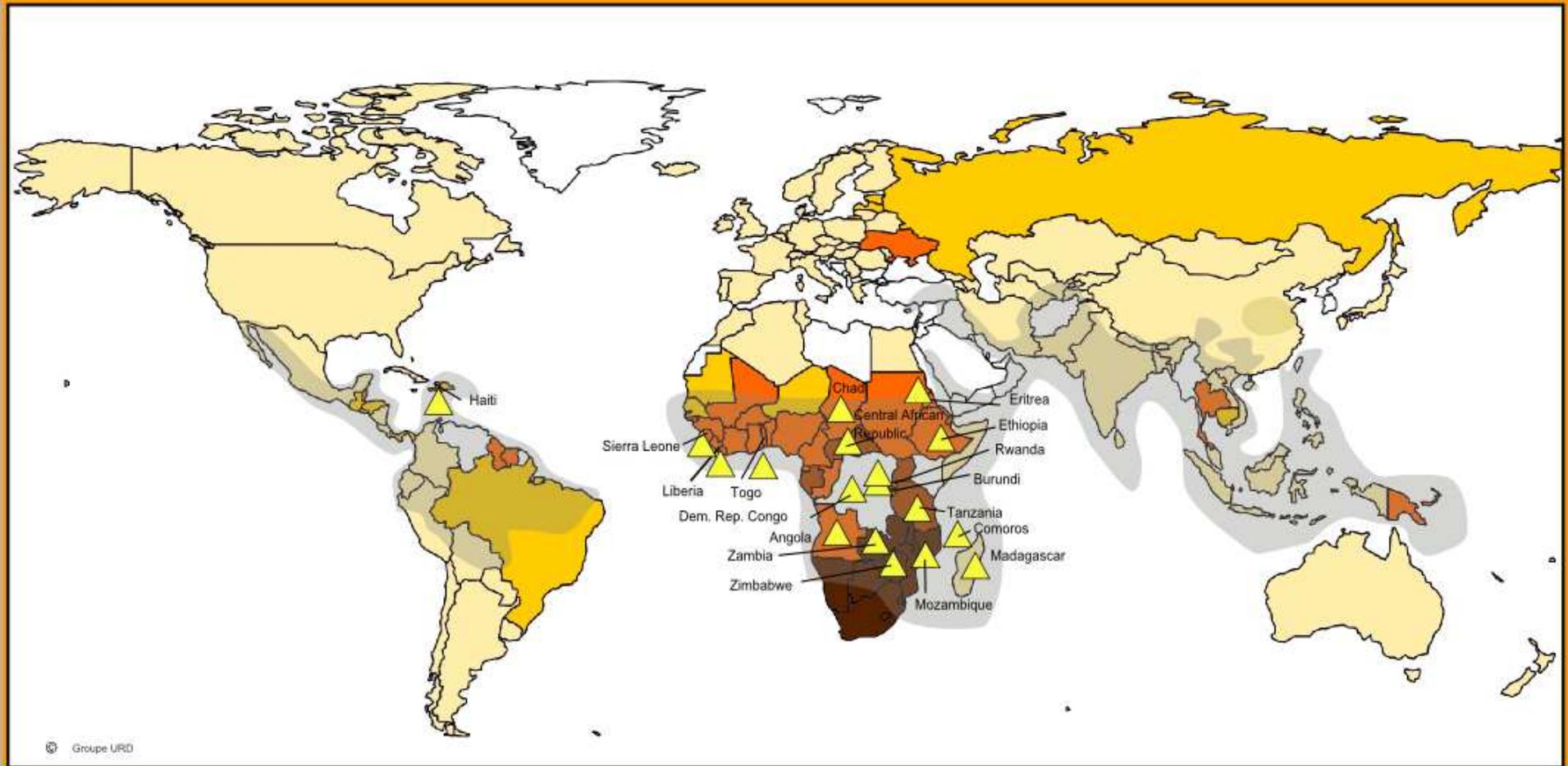
Box 6. Brain drain and health risks

Around 100 000 nurses have left the Philippines in the last ten years. Today, 118 000 nursing positions are vacant in the United States, and it is estimated that there will be 800 000 in 2020: professionals from the South are therefore in high demand. In Norway, around 20% of general practitioners are from countries outside Europe. As for the United Kingdom, it takes in around 15 000 nurses per year from countries in the South. This migration of course causes considerable problems in terms of access to healthcare in the South, where there is already a limited number of qualified personnel. If there is a health crisis in these countries, managing the situation will be all the more complicated due to the fact that there will be fewer qualified people in place. Deploying people with the necessary skills will be very costly. How should this migration of healthcare professionals from the South to the North be regulated? The WHO is due to make proposals in 2010: an ethical code of practice for international recruitment based on the voluntary participation of States, compensation (funding of training) for the countries from which people are emigrating and possibly quotas and restrictions.

³⁹ Chossudovsky, 1998

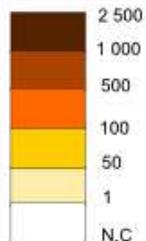
MAP 9

HIV, MALARIA AND FOOD INSECURITY



© Groupe URD

Prevalence of HIV in 2007, from 100 000 people aged 15 or more



Zones with malaria

Country where 35% or more of the population is undernourished

Map base: <http://finder.geocommons.com/overlays/18457>, Smoothing with MapShaper

HIV: WHO, World Health Statistics, HIV/AIDS, Malaria and TB; 2007.

Malaria: Hugo Ahlenius, UNEP/GRID-Arendal; Climate change and Malaria, scenario for 2050; 2005.

Food insecurity: FAO Statistics Division; Prevalence of undernourishment in total population (%), 2006.

Produced by: Groupe URD, 2010
<http://www.urd.org/>

Chapter III

Vulnerability and resilience

Vulnerability and resilience are two sides of the same question: the ability of individuals, societies and States to cope with destructive events. This question is central to strategic reflexion about future unintentional risks.

Societies which in the past were unable to develop their resilience, or their ability to absorb shocks, were forced to evolve very quickly or they were destroyed.

In the future, resilience will be challenged by persistent natural hazards, some of which will become increasingly frequent and dangerous, as well as the multiplication of new risks linked to technological progress. In the face of such risks, the resilience of communities can be weakened and their vulnerability increased. It is of paramount importance that planners are able to anticipate and understand the different facets of vulnerability as well as resilience strategies.

1.7 Factors of community vulnerability: the “macro” approach

No area of the planet will be spared from future unintentional risks. No matter what societies are affected, issues of vulnerability and resilience in the face of these risks will inevitably need to be taken into account in the internal policies of the States involved as well as in the agendas of international aid organizations. For the time being, no one appears to be prepared to confront the complexity of the threat which future unintentional risks represent.

Societies undeniably need to measure their vulnerability before risks become reality, in order to take the necessary measures. To do so, they need to understand the complex relations between **dangers** (natural, technological, health-related and economic) and **vulnerabilities** (physical, social, economic and political). The evaluation of vulnerabilities is the first and perhaps most important step towards the development of societies which are more resilient to future unintentional risks.

A comparative study of the future unintentional risks of each country should be carried out on the basis of two complementary parts:

- a probabilistic approach to the **level of exposure to these “unintentional risks”**;
- analysis of physical, social, economic and political **vulnerability**.

For many years now, research has shown the inequality between rich and poor countries faced with risk. Two approaches to the analysis of vulnerability have been developed, each of which focuses on different factors:

- The first focuses essentially on the social aspect of vulnerability and considers poor countries or countries with failed governance to be most “at risk”;
- The second focuses more on the economic aspects of vulnerability and places “rich” countries among those with most to lose.

The social approach to vulnerability in relation to the risk of natural disasters highlights the inequalities between societies of the North and South in terms of risk.

There are more natural disasters in developing countries, but more importantly, there are 40 times more victims for a similar disaster. The level of protection which exists in a country is closely linked to the prevention policies which are applied, governance and its degree of development. Current figures on the distribution of disasters and the number of victims confirm that, in rich countries, States also theoretically invest more in terms of means and disaster management policies. This creates a further level of resilience for infrastructures and communities faced with disasters. The example of hurricane Katrina in the United States, however, shows that even in developed countries, the response to unintentional risks is not always of an optimal level. Thus, in certain cases, where economies are changing very quickly (e.g. in certain Asian countries), but social policy and legislation on risks are only changing slowly (one of the reasons for this being to preserve competitive advantages in relation to economies of the North), risks are increasing. However, there has not yet been any major investment to limit the damage of the extremely frequent disasters in this part of the world.

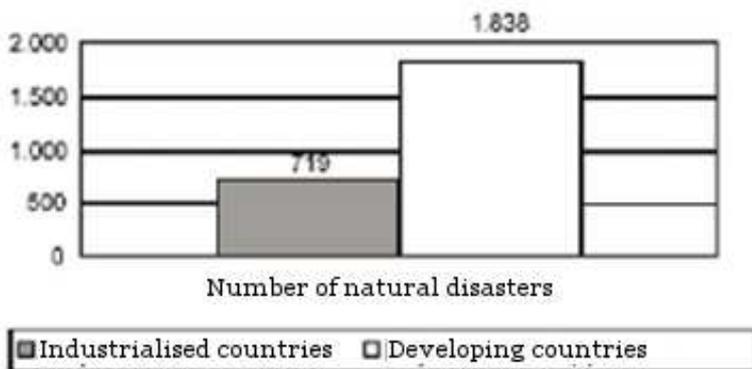


Figure 6. Distribution of natural disasters between industrialized and developing countries

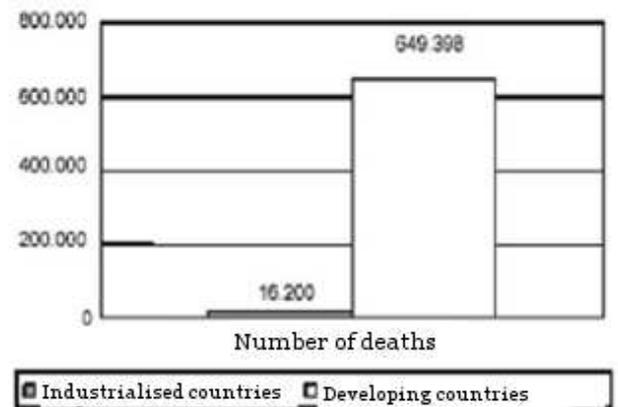


Figure 7. Distribution of victims of natural disasters between industrialized and developing countries

Predictions of the effects of climate change remain based on models. Initial attempts to calculate impacts have been carried out using models of very different kinds. However, a certain number of physical components of natural risk are divided based on known factors which are distributed following reasonably specific rules. The first category is linked to climate and geology (areas where there is movement between tectonic plates, delta areas, highly urbanised areas which are exposed to cyclones, etc.) and the second is linked to health and technological vulnerability and requires approaches which are still being developed. These vulnerability criteria will be constantly changing in future decades, with the possibility of technological failure and new health risks. The analysis of vulnerability factors and resilience is a field where a great deal of work remains to be done. It involves a large range of disciplines amongst which there should be a combination of hard and social sciences (economics, sociology, ethology, political science, etc.).

Due to the difficulty of finding detailed socio-economic and demographic indices for all countries, certain researchers, like Gilles André, have decided to use four synthetic indices which are already present in the knowledge sector: **GDP per inhabitant, the Human Development Index (UNDP), the level of urbanisation (UN Habitat), and the level of demographic growth (UNFPA).**

1. UNDP's Human Development Index (HDI) combines several socio-economic factors (health, wealth and education) which are representative of a country's level of development. In this method of calculating vulnerability, the HDI value is inverted as it is considered that the more a country is developed, the more it will be able to protect itself against natural phenomena.

2. GDP per inhabitant. Here again, this method considers that the wealth of a country allows it to develop disaster prevention and anticipation means and to intervene rapidly when a crisis takes place. Experience has shown that most of the time, the effectiveness of relief operations, healthcare bodies, the number of hospitals available and the ability to control epidemics are related to the wealth of a country (André 2003). The transformation of the value of GDP per inhabitant into a logarithmic value allows the effects of scale to be minimized in the final calculation of vulnerability. Using Ercole and Thouret's definition of vulnerability (1994), which is the propensity to sustain damage, following the response capacity of societies in relation to threats of natural origin, it emerges that the richer a society is the less difficulty it has to regain stability after a natural disaster and vice versa.

3. The proportion of a country's population which is urban: Though there is no direct correlation between this parameter and increased risk, according to certain authors⁴⁰, urbanization, which is synonymous to the spatial concentration of the population, is an aggravating factor of vulnerability⁴¹. As a rule, highly urbanized and densely populated areas are more vulnerable due to the fact that people and wealth is concentrated. Some old urban centres have been planned others have not. Some cities have already experienced natural disasters and have learned a certain number of lessons from these. They appear to be potentially less vulnerable than more recently developed urban areas which are the product of uncontrolled demographic growth, often spontaneously built and which have become permanent due to the rural exodus accelerated by the pauperization of rural areas or because of urban sprawl caused by emerging middle classes who want a house which is not available within the existing limits of the city. These new urbanization dynamics do not control the flow of people who often settle in the sectors which are the most exposed to natural hazards. This is why an indicator of the urban structure of the country concerned - the urban population/demographic growth ratio - is used in the calculation of vulnerability, thus allowing two types of urban structure to be differentiated. However, properly thought out and planned urbanization, which avoids the settlement of communities in areas exposed to natural hazards (flood plains, unstable slopes or the slopes of volcanoes, etc.), can be a way of reducing vulnerability.

The economic approach to vulnerability involves an *a priori* estimation of the economic damage caused by a natural disaster. It is based on the calculation of losses in monetary terms. Using this approach, the higher the value of the goods exposed, the greater the losses will be and thus the greater the economic risk. But for two goods of the same value, vulnerability to a hazard will depend on the degree to which they are protected and the capacity to prevent the natural phenomenon. Though levels of prevention can be estimated at sub-national and national levels (the level at which civil protection plans such as the ORSEC, or Avian flu plans, etc. are applied) it is more difficult to apply this at the level of a group of countries or a continent. Prevention strategies are, in essence, linked to the policies and the quality of governance⁴² of the States involved, as well as the economic level and the degree of economic and social development of countries.

It is clear that this approach does not sufficiently take into account the complexity of situations: it would be interesting, for example, to disaggregate macro factors into more micro factors (e.g. the proportion of GDP represented by industrial production or agriculture and fishing). This would make it easier to understand where losses were likely to be made in the event of a disaster and therefore the

⁴⁰ Ledoux 1995, Blaikie 1994

⁴¹ Ledoux, 1995

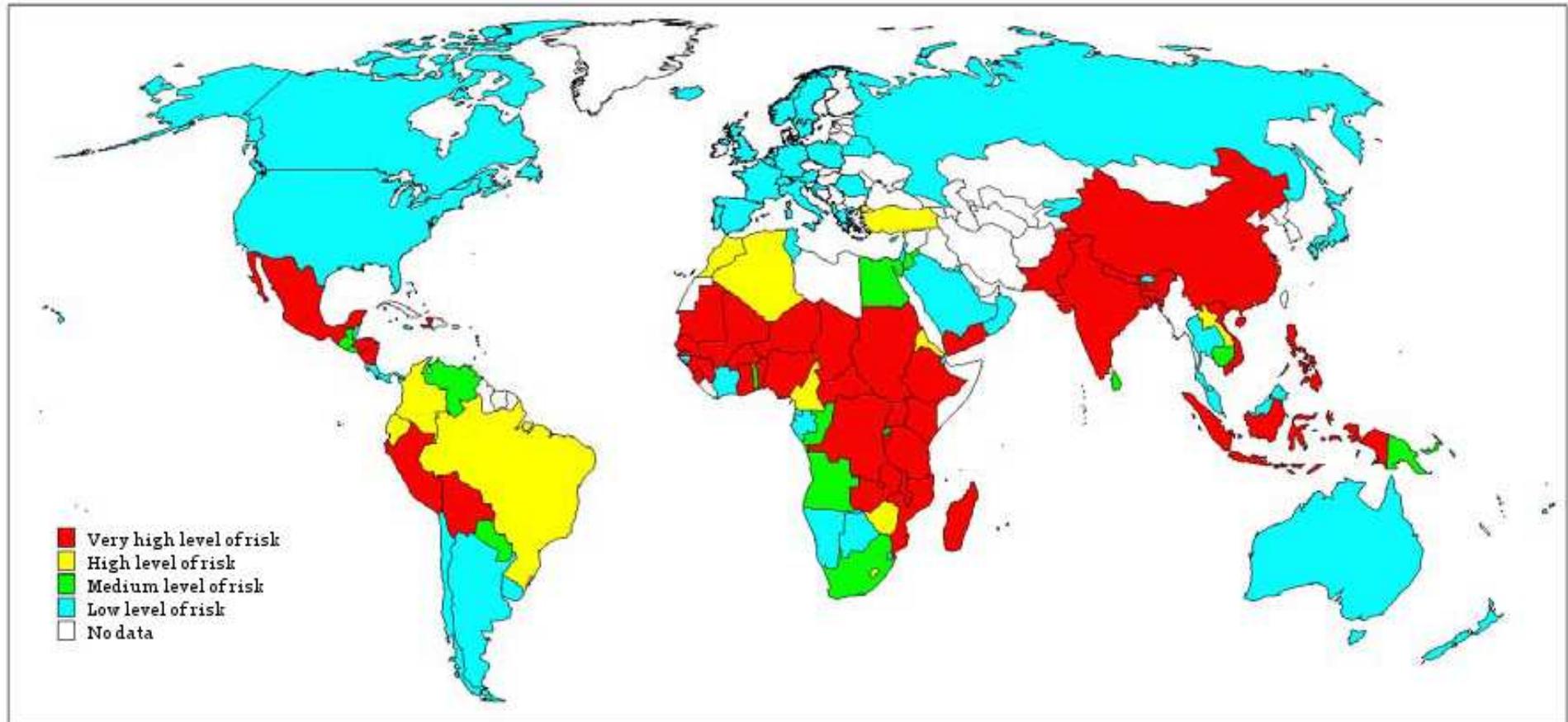
⁴² SEN A. 1982

nature of the economic risk linked to the risk of a disaster. With this second approach, therefore, the GDP per inhabitant (expressed as a logarithm) allows the overall wealth of a country to be estimated and by extension the percentage of national wealth that the goods exposed represent. GDP is therefore one of the factors of increased “economic” vulnerability. Inverted, the HDI of a country can be used to judge, in part, its capacity to predict and protect itself from natural disasters. The more developed the country, the more it will develop policies to prevent and predict natural disasters and the more it will invest in protecting the goods which are exposed. The HDI is therefore one of the factors of decreased vulnerability. For example, in relation to protection measures against earthquakes, it is clear that earthquake resistant construction norms are generally properly applied and respected in developed countries whereas in developing/emerging countries like Turkey and Algeria or in South America, almost no norms exist or if they do, they are not respected. The most obvious example of this was the 1999 Izmit earthquake in Turkey, where many of the buildings which were destroyed had been built in the 1990s at a time when earthquake resistant construction rules were already in application in the country.

Even though the two ways of calculating risk are based on different premises, they do not systematically give contradictory results, but rather are complementary. Combining them as part of a comparative analysis to evaluate risk helps to identify several groups of countries:

- The first group is characterized by little risk of hazards, significant risk management capacity which limits human loss, but on the other hand, the risk of considerable economic loss if a major disaster was to take place. For example, Scandinavian countries and Canada are in this category.
- The second group of countries are more exposed to natural phenomena, but have a strong disaster management capacity and reasonably strict norms. In these countries, human losses should remain limited, without being negligible. There can be reasonably significant economic damage, due to the value of infrastructure. France, the United Kingdom, Australia and the United States fall into this category.
- The third group of countries is highly exposed to risk and is in the process of developing its disaster management capacity. These countries have built expensive industrial infrastructure and facilities but do not have very strong anti-disaster norms. Disasters can therefore have a major effect both in human and economic terms. The majority of countries in Central and South America, India, China and the main countries of South-East Asia are all in this category;
- Finally, the fourth group is characterized by high levels of risk due to major exposure to hazards but almost no real response capacity. These countries generally have very little infrastructure and losses, which can be very high, are essentially human. Many countries in Africa, Central Asia, Southern Asia (Afghanistan) and South East Asia (Laos, Myanmar) are in this category.

MAP 11. ESTIMATED NATURAL RISK PER COUNTRY USING A SOCIAL APPROACH



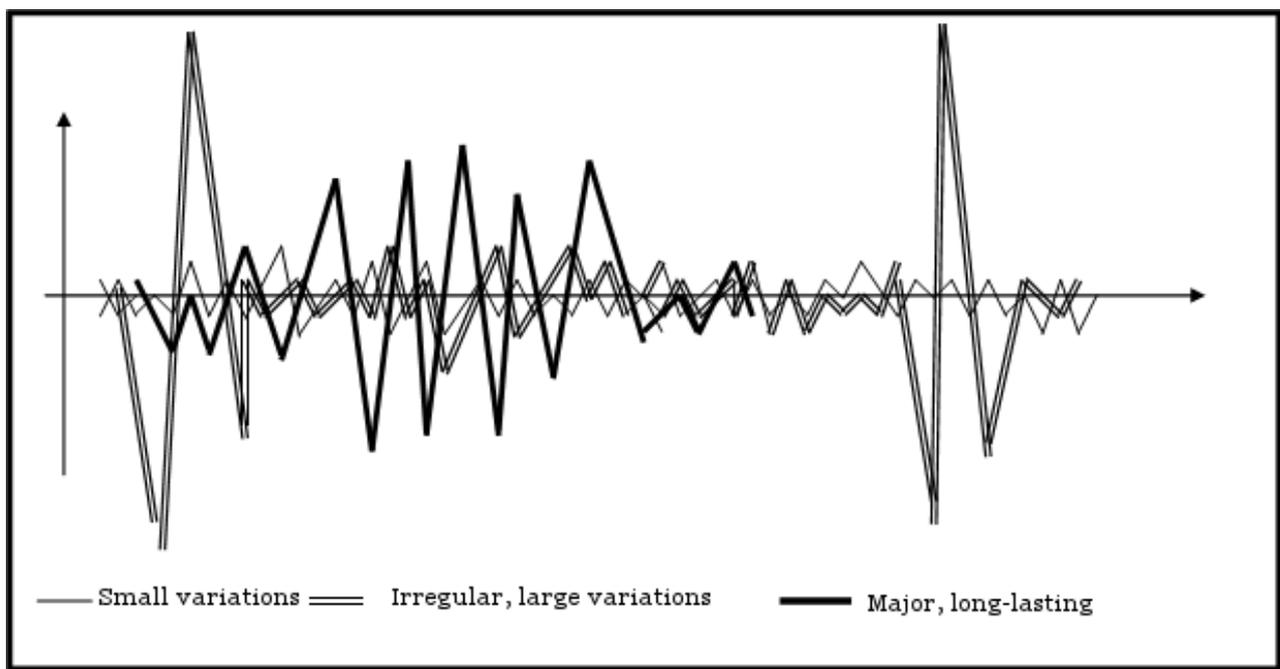
Source : André Gilles, *Cartographie du risque naturel dans le monde. Etude comparative entre une approche d'ordre social et une approche d'ordre économique de la vulnérabilité*

I.8 Ways of analysing vulnerability at the micro level

Vulnerability and resilience influence social mechanisms. Societies are formed and evolve in all kinds of environments, even hostile ones. A society's experience of disasters explains certain parameters of its reaction, the strength or weakness of its risk management mechanisms and the strength of its adaptation systems.

- The more frequent a type of disaster, the more a society will have developed its ability to manage it, on the basis of previous experience⁴³.
- The rarer a type of disaster, the weaker the collective memory and sensitivity to risk, which leads to the absence of adaptation mechanisms.

Figure 8. Analysis of the frequency with which different types of disaster take place



Rare events

- In 2004, part of the population of the Sumatra islands knew that they should take refuge on higher ground when there was a drop in the sea level which was a sign that the Tsunami wave was about to arrive, because the image of the tsunami was present in the collective memory. Elsewhere, women and children rushed to collect the fish which had been left behind by the sea and were killed by the wave.
- In Haiti, the frequency of hurricanes and tropical storms meant that they became the focus of attention, despite the fact that major earthquakes have regularly devastated entire cities throughout the country's history (though this was 200 years ago...)

Frequent events:

- Peasant farmers affected by climate change have developed risk mitigation strategies, based on the use of diverse varieties and cultivation methods.
- In areas where there is regular flooding, certain communities systematically build on stilts and store their crops in raised areas.

⁴³ N. Mubiru D., 2009

Analysis of vulnerability should not only take into account the issue of frequency but also those linked to thresholds. It is critical to identify key indicators for thresholds, both because these determine when a decision is made to launch an operation and because it will allow the evolution of vulnerability to be monitored.

Accepted or contested danger threshold indicators:

It has become essential for States, who are responsible for the future of communities and territories, but also for their own survival, to establish risk “**thresholds**” using the notion of “**acceptable risk**” as the basis for analysis. Historically, this has brought a whole series of mechanisms such as cartographic monitoring, legal proceedings, town and country planning methods and technical and social prevention techniques, which have generally been imposed via unilateral decisions. But these “top down” decisions have often not received broad acceptance. Other mechanisms based on the notion of “**risk accepted by agreement**” aim to achieve bottom-up social consensus.

It is important to note how much the notion of “accepted risk” depends on the context and changes in relation to space and time: **the notion of risk and the social acceptability of risk are determined by the socio-economic conditions of the moment and the exposure to risk that has been experienced in the past.** It therefore varies a great deal depending on the time and place. The threshold of acceptability is therefore something that changes and which needs to be revised regularly.

However, it is clear that these changes to the threshold of acceptability are only likely to have a minor effect because adaptation is a continual process in the face of gradual changes and the way they are perceived. The prospective analysis of “**relative and absolute risks**” makes a longer term approach possible, which can be used as a basis for a planning strategy, or to prepare the ground for risk management. Mathematical models of disaster scenarios and impacts (**acceptable, tolerable and unacceptable**) highlight uncertainties and the importance of developing more refined diagnoses of risk contexts. To do this, it is essential to combine the potential effects of climate change and the degree of vulnerability of each country, and also **to take into account the most vulnerable groups within each country.**

One of the most important areas to work on to reinforce resilience mechanisms is that of local levels⁴⁴. This includes decentralised State bodies (prefectures, governorates, etc.), decentralised institutions (municipal and regional authorities) and grassroots civil society organisations: local NGOs and the village level (or what is referred to in Anglo-Saxon literature as the “community” level).

Faced with food-related vulnerability and tensions on the market for basic products, a new economic dynamic is emerging which is leading a certain number of emerging countries (China and the Gulf States) and even developed countries (Korea) to rent more and more arable land in certain LDCs (Least-developed countries), particularly in Africa as well as in certain Eastern European countries like Ukraine. Due to local people being evicted from cultivable land, food production being redirected to other areas for consumption and family-based peasant farming systems being transformed into industrial units where the peasants are only employees, this taking over of a country’s land resources can threaten the local population’s food security and create the risk of significant political crises in the mid term. (cf. Map n°12).

⁴⁴ Mark C., 2006

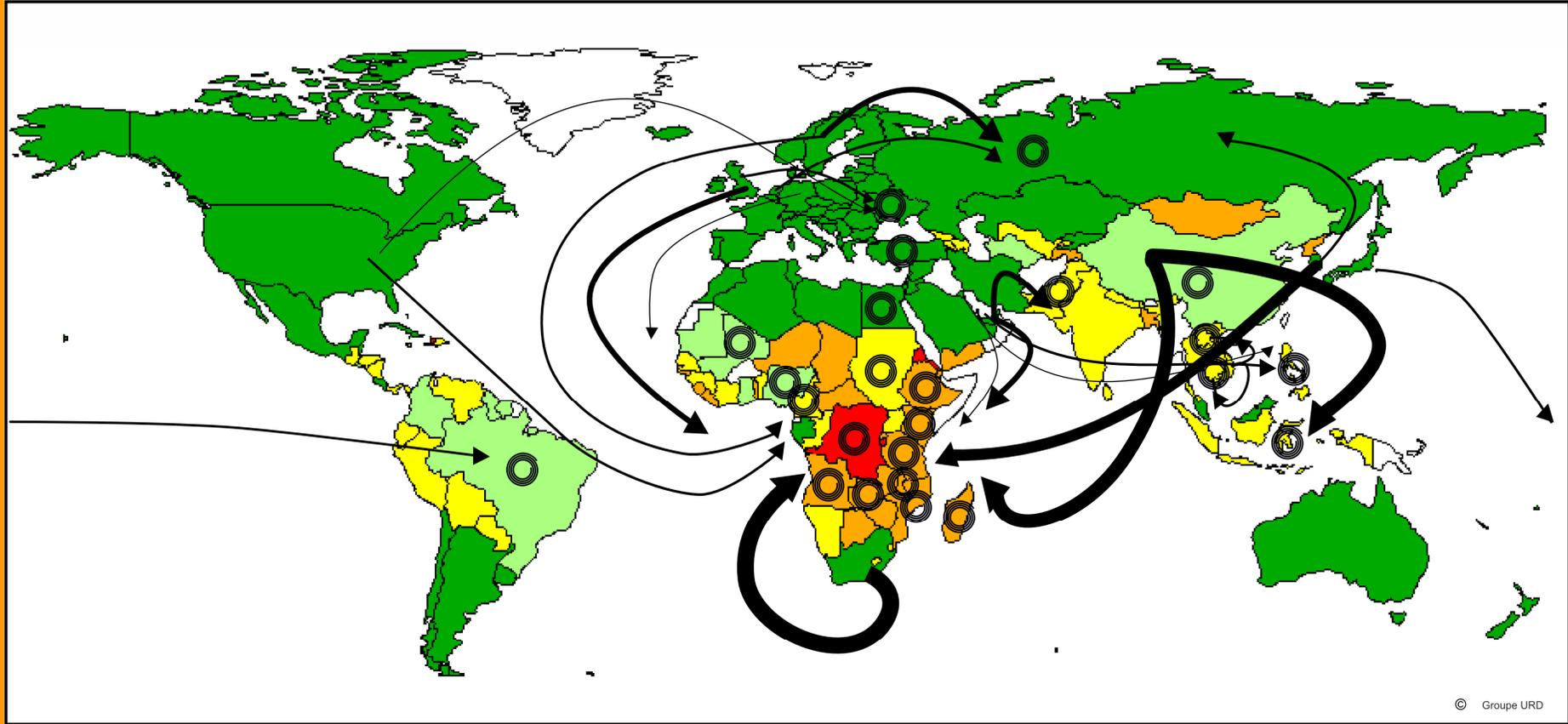
These phenomena are complex and are not very widely known:

- Land appropriation is difficult to quantify and qualify, but the scale on which it is taking place appears to be much smaller than the media attention it has received might lead us to think.
- These investments are being made by a wide variety of economic operators, both in terms of nationality and status, and most often they involve host States, particularly via contracts for infrastructure or the transferral of transformed products. Embezzlement appears to be a major risk in relation to these contracts. In Africa there is a variety of different types of transaction. Sales are rare. Rental contracts are most often short and do not have a clearly identified quid pro quo.
- Though the media has focused its attention on projects which are aiming to improve the food security of the investor's country, there is a variety of different motives for investment.

This is still potentially a problem which needs to be monitored properly: the civil societies of the countries involved will soon begin to take notice of this gradual takeover of agricultural land by a group of countries who are worried about their own supplies and who are investing either in a speculative manner (buying, using and re-selling) or with a longer-term view (more closely resembling a form of colonialism).

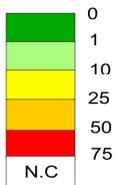
MAP 12

FOOD INSECURITY AND AGRICULTURAL LAND BOUGHT BY FOREIGN INVESTORS



© Groupe URD

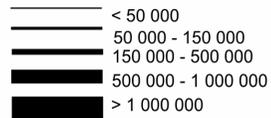
Percentage of the population undernourished between 2004-2006 (in%)



Countries where land has been bought by foreign investors



Quantity of land bought by foreign investors (hectares)



Map base: <http://finder.geocommons.com/overlays/18457>, Smoothing with MapShaper

Food insecurity: FAO Statistics Division; Prevalence of undernourishment in total population (%), 2006.

Land grabbing: "Land Grabbing by Foreign Investors in Developing Countries: Risks and Opportunities"; IFPRI, 2009

Foreign investment: "Land Grabbing by Foreign Investors in Developing Countries: Risks and Opportunities"; IFPRI, 2009

Produced by: Groupe URD, 2010
<http://www.urd.org/>

World_Undernourishment_LandGrabbing_care10-v1_A4L

Chapter IV

The need to promote mapping of future unintentional risks

1.9 The need for global risk mapping: hot spots

The approach developed here is based on a more detailed geographic definition of each of the risks analysed above using concepts such as that of the “hot spot”⁴⁵ or the “syndrome”.

The theory of hot spots originated in the fields of vulcanology and seismology. The hot spots described in these fields were places where there was a known concentration of energy linked to tectonic plate phenomena. These hot spots, which are often well mapped, are the places where the majority of volcanic eruptions, earthquakes and numerous other less dramatic phenomena such as geysers or hot springs take place. The development of seismology has meant that geographic, analytical and predictive knowledge are central to the theoretical development of the hot spot model. The links between the activities of the earth’s crust, climatic phenomena and the environment are central to the broadening of this theory’s field of application. Rapid changes to ecosystems after major eruptions (toxicity of lava and water, long-lasting clouds of ash which can perturb the climate in entire regions making life in cities unbearable) highlight the environmental component of seismic theory. The sphere of validity and the field of application of this approach have extended to meteorology (with the analysis of the El Niño and La Niña phenomena), analysis of the repercussions of human activities on biodiversity (endangered biodiversity hotspots, damaged ecosystems due to the introduction of alien species – Nile Perch in Lake Victoria, killer bees moving up the West Coast of the United States, the introduction of caprids into numerous island ecosystems) and changes in the ozone layer. This approach has been extended to geopolitics, geostrategy and economics.

This mapping includes:

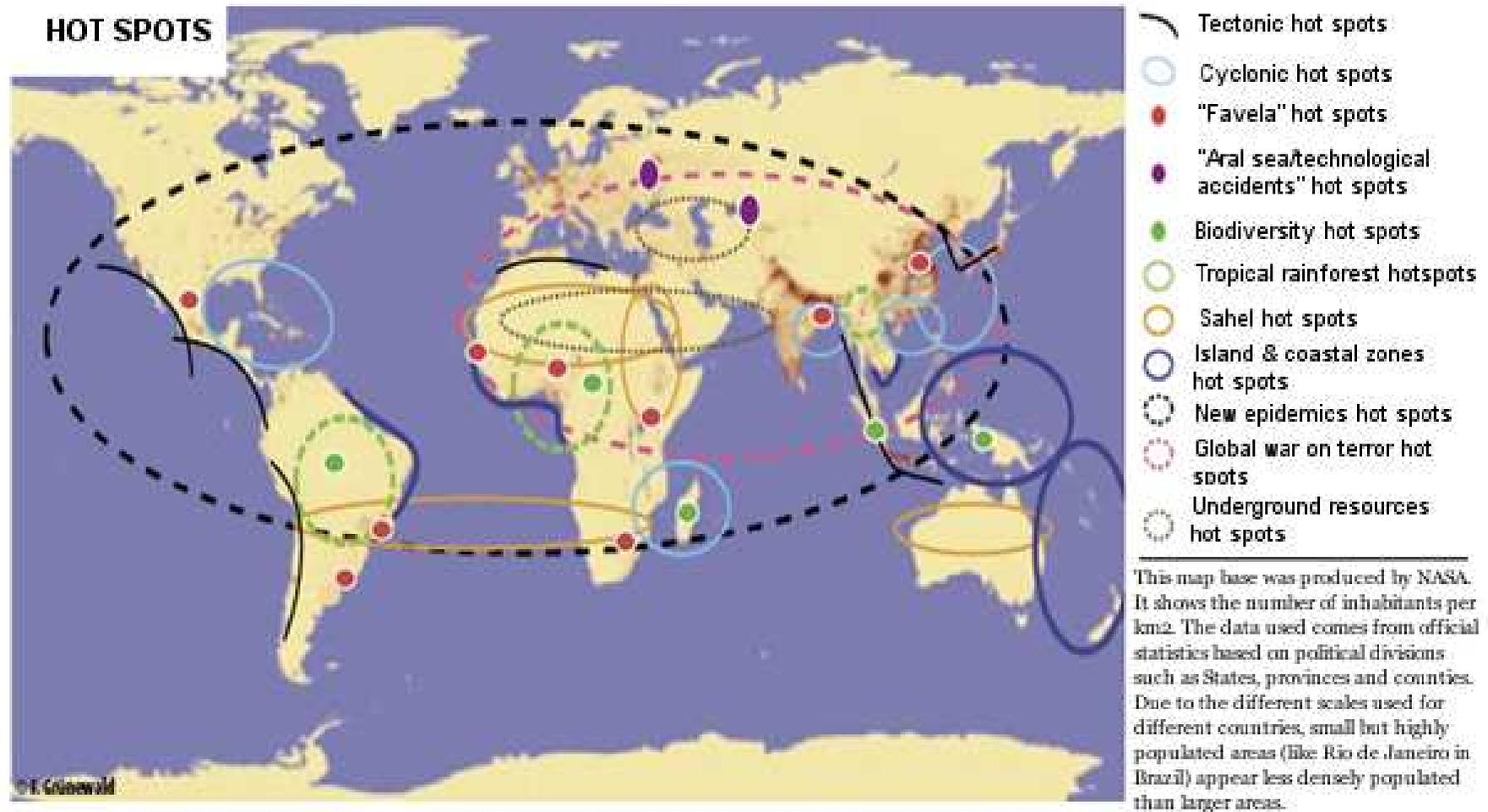
- maps for each risk ;
- maps with combined risks to show high-risk points.

⁴⁵ The concept of “hot spots” comes from tectonics and was used to describe high risk sites where there was a permanent build up of tension. The term was gradually applied to other sectors. Biodiversity hotspots are exceptional places in terms of riches, but also dangers.

Table 3. Hot spots, disasters and predictability

	Syndromes	Analysis of causes	Possible scenarios for the future	Predictability
Socio-natural syndromes (hot spots)	Tectonic syndrome	Risk of accumulation of energy under the earth's crust	Earthquakes, tsunamis, volcanic eruptions, either in a very active zone or in a zone where the phenomenon is rare.	High
	Sahelian syndrome	Reduced rainfall due to climate change	Regular but increasingly unpredictable movement of communities Increased conflict over resources	High
	"Coastal area and small island" syndrome	Rising sea level due to melting glaciers	Forced displacement to higher ground Conflict with communities situated on higher ground Large-scale disasters with catastrophic socio-economic effects	High
	"Tropical and equatorial forest" syndrome	Deforestation and use of land for agriculture	Reduction of natural resources and gradual impact on the climate	Medium
	Aral Sea syndrome	Tragically inappropriate management of rare resources such as water	Appearance of new ecosystems Conflicts over resources	Medium
	Biodiversity syndrome	Competition over natural resources and the elimination of rare species	Deterioration of natural resources with an impact on production systems Appearance of new ecosystems Conflicts over resources	Low
Socio-political syndromes (hot spots)	Pandemic syndrome	Result of the major flux of people and goods	Major crises affecting millions of lives Limited and localised impact without major global effects	Low
	Fragile city / favela syndrome	Rapid urbanisation	Increased growth in certain highly urbanised areas Appearance of new urban civilisations	High
	Technological choice/ Chernobyl syndrome	Development of less safe new technology or misuse of existing technology.	Increasingly frequent serious incidents Increased focus on risk reduction via control processes and the development of norms	Medium

MAP 13. HOT SPOTS



I.10 For local mapping of risk systems

In order to be practically useful, this mapping of future unintentional risks also needs to be local. It is only at the local level, using a detailed approach to areas with multiple risks that issues linked to the duration of combined risks can be highlighted.

Three examples of risk systems which will need to be taken into account in the coming decades are described below:

- The Mediterranean basin system;
- The South and South-East Asian system;
- The Central America and Caribbean system.

Each of these systems includes an exposure component and a wide range of risks linked to:

- natural conditions (high level of seismic activity, areas affected a great deal by climate change phenomena),
- socio-economic changes (high demographic growth and increased population density in coastal zones and valleys, rapid industrialisation, etc.).

I.10.1 The Mediterranean risk system

Throughout history there have been many disasters in the Mediterranean basin: earthquakes which destroyed the Roman cities on the Lebanese coast, volcanic eruptions in Sicily, destructive tremors in Algeria, Turkey, etc.

Population density has increased a great deal all around the Mediterranean and technological and chemical disasters are also relatively frequent. In addition, the pollution level in this almost closed marine ecosystem, has reached alarming levels which creates a major risk for the system's ability to produce fish, and even for its ability to regenerate itself. Water scarcity is at the centre of complex dynamics linked to social contracts (oasis systems, irrigation networks) and institutional and political contracts ("upstream/downstream" management of waterways, use of cross-border phreatics) which, in certain very politicized cases, could lead to conflict (Palestine, Lebanon, Jordan).

It is important to have a systemic view of this zone, and to consider different units which have both shared and individual issues (cf. Map 14):

- coastal areas;
- regions further inland;
- the centrifugal lines of the major rivers.

The analysis of the Mediterranean zone reveals a very high level of combined risks linked to:

- higher population density in coastal zones and on fertile plains;
- a multitude of industrial sites with varying levels of risk management;
- high risk of flooding and permanent seismic activity;
- development of new plant diseases and propagation of new parasites.

In addition to this is a major increase in the mobility of goods and people, and notably, the intense transportation of petrol and industrial products in an ecosystem which is already under a great deal of pressure. The nature of the political systems in the zone varies a great deal, but they are all regularly challenged in their ability to manage disasters and anticipate unintentional risks.

MAP 14

INDUSTRIAL AND NATURAL RISKS AROUND THE MEDITERRANEAN



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500 km

Number of inhabitants

- 150 000 - 500 000
- 500 000 - 1 500 000
- 1 500 000 - 5 000 000
- 5 000 000 - 10 000 000

- Principle maritime routes for oil
- * Petro-chemical complexes
- Predicted rise in sea level: 1 meter by 2100
- ▨ Areas subject to earthquakes of 5 MMI or above

Map base: <http://finder.geocommons.com/overlays/18457>.
 Population: Database prepared by Hugo Ahlenius, Nordpil. The population data was related to the ESRI Data & Maps 2008 cities datasets. 2009.
 Seismic risk: Dataset "Earthquakes footprint of Modified Mercalli Intensity shakemaps 1973-2007"; UNEP/DEWA/GRID-Europe, 2009.
 Sea level rise scenario: <https://www.cresis.ku.edu/data/sea-level-rise-maps>.
 Petro-chemical complexes: "Transports maritimes et transport par pipe du pétrole et du gaz" document Plan Bleu 2000
 Principle maritime routes for oil: "Transports maritimes et transport par pipe du pétrole et du gaz"; document Plan Bleu 2000
 Produced by: Groupe URD, 2010

<http://www.urd.org/>

Mediterranean_Industry&SeismicRisk_carrier_v1_A4C

I.10.2 South and South-East Asian risk systems

South and South-East Asia are faced with major risk factors and will continue to be among the regions of the world most seriously affected by future unintentional risks. Several large sub-systems can be identified:

- The piedmonts, plains and deltas which are connected to the Himalayan mountain range (Pakistan, Bangladesh, Myanmar, Thailand, Cambodia, Vietnam and China): these areas are crossed by large rivers (the Ganges, the Brahmapoutra, the Irrawaddy, the Chao Phraya, the Mekong, the Red River and the Yangtze) and are home to cultures where there is a high level of inequality and where, despite the appearance of middle classes, poverty is far from having been eliminated.
- The South-East Asian peninsula, which includes many of the new emerging countries such as Malaysia, Indonesia and the Philippines.

These regions share high population density, rapid industrialization, a specific role in globalization due to their cheap labour as well as weak legislation in terms of social conditions and the management of technological risks. They have specific combinations of future unintentional risks. (cf. Map 15)

I.10.2.1 Southern Asia

Southern Asia's risk system has the following characteristics:

- In the areas within the Himalayan mountain range, the deterioration of the mountain ecosystems is such that forests no longer act as a buffer and monsoon rains run down to the plains very quickly, increasing the risk of flooding on lower ground. Human activity leads to an ever increasing level of embankment which prevents the flow and dispersal of floodwater. The development of irrigated agriculture in these plains and the increasing industrialization of the region have led to very high population density which means that human and economic losses are potentially extremely high.
- Delta areas, which regularly have flooding rivers going through them, are also subject to the influence of tides and rising water levels as well as cyclone phenomena. Many delta areas are among the most densely populated regions in the world with people often living in very precarious conditions.
- The industrialisation of the region is taking place without much concern for social legislation or the security norms of industrial facilities.
- The political regimes of the different countries in the area are generally strong: India, Pakistan, Indonesia, Malaysia, Vietnam, Cambodia and China. But they are often contested. This can affect their capacity to react and also makes them very sensitive to accusations of poor disaster management.

I.10.2.2 The South-East Asian peninsula

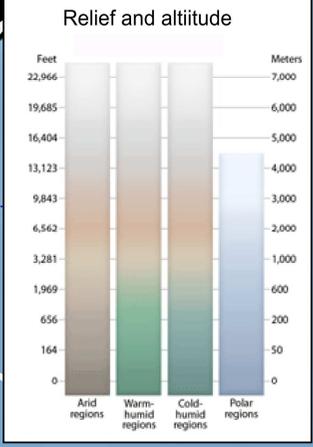
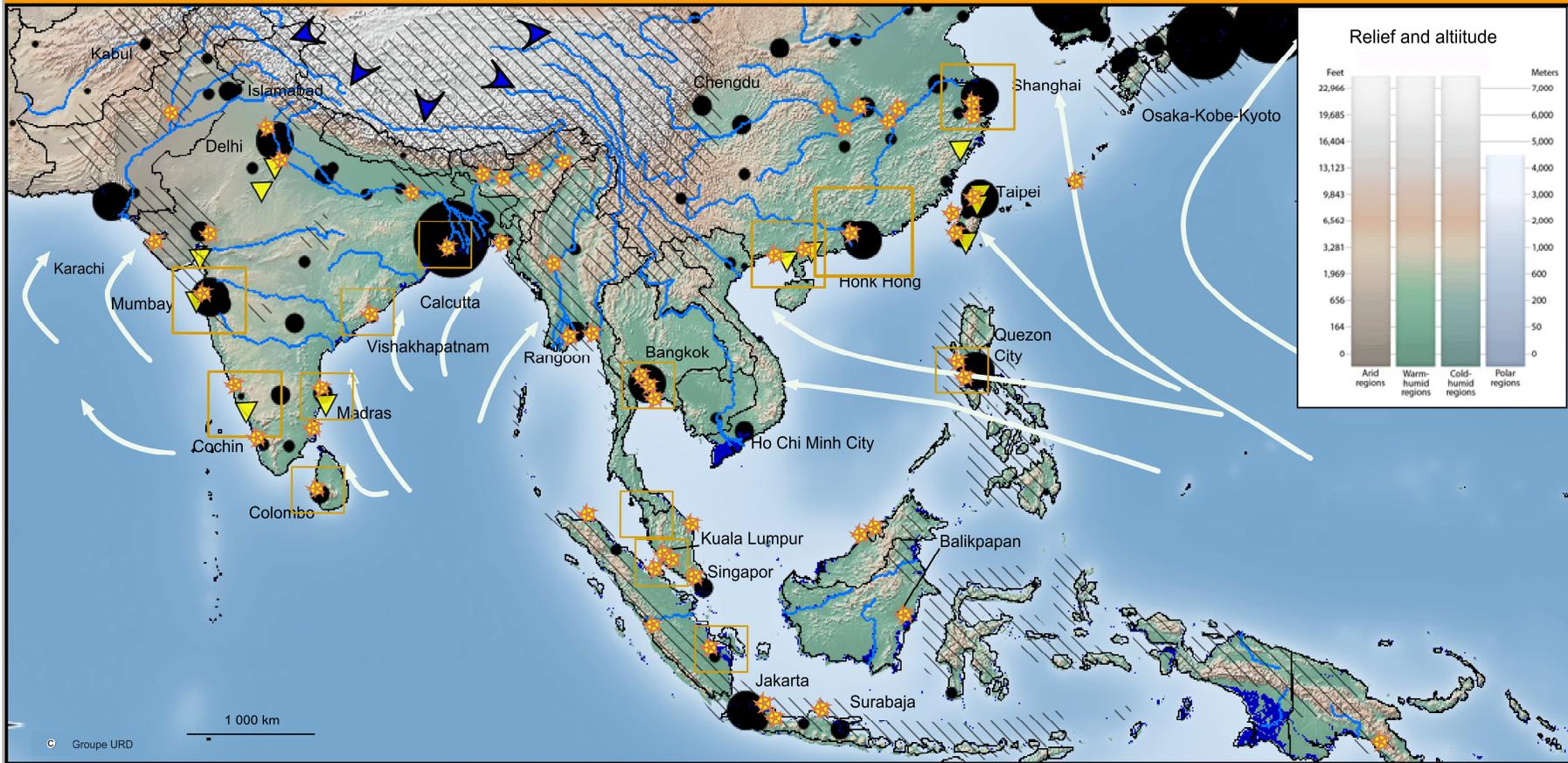
South-East Asia's risk system has the following characteristics:

- The South-East Asian peninsula includes a series of islands in ark formation and regions located on fault lines and active subsistence zones, which are regularly shaken by earth tremors which can have a devastating effect both directly and due to the tsunamis that they generate: the Arakan ark, the volcanic area of the Philippines.

- South-East Asia has two large areas which are severely affected by climatic phenomena linked to thermal flows between the air and the sea. Cyclones and tropical storms alternate with periods of drought. One of these areas faces the Atlantic Ocean: periods when there are a lot of cyclones tend to take place in El Niño years whereas periods of drought when there are forest fires tend to take place in La Niña years. The other area faces east and extends along the South China Sea towards Vietnam and the Philippines.
- There is often large-scale industrialisation in certain urban and peri-urban areas, which increases the level of economic losses brought about by disasters.
- The expansion of monoculture plantations such as oil palm is creating environmental risk of a more and more serious nature in large areas. There is both a dramatic reduction in biodiversity and an increased risk of forest fires, as has been seen in Indonesian Kalimantan⁴⁶.
- Finally, the governments in the area are often quite authoritarian and have developed quite sophisticated disaster management capacities.

MAP 15

INDUSTRIAL AND NATURAL RISKS SOUTH OF THE HIMALAYAS AND IN SOUTH EAST ASIA



- Number of inhabitants**
- 150 000 - 500 000
 - 500 000 - 1 500 000
 - 1 500 000 - 5 000 000
 - 5 000 000 - 10 000 000
 - > 10 000 000

- Areas subject to earthquakes of 5 MMI or above
- Predicted rise in sea level: 1 meter by 2100
- Usual trajectory of cyclones of category 3 or above
- Melting glaciers and risk of flooding downstream

- Areas with major industrial ports
- Oil refinery
- Nuclear power station

Map base: <http://finder.geocommons.com/overlays/18457>
 Relief: Map "Cross Blended Hypso with Shaded Relief and Water", by Natural Earth, 2009
 Population: Database prepared by Hugo Ahlenius, Nordpil. The population data was related to the ESRI Data & Maps 2008 cities datasets, 2009.
 Rise in sea level scenario: <https://www.cresis.ku.edu/data/sea-level-rise-maps>.
 Seismic risk: Dataset "Earthquakes footprint of Modified Mercalli Intensity shakemaps 1973-2007"; UNEP/DEWA/GRID-Europe, 2009.
 Intensity of cyclones: "Tropical cyclones windspeed buffers footprint 1975-2007"; UNEP/DEWA/GRID-Europe, 2009.
 Nuclear power stations: International Nuclear Safety Center at ANL, 2005
 Oil refineries Google map, Crude Oil Refineries 2008, fichier .kmz
 Industrial ports: AAPA, Port Industry statistics, World Port Ranking 2007
 Produced by Groupe URD, 2010 <http://www.urd.org/>

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1.10.3 The risk systems of Central America and the Caribbean

This region regularly appears in the list of countries the most affected by unintentional risks⁴⁷ and will continue to be in the coming decades. Several sub-systems exist:

- Areas with a great deal of tectonic activity, with volcanic arcs and areas with a high level of seismic activity due to overlapping terrestrial plates (Central America, the Andes and the Caribbean) ;
- The areas exposed to the violent climatic phenomena of the Gulf of Mexico/Caribbean sea⁴⁸ (again, linked in general to thermal flows in the oceans and El Niño and La Niña) ;
- Areas affected by both phenomena (Haiti).

Risks need to be analysed in terms of vulnerability and exposure to risks per zone (cf. Map 16):

- Some of the coastal areas of these regions are quite highly populated: these regions will potentially be affected by the rise in sea levels and the risk of tsunamis.
- Some large cities are situated inland, often with an uneven landscape and high exposure to the risk of landslides, particularly for all the informal peri-urban settlements (favelas/shanty towns in unstable areas such as Tegucigalpa in Honduras).
- Rural regions often have difficult situations in terms of land ownership, with the large fertile plains monopolised by big landowners or international companies, and family-based agriculture limited to slopes which are exposed to the risk of erosion and therefore all the more sensitive to climatic disorder.
- In certain countries of this zone, some rural regions have developed on substrates of rich volcanic ash and have seen the development of a flourishing agrarian economy, with high population density in areas where there is a high risk of eruption. Consequently, the industrial installations which have accompanied this increase in population density are also in these high-risk zones.

Apart from Haiti, the majority of countries in the zone are already fully engaged in the industrialisation process, with Seveso-type facilities in high-risk areas.

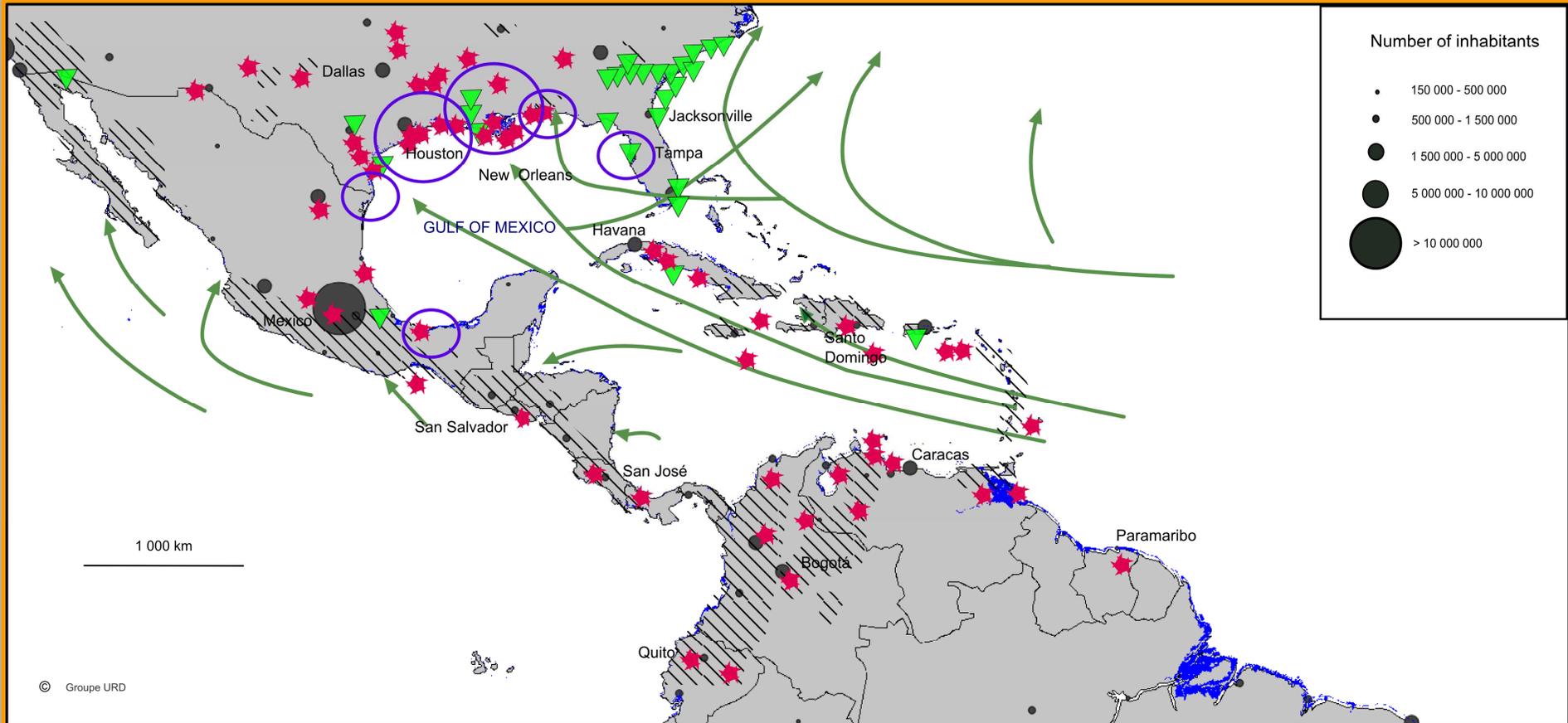
In the region, different types of response to disasters are possible depending on the capacities of States. Certain countries, like Cuba or the Dominican Republic, have developed relatively effective crisis management mechanisms despite their weak economies. Other countries, such as Mexico, also have quite effective mechanisms, such as for evacuating coastal areas.

⁴⁷ Groupe URD, 2002

⁴⁸ GEODE Caraïbe, 1999

MAP 16

INDUSTRIAL AND NATURAL RISKS IN CENTRAL AMERICA AND THE CARIBBEAN



Number of inhabitants

- 150 000 - 500 000
- 500 000 - 1 500 000
- 1 500 000 - 5 000 000
- 5 000 000 - 10 000 000
- > 10 000 000

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- Predicted rise in sea level: 1 meter by 2100
- Areas subject to earthquakes of 5MMI and above
- Usual trajectory of cyclones of category 3 and above

- Areas with major industrial ports
- Oil refinery
- Nuclear power station

Map base: <http://finder.geocommons.com/overlays/18457/>
 Population: Database prepared by Hugo Ahlenius, Nordpil. The population data was related to the ESRI Data & Maps 2008 cities datasets, 2009.
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 Intensity of cyclones: "Tropical cyclones windspeed buffers footprint 1975-2007", UNEP/DEWA/GRID-Europe, 2009.
 Nuclear power stations: International Nuclear Safety Center at ANL, 2005
 Industrial ports: AAPA, Port Industry statistics, World Port Ranking 2007
 Oil refineries: Google map, Crude Oil Refineries 2008, fichier .kmz

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<http://www.urd.org/>

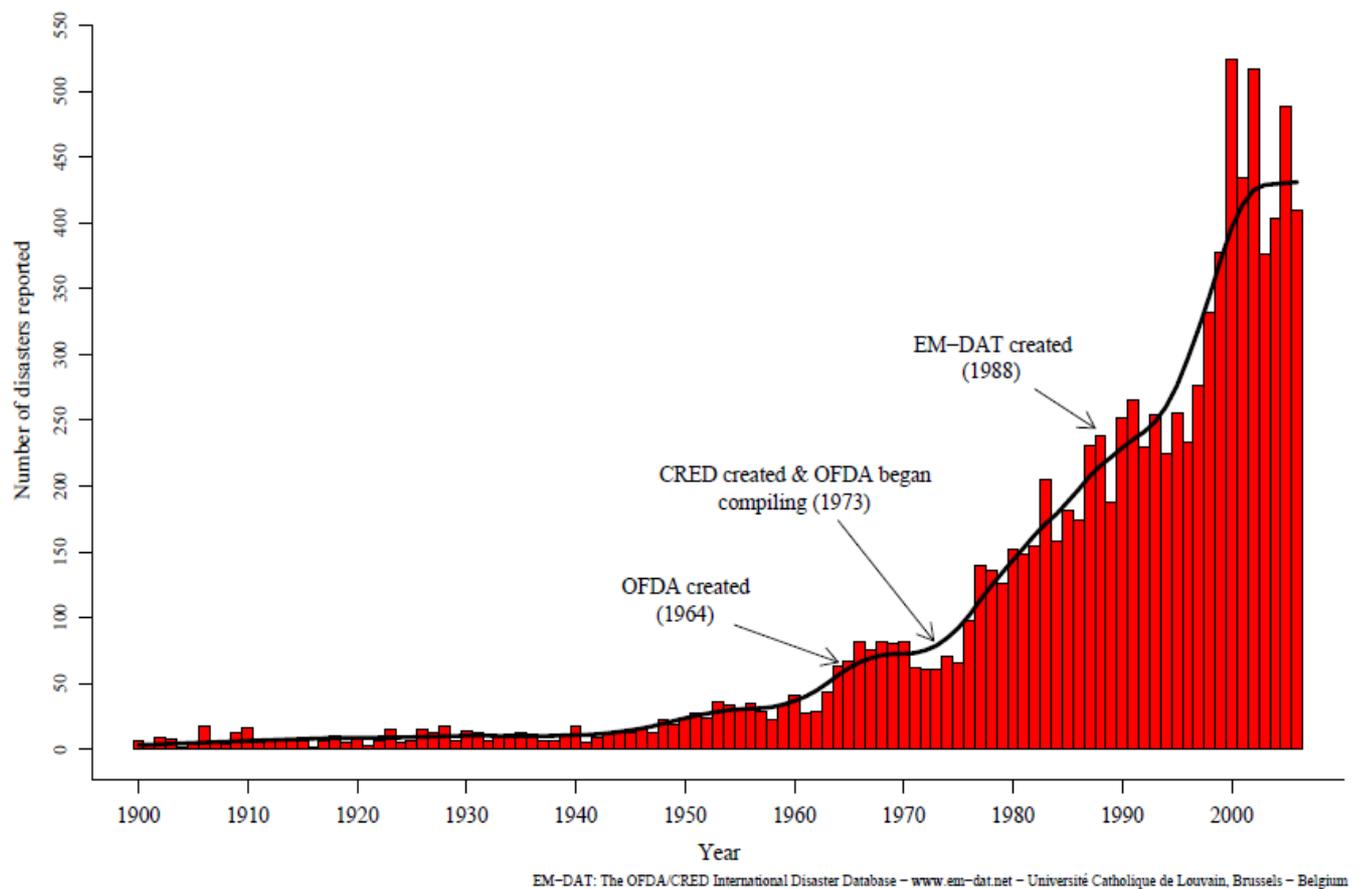
Chapter V

The possible consequences of future unintentional risks

Thinking ahead to future unintentional risks means using several tools and approaches:

- Analysis of the frequency of past phenomena. This analysis allows both the main trends of the past and the correlation between factors to be identified and early warning signs and mechanisms (weak signals) to be explored;

Figure 9. Natural disasters recorded during the period 1900-2006



- Analysis of crisis-generating mechanisms, which involves putting into perspective structural and economic causes as well as vulnerability factors over the next thirty years.

There are a large number of questions regarding descriptive and prospective models, linked to the level of understanding of the different phenomena and strategic thinking on predictions. Predictive models depend a great deal on the period of time being considered. The longer the period, the more difficult it is to establish the probability of a particular type of disaster or the conditions in which it is more or less likely to take place.

Table 4. Anticipation approaches

	The future is...			
	Certain	Probable	Possible	Unknown
Thinking is...	Linear	Contextual	Creative	Opportunist
Planning focuses on...	Tactics and timetables	Contingency plans	The elaboration of scenarios	Understanding complexity
Management focuses on...	Corrections and arrangements	The most rational responses	Robust strategies	The definition of minimal specifications

According to René Thom, who first developed catastrophe theory, a catastrophe⁴⁹ is, above all, a break in continuity which brings a change of state and which can be predicted on the basis of a certain number of parameters (he worked on disaster models and establishing disaster curves as a predictive tool). Even though this mathematician’s work was essentially centred on the phenomenology of disasters, actors who work on the reality of disasters need to be able to prepare themselves to manage them in a holistic manner. Faced with the limits of anticipation, presented in the table above, it is important to remember how difficult prediction is due to the multiplication of factors which influence how contexts and risks evolve and the fact that the number of possible combinations between these increases with time.

Several major trends have emerged and these will be analyzed in the subsequent chapters:

- the **multiplication of large-scale disasters**;
- the **increased mobility of populations** in the face of risks and increasingly unpredictable living conditions at national and sub-regional levels;
- the increasing **instability** of certain areas due to increased competition over resources and land where there are fewer risks.

⁴⁹ Catastrophe theory provides a methodology to establish models for situations which, otherwise, would be very difficult to understand and for systems which can not be described because they include too many elements [...] It provides a means of making situations which are generally too complex to analyse with reductionist methods intelligible [...] It has the drawback of being a qualitative, topological theory, which does not provide quantitative limits to the deformation of forms which is considered [...] It gives a kind of local description of a system, within certain control parameters. PNPE p29-30.

I.11 The proliferation of large-scale disasters

Analysis of the recent past (cf. figure 9) shows that the proliferation of large-scale disasters and their increasingly serious impact are going to be a permanent part of the landscape in the coming decades because of:

- the influence of vulnerability factors linked to a high level of demographic growth which pushes large numbers of people to settle in “high risk” areas;
- the speed of urbanisation in certain regions (South and South-East Asia, Sub-Saharan Africa) ;
- the growing imbalance in certain regions between the resources available and people’s needs (in terms of water, cultivable land, forest and fodder resources, etc.);
- the serious deterioration of mountain and piedmont ecosystems and the consequent reduction in the buffer role that forest ecosystems play on rainfall in areas at high altitude and on sloping ground;
- the deterioration of delta and coastal ecosystems, which are unable to absorb the flow of water from upstream and from phenomena connected to the sea level downstream.

The frequent installation of industrial facilities in high risk sites combined with the economic logic of short term profitability (which reduces investment and maintenance capacity) makes technological risk increasingly a problem.

Over the next thirty years, some regions will be particularly vulnerable and will need to be monitored particularly closely:

- The very arid band across Sub-Saharan Africa to the North of the Equator, from Somalia to Mauritania. This is where the major famines to come will take place, because the capacity of ecosystems and rural economies to provide for increasingly large populations will be increasingly limited as aridity is exacerbated and climate change causes more turbulence;
- The areas around the large watersheds to the South and the East of the Himalayas. These regions will be more and more frequently and severely affected by floods caused by heavy rainfall (unusually heavy monsoons, cyclones, etc.);
- Coastal zones and the small islands of Asia and Oceania. Some of these areas are already doomed due to the rising sea level (Maldives and Tuvalu);
- Areas where there is a lot of tectonic activity. The increased population density in urban and peri-urban areas and also in certain volcanic regions where people are drawn by the fertility of the soil makes these areas potentially very dangerous;
- Areas where industrial development has taken place with weak regulation. The absence of anti-risk legislation or the non-application of existing legislation due to the weakness of the authorities leads to highly dangerous situations.

I.12 Mobility as a response to unintentional risk

The major migrations which have affected humanity⁵⁰ have been brought about by conflict, poverty⁵¹ and the search for resources. Chronic hunger due to drought, floods and economic and land ownership policies (e.g. the land distribution system implemented by the British contributed to the Great Famine in Ireland), the degradation of ecosystems and the consequent competition over resources,

⁵⁰ HISTOIRE, 2009

⁵¹ Melonio Th., 2008

vulnerability to natural risks, gradual environmental changes linked to climate change and problems related to economics and development⁵² have contributed to the major migrations in recent centuries. This situation is as relevant today as it was in the past⁵³.

The term “environmental refugees”, used for the first time by Lester Brown⁵⁴ in 1976, one of the great development thinkers, is used more and more. Though migration is complex and is influenced by multiple factors⁵⁵, according to certain authors⁵⁶ the migrations caused by the increased pressure on resources and environmental risks are well on the way to becoming one of the major political, humanitarian and development challenges of the coming decades (cf. Map 17). It is true that great uncertainty remains about the rhythms and timing of these phenomena (rapid or slow onset), their scale (massive or progressive) as well as about the regional variations which may exist. Though there is still debate about these issues, it is important to think about them creatively.

Several scenarios⁵⁷ have been considered on the basis of different possible combinations of environmental, economic, demographic and political parameters:

The optimistic scenario is based on the hypothesis that there is a realisation amongst different countries of the issues involved in demographic control, that the emerging countries of the BRIC (Brazil-India-China) adopt greenhouse gas reduction policies and that credible global economic governance is established. This scenario predicts a rapid limitation of migration linked to environmental issues and risks due to theoretically positive changes in the mid term. The majority of observers feel that the probability of this scenario is very low.

The pessimistic scenario: increasing risks, environmental deterioration and climate change will potentially lead to displacement on such a scale that the world is unable to prevent it or deal with it effectively. Even though this phenomenon might be progressive, for example, due to adaptation and resilience capacity, certain authors feel that population displacement will become massive in certain high-risk areas and could, eventually, lead to political and military confrontation.

52 UNFPA, 2005

53 Audebert C. Ma Moug., 2007

54 Brown et al, 1976

55 UNFPA/IIED, 2009

56 Christian aid, 2007

57 Brown O., 2007

Equally pessimistic is the view of a certain number of experts who state that significant displacement has already taken place and that more will take place as climate change intensifies⁵⁸. Similarly, the ecological disasters which can take place as the result of industrial or technological disasters can lead to the long term sterilization of ecosystems which leads to the displacement of whole communities. Professor Norman Myers of the University of Oxford has said that, “when global warming takes hold there could be as many as 200 million people displaced by 2050.”⁵⁹ This is a horrifying prospect: the multiplication by ten of the number of people currently documented as displaced or refugees.

There are many complex factors which influence migrants’ decisions to leave their homes. It is very difficult to distinguish the causes and effects between poverty, climate change, forced migration⁶⁰ and the simple attraction of wealthier countries and the hope of a less difficult future. Currently, the vast majority of so-called “environmental” migrants come from arid rural regions in the least developed countries. The majority of environmental migrants settle in the urban centres of their own countries, with only a small proportion migrating to a neighbouring country (South to South migration). This trend will probably become more complex in the years to come as densely populated delta areas (Bangladesh⁶¹, India, South-East Asia, Pakistan, China, etc.) and coastal areas become increasingly affected by rising sea levels, more and more frequent violent climatic events, massive and violent flood waters from upstream and a combination of the events described above.

The consequences of migration caused by the environment are not all negative. Leaving regions where there is environmental degradation or which can no longer be used for agriculture can also be seen as a strategic response by the affected communities. Furthermore, migration can, to a certain extent, help to slow down the process of environmental degradation and allow the members of the community who do not migrate to adjust their coping strategies by changing their agricultural practices or, for example, developing new non-agricultural practices.

Nevertheless, the majority of the consequences of mass migration remain negative: amongst these is the intensification of humanitarian crises, increased urbanisation accompanied by the expansion of shantytowns and the disruption of development. The studies carried out to date show that migration alone does not resolve the principle causes of the problem because the population of damaged regions does not fall sufficiently to allow the environment to be re-established or poverty to be reduced and, in most cases, increased vulnerability continues to be created.

⁵⁸ Achim Steiner is a UN Under-Secretary General and is the Executive Director of the United Nations Environment Programme (UNEP).

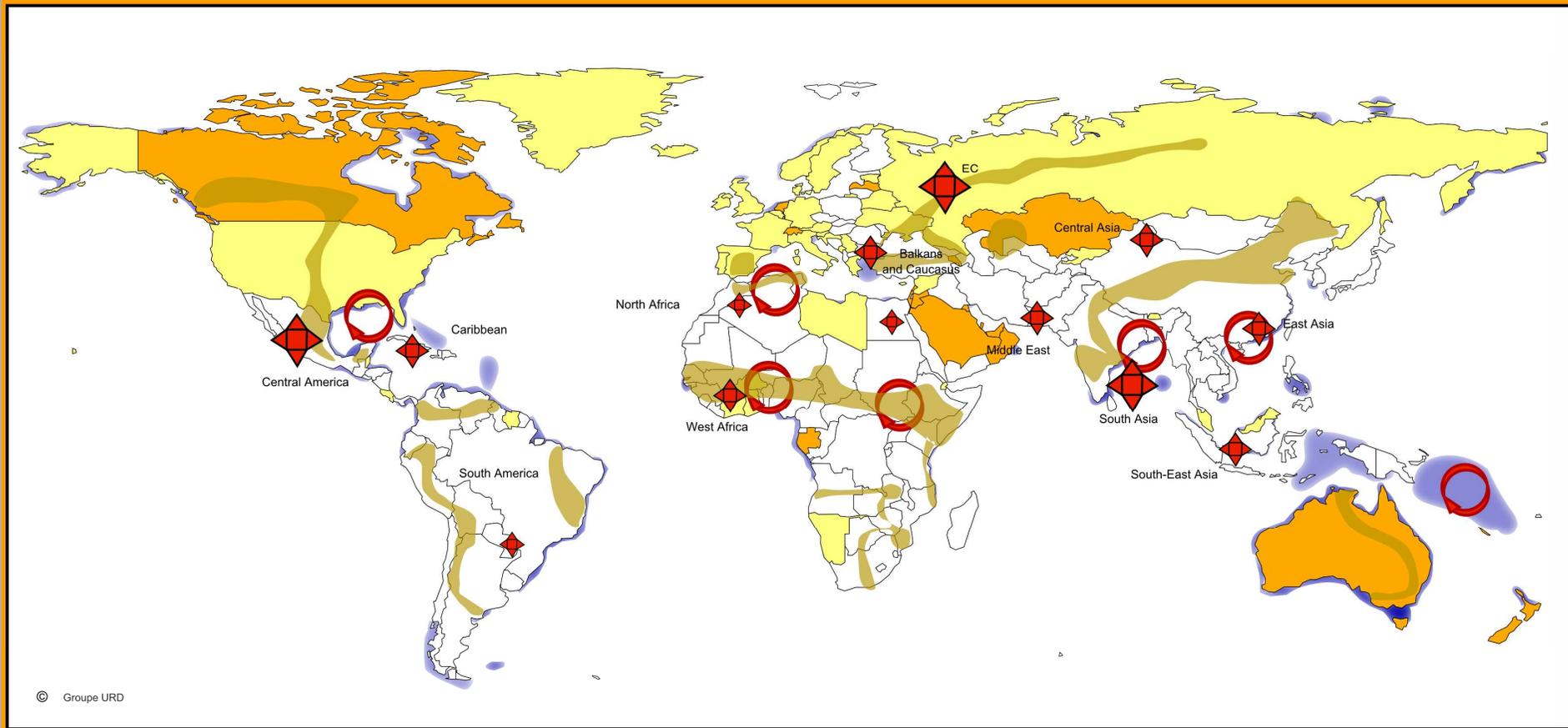
⁵⁹ Myer & al, 1995

⁶⁰ Oli Brown, Programme manager at the International Institute for Sustainable Development.

⁶¹ Raillon, 2010

MAP 17

GLOBAL MIGRATION AND CLIMATE CHANGE



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Major sources of migration (2005)

-  10 - 20 million emigrants
-  5 - 10 million emigrants
-  3 - 5 million emigrants

Immigrant countries
(proportion of immigrants in 2005)

-  5 - 15%
-  More than 15%
-  Potential migration due to climate change

Areas at risk
from climate change

-  Rising sea level (1m)
-  Desertification and drought

Map base: <http://finder.geocommons.com/overlays/18457>; smoothing with MapShaper.
 Emigration&Immigration: HDR "Human movement: snapshots and trends", tableau excel, 2009
 Drought: "Le Monde diplomatique, Atlas environnement 2007 du Monde diplomatique", Paris Map.
 Sea level rise scenario: <https://www.cresis.ku.edu/data/sea-level-rise-maps>.
 Potential migration: "Future floods of refugees, a comment on climate change, conflicts and forced migrations", report by Norwegian Refugee Council, 2008
 Produced by Groupe URD, 2010
<http://www.urd.org/>

World_Migration&Clim_carte-v1_A4CL

I.13 Future unintentional risks and conflict factors

Experts predict that climate change and demographic growth will increase pressure on limited resources (energy, land, food, water, etc.) and will create or increase tension both within and between States. Conflicts over water could take place in Central Asia⁶² and significant tension could break out over the “upstream-downstream” management of the main waterways and cross-border aquifers. These situations can potentially become major risks for regional and global security, even though there have recently been a number of successful initiatives where the risk of tension and conflict over water was transformed into an opportunity for cooperation between neighbouring countries to manage these resources more effectively: the Mekong River Commission, the Organization for the Development of the Senegal River, etc.

The link between unintentional risks, social tension and conflict is already fixed in the minds of many leaders. The environmental degradation caused by human activities and climate change are making floods (Pakistan in 2010) and droughts more serious, which will lead to large scale migration and will create more poverty. The social phenomena that this will cause will be among the greatest challenges facing the global community. Faced with the crisis in food prices in 2008, due for the most part to speculation, the Managing Director of the IMF stated that if food prices continued to rise, hundreds of thousands of people would starve. He predicted that the consequences would not just be humanitarian and economic, but could also lead to war.⁶³ In the end, this tragic scenario did not take place because the hyperinflation of food prices was put in check. It is clear that with food stocks which are regularly very low, food security is a source of concern, both globally and for numerous countries. The combination of this situation and an unintentional risk could lead to major social unrest and conflict. Faced with the certainty of a poor grain harvest in 2010, Russia recently froze all exports. A decision of this kind, where a drop in the balance of payments is deemed preferable to the risk of large-scale social unrest, is based on the hypothesis that there will not be an international shortage because other producers will be able to compensate for what is not exported by Russia (see FAO study). But this risk remains one of the possible scenarios for the future (cf. Map 18).

The probability that future unintentional risk will contribute to increased migration which will then cause conflict⁶⁴ is far from negligible. This type of migration is therefore an important issue in relation to geopolitical analysis and international security as well as being central to major development issues.

In 2004, the Report of the UN Secretary-General highlighted the importance of the relationship between the environment, disaster management, security and social and economic development to maintain world peace in the 21st century. As a consequence, no serious discussion of existing or emerging threats to security can take place without taking into account the destabilizing role of unintentional risks. This evolution in the analysis of security demands that a radical change takes place in the way the international community engages in conflict management.

Since the end of the Cold War, fundamental changes have influenced the way the international community has approached peace and security. There has been a considerable diversification in the potential causes of insecurity. Though political and military questions remain critical, economic and social risks like poverty, infectious diseases, environmental degradation, natural and technological

⁶² Lamballe A., 2010

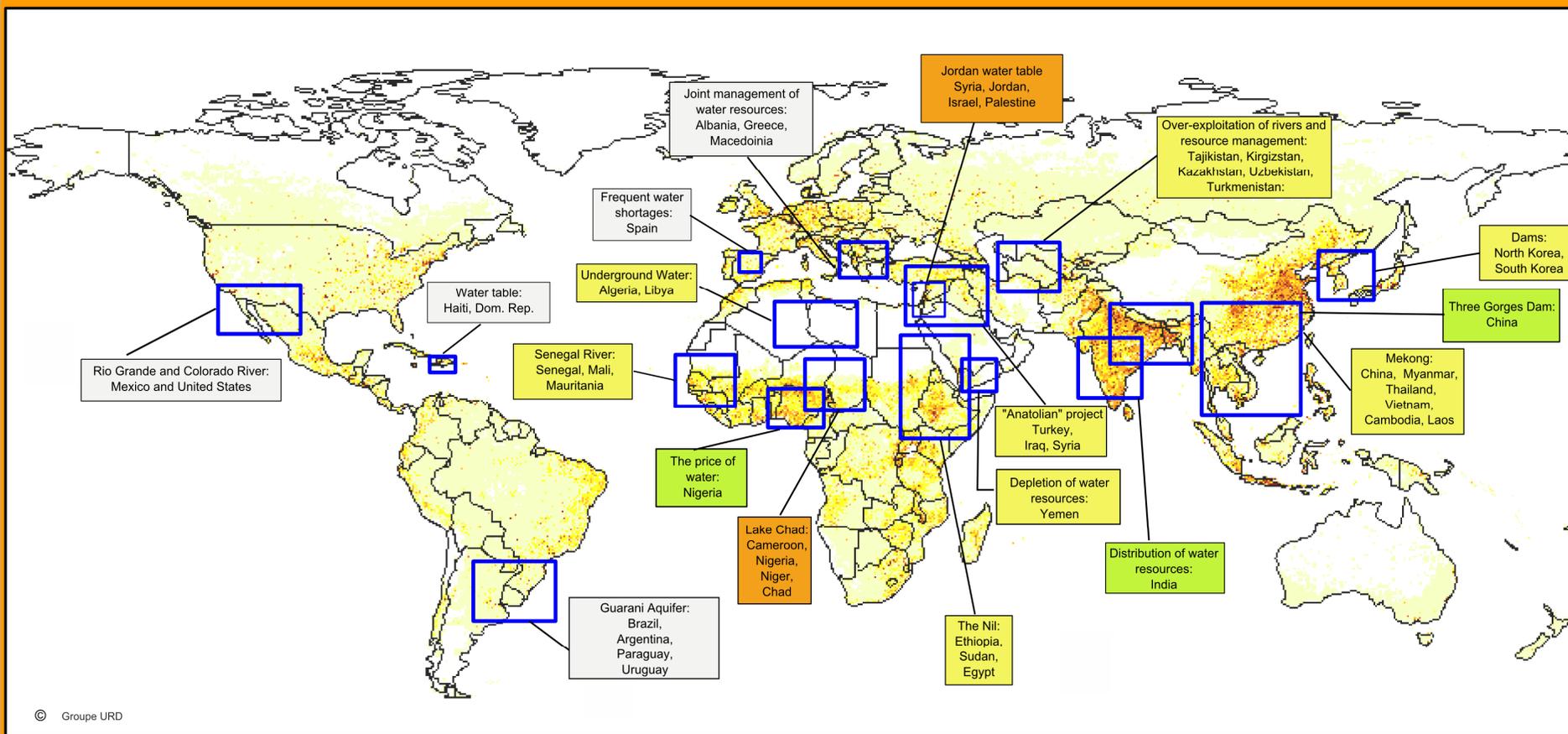
⁶³ Conférence de Presse du 12 avril 2008

⁶⁴ Piguet, 2008

disasters and pandemics are now considered to be important factors which contribute to global instability.

MAP 18

CONFLICT AND TENSIONS OVER WATER AND VULNERABILITY TO DROUGHT



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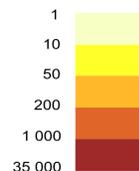
Existing and potential tension and conflict over water

- Country Existing conflicts
- Country Major tension
High risk of conflict
- Country National tension
- Country Existing tension
Low risk of conflict

Areas where there is tension and conflict over water



Vulnerability to drought in 2007 (no. of inhabitants/year)



Map base: <http://finder.geocommons.com/overlays/18457/>; Smoothing with MapShaper.

Drought: UNEP/DEWA/GRID-Europe; Physical exposition to droughts events 1980-2001; dataset ref. 2009.

Conflict and tension over water:
 *Pacific Institute "Water Conflicts Chronology List" (from 2008 to 2009)
 **"Des conflits liés à l'eau" map from "Dessous des cartes"Arte.
 *World Water Program.

Produced by Groupe URD, 2010
<http://www.urd.org/>

World_AridityWaterConflict_carte1-1/4

Conclusion

Each year, around 250 million people on average are affected by natural and technological disasters and epidemics. In an average year between 1998 and 2009, 90 per cent of these people suffered the consequences of climate-related disasters such as droughts and floods, whereas the future of the remaining 10% was compromised by turbulence of the earth's crust, technological disasters and economic crises.

The grimmest predictions envisage that by 2015 the number of victims of unintentional risks could increase by more than 50 per cent to more than 370 million people affected per year. Though the factors of uncertainty increase in number and in scale when we attempt to make predictions further into the future, unintentional risks will continue to have major repercussions for the earth and its inhabitants.

Demographic growth, climate change, scenarios based on trends in urbanisation, environmental degradation, the absence or non-application of minimal industrial security norms, economic disorder and the mismanagement of environmental issues will lead to an increase in the number and the impact of these disasters. In addition, an increasing number of people will be vulnerable to disasters due to poverty and risks which are inherent to the places they have settled. Furthermore, the influence of future unintentional risks could increase the threat of new conflicts and lead to even greater mass displacement.

Each of these perspectives is in itself a source of concern for human security. What is more, there is a multitude of possible combinations and synergies between different risks. It is very probable, and therefore all the more worrying, that communities will increasingly find themselves confronted with combinations of risk factors.

Action needs to be taken on three levels:

- **anticipation**, which needs to be based on in-depth research into risk factors and the different way in which they can combine (including hotspot theory). The long-term objective is development policy which allows risk reduction, strengthened resilience and preparation for crisis management operations.
- **reducing the vulnerability of societies**, which involves both reinforcing the resilience of communities and making a major effort to reduce the vulnerability of critical infrastructure, needs to be one of the new key paradigms of international cooperation.
- **developing and promoting effective early warning systems** to limit the impact of localised extreme events by allowing people to adjust their behaviour and State and civil society authorities to take ad-hoc measures. To do this, the identification and mapping of risk factors is indispensable. Significant investment in understanding natural phenomena and all future unintentional risks is crucial, even though there will not necessarily be an immediate "return on the investment".

This three-part strategy should be developed for each identified risk.

Several points of a more operational and practical nature may become essential in relation to future unintentional risks in the health sector:

1. **Knowledge and understanding of unintentional risk factors need to be developed:**
 - **Major endemics and health risks need to be monitored and active research carried out ;**
 - **It is important to improve understanding of tectonic phenomena** on different levels (global plate tectonics, regional and local processes in specific areas – the Arakan archipelago, the main ocean ridges, identified zones where there is friction between plates): this research will then allow prevention strategies to be developed and anticipation capacity to be strengthened
2. **International cooperation needs to be reinforced**, both between States but also at the level of the relevant bodies such as the WHO's Global Outbreak Alert and Response Network (GOARN).
3. **Carry out detailed assessments which combine different levels (global, regional, local, social, economic, traditional, technological)**
 - The goal should be to move beyond confrontations between decision-makers about **issues of scale in town planning**, between the State and local authorities and between economic and social issues. In an urban environment, this involves carrying out more complete analyses of urban systems, and establishing a hierarchy of strong and weak points (structural vulnerability: networks, buildings, etc.).
 - The idea of **"risk basins"** should be developed with a multi-disciplinary community of regional actors and inter-State policy steering (e.g. the creation of the Euro-Mediterranean Risk Science Institute around the Mediterranean basin). A common database should be created.
4. **It is necessary to continue research into the recognition of early warning signals:** it is the key to warning mechanisms and taking crucial evacuation measures.
5. **Disaster prevention and preparedness cultures need to be reinforced**
 - **Better understanding is needed of the impact of disasters in order for risks to be taken into account more appropriately:** Risks should be analysed in relation to multiple, parallel, combined or inter-active hazards. The approach should not be limited to the risk management sector, but should be global, cross-cutting, cross-disciplinary and tuned into warnings from all sources.
 - **Regular involvement and participation in exercises which take place in different contexts** (e.g. the efforts made by the US army to organise exercises to control epidemics in Senegal and Mali⁶⁵) ;
 - The **capacity to take action should be maintained**, including the appropriate specialised equipment to carry out operations in these difficult situations which are often very dangerous for the teams deployed;
 - **Establish action plans** (in addition to contingency plans which are not sufficient on their own). Disaster management action plans are needed at the level of cities with both public and private involvement including preparing people, for example, via simulation exercises. Methodologies should be applied to help in the choice of priorities (reinforcement of buildings indispensable in managing crises, a counter example being a fire station in the Gard department which was completely inundated during the recent floods).
 - **Structural prevention strategies and plans are needed in advance to make emergency response plans meaningful:** Territorial development plans should be made more coherent with impact, vulnerability and technological risk

⁶⁵ Entretien avec la responsable de l'USAID à Dakar

prevention plans such as the *Plan Séisme France*. The objective should be to create partnerships between regions and States via conventions, which include earthquake resistant rules and monitoring of their application.

- **Build a communication strategy to raise awareness about risk:** Target audiences need to be clearly identified: elected representatives (decision-makers), local civil society actors (the life blood of communities) and academics (culture). The Plan Sismik in Guadeloupe is a good example. It is also important to clarify the message to be transmitted and the media to be used: TV, brochures, training in prevention for tradesmen in the building industry, etc.
- 6. **Evaluation and learning approaches need to be systematically developed:** regular feedback and evaluations as early as the emergency phase can contribute to learning.
- 7. It is essential to be **involved in global governance mechanisms** for the management of pandemics and health risks. Though **good governance** is undoubtedly the most important factor in the management of natural disasters at the national level, anticipation and preparation capacity is of primary importance in relation to the effectiveness and efficiency of international aid in relation to managing unintentional risks.

ANNEX

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- <http://www.humanitarianfutures.org/main/>

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- <http://www.iddri.org/>

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- <http://www.ipcc.ch/home>

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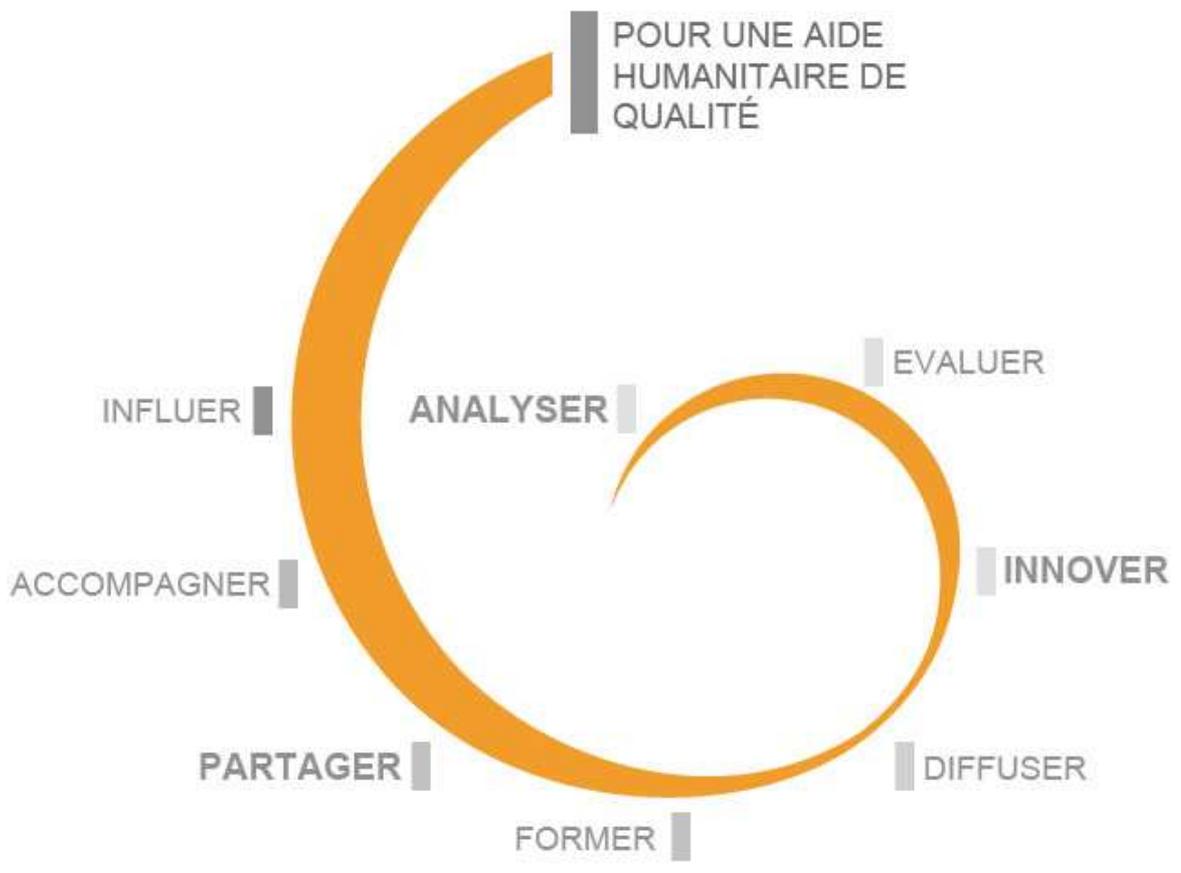
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