

# **CLIMATE CHANGE ADAPTATION IN EUROPE AND CENTRAL ASIA: DISASTER RISK MANAGEMENT**

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**June 22, 2008**

**Europe and Central Asia Region**





## ACRONYMS AND ABBREVIATIONS

CAT DDO	Catastrophic Deferred Drawdown Option
CDP	Carbon Disclosure Project
CMEPC	Civil-Military Emergency Preparedness Council
ECA	Europe and Central Asia
ECMWF	European Centre for Medium-range Weather Forecasting
EOC	Emergency Operations Center
ER	Emission Reductions
EU	European Union
GIS	Geographic Information Systems
ICEED	Informal Conference of South Eastern Europe Directors
IFRS	International Financial Reporting Standard
IPCC	Intergovernmental Panel for Climate Change
MCR	Minimum Capital Requirement
MIC	Monitoring and Information Center
NAO	North Atlantic Oscillation
NIBS	U.S. National Institute of Building Sciences
SCR	Solvency Capital Requirement
SEE	South Eastern Europe
SEEDRMAP	South Eastern Europe Disaster Risk Mitigation and Adaptation Program
UN/ISDR	United Nations International Strategy for Disaster Reduction
WB	World Bank
WMO	World Meteorological Organization

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## **ACKNOWLEDGEMENTS**

The main authors of this report are John Pollner, Lead Financial Officer in the Private and Financial Sectors Development Department (ECSPF) and Jolanta Kryspin-Watson, Operations Analyst in the Sustainable Development Department (ECSSD) of the World Bank Europe and Central Asia Region, and Sonja Nieuwejaar, consultant.

Preparation of this paper was possible due to the guidance and support of Marianne Fay, Co-director of the World Development Report 2010 "Climate Change and Development", who provided championship to this effort and invaluable insights which helped shape the report.

The team also benefited greatly from the support extended by the World Bank ECSSD management. Special thanks go to Wael Zakout, Sector Manager for his guidance and support.

## EXECUTIVE SUMMARY

The following paper serves as a sectoral background note for the regional report “*Managing Uncertainty: Adapting to Climate Change in Europe and Central Asia Countries*”. It focuses on what is known about the implications of climate change for extreme weather and the ability of Europe and Central Asia (ECA) to mitigate and manage the impact of extreme events. It also explains how climate change will increase weather-induced disasters in ECA, highlighting the sensitivity of ECA’s population to these hazards, and recommending various measures in the area of financial and fiscal policy, disaster risk mitigation, and emergency preparedness and management, to reduce current and future vulnerabilities.

The goals of this paper are to: (i) present forecasts on how climate change will affect weather-related hazards and secondary effects, and what impact the extreme hydrometeorological phenomena will have on the countries of Europe and Central Asia; and (ii) provide an overview of measures to mitigate and manage these risks.

Climate change resulting from growing greenhouse gas emissions is expected to lead to rising temperatures and changing rainfall patterns. The effects may vary by sub-regions and localities but in general the following may be expected to take place:

- An increase in temperature and decrease in mean precipitation will lead to an increase in the frequency and severity of drought and heat waves.
- Increasingly warm ocean surface temperature which generates more and stronger hurricanes as well as commensurate flooding after such event.
- Severe drought will lead to an increase in forest fires.
- Greater intensity of wind and rain which will cause severe floods and landslides.

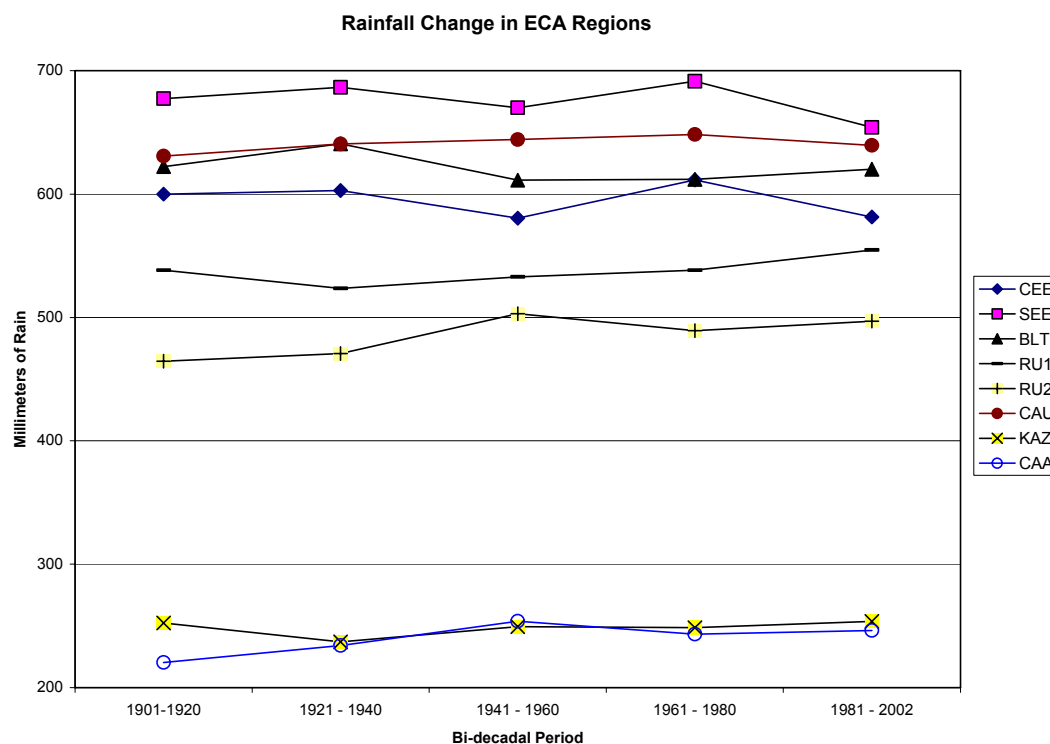
The table and chart below show the average annual precipitation within different ECA sub-regions, shown according to bi-decadal periods since the start of the century. While not all regions demonstrate distinct trends, there is a noticeable rise in precipitation in Russia (Urals and Siberia) and Central Asia, and a decrease in Central/Eastern Europe and South Eastern Europe. The latter sub-region’s effects were recently noted during last year’s drought induced wildfires and severe heat extremes.

**Table 1. Mean Annual Precipitation**

		Mean Annual Precipitation (mm)				
Sub-Region		1901-1920	1921 - 1940	1941 - 1960	1961 - 1980	1981 - 2002
Central Europe	CEE	600	603	580	612	581
South East Europe	SEE	677	687	670	691	654
Baltics	BLT	622	641	611	612	620
Russia - Central and Volga	RU1	538	524	533	538	555
Russia - Urals and W. Siberia	RU2	464	471	503	489	497
Caucasus	CAU	631	641	644	648	639
Kazakhstan	KAZ	252	237	249	249	254
Central Asia	CAA	220	234	254	243	246

Source: Wesphal M., ENV

**Figure 1. Rainfall Change in ECA Regions**



SIGMA, the catastrophe analysis arm of Swiss Re, one of the major global reinsurance companies (which insures the insurance industry), has also reported increasing incidences of weather induced disasters in the following countries:

<b><u>Country</u></b>	<b><u>Hazard</u></b>
Hungary	Wind storms, Floods
Poland	Cold wave, Floods
Russia	Cold wave
Romania	Cold wave, Floods
Bulgaria	Cold wave, Floods
Czech Republic	Cold wave, Floods
Turkey	Cold wave, Floods
Estonia	Cold wave
Latvia	Snow fall, extreme cold, power shortage
Lithuania	Snow fall, extreme cold, power shortage
Moldova	Snow fall, extreme cold, power shortage
Slovakia	Floods
Serbia	Floods
Montenegro	Floods
Croatia	Floods

With climate change contributing to an increase in disaster risk, disaster risk management becomes a vital and urgent component of any climate change adaptation program. As part of climate change adaptation policies and investments, ECA countries need to focus on reducing their vulnerability and plan for measures to mitigate natural hazard risks.

Taking into account the projected impact of climate change, the reduction of current and future vulnerabilities to climate change risk should build upon and expand existing disaster risk management efforts. This paper highlights the importance of investing in “win-win” options. Regardless of the accuracy in climate change predictions, reduction of current weather-related disaster risk will reduce losses and initiate necessary actions for climate change adaptation. Planning for extreme weather events also supports preparedness for a variety of other emergencies and therefore will also have certain benefits.

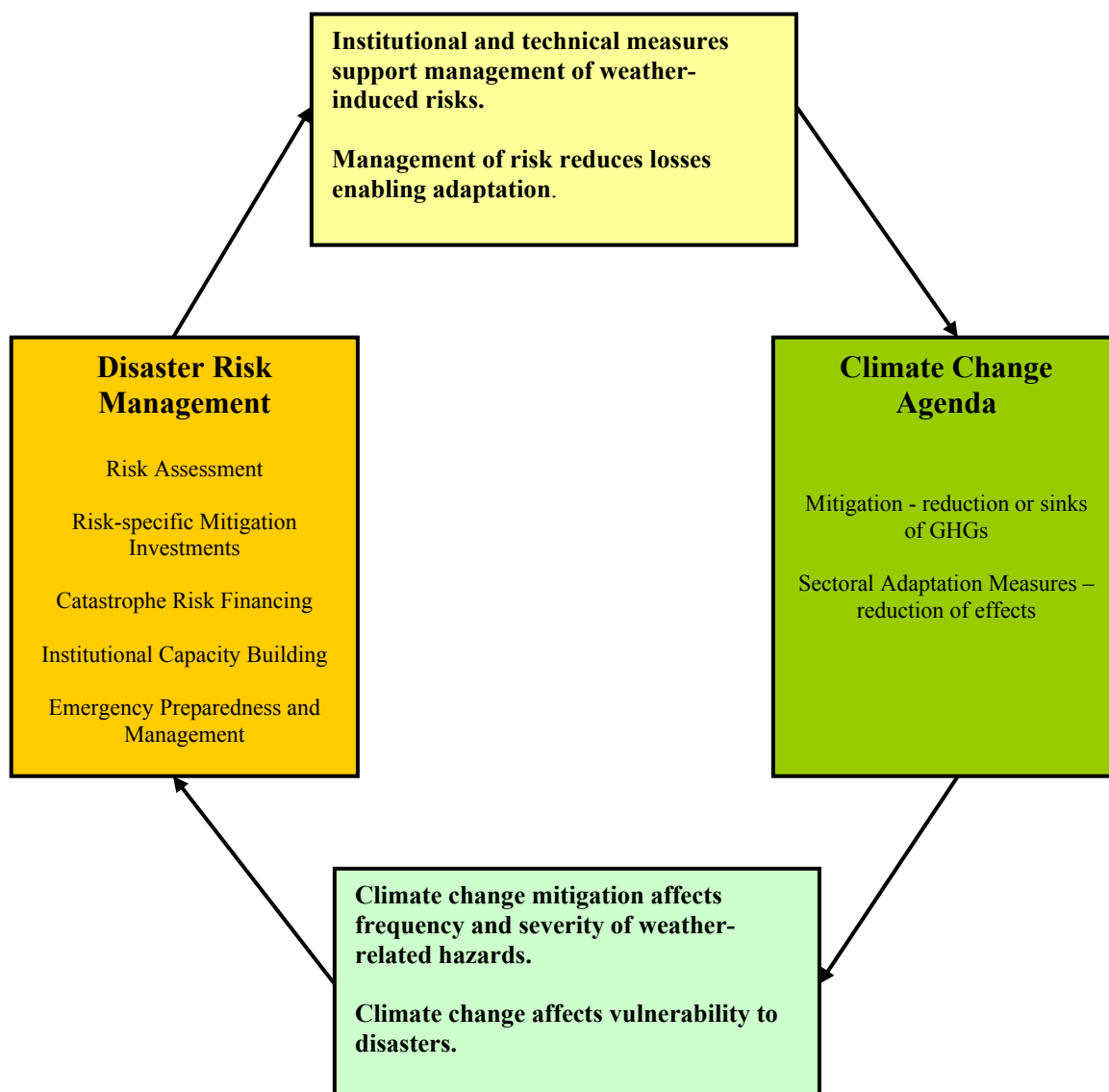
Climate change places emphasis on the need to identify and support generic adaptive capacity along with hazard-specific mitigation capacity, as described in the paper. However, it is important to recognize that response and disaster mitigation based on past vulnerabilities may not suffice in light of scientific forecasts because in many countries of Europe and Central Asia these existing mechanisms are already insufficient for the current level of vulnerabilities.

With growing scientific evidence of climate change, policymakers need to realize the importance of taking actions that can address disaster risk while decreasing the effects of climate change through vulnerability reduction. For disaster risk management to be effective, institutional structures and management tools to respond to weather-induced catastrophic events should be one of the key elements of local and national adaptation



strategies. Better management of disaster risk will also maximize use of the available resources for adapting to climate change. The linkages between disaster risk management and climate change are summarized in the below diagram.

**Figure 2. Climate Change and Disaster Risk Management**



Across the ECA region, developing and strengthening an *institutional and legislative disaster risk management framework* would assist in budget appropriations, planning and finally the implementation of disaster risk management plans. Ensuring that legal statutes are clear and that hazard risk management is properly funded is the first step. A strong system should have a robust preparedness program with plans, training and exercises for all levels of its emergency management system. *Clarifying the roles and responsibilities* of local and national governmental bodies in risk reduction as well as

emergency preparedness and response, would improve disaster risk management capacity.

There are many ‘hard’ and ‘soft’ measures countries can take to reduce the risk of natural hazards and adapt to climatic changes. However, before undertaking any concrete steps, it is recommended to first complete ***hazard risk assessments*** and corresponding hazard maps. Risk assessments are also crucial for policymakers to embark on the process of evaluation of the cost/benefit of risk mitigation investments leading to prioritization of investments.

Historically, Europe and Central Asia have been significantly affected by hydrometeorological hazards. The effect these disasters have on the population and infrastructure are exacerbated by several factors such as settlements in disaster-prone areas, debilitating land and water use, lack of regulations and standards which take into account hazard risks, and failure to comply with building codes and land use plans. ***Hazard-specific investments*** can reduce the risk of hydrometeorological hazards and increase adaptive capacity. Early warning systems for various hazards can be developed to monitor heat waves, forest fires and hydrometeorological events such as floods. Flood risk reduction measures can range from soft measures such as developing flood management plans to hard measures such as investments in flood protection schemes. Drought can be reduced through the introduction of drought resistant crops and the risk of storms can be reduced by retrofitting buildings to withstand heavy winds. A combination of regulatory, structural, and protective measures can be taken by both the government and the public to reduce risk and decrease a country’s vulnerability to natural hazards and adapt to climatic changes.

Another important adaptation measure is to ***strengthen the technical capacity*** of emergency responders. This includes purchasing personal protective equipment, tools, and vehicles. To ensure that all levels of government and emergency units can communicate, investing in an interoperable emergency communications and information system is of critical importance. Moreover, ***ensuring that the public is aware*** of the risk of natural hazards and is educated in preparedness and response actions are effective, relatively, low-cost measures which can be pursued by the governments of the region.

***Development institutions and credit markets*** are ready to finance losses, provided that adequate adaptation measures have been taken in advance so as to minimize what needs to be “insured”. Therefore, governments, individually and collectively, need to quantify their climate induced disaster exposures and calculate the budget allocations required to cover reasonably projected losses. If these are not sustainable, they should consider the range of ***financial instruments*** to optimize (i.e. lower) the cost of premium-equivalent outlays while maximizing any loss payout needed if a climate change induced disaster affects their territory.

The use and price of ***pooled risk approaches, capital market mechanisms, insurance and credit instruments***, can be calculated in combination, to reduce the cost of such financial protection for emergency reconstruction, while avoiding the economic and budgetary disruptions this would otherwise entail.

## INTRODUCTION

Based on the available data and studies, the paper shows that extreme weather events are expected to be recurrent and can lead to disasters that may overwhelm a country's emergency management capability. It highlights ECA's vulnerability to disasters and points to measures to mitigate the risk and manage these events. It also presents technical options and policy recommendations to guide activities that can be undertaken by governments in planning and preparing for climatic changes.

It should be noted that the paper concentrates on hazards that have very clear and obvious links to climatic change (i.e., those of hydrometeorological origins, such as floods, wild fires, droughts and strong winds) but also covers landslides which can be triggered by floods. Many discussed measures and recommended actions are of a multi-hazard nature and are cross-cutting, while the technical disaster mitigation tools and techniques are more hazard-specific. For the latter, the paper covers weather-induced hazards and, with the exception of land and mud slides that are triggered by floods and heavy rains, it leaves out the issues related to seismic risk. While there are ongoing studies in other regions which investigate a possible link between climate change and seismic and volcano eruption risks, this link has not yet been sufficiently explored for the ECA region and, therefore, is not covered by the paper.

The reader should be alerted to the fact that *definitions of mitigation measures are different in the context of disaster risk reduction and climate change*. The Intergovernmental Panel for Climate Change (IPCC) defines mitigation as “a human measure to reduce the sources or enhance the sinks of greenhouse gases”. Climate change mitigation measures include energy conservation, enforcement of land use plans, strengthening institutional and legislative mechanisms, energy efficiency measures, waste management, substituting fossil fuels with renewable energy sources, and measures in the transport and agricultural sectors, and sequestering carbon biologically through reforestation or geo-physically.<sup>1</sup>

For disaster risk management experts, the term mitigation, as defined by the UN International Strategy for Disaster Reduction (ISDR), means “structural and non-structural measures undertaken to limit the adverse impact of natural disasters, environmental degradation and technological hazards”. These may include seismic retrofitting, construction of flood protection schemes, and reforestation aimed at landslide risk reduction, to name a few examples. In the climate change context, these would be called “adaptation” activities. These activities represent one aspect of adaptation as adaptation to climate change encompasses broader and more comprehensive measures. For climate change experts, adaptation means adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm.<sup>2</sup>

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<sup>1</sup> *On Better Terms – A Glance at Key Climate Change and Disaster Risk Reduction Concepts*; United Nations 2006

<sup>2</sup> *Ibidem*.

The paper applies disaster risk reduction terminology while presenting them in the broader framework of the adaptation to climate change.

Because ECA spans differing topography and climate, for the purpose of the report, the region has been divided into 6 sub-regions:

1. Baltic States: *Estonia, Latvia and Lithuania, Belarus, Poland*
2. Caucasus States: *Armenia, Azerbaijan, and Georgia*
3. Central Asian States: *Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan*
4. Central European States: *Czech Republic, Hungary, Moldova, Romania, Slovakia, and Ukraine*
5. Russia
6. South Eastern European States: *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Montenegro, FY Macedonia, Serbia, Slovenia and Turkey*

## 1. BACKGROUND AND RISK CONTEXT OF CLIMATE CHANGE IN ECA

The countries of Europe and Central Asia are prone to a variety of natural hazards, including floods, droughts, wild fires, earthquakes, strong winds and landslides. As seen in Table 2 (ECA Disaster Matrix), multiple disasters occur in each ECA country. For the purposes of this paper, the table does not present the seismic risk to which many countries of the region are exposed. Because this background paper focuses on the impact climate change has on natural hazards, the focus is on hazards that are exacerbated by hydrometeorological phenomena.

### **Review of Hydrometeorological Hazards by ECA Sub-Region**

#### **Baltic.** *Estonia, Latvia, Lithuania, Belarus, Poland*

The Baltic States are extremely vulnerable to high wind, storm surge along the coast, and flooding along the Oder and Vistula Rivers. In 1993, floods in Belarus caused US\$100 million in damage and affected 40,000 people. In 1997, flooding in Poland killed 55 people, impacted 224,500 others, and caused US\$3.5 million in damage.

Storms have also caused major damages in the Baltic. In 2005, windstorms hit Estonia causing US\$1.3 million in damage. Both in 1999 and 2005, Latvia experienced major windstorms causing over US\$325 million in damage. And in 1993, windstorms struck Lithuania, affecting over 780,000 people.<sup>3</sup>

#### **Caucasus.** *Armenia, Azerbaijan, and Georgia*

The Caucasus States are at risk of floods, drought and landslides. Although Armenia's major risk is earthquake (100% of the country is prone to earthquakes), 98% of the country is at risk of drought and 31% of the country is at risk of flooding.<sup>4</sup> In June of 1997, flooding killed 4 people and affected 7,000.<sup>5</sup> Three years later, drought affected 297,000 people and caused US\$100 million US in damage.

Azerbaijan is also affected by landslides, flood and drought. Over 80% of the country is at risk for flooding and drought.<sup>6</sup> In June of 1997, eleven people died and 700,000 were affected by flooding. In 2000, over ten people lost their lives from landslides, and that same year, drought caused US\$100 million in damage.<sup>7</sup>

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<sup>3</sup> Emergency Events Data Base (EM-DAT) [www.emdat.be](http://www.emdat.be)

<sup>4</sup> Natural Hazards Assessment Network (NATHAN) <http://mrnathan.munichre.com/>

<sup>5</sup> Emergency Events Data Base (EM-DAT) [www.emdat.be](http://www.emdat.be)

<sup>6</sup> Natural Hazards Assessment Network (NATHAN) <http://mrnathan.munichre.com/>

<sup>7</sup> Emergency Events Data Base (EM-DAT) [www.emdat.be](http://www.emdat.be)

**Table 2. Disaster Matrix by ECA Country**

	<b>Flood</b>	<b>Land Slides</b>	<b>Drought</b>	<b>Extreme temperature</b>	<b>Wind storm</b>	<b>Wild fire</b>	<b>Wave /Surge</b>
Albania	X	X	X	X	X	X	
Armenia	X	X	X		X		
Azerbaijan	X	X	X				
Belarus	X			X	X		
Bosnia and Herzegovina	X	X	X		X	X	
Bulgaria	X	X	X	X	X	X	
Croatia	X		X	X	X	X	
Czech Republic	X	X		X	X		
Estonia	X	X		X	X		
FY Republic of Macedonia	X	X	X	X	X	X	
Georgia	X	X	X		X		
Hungary	X		X	X	X		
Kazakhstan	X	X		X	X	X	
Kyrgyz Republic	X	X		X	X		
Latvia	X			X	X		
Lithuania	X		X	X	X		
Moldova	X	X	X	X	X		
Poland	X			X	X	X	
Romania	X	X	X	X	X		
Russian Federation	X	X	X	X	X	X	X
Serbia	X			X	X	X	
Slovak Republic	X			X	X	X	
Montenegro	X			X	X	X	
Slovenia	X	X		X			
Tajikistan	X	X	X		X		
Turkey	X	X		X	X	X	
Turkmenistan	X						
Ukraine	X	X		X	X		
Uzbekistan	X	X	X				

Sources: EM-DAT 2008 and Pusch “Preventable Losses: Saving Lives and Property through Hazard Risk Management”; 2004.

*\*Note: Although not included in the table above, ECA countries are also affected by non-hydrometeorological hazards such as earthquakes, technological disasters and epidemics.*

Georgia, like its neighbors, has also been struck by destructive floods and drought. In 2000, it too suffered from drought, which impacted 696,000 people and caused US\$200 million in damage.<sup>8</sup> And over the past thirty years, Georgia has been hit by major floods. In 1987, floodwaters completely destroyed 2,600 buildings, resulting in \$US 300 million in damages.

Not noted in the table above but important nonetheless are mudflows. Mudflows occur in the mountainous regions of the Caucasus, damaging settlements and causing major economic loss. In Azerbaijan, on average, annual economic losses due to mudflows are US\$ 15 million. In Armenia, mudflows have damaged around 200 settlements.<sup>9</sup> And in Georgia, 58% of the country is prone to landslides, with 3.5 million hectares of land at risk of mudflow and landslides (see Table 3).<sup>10</sup>

**Central Europe.** *Czech Republic, Hungary, Moldova, Romania, Slovakia, and Ukraine*  
Central Europe is exposed to landslides, high wind and heat waves but one of its greatest hazards is flood. In fact, Romania is known as one of the most flood-prone countries in ECA. Over the past decade, floods have killed over 1,400 people - 1,000 people in 1926; 215 people in 1970; 60 people in 1975; 108 people in 1991; and 33 people in 1995. Floods alone have caused over US\$2 billion in damage for Romania.<sup>11</sup>

The Czech Republic and Hungary have also experienced major flooding. In 2002, the Czech Republic incurred 3€ billion in damages due to floods. In Hungary, from 1900 to today, the top 8 disasters have all been due to flooding, impacting over 179,000 people.<sup>12</sup>

Although flooding affects Moldova and Ukraine, wind and heat have caused even more damage. In November of 2000, a windstorm affected the livelihood of 2,600,000 people. And for the Ukraine, the deadliest hazard was the recent heat wave in 2006, which claimed the lives of 801 people.<sup>13</sup> Drought became a recurrent problem for the Moldovan agriculture sector causing estimated annualized losses between US\$ 1.6 million and US\$20 million<sup>14</sup>.

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<sup>8</sup> *Ibidem*.

<sup>9</sup> United Nations Environment Programme. Caucasus Environment Outlook (CEO). Tbilisi, Georgia, 2002.

<sup>10</sup> *Ibidem*.

<sup>11</sup> Emergency Events Data Base (EM-DAT) [www.emdat.be](http://www.emdat.be)

<sup>12</sup> *Ibidem*.

<sup>13</sup> *Ibidem*.

<sup>14</sup> *Rural Productivity in Moldova – Managing Natural Vulnerability*; World Bank, May 2007

**Table 3. Exposure to Landslides in ECA**

Country	Extent of hazard area (classes 4–6)		Population located in hazard area (classes 4–6)	
	Square kilometers	Percentage of country area	Number of people	Percentage of total population
Turkey	194,000	25	8,100,000	11
Kyrgyz Republic	93,000	47	1,016,000	20
Russian Federation	168,000	1	1,013,000	<1
Georgia	40,000	58	987,000	19
Romania	16,000	7	952,000	4
Tajikistan	52,000	36	728,000	11
Bosnia and Herzegovina	12,000	25	520,000	12
Azerbaijan	15,000	9	500,000	6
Uzbekistan	11,000	3	415,000	2
Slovenia	500	29	230,000	12
Moldavia	28	0.1	1,640	<1
Czech Republic	104	0.1	9 200	<1

Source: Norwegian Technological Institute

**Russia.** In Russia, floods and storms result in 1,000 deaths per year, with the hardest hit regions being where the population is the poorest - in Eastern Siberia, the Far East, and the Southern regions.<sup>15</sup> Russia also experiences landslides with about 700 towns at risk. On average, both floods and landslides cause annual economic losses of \$300 million.<sup>16</sup> In the past twenty years, extreme temperatures have also killed over 1,500 people.<sup>17</sup> And drought impacted 1 million people in 2003.

**South Eastern Europe.** *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Montenegro, FY Macedonia, Serbia, Slovenia and Turkey*

The countries of South Eastern Europe are exposed to a variety of natural hazards, including floods, droughts, forest fires, earthquakes and landslides. Albania, Croatia, Macedonia, and Serbia and Montenegro are the most susceptible to floods. On average,

<sup>15</sup> A. Kokorin, "Report No 2. Expected Impact of the Changing Climate on Russia and Central Asia Countries and Report No 3. Ongoing or Planned Adaptation Efforts and Strategies in Russia and Central Asia Countries," WWF Russia, 2008.

<sup>16</sup> C. Pusch, "Preventable Losses: Saving Lives and Property through Hazard Risk Management - A Comprehensive Risk Management Framework for Europe and Central Asia," [Disaster risk management working paper series](#), no. 9, World Bank, 2004.

<sup>17</sup> Emergency Events Data Base (EM-DAT) [www.emdat.be](http://www.emdat.be)



Serbia and Montenegro experiences one flood event every two years.<sup>18</sup> In Croatia, floods jeopardize more than 15% of its territory.<sup>19</sup>

While the key natural hazard to Turkey is earthquake, the coastal plains are also vulnerable to flooding. On average, one flood strikes Turkey every year. In May of 1998, Turkey experienced one of the worst floods in the past 100 years. Floods damaged northwestern Anatolia, affecting 4 cities, 10 towns, and 110 villages. 30 people died and over one million people were impacted. 2,200 houses were destroyed or badly damaged and estimated losses went as high as US\$2 billion.<sup>20</sup>

**Central Asia.** *Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan*

The countries of Central Asia are prone to earthquakes, floods, drought, avalanches and landslides. Over the past decade, 2,500 people have died and 5.5 million (10% of the total population) were affected by natural disasters in Central Asia.<sup>21</sup>

One of the most sensitive countries to natural hazards is Tajikistan. Extreme poverty (64% of the population lives below the poverty line) and lack of emergency management capacity have increased Tajikistan's sensitivity to natural hazards.<sup>22</sup> In 2000, 3 million people were impacted by drought. In 2006, 13,000 people were affected by flooding and mudslides. And 36% of Tajikistan is at risk of landslides (see Table 3).

Turkmenistan and Kazakhstan are also regularly affected by landslides and floods. In 2004, landslides killed 48 people in Kazakhstan. And flooding is also a major risk for Kyrgyzstan. In 2005, floods impacted 2,700 people, washing away wheat crops and devastating the local economy as well as causing food shortages. Kyrgyzstan is also at significant risk of landslides, with 20% of the country's population living in areas prone to landslides (see Table 3).

Kyrgyzstan shares the Ferghana Valley with Tajikistan and Uzbekistan, which is also at risk for flooding. In the Ferghana Valley, the majority of the population is poor and live close to the riverbanks for their agricultural and domestic water needs.

Uzbekistan is at great risk of drought, which regularly affects the north and north-west of the country, particularly around the Aral Sea where irrigation has aggravated salinization and desertification. In 2000, 600,000 people were affected by drought, causing over US\$50 million in damage.

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<sup>18</sup> UN/ISDR - WB. South Eastern Europe Disaster Risk Mitigation and Adaptation Initiative: Risk Assessment in South Eastern Europe - A Desk Study Review. Geneva, Switzerland: United Nations, 2008.

<sup>19</sup> C. Pusch, "Preventable Losses: Saving Lives and Property through Hazard Risk Management - A Comprehensive Risk Management Framework for Europe and Central Asia," [Disaster risk management working paper series](#), no. 9, World Bank, 2004.

<sup>20</sup> Gurer and H. Ozguler, "Integrated Flood Management – Case Study 1 - Turkey: Recent Flood Disasters in Northwestern Black Sea Region," WMO/GWP Associated Programme on Flood Management, 2004.

<sup>21</sup> European Commission - Humanitarian Aid Office (ECHO), "Commission funds disaster preparedness actions in Central Asia worth EUR 2.5 million," 28 May 2004.

<sup>22</sup> World Bank, "Report No: 30853-TJ- Republic of Tajikistan Poverty Assessment Update," 2005.

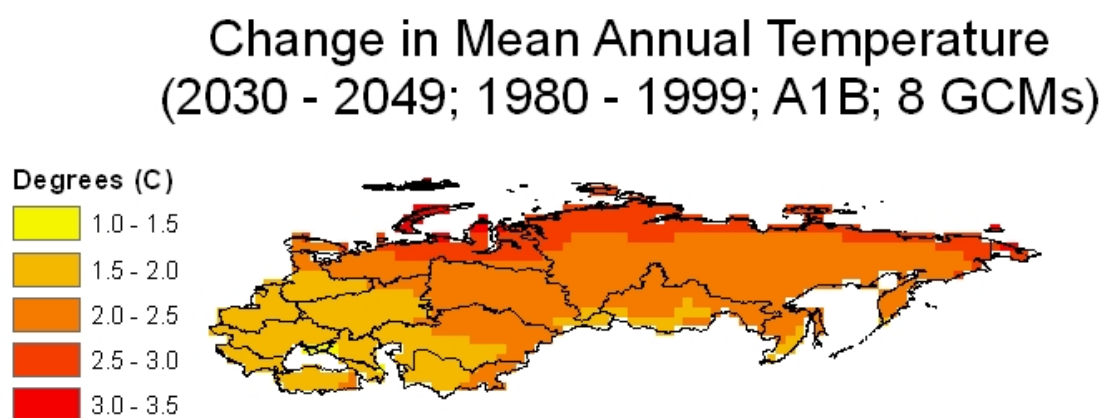
## **Impact of Climate Change on Europe and Central Asia**

Recent studies show that not only are global temperatures on the rise, but global precipitation patterns are also changing. Although more scientific research needs to be done, the general conclusion is that the increase in temperature is accelerating the hydrological cycle and altering marine systems, which in turn is changing precipitation patterns.<sup>23</sup> The key implication of changing precipitation patterns is an exacerbation of hydrometeorological hazards such as floods, landslides, drought, heat waves and soil erosion.<sup>24</sup>

**Overview of Climate Change on ECA.** Historically, Europe and Central Asia have been impacted by hydrometeorological hazards, to include wave surge events. With climate change, these hazards are expected to intensify and increase in number.

Rise in Temperature. By 2050, all of Europe and Central Asia will see an increase in both summer and winter temperatures and experience a decline in frost days and an increase in heat waves (see Table 4). Russia's Western Arctic will undergo the greatest temperature change with a mean annual temperature increase of 2.6° C (see Figure 3) and a significant increase in the winter temperature of 3.4° C.

*Figure 3. Change in Mean Annual Temperature*



Source: World Bank

<sup>23</sup> For more information on the relationship between climate change and increasing flood risks, please refer to the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change

<sup>24</sup> M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change," Cambridge, UK: Cambridge University Press, IPCC, 2007.

Table 4. Climate Change Data by ECA Sub-Region

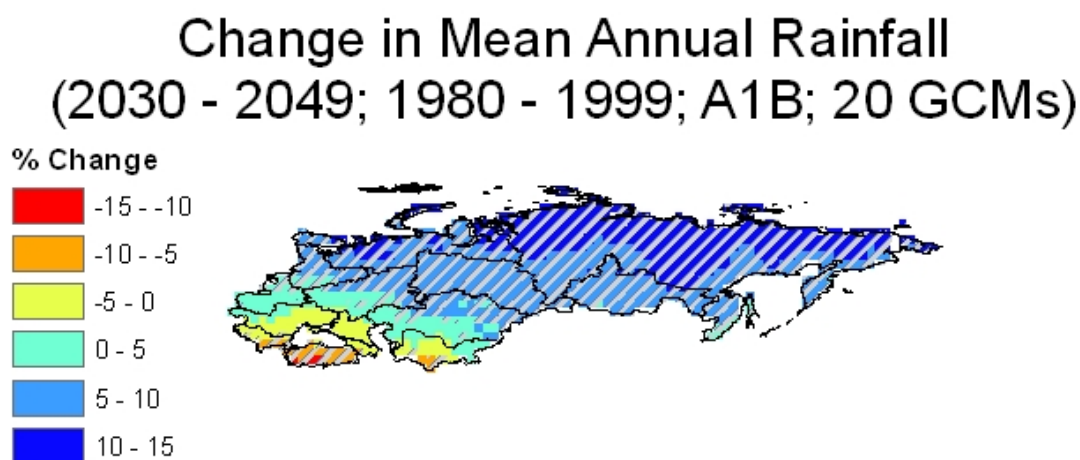
REGION	Mean Annual Temperature Change	Mean Seasonal Temperature Change	Change in Mean Annual Precipitation	Change in Seasonal Precipitation	Change in Annual Runoff (a measure of water availability)	Precipitation Intensity	Precipitation per Extreme Events	Consecutive Dry Days	Frost Days	Heat wave Duration
Baltics	1.6° C	1.7° C (Summer) 2.0° C (Winter)	~	~	-6% (South) 11% (North)	5%	8%	~	-30	25
Central Asia	1.9° C	2.4° C (Summer) 1.6° C (Winter)	~	~	-12%	4%	2%	~	-21	22
Kazakhstan	2.0° C	2.4° C (Summer) 1.8° C (Winter)	4%	~ (Summer) 9% (Winter)	3%	5%	7%	~	-22	29
Caucasus	1.7° C	2.1° C (Summer) 1.6° C (Winter)	~	~	-16%	4%	4%	4	-22	23
Central Europe	1.7° C	1.8° C (Summer) 1.9° C (Winter)	~	~	-13%	4%	5%	2	-26	28
Southeastern Europe	1.8° C	2.1° C (Summer) 1.8° C (Winter)	-6%	~ (Summer) -6% (Winter)	-25%	2%	~	5	-17	25
Russia: Baltic	1.9° C	1.9° C (Summer) 2.5° C (Winter)	6%	~ (Summer) 10% (Winter)	13%	6%	6%	~	-23	31
Russia: Volga	1.9° C	2.0° C (Summer) 2.1° C (Winter)	5%	~ (Summer) 9% (Winter)	7%	6%	7%	~	-23	34
Russia: North Caucasus	1.6° C	2.0° C (Summer) 1.6° C (Winter)	~	~	-12%	4%	4%	2	-20	37
Russia: Siberia and Far East	2.4° C	2.3° C (Summer) 2.6° C (Winter)	11%	~ (Summer) 17% (Winter)	22%	5%	9%	-3	-14	29
Russia: South Siberia	2.1° C	2.2° C (Summer) 1.9° C (Winter)	8%	8% (Summer) 18% (Winter)	14%	4%	6%	-4	-14	23
Russia: Urals and Western Siberia	2.2° C	2.3° C (Summer) 2.2° C (Winter)	7%	6% (Summer) 15% (Winter)	10%	6%	6%	~	-18	31
Russia: Western Arctic	2.6° C	2.2° C (Summer) 3.4° C (Winter)	10%	~ (Summer) 16% (Winter)	17%	6%	7%	-1	-20	35

‘~’ climate models were not in agreement.

Source: World Bank

Change in Precipitation Patterns. In the northern ECA region, mean annual rainfall is predicted to increase by 10-15%, and in the southern ECA countries rainfall will significantly decrease, by as much as -15% (see Figure 4).

**Figure 4. Change in Mean Annual Rainfall**



Source: World Bank

All ECA regions will experience an increase in precipitation intensity; however, they will differ drastically in annual runoff (a measure of water availability). Russian Siberia and Far East will experience a 22% increase in annual runoff while South Eastern Europe will have an average decrease of 25% (see Table 4).

The variances across Europe and Central Asia of the predicted impact of climate change on hazard risk for each sub-region is described below.

#### **Baltic.** *Estonia, Latvia, Lithuania, Belarus, Poland*

Prediction of Climate Change. For the Baltic States, mean annual temperature is expected to increase by 1.6° C, resulting in a decrease in frost days and an increase in heat waves by 2050. Although the climate models do not agree on changes in mean annual precipitation, it is expected that the southern Baltic region will experience a decrease in annual runoff and the northern Baltic region will experience an increase in runoff.<sup>25</sup> Moreover, the Baltic will see an increase in precipitation intensity and precipitation per extreme events.

Impact on Natural Hazards. Over the past 50 years, the Baltic Sea has seen an increase in wind speeds. Although this rise has been attributed to the North Atlantic Oscillation (NAO), it has also been noted that the NAO may be enhanced with global warming, increasing wind speeds.<sup>26</sup> If

<sup>25</sup> Annual Runoff is a measure of water availability

<sup>26</sup> S.C. Pryor and R.J. Barthelmie, "Long Term Trends in Near-Surface Flow over the Baltic," International Journal of Climatology, 23: 271–289, 2003.

wind speeds increase, not only will it increase the risk of windstorms, but it will also increase the size of waves and storm surge, causing greater flooding along the Baltic coast and worsening coastal erosion. Across the Baltic countries, it is also expected that climate change will result in an increase in river flooding and waterlogged soil.

**Caucasus.** *Armenia, Azerbaijan, and Georgia*

Prediction of Climate Change. For the Caucasus States mean annual temperature is expected to increase by 1.7° C and much like the Baltic, the Caucasus States and Turkey will see a decrease in frost days and an increase in heat waves by 2050. As for precipitation, climate models are in disagreement on mean annual precipitation, however, models concur that annual runoff will decrease. Meanwhile, precipitation intensity and precipitation per extreme event will increase.

Impact on Natural Hazards. The probable result of a decrease in annual runoff will be a decrease in reservoir water levels, which is a major factor in intensifying landslides.<sup>27</sup> Rising temperatures and a decrease in runoff will also increase drought and desertification for the Caucasus, especially in the Eastern part of the region. Desertification has intensified in recent years, even affecting areas that are typically not affected such as riparian forests.<sup>28</sup>

Another impact on the Caucasus due to climate change is that the level of the Black Sea will continue to rise. Since 1923-1925, the Black Sea has risen at a rate of 2.5mm per year. This rise will increase the vulnerability of the coastline; multiply the risk of flooding along rivers; and foster salinization. Damage from sea level rise can already be observed in Georgia's Poti and Rioni delta, which has over the past century receded by 0.52m relative to the sea.<sup>29</sup>

**Central Europe.** *Czech Republic, Hungary, Moldova, Romania, Slovakia, and Ukraine*

Prediction of Climate Change. The countries of Central Europe will see an increase of 1.7° C in mean annual temperature. Although the models do not concur on the change of annual precipitation for the years 2030-2049, they all agree that the annual runoff will decrease by 13%. Furthermore, Central Europe will see an increase in heat waves and the greatest decrease in frost days in all of Europe and Central Asia.

Impact on Natural Hazards. The countries of Central Europe will see an increase in heat waves. Moreover, what is considered 100-year droughts will return every 50 years for Hungary, Romania, Moldova and Ukraine.<sup>30</sup>

**Russia.** *Russia's Baltic region, Volga, North Caucasus, Siberia and Far East, South Siberia, Urals and Western Siberia, and Western Arctic*

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<sup>27</sup> United Nations Environment Programme. Caucasus Environment Outlook (CEO). Tbilisi, Georgia, 2002.

<sup>28</sup> *Ibidem.*

<sup>29</sup> *Ibidem.*

<sup>30</sup> M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change," Cambridge, UK: Cambridge University Press, IPCC, 2007.

Prediction of Climate Change. By 2050, the entire country of Russia, from the Arctic to the Urals to the Volga to the Caucasus States, will undergo a decrease in frost days and an increase in heat waves.<sup>31</sup> Overall, mean annual temperature in Russia is expected to increase 1.6 – 2.6° C, with Russia's North Caucasus experiencing the low end of temperature increase of 1.6° C and Russia's Western Arctic experiencing the high end with 2.6° C increase in temperature.

With the exception of Russia's North Caucas region<sup>32</sup>, Russia will encounter a significant increase in mean annual precipitation from 6-11%.<sup>33</sup> Russia will also experience an increase in precipitation intensity and precipitation per extreme events.

Impact on Natural Hazards. The effect of climate change on Russia will significantly increase Russia's exposure to natural hazards. In the northern part of the country, increasing temperatures will lead to the thawing of permafrost. Permafrost, or perennially frozen ground, covers 60% of Russian territory. By 2050, models predict that total permafrost area could be reduced by 15-20%, with the Arctic Coast and West Siberia experiencing as much as 50% during the summer.<sup>34</sup>

Thawing will not only increase water volume but will cause ground surface displacement. When permafrost thaws, the ground will not settle uniformly, which will result in an uneven surface called 'thermokarst'. As already seen in the Arctic, the resettling of ground surface has caused buildings to sag, pipelines to crack and roads to buckle. In fact, scientists predict that thermokarst will not only cause major damage to the built environment, but if ground subsides near the coast, the land will be overtaken by sea water.<sup>35</sup>

Increasing temperatures will not only cause northern Russia's permafrost to thaw but it will also melt glaciers and sea-ice. Snow is also expected to melt faster causing underground water levels to rise. Wind storms are predicted to increase. All of these factors, plus a predicted increase in precipitation by 10-15%, is expected to cause major flooding for most of Russia.

For the southern regions of Russia, temperatures are not only expected to rise but precipitation is expected to decrease, which will increase the risk of drought. By 2020, it is predicted that for the Southern regions drought will have a significant negative impact on agriculture, as much as a 22% decrease in cereal production and 14% loss of forage crops for the North Caucasus.<sup>36</sup> Climate models also predict an increase in wind and an increase in precipitation when it does rain.

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<sup>31</sup> World Bank Climate Data Change Studies.

<sup>32</sup> Climate models for North Caucas do not agree on the sign of change for annual or seasonal precipitation for 2030 – 2049 compared to 1980 – 1999.

<sup>33</sup> World Bank Climate Data Change Studies.

<sup>34</sup> A. Kokorin, "Report No 2. Expected Impact of the Changing Climate on Russia and Central Asia Countries and Report No 3. Ongoing or Planned Adaptation Efforts and Strategies in Russia and Central Asia Countries," WWF Russia, 2008.

<sup>35</sup> U.S. Arctic Research Commission Permafrost Task Force. Climate Change, Permafrost, and Impacts on Civil Infrastructure. Special Report 01-03, U.S. Arctic Research Commission, Arlington, Virginia. (2003).

<sup>36</sup> A. Kokorin, "Report No 2. Expected Impact of the Changing Climate on Russia and Central Asia Countries and Report No 3. Ongoing or Planned Adaptation Efforts and Strategies in Russia and Central Asia Countries," WWF Russia, 2008.

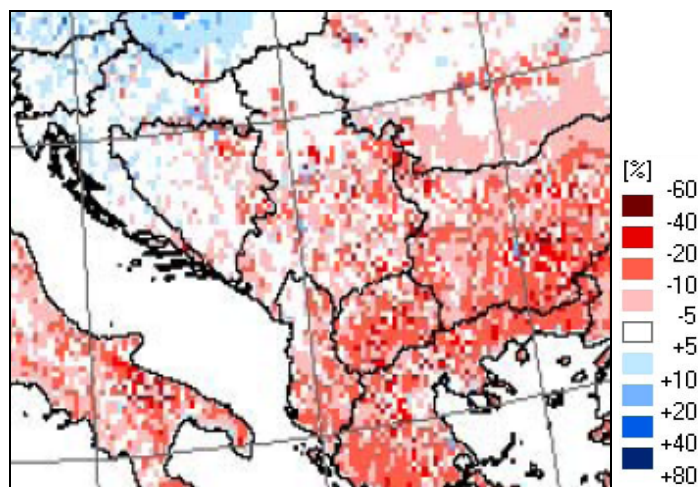
The increase in temperature will also increase the frequency of forest fires. The area and frequency of forest fires will increase as well as the length of the fire-risk. And ultimately, even the South Siberian regions will be affected, increasing their summer fire-risk period by 30-50%.<sup>37</sup>

**South Eastern Europe.** *Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Montenegro, FY Macedonia, Serbia, Slovenia and Turkey*

Prediction of Climate Change. South Eastern Europe will be one of the ECA regions hardest hit by global warming. Annual temperatures are expected to increase by 1.8° C. The highest increases will be in Albania, Macedonia and the southern parts of Bosnia and Herzegovina, Serbia, and Montenegro.<sup>38</sup>

The north western tip of South Eastern Europe will see an increase of rainfall by 5% (see Figure 5). However, for the rest of the Adriatic coastline and Western Balkans region (to include Albania and Macedonia), annual mean precipitation is expected to decrease by 10-20%. Annual precipitation is expected to decrease and annual runoff will sharply fall off by 25%. Despite the lack of precipitation, when it does rain, it will be more intense.

**Figure 5. Change in mean annual precipitation in 2071-2100 relative to 1961-1990 (%)**



Source: European Commission (2007)

<sup>37</sup> A. Kokorin, "Report No 2. Expected Impact of the Changing Climate on Russia and Central Asia Countries and Report No 3. Ongoing or Planned Adaptation Efforts and Strategies in Russia and Central Asia Countries," WWF Russia, 2008.

<sup>38</sup> European Commission, "Green Paper from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: Adapting to Climate Change in Europe - Options for EU Action," 29 June 2007..

Impact on Natural Hazards. For South Eastern Europe, the decrease in precipitation and increase in temperature will lead to greater frequency and severity of drought. Moreover, heat waves combined with drought will aggravate conditions that will lead to an increase in forest fires.

Despite the decrease in rainfall in South Eastern Europe, it's expected that flooding will also increase in SEE countries. First, scientists predict that the northern Adriatic coast will be prone to more severe and longer lasting floods due to higher wind speeds, which will intensify storm surge.<sup>39</sup> Second, when South Eastern Europe does receive rain, scientists predict an increase in precipitation intensity.<sup>40</sup> Drought conditions combined with intense bursts of precipitation may lead to flash floods.<sup>41</sup>

An increase in the intensity of rainfall combined with drought conditions can also lead to greater soil erosion rates and an increase in risk of landslides in South Eastern Europe. Droughts lead to a loss of soil nutrients and vegetative structure and slopes that have lost soil structure are more prone to landslides when they are weakened by heavy rains.

#### **Central Asia. *Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan***

Prediction of Climate Change. Overall, Central Asia will see an increase of 2° C. Although climate models do not concur on average precipitation, they all agree that annual precipitation intensity will increase. They also predict that annual runoff will decrease by 12%. This decrease will have a major impact on water resources such as the Aral Sea.

Impact on Natural Hazards. The increase in temperature and decrease in annual runoff will cause an increase in heat waves. Heat waves and higher evaporation will lead to drought, the loss of crops and pastures, and the expansion of desert areas.<sup>42</sup> Glaciers will melt, which could lead to flooding in some areas and in other areas, shortages of fresh water.<sup>43</sup> An increase in intensity of precipitation will aggravate mudflow, landslides and avalanches.<sup>44</sup> In particular, climate change will hasten the shrinking of the Aral Sea.<sup>45</sup>

In summary, due to climatic changes, the following is expected to take place in Europe and Central Asia:

- An increase in temperature and decrease in mean precipitation will lead to an increase in the frequency and severity of drought and heatwaves.

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<sup>39</sup> M. Pasari, M. Orli and A. Mohorovi, "Meteorological Forcing of the Adriatic: Present vs. Projected Climate Conditions," *Geofizika* Vol. 21 2004. 28 December 2004.

<sup>40</sup> United Nations Environment Program, *Climate Change 2007: Impacts, Adaptation, and Vulnerability*, 2007, p. 547.

<sup>41</sup> DESA, ISDR and USA NOAA, *Guidelines for Reducing Flood Losses*. United Nations, 2004.

<sup>42</sup> UNEP/GRID-Arendal, "Climate Change and Natural Disaster Impacts in the Ferghana Valley," UNEP/GRID-Arendal Maps and Graphics Library. 2005.

<sup>43</sup> A. Kokorin, "Report No 2. Expected Impact of the Changing Climate on Russia and Central Asia Countries and Report No 3. Ongoing or Planned Adaptation Efforts and Strategies in Russia and Central Asia Countries," WWF Russia, 2008.

<sup>44</sup> *Ibidem*.

<sup>45</sup> *Ibidem*.



- Severe drought will lead to an increase in forest fires.
- Greater intensity of wind and rain will cause severe floods and landslides.

Consequently, based on current knowledge, disaster risk management becomes a vital and urgent component of adaptation to and coping with climatic changes.

## 2. ADAPTATION THROUGH DISASTER RISK MANAGEMENT

A broad concept of hazard risk management comprises a systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This includes all forms of activities such as structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards<sup>46</sup>.

The countries of the ECA region have gone through major political, social, economic and administrative changes, which have affected the institutional aspects of disaster risk management. The primary challenge and focus in restructuring disaster risk management in the region has been: (i) demilitarization of the civil protection services; and (ii) restructuring of many disaster management functions. The advancement of these processes vary across the ECA region but the direction taken is highly commendable.

A recent analysis on hazard risk management in the countries of South Eastern Europe reviewed the status on the decentralization of disaster risk management, community participation, legislative frameworks, training and education, international cooperation, emergency response planning, exercises, public awareness, communication and information management systems and technical capacity for emergency response (see table 5). The analysis showed that there are many aspects that require improvement for effective hazard risk management.

These findings were consistent with a 2004 study completed for all ECA countries on their capacity to manage risk posed by disasters,<sup>47</sup> which can be summarized as follows:

- *The concept of hazard risk management is not fully institutionalized* – while at least some elements of a regulatory framework are in place, there is a lack of sufficient statutory authority, which would allow for the formulation and execution of comprehensive disaster risk programs.
- *Coordination mechanisms between authorities are not well developed* – this concerns both the horizontal coordination between various sectors, and linkages between the central and local levels.

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<sup>46</sup> After ISDR *Terminology: Basic Terms of Disaster Risk Reduction*.

<sup>47</sup> C. Pusch, “Preventable Losses: Saving Lives and Property through Hazard Risk Management - A Comprehensive Risk Management Framework for Europe and Central Asia,” [Disaster risk management working paper series](#), no. 9, World Bank, 2004.

- *Hazard warning and monitoring systems require improvement* – particularly, the hydrometeorological systems in the region should be enhanced and technological advancements in this area should be taken advantage of. Hydromet data can be a very efficient tool if it rests on regional and sub-regional collaboration and information sharing between riparian countries.
- *Economic considerations are not fully integrated in investments decisions* – it is particularly important that cost-benefit or cost-efficiency analysis is part of the investment prioritization process necessary for the development of sectoral, national and local disaster risk mitigation plans and climate change adaptation strategies.
- *Catastrophe risk financing tools are not fully utilized* – the transferring of disaster risk to the capital markets is feasible for most of the region's countries, whether it is on the individual country level as in the case of the most advanced economies for selected hazards, or in the case of smaller countries through a regional and sub-regional risk pooling mechanism.
- *Insufficient funding of disaster risk mitigation investments* – reduction of economic and social losses due to disasters is possible if priority, cost-effective investments are made ex-ante. The recovery and reconstruction is much more costly in the aftermath of a disaster.
- *Information and communication systems require upgrading* – this is needed for managing emergency information and tracking resources. Some countries in the region, e.g., Turkey, Romania, and Croatia, have initiated improvements in their emergency communication and information systems but many others are lagging behind.

Taking into account the projected impact of climate change, the reduction of current and future vulnerabilities to hydrometeorological risk should build upon and expand existing disaster risk management efforts. It is important to recognize that response and disaster mitigation based on past vulnerabilities may not suffice in light of recent scientific forecasts, while in many countries of Europe and Central Asia these existing mechanisms are already insufficient for the current level of vulnerabilities.

Given the uncertain impact of climate change on extreme weather phenomena, the planning process for extreme weather events also addresses high-frequency though low-impact emergencies and many of the possible investments in adaptation within the area of disaster risk management will have multiple benefits.

While ECA countries recognize the importance of mitigating the risk of natural hazards, most do not have a comprehensive disaster risk reduction strategy and multi-year cross-sectoral investment plan. The following chapters describe some measures which a country can undertake to reduce disaster risks.

**Table 5. Disaster Risk Management in the South Eastern Europe Countries**

Country	Decentralized Emergency Management System	Community Participation	Legislative Framework	Training and Education	International Cooperation	Emergency Response Planning	Exercises	Public Awareness	Communication & Information Management System	Technical Capacity for Emergency Response
<i>Albania</i>	N	N	N	S	G	S	N	S	N	N
<i>BiH</i>	N	N	U	N	S	N	N	N	N	S
<i>Bulgaria</i>	N	N	S	N	S	N	N	N	N	S
<i>Croatia</i>	N	N	S	N	S	S	S	N	N	S
<i>Macedonia</i>	N	N	S	S	S	N	N	N	N	N
<i>Moldova</i>	N	N	N	N	S	N	N	N	N	S
<i>Romania</i>	N	N	S	S	G	S	N	N	S	S
<i>Serbia</i>	N	N	U	N	S	N	N	N	N	U
<i>Montenegro</i>	S	S	U	S	S	N	N	N	N	U
<i>Slovenia</i>	S	S	S	S	S	N	S	S	S	S
<i>Turkey</i>	N	S	S	S	G	S	S	S	S	S

G – Good

S – Satisfactory

N – Needs Improvement/Not Available

U – Under Development

Source: *Synthesis Report on SEE Countries Disaster Risks*; UN/ISDR-WB; July 2007.

### 3. FINANCIAL AND INSURANCE INSTRUMENTS

**Impact of Climate Change on “Natural” Disasters.** While many disasters follow secular trends, those linked to weather appear to be subject to increasing intensity, a phenomenon which is attributed to climate change. Climate change effects, while not fully quantified or causally connected to all sub-regions, are estimated, for financial/loss planning purposes, to affect weather induced disasters in distinct ways:

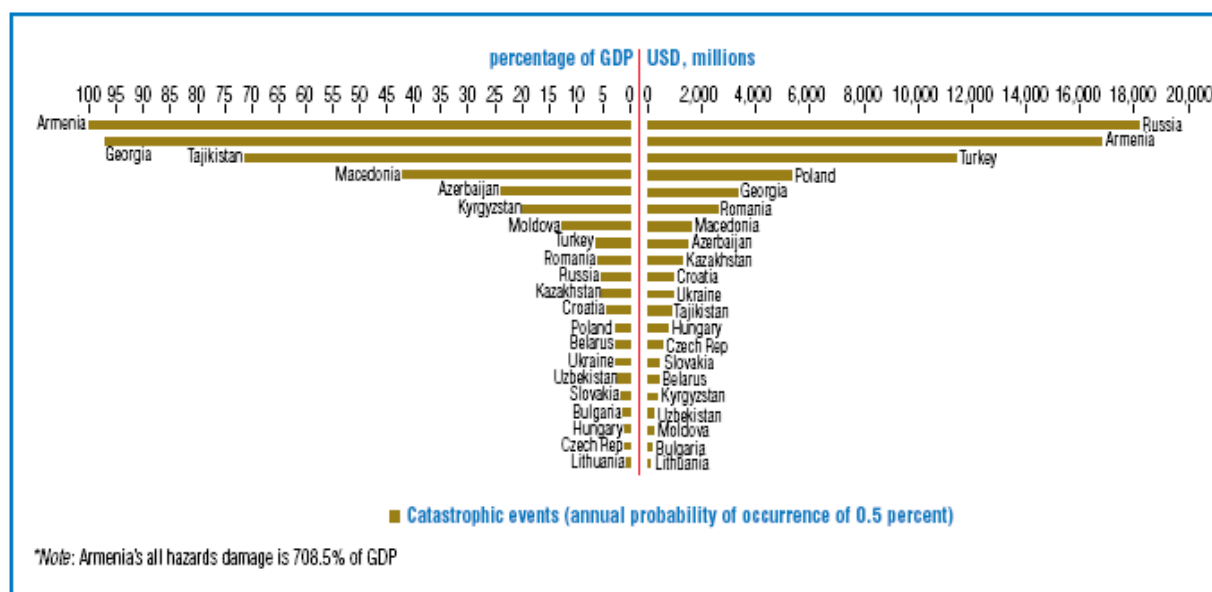
- (a) increased earth temperatures due to climate change are likely generating longer and more intense droughts in countries in southeastern Europe,
- (b) increased temperatures that raise ocean surface temperature result in a higher incidence of larger strength hurricanes, cyclones and typhoons in subtropical areas. This leads to not only increased wind- and rain-induced damages in the directly affected areas, but also to weather change impacts on neighboring systems adjoining the Atlantic basin;
- (c) increased precipitation resulting rising temperature coupled with some of the above factors, as well as from the seasonal high and low pressure displacements, can result in increased rain and flooding in many regions.

These effects are estimated to have increasing trends in the intensity and frequency of catastrophic events, although the historical and recent information is insufficient to determine the precise direction of such trends and thus the statistical uncertainty prevents policy-makers (as well as private insurers) from planning adequately given the opportunity cost of setting funds aside for a “rainy day.”

**Impact on ECA Economy.** For Europe and Central Asia, over the past 30 years, disasters have caused \$70 billion in economic losses. On average, expected annual losses are \$2 billion, with most of the losses concentrated in Armenia, Romania, Poland, the Russian Federation, and Turkey.

Due to catastrophic events that have an annual probability occurrence of 0.5 percent, expected economic loss for the Kyrgyz Republic and Moldova is 10% of GDP. For Armenia, Azerbaijan, Georgia, Macedonia, and Tajikistan, expected losses double to 20% of GDP. To better illustrate the economic loss potential of disasters, figure 6 shows the impact of catastrophic events on GDPs of ECA countries.

**Figure 6. Economic loss potential\***



\*The figure does not include drought, forest fire, and industrial accident hazards.  
Source: Pusch 2004

**Types of Financial Protection Mechanisms.** From a country perspective, financial mechanisms to address losses generated from climate change-induced disasters can be “macro/sovereign” or “individual/industry” linked. Sovereign “insurance”, for example aims to address major economic disruptions from disasters that have a strong adverse impacts on budget finances, and where special insurance instruments correlated to large magnitude events could be used by governments to hedge and compensate for potential fiscal losses (such as for reconstructing essential infrastructure). In such an instance, the “insurer” would normally have a broad capital base to redistribute losses without creating systemic financial problems (the insurer thus could be large capital market investors/hedgers, major global reinsurers or other countries).

On the other side, individual insurance (whether for businesses or households) is linked to specific damages to their assets. This type of insurance is typically provided by the traditional insurance industry and requires verification of the damaged assets before paying out loss claims. It is well suited to protect private sector assets and requires the government to primarily ensure the financial sustainability and solvency of the insurance providers.

Both types of insurance are essential although “sovereign” mechanisms are a newer phenomenon being increasingly considered to supplement fiscal budgets using novel financial mechanisms that avoid the volatility of market prices (premiums) for traditional insurance. Governments primarily require stable expenditure trends such as for budgeted premiums (under typically limited fiscal envelopes) otherwise a fiscal insurance policy would not be sustainable for long.

**Magnitudes of Country Losses.** To further illustrate the negative impact natural disasters can have on the economy, the table below shows some specific examples of economic loss in various ECA countries. With a potential increase in windstorms and hurricanes due to ocean temperature warming, this issue becomes more acute.

**Table 6. Economic Losses from Natural Disasters in SEE Countries, 1974-2006**

Number of years taken for average	Country	GDP PPP per capita [\$ /inh.] 2005	Annual average economic loss due to all perils (million USD)	% to GDP	Economic loss (in million USD)			
					Drought	EQ	Flood	Tropical cyclone
1974-2006	Albania	2755.3	68.67	2.49	2238	2 to 5	24.673	0
1989-2006	Bosnia and Herzegovina	2384.0	22.94	0.96	408	> 5*	0	0
1974-2006	Bulgaria	4733.9	14.76	0.31	0	5*	260.23	0
1989-2006	Croatia	6376.2	33.76	0.53	330	> 5*	0	0
1989-2006	Macedonia	4467.7	24.59	0.55	0	5*	353.6	0
1984-2006	Moldova	2876.1	61.40	2.13	0	0	152.584	31.6
1974-2006	Romania	5954.9	292.76	4.92	500	2756*	3269.3	0
1989-2006	Serbia and Montenegro	4936.0	82.0	1.66		2705	0	0
1984-2006	Slovenia	13611.4	7.31	0.05	0	10	5	0
1974-2006	Turkey	4680.8	560.56	11.98	0	15988	2511	0

Source: EM-DAT, \*from National Geophysical data Centre website, GDP- the World Bank statistics

Notes: Economic loss of other perils is also included for calculating annual average economic loss.

Although multiple small disasters can slowly erode a nation's budget, all it takes is one major catastrophe to severely affect the economy. In 1999, for example, a major earthquake in Turkey caused economic damages estimated at 3–6 percent of GDP.<sup>48</sup> And in 2002, in the Czech Republic, flooding caused 3€ billion in damages. Fortunately for the Czech Republic, 40% of losses were insured – a lesson the country learned from the floods of 1997.<sup>49</sup>

The Czech Republic, however, is unique for the ECA region. In general, ECA countries primarily have budget but not insurance funds for such eventualities (see table 7) but have yet to develop more sophisticated financial instruments to cope with such losses on a systematic basis, especially since climate change effects may be increasing the frequency and intensity of hazards.

<sup>48</sup> C. Pusch, "Preventable Losses: Saving Lives and Property through Hazard Risk Management - A Comprehensive Risk Management Framework for Europe and Central Asia," [Disaster risk management working paper series](#), no. 9, World Bank, 2004.

<sup>49</sup> CEA Insurers of Europe, "Reducing the Social and Economic Impact of Climate Change and Natural Catastrophes Insurance Solutions and Public-Private Partnerships," Brussels, June 2007.

**Table 7. Natural Disaster Funds in ECA Countries**

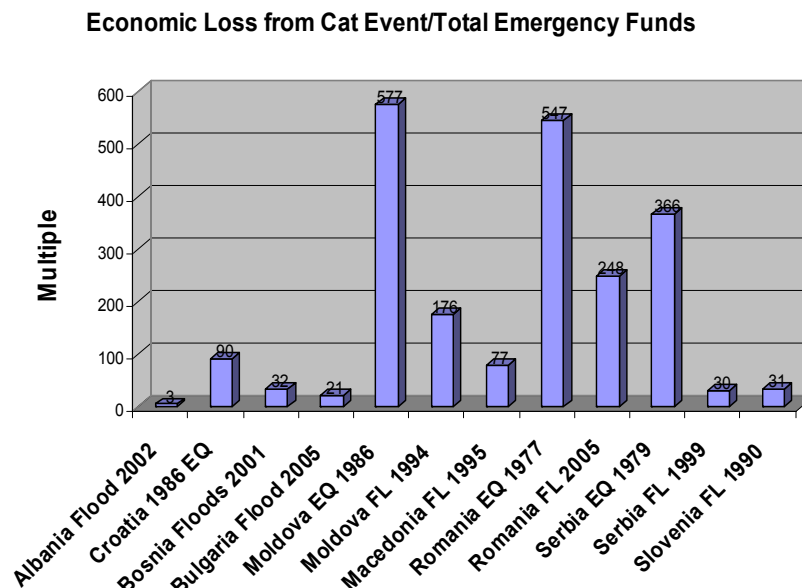
Country	National Disaster Fund	Size (USD mm)	Annual Appropriations (USD mm)	Local Disaster Funding
Albania	(i) Civil emergency fund (ii) Council of Ministers reserve fund (can be used for emergencies) (iii) Ministries' reserve funds	0.4 17	0.4 annually if needed plus additional budgetary appropriations in case of emergency	Local government reserve funds
Croatia	Budget reserve	5.5	Annual allocations	Municipal budget funds
Bosnia and Herzegovina	Budget reserves Fund for special reimbursement for protection and rescue	0.5	0.5 payroll tax	
Republika Srpska	Budgetary reserve		Annual appropriations	
Bulgaria	Republican fund*	31.25	Depends on annual budgetary appropriations	Municipal budgets
Macedonia	State budget reserve The Solidarity fund	6.0	Annual appropriations Donations	
Moldova	Reserve fund Agencies' reserve funds	2.3	Annual budgetary replenishments	2% of local budgets
Montenegro	Disaster assistance fund	0.52	0.52	
Romania	Intervention fund  Reserve budgetary fund	5.0	Annual appropriations Annual local budget appropriations	5% of local budgets
Serbia	Disaster Emergency Fund Reserve Fund	1  21	1  1	
Slovenia	Budget reserve fund	40	Annual budget appropriations	

*Source: World Bank and UN ISDR; Mitigating Adverse Financial Effects of Natural Hazards on the Economies of South Eastern Europe; 2008*

Furthermore, as seen in Figure 7, ECA government budget funds are grossly insufficient to finance large losses from extreme events. This calls for a more rational fiscal policy which could budget annual premiums for risk transfer (insurance), but avoid massive layouts and fiscal/economic disruption at the time disaster-related emergency expenditures are needed.



**Figure 7. Economic Loss from Catastrophic Events and Emergency Funds**



Source: *Ibidem*.

While risk mitigation and adaptation actions are imperative to reduce the losses from such events which can arise with short warning, certain residual risks and losses will materialize nonetheless. These can potentially be covered through financial and insurance markets and by the creation of special financing and risk transfer facilities in collaboration with the private and public sectors and international institutions.

**Insurance Industry Concerns on Climate Change.**<sup>50</sup> For insurance purposes, catastrophe risks are broken up into layers. The lower, or more frequently hit layers where implicit premiums are not much greater than the expected loss (commonly called working layers), are usually retained by the direct insurer, depending on size, capital resources and portfolio diversity. The higher layers are laid off to reinsurers or the capital markets (the latter most often through catastrophe bonds). As the higher layers represent the least frequent but most severe events, about which there is little data (and where climate change is likely to have the most effect), there is a much greater amount of capital required per unit of sum insured and the premium is a greater multiple of expected loss. Ken Froot, Professor of Harvard, brought this to light in his 1999 book on catastrophe bonds where the price to expected loss multiple ranges between 1 and 2 at the lower layers and up to 8 for the top layer.

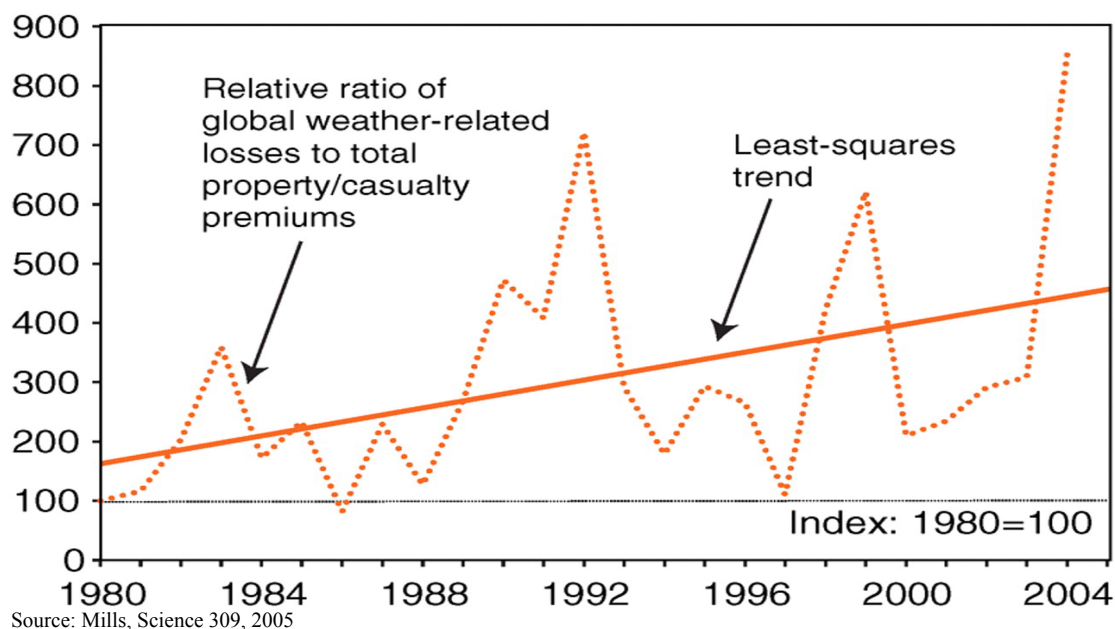
What was of most concern at the time the Froot book was written was that direct insurers were not buying sufficient coverage at the upper layers, presumably because of a combination of price and career horizons that are short compared to the return periods of the catastrophes concerned. However, there is some evidence that this is changing, possibly driven by the increased frequency of climate change induced natural disasters in the last decade and a half. From an

<sup>50</sup> R. Lester, "Climate Change, Development and the Insurance Sector", presented at Williams College, April 2008

insurer's point of view, this increased frequency and cost of catastrophic losses is due to hydrometeorological events and may reflect the lagged impact of human induced CO<sub>2</sub> contamination finally emerging.

**Figure 8. Hydrometeorological insurance losses versus total non life insurance premium**

(1980 base ratio normalized to 100)



Aside from balance sheet realities of insurance companies, there are other imperatives for direct insurers to offload climate induced catastrophe exposures. In particular, it is very uncommon for insurers to be allowed to build reserves for losses that may occur after the current operating cycle. The insurance elements of the new international financial reporting standard (IFRS) do not allow for such reserving, and any catastrophe buffers need to be held as equity capital. In addition most tax regimes do not allow catastrophe reserves to be set aside from pre-tax income. Executives or boards are not likely to allow large amounts of unutilized capital to build up in the normal course of events.

The incentive to hold minimal capital will be to some extent offset if current thinking about insurer regulatory capital becomes the norm. This thinking is best captured by the proposed Solvency II regime in Europe, which follows the Basel II formulation for banks. Under Solvency II, insurers will be required to establish two capital levels, a solvency capital requirement (SCR), which represents the economic capital required given the risk characteristics of the insurer, and a minimum capital requirement (MCR), below which the insurer will lose its right to trade.

If an insurer falls below its solvency capital level the financial supervisor will be required to intervene in its affairs. The solvency capital will reflect a range of risks including market, capital, reserving and underwriting risk. All four of these will be affected by climate change and the capital allocation for reserving and underwriting risk will include an explicit allowance for

retained catastrophe risk. In addition there is a trend for insurance supervisors to look at quality of reinsurance when determining insurer solvency.

The financial sector and the European Insurers' Association have been actively monitoring developments related to climate change induced effects on their business. The mega global insurer, AIG, has been one of the few US based institutions to actively acknowledge this issue. Insurers are also active participants in the Carbon Disclosure Project (CDP) and the UNEP Financial Institutions partnership which hosts the Climate Change Working Group.

The insurance analysis tool for estimating probability loss distributions of extreme events is captured in graphs named "exceedance curves". Exceedance curves can be adjusted to allow for mitigation strategies and for changing hazard characteristics, including those arising from climate change. To date, the insurance sector has tended to rely on historical data in deriving loss distributions but given the apparent rate of change of expected losses from hydrometeorological events and increasing uncertainty as to what is going on with the climate it seems likely that some projection of future experience and attendant uncertainties will be incorporated before too long.

**The Insurance Market for Extreme Events.** The global catastrophe insurance market exhibits inherent cyclical risks with rising and falling price cycles. If insurance premiums for extreme events fluctuate periodically, this generates a problem with respect to countries "hedging" against climate change induced disaster losses. This makes it difficult for countries to budget fiscal allocation in a reliable and sustainable manner once they decide to deploy such financial tools.

Disaster-prone countries can obtain alternative protection against catastrophic risk and premium volatility by using capital markets. Capital markets generally can help insure low probability/high impact events since the risk taken by them is akin to a default risk on a bond. The climate change induced events fall into this category since the probabilities of extreme losses to date have been in the 1 percent range (annualized), which is the probability expectation acceptable to the markets. This allows the capacity of the broader financial private sector to absorb and spread the risks, both domestically and internationally. Two mechanisms are proposed for more efficient management of catastrophic risk: (a) pooled insurance coverage supported by liquidity and credit enhancement facilities, and (b) weather-indexed bonds to securitize risk.

Multilateral development institutions can play a catalytic role in supporting the development of these mechanisms, while still ensuring actuarially fair premiums. In fact, an example of each mechanism has already been developed and implemented in client countries with support of the World Bank. The Caribbean Catastrophe Risk Insurance Facility implemented a risk pool, which reduced the cost of premiums paid by the island governments to protect against extreme hurricane and earthquake events. In the second case, the Bank assisted Mexico in launching an indexed catastrophe bond (in this case the hazard was extreme earthquake). Currently, the Bank is assisting ECA countries in establishing the Catastrophe Risk Insurance Facility (ECA Re) which will pool individual disaster risks and provide coverage to homeowners and SMEs in the Southeast and Central Europe.

Smaller countries may require multilateral support (a credit enhancement) to gain access to capital markets. Governments and local industry may simply need to recognize that new mechanisms can both increase coverage and stabilize the cost of premiums. Such assessments require skills in financial modeling, something multilaterals can help organize and finance.

Climate change induced catastrophic events are unique among insurance risks. While traditionally non-catastrophic insurable risks occur with predictable frequency and relatively low losses, catastrophes occur infrequently but with high losses. Three mechanisms have been developed in recent years to tap capital markets to better manage these risks.

In the U.S., public authorities in earthquake-prone California and in hurricane-prone states such as Florida and Hawaii collaborated with the private sector to address insurers' fears of large losses (and thus potential market flight). These public-private efforts combined catastrophe coverage under special-purpose pooled funds with outside capital (such as long-term loans and bonds that securitize insurance risks), increasing the availability of insurance by tapping capital markets. The pooling arrangement achieved efficiencies of scale while giving all parties the confidence that contractual obligations would be met. This approach is also used in Europe where national governments provide last recourse funding and coverage for extreme events (e.g.: France, Spain).

In Japan, Europe, and the United States, markets for "catastrophe bonds" have offered an alternative for transferring risks especially when global insurance and reinsurance markets become pressed for capital due to payment of claims for above average catastrophic events (these periods coincide with "hardening" markets, i.e., higher premiums charged until the industry can recover its capital).

In the alternative catastrophe bond markets (where the global markets have a capital multiple of approximately 70 times that of the global insurance markets) investors buy high-yield bonds from the party that seeks to be insured. These bonds can either be backed by premiums collected on an underlying insured pool of assets and property, or can be structured as a financial option where a physical measurable disaster triggers the loss of interest and principal if a major catastrophe occurs during the life of the bond, and thus the bond proceeds are used by the "insured party" but lost by the investors. Investors are attracted to these bonds because of their low probabilities of "disaster default" while paying attractive yields, and by their lack of risk correlations with overall financial markets which provides them a diversified asset. Many of these risk management methods could be adapted for use in developing countries.

**Volatile Premiums for Traditional Insurers.** In countries prone to extreme weather phenomena generated from climate change and catastrophe-prone developing countries, the domestic insurance industry generally reinsures its local portfolio with international re-insurance companies that can better bear the risk of catastrophic losses through global diversification. Insurance for extreme events is generally available for developing countries. But following an unusual series of major losses domestically or globally, insurance could become scarcer and pricier as mentioned above.

Thus, relying on reinsurance from foreign companies affects the price of disaster insurance. If prices rise sharply again after a major catastrophe occurs, extreme event reinsurance markets will tighten. In 1990, for example, the rate for home insurance in parts of the hurricane-prone Caribbean was 0.4 percent. After Hurricane Andrew hit Florida in 1992, prices more than tripled reaching 1.3 percent in 1994 then declined to 0.8 percent near the end of the decade. While the Caribbean itself was not the major area affected by Hurricane Andrew, prices in that region rose dramatically because global insurance/reinsurance capital was exhausted and the industry needed to recover it through higher premiums to remain solvent in the longer term. By contrast, Hurricane Mitch, which devastated parts of the Caribbean and Central America in 1998, had little effect on insurance prices because much of the property it damaged was uninsured and thus the insurance industry did not have to pay out.

Transferring risks abroad also means that domestic insurers retain very little of the underwriting risk so they face low incentives to monitor compliance with structural codes or to promote measures to prevent losses through adaptation actions or improve industry efficiency that in the long run might lower the cost of insurance. And when all but very low levels of risk are reinsured abroad, the reinsurance coverage is generally expensive because of the high likelihood that it will be triggered. Contracting reinsurance at much higher levels of loss would lower the premiums because of the lower probability that losses would reach those levels. Thus, a key issue is finding the right balance over time between retaining risk locally and transferring it abroad, the latter being mainly for the most extreme events.

**Fiscal Considerations.** Governments may directly be involved in insuring against extreme events associated with climate change (e.g.: increasing strength hurricanes, floods or droughts). Ironically, those countries with the highest exposure to climate induced catastrophe risk are those least in a fiscal position to afford the cost of protection in terms of reallocating scarce budget resources away from already thin social programs. Therefore, in considering sovereign clients for the deployment of catastrophe bonds, the current budget and policy environment must be considered as an initial realism check.

However, even in countries with healthy fiscal accounts, the idea of risk transfer via cat bonds and/or other instruments makes sense. For such countries, a mega catastrophe would not mean a loss representing a small 1% - 2% of GDP as in the U.S. but rather anywhere from 10% to 120% of GDP and hence the relevance of such risk transfers for many developing countries.

Sovereigns manage various types of country structures from federalist states to highly centralized states. In the former, catastrophe risk programs can be welcome from the perspective of the central government's need to manage unusual budgetary flows but any country-wide risk exposure analysis needs to take into account that fiscal responsibilities exist at the decentralized levels and the central government may not participate in coverage at those levels. In countries with traditionally more centralized management, nationwide exposure may be more relevant to the authorities but the budgetary cost of cat bond risk transfer may make such propositions unrealistic. In such cases, the design of cat bond products should be coupled with a decision model for prioritizing the hierarchy of assets or infrastructure at risk which can be included given budgetary limitations.

**Insurance or Fiscal Hedge.** The diagnosis of sovereign needs for risk transfer using the cat bond market also needs to take into account whether client governments are seeking targeted disaster protection (e.g.: protection of infrastructure in key cities) or merely a source of funding to prevent excessive fiscal volatility in the event of a major disaster. While from a product outcome perspective the difference is not all that great, from a design perspective it can make the difference between the relevance that a given government may express for a potential cat bond program.

For example, in assessing client needs, the requisite risk modeling work may take the form of either (a) quantifying asset and infrastructure losses and their probabilities across key urban centers and designing an instrument to cover a significant portion of those losses, appropriately priced, or (b) determining probabilities of events of certain magnitudes which are historically associated with PML type damages and pricing a cat bond based on such probabilities.

While the above scenarios require similar methodologies to develop and price a cat bond, the approach differs in that the first case focuses on selective losses by geographic location while the second approach deals mostly with how much funding will be used up and thus need replenishment to avoid disruptions or delays. In general, experience shows that countries with high exposure but few budgetary means are more likely to be interested in the first ‘location targeted’ approach while countries with modest exposure and a sound budgetary situation are more likely to gravitate towards the second approach (the fiscal hedge). In the first approach, however, asset selectivity is key since under a limited budgetary (or deficit) situation, governments will seek to minimize the cost of premium/spread given the political difficulty of reserving scarce budgets for ‘contingent’ events.

**Cat Bonds vs. Reinsurance.** One question which is likely to come up under any discussion with sovereign clients with respect to implementing a cat bond program will be the alternative of using the reinsurance market. Nevertheless, the emerging and more common practice lately of cat bond structuring using parametric triggers clearly gives this instrument a competitive advantage. First, even if the risk modeling phase perfects the vulnerability and loss estimations on an individual asset basis within sovereign territories allowing for an indemnity based approach, most institutional investors would likely shy away from indemnity-based triggers given the difficulty in providing assurances against moral hazard, adverse selection and simply the loss adjusting/verification process.

While an outright reinsurance/insurance contract channeled via that industry is certainly an option and the premium costs may certainly be lower than cat bond spreads, the bulk of the costs will precisely come in during the loss adjustment process which will need to involve local insurance intermediaries. Therefore, under an indemnity approach, all these costs will need to be quantified and compared with the purely financial costs of a cat bond transaction. The trigger verification (e.g. for climate change induced hurricane/typhoon/cyclone risks) under a parametric cat bond contract, which counts on the reporting of not only national/local but also internationally renowned weather agencies, facilitates the marketability of such instruments in the investor market with the added benefit of diversifying that investor group’s portfolio risks.

**Multiple Products.** In the end, sovereign clients, while interested in the idea of parametrically based cat bonds, are seeking like all rational economic agents to maximize their coverage while minimizing their costs. In this context, while the cat bond is certainly an interesting and attractive instrument (and for some sovereigns may be an attractive opportunity to establish a market presence), it is not a panacea. Many client governments have highly sophisticated analysts and policy makers and are not merely impressed by an innovative product. Rather, after solid risk modeling analysis, they would like to see the options and combinations of capital market, insurance and credit instruments which can expand their coverage against climate induced catastrophic exposure without a prohibitive cost to their fiscal purse.

In this regard a more optimal approach is to work in partnerships across financial industries and international agencies, to offer a mix of products yielding an optimal result. In this context, the loss layers reflective of any portfolio of climate change induced disaster exposure provides good reference points for the applicability of each kind of product whether it be cat bonds, reinsurance, credit or other. For example, windstorm or flood risk in high exposure countries can generate a range of loss scenarios where just one type of instrument for coverage may be inadequate or insufficient.

In the case of ‘upper mezzanine level’ losses, say at probabilities of 2% -3%, the cat bond market may be inappropriate given the traditional less frequent attachment points for such instruments. Rather, a contingent long amortizing credit with a low or no commitment fee may be more cost effective since the probability of loss is such that calculating the actuarial average of using the credit and repaying it with interest (versus not using it and only paying a front end fee), may result in a much lower equivalent premium cost than other instruments.

In the case of ‘lower mezzanine level’ losses not in the cat bond range, a credit may be invoked a little too frequently making it a costly and debt rising proposition. Rather, the reinsurance/insurance market would be better suited at such a level with modest but not overly high losses. At the lower layers, the most optimal approach given the cost of premiums for highly frequent events would be retention, in this case through an allocation of government budgetary resources. Under a serious government risk transfer program, this would be a natural structure but of course the expected monetary losses and their associated probabilities are crucial in designing the attachment and exhausting points of each loss layer.

**Other Fiscal Considerations.** Sovereign clients have different risk and utility profiles than corporate clients who have very specific concentrated exposures which have been well suited for risk transfer via catastrophe bonds. In assessing country client needs, the World Bank encourages that the loss estimation and financing gap approaches be complemented with a deliberate analysis of the policy context, macroeconomic/fiscal practices and even political considerations in the design of government risk transfer programs. However, partnerships with the Bank and across the financial, capital markets and reinsurance industries are encouraged since it is apparent that the nature of sovereign management and, in particular, climate induced catastrophic risk management at a national level, is a complex business and requires complex solutions.

If not emphasized sufficiently, country economic policymakers and politicians will always need a large stock of analytical ammunition to demonstrate that any cat bond or other form of

contingent risk transfer program can actually increase the long term welfare of a country even if in the short term it means holding back highly sought fiscal resources from competing sources.

**Practical Issues in Transferring Extreme Climate Induced Risks to the Capital Markets.** A numerical example shows how capital markets can replace or supplement insurance and reduce costs, while absorbing higher magnitude extreme risks. Assume that a primary insurance company calculates the probability of a loss of more than US\$150 million but less than US\$250 million at 1 percent. If the primary insurer purchases reinsurance at this level, it would cost more since the variance uncertainty, business costs and required profit would add up higher than the pure probability rate. Otherwise, at 1 percent it would hardly break even over time. Adding administrative and operating costs as well as an uncertainty factor, and the required return on equity, the reinsurer might charge a premium of 5 percent (1 percent + 4 percent). Such a margin is typical at these infrequent high catastrophe levels where climate change induced phenomena comes into play, particularly when markets “harden”.

Alternatively, the primary insurer could issue a US\$100 million bond to investors then put the US\$100 million in treasury notes paying 4 percent. The investors' principal of US\$100 million would be put at risk as part of the contract as discussed earlier. If a catastrophe with losses exceeding US\$250 million occurred, the investors would lose all of their principal since the upper insured limit would have been breached (known as the “exhaustion point”). For putting their principal at risk, the investors would demand at least an 8 percent return – 4 percent as risk-free interest and 4 percent for the “pure” risk of losing their principal (akin to a default risk or the equivalent reinsurance pricing). However, no other costs or profits would be demanded beyond those. Net of the investment in treasury notes, the insurer's total financing cost would approach 4 percent, compared with the 5 percent of traditional reinsurance.

In yet another option, the insurer could arrange a standby credit of US\$100 million with a modest commitment or front end charge amounting to 0.5 percent and an interest rate of 7 percent that kicks in if the loan is needed. If a catastrophe occurs, assuming a ten-year repayment period for principal, this would yield a combined principal plus interest (insurance premium equivalent) annual cost of 10 percent.

Thus, the expected financing cost would be the probability weighted average of that versus the chance of not disbursing and only paying the commitment fee. This would amount to 0.01 (10%) + 0.99 (0.5%), which equals 0.6%, much lower than with direct reinsurance. It should be noted that even with a higher uncertainty factor added to the probability (such as a 20 percent chance of the disaster occurring), the cost effectiveness result would not change. These capital market or credit schemes to replace or supplement insurance thus have many possible variations. These range from full risk transfer with no financing (where the full principal is at risk, just as in reinsurance) to zero risk transfer with full financing (full repayment of principal).

**New Insurance Technologies to Adapt to Climate Change Losses.** Two compatible financial structures could be used to address the challenges of catastrophe insurance in climate induced disaster-prone countries, separately or as a joint mechanism.

*Pooled Coverage Supported by Liquidity and Credit Enhancement Facilities.*



A mechanism could be established in which liquidity and credit enhancement facilities support insurance coverage against catastrophic risks. The domestic insurance industry would transfer catastrophic coverage (through premium cessions) to a central fund regulated by the government and operated by the insurance industry. The risks covered would not be reflected on the balance sheets of local insurers but would instead be liabilities of the pooled fund. The international insurance industry could then reinsure climate induced catastrophic coverage under the fund up to a specified loss limit.

Multilateral institutions might provide contingent credit at the next highest loss level, supporting the liquidity of the fund in the event of immediate large losses in the initial years of operation. The credit would eventually be repaid and secured through future premium collections by the fund. The extended repayment period would provide optimal risk spreading over time. This layer of cover would also serve as a partial buffer against fluctuations in international reinsurance pricing (if capital markets were not used) since the loan terms would, in contrast, remain unchanged. Once such arrangements prove financially viable, local financial markets or international commercial lenders could offer liquidity support facilities. Development of these instruments would be catalyzed by the initial credit provided by multilateral development institutions. While this mechanism would finance rather than transfer risk, if structured with proper terms and appropriate levels of excess-of-loss coverage, it could provide more cost-effective coverage and longer-term price stability than traditional insurance markets, particularly for the potentially volatile climate induced disasters.

**Weather-Indexed Bonds.** Weather-indexed catastrophe bonds, based on payouts linked to measurable weather events (as reflected in weather indexes or parametric measures), have the advantage of being relatively easy to implement once a reliable weather measurement mechanism is identified. They bypass the traditional insurance loss adjustment process, which requires site-by-site evaluation of losses before indemnity is provided. The payout is simply based on the weather index reaching a certain range. For example, payouts for the Tokyo Marine Insurance cat bond, while not weather related are based on specified Richter measures of earthquake intensity and damages in Tokyo within a specified radius around the city. This is known as a “parametric” trigger.

The main risk with weather-indexed instruments or parametric triggers is basis risk – this is the risk that the basis of data for triggering the loss payment (such as a high wind speed, excessive rainfall, or earthquake intensity) is not directly linked to actual losses on the ground (such as specific damage to a house, building or major piece of infrastructure). A loss payment could be made (with the bondholder losing interest and principal) even though the insured experiences no loss. Or the insured party may experience a loss but receive no indemnity because the parametric index was not triggered (e.g.: as a result of a lower-than-threshold wind speed).

Most catastrophe bonds – such as those issued in Europe and the United States – are triggered by reported losses and indemnification claims in the industry rather than weather indexes.<sup>51</sup> However, investor appetite for such bonds issued in developing countries is low because of lack

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<sup>51</sup> Note: An index is a form of a parametric trigger. Usually the term index is used when an existing scale for a measurement index (e.g.: a temperature index, a reported industry index) is used instead of a custom-made physical measurement.

of direct knowledge of the local insurance industry. Bonds based on easily verifiable weather indexes or parametric triggers would be more attractive. Adding to their attractiveness are the opportunities they would offer international investors for portfolio diversification, since natural disasters have little or no correlation with global financial market trends, as discussed earlier.

What would the financial structure of a scheme based on weather-indexed bonds look like? Catastrophe bonds could cover public infrastructure or provide financing to a private pooled fund, as described in the previous section. The bonds would pay higher-than-average yields but would also carry a risk of a significant drop in the coupon rate or a loss of principal in the event of a climate induced catastrophe that leads to loss payments. A multilateral institution or affiliate could guarantee the contractual payments of bond coupons and any principal due investors if no disaster occurred. In a fully private arrangement the bond payments would need to be fully secured by the premiums collected in the common fund. The basis for triggering loss payments could be information from weather station tracking equipment, with satellite links to global recording centers, or from weather monitoring systems of major industrialized countries which typically tracks high-altitude hurricane activity, for example, in the Pacific and Atlantic regions.

Before weather-indexed bonds are introduced, historical data on weather events and associated losses would need to be compiled and analyzed to ensure a sufficiently strong correlation between index-triggered payments and actual losses. Climate change effects on previous trends in natural disaster would need to be incorporated to adjust the expected probabilities of such events. These data are essential for structuring and pricing such “insurance” contracts.

**Protection for Agricultural Losses.** While weather indexed bonds are generally structured for high impact events such as hurricanes/typhoons or other forms of windstorm, one of the effects of climate change is the increasing temperatures (e.g.: South Eastern Europe) leading to drought periods. While the catastrophe bond market is less apt for such “slow onset” events which have less of a random-type distribution, there are other weather contracts (structured like financial options) that could be used to compensate farmers financially for periods of severe drought (and potentially severe rainfall as well).

Such weather “options” are generally structured as an insurance contract where the farmer or temperature-linked business pays a premium in case crop output is not as expected in a year of severe heat (conversely, these contracts are also used for years of severe cold where crops can freeze). The trigger of the contract is generally the temperature index, i.e., an established parametric measure. However, the contract (which would pay a pre-defined fixed amount in the event it is triggered), can only be called if the higher (or lower) than threshold temperatures persist for a pre-defined number of days – such temperatures for such elapsed times, are estimated by agricultural experts to result in crop losses. Thus, the contracts would pre-define all such parameters and the payment (on which the premium would be based) is set according to the compensation needs of farming and agricultural businesses affected by climate change.

If the affected farming community is of modest to low income, Governments can also assist by subsidizing part of the premium of such weather contracts, or alternatively have the Government be the protection provider. In this latter case, however, the country would not be transferring the risk since, the event occurrence would result in the Government paying farmers’ insurance claims out of the fiscal purse, albeit, compensated via some of the premiums collected. Thus, if

the Government wishes to subsidize the premium, it would be better to do so with a third party providing the actual insurance protection. Such third party, would have to be first vetted regarding its own creditworthiness.

**Mechanisms Combining Instruments and Role of Development Institutions.** While a weather-indexed bond could be developed on its own to protect government resources, it could also be combined with a climate catastrophe insurance pool where the bond could serve as one of the upper layers of coverage. Such risk transfer mechanisms involving capital market instrument under multi-period contracts can further reduce the potential volatility of insurance and reinsurance prices. They would also enable governments to insure public property against climate induced catastrophes, at more reasonable prices than going to the traditional market alone. And they would enable the local insurance industry to extend coverage to such hard-to-insure sectors as small farmers, public infrastructure, and low-income communities.

Financial support from multilateral institutions to create an insurance pool for climate change affected countries and weather-indexed bonds (both of which have been done before for traditional natural disasters), can be combined separately or together. These would meet several objectives. The support would help reduce potential market failures due to historical premium volatilities which would result in lapses in coverage for ever increasing risks. It would also help overcome suboptimal coverage resulting from scale diseconomies in countries' insurance markets if they go it alone, and the lack of incentives for measures to adapt to catastrophic losses. In addition, capital market-based arrangements could increase the insured asset base in developing economies while promoting reliability in economic compensation following natural disasters. Such support could encourage participation by the national and international insurance industries once they realized that all the risk was not being transferred to them.

Such initiatives go hand in hand with the needed restructuring of local insurance industries. Thus the involvement of multilateral institutions could help strengthen the domestic insurance industries and improve hazard adaptation measures. Where regional rather than national arrangements are more optimal, multilateral institutions could facilitate the needed inter-country policy dialogue.

**Insurance Associated with Carbon Mitigation Mechanisms.** While mitigation of climate change effects through reduction of carbon emissions is the primary course of action to attack climate change, the emission reductions (ER) market may also benefit from insurance instruments. While the current Kyoto protocol agreements and the EU's emissions trading system has succeeded in creating a market in ERs, the next phase contains uncertainties about the parameters of the ER market, such as equilibrium ER trading prices, initial rights or auctioned rights, emission credits, etc. One mechanism which might be considered while policymakers continue deliberations on the parameters of the market and the new protocols to be established, would be an insurance mechanism to protect sellers and purchasers of ER credits from price swings which may be caused by regulatory or framework uncertainties yet to be firmed up.

One such mechanism could be an insurance provider protecting or compensating ER sellers against unanticipated ER price swings. The EU, for example, could be the seller of such insurance and charge a premium to those needing price protection. ER sellers would be the

primary clients since they are most likely to buy such insurance to avoid over-investing in mitigation without a guarantee of a floor ER price.

However, the insurance for ER credits would be limited in the price variation covered (for example a 25% variance against “initial market conditions”), so as to limit the claims liability of those countries (e.g. EU) providing such insurance. Multilateral institutions could offer such countries a contingent style facility for use in paying such claims immediately if they arose. The premiums charged for the limited price variance protection would be used to pay for any contingent loan fees and possibly principal, if a claims event occurred. By limiting the price variance that was protected, it would be easy to quantify what the maximum liability of such a scheme might be.

**Conclusions.** Climate change induced disasters are likely to rise given recent evidence of weather trends. The insurance industry is recognizing this and adapting its analytical models for this purpose. The capital markets have also come in to provide more capital, provided that the risks are reflected in the overall pricing demanded from such exotic bonds.

Development institutions and credit market are ready to finance losses, provided that adequate adaptation measures have been taken in advance so as to minimize what needs to be “insured”. Therefore, governments, individually and collectively, need to quantify their climate induced disaster exposures and calculate the budget allocations required to cover reasonably projected losses. If these are not sustainable, they should consider the range of financial instruments to optimize (i.e., lower) the cost of premium-equivalent outlays while maximizing any loss payout needed if a climate change induced disaster affects their territory.

The use and price of pooled risk approaches, capital market mechanisms, insurance and credit instruments, can be calculated in combination, to reduce the cost of such financial protection for emergency reconstruction, while avoiding the economic and budgetary disruptions this would otherwise entail.

## 4. OVERVIEW OF RISK MITIGATION MEASURES

**Disaster Risk Mitigation.** The term mitigation, as defined by the UN International Strategy for Disaster Reduction (ISDR), means “structural and non-structural measures undertaken to limit the adverse impact of natural disasters, environmental degradation and technological hazards”. According to a study done by the U.S. National Institute of Building Sciences (NIBS), on average, one dollar spent on hazard mitigation saves four dollars in future disasters.<sup>52</sup> Moreover, because of mitigation efforts taken in the United States between 1993 and 2003, NIBS predicts that at least 220 lives will be saved over the next fifty years.<sup>53</sup>

Mitigation reduces the impact of disasters, saves lives and reduces economic loss. Mitigation measures can be taken for every hazard and can be classified into four subject areas.<sup>54</sup>

Retrofitting. Property protection involves the modification of existing structures to withstand natural hazards. Examples include installing back-up valves in sewage and water pipes, elevating structures, installing storm shutters, seismic strengthening, etc.

Regulations. Regulations involve controlling the use of land and construction of buildings to reduce potential loss. Examples include enforcing building codes and establishing land use zones.

Protective Structures. Structures can be built to protect and mitigate the impact of disasters. Examples include erecting seawalls, building safe rooms, and constructing levees.

Natural Resource Management. Managing natural resources minimizes risk of hazards. Examples include controlling erosion, managing forests, and restoring wetlands.

Mitigation measures can also be grouped into two types of actions, i.e., “soft” measures which are typically non-structural, process-oriented actions that can be completed through regulations and planning, such as mapping hazards and enforcing building codes, and “hard” measures which usually encompass structural investments, such as building dykes and reservoirs. Both soft and hard measures are discussed below.

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<sup>52</sup> Multihazard Mitigation Council (MMC) - U.S. National Institute of Building Sciences (NIBS), “Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities,” Washington, DC, 2005.

<sup>53</sup> *Ibidem.*

<sup>54</sup> U.S. Federal Emergency Management Agency (FEMA), “FEMA 386-3: Developing the Mitigation Plan: Identifying Mitigation Actions and Implementation Strategies,” April 2003.

## **All-Hazard Risk Mitigation Measures**

The following are recommended actions to reduce the general risk of natural hazards.

**Development of Regulatory and Institutional Framework.** A regulatory and institutional framework establishes national responsibilities for risk mitigation by providing authority to respective government agencies to carry out responsibilities related to the agreed upon government measures. Included in such framework are specific legislations that allow jurisdictions to adopt and enforce land use ordinances and building codes.

The framework should also include the development of a national mitigation action plan. After assessing risks and potential mitigation measures, an action plan can be developed describing how actions and investments will be prioritized, implemented and administered.

As part of the South Eastern Europe Disaster Risk Mitigation and Adaptation framework program the World Bank will support the development of comprehensive disaster risk management and adaptation strategies in the SEE countries, which will include sectoral reviews and multi-sector analyses involving all key stakeholders. The reviews will provide recommendations for organizational and legislative improvements and priority investments in adaptation and disaster risk reduction.

**Hazard Monitoring and Data Collection.** In order to determine the vulnerability of a country's population, the institutions responsible for monitoring hydrology and meteorology and collecting geological data must be properly equipped. The monitoring and data collection for natural hazards may be spread across institutions. For example, monitoring the risk of landslides may require geological surveys as well as hydrometeorological forecasting. Collection and analysis of data should be shared across institutions to ensure the proper evaluation of risks.

**Development of Risk Assessments.** The development of natural hazard risk assessments for selected areas and hazards, based on the analysis of historical events at these locations, can feed into probability distributions and predictions of likely future occurrences. To undertake a risk assessment, data should be collected and analyzed on the assets and population exposed in a given location. Probable damage scenarios, vulnerability models and loss scenarios analyses are useful tools, which constitute key foundations for the development of preparedness actions and investments as well as for risk financing options.

Among the countries of ECA region which carried out such assessments is Albania which, with support from international donors, completed a multi-hazard risk assessment for floods, landslides, forest fires, heavy snow, earthquakes, epidemics, and technological hazards. For each hazard type, the study assessed areas at risk, impact on the population and infrastructure, estimation of potential casualties and evacuation needs. The study also focused on some broader groups of elements at risks, such as: particularly vulnerable population, housing, public facilities (schools and hospitals), vital transport infrastructure and critical industrial complexes.

**Hazard Risk Mapping.** Hazard risk mapping can provide data on the likelihood and consequences of specific hazards in selected areas, information that gives a basis for risk

mitigation prioritization and investments. A critical element in reducing vulnerability is analysis of human settlements and infrastructure in the high-risk areas. Geographic Information Systems (GIS), with layers of digital data, create risk maps and data sources enabling further use of subsequent mitigation measures, such as land use planning, improved building codes, incorporation in the relevant legislation, securing funds for investments, etc.

**Implementation of All-Hazard Land Use Plans and Development/Enforcement of Building Codes.** The safety of future structures can be addressed through land use planning, resistant designs and construction, building regulations and permitting systems, and enforcement of urban plans and building codes. This measure is particularly important in fast-growing and often unregulated development areas. Spatial development plans and regulations which take into account natural hazards, as well as enforcement of the existing or newly formulated building codes and regulations, is of key importance for mitigation against all hazards.

Several municipalities in Turkey, particularly those most vulnerable to hazard risk, carried out multi-hazard risk analyses, hazard mapping, loss estimations and development of mitigation plans. This work has had as a purpose an improvement of land use plans, based on a particular risk of a given municipality, and allowed them to make informed decisions in regard to their urban development. Based on the results of this pilot work supported by the Bank through the Marmara Earthquake Emergency Reconstruction project, further amendments were made to the respective regulations, including formulation of the Development Law.

**Construction of Hazard-Resistant Buildings.** The purpose of constructing hazard-resistant buildings is to prevent loss of lives and injuries sustained as a result of damaged buildings. In addition, in case of certain types of public facilities, such as hospitals, emergency response services, etc., it is important that they continue their operations in the aftermath of a disaster. Typically, designs account for seismic events. However, buildings can also be constructed to resist wind and lessen the damage from floods.

**Provision of Risk Mitigation Education to the Public.** It is important to develop and implement a public awareness campaign to educate individuals on how they can personally reduce the risk of hazards that occur in their area. This kind of information should be disseminated to the public through television and radio, schools, community outreach programs, etc. Public awareness of the risks also helps monitor developments on the ground and keep authorities accountable for their actions in the area of adaptation and hazard risk mitigation. As an example, Romania has developed under the Hazard Risk Mitigation and Emergency Preparedness project, a multi-hazard public awareness campaign tailored to various target audience, such as children, using multiple media, including internet web site with links to educational tools for students.

### **Hazard-Specific Adaptation Investments**

**Flood Risk Reduction.** Taking into account the projected impact of climate change and growing risk and losses due to floods in the ECA region, there is a need for improvement and expansion of flood protection in order to reduce a country's vulnerability to floods. The following are examples of soft and hard measures that can be taken:

Implementation of Flood Management Program. Flood management should be addressed within the context of the river basin and catchment water management plans. Watershed basin planning and feasibility studies for the rehabilitation and upgrading of the existing flood protection schemes should be developed or further reviewed in light of climate change projections. Flood management also includes floodplain zoning, the development of a land use plans, and implementation of regulations. Specifically for the coastal regions, prone in the long-term to water level rising, a flood management program should include coastal planning and the development of coastal zone regulations such as shoreline setback requirements.

Natural Resources Management. Restoring resources to its natural state may reduce the impact of flooding. For example, restoring dunes and beaches can impede coastal erosion. Removing debris in river channels will allow for the natural movement of water and prevent sediment from building up. To assist in the design of specific measures, multi-country studies for specific watershed areas can be carried out and agreements reached to determine how the management of natural resources within each country can reduce the likelihood of flooding.

Flood Protection Infrastructure. Flood protection investments which safeguard particular localities, may include: riverbank protection; improvement of reservoirs and dykes; retrofitting of dams for safety with larger spillways and gates, enlarging floodways; building levees, floodwalls, seawalls/bulkheads; dam monitoring; reviews and revisions of operating rules for dams, etc. Decisions on flood protection investments should be preceded by feasibility studies that incorporate economic, environmental and social assessments, and take into account not only historical frequency and loss data but also climate change data and projections, as the probability and return periods may change, which will require a modified technical approach.

In Poland, the World Bank has supported improvements in the flood management system through the policy framework and institutional capacity for flood management, investments to upgrade hydrotechnical infrastructure, modernizing flood management systems and meteorological systems, updating mapping and modeling of river basin areas using GIS, improving forecasting and planning, and building flood protection infrastructure. The recent major flood protection project will protect estimated 2.5 million people in the Odra River Basin against loss of live and property damage through establishment of a storage in a dry polder on the river upstream enabling reduction of flood peak downstream of the reservoir.

Flood Resistant Construction. There are a variety of measures that can be undertaken to build flood-resistant structures. First, buildings can be constructed with flood-resistant materials.<sup>55</sup> Buildings walls can be strengthened to withstand the pressure of floodwaters and floating debris and the structures can be properly anchored to its foundation or footing. Buildings can be elevated above the average waterline for a 100-year flood event so that the floors of the building are situated above floodwater level.

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<sup>55</sup> The U.S. Federal Emergency Management Agency defines flood-resistant as materials that can withstand direct contact with flood waters for 72 hours without being significantly damaged. U.S. Federal Emergency Management Agency (FEMA), "Build with Flood-Resistant Materials," <http://www.fema.gov/plan/prevent/howto/how2025.shtm#other> (accessed April 2008).



Hydro-meteorological Monitoring and Forecasting System. Due to the current and projected impact of weather-induced natural hazards, the effective functioning of hydro-meteorological systems is very important for disaster preparedness and response. Floods occur through the inundation of large water plains but also in areas of small, shallow rivers. Spillages and failures of dams can also cause flooding. In many cases, these disasters are predictable in a given time horizon and allow for early warning and response actions, particularly in downstream countries. But in order for the warning and response to be effective, a reliable weather and water monitoring system must be in place. In this context, information flow within a country and sharing meteorological and hydrological data and forecasting between the upstream and downstream countries is of paramount importance.

The National Hydromet Modernization Project in Russia aims at increasing the accuracy of forecasts provided to the Russian people and economy by modernizing key elements of RosHydromet's technical base and strengthening its institutional arrangements. This will enable enterprise and household adjustments to protect lives and support economic growth. The project supports: (i) modernization of computing, archiving and telecommunications facilities, (ii) upgrading of the observation networks, (iii) institutional strengthening, improvement in output dissemination, and emergency preparedness.

The ECA has just completed a Review of Weather and Climate Services in the region. The study was carried out to strengthen understanding of the governments of ECA's client countries of gains that could be made by enhancement of weather and climate services and highlighted cost-effective solutions to regional capacity gaps.

Retrofitting of Buildings and Infrastructure. Measures to retrofit existing buildings to withstand flooding may include anchoring of storage tanks to prevent flotation; installation of flood vents so that the pressure of floodwaters equalizes and saves the building from extreme damage. It is also important to protect wells from flood waters, prone to being contaminated by such toxic materials as raw sewage, oil and chemicals, through such technical measures as extending the well's casing at least 2 feet above the highest known flood elevation and installing backflow valves in the water line.<sup>56</sup>

**Extreme Temperature and Wildfire Risk Reduction.** A key risk associated to increasingly frequent heat waves and dry conditions is wildfire. Forests in Europe that are already moisture-limited or temperature-limited will have greater difficulty in adapting to climate change. Fire protection will be an important component in protecting forest and grassland, particularly in South Eastern Europe. Recent wildfires of summer 2007 have highlighted that losses and long-term environmental consequences of forest fires are increasing in the region and that comprehensive fire safety measures need to be adopted.

Monitoring of Forest Fires. In case of risk of wildfires, development of an early warning system for monitoring forests is particularly advisable. To help predict when forest fires are more likely to occur, this early warning system should include a forest fire index that incorporates such data as soil moisture, air humidity, precipitation, etc. GIS and satellite imagery can also enhance the

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<sup>56</sup> U.S. Federal Emergency Management Agency (FEMA), "Protect Wells from Contamination by Flooding," <http://www.fema.gov/plan/prevent/howto/how2026.shtm> (accessed April 2008).

monitoring of forest fires by digitizing maps and referencing them to forest inventory data. As in the case of floods, the internal cooperation within a country, between various sectors and agencies (e.g., hydromet, forestry sector, fire fighting command), and externally with the neighboring states, is very important for the wildfires monitoring system to be effective.

Observed increase in number of wild fires the South Eastern Europe has been associated with the climate change. Most of these forest fires are trans-boundary in nature, therefore coordination on early warning systems and response is of critical importance for neighboring countries. Efforts to better coordinate response to forest fires and other hazards were initiated in Croatia. Last year, the Government of Croatia approved establishment of a Regional Coordination Center (RCC) for Wild Fires and proposed project being currently under preparation will support the creation of such center in Split. The project may also finance creation of a database for forest monitoring. The data base would include such elements as plant species and soil conditions, flammability, etc., which together with the information coming from the hydrometeorological services (temperature, wind, humidity, etc.) would facilitate early detection of wild fires. The database would be firstly created for Croatia and then extended to cover other countries of the region, starting with the neighboring states. The project also plans to finance development of forest fire scenario models which would serve as a response planning and training tool.

Development of Forest Management Program. In view of climatic changes, managing forests through incorporation of wild fires mitigation may include: the replacement of highly flammable species, regulation of age-class distributions, and widespread management of accumulated fuel, eventually through prescribed burning, as well as changing the species composition of forest stands and planting forests with genetically improved seedlings adapted to a new climate, the thinning of plants and trees, extending the rotation period of commercially important tree species to increase “sequestration” (the storage of carbon), and planting based on a forest’s micro-climate. The introduction of multi-species planting into currently mono-species coniferous plantations can also be beneficial.

Much can be done for better forest resources management at the community level. In Armenia, the Natural Resources Management and Poverty Reduction project is assisting communities in northern part of the country through community based forest management and small-scale local initiatives to revert degradation of natural resources. The locally implemented measures include reforestation, re-seeding of indigenous species and rehabilitation of forest pastures, meadows and steppes, etc.

Regulation of Land Use. Regulations and their enforcement regarding settlement in the proximity to forest areas are of key importance to wild fire mitigation. Therefore, regulations should be developed and locally enforced regarding population settlements near forests. Regulations can include requiring land use permits and fees, establishing safety zones around dwellings by requiring the removal of vegetation around houses, and banning settlements in proximity to high risks areas. These measures can limit the negative impact of human activities on areas vulnerable to wild fires.

Public Awareness Campaigns. The countries which according to the climate data are increasingly prone to heat waves should develop an aggressive public awareness program.

Information such as how extreme heat can affect the body and what steps can be taken to reduce heat's impact is an important measure towards saving lives. Also, education and public awareness efforts targeted towards specific groups, such as farmers, tourists, and house owners in the vulnerable areas, on the behavior in the high-risk seasons, can reduce wild fire risk.

**Landslide and Mudflow Risk Reduction.** There are many countries in the ECA region that are prone to landslides. While landslides fit into the geo-hazards category, they often occur as secondary consequences of other events. In the context of hazards derived from climatic conditions, floods can be key triggers for landslides in particularly prone areas. Taking into account projected increase in precipitation intensity and precipitation per extreme event, the vulnerability to mudslides and landslides is expected to grow. Similar to earthquakes, the occurrence of landslides and their precise location are difficult to predict, though there are already some technologies, notably coming from satellite imaging, which can analyze ground movements and project likelihood of slides. Some key landslide and mudslide risk reduction measures comprise the following elements:

Development of Landslide and Mudflow Maps, and Monitoring System. A cornerstone for landslide mitigation is knowing the location of areas particularly prone to landslides. Therefore, studies and GIS maps should be produced for selected areas, including data on morphology, hydrogeology, land use, soil type, etc. The current satellite technology also allows for better monitoring of slope movement. These analyses can serve as foundations for the regulations, land use plans, and if feasible, stabilization works.

In order to reduce the risk related to Lake Sarez, in Tajikistan, a modern monitoring system, coupled with an early warning system has been recently installed as part of the Lake Sarez Risk Mitigation project. The satellite-based remote sensing technology detects and measures ground deformation arising from natural or induced causes to millimeter accuracy. The system is coupled with hydromet monitoring system and is aimed at alerting people living in the lake Sarez area which is vulnerable to landslides, floods and earthquakes. The system also helps map hazard risk scenarios.

Regulation of Land Use and Population Settlements. Landslides often occur as disasters associated with other hazard events, and can be triggered by floods and earthquakes. Key to landslide risk reduction is spatial planning and environmental management (e.g., afforestation). Hence, the importance of regulations and their enforcement regarding land use. Foremost, buildings and other infrastructure should not be built on land vulnerable to landslides such as drainage ways or steep slopes.

Slope Stabilization Works. In cases where it is economically and technically feasible, slope stabilization and erosion control measures can be employed. Planting ground covering slopes and building retaining walls on hillsides may reduce landslide risk.

**Drought Risk Reduction.** The risk of drought is expected to increase due to climatic changes in many ECA countries, particularly those in South Eastern Europe, Caucasus, parts of Russia, and Central Asia. The increasing shortages of water will affect both rural and urban areas. Therefore,

many of the below summarized measures might be considered for implementation by the governments.

Regulation of Water Use. Governments can take a number of regulatory and technical measures to reduce the demand for water. Water metering and leak detection programs can be implemented to better regulate and enforce water usage. Emergency water conservation regulations can also be enacted when it is determined that a community is entering a drought situation.

Drought Resistant Crops. Either substituting crops or introducing new species of drought resistant crops are options farmers can take to reduce the impact of drought on agriculture (e.g., replacing winter with spring wheat), cultivars (higher drought resistance and longer grain-filling).

Soil Management Practices. Practicing good soil management maintains a soil's structure and composition, which reduces soil degradation and erosion. Reducing erosion decreases surface runoff and increases soil moisture. Soil management practices include crop rotation, terracing, off-season tillage or reducing tillage, diversifying crops, mulching and reclamation of salinized soil.

Building Water Retention Structures. Building structures that retain water can increase soil moisture and replenish groundwater. Water retention structures include trenches and contour bunds, check dams and percolation ponds, all of which direct and retain the flow of runoff.

New Irrigation Methods. Adopting efficient irrigation methods will reduce the demand for water. Incorporating or substituting current irrigation methods with such schemes as harvesting rainwater and drip irrigation can improve water usage and reduce demand. Landscape contouring such as forming saucer basins under trees and planting crops using ridges and furrows, can also help collect and direct runoff to planted areas.<sup>57</sup>

In Kyrgyz Republic, the Bank through the Water Management Improvement project is supporting enhancements in irrigation service delivery and water management. The works include construction of, or repair to, headworks, settling basins and sediment ejectors, concrete lining, overpasses and underpasses to take cross-drainage and sediment flows across canal sections, repair, replacement, or construction of channel control structures, mechanical desilting of canal sections; and repair to, or construction of, gauging stations.

Enhancement of Hydro-meteorological Monitoring System. Establishing a reliable weather and water monitoring system is both flood (as explained above) and drought risks mitigation measure which allows for prediction and early response but also helps in development of long-term strategies. Modernizing the hydromet system will increase the accuracy of weather forecasts and will allow farmers to better plan the sowing and harvesting of crops.

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<sup>57</sup> The Ojos Negros Research Group. Drought Facts. [http://threeissues.sdsu.edu/three\\_issues\\_droughtfacts04.html](http://threeissues.sdsu.edu/three_issues_droughtfacts04.html), (accessed April 2008).

Collection and Monitoring of Drought Data. Predicting and monitoring of drought requires a wide collection of data. Soil moisture, levels of stored water, snow pack quantity, melt rate, and rainfall, are examples of hydro data that can be collected to determine drought risk. Assessing drought's impact also requires extensive data collection. Type of land use, demographics, and existing infrastructure are all factors that are taken into account to determine how drought will affect a community. Being able to determine when localities are in drought and its impact, allows government to trigger drought-related actions, like regulating public water usage and launching targeted water supplies.

**Strong Winds and Storms Risk Reduction.** Climate change projections indicate that the Baltic and South Eastern Europe countries will experience increased wind speeds which can pose another risk to infrastructure and population, which will have to be addressed by governments and individuals through technical measures. For the latter, public education of those tools is particularly important.

Designing, Building and Retrofitting of Wind Resistant Structures. Designing and constructing buildings and other infrastructure to resist wind in risk-prone areas is a key adaptation measure. In particular, proper roof design and construction is the number one factor for mitigating wind damage to a building. For example, buildings with hip or flat roofs are more wind resistant than others such as gable end roofs. Constructing with strong roof materials such as 26 gauge alusteel sheeting can also improve a building's envelope. Construction techniques such as spacing timber purlings no more than 900mm apart are other ways to build wind-resistant roofs.<sup>58</sup> Buildings can also be retrofitted to withstand strong winds. Retrofitting may involve installing straps to secure roofs, and clipping metal siding to a building's frame.

Assigning Shelters. In the particularly vulnerable communities, assigning or building shelters for people to protect them from high-speed winds and other hazards should be considered. This requires development and execution of public alerts and evacuation procedures.

Enforcement of Building Codes. Structures should be designed to withstand heavy winds. In areas that are at risk of strong winds, relevant building codes should be developed and enforced. Areas that have adopted and enforced high-wind building codes have clearly benefitted from these regulations. For example, in 1995, the coastal areas in the State of Florida began to use and enforce wind-resistant building codes. In a study on insurance claims from Hurricane Charley in 2004, it was determined that for houses built after the building codes were enforced, frequency of claims were reduced by 60%, and when a loss did happen, the claim was 42% lower.<sup>59</sup>

Protection of Building Envelope. Resistance of buildings to high winds can be improved through relatively simple measures. Because a broken window or other opening in a building's envelope can increase the difference in pressure and cause roof failure, the need to protect windows and doors should be communicated to the population. Doors can be protected by covering them in

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<sup>58</sup> Organization of American States - Caribbean Disaster Mitigation Project. "Costs and Benefits of Disaster Mitigation in the Construction Industry," Note: originally prepared by Pereira J. (1995) for presentation at the Caribbean Disaster Mitigation Planning Workshop, Trinidad, 14–16 March 1995. 2001.

<sup>59</sup> Institute for Business and Home Safety, "The Benefits of Modern Wind Resistant Building Codes on Hurricane Claim Frequency and Severity," 2005.

sturdy fabric screens. Installation of storm shutters can reduce damage to windows from wind-borne objects. Securing outside objects and trimming trees around structures will also reduce the chance of flying debris.

Meteorological Monitoring. Like in the case of heavy rains and floods, the monitoring of weather and country forecasting capacity is a key prerequisite for early warning of the population and taking timely preparedness measures. Also, the availability of historical meteorological data and projected medium- and long-term changes can inform government's policy and regulatory decisions.

## 5. EMERGENCY MANAGEMENT

Emergency management is defined as the organization and management of resources and responsibilities for dealing with all aspects of emergencies. Emergency or disaster management involves plans, structures and arrangements established for a comprehensive and coordinated response to the whole spectrum of emergency needs.<sup>60</sup> The following section discusses main actions governments of the region can take to strengthen their emergency management capacity, focusing on preparedness and response aspects.

**Development of Institutional and Legal Arrangements.** Emergency management occurs at all levels – national, regional and local. The legislative framework should define the authority to carry out emergency management duties, how a disaster is declared, and the mechanisms for accessing emergency resources. Other legal considerations include outlining emergency powers; identifying lines of succession in case a government's leader is affected by the emergency; and defining authorities and actions a successor may take during a disaster.

To properly coordinate emergency services, the roles and responsibilities of key stakeholders should also be specified, not only for government agencies but also for non-governmental organizations. Moreover, if emergency management resources are owned by local entities, mutual aid agreements need to be developed so that neighboring towns can share resources. These agreements can also be developed nation-to-nation.

**Emergency Response Planning.** A response plan should clearly delineate roles and responsibilities of disaster response organizations. It should explain how organizations coordinate both horizontally with each other and vertically with local and national authorities. Often, national response plans include how to request international resources while local plans include evacuation and shelter plans. Typically, response plans consist of operational and logistical components, including procedures for damage and needs assessment in the aftermath of a disaster.

**Emergency Training and Exercises.** After plans have been developed, they need to be trained and exercised to determine gaps and shortfalls. A training and exercises program should be conducted at the national, regional and local levels to test coordination, response, and readiness, and to modify the emergency response plans, if needed.

**Monitoring, Alert and Early Warning Systems.** Monitoring, alert and early warning systems involve the communication of all-hazard forecasts to the public and government officials. An early warning system comprises a regularly tested process to receive data and disseminate

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<sup>60</sup> UN International Strategy for Disaster Reduction, “*Basic Terms of Disaster Risk Reduction*,” March 2004.

warnings 24 hours a day, 7 days a week. It includes a back-up system to ensure communications in case the primary system fails. Communications to the public are hazard-specific and contain clear emergency directions. Alert and warning systems are designed for specific hazards, such as floods and strong winds.

Flood, heavy rain and strong wind warning systems combine meteorological data (rainfall, snowmelt, and storms) with water-level measurements on rivers and reservoirs to provide data for warnings of approaching floods and storms. The early warning system should establish data sharing and functional linkages between hydromet service organizations and emergency response units (e.g., civil protection) and authorities, to allow sufficient time to inform the public of response measures, such as evacuations, and launch rescue operations. In the area of flood early warning, the transboundary cooperation between countries sharing the river basins is particularly important.

**Public Awareness and Education.** Public knowledge about natural and technological hazards and measures to reduce risk and respond to disasters is a vital element of emergency management. Public awareness strategies and campaigns, and production of public awareness materials (e.g. printed materials, infomercials, public displays, etc.) through various delivery measures (e.g. radio, TV, press, public information centers) should be developed.

Another measure to enhance public awareness and preparedness is the education of students in schools on natural hazards, prevention, preparedness and response. Educational programs can have national coverage or be tailored to certain types of disasters to which given localities are prone and to age-differentiated student audiences. School curricula, educational materials, and teacher training, can be developed in order to provide scientific understanding of natural hazards.

**Establishment of Emergency Operations Centers.** A key element of emergency response is the establishment of an emergency operations center (EOC). An EOC is where emergency services are coordinated. It is responsible for activating staff to respond to emergencies; requesting resources such as equipment and teams; coordinating response and recovery activities; tracking resources; and collecting information from the field such as damage and needs assessments. An emergency operations center is an important element in developing a robust emergency management system.

In Turkey, the Bank projects have helped establish the national emergency operations center in Ankara as well as the center for the Istanbul province, with full technical information and communication capacities to manage emergencies and disasters.

**First Response Services.** First response services include fire fighting, medical, public safety, and search and rescue services. Typically, fire fighting services not only manage fires but also respond to vehicle accidents and hazardous material emergencies such as explosions. Search and rescue, swift water rescue and other specialized teams usually fall under civil protection or fire fighting services.

First response can be strengthened through provision of equipment and tools such as personal protection equipment or emergency medical units. The planning for the location of the



emergency response equipment should take into account accessibility and safety of storage. First responders can also be strengthened through continuous training and exercises.

**Mass Care Services.** Mass care is an essential element of emergency response, which includes temporary shelters and comfort stations to provide medical assistance, food and water to the public. When providing shelter services, proper sanitation, emergency power, safety of food and water supplies and prevention of infectious outbreaks must be considered.

**Development of Robust Logistics System.** Logistics is the backbone of an emergency response. It includes facility management, resource management, and transportation. Facility management encompasses the identification, acquisition and set-up of response facilities such as staging areas. Resource management is the identification, acquisition, storage, maintenance, distribution, accounting and disposal of emergency resources. Transportation involves the movement of resources into the affected area. Logistics requires strong coordination across all emergency functions.

**Emergency Communication and Information Systems.** Provision of accurate and timely information to decision-makers and response units is crucial for saving lives and property. Interoperability and coverage of both voice and data communications capabilities across emergency management agencies, such as fire brigades and medical units, is of key importance. Emergency management information systems collect, analyze, and share real-time data between emergency management institutions and other public authorities at the national, regional and local levels. The system should allow for two-way processing of information and support the daily operations of relevant agencies.

In recognition of importance of such a system, the Government of Romania has proceeded with, and is in an advanced stage of establishment of a modern national emergency management system which will link all key government institutions and incorporate already existing sectoral systems into an integrated information management system which will support not only management of major catastrophic events but also the decision-making process in other emergencies and operations. The system being developed is part of the Hazard Risk Mitigation and Emergency Preparedness project.

## 6. CONCLUSIONS AND RECOMMENDATIONS FOR PUBLIC POLICY

Climate change is expected to increase global temperature, thereby changing precipitation patterns worldwide. For all sub-regions of Europe and Central Asia, these climatic changes are likely to increase the risk of extreme weather-related hazards. To reduce financial and environmental vulnerability and *improve adaptive capacities*, specific measures as described in the preceding chapters should be considered by decision makers.

It should be noted that these measures will not only strengthen climate change adaptation but will also benefit the management of present-day disasters that the region already endures. Furthermore, these actions and investments will not only decrease the risk of large-scale catastrophes brought on by climate change but also the risk of small and medium-sized disasters.

Across the ECA region, developing and strengthening an *institutional and legislative disaster risk management framework* would assist in budget appropriations, planning and finally the implementation of a disaster risk management plan. Ensuring that legal statutes are clear and that hazard risk management is properly funded is the first step. A strong system should have a robust preparedness program with plans, training and exercises for all levels of its emergency management system.

*Clarifying the roles and responsibilities* of local and national governmental bodies in risk reduction as well as emergency preparedness and response, would also improve disaster risk management capacity. Emergency risk management is a multi-sectoral process, with multiple governmental entities responsible for overlapping functions. Not only do emergency risk management responsibilities fall horizontally among multiple governmental bodies but with decentralization, emergency management responsibilities also fall vertically. This matrix can be confusing and ineffective if roles and functions are not clearly defined at every level.

There are many ‘hard’ and ‘soft’ measures a country can take to reduce the risk of natural hazards and adapt to climatic changes. However, before undertaking any concrete steps, it is recommended to first complete *hazard risk assessments* and corresponding hazard maps. Data from the risk assessment can also assist policymakers in developing all-hazard land use plans, which in turn will help develop all-hazard building codes. Risk assessments are also crucial for policymakers to embark on the process of evaluation of the cost/benefit of risk mitigation investments leading to prioritization of investments.

Historically, Europe and Central Asia have been significantly affected by hydrometeorological hazards. The effect these disasters have on the population and infrastructure are exacerbated by several factors such as settlements in disaster-prone areas, debilitating land and water use, lack of regulations and standards which take into account the hazard risks, and failure to comply with

building codes and land use plans. **Hazard-specific investments** can reduce the risk of hydrometeorological hazards and increase adaptive capacity. Early warning systems for various hazards can be developed to monitor heat waves, forest fires and hydrometeorological events such as floods. Flood risk reduction measures can range from soft measures such as developing flood management plans to hard measures such as investments in flood protection schemes. Drought can be reduced through the introduction of drought resistant crops and the risk of storms can be reduced by retrofitting buildings to withstand heavy winds. A combination of regulatory, structural, and protective measures can be taken by both the government and the public to reduce risk and decrease a country's vulnerability to natural hazards and adapt to climatic changes.

Another measure a government can take is to **strengthen the technical capacity** of emergency responders. This includes purchasing personal protective equipment, tools, and vehicles. To ensure that all levels of government and emergency units can communicate, investing in an interoperable emergency communications and information system is of critical importance. Moreover, **ensuring that the public is aware** of the risk of natural hazards and is educated in preparedness and response actions are effective, relatively, low-cost measures which can be pursued by the governments of the region.

**Development institutions and credit markets** are ready to finance losses, provided that adequate adaptation measures have been taken in advance so as to minimize what needs to be "insured". Therefore, governments, individually and collectively, need to quantify their climate induced disaster exposures and calculate the budget allocations required to cover reasonably projected losses. If these are not sustainable, they should consider the range of **financial instruments** to optimize (i.e. lower) the cost of premium-equivalent outlays while maximizing any loss payout needed if a climate change induced disaster affects their territory.

The use and price of **pooled risk approaches, capital market mechanisms, insurance and credit instruments**, can be calculated in combination, to reduce the cost of such financial protection for emergency reconstruction, while avoiding the economic and budgetary disruptions this would otherwise entail.

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