Central Asia and Caucasus Disaster Risk Management Initiative (CAC DRMI)

Risk Assessment for Central Asia and Caucasus
Desk Study Review

THE WORLD BANK

ISDR
International Strategy for Disaster Reduction

CAREC

The study review was developed through funding by the Global Facility for Disaster Reduction and Recovery (GFDRR), a partnership between Australia, Canada, Denmark, the European Commission, Finland, France, Germany, Italy, Japan, Luxembourg, Norway, Spain, Sweden, Switzerland, the United Kingdom, the United Nations International Strategy for Disaster Reduction, the USAID Office of U.S. Foreign Disaster Assistance, and the World Bank. The GFDRR mandate is to help developing countries reduce their vulnerability to natural hazards.

Preface

The countries of Central Asia and the Caucasus (CAC) have a history of devastating disasters that have caused economic and human losses across the region. Almost all types of natural and technological hazards are present, including earthquakes, floods, landslides, mudslides, debris flows, avalanches, droughts and extreme temperatures. Earthquakes are the most dangerous hazard, causing destruction to human life, buildings and infrastructure alike, while also triggering secondary events such as landslides, mudslides and avalanches. This mountainous region provides compelling evidence of the destructive power of such secondary events: landslides, mudslides and debris flows caused most casualties during the earthquakes in Armenia (1988 Spitak), Azerbaijan (2000 Baku), Kazakhstan (1887, 1889, and 1911 Almaty), Kyrgyzstan (1992 Jalal-Abad), Tajikistan (1949 Khait, 1989 Gissar), Turkmenistan (1948 Ashgabat) and Uzbekistan (1966 Tashkent). Climate change is expected to exacerbate disasters associated with hydro-meteorological hazards.

The region is also exposed to epidemics such as bacterial infections and technological disasters including dam collapse and hazardous material release. Often these disasters transcend national borders and overwhelm the capacities of individual countries to manage them. Most countries in the region have limited financial resources and physical resilience. Furthermore, the level of preparedness and prevention varies from country to country and regional cooperation does not exist to the extent necessary. Because of this high vulnerability and the relatively small size of most of the CAC countries, it will be more efficient and economically prudent for the countries, which traditionally have long historical links, to cooperate in the areas of civil protection, and disaster preparedness and prevention.

With the aim of reducing CAC's vulnerability to the risk of disasters, and within the context of the Global Facility for Disaster Risk Reduction (GFDRR), the World Bank and the United Nations International Strategy for Disaster Reduction (UNISDR) – in partnership with other international bodies such as (for hydrometeorology) the World Meteorological Organization (WMO) and under the umbrella of the Central Asia Regional Economic Cooperation (CAREC) programme – has initiated the Central Asia and Caucasus Disaster Risk Management Initiative (CAC DRMI), which is in line with the Hyogo Framework for Action 2005-2015 (HFA).

CAC DRMI incorporates three focus areas, with the possibility of including new activities: (i) coordination of disaster mitigation, preparedness and response; (ii) financing of disaster losses, reconstruction and recovery, and disaster risk transfer instruments such as catastrophe insurance and weather derivatives, and (iii) hydro-meteorological forecasting, data sharing and early warning. The initiative will form the foundation for regional and country-specific investment priorities in the areas of early warning, disaster risk reduction and financing. It will build on the existing cooperation in the region, and will complement and consolidate the activities of the institutions involved to promote more effective disaster mitigation, preparedness and response. These institutions include international finance institutions, the European Union (EU), the Council of Europe, the United Nations [notably the United Nations Development Programme (UNDP), the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) and the United Nations Children's Fund (UNICEF)], regional cooperation institutions such as the Economic Cooperation Organization (ECO), and bilateral donors such as the Swiss Development Cooperation (SDC) and the Japan International Cooperation Agency (JICA).

As part of the work of CAC DRMI on coordination for disaster mitigation, preparedness and response (focus area i), this desk review analyses disaster risks at the country, sub-regional and regional levels. It also analyses trans-boundary disaster risks and their effects; analyses projected losses in the absence of mitigation measures; and reviews and analyses climate change assessment, hazard risk management status of CAC countries, regional and international initiatives, population growth and migration patterns, economic and physical developments, and urban expansion and rural development. Risk assessments for all the countries have been prepared and regional issues and potential areas of co-operation are addressed. The review concludes with recommendations on the way forward for CAC DRMI.

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This study has been possible thanks to the contributions of several national and regional interlocutors:

National interlocutors

Armenia - *Armenian Rescue Service:* Mr. Boris Pakov, Head of Shift Forces, Crisis Management Centre; *HFA Focal Point Institution*, *National Survey for Seismic Protection (NSSP)*: Dr.Alvaro Antonyan, President; Dr. Hayk Hakobyan, Head of International Department; *Alternative Institution, Armenian Rescue Service:* Mr. Sergey Azaryan, Colonel, Head of Population and Territories Protection Department; Dr. Arshavir Avagyan, Chief Scientific and Technical Specialist;

Azerbaijan - *Ministry of Communications and Information Technologies:* Mr.Rufat Gulmammadov, Head of Information Society Department; *HFA Focal Point Institution, Civil Protection Department (part of Ministry of Defense):* Mr. Javad Gasimov Shukuroglu, Colonel, Head of Civil Protection; *Ministry of Emergency Situations:* Mr. Kamaladdin Heydarov, Minister of Emergency Situations; Mr. Rafail Mirzayev, First Deputy Minister;

Georgia - *HFA Focal Point Institution, Ministry of Environmental Protection and Natural Resources:* Mr. Giorgi Jaoshvili, Adviser to the Minister; *Alternative Institution, Centre of Monitoring and Forecast (part of Ministry of Environmental Protection and Natural Resources):* Mr. Jemal Dolidze, Head of Centre; *Institute of Geophysics:* Prof. T.Chelidze, Professor in the Institute; Dr. Z. Javakhishvili, Doctor in the Institute; *Hydrometeorological Department of the National Environmental Agency (NEA):* Dr. Ramaz Chitanava, Head; Mr. Muraz Bakhsoliani, Head of the Division on Registration of Natural Hydromet Disasters and Mitigation of Anticipated Results; *Department of Geological Risks and Geological Environment of the NEA:* Prof. Emil Tsereteli, Head; *Department of Bank Protection of the NEA:* Mr. Tariel Beridze, Head; *Emergency Response Department of the Ministry of Internal Affairs:* Mr. Temuri Melkadze, Head of the Analytical Division;

Kazakhstan - *Kazakh National Agrarian University:* Mr. Seitkazy A. Keshuov, Vice-rector for Science and International Relations, Doctor of Technical Sciences, Professor; Mr. Kuanishbek N. Karabaev, Head of Department of International Relations; *KazGASA:* Mr. Amirlan A. Kussainov, President; Mr. Erik T. Bessimbaev, Professor, Ph.D (Techn.), Director of Scientific-Practical Centre on Earthquake Engineering; *Kazakh Research and Experimental Design Institute on Earthquake Engineering and Architecture (KazNIISSA):* Mr. Anvar Taubaev, Professor, Head of Laboratory of System Analysis of Earthquake Consequences; *K.I.Satpaev Kazakh National Technical University:* Mr. Ondasyn A. Isakov, Professor of Construction and Architecture; Mr. Dulat K. Kalitov, Director of K.Tyrysov Institute of Geological Prospecting; Mr. Erkasyn B. Utepov, Professor, Head of Life and Labour Safety Chair; Mr. Malys Absametov, Vice-Rector for Science and International Cooperation; *Ministry of Emergency Situations of the Republic of Kazakhstan:* Mr. Vladimir Karpovich Bozhko, Minister; Mr. Ablai K. Sabdalin, Vice-Minister; Ms. Natalia V. Kim, Press-secretary of the Minister; Mr. Syrym G. Gabbasov, Director of Emergency Situations Prevention and Perspective Development Department, Ph.D. (Technical); *Kazhydromet:* Mr. Talgat Maratovich Zeinullin, Director-General; Ms. O. Abramenko; *NGO "Man and Elements":* Ms. Svetlana Tuleeva, Director;

Kyrgyzstan - *Ministry of Emergency Situations of the Republic of Kyrgyzstan:* Mr. Kamchibek Kydyrshaevich Tashiev, Minister; Mr. Turatbek Sh. Djunushaliev, Vice-Minister; Mr. Anarkul M. Aitaliev, Director of Department of Emergencies Monitoring and Forecasting and Mining Tailing Management; Mr. Taalaibek A. Temiraliev, Head of Department of External Relations and Investment; Ms. Chinara Berbaeva, Department of External Relations and Investments; *Kyrgyzhydromet Main Hydrometeorological Administration:* Mr Muratbek T. Bakanovad; *State Agency on Architecture and Construction:* Mr. Kanybek Zhaichievich Narbaev, Director; *Ministry of Education:* Mr. Choro Z. Elemanov, Vice-Rector for Studies, Candidate of Engineering Science, Associate Professor; *Kyrgyz State University of Construction, Transport and Architecture (KGUSTA):* Mr. Akymbek A. Abdykalykov, Rector, Ph.D, Professor; Akylbek Chymyrov, Head of Department; *K.I.Skryabin Kyrgyz Agrarian University:* Ms. Roza S. Bekboeva, Head of Department of Hydraulic Engineering Institute of Natural Resources Management; *Kyrgyz Scientific Research Institute of Building:* Mr. Seytbek T.Imanbekov, Director, Associate Member of Engineer Academy of Kyrgyz Republic;

Tajikistan - *Ministry of Education of the Republic of Tajikistan:* Mr. Farhod K.Rahimov, First Deputy Minister; *Ministry of Energy and Industry of the Republic of Tajikistan:* Mr. Makhmadsharif M. Khakdodov, Deputy Minister, Ph.D (Technical), Professor; *Committee on Emergencies and Civil Defence under the Government of the Republic of Tajikistan:* Mr. Haibullo Latipov, Chairman; Mr. Kadam Maskaev, Deputy Head of Department of Monitoring and Warning System, 'Usoy' Department; Mr. Nemat Sh. Abdurasulov, Head of International Cooperation Department; Mr. Jamshed Kamolov, Head of Department on Population Protection; Mr. Alisho Shomahmadov, Head of the Information and Communication Centre; *Tajik Technical University:* Mr. Anvar A. Abdurasulov, Rector; Mr. Khisrav R. Sadykov, Head of Department of Automatic Electric Drive and Electric Stations; *Institute of Earthquake Engineering and Seismology, Academy of Science, Republic of Tajikistan:* Mr. Jahongir Nizomov, Director, Ph.D. (Technical), Professor; *Institute of Geology, Academy of Sciences of the Republic of Tajikistan:* Mr. Ali B. Babaev, Deputy Director; *Agency for Architecture and Construction:* Mr. A. Kamilov, Chairman; *NGO "Man and Nature":* Ms. Svetlana M. Vinnichenko, Head of NGO; *NGO "PMP International":* Mr. Sabit H. Negmatullaev, Director of NGO, Academician; *NGO "Little Earth":* Mr. Timur Idrisov, Director; *"Kuhiston" Foundation:* Ms. Svetlana Blagoveschenskaya, Technical Director; *Agency on Hydrometeorology of the Republic of Tajikistan:* Mr. Bekmurod Mahmadaliev, Director; Mr. Anvar Khamidov, Deputy Director; Mr. Naulya Mustaeva, Senior specialist, Foreign Affairs Department;

Turkmenistan - *National Committee on Hydrometeorology, Administration of Hydrometeorology:* Mr. Kakamurat Yazyev, Chairman; *Ministry of Construction and Construction Industry, Research Institute of Seismology:* Mr. Murad M. Charyev, Deputy Director of Science, Research Institute of Seismology; *Cabinet of Ministers of Turkmenistan:* Mr. Hemrakuly I. Italmazov, Senior Specialist, Department of State Commission on Emergency Situations and Population Protection; *Institute of Seismology:* Dr. Batyr Nazarovich Gaipov, Director; Mr. Guvanch Hummedov; *NGO Tebigy Kuwwat:* Mr. Serdar Mamedniyazov, Scientific Secretary.

Uzbekistan - *Ministry of Emergency Situations:* Mr. Turagalov, Deputy Head; Mr. Abbos Komilov, Head of International Relations Department and Human Resources Department; *Uzbek Academy of Science, Institute of Mechanics and Seismic Stability of Structures:* Mr. Tursunbay R. Rashidov, Professor, Head of Department; Mr. Mashrab Akhmedov, Senior Researcher, Ph.D.; *Mavlyanov Institute of Seismology:* Mr. Rashod N. Ibragimov, Professor; Mr. Alisher Ibragimov, Head of Digital Seismic Network, Head of Earthquake Physics Lab; *Tashkent State Technical University:* Mr. Sharakhmat A. Shaabidov, Rector; Mr. Orunboy Yuldoshev, Head of Life Safety Chair; *Social Ecological Organization 'Hayot':* Mr. Khusan T. Tursunov, Chairman; *Tashkent branch of I.Gubkin Russian State University of Oil and Gas:* Mr. Bakhtiyar S. Nurtaev, Executive Director, Candidate of Physics - Mathematics Sciences; *UZLIITI:* Mr. Shamil Abdullaevich Hakimov, Head of Constructions Department; *Centre of Hydrometeorological Service at Cabinet of Ministers of the Republic of Uzbekistan:* Prof. Victor E. Chub, Minister, Director-General of Uzhydromet; Ms Malika Nazarova, Chief of International Department; *Ecoforum of Uzbekistan:* Mr. Saidrasul Sanginov, Chairman of Council;

Regional (and International) interlocutors

Armenia - *Council of Europe, European Interregional Centre for Training Rescuers (ECTR):* Mr. S. Badalyan, Director, Counsellor to the Minister of Foreign Affairs of the Republic of Armenia, Director of the European Interregional Centre for Training of Rescuers;

Azerbaijan - *European Centre on Training and Information of Local and Regional Authorities and Population in the Field of Natural and Technological Disasters (ECMHT):* Mr. Gulagha BABAEV, President;

Kazakhstan - *UNDP:* Mr. Haoliang Xu, Resident Representative; Ms. Victoria Baigazina, Programme Coordinator; *UNCU:* Ms. Dina Khassenova, UN Coordination officer for Kazakhstan; *UNESCO:* Ms. Inna Melnikova, Specialist, Education Programmes; *UNOCHA:* Ms. Gabriella Waajman, Regional Disaster Response Advisor; Mr. Ali Buzurukov, Humanitarian Affairs Officer; *IFRC:* Ms. Drina Karahasanovich, Regional Representative; Ms. Valentina Sosnovaya, Specialist; *Eurasia Foundation:* Mr. Jeff Erlich, President;

Kyrgyzstan - *Swiss Cooperation Office in the Kyrgyz Republic Swiss Consular Agency:* Ms. Asel Omoeva, National Program Officer; Ms. Rahat Yusubalieva, Junior Program Officer; *The Netherlands Red Cross:* Ms. Sacha Bootsma, Regional Disaster Management Coordinator for CA; Mr. Bahtiar Mambetov, Regional Project Manager; *UNDP:* Mr. Neal Walker, Resident Coordinator; Mr. Nato Alhazishvili, Deputy Resident Representative; Mr. Muratbek Koshoev, Disaster Management Program Advisor; Mr. Sanjar Ibragimov, Assistant, Disaster Management Component; *UNICEF:* Mr. Nurbek Teleshaliyev, Specialist on Education; Mr. Tim Schaffter, Representative; *WHO:* Mr. Emil Omuraliev, Disaster Preparedness and Response Focal Point for Kyrgyzstan; *UNV:* Mr. Achim Merlo, UNV Programme Officer; *IOM:* Ms. Janna Salieva, Programme assistant; *World Bank:* Ms. Gulbara Tagaeva, Project Manager Disaster Hazard Mitigation Project PIU; Mr. Asylbek Keshikbaev, Project Manager, Disaster Hazard Mitigation Project PIU; *Central Asian Institute of Applied Geosciences:* Mr. Bolot Moldobekov, Co-Director; Mr. Sheishenaly Usupaev, Leading scientist;

Tajikistan - *Mission East:* Mr. Afzalsho Nasibov, Project Manager; *FOCUS Humanitarian Assistance:* Mr. Mustapha Karim, CEO; *ECHO:* Mr. dam Yao, ECHO Correspondent for Central Asia; *SDC:* Mr. Rudolf Schoch, Country Director, Counsellor, Consul; Mr. Matthias Anderegg, Disaster Reduction Programme Officer, Central Asia; Mr. Anvar Sabzaliev, Disaster Reduction Programme Officer; *German Technical Cooperation - GTZ:* Dr.Peter Thominski, Program Advisor, Disaster Risk Management Program in Tajikistan; *UNICEF:* Ms. Marina Zhukova, Education Project Assistant; Mr. Rustam Ubaidulloev, Emergency Officer, Disaster Management Project; *International Federation of Red Cross and Red Crescent Society:* Mr. Shamsiddin Muhidinov, Disaster Management Programme Coordinator; *CAREC (Central Asian Regional Ecological Center):* Ms. Malika Babadjanova, Director; *World Bank:* Mr. Bobojon Yatimov, Rural Development Specialist;

Turkmenistan - *UNDP:* Mr. Richard Young, Resident Coordinator; Mr. Begench Yazliyev, UN Coordination Analyst; *IOM:* Mr. Tahyr Seidov, Senior Programme Assistant; *UNICEF:* Mr. Mohamed Waheed Hassan, Representative; *WHO:* Ms. Bahtygul Karriyeva, Head of WHO Office; *UNICEF:* Mr. Ayadil Saparbekov, Project Officer, Health and Nutrition; *Red Crescent Society:* Ms. Zuhra Kazakovna Yellieva, Chairperson;

Uzbekistan - *Red Crescent Society of Uzbekistan:* Mr. Mannon R. Rahimov, Professor; *UNDP:* Ms. Anita Nirody, RC; Mr. Kyoko Postill, DRR; Ms. Anvar Nasretdinov, Programme Analyst/ Environment & Energy Unit; Ms. Gulnara Akramova, Program Assistant/Environment & Energy Unit; *UNICEF:* Oyunsaihan Dendevnorov, Manager Area-based Programme; Mr. Hushnid Sattarov, Project advisor; *UNESCO:* Mr. Bakhtiyor Namazov, Education officer.

Abbreviations and Acronyms

AAL	Average Annual Loss
ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
ADRC	Asian Disaster Reduction Centre
ASBP	Aral Sea Basin Program
ASC	Asian Seismological Commission
BWO	Basin Water Organization
CAC DRMI	Central Asia and Caucasus Disaster Risk Management Initiative
CAREC	Central Asia Regional Economic Cooperation
CRED	Centre for Research on the Epidemiology of Disasters
DRI	Disaster Risk Index
ECO	Economic Cooperation Organization
EM-DAT	Emergency Events Database, developed by Office of US Foreign Disaster Assistance and the Centre for Research on the Epidemiology of Disasters
ESCAP	Economic and Social Commission for Asia and the Pacific
EU	European Union
EV	Economic Vulnerability
GCM	Global Circulation Model
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Risk Reduction
GHG	Greenhouse Gases
GIS	Geographic Information System
GLOF	Glacial Lake Outburst
GNI	Gross National Income
GNP	Gross National Product
GSHAP	Global Seismic Hazard Program
HDA	Human Development Index
HFA	Hyogo Framework for Action 2005 - 2015
IAEA	International Atomic Energy Agency
ICMH	International Centre for Migration and Health
ICWC	Interstate Commission for Water Coordination
IFAS	International Fund for the Aral Sea
IFRC	International Federation of Red Cross and Red Crescent Societies
IIEES	International Institute of Earthquake Engineering and Seismology
IMF	International Monetary Fund
IOM	International Organization for Migration
JICA	Japan International Cooperation Agency
JRMP	Joint Rivers Management Programme
LSRMP	Lake Sarez Risk Mitigation Project
MDG	Millennium Development Goals
MoES	Ministry of Emergency Situations
MRI	Meteorological Research Institute
MSL	Mean Sea Level
NGDC	National Geophysical Data Centre
NGI	Norwegian Geotechnical Institute

OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OFDA	Office of the US Foreign Disaster Assistance
PGA	Peak Ground Acceleration
PRECIS	Providing Regional Climates for Impact Studies
RCM	Regional Circulation Model
SDC	Swiss Agency for Development and Cooperation
SIC	Scientific Information Center
SIDA	Swedish International Development Cooperation Agency
TDRM	Total Disaster Risk Management
UN	United Nations
UNDAC	United Nations Disaster Assessment and Coordination
UN DESA	United Nations Department of Economic and Social Affairs
UNFCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNICEF	United Nations Children's Fund
UNISDR	United Nations International Strategy for Disaster Reduction
USAID	United States Agency for International Development
WB	World Bank
WEMP	Water and Environment Management Project
WMO	World Meteorological Organization

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Chapter 1

Executive summary

This desk review report has been prepared as part of the Central Asia and Caucasus Disaster Risk Management Initiative towards disaster risk reduction in CAC, in line with the Hyogo Framework for Action 2005 – 2015. The objective is to prepare a simplified quantitative risk assessment to determine the social and economic loss potentials and the likelihood of occurrence of different hazards at country, sub-regional and regional levels.

The review analyses and assesses disaster risk at country, sub-regional and regional levels, focusing on natural and technological hazards. It analyses trans-boundary disaster risks and their effects, and projected losses in the absence of mitigation measures. The review also analyses climate change assessment, hazard risk management status of CAC countries, regional and international initiatives, population growth and migration patterns, economic and physical developments, urban expansion and rural development in CAC countries.

CAC consists of the eight former Soviet republics of Armenia, Azerbaijan and Georgia (Caucasus), and Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan (Central Asia). It covers an area of about 4.2 million square kilometres and has a population of around 75 million. The region extends from the Black Sea in the west to China in the east, and from southern Russia in the north to Afghanistan and Iran in the south.

The region is geographically diverse and includes several high mountain chains, vast deserts and treeless, grassy steppes. It is home to large river systems such as the Amu Daria and Syr Daria, and major water bodies such as the Caspian and Aral seas and the Balkhash and Sarez lakes. The region experiences very large temperature fluctuations.

Given the fact that two-thirds of the region's population is concentrated in the mountainous southern quarter, which is highly prone to all kinds of hazards, the diverse geography and extreme weather conditions – coupled with climate change – exacerbate the risks from disasters. On a regional basis, more than 30 per cent of the population lives below the poverty line, making it highly vulnerable to the adverse consequences of these disasters.

Reported economic disaster data have been used to analyze risk profiles at country, sub-regional and regional levels. Analyses of projected losses in the absence of mitigation measures expressed in the form of average annual loss (AAL) and economic loss potential for selected probabilities of exceedance have been carried out.

1.1 Key findings

Disasters

The economic risk assessment analyses find that earthquakes are the dominant disaster risk in CAC followed by floods, landslides and droughts. Industrial accidents, transport accidents, miscellaneous accidents and epidemics are other significant disasters. During the last 20 years (1988-2007), the reported 177 disasters have caused 36,463 deaths. Out of the reported disasters, 19 per cent were earthquakes, 25 per cent were floods, 13 per cent were landslides and 3 per cent were droughts (Figure 42). Earthquakes caused the maximum number of deaths: 32,834.

Vulnerability

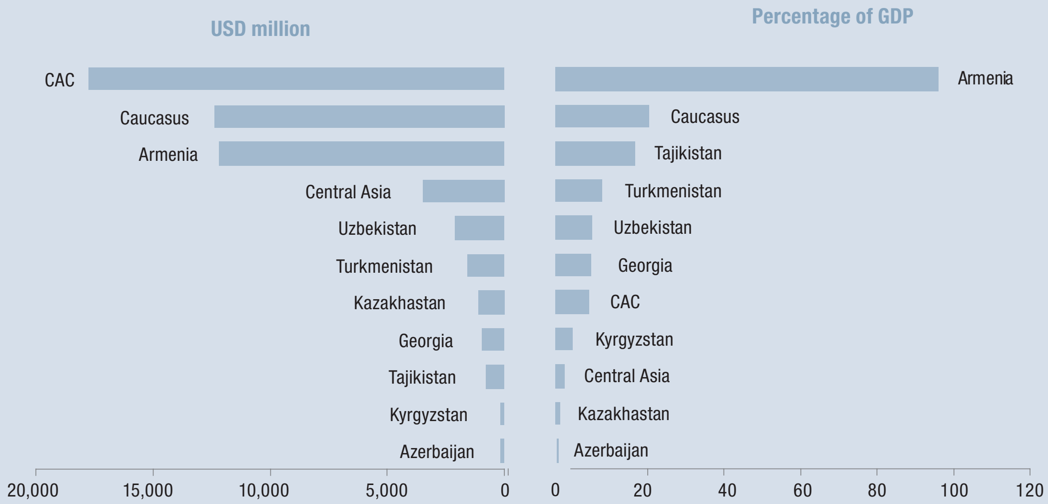
The social vulnerability (SV) ranking of each country was estimated based on the average number of people killed per year per million (relative social vulnerability). The analysis of disaster data for the period 1988-2007 shows that the average number of people killed per year per million in Armenia is more than 6.3 times that of Tajikistan (the second highest). In terms of relative SV ranking, Armenia has the highest followed by Tajikistan, Georgia, Azerbaijan, Kyrgyzstan, Kazakhstan, Uzbekistan and Turkmenistan. From a sub-regional perspective, the average number of people killed per year per million in the Caucasus is more than 9.8 times that of Central Asia. Thus, in terms of SV, southern Caucasus countries are more vulnerable than those of Central Asia. However, as discussed in the CAC regional profile, relative SV ranking is 'biased' due to the December 1988 earthquake in Spitak, Armenia, in which 25,000 people died.

It is well known that economic losses and number of disasters are not well correlated. For example, the number of earthquake disasters in CAC is much lower than floods, though economic losses caused by earthquakes are much higher than floods. The quantitative risk assessment performed in this study confirms the following risk patterns:

- Armenia: earthquakes represent the dominant risk followed by droughts and floods;
- Azerbaijan: droughts, floods and earthquakes are significant risks;
- Georgia: landslides and earthquakes are significant risks;
- Kazakhstan: earthquakes are the dominant risk followed by floods;
- Kyrgyzstan: earthquakes are the dominant risk followed by landslides and floods;
- Tajikistan: floods are the dominant risk followed by earthquakes and landslides;
- Turkmenistan: earthquakes are the dominant risk followed by floods;
- Uzbekistan: earthquakes are the dominant risk followed by droughts.

Disasters can have enormous economic consequences. The quantitative risk assessment performed in this study confirms that a catastrophic event with a 200-year return period (0.5 per cent annual probability of exceedance) would have a major impact on CAC countries' economies, which are already fragile. To gauge the potential economic impact, the economic vulnerability (EV) ranking of each country has been

Figure A: Economic Loss Potential for annual probability of exceedance of 0.5 per cent*



*Note: Armenia all hazards damage is 132.5% of GDP (2007) estimated in terms of likely economic losses that an event with a 200-year return period would cause as a percentage of that country's Gross Domestic Product (GDP) (Figure A). According to this categorization, Armenia has the highest EV ranking in the region, followed in descending order by Tajikistan, Turkmenistan, Uzbekistan, Georgia, Kyrgyzstan, Kazakhstan and Azerbaijan. However, as discussed in the CAC regional profile, the analysis is 'biased' due to the December 1988 earthquake in Spitak, Armenia (Figure B).

Urban areas are especially vulnerable to the adverse impact of disasters. Tashkent, Baku, Almaty, Tbilisi, Bishkek, Yerevan, Dushanbe, Ashgabat and Astana are the most populated cities in CAC and all are undergoing intense economic activity. With the exception of Tbilisi and Yerevan, all are experiencing high population growth. All these cities, with the exception of Astana, are highly vulnerable to earthquakes and all nine are potentially vulnerable to floods. In a simple risk assessment, taking into account the cities' hazard zonation and populations, earthquakes emerge as by far the major risk, while the risks posed by floods and landslides are far less significant.

Tashkent, Baku and Almaty form the group with the highest risk, followed by Tbilisi, Bishkek and Yerevan, which face about half the risk of the former group. The single most important factor affecting vulnerability is the increase in population sizes, particularly the high-density populations concentrated in the cities.

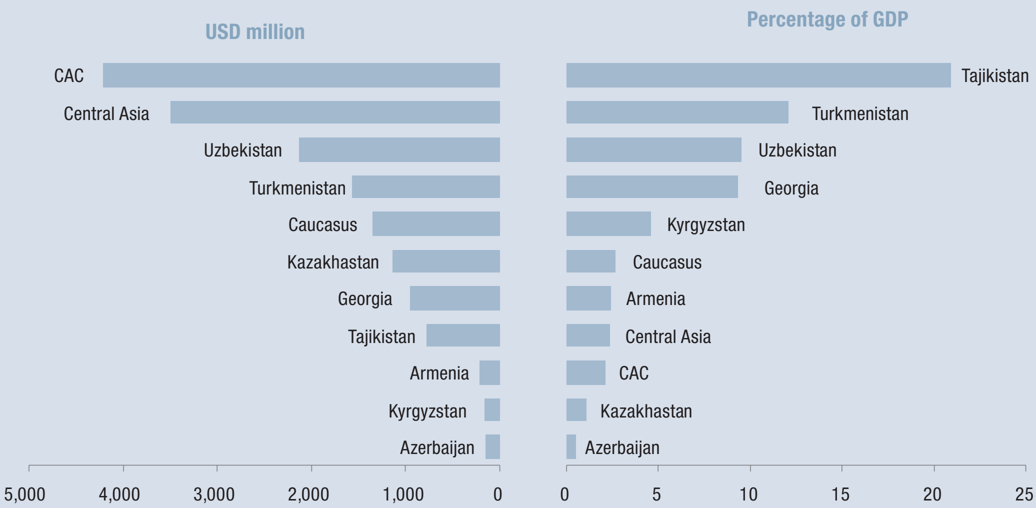
The study identifies migration as a factor influencing population distribution across CAC. During the Soviet era, human migration between republics was promoted as well as controlled by the State. There was an acute spike in migration prompted by the major socio-political upheavals that were brought about by the disintegration of the Soviet Union. Due to the ensuing recession, several support mechanisms that were part of the highly-structured social welfare support system failed.

The next wave of migration occurred between 1993 and 1995 when ethnic Russians returned to Russia due to growing nationalism. In more recent times, migration has taken socio-economic overtones. This involves both internal (rural-urban) and cross-border movement, although it is mainly within the region and makes the pattern of migration somewhat 'circular'. The newly-emerging factors affecting migration are economic, demographic, environmental and religious.

Climate change impact

The review finds that global circulation models addressing climate change do not present a uniform view of the potential impact of climate change on CAC, except for predicting a general increase in

Figure B: Economic Loss Potential for annual probability of exceedance of 0.5 per cent after removal of December 1988 Spitak earthquake in Armenia



temperature. A high-resolution climate change model of the region appears to be more stable and predicts a temperature increase of 4°C to 6°C over the next 80 years and a potential for minor increases in maximum rainfall in the Caucasus region. The main impact will be a decrease in water availability and potential for droughts.

1.2 Way forward

Based on the analysis, the review makes the following recommendations to reduce disaster risk in CAC:

Additional analyses
Three levels of analyses are envisioned to refine the result presented in this report. These analyses should first focus on earthquakes and floods as they are the most damaging quick-onset disasters.

Level 1: An analysis similar to this one based only on historical records should be repeated at a higher level of resolution. Instead of limiting the resolution of the analysis at the country level, a high-resolution grid (for example a 100-kilometre grid) should be considered. Risk aggregation by hazard type and area would provide, at low cost, a much more refined picture of the risk than is offered by the present analysis.

Level 2: On a second level, using the same methodology, worst-case scenarios should be considered for the highly-populated cities. This simple analysis would provide a reasonable quantification of loss, given the occurrence of a particular disaster scenario. The uncertainty around the risk could then be bracketed by scientifically estimating the range of probability of occurrence of such scenarios.

Level 3: On a third level, fully probabilistic analysis containing all the elements of standard risk analysis should be performed for the hazards and regions identified as high risk in levels 1 and 2.

Drought hazard should be addressed in the context of climate change and long-term adaptation strategies should be considered.

Analysis of accident-related hazards should focus on large industrial accidents such as radioactive material release and chemical contamination. Facilities such as nuclear power plants and chemical processing plants should be identified, their safety assessed both in terms of construction/equipment and procedures, and their risk quantified.

Coordinated response to disasters
The trans-boundary nature of the disaster-prone mountain chains of the Caucasian (lesser Caucasus) and Central Asian (Kopetdag, Pamir, Pamir-Hindukush, Tien-Shan, Djungaria, and Altai) countries call for a planned and coordinated approach towards disaster response for efficient rescue and relief operations.

The capacity for enhanced coordination exists and is facilitated by the fact that all CAC countries, except Georgia and Turkmenistan, already have their own ministries to deal with emergency situations, usually called Ministries of Emergency Situations (MoES). However, in Georgia the emergency situation and civil safety services are controlled by the Ministry of Interior and Administration (MIA) and in Turkmenistan by the disaster management department within the Ministry of Defense. Usually the Ministry has disaster management departments at national as well as province and, in some cases, district levels. The forecasting departments are included within individual ministries.

Community-based disaster response also needs to be strengthened because whenever a disaster occurs the local community is the first-responder.

Nodal organizations such as the International Federation of Red Cross and Red Crescent Societies (IFRC) could play a key role in facilitating coordination among these ministries and departments to reduce trans-boundary hazards. The coordination, capacity and efficiency of these types of networks could be enhanced and their focus expanded to address disaster risk reduction. The achievement of such goals could be facilitated through human and financial resource augmentation, skill improvement and infrastructure development, carried out with the participation of all the CAC countries to ensure future sustainable use of the networks.

Centralized database

Improving access to information could enhance the capacities of all the CAC countries to prepare for and deal with the impact of disasters. The centralization and coordination of data gathering both within and between countries, particularly information relating to earthquakes and hydro-meteorological events, could facilitate this. Indeed, the presence of trans-boundary zones of high seismic activity and rivers whose flow or dam management has a direct impact on neighbouring countries makes such coordination imperative.

With the exception of earthquakes, the onset of major hazards such as flooding can normally be predicted. Consequently, measures such as public education and early-warning mechanisms could significantly reduce the number of deaths and other losses caused by disasters. Again, trans-boundary cooperation and coordination could significantly enhance current capacities, especially through mechanisms such as flood early-warning systems.

Strengthening institutions

In conjunction with greater regional cooperation, the strengthening of relevant institutions is crucial for developing strategies towards hazards of a trans-boundary nature. Decentralizing those institutions and carrying out strengthening according to a commonly-accepted framework could be a way of maximizing the potential benefits of such enhancements.

To ensure participation of all stakeholders, hazard management strategies should be judiciously selected after considering the local and regional situational factors as well as the developmental needs of the region. By considering the characteristics of the terrain and size of the countries involved, different strategies could be merged with the development planning process to work towards disaster risk reduction.

Improvement to disaster risk assessment

Although all CAC countries have disaster management plans in place, they could each benefit from greater refinement as they tend to lack the detail necessary to reflect ground realities. This could be efficiently achieved through establishing plans based on the kind of level 2 and level 3 analysis recommended earlier in this chapter (section 1.2), reflecting realistic scenarios and associated responses. In addition, the disaster risk management plans could be integrated into local development plans, which in turn could be further assimilated within regional, sub-regional and national programmes.

Carrying out disaster risk management activities within a common framework would facilitate their integration at the national or trans-national level.

Poverty alleviation and awareness

Poverty significantly exacerbates the impact of hazards on both a human and an economic level. Poverty usually implies that resilience is low, that constructions are inadequate to resist disasters such as earthquakes, or that land-use planning is insufficient to mitigate the impact of catastrophes such as floods. The large scale of devastation typical when disaster strikes a poor area is testament to the effects of poverty.

Furthermore, poverty is associated with an absence of pre-emptive responses to hazards, either because the authorities do not have the appropriate information to warn the population of the imminence of the event or because of the unwillingness or inability of local people to evacuate their area and abandon their land and livelihoods.

Poverty reduction is indeed a much broader issue and is clearly outside the scope of this study. However, continuous steps to increase awareness of major hazards can be managed with limited resources at a local level to obtain quick and effective results.

1.3 Report structure

The report is organized as follows:

- Chapter 2 provides an overview of disaster risk assessment, taking into account the shift in disaster management practices towards an integrated disaster risk reduction approach.
- Chapter 3 briefly examines the geography and demographic characteristics of the Central Asia and Caucasus region.
- Chapter 4 outlines the methodology adopted to carry out the risk assessments used in this study.
- Chapter 5 provides country profiles and an analysis of disaster risk assessment at country level. This includes an examination of the socio-economic and biophysical context of individual countries, as well as specifics such as disaster risk statistics. Information is presented in a concise format for easy and quick reference.
- Chapter 6 provides a sub-regional profile and analyses disaster risk assessment at the sub-regional level, following the format used in the country profiles.
- Chapter 7 provides a regional profile and analyses disaster risk assessment at regional level.
- Chapter 8 examines trans-boundary disaster risk and its effects, including a look at major trans-boundary disasters in CAC and the ways in which the events were managed.
- Chapter 9 examines migration and its effects on individual countries' demographic characteristics and looks at the dynamics, both historical and contemporary, underlying this flow of people from one locality, province or country to another.
- Chapter 10 provides a summary of climate change assessments, identifying the vulnerabilities of individual countries and examining the potential impact of such change across the region.
- Chapter 11 examines the hazard risk management framework, assessing the levels of individual countries' emergency preparedness, institutional capacity building, risk mitigation investments and catastrophe risk financing.
- Chapter 12 examines regional and international initiatives, outlining some of the major projects.
- Chapter 13 identifies priority areas requiring more detailed risk assessment based on the data gathered for this report.
- Chapter 14 includes conclusions and summary recommendations.
- Annexes, including risk assessment methodology; international initiatives on regional cooperation; references; list of organizations and institutions; and relevant Internet sites.

Chapter 2

Risk assessment: an overview

"Building a culture of prevention is not easy. While the costs of prevention have to be paid in the present, its benefits lie in a distant future. Moreover, the benefits are not tangible; they are the disasters that did NOT happen."
Kofi Annan, 1999

The frequency and impact of disasters triggered by natural hazards have grown dramatically since the early twentieth century, rising by more than 800 per cent worldwide over the last 40 years alone (Munich Re, 2005; CRED EM-DAT, 2005). Moreover, the global trend is set to worsen now that climate change has become a threat, prompting an anticipated increase in the frequency and severity of weather-related disasters. At the same time, the impact of disasters caused by technological hazards is also rising.

Disasters due to natural or technological hazards can have catastrophic impacts on nations and regions. These events can disrupt the social, economic and environmental status of societies at a number of different levels. The social impact of disasters includes loss of livelihoods, assets and infrastructure, as well as harm to emotional and physical well-being. Disasters can cause social unrest, which can lead to the discontinuation of development programmes. Environmental losses are often significant.

Disasters tend to hit the poorest most as they have little or no financial or physical resilience. The poor tend to depend most on a well-functioning environment for their livelihoods and struggle most to rebuild their lives and assets in the aftermath of a disaster.

The extent of damage caused by disasters depends on the vulnerability of the affected area as well as the severity of the hazard. Consequently, efforts aimed at reducing vulnerabilities through such measures as prior hazard forecasting or enhancing resilience can help to greatly reduce the impact of disasters.

Until the 1990s, disaster risk assessments were given lower priority than disaster response (rescue and relief). Since then, there has been a strategic shift in disaster management practices towards an integrated disaster risk reduction approach, which includes incorporating disaster risk reduction planning in the development process of countries and regions. There are several international initiatives, particularly those of the UNDP and the World Bank, that encourage nations to integrate disaster preparedness and mitigation into their development plans. This has brought a new dimension and perspective to the efforts to manage disasters.

In the CAC countries of the former Soviet Union, disaster response was traditionally stronger than disaster risk reduction. During the Soviet era, all the countries of the region had disaster response committees and ministries within their government structures and all promoted disaster response activities through school curricula. With today's new priorities the issues of monitoring, forecasting and early warning of natural and technological disasters are gaining in importance in the region, although preventive measures are as yet still lacking and a response-oriented approach is very often the only one applied.

Nevertheless, there does seem to be a gradual shift towards incorporating disaster risk management into development plans. It is significant that all eight countries participated in the Second World Conference for Disaster Risk Reduction, held in Hyogo in January 2005, and all except Turkmenistan committed to adopt the Priorities for Action outlined in the HFA.

The recognition of the greater need for protective strategies to safeguard societies and economies from the adverse effects of disasters has focused attention on to vulnerabilities and risk factors, and the beneficial role of disaster risk management. Appreciating the need for disaster risk reduction and implementing the concept requires a proper understanding of factors including the nature and severity of the impact of disasters, knowledge of previous occurrences, an identification of any trends and an understanding of the vulnerability of populations and property.

To facilitate the implementation of disaster risk reduction, UNISDR and UNDP are currently revising a core set of indicators and a methodology developed in 2004 (UNDP, 2004) to guide and monitor progress towards the reduction of risk from natural or technological hazards. Other measures include the several initiatives to develop global databases on hazards. EM-DAT, developed by the Office of US Foreign Disaster Assistance

(OFDA) and the Centre for Research on the Epidemiology of Disasters (CRED), is one such effort and is widely used for macro-level risk assessment.

Disaster events can vary in magnitude or intensity, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing. Disasters from drought, being slow-onset hazard events, have lingering impacts on society and it may be difficult to define the exact dates of such events. Generally, disaster statistics tend to be more precise on a smaller scale where the evaluation of damage is undertaken in a more systematic manner, based on agreed methodologies (UNISDR, 2004).

Academics and emergency managers are continuously working to develop appropriate methodologies for assessing disaster risks, and several methods are in the process of being finalized or have recently been published (Inter-American Development Bank, 2005; UNDP, 2004). There is a great deal of effort taking place in benchmarking and vulnerability/risk indexing (ProVention Consortium, 2006). UNDP, for example, published a global report entitled 'Reducing Disaster Risk: a Challenge for Development' (UNDP, 2004), and has developed the Disaster Risk Index (DRI) and a relative vulnerability assessment using various indicators. Vulnerability and DRI are almost always challenging. It is always a difficult matter to weigh the catastrophic severity of a disaster that might occur at 100- or 200-year intervals against the annual flood that will most certainly occur. Furthermore, the possibility of disasters caused by technological hazards such as dam failure, hazardous material release or nuclear accident, which can impact generations, has to be weighed against the full range of risks through disasters caused by natural hazards.

For relative vulnerability assessments, various economic and social variables have been used. But in most of these methodologies there are several common variables, such as the number of events, the number of deaths, the number of deaths per year per million people, the size of the affected population per year or the amount of economic loss.

Chapter 3

The study area

The CAC region (Figure 1) covers an area of 4.2 million square kilometres, and has a total population of 75 million (Table 1). Central Asia, consisting of the five former Soviet republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, is a region of Asia from the Caspian Sea in the west to China in the east, and from southern Russia in the north to Afghanistan in the south. Historically, Central Asia has acted as a crossroads for the movement of people and goods between Europe, Western Asia, South Asia and East Asia (also known as the Silk route). The Caucasus sub-region, consisting of the three post-Soviet states of Armenia, Azerbaijan and Georgia, sits between the Black Sea to the west and the Caspian Sea to the east.

Geographically, Central Asia is an extremely large sub-region with varied geography, including high passes and mountains such as Tian Shan, vast deserts and treeless, grassy steppes. Major rivers of the sub-region include the Amu Daria and the Syr Daria. Major bodies of water include the Aral Sea and Lake Balkhash, both of which are part of the huge West/Central Asian endorheic basin that also includes the Caspian Sea. Temperature fluctuations are severe, since Central Asia is not buffered by a large body of water. In the Caucasus sub-region, the Caucasus Mountains are the dividing line between Asia and Europe. The highest mountain in CAC is Peak Somoni, which at 7,495 metres is the highest peak of the Pamir mountain chain. It is located in north-west Tajikistan and is the highest point of the former Soviet Union.

Some 70 per cent of CAC's 4.2 million square kilometres is classified as agricultural land, of which only 15 per cent is arable. Wheat, cotton and livestock are the important agricultural commodities. Rangelands occupy 275 million hectares. The environment is characterized by low and variable rainfall and temperature extremes (http://www.icarda.cgiar.org/IntlCoop_CACRP.htm).

Figure 1: Location map of Central Asia and Caucasus region

Table 1: Overview of countries in Central Asia and Caucasus region

Country	Area		Population		Pop. density (km^2)	% Pop. below poverty line*	Annual Pop. growth %	Urban Pop. (2006) %**	GDP growth annual %	GNI per capita PPP ($)
	Km^2 ('000)	% of Region	Million	% of Region						
Armenia	29.8	0.7	3.00	4.0	101	26.5 (2006 est)	-0.3	64	13.7	5,900
Azerbaijan	86.6	2.1	8.57	11.4	99	24.0 (2005 est)	1.0	50	19.2	6,260
Georgia	69.7	1.7	4.40	5.8	63	31.0 (2006)	-0.8	51	12.4	4,770
Kazakhstan	2,724.9	65.0	15.48	20.6	6	13.8 (2007)	1.1	56	8.5	9,700
Kyrgyzstan	199.9	4.8	5.24	7.0	26	40.0 (2004 est)	1.0	34	7.4	1,950
Tajikistan	142.6	3.4	6.74	8.9	47	60.0 (2007 est)	1.5	24	7.8	1,710
Turkmenistan	488.1	11.6	4.96	6.6	10	30.0 (2004 est)	1.3	46	11.5*	5,300*
Uzbekistan	447.4	10.7	26.87	35.7	60	33.0 (2004 est)	1.4	36	9.5	2,430
Total	4,189.0	100.0	75.26	100.0						

Source: World Bank statistics:
(http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20535285~menuPK:1192694~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html)
*https://www.cia.gov/
**http://www.adb.org/

Chapter 4

Methodology

A simple and straightforward approach to estimating risk is to base calculations solely on the data provided by historical records. If the data sets are relatively complete, and cover a period long enough to include several return periods of the events under consideration, then reliable estimates can be derived. More robust approaches model the physics of event generation and introduce geophysical parameters to supplement the incompleteness of the historical record approach. However, the development and implementation of such models require significant time and resources, way beyond the scope of the present study.

This synthesis report on CAC is based on a desk review of existing studies by academia, governments and international governmental and non-governmental organizations. The following sections describe the methodology adopted in carrying out the hazard and risk assessments.

4.1 Data review

A survey of literature on economic loss data due to disasters shows that for most CAC countries, disaster economic loss data for all hazards except earthquakes are available from the late 1980s. Thus, the report analyses and estimates the hazard, vulnerability and risk based on the historical events that have impacted the region over the last 20 years (1988 to 2007).

Because most hazards have short return periods, of less than 20 years, this window provides a reliable picture of the characteristics of the phenomena. Nevertheless, significant disaster events at country, sub-regional and regional levels that predate the late 1980s have also been reviewed; earthquakes that have long to very long return periods require special treatment. Consequently, in terms of economic losses, a longer duration of earthquake data covering about 100 years has been reviewed, analyzed and simulated based on damage description and number of people killed and affected.

However, to provide consistency with the other hazards, disaster risk statistics for all the hazards are provided for a 20-year period.

Since data quality and completeness are critical in the implementation of the proposed approach, special efforts have been made to identify, document, verify and process the data. The remainder of this section addresses the data resources, and their use and limitations in the context of this study.

Data sources

Since 1980, significant efforts have been made by various academic and multilateral development agencies to compile historical disaster data and generate standardized data across the globe for disaster risk mitigation activities. As a result, numerous databases are available in print and on the Internet. This section describes the most relevant data sources identified for this study.

- The Centre for Research on the Epidemiology of Disasters (CRED) maintains the EM-DAT global database on disasters (natural and technological hazards), which is one of the most exhaustive sources of data available in the public domain. While EM-DAT data date back to the 1900s, data on economic losses caused by disasters in CAC have become generally available since the 1980s.
- The Asian Disaster Reduction Centre (ADRC) has compiled data from various sources, including: United Nations Office for the Coordination of Humanitarian Affairs (OCHA), DesInventar, US Government, Japan Government, OFDA, IFRC, WMO, the reinsurance industry and private agencies. The data are available for Armenia, Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan in the form of country reports.
- The National Geophysical Data Centre (NGDC) database is an exhaustive database on earthquake events since 1900 for most countries in the world. The database has an approximate economic loss range for events where exact economic loss estimates are not available.
- The United Nations Environment Programme (UNEP) provides an on-line DRI tool (http://

gridca.grid.unep.ch/undp/cntry_profile.php). This tool provides hazard-specific information at country level on vulnerability variables such as population density in flooded area, urban growth, percentage of arable land and Gross Domestic Product (GDP) per capita. The DRI tool addresses disaster risk for four natural hazards, namely earthquake, flood, drought and cyclone, using population vulnerability (UNDP, 2004; Dao and Peduzzi, 2004).
- OCHA is a United Nations body principally focusing on humanitarian action in partnership with national and international actors in disaster risk management.
- Dartmouth Observatory has compiled flood data across the world for major events since 1980. The site has documented the flood extents for different periods using satellite data. Dartmouth data has recorded a Glide number for each event, which is a unique identifier and a standard practice many international organizations are now following. The site is exclusively for flood data, though economic losses are sparsely documented.
- The Norwegian Geotechnical Institute (NGI) prepared a landslide hazard map in 2004 for the entire world in Geographic Information System (GIS) format (NGI, 2008; personal communication).

In addition, there are various hazard-specific studies analyzing particular events at country level. However, these comprehensive reports fall short in providing detailed country-level risk information.

The World Bank, under Global Risk Analysis, has developed a methodology for modelling hazard and vulnerability, calibrated using data from CRED EM-DAT. The analyses are available at http://geohotspots.worldbank.org/hotspot/hotspots/disaster.jsp and the results are published in the report 'Natural Disaster Hot Spots, Disaster Risk Management series No.5, World Bank' (Dilley et al., 2005).

Published GIS-based maps of natural hazards and data available in the public domain, such as the atlas of southern Caucasus, have been referred to at various stages (Chelidze, 2007).

Apart from the above-mentioned sources, specific reports and data on countries, sub-regions and CAC have been reviewed and analyzed, especially those on climate change assessment, population growth and migration patterns, economic and physical developments, and urban expansion and rural development. Several key institutions and organizations in the region were contacted during the production of this report.

Data issues

In spite of the efforts of data gathering organizations, historical data on disasters have many inherent problems. Guha-Sapir and Hargitt (2004) have highlighted several issues on the availability of disaster-related data in the report 'Thirty Years of Natural Disasters 1974-2003: The Numbers'. The key problems highlighted in the report include:

- Lack of a single organization performing data collection and compilation, which can lead to lack of standardization in data collection methodologies and definitions.
- Biased data can occur because of the rationale behind data gathering.
- Prolonged disaster events (like famine over many years) may be recorded as multiple events.
- Regional events which spread across different political boundaries, such as floods or earthquakes, can be recorded in all the affected countries and may be counted as different events.
- Change in national boundaries can also cause ambiguities and difficulties in comparing historical data.
- Fragmented jurisdiction within a country over the different types of disasters can lead to inconsistencies in loss and social impact estimation.

In addition to these, there are concerns regarding the lack of standardized methods for assessing damage across the globe. Most database managers gather data from a variety of public sources, such as newspapers, insurance reports or via aid agencies. The original information is not gathered specifically for analytical purposes, so even if the compiling organization applies strict definitions, there can still be inherent shortcomings in the data.

There are other issues in disaster data gathering that concern the impact diffusion of events. Hazards such as droughts do not have clear-cut start and end dates as the occurrences start slowly and their impacts linger long after the official end of the events. Furthermore, the impact can extend far beyond the visible physical damage and can often affect livelihoods.

All the datasets obtained from the identified sources have been examined with these issues in mind. The steps required to resolve at least some of them are presented in the next section.

Data selection and cleaning

As described in the previous section, a large number of sources contain data gathered by different agencies and under different programmes. An important part of the risk assessment process is to identify the most reliable sources, cross check them with other sources, and identify and resolve inconsistencies in order to create a best-estimate database for use in the study. Table 2 presents the data sources used for each hazard listed, in order of importance. The rest of this section presents some of the steps followed to assure that the most reliable data were gathered and used.

Along with the inherent data issues identified in the previous section, a specific problem faced in CAC is that a majority of these countries were formed during the early 1990s and retrospective country-specific economic loss data have been available only since the late 1980s, and for a few hazards since the late 1990s. Consequently, collection and collation of economic loss data are a challenge.

Another specific problem faced in the study of smaller countries concerns the problem of disasters spreading across national boundaries. Many events, including floods, earthquakes, droughts and extreme temperatures, transcend borders and are recorded in more than one country, resulting in duplication of event and impact values when data are used for analysis at a regional level. To avoid this issue, data sources like Dartmouth have documented data by event rather than by country. In such cases, the format adopted in the CRED EM-DAT database is used to identify, correlate and record data for individual country losses.

To deal with these anomalies, the data from different sources are compared on an event-by-event basis. The event was ignored if it was not reported in any of the said sources. If an event was only recorded in one data source, it was cross checked using published reports, papers and even media news reports, particularly if there were major variations in the reported number of deaths, affected population and economic loss.

4.2 Hazard and vulnerability estimates

The hazard and vulnerability at the region and country levels were derived from the sets of data discussed in the previous section. The hazards were estimated semi-quantitatively rather than fully probabilistically. They were further investigated to assess their geographical commonality and overlap. Vulnerability was defined as being proportional to the population at risk. For vulnerability assessment, quantitative techniques were used to relate the hazards with the socio-economic factors of the region.

4.3 Risk assessment

Risk is commonly quantified as the product of hazard by exposure. In this study, the intent is to quantify the risk directly based on recorded historical losses. This approach is much simpler than the standard probabilistic methods but provides reliable estimates so long as records cover a sufficient period, as explained earlier in this chapter. In the case of this study, data covering a 20-year period (1988-2007) are considered for all hazards except earthquakes. As outlined in section 4.1, data for earthquakes are used which cover a longer period because damaging earthquakes

Table 2: Details on data sources used and period covered for each hazard in the study

Hazard	Period	Source	Comments
Earthquake	1887 - 2007	NGDC, GSHAP, CRED EM-DAT, ADRC	Data compared and cleaned using different sources including individual research papers. For regional analysis, damaging earthquakes from 1887 to 2007 have been considered. For some countries there is not enough economic loss data to compute hazard-specific AAL.
Flood	1988 - 2007	Dartmouth Observatory, CRED EM-DAT, ADRC, OCHA, WB	
Drought	1988- 2007	CRED EM-DAT, ADRC, OCHA, WB	
Landslide/ mudslide	1988– 2007	CRED EM-DAT, ADRC, OCHA, NGI, WB, InTerragate	
Extreme-Temperature	1988 - 2007	CRED EM-DAT, ADRC	
Epidemic	1988 - 2007	CRED EM-DAT, ADRC	
Industrial, Transport and Miscellaneous Accidents	1988 - 2007	CRED EM-DAT	

generally have return periods of longer duration than those of other hazards.

In addition to the general data issues identified in Section 4.1, it is important to consider the following additional issues:

- The use of historical data for loss computation may have some shortcomings. Often damage estimates of large, catastrophic events tend to be overestimated, while those of more frequent, less severe events are often underestimated. Moreover, smaller events, particularly those that individually cause relatively little damage, are often not reported at all.
- In general, when two sources of data are available the one with the more conservative estimate is considered.
- The severity of reported damage often depends on the economy of the affected area, even though the intensity of hazard may be similar. For example, floods in developed countries tend to cause higher economic losses per unit area flooded than floods in countries such as Kazakhstan.

The methodology for loss analysis was adopted from Pusch (2004) 'Preventable Losses: Saving Lives and Property through Hazard Risk Management, A Comprehensive Risk Management Framework for Europe and Central Asia, Working Paper series no. 9, The World Bank' and is presented in Annex 1. Statistical methods were applied to determine the probability and frequency of a hazard occurrence and the level of economic losses it could cause. Number of deaths, deaths per year, deaths per million population and affected population were also estimated. Economic loss potential for different probabilities of exceedance and AAL were calculated for country, sub-regional (Central Asia and Caucasus) and regional (CAC) levels.

4.4 Presentation of results

The results are presented at country, sub-regional and regional levels. At each level data are presented to capture the composition of disasters by hazard type and within country, and the relation between events and their impact is examined, along with estimations of socio-economic losses.

There is a strong link between natural hazards and their biophysical settings, while vulnerability depends largely on socio-economic conditions. Consequently, a brief overview of each country is provided as background information prior to the disaster risk assessment. The review analyses disaster events and their impact at the country, sub-region and regional levels in the context of biophysical and socio-economic settings.

Chapter 5

Country risk profiles

This section deals with the preliminary assessment of disaster risks in CAC countries. The assessment is conducted from both hazard-specific and country-level perspectives. Reported disaster data for various hazards at country level are used for hazard-specific and country-level risk assessment. The approach adopted for economic loss analysis is presented in Annex 1.

An event with an 0.5 per cent probability of occurrence in one year occurs on average every 200 years and generally corresponds to a catastrophic event. An event with a 5 per cent and 20 per cent probability of occurrence occurs on average every 20 years and 5 years, respectively.

As a preamble to the country-level risk assessments, the physical and social settings of each country are provided in brief. This is important as disaster frequency and intensity have a direct relationship with the biophysical and socio-economic setting of the region.

The country-level socio-economic indicators are taken from the World Bank (2007; http://web.worldbank.org), Asian Development Bank (ADB, 2007; http://www.adb.org) and World Fact Book (CIA, 2007; http://www.cia.gov); and disaster risk statistics are prepared based on reported disaster data. Where a socio-economic indicator is not available for the year 2007, the corresponding value available for the latest year is used. For CAC and sub-regions, socio-economic indicators have been estimated from country-level socio-economic indicators.

As outlined in Chapter 4, data for transport, miscellaneous and industrial accidents comes from CRED EM-DAT. For an emergency event to be classified as a disaster it must meet at least one of the following criteria:

- 10 or more people reported killed
- 100 people reported affected
- Declaration of a state emergency
- Call for international assistance

5.1 Armenia

Overview

Country-level Information (2007)	
Geographic area (km²)	29,800
Population	3,000,000
Population density	101
Population growth (annual %)	-0.3
Urban population (% of total)	64 (2006)
Poverty headcount ratio, $2 a day (PPP) (% of population)	26.5 (2006)
GDP (current $) (billion)	9.18
GDP growth (annual %)	13.7
GNI per capita, PPP ($)	5,900
Agricultural GDP (%)	18
Industry GDP (%)	44
Service GDP (%)	38
Human Development Index (HDI)	0.771 (2006)

Regional setting

The republic of Armenia is a landlocked mountainous country in the southern Caucasus, located in the north-east of the Armenian Upland (also known as Mountain Island or Roof of Asia Minor) between the Black Sea and the Caspian Sea. The country is bordered to the north and east by Georgia and Azerbaijan, respectively, and to the south and west by Iran and Turkey, respectively. The country has an area of 29,800 square kilometres and a population of 3 million. The terrain is mostly mountainous, with highest, average and lowest elevations of 4,095 metres (Mount Ararat), 1,800 metres and 380 metres above mean sea level, respectively (Yeveran, 2004). The Armenian climate is markedly continental, with dry and sunny summers from June to mid-September. The temperature fluctuates between 22°C and 36°C during this period, although the low level of humidity mitigates the effect of the high temperatures. However, winters are quite cold, with temperatures ranging from -10° C to -5°C. Lake Sevan, in the Armenian Upland, is the second largest lake in the world relative to altitude. It is 1,900 metres above mean sea level.

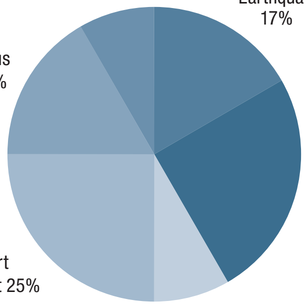
Hazard profile

Armenia is one of the most disaster-prone countries in the southern Caucasus. The country is vulnerable to disasters due to both natural hazards, including earthquakes, droughts, floods, landslides, avalanches, mudslides, strong winds, snowstorms, frost and hail; and technological hazards, including transport and industrial accidents. Figure 2 shows the hazard-specific distribution of various disasters that occurred in the country during the period 1988-2007.

Earthquakes are the most dominant hazard in Armenia. As per GSHAP (GSHAP, 1998), Armenia lies in a region with moderate to high seismic hazard. The analysis of disaster data (1987-2008) shows that although there were fewer earthquakes than floods, the earthquake events caused a disproportionately large amount of damage to the country. The most devastating, the 7 December 1988 Spitak earthquake, had a magnitude of 6.9 and killed 25,000 people, affecting more than 1.6 million others. Direct economic loss was estimated at $14.2 billion. The July 1997 Noyemberyan city earthquake affected 15,000 people and caused an economic loss of $33.33 million.

The drought hazard is significant in Armenia. Among the recent events, the 2000 drought severely affected 297,000 people and reportedly caused damage of $100 million.

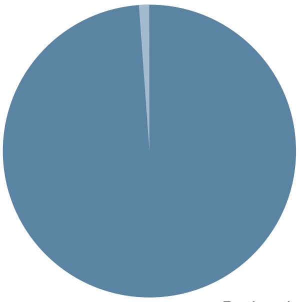
Figure 2:
Percentage distribution of reported disasters in Armenia



Disaster Risk Statistics (1988-2007)

Disaster type	No. of disasters/ year	Total no. of deaths	Deaths/ year	Relative vulnerability (deaths/year/ million)
Earthquake	0.10	25,000	1,250	416.67
Flood	0.15	5	0.25	0.08
Drought	0.05		0.00	0.00
Transport Accidents	0.15	82	4.10	1.37
Miscellaneous Accidents	0.10	16	0.80	0.27
Industrial Accidents	0.05	21	1.05	0.35

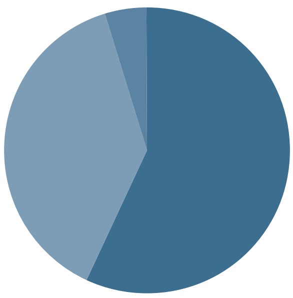
Figure 3:
Average annual economic loss ($ million) of Armenia



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	12,162	132.5
5.0%	3,942	42.9
20.0%	1,170	12.7

Figure 4:
Average annual economic loss ($ million) of Armenia (Spitak earthquake removed)



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	220	2.4
5.0%	71	0.8
20.0%	23	0.2

The flood hazard is also significant. The single flood event of June 1997 affected 7,000 people and caused an economic loss of $8 million.

No landslide-related disaster data were reported in Armenia during the period. However, one third of Armenia is exposed to landslide hazard. During a recent five-year period, landslides left more than 2,000 families homeless: an average of 400 families per year (Pusch, 2004).

In April 2004, crops were damaged in large areas when a sudden 15 ºC drop in temperatures caused severe frost.

Armenia suffered from numerous technological disasters. There were reportedly three major transport accidents, one major industrial accident and two major miscellaneous accidents. These events reportedly killed 119 people and affected 810 others. However, no economic loss figures are available. The country is also exposed to chemical hazards, such as chemical pipelines and chemical plants, and it faces a possible radiation hazard originating from the nuclear plant at Metsamor. The International Atomic Energy Agency (IAEA) considers this plant dangerous because of its location in an earthquake zone and its type (Anagnosti, 2008).

Risk profile

Vulnerability indicators such as the number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year time intervals covering the 20-year period 1988-2007. Figure 5 (a, b, c) plots the total number of deaths, number of people affected and economic losses against each hazard type, while Figure 6 (a, b, c) presents the same variables plotted against 5-year periods. Figure 5 shows that of the hazards, earthquakes caused the largest number of deaths (25,000), affected the largest number of people (1.66 million) and caused the highest economic loss ($14.2 billion), despite having a low occurrence (two events).

The period 1988-1992 (Figure 6) was the worst in terms of number of deaths (25,038), number of people affected (1.64 million) and economic loss ($14.2 billion). Floods and transport accidents had the highest frequency (0.15 per year). Earthquakes had the highest death rate (1,250). The relative vulnerability (deaths/year/million) was highest for earthquakes (417), followed by transport accidents (1.37).

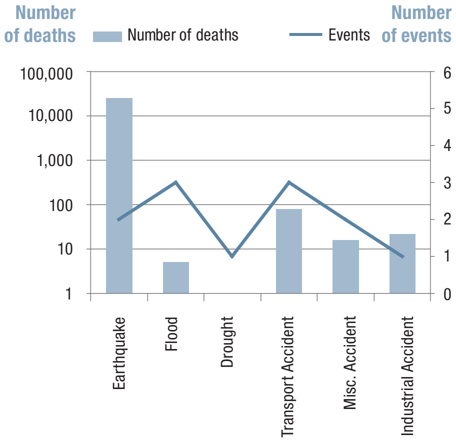
Earthquakes are the dominant risk in Armenia, with an economic AAL of $680 million, followed by droughts ($6 million) and floods ($0.7 million) (Figure 3). The 20-year return period loss for all hazards is $3.94 billion (43 per cent of GDP), while the 200-year return period loss is $12.16 billion (132.5 per cent of GDP).

It may be noted that the above analysis is 'biased' due to the December 1988 Spitak earthquake (Figure 4).

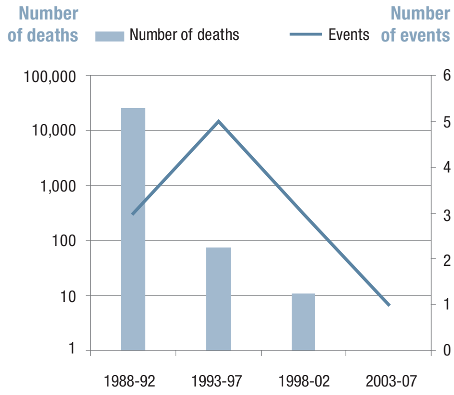
Figure 5: Armenia: Disaster events and socio-economic impact by hazard type (1988-2007)

Figure 6: Armenia: Disaster events and socio-economic impact by 5-year periods (1988-2007)

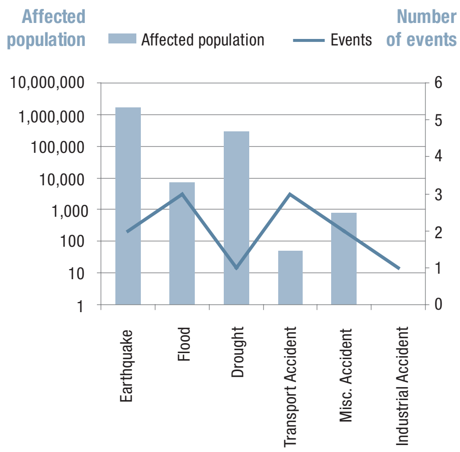
5a Disaster events and number of deaths



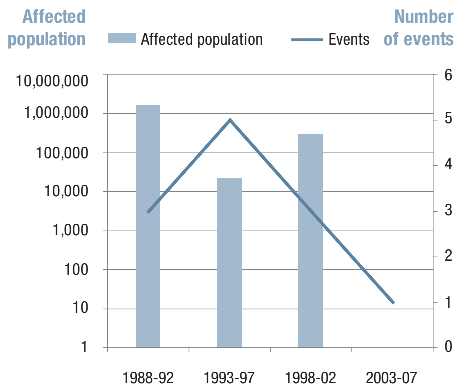
6a Disaster events and number of deaths



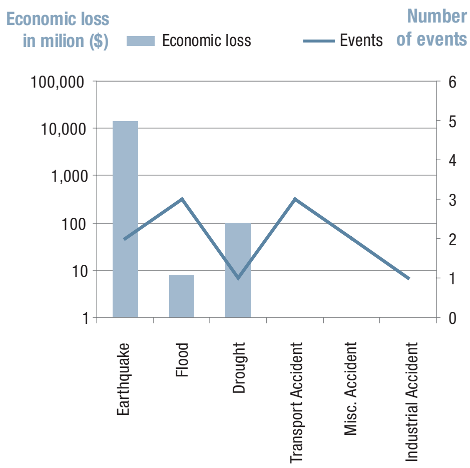
5b Disaster events and affected population



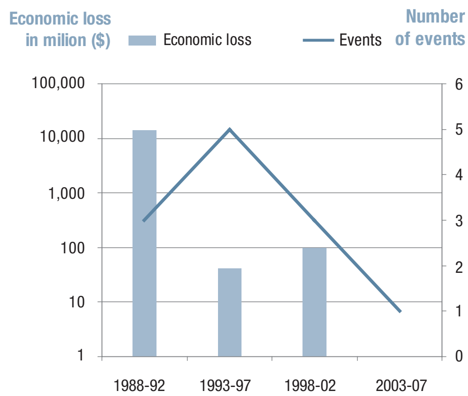
6b Disaster events and affected population



5c Disaster events and economic loss



6c Disaster events and economic loss



5.2 Azerbaijan

Overview

Country-level Information (2007)	
Geographic area (km^2)	86,600
Population	8,570,000
Population density	99
Population growth (annual %)	1.0
Urban population (% of total)	50 (2006)
Poverty headcount ratio, $2 a day (PPP) (% of population)	24 (2006)
GDP (current $) (billion)	31.25
GDP growth (annual %)	19.2
GNI per capita, PPP.($)	6,260
Agricultural GDP (%)	6
Industry GDP (%)	62
Service GDP (%)	32
Human Development Index (HDI)	0.758 (2006)

Regional setting

The Republic of Azerbaijan is the largest and most populous country in the southern Caucasus region, located partially both in Western Asia and Eastern Europe. The country is bounded by the Caspian Sea to the east, Armenia to the west, Russia to the north, Georgia to the north-west and Iran to the south. The country has an area of 86,600 square kilometres and a population of 8.57 million. The territory of Azerbaijan extends 400 kilometres from north to south, and 500 kilometres from west to east. Forty per cent of the country is mountainous. The highest and lowest elevations in Azerbaijan are 4,466 metres (Mount Bazardüzü) and -28 metres (in the Caspian Sea), with respect to mean sea level. The climate in Azerbaijan is subtropical on most of the country's foothills and plains, due to the presence of the Greater Caucasus mountain range in the north. It protects the country from the direct influences of cold air masses from the north. The plains and foothills are characterized by high solar radiation rates. The maximum and minimum temperature variation is very large, from +46° C to -33° C. The largest lake is Sarısu, with an area of 67 square kilometres, and the major and longest river is Kura, with a length of 1,515 kilometres.

Hazard profile

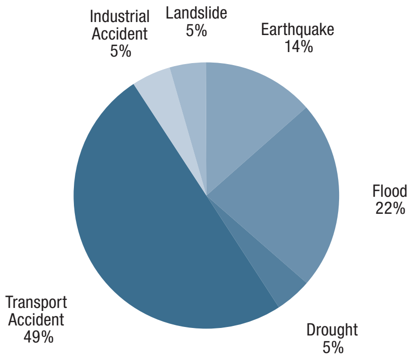
Azerbaijan is vulnerable to disasters due to both natural hazards, including floods, earthquakes, droughts, landslides, avalanches, debris flows and mud flows; and technological hazards, including transport and industrial accidents. Figure 7 shows the hazard-specific distribution of various disasters that occurred during the period 1988-2007.

Azerbaijan is susceptible to heavy flooding because of its topography and the water-related fluctuations in the Caspian Sea (Pusch, 2004). Analysis of the disaster data show that floods have affected a large number of people and caused significant economic losses in the past 20 years. For example, the April 2003 flood in the Ismayilli-Gobustan region alone affected 31,500 people and caused an economic loss of $55 million. Earlier, in June 1997, a flood in the Tovuz-Khanlar region affected 75,000 people and caused an economic loss of $25 million.

In the year 2000, a severe drought caused an economic loss of $100 million.

As per GSHAP (GSHAP, 1998), Azerbaijan lies in a region with moderate to very high seismic hazard. A magnitude 6.3 earthquake in the Baku region in November 2000 killed 31 people, affected 3,294 others and incurred a reported economic loss of $10 million. An earthquake in July 1998 reportedly

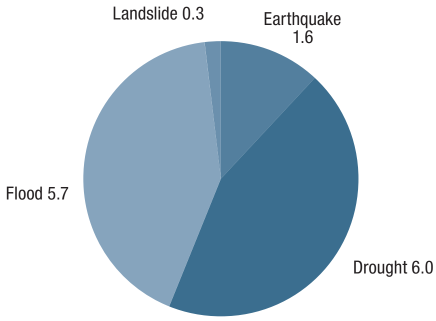
Figure 7:
Percentage distribution of reported disasters in Azerbaijan



Disaster Risk Statistics (1988-2007)

Disaster type	No. of disasters / year	Total no. of deaths	Deaths/ year	Relative vulnerability (deaths/ year/ million)
Earthquake	0.15	33	2.00	0.19
Flood	0.25	16	0.80	0.09
Drought	0.05	-	0.00	0.00
Landslide	0.05	11	0.55	0.06
Transport Accidents	0.55	675	33.75	3.94
Industrial Accidents	0.05	25	1.25	0.15

Figure 8:
Average annual economic loss ($ million) of Azerbaijan



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	179	0.57
5.0%	71	0.23
20.0%	25	0.08

killed one person, affected a large number of people and damaged hundreds of houses.

Occurrences of landslides during heavy rains cause significant damage to human settlements, industry, farms and roads (Pusch, 2004). However, the only reported disaster event due to a landslide was in April 2000. A total of 11 people were killed and economic loss amounted to $4 million.

Azerbaijan also suffered from several technological disasters. There were reportedly 11 major transport accidents along with one major industrial accident between 1988 and 2007. These accidents killed 700 people and affected 357 others. However, no economic loss figures are available. The country also faces a possible nuclear radiation hazard originating from the nuclear plant at Metsamor, in Armenia. This plant is considered dangerous by the IAEA because of its location in an earthquake zone and its reactor type (Anagnosti, 2008).

Risk profile

Vulnerability indicators such as the number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year intervals covering the 20-year period 1988-2007. Figure 9 (a, b, c) plots the total number of deaths, affected population and economic losses against each hazard type, while Figure 10 (a, b, c) presents the same variables plotted against 5-year periods.

Figure 9 shows that among natural hazards, earthquakes caused the largest number of deaths (33), floods affected the largest population (1.77 million) and droughts caused the highest economic loss ($100 million). Among technological hazards, transport accidents caused the largest number of deaths (675), followed by industrial accidents (25).

The period 1993-1997 (Figure 10) was the worst in terms of number of deaths (500) as well as for number of people affected (1.734 million), while 1998-2002 was the worst in terms of economic loss ($119 million), caused mainly by the drought of 2000.

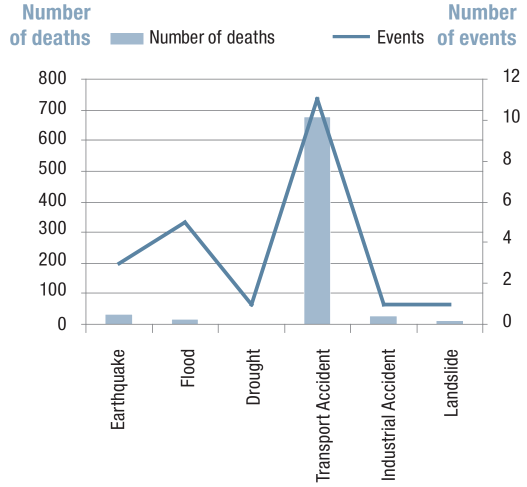
Transport accidents had the highest frequency (0.55) and death rate (33.75). The relative vulnerability was highest for transport accidents (3.94), followed by earthquakes (0.19).

Droughts are the dominant risk in Azerbaijan, with an economic AAL of $6 million, followed by floods ($5.7 million), earthquakes ($1.6 million) and landslides ($0.3 million) (Figure 8). The 20-year return period loss for all hazards is $71 million (0.23 per cent of GDP), while the 200-year return period loss is $179 million (0.57 per cent of GDP).

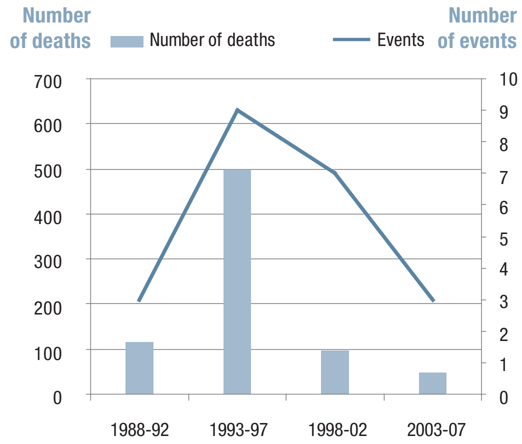
Figure 9:
Azerbaijan: Disaster events and socio-economic impact by hazard type (1988-2007)

Figure 10:
Azerbaijan: Disaster events and socio-economic impact by 5-year periods (1988-2007)

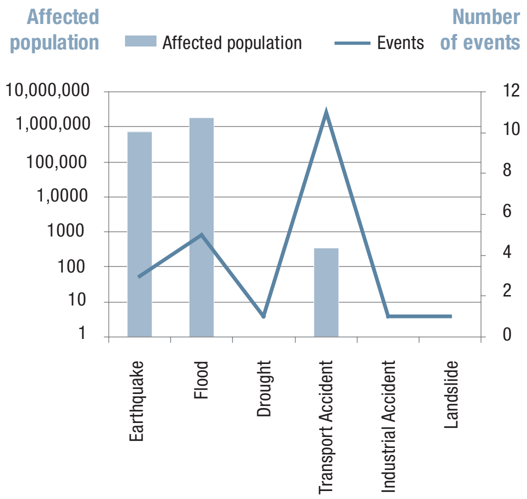
9a Disaster events and number of deaths



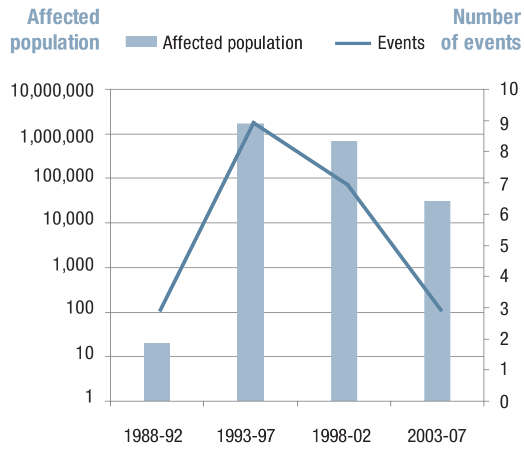
10a Disaster events and number of deaths



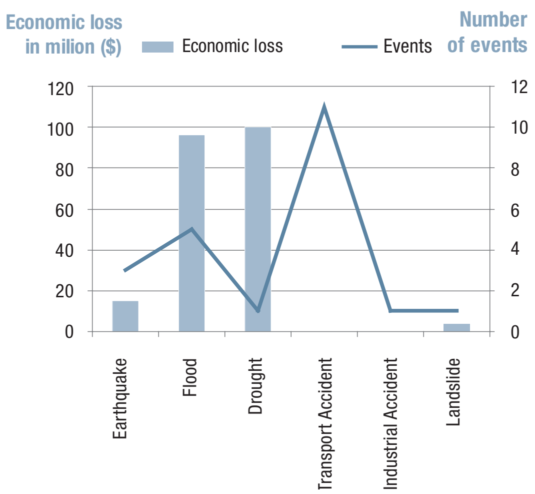
9b Disaster events and affected population



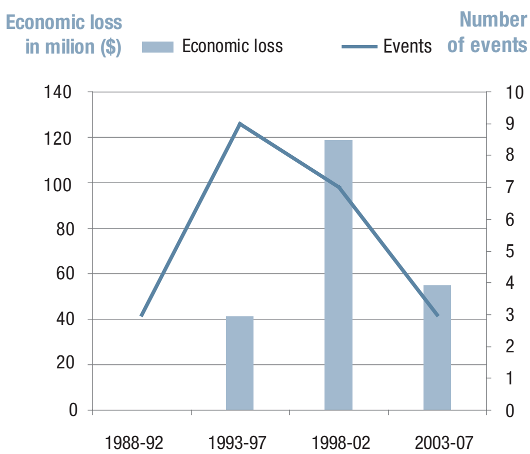
10b Disaster events and affected population



9c Disaster events and economic loss



10c Disaster events and economic loss



5.3 Georgia

Overview

Country-level Information (2007)	
Geographic area (km^2)	69,700
Population	4,400,000
Population density	63
Population growth (annual %)	-0.8
Urban population (% of total)	51 (2006)
Poverty headcount ratio, $2 a day (PPP) (% of population)	31.0 (2006)
GDP (current $) (billion)	10.18
GDP growth (annual %)	12.4
GNI per capita, PPP ($)	4,770
Agricultural GDP (%)	11
Industry GDP (%)	24
Service GDP (%)	65
Human Development Index (HDI)	0.763 (2006)

Regional setting

The Republic of Georgia is a transcontinental country, along the dividing lines of Asia and Europe and in the southern Caucasus, situated between the Black Sea to the west and the Caucasus mountains to the north. The country is bordered by Russia to the north, Azerbaijan to the east, Armenia to the south and Turkey to the south-west. Georgia is a small country, with an area of 69,700 square kilometres and a population of 4.4 million. Eighty per cent of the territory of Georgia is mountainous, with highest and lowest elevations of 5,201 metres (Mount Shkhara) and zero metres (Black Sea) above mean sea level. The Mtkvari and the Rioni are the two main rivers of Georgia, with lengths of 1,564 kilometres and 527 kilometres, respectively. Lake Paravani is the largest lake in the country, with an area of 37 square kilometres. The climate is extremely diverse and there are two main climatic regions. The western part is humid and warm, and the eastern part has a moderately warm continental climate. The summers are humid and warm, with an average temperature of 23° C in July, whereas winters are mild, with an average temperature of -5° C in January.

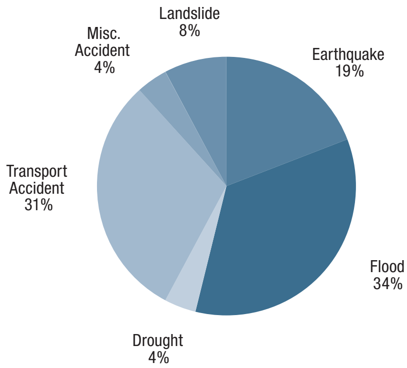
Hazard profile

Georgia is vulnerable to natural hazards including floods, earthquakes, droughts, landslides, avalanches, debris flows and mud flows; and technological hazards including transport and industrial accidents. Figure 11 shows the hazard-specific distribution of various disasters that occurred in the country for the period 1988-2007.

The landslide hazard is serious in Georgia and 10,000 potential landslide centres have been identified, of which 3,000 are active (Pusch, 2004). During March to April 1989, landslides killed 98 people, affected 2,500 others and incurred a reported economic loss of $423 million.

As per GSHAP (GSHAP, 1998), Georgia lies in a region with moderate to very high seismic hazard. Analysis of the disaster data show that Georgia is severely affected by earthquakes. Earthquakes have affected large numbers of people and caused significant economic losses over the past 20 years. An earthquake in the Tbilisi region on 25 April 2002 killed 6 people, affected 19,156 others and caused an economic loss of $350 million. A magnitude 7 earthquake in the Racha-Imereti region on 29 April 1991 killed 100 people, affected 100,000 others and caused an economic loss of $10 million. This was followed by a magnitude 6.5 earthquake on 15 June 1991 in the Dzhava-Tskhinvali region, which killed 8 people and affected 3,740 others.

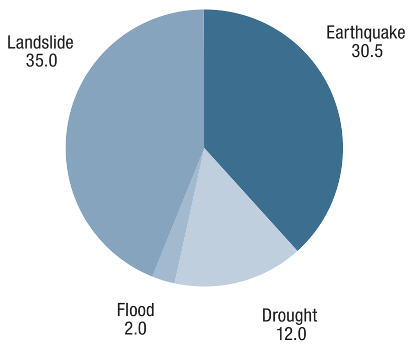
Figure 11: Percentage distribution of reported disasters in Georgia



Disaster Risk Statistics (1988-2007)

Disaster type	No. of disasters / year	Total no. of deaths	Deaths / year	Relative vulnerability (deaths/year/ million)
Earthquake	0 25	118	6.00	1.34
Flood	0.45	10	0.50	0.11
Drought	0.05	-	0.00	0.00
Landslide	0.10	98	4.90	1.11
Transport Accidents	0.40	369	18.45	4.19
Miscellaneous Accidents	0.05	15	0.75	0.17

Figure 12: Average annual economic loss ($ million) of Georgia



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	951	9.34
5.0%	398	3.91
20.0%	146	1.43

Flood events are also very frequent in Georgia. The February 1987 flood in the Tbilisi region alone killed 110 people, affected 36,000 others and caused an economic loss of $546 million. In 1997, the flood events in the Tbilisi-Gori-Kvemo-Kartli region killed 7 people, affected 500 others and incurred a reported economic loss of $29.5 million. In June 2005, the flood in the Mtsketa-Tianetsk region killed 1 person, affected 51 others and caused an economic loss of $2 million.

The only reported drought was in the Kakheti-Kvemo-Kartli region in the year 2000, which affected 696,000 people and caused an economic loss of $200 million.

Georgia also suffered from many technological disasters. There were reportedly 8 major transport accidents along with one major miscellaneous accident. These accidents reportedly killed 384 people and affected 115 others. However, no economic loss figures are available. The country also faces a possible nuclear radiation hazard originating from the nuclear plant at Metsamor, in Armenia. This plant is considered dangerous by the IAEA because of its location in an earthquake zone and its reactor type (Anagnosti, 2008).

Risk profile

Vulnerability indicators such as the number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year intervals covering the 20-year period 1988-2007. Figure 13 (a, b, c) plots the total number of deaths, affected population and economic losses against each hazard type, while Figure 14 (a, b, c) presents the same variables plotted against 5-year periods.

Figure 13 shows that among all hazards, transport accidents caused the largest number of deaths (369), followed by earthquakes (118) and landslides (98). Droughts affected the largest number of people (696,000), followed by earthquakes (122,906) and floods (4,041), while landslides caused the highest economic loss ($423 million), followed by earthquakes ($360 million).

Overall, transport accidents caused the largest number of deaths, while disasters caused by natural hazards such as landslides and earthquakes caused the largest economic losses.

The period 1988-1992 (Figure 14) was the worst in terms of number of deaths (468), while 1998-2002 was the worst in terms of the number of people affected (715,156) and economic loss ($550 million), due mainly to the 2000 drought and 2002 earthquake.

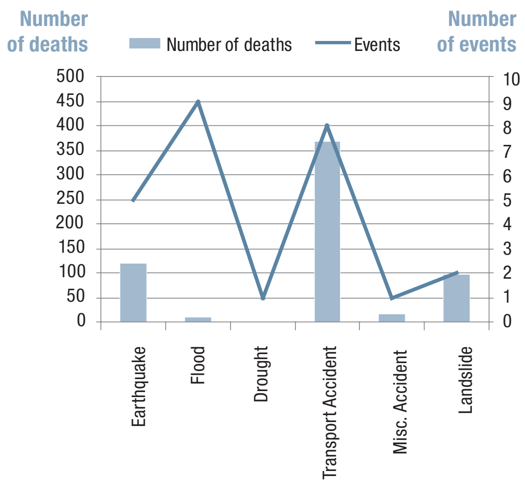
Floods had the highest frequency (0.45), followed by transport accidents (0.40), earthquakes (0.25) and landslides (0.10). The relative vulnerability was highest for transport accidents (4.19), followed by earthquakes (1.34) and landslides (1.11).

Landslides and earthquakes are the dominant risks in Georgia, with an economic AAL of $35 million and $31 million, respectively (Figure 12). The 20-year return period loss for all hazards is $398 million (3.91 per cent of GDP), while the 200-year return period loss is $951 million (9.34 per cent of GDP).

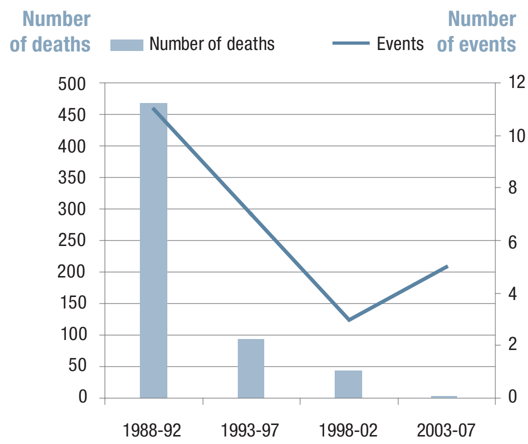
Figure 13: Georgia: Disaster events and socio-economic impact by hazard type (1988-2007)

Figure 14: Georgia: Disaster events and socio-economic impact by 5-year periods (1988-2007)

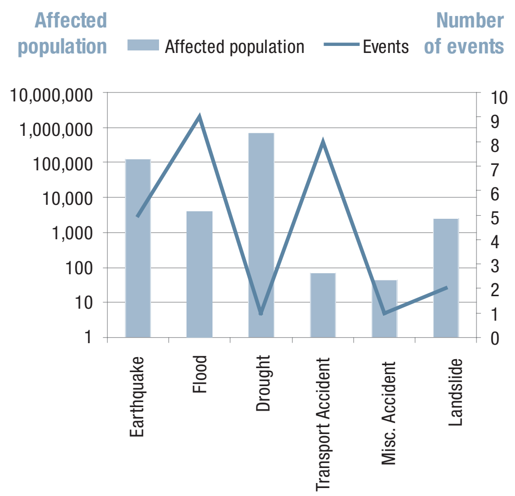
13a Disaster events and number of deaths



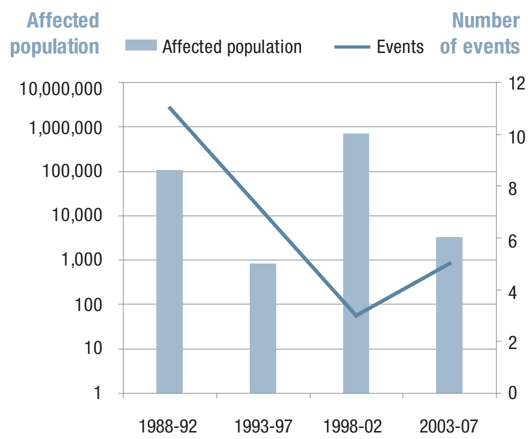
14a Disaster events and number of deaths



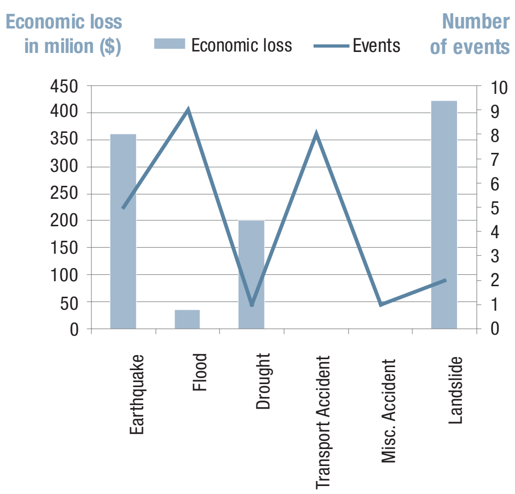
13b Disaster events and affected population



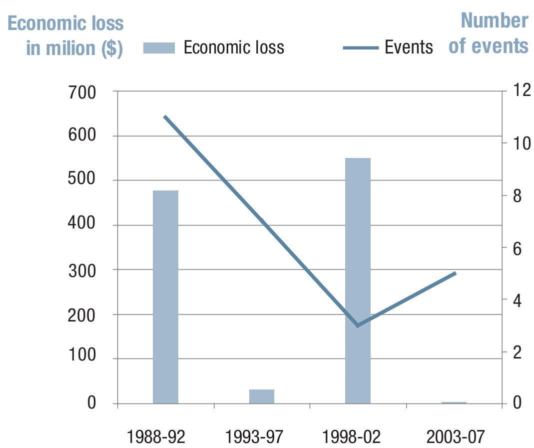
14b Disaster events and affected population



13c Disaster events and economic loss



14c Disaster events and economic loss



5.4 Kazakhstan

Overview

Country-level Information (2007)	
Geographic area (km²)	2,724,900
Population	15,480,000
Population density	6
Population growth (annual %)	1.1
Urban population (% of total)	56 (2006)
Poverty headcount ratio, $2 a day (PPP) (% of population)	13.8
GDP (current $) (billion)	103.84
GDP growth (annual %)	8.5
GNI per capita, PPP ($)	9,700
Agricultural GDP (%)	7
Industry GDP (%)	44
Service GDP (%)	49
Human Development Index (HDI)	0.807 (2006)

Regional setting

The Republic of Kazakhstan is the largest country in Central Asia and CAC, and is the ninth largest country in world. With an area of 2.74 million square kilometres, Kazakhstan is equivalent to the size of Western Europe. The country is bounded by Russia to the north, China to the east, Kyrgyzstan and Uzbekistan to the south, and the Caspian Sea and Turkmenistan to the west. The population of the country is 15.48 million, which means its population density is low at just six people per square kilometre.

There is considerable variation in topography within Kazakhstan, with highest and lowest elevations of 7,010 metres (Mount Khan Tengri) in the Tian Shan range and -132 metres in the Caspian Depression, respectively. Seventy per cent of the country, including the entire west and most of the south, is either desert or semi-desert. The terrain in these areas is bare, eroded, broken uplands with sands. Kazakhstan contains an extensive network of rivers such as the Syr Daria, Ural, Irtysh and Tobol and several large lakes including the Caspian Sea, the Aral Sea and the Zaysan. In the mountainous areas there are 2,720 glaciers and over 500 glacial lakes which pose a high glacial lake outburst (GLOF) hazard.

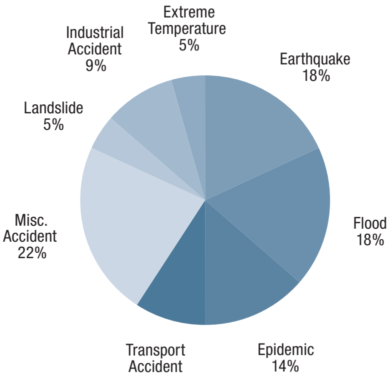
The country experiences continental climatic conditions such as warm and humid summers. However, winters can be cold, with average temperatures in the north just -3°C. Average winter temperatures in the south are 18°C. Summer temperatures average 19°C in the north and 30°C in the south. As a whole, temperature variations are extremely high: the summer extreme can exceed 40°C, while in winter it can plummet to -50°C.

Hazard profile

Kazakhstan is vulnerable to natural hazards including earthquakes, floods, landslides/mudslides/debris flows, avalanches and extreme temperatures; and technological hazards including transport, miscellaneous and industrial accidents. Figure 15 shows the hazard-specific distribution of various disasters that occurred in the country from 1988 to 2007.

As per GSHAP (GSHAP, 1998), Kazakhstan lies in a region with low to very high seismic hazard. The Tien-Shan and Altai mountains are in a very high seismic hazard region. The region is home to 6 million people (more than one third of the total population) and more than 40 per cent of the nation's industrial capacity. Due to its remoteness and poor damage assessment practices,

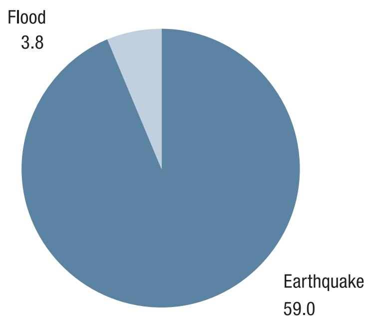
Figure 15:
Percentage distribution of reported disasters in Kazakhstan



Disaster Risk Statistics (1988-2007)

Disaster type	No. of disasters / year	Total no. of deaths	Deaths / year	Relative vulnerability (deaths/year/ million)
Earthquake	0.20	15	0.75	0.05
Flood	0.20	10	0.50	0.03
Landslide	0.05	48	2.40	0.16
Extensive Temperatures	0.05	11	0.55	0.04
Epidemic	0.15	7	0.35	0.02
Transport Accidents	0.10	42	2.10	0.14
Miscellaneous Accidents	0.25	85	4.25	0.27
Industrial Accidents	0.10	64	3.20	0.21

Figure 16:
Average annual economic loss ($ million) of Kazakhstan



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	1,136	1.09
5.0%	348	0.34
20.0%	100	0.10

earthquake damage in the country is under-reported.

Historically, Kazakhstan has experienced highly damaging earthquakes, which experts suggest tend to occur every 80 to 100 years. The last highly-damaging period of seismic activities was 1885-1911, when several large earthquakes struck at Verneskoye (1887), Chilik (1889) and Keminskoye (1911). During these earthquakes, the city of Almaty was almost flattened.

The 1911 Kemin (Kebin) earthquake in the northern Tien-Shan mountains (Kazakhstan, Kyrgyzstan) formed a complex system of surface ruptures. Six fault segments of the Kemin-Chilik and the Aksu fault zones with different strikes, dips and kinematics were activated during the earthquake. Damage occurred in the Chong-Kemin (Bol'shoy Kemin) valley as well as at Anan'yevo and Oytal, Kyrgyzstan. Faulting, fractures and large landslides were observed over an area of 200 square kilometres in the Chong-Kemin and Chilik valleys and along the shore of Lake Issyk-Kul. The earthquake was felt more than 1,000 kilometres away in Kazakhstan and Russia and was one of the strongest events of a sequence of seismic catastrophes that affected the Kungei and Zaili-Alatau mountain ranges between 1887 and 1938 (http://www.sibran.ru/psb/show_text.phtml?eng+3349+9).

Since then, there have been no such subsequent large damaging earthquakes and there are high possibilities of another series of such events within the next 10-15 years (IRIN, 2004). The more recent Zhambyl province earthquake in May 2003 killed 3 people and affected 36,626 others. The August

1990 earthquake on the Kazakhstan-China border killed 1 person and affected 20,008 others, causing an economic loss of $3 million (NGDC).

The flood hazard is also significant in Kazakhstan. In the plains, spring floods fed by rain and snowmelt occur and mountainous regions suffer mud flows triggered by rainfall or breaches of glacial lakes. However, the largest mud flows are those triggered by earthquakes (Pusch, 2004). Analysis of disaster data show that the country suffers from frequent flood disasters. Recent events include the June 1993 flood in the Embinskyi-Kzylkoginskyi region, which killed 10 people, affected 30,000 others and caused an economic loss of $36.5 million. The April 2000 flood in the Denisovsky-Zhitikarinsky region affected 2,500 people and caused an economic loss of $1.5 million. Recently, the March 2005 flood in the Shiyeli-Syr Dariya region affected 25,000 people and caused an economic loss of $7.6 million.

Landslides also pose a significant hazard. The March 2004 landslide in Talgar district reportedly killed 48 people.

Kazakhstan suffered from various epidemic hazards. In December 1998, 7 people were killed and 593 made ill by bacterial infection, while from 1999–2000, 280 people were infected by typhus.

Technological disasters include two major transport accidents, two industrial accidents and five miscellaneous accidents including food poisoning and explosions. These accidents reportedly killed 191 people and affected 303 others. No economic loss figures are available.

Risk profile

Vulnerability indicators such as the number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year intervals covering the 20-year period 1988-2007. Figure 17 (a, b, c) plots the total number of deaths, affected population and economic losses against each hazard type, while Figure 18 (a, b, c) presents the same variables plotted against 5-year periods.

Figure 17 shows that among all hazards, miscellaneous accidents such as explosions in buildings and food poisoning caused the largest number of deaths (85), followed by industrial accidents (64) and landslides (48). Floods affected the largest number of people (61,168) and caused the largest economic loss ($46 million).

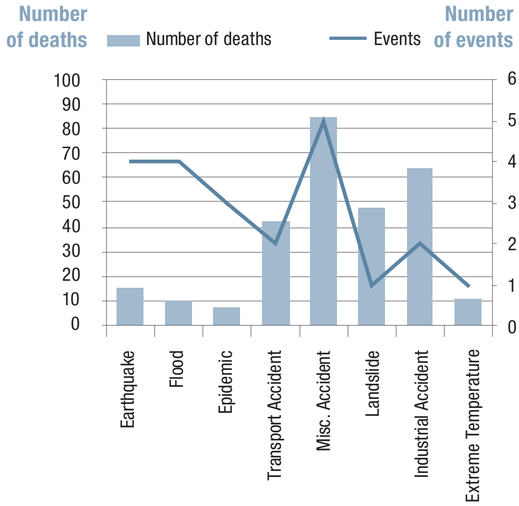
The period 2003-2007 (Figure 18) was the worst in terms of number of deaths (126) and number of people affected (61,793), while 1993-97 was the worst in terms of economic loss ($36.53 million), caused mainly by the 1993 flood. Miscellaneous accidents had the highest frequency (0.25) and the highest death rate (4.25). The relative vulnerability was highest for miscellaneous accidents (0.27), followed by industrial accidents (0.21), landslides (0.16), transport accidents (0.14) and earthquakes (0.05).

Earthquakes are the dominant risk in Kazakhstan, with an economic AAL of $59 million, followed by floods ($3.8 million) (Figure 16). The 20-year return period loss for all hazards is $348 million (0.34 per cent of GDP), while the 200-year return period loss is $1.136 billion (1.09 per cent of GDP).

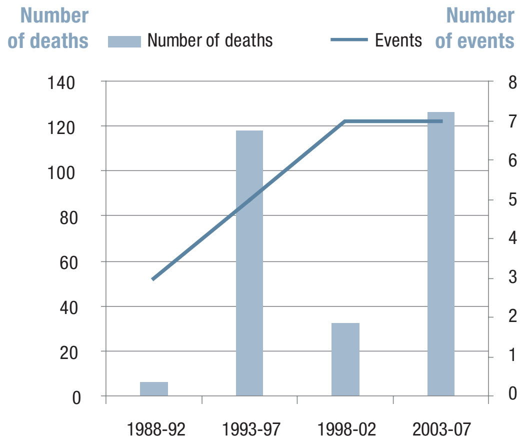
Figure 17: Kazakhstan: Disaster events and socio-economic impact by hazard type (1988-2007)

Figure 18: Kazakhstan: Disaster events and socio-economic impact by 5-year periods (1988-2007)

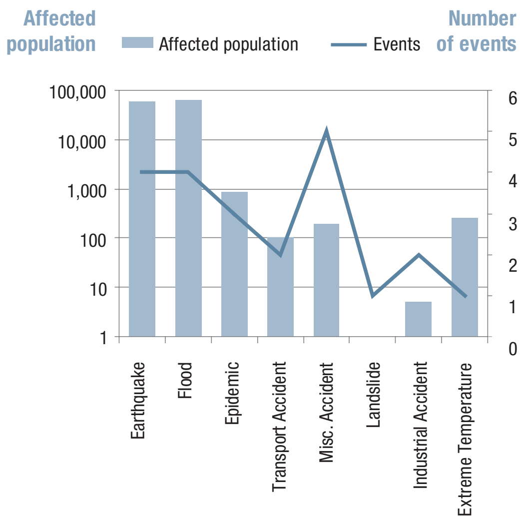
17a Disaster events and number of deaths



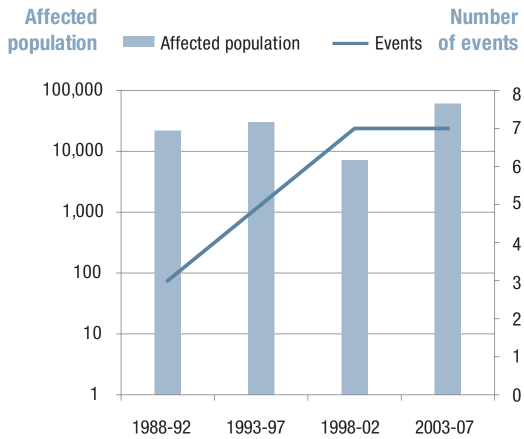
18a Disaster events and number of deaths



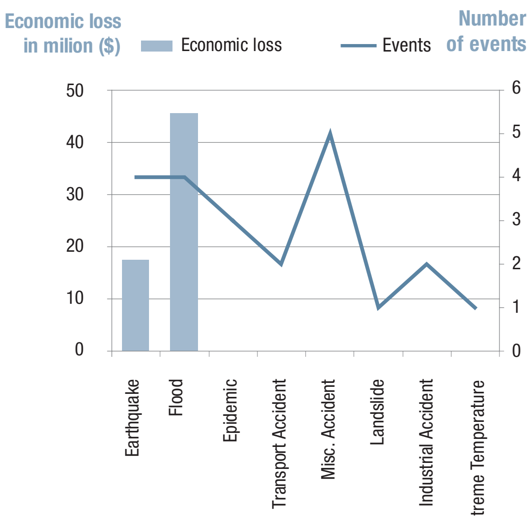
17b Disaster events and affected population



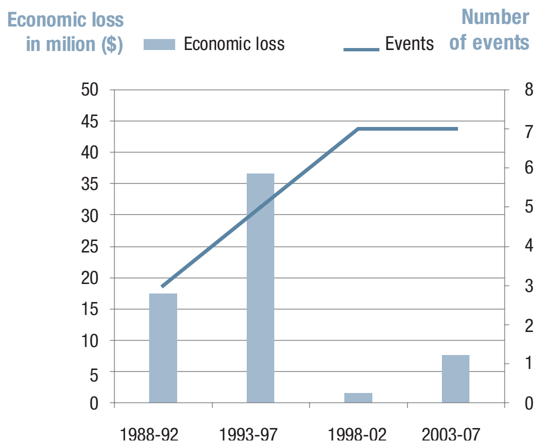
18b Disaster events and affected population



17c Disaster events and economic loss



18c Disaster events and economic loss



5.5 Kyrgyzstan

Overview

Country-level Information (2007)	
Geographic area (km^2)	199,900
Population	5,240,000
Population density	26
Population growth (annual %)	1.0
Urban population (% of total)	34 (2006)
Poverty headcount ratio, $2 a day (PPP) (% of population)	40.0 (2004)
GDP (current $) (billion)	3.5
GDP growth (annual %)	7.4
GNI per capita, PPP ($)	1,950
Agricultural GDP (%)	33 (2006)
Industry GDP (%)	20 (2006)
Service GDP (%)	47 (2006)
Human Development Index (HDI)	0.694 (2006)

Regional setting

Kyrgyzstan is a landlocked mountainous country in the eastern part of Central Asia. The country is bordered by Kazakhstan to the north, Uzbekistan to the west, Tajikistan to the south-west and China to the east. Kyrgyzstan has an area of 199,900 square kilometres, with a population of 5.24 million. The Tian Shan mountain range covers 80 per cent of the country (Anagnosti, 2008). The topography of Kyrgyzstan is quite rugged, with highest and lowest elevations of 7,439 metres (mount Jengish Chokusu) and 132 metres (Kara-Daryya) above mean sea level, respectively. Naryn is the country's largest river (renamed Syr Daria after entering Uzbekistan), and the largest lake is Yssyk-Kul (1,607 metres above mean sea level), located in the north-eastern part of the country.

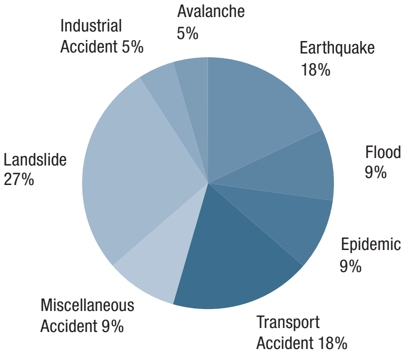
The climate of Kyrgyzstan varies widely in different parts of the country, from a low dry continental climate in the mountain slopes to a 'polar' climate in the highly elevated areas of the Tian Shan mountain range. The Fergana Valley, in the south-west, experiences a subtropical climate, with extremely hot summers and temperatures of up to 40°C. The average winter temperature ranges from -4°C to -9°C, whereas the summer temperature varies from 20°C up to 27°C. In winter, the coldest areas of the country experience below-freezing temperatures for as long as 40 days, and even some desert areas experience constant snowfall for more than one month.

Hazard profile

Kyrgyzstan is vulnerable to disasters caused by natural hazards including earthquakes, landslides, avalanches and floods. Figure 19 shows the hazard-specific distribution of various disasters that occurred in the period 1988-2007.

Analysis of the disaster data shows that Kyrgyzstan is severely affected by earthquakes. As per GSHAP (GSHAP, 1998), Kyrgyzstan lies in a region with high to very high seismic hazard. An earthquake of magnitude 7.3 struck the Dshalal-Abad region on 19 August 1992 killing 54 people, affecting a further 86,800 and incurring a reported economic loss of $130 million. Earlier that year, on 15 May 1992, a magnitude 6.6 earthquake in the Burgandi-Nookat region killed 4 people, affected 50,000 others and caused an economic loss of $31 million. A magnitude 7 earthquake in the Ak-Tala district on 9 January 1997 affected 1,230 people and caused an economic loss of $2 million, while a magnitude 5.8 earthquake on 26 December 2006 in the Isakeevo-Kochkorka region affected 12,050 people.

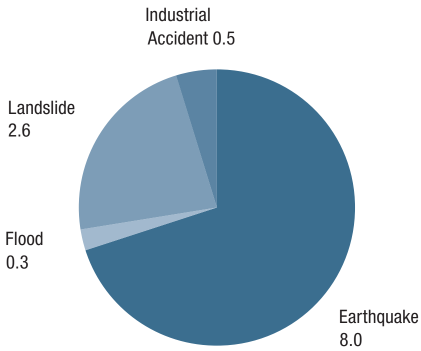
Figure 19:
Percentage distribution of reported disasters Kyrgyzstan



Disaster Risk Statistics (1988-2007)

Disaster type	No. of disasters / year	Total no. of deaths	Deaths/ year	Relative vulnerability (deaths/year/ million)
Earthquake	0.20	58	2.90	0.55
Flood	0.10	4	0.20	0.04
Landslide	0.30	238	11.90	2.27
Avalanche	0.05	11	0.55	0.10
Epidemic	0.10	22	1.10	0.21
Industrial Accidents	0.05	4	0.20	0.04
Transpot Accidents	0.20	88	4.40	0.84
Miscellaneous Accidents	0.10	21	1.05	0.20

Figure 20:
Average annual economic loss ($ million) of Kyrgyzstan



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	160	4.57
5.0%	49	1.40
20.0%	15	0.42

Recently, on 5 October 2008, a powerful earthquake of magnitude 6.6 hit the south-east of Kyrgyzstan, 220 kilometres from the main city of Osh, near the borders of Tajikistan and the People's Republic of China. The earthquake struck the two districts (rayons) of Alai and Chonalai and severely damaged the village of Nura, killing 74 people (including 43 children) and injuring a further 157. An estimated 90 per cent of the village infrastructure was destroyed and more than 850 people were left homeless. The estimated damage caused by the earthquake in the area covered by the assessment was in the range of $8 million – $10 million (ADB, 2008).

Landslide hazards are also significant in the country. Approximately 5,000 potential active landslide sites have been identified, out of which 3,500 are in the southern part of country. Every year, on average, landslides kill dozens of people and 700 houses are damaged or destroyed (Pusch, 2004). On 14 April 1994, a major landslide in the Osh Jalal-Abad region killed 111 people, affected 58,500 others and caused an economic loss of $36 million. Earlier, in March 1994, 51 people were killed by a landslide in the Uzgen region. Meanwhile, in April 2003 a landslide in the Uzgen district killed 38 people and affected 211 others, while in April 2004 two separate landslides in the Alay district and the Kara-Sogot region killed a total of 38 people and affected 96 others.

Mud flows and floods also cause significant damage. Floods are initiated by heavy rains, snowmelt and breaches of natural dams. There are more than 8,500 glaciers in Kyrgyzstan, encompassing an area of 8,000 square kilometres. Similarly, out of more than 1,000 high mountain lakes 200 are identified as dangerous (Pusch, 2004). In June 2005, a flood in the region of Uzgen killed 3 people, affected 2,050 others and caused an economic loss of $2.66 million. In May 1998, a flood event in the Jalal-Abad region killed 1 person, affected 7,728 others and caused an economic loss of $2.4 million.

Kyrgyzstan has suffered from various epidemic disasters. In March 1997, 22 people were killed and 336 others made ill by bacterial infection. In 1998, 458 people contracted typhus fever.

The country has also suffered numerous disasters caused by technological hazards. Over the past two decades, there have been four major transport accidents, one major industrial accident and two major miscellaneous accidents, including dam collapse, classified as disasters. These accidents reportedly killed 113 people and affected a further 1,217, with a reported economic loss of $8 million due to industrial accidents alone. Furthermore, the country has a potential nuclear radiation hazard from the release of radio-nuclides from mine tailings and waste dumps (Pusch, 2004).

Risk profile

Vulnerability indicators such as the number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year intervals covering the 20-year period 1988-2007. Figure 21 (a, b, c) plots the total number of deaths, affected population and economic losses against each hazard type, while Figure 22 (a, b, c) presents the same variables plotted against 5-year periods.

Figure 21 shows that among natural hazards, landslides caused the largest number of deaths (238), followed by earthquakes (58). Earthquakes affected the largest number of people (150,086) and caused the highest economic loss ($163 million), followed by landslides, which affected 59,809 people and caused an economic loss of $38 million.

The highest number of deaths from disasters was in the period 1993-97 (Figure 22), when 196 people died. The period 1988-1992 was the worst in terms of number of people affected (136,806) and economic loss ($161 million), mainly caused by the devastating earthquake of 1992. Among technological hazards, transport accidents caused the largest number of deaths (88), followed by miscellaneous accidents (21).

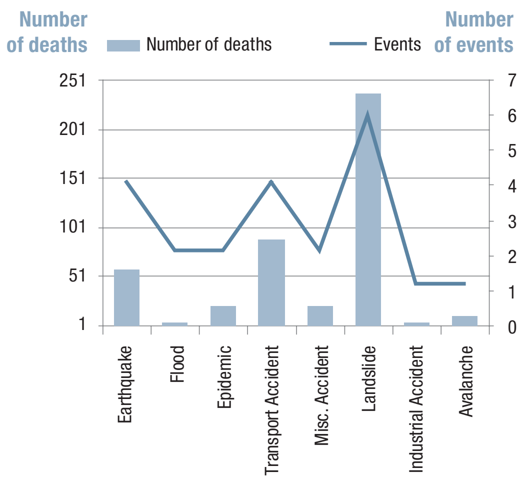
Landslides had the highest frequency (0.30 per year), followed by earthquakes and transport accidents (0.20 per year each). The death rate was highest for landslides (11.90), followed by transport accidents (4.4) and earthquakes (2.9). The relative vulnerability was highest for landslides (2.27), followed by transport accidents (0.84) and earthquakes (0.55).

Earthquakes are the dominant risk in Kyrgyzstan with an economic AAL of $8 million, followed by landslides ($2.6 million) (Figure 20). The 20-year return period loss for all hazards is $49 million (1.4 per cent of GDP), while the 200-year return period loss is $160 million (4.57 per cent of GDP).

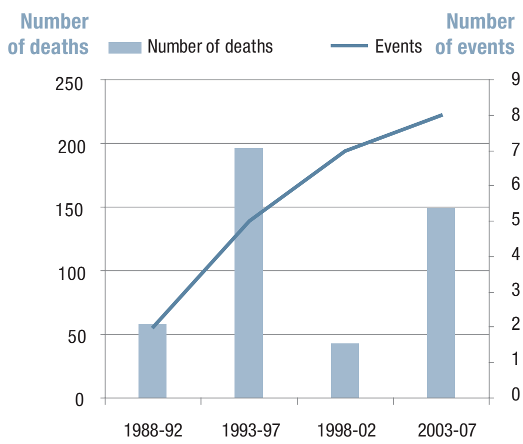
Figure 21: Kyrgyzstan: Disaster events and socio-economic impact by hazard type (1988-2007)

Figure 22: Kyrgyzstan: Disaster events and socio-economic impact by 5-year periods (1988-2007)

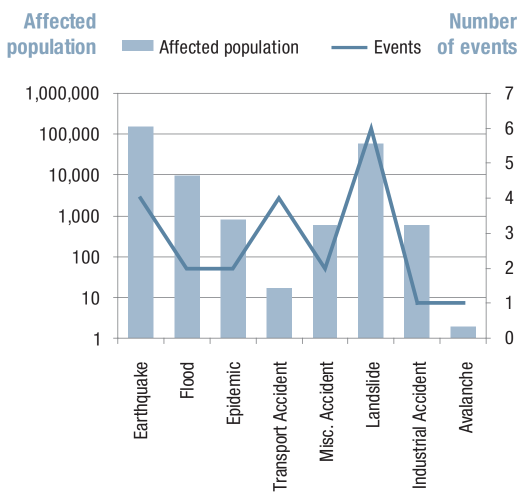
21a Disaster events and number of deaths



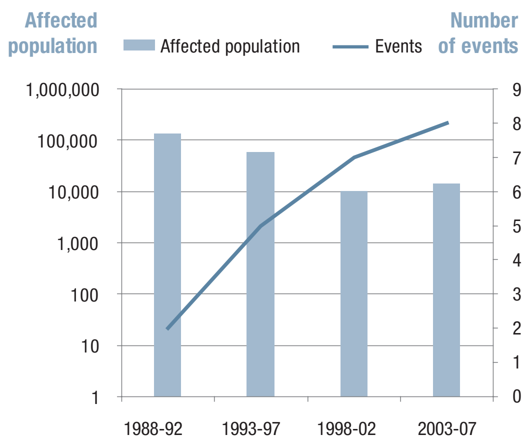
22a Disaster events and number of deaths



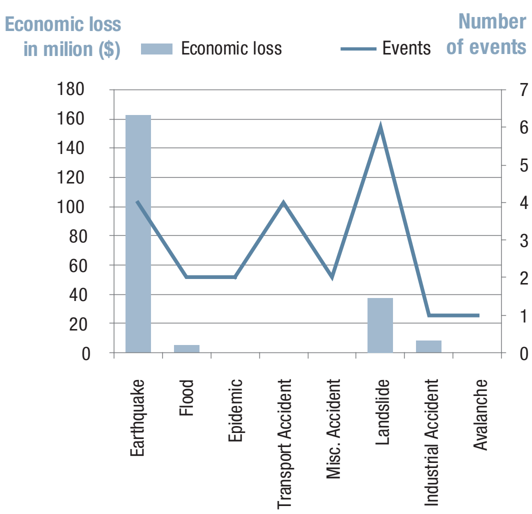
21b Disaster events and affected population



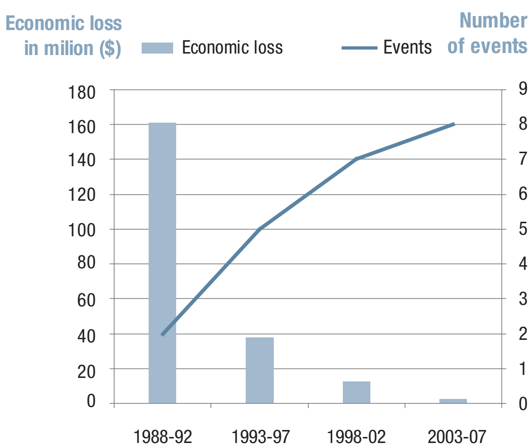
22b Disaster events and affected population



21c Disaster events and economic loss



22c Disaster events and economic loss



5.6 Tajikistan

Overview

Country-level Information (2007)	
Geographic area (km^2)	142,600
Population	6,740,000
Population density	47
Population growth (annual %)	1.5
Urban population (% of total)	24 (2006)
Poverty headcount ratio, $2 a day (PPP) (% of population)	60
GDP (current $) (billion)	3.71
GDP growth (annual %)	7.8
GNI per capita, PPP ($)	1,710
Agricultural GDP (%)	21
Industry GDP (%)	28
Service GDP (%)	51
Human Development Index (HDI)	0.684 (2006)

Regional setting

Tajikistan is the smallest country in Central Asia. It is a landlocked mountainous country surrounded by Afghanistan to the south, Uzbekistan to the west, Kyrgyzstan to the north and China to the east. The country has an area of 142,600 square kilometres and a population of 6.74 million. More than 90 per cent of its territory is mountainous and over half lies above 3,000 metres from mean sea level. The mountainous region is dominated by the Trans-Alay Range in the north and the Pamirs in the south-east. There is considerable variation in topography, with highest and lowest elevations of 7,495 metres (the Somoni Peak of the Pamir mountain chain, which was also the highest point of the former USSR) and 300 metres (in the Syr Daria basin) above mean sea level, respectively. The most populated areas are in the lowlands south of Dushanbe and northern Khujand regions. Mountainous terrains separate the two, and consequently the valleys are overpopulated.

The climate of Tajikistan varies from continental and subtropical to semi-arid, with 17.5 per cent desert (Lal, 2007). Even though high mountains shield the cold air masses from the Arctic, the Fergana valley and other lowland areas experience sub-zero temperatures for more than three months of the year. Rainfall in Tajikistan is the highest in Central Asia, ranging from 500-600 mm to 1,500 mm in the mountains.

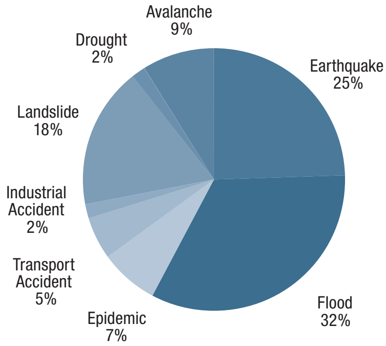
Hazard profile

Tajikistan is vulnerable to a variety of disasters caused by natural hazards, including floods, earthquakes, mud flows, landslides, epidemics, droughts, avalanches, insect infestation and wind storms; and technological hazards including transport, miscellaneous and industrial accidents. Figure 23 shows the hazard-specific distribution of various disasters that occurred in the country for the period 1988-2007.

The complex topography of this mountainous country, its high rainfall levels and large number of glaciers mean that Tajikistan is highly exposed to flood hazards. The floods are largely caused by outbursts from mountain lakes, which store huge volumes of water behind unstable natural barriers. Tajikistan's Lake Sarez is one of the world's potentially dangerous lakes (Pusch, 2004).

Analysis of disaster data shows that Tajikistan is severely affected by flood disasters, with 19 such events taking place in the past two decades. The most significant include: a flood in May 1992 which killed 1,346 people, affected 63,500 others and caused an economic loss of $300 million; a

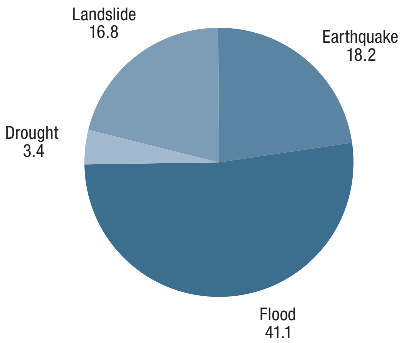
Figure 23: Percentage distribution of reported disasters Tajikistan



Disaster Risk Statistics (1988-2007)

Disaster type	No. of disasters / year	Total no. of deaths	Deaths/ year	Relative vulnerability (deaths/year/ million)
Earthquake	0.70	6,601	330.05	48.97
Flood	0.95	1,498	74.90	11.11
Landslide	0.50	339	16.95	2.51
Drought	0.05	-	-	0.00
Avalanche	0.25	100	5.00	0.74
Epidemic	0.20	171	8.55	1.27
Transport Accidents	0.15	124	6.20	0.92
Industrial Accidents	0.05	30	1.50	0.22

Figure 24: Average annual economic loss ($ million) of Tajikistan



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	776	20.92
5.0%	355	9.56
20.0%	139	3.75

flood in May 1993 which killed 5 people, affected 75,357 others and incurred a reported economic loss of $150 million; a flood in April 1998 in the Ainy region which killed 51 people, affected 40,974 others and caused an economic loss of $66 million; and, more recently, a flood in July 2005 which affected 1,890 people and caused an economic loss of $50 million.

Landslide hazards are also significant in Tajikistan. The most active landslide zones are between 700 metres and 2,000 metres above mean sea level. About 50,000 landslide sites have been identified. Of these, 1,200 threaten human settlements or facilities (Pusch, 2004). A landslide in May 1993 killed 5 people, affected 75,357 others and caused an economic loss of $149 million, while a landslide in April 2003 killed 1 person, affected 6,000 others and incurred a reported economic loss of $41 million.

As per GSHAP (GSHAP, 1998), Tajikistan lies in a region with high to very high seismic hazard. A magnitude 5.8 earthquake in the Gissar region in 1989 caused an economic loss of $25 million. In July 2006, an earthquake in the Koumsanguir area affected 15,427 people and caused an economic loss of $22 million, while a magnitude 5.9 earthquake in 1985 affected 8,080 people and incurred a reported economic loss of $200 million.

The only reported drought occurred in the year 2000, affecting 3 million people and incurring an economic loss of $57 million.

Tajikistan is also vulnerable to epidemic hazards. In December 1997, 168 people were killed and 15,618 others were affected by typhoid, while an outbreak of typhoid in 1999 killed three people and affected a further 200.

The country also suffered from several technological disasters. There were three major transport accidents and one major industrial accident. These accidents reportedly killed 154 people and affected 1,621 others.

Risk profile

Vulnerability indicators such as the number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year intervals covering the 20-year period 1988-2007. Figure 25 (a, b, c) plots the total number of deaths, affected population and economic losses against each hazard type, while Figure 26 (a, b, c) presents the same variables plotted against 5-year periods.

Figure 25 shows that among natural hazards, earthquakes caused the largest number of deaths (6,601), followed by floods (1,498) and landslides (339). Droughts affected the largest population (3 million) and floods caused the highest economic loss ($606 million). Among technological hazards, transport accidents caused the largest number of deaths (124), followed by industrial accidents (30).

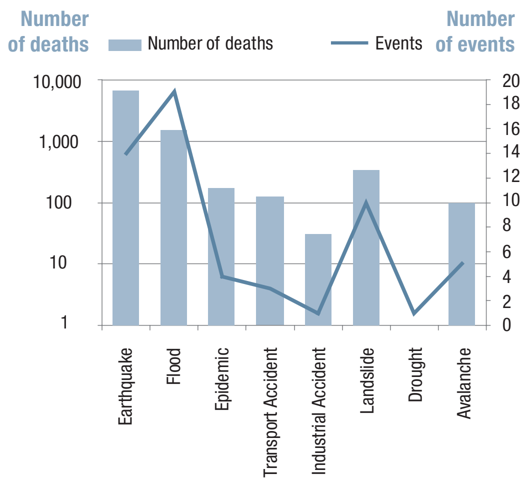
The period 1998-2002 (Figure 26) was the worst in terms of number of deaths (6,480) and number of people affected (3 million). The period 1988-1992 was the worst in terms of economic loss ($349 million), mainly caused by the 1992 flood. Floods had the highest frequency (0.95), followed by earthquakes (0.70) and landslides (0.50). The death rate was highest for earthquakes (330), while the relative vulnerability was highest for earthquakes (49), followed by floods (11) and landslides (2.5).

Floods are the dominant risks in Tajikistan (Figure 24), with an economic AAL ($41.1 million), followed by earthquakes ($18.2 million) and landslides ($16.8 million). The 20-year return period loss for all hazards is $355 million (9.56 per cent of GDP), while the 200-year return period loss is $776 million (20 per cent of GDP).

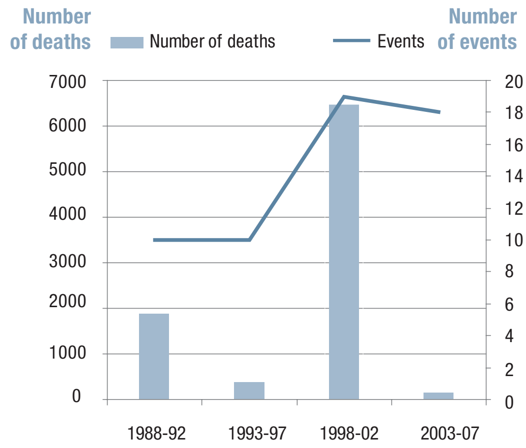
Figure 25: Tajikistan Disaster events and socio-economic impact by hazard type (1988-2007)

Figure 26: Tajikistan: Disaster events and socio-economic impact by 5-year periods (1988-2007)

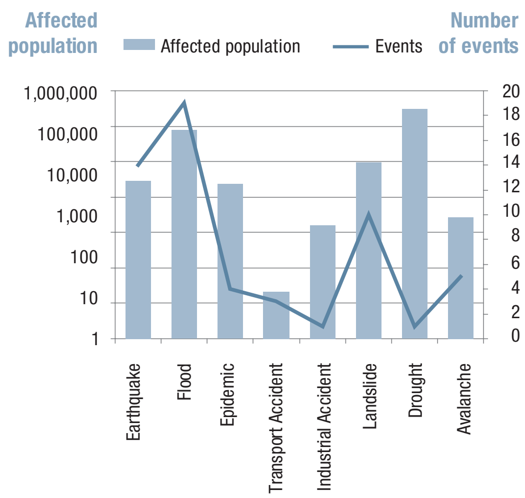
25a Disaster events and number of deaths



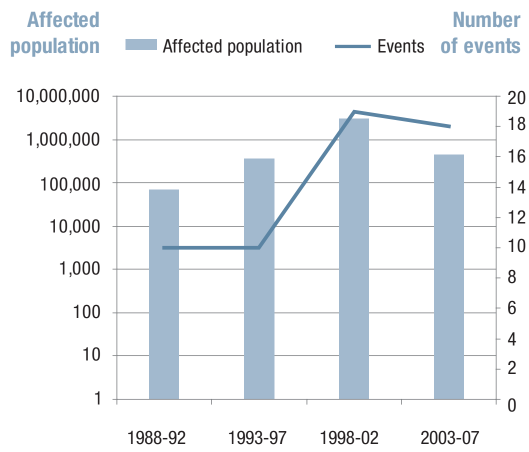
26a Disaster events and number of deaths



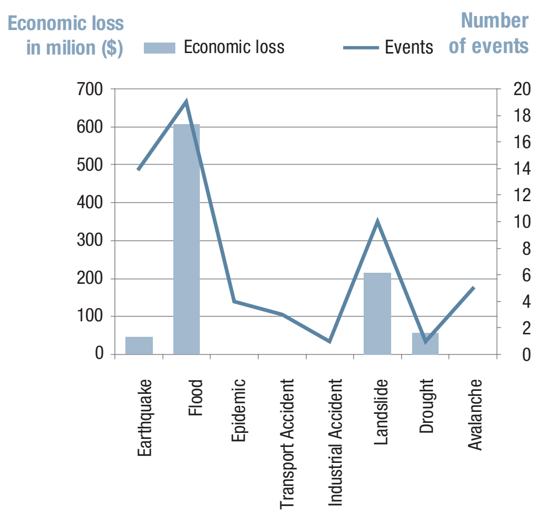
25b Disaster events and affected population



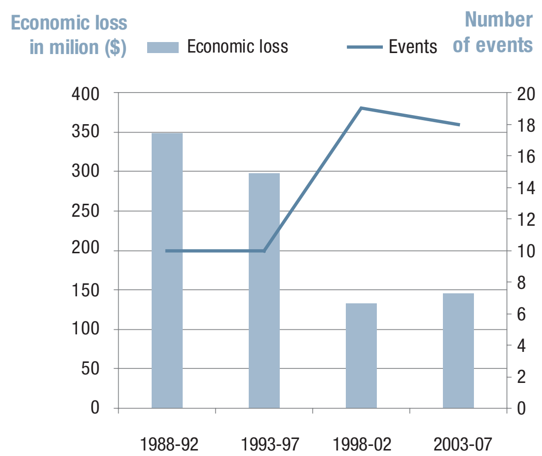
26b Disaster events and affected population



25c Disaster events and economic loss



26c Disaster events and economic loss



5.7 Turkmenistan

Overview

Country-level Information (2007)	
Geographic area (km^2)	488,100
Population	4,960,000
Population density	10
Population growth (annual %)	1.3
Urban population (% of total)	46 (2006)
Poverty headcount ratio, $2 a day (PPP) (% of population)	30 (2004)
GDP (current $) (billion)	12.93
GDP growth (annual %)	11.5
GNI per capita, PPP ($)	5,300
Agricultural GDP (%)	11.5
Industry GDP (%)	40.8
Service GDP (%)	47.7
Human Development Index (HDI)	0.728 (2006)

Regional setting

Turkmenistan is a landlocked country in Central Asia, situated between the Caspian Sea to the west and the great Amu Daria to the east. It is bordered by Afghanistan to the south-east, Iran to the south-west, Uzbekistan to the north-east and Kazakhstan to the north-west. It has a longest border of 1,786 kilometres, with the Caspian Sea. The country has an area of 488,100 square kilometres and a population of 4.96 million.

The Karakum Desert, also known as Garagum, is one of the world's largest sand deserts and it covers 80 per cent of the total area. Dunes rise to mountains in the south and low mountains along the border with Iran and the Caspian Sea. The highest and lowest elevations in the country are 3,139 metres (mountain peak Gora Ayribaba) and -81 metres (Vpadina Akchanaya) above mean sea level, respectively. The major rivers of the country are the Amu Daria, the Murghab and the Tejen. The country's desert region has a subtropical climate, with low rainfall. Summers are long (from May through September), hot and dry, while winters generally are mild and dry, although occasionally cold and damp in the north. Most precipitation falls between January and May (Anagnosti, 2008).

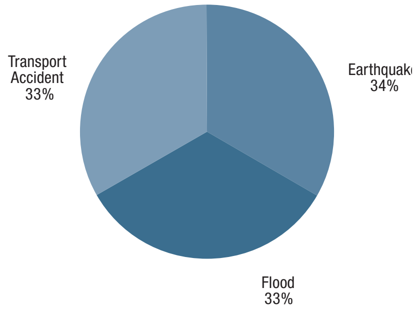
Hazard profile

Turkmenistan is vulnerable to a number of disasters due to both natural hazards, including floods, earthquakes and landslides; and technological hazards, including transportation accidents. The reported disaster data for the past 20 years is very scarce. Figure 27 shows the hazard-specific distribution of various disasters that occurred in the country for the period 1988-2007.

As per GSHAP (GSHAP, 1998), Turkmenistan lies in a region with low to high seismic hazard. Analysis of reported disaster data show that Turkmenistan is severely affected by earthquakes. An earthquake of magnitude 7.2 in the Ashkabat region on 5 October 1948 reportedly killed 110,000 people and caused an economic loss of $25 million. An earthquake of magnitude 7.1 which struck on 5 January 1929 killed 3,257 people. The two primary seismic zones lie under the Turkmenbashi and Ashkhabad regions (Pusch, 2004).

Flood hazards are also significant as floods are common in the watersheds of the Atrek and Siraks rivers, notably where the Siraks border Iran. The only recorded flood disaster was in January 1993, when 420 people were affected and reported economic loss amounted to $100 million.

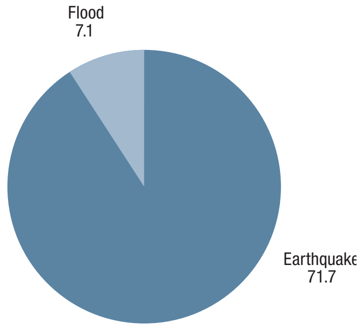
Figure 27: Percentage distribution of reported disasters Turkmenistan



Disaster Risk Statistics (1988-2007)

Disaster type	No. of disasters /year	Total no. of deaths	Deaths/ year	Relative vulnerability (deaths/year/ million)
Earthquake	0.05	-	-	0.00
Flood	0.05	-	-	0.00
Transport Accident	0.05	40	2.00	0.40

Figure 28: Average annual economic loss ($ million) of Turkmenistan



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	1,564	12.10
5.0%	433	3.35
20.0%	115	0.89

Landslides are not a significant hazard and occur mostly in sparsely populated mountain areas (Pusch, 2004).

The only reported disaster caused by a technological hazard was a transport accident in the Vatutino region which killed 40 people on 18 September 1998.

Risk profile

As discussed above, availability of disaster data with economic losses in Turkmenistan is limited in comparison with other CAC countries.

Vulnerability indicators such as the number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year intervals covering the 20-year period 1988-2007. Figure 29 (a, b, c) plots the total number of deaths, affected population and economic losses against each hazard type, while Figure 30 (a, b, c) presents the same variables plotted against 5-year periods.

Figure 29 shows that among natural hazards, floods affected the largest population (420) and caused the highest economic loss ($100 million). Among technological hazards, transport accidents caused the largest number of deaths (40).

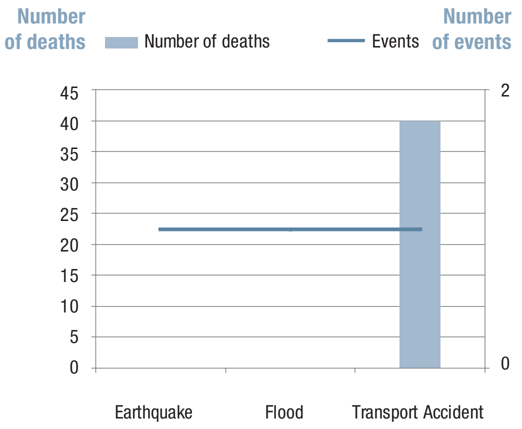
The period 1998-2002 (Figure 30) was the worst in terms of number of deaths (40), while 1993-97 was the worst in terms of affected population (420) and economic loss ($100 million), caused mainly by the 1993 flood. The average annual occurrence of earthquakes, floods and transport accidents is low (0.05) for each hazard, due to the lack of significant disaster data. The death rate was highest for transport accidents (2.0) and relative vulnerability was also highest for transport accidents (0.40).

Earthquakes are the dominant risk in Turkmenistan with an economic AAL of $72 million, followed by floods ($7 million) (Figure 28). The 20-year return period loss for all hazards is $433 million (3.35 per cent of GDP), while the 200-year return period loss is $1.564 billion (12.1 per cent of GDP).

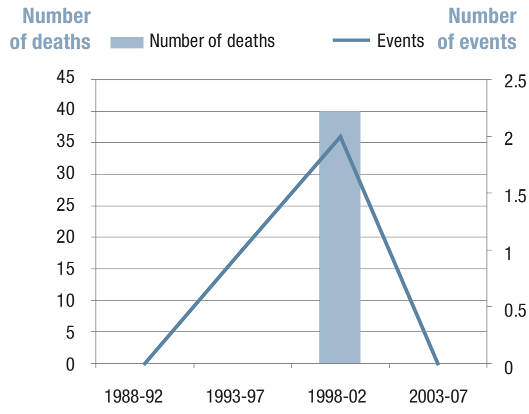
Figure 29: Turkmenistan: Disaster events and socio-economic impact by hazard type (1988-2007)

Figure 30: Turkmenistan: Disaster events and socio-economic impact by 5-year periods (1988-2007)

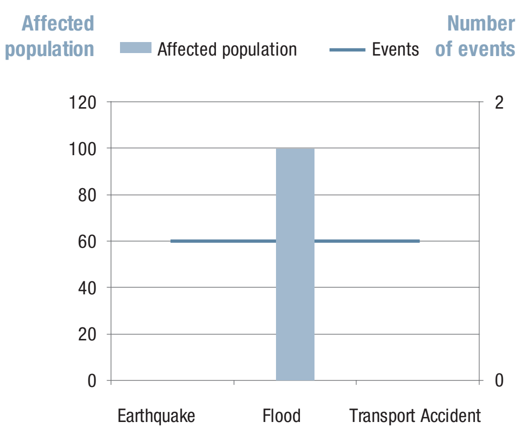
29a Disaster events and number of deaths



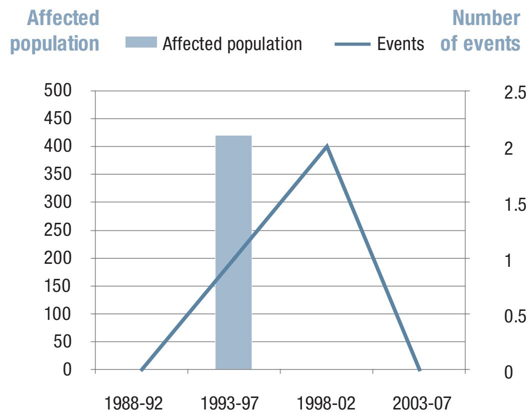
30a Disaster events and number of deaths



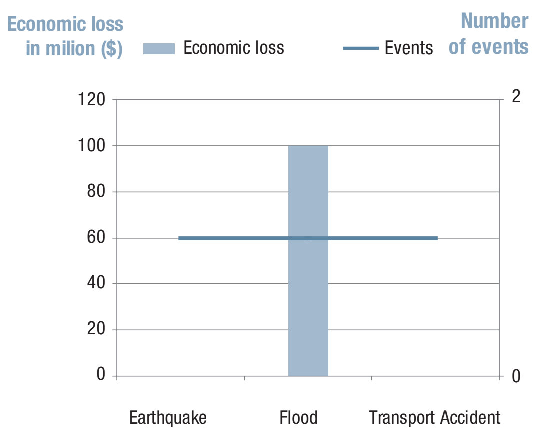
29b Disaster events and affected population



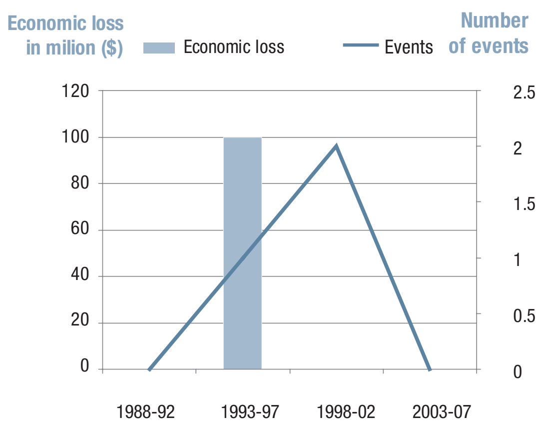
30b Disaster events and affected population



29c Disaster events and economic loss



30c Disaster events and economic loss



5.8 Uzbekistan

Overview

Country-level Information (2007)	
Geographic area (km^2)	447,400
Population	26,870,000
Population density	60
Population growth (annual %)	1.4
Urban population (% of total)	36
Poverty headcount ratio, $2 a day (PPP) (% of population)	33 (2004)
GDP (current $) (billion)	22.31
GDP growth (annual %)	9.5
GNI per capita, PPP ($)	2,430
Agricultural GDP (%)	24
Industry GDP (%)	27
Service GDP (%)	49
Human Development Index (HDI)	0.701 (2006)

Regional setting

The Republic of Uzbekistan is a landlocked country in Central Asia, situated between the Amu Daria and Syr Daria rivers, the Aral Sea and the slopes of the Tien Shan Mountains. It is bordered by Kazakhstan to the north and north-west, Kyrgyzstan and Tajikistan to the east and south-east, Afghanistan to the south and Turkmenistan to the south-east. Most of the territory of Uzbekistan is occupied by plains, including the Turanian plain, which covers nearly four fifths of the country's territory. The country has a total area of 447,400 square kilometres and a population of 26 million. The highest and lowest elevations are 4,301 metres (the mountain peak of Adelunga Toghi) and -12 metres (Sariqarnish Kuli) above mean sea level, respectively. The Amu Daria and Syr Daria are the country's two major rivers and are used primarily for irrigation, including to arable lands such as the Fergana valley.

Uzbekistan's climate is classified as continental, with hot summers and cool winters. Summer temperatures often surpass 40°C, while winter temperatures average -2°C, but may fall as low as -40°C. Most of the country is quite arid, with average annual rainfall amounting to between 100 mm and 200 mm and occurring mostly in winter and spring. Between July and September little precipitation falls, essentially stopping the growth of vegetation during that period (Anagnosti, 2008).

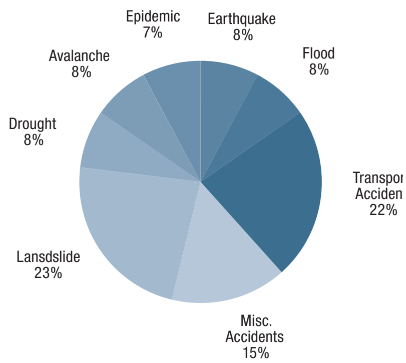
Hazard profile

Uzbekistan is prone to a number of disasters due to both natural hazards, including earthquakes, droughts, floods, landslides and epidemics; and technological hazards, including transport and miscellaneous accidents.

Figure 31 shows the hazard-specific distribution of various disasters that occurred in the country during the period 1988-2007.

Earthquakes are the most dominant hazard in Uzbekistan. As per GSHAP (GSHAP, 1998), Uzbekistan lies in a region with low to very high seismic hazard. Analysis of disaster data show that Uzbekistan has been severely affected by several devastating earthquakes. The capital city, Tashkent, was struck by an earthquake on 26 April 1966 which killed 10 people, affected 100,000 others and incurred a reported economic loss of $300 million. The magnitude 7.0 earthquake of Gazli on 17 May 1976 caused an economic loss of $85 million. On 19 March 1984, a magnitude 7.0 earthquake in the Gazli–Bokhara region affected 201,100 people and caused an economic loss of $5 million. In May 1992, an earthquake of

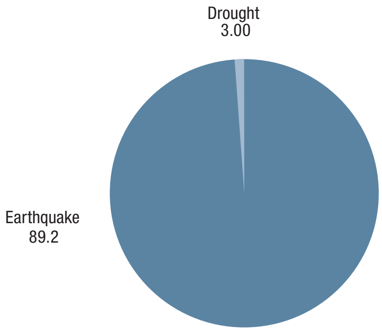
Figure 31:
Percentage distribution of reported disasters Uzbekistan



Disaster Risk Statistics (1988-2007)

Disaster type	No. of disasters/ year	Total no. of deaths	Deaths/ year	Relative vulnerability (deaths/year/ million)
Earthquake	0.05	9	0.45	0.02
Flood	0.05	-	-	0.00
Landslide	0.15	75	3.75	0.14
Drought	0.05	-	-	0.00
Avalanche	0.05	24	1.20	0.04
Epidemic	0.05	40	2.00	0.07
Transport Accidents	0.15	83	4.15	0.15
Miscellaneous Accidents	0.10	107	5.35	0.20

Figure 32:
Average annual economic loss ($ million) of Uzbekistan



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	2,128	9.5
5.0%	623	2.8
20.0%	177	0.8

magnitude 6.2 killed 9 people and affected 50,000 others in the Andizhan region.

Drought hazards are significant: a single drought event in 2000 affected 600,000 people and caused an economic loss of $50 million.

Uzbekistan is also vulnerable to floods and mud flows. A few are caused by snowmelt run-off or severe storms; very large floods and mudslides are generally caused by the outbreak of mountain lakes. There are also trans-boundary hazards from the hundreds of lakes in Kyrgyzstan and Tajikistan that are upstream of Uzbekistan in the Aral Sea basin. In 1998, flooding from the Shakhimardan River originating in Kyrgyzstan killed 100 Uzbeks and caused damage estimated at $700 million. Lake Sarez, in Tajikistan, also represents a flooding hazard for Uzbekistan and Tajikistan (Pusch, 2004).

A flood event in February 2005 in the Boymurod region affected 1,500 people.

Landslide hazards are significant in the country's mountain and foothill areas, while there have been over 2,600 extreme mud flows in the past 80 years (Pusch, 2004). A landslide in the Angren region on 4 May 1991 killed 50 people, while a landslide in January 1992 killed 1 person and affected 400 others.

Uzbekistan is also vulnerable to epidemic hazards. In February 1998, 40 people died and 148 others were affected by bacterial infection.

The country also suffered from several technological disasters, including 3 major transport accidents and 2 miscellaneous accidents that reportedly killed 190 people and affected 23,988 others.

Risk profile

Vulnerability indicators such as number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year intervals covering the 20-year period 1988-2007. Figure 33 (a, b, c) plots the total number of deaths, affected population and economic losses against each hazard type, while Figure 34 (a, b, c) presents the same variables plotted against 5-year periods.

Figure 33 shows that among natural hazards, landslides caused the largest number of deaths (75), followed by avalanches (24); droughts affected the largest population (600,000), followed by earthquakes (50,000); and droughts caused the largest economic loss ($50 million in 2000). Among technological hazards, miscellaneous accidents such as explosions and collapse of buildings caused the largest number of deaths (107), followed by transport accidents (83).

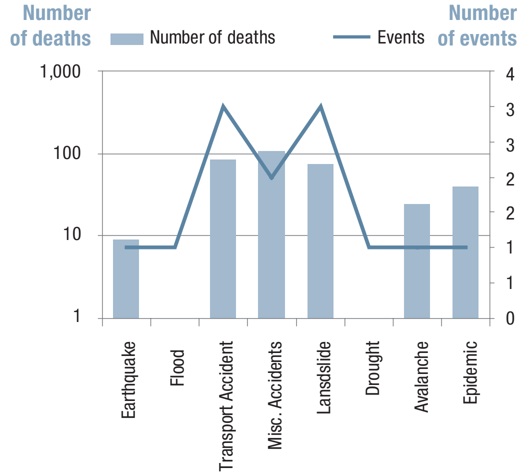
The 5-year period 1998-2002 (Figure 34) was the worst in terms of number of deaths (195), affected population (624,136) as well as economic loss (50 million). Landslides and transport accidents have the highest frequency (0.15 per year). The death rate was the highest for miscellaneous accidents (5.35), followed by transport accidents (4.15) and landslides (3.75). The relative vulnerability was the highest for miscellaneous accidents (0.20), followed by transport accidents (0.15) and landslides (0.14), avalanches (0.04) and earthquakes (0.02).

Earthquakes are the dominant risk in Uzbekistan, with an economic AAL of $89 million, followed by droughts ($3 million) (Figure 32). The 20-year return period loss for all hazards is $623 million (2.8 per cent of GDP), while the 200-year return period loss is $2.13 billion (9.5 per cent of GDP).

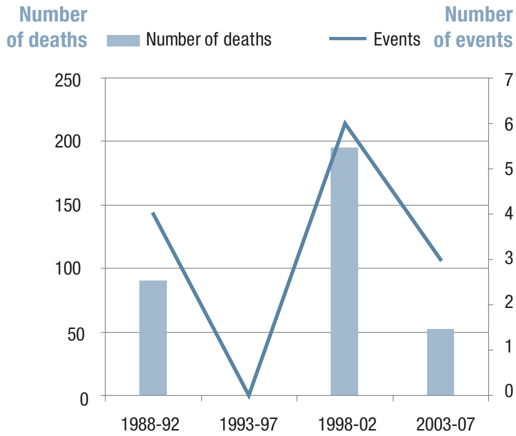
Figure 33: Uzbekistan: Disaster events and socio-economic impact by hazard type (1988-2007)

Figure 34: Turkmenistan: Disaster events and socio-economic impact by 5-year periods (1988-2007)

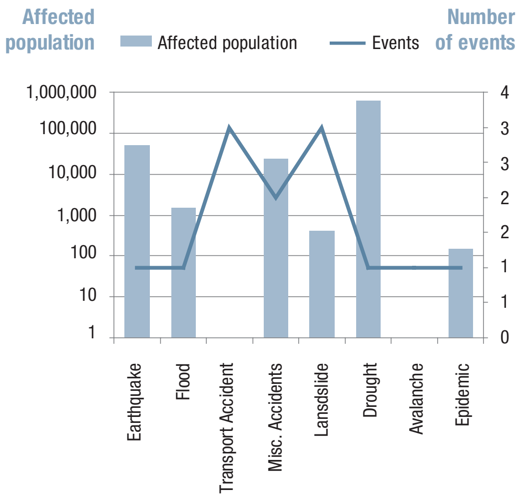
33a Disaster events and number of deaths



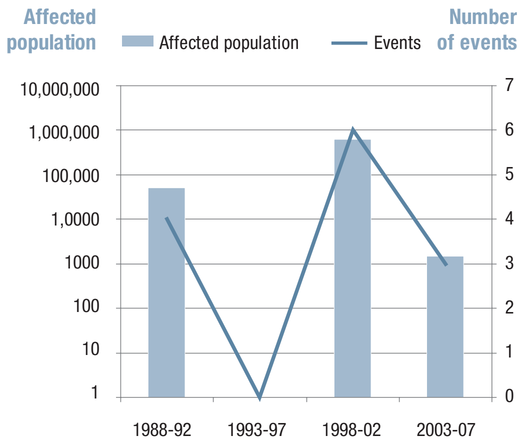
34a Disaster events and number of deaths



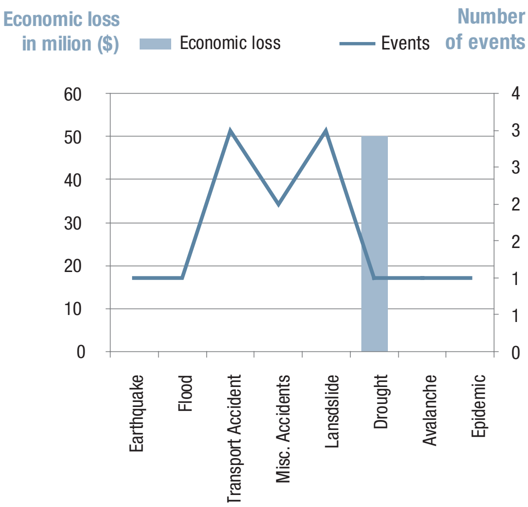
33b Disaster events and affected population



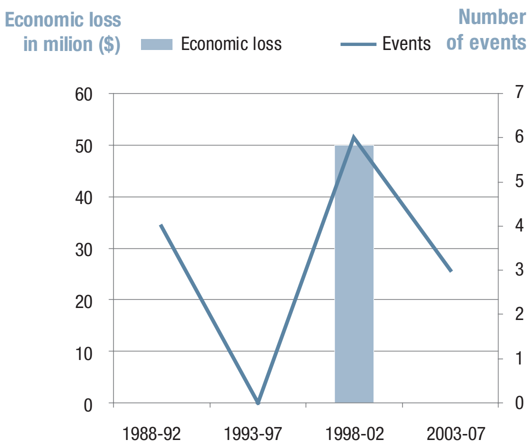
34b Disaster events and affected population



33c Disaster events and economic loss



34c Disaster events and economic loss



Chapter 6

Sub-region profiles

6.1 Central Asia sub-region

Overview

Central Asia Sub-region-level Information (2007)	
Geographic area (km²)	4,002,900
Population	59,290,000
Population density	15
Population growth (annual %)	1.3
Urban population (% of total)	40.5
Poverty headcount ratio, $2 a day (PPP) (% of population)	31.4
GDP (current $) (billion)	146.29
GDP growth (annual %)	8.9
GNI per capita, PPP ($)	4,444
Agricultural GDP (%)	11.0
Industry GDP (%)	40.1
Service GDP (%)	48.9
Human Development Index (HDI)	0.728 (2006)

Regional setting

Central Asia consists of five former Soviet republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan and is a region of Asia from the Caspian Sea in the west to central China in the east, and from southern Russia in the north to Afghanistan in the south. Historically, Central Asia has acted as a crossroads for the movement of people and goods between Europe, Western Asia, South Asia and East Asia (also known as the Silk route).

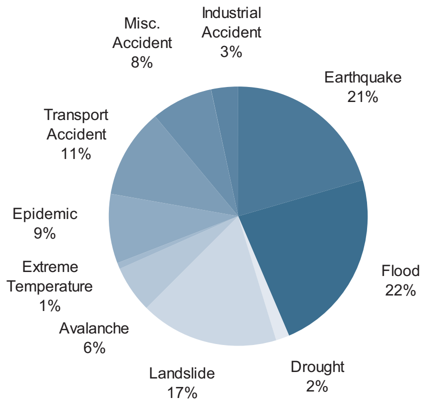
Central Asia covers an area of 4 million square kilometres and has a population of 59 million. Kazakhstan is the largest country in the region, covering 68 per cent of the total area. Turkmenistan and Uzbekistan are the second and third largest, accounting for 12 per cent and 11 per cent of the total area, respectively. Uzbekistan is the most heavily populated country, with a regional share of 45 per cent, followed by Kazakhstan, which accounts for 26 per cent. Kazakhstan is the most sparsely populated country in Central Asia, with a density of just 6 people per square kilometre. As a whole, the region has a population density of just 15 people per square kilometre.

Geographically, Central Asia is an extremely large sub-region of varied geography, including high passes and mountains such as Tian Shan, vast deserts and treeless, grassy steppes. This region is characterized by some of the most sparsely populated areas in the world. Major rivers of the sub-region include the Amu Daria and the Syr Daria. Major bodies of water include the Aral Sea and Lake Balkhash, both of which are part of the huge west/central Asian endorheic basin that also includes the Caspian Sea. Because Central Asia is not buffered by a large body of water, temperature fluctuations are severe and vary from -40ºC to +40ºC.

Hazard profile

The Central Asia region is vulnerable to a number of disasters caused by both natural hazards, including earthquakes, floods, landslides/mudslides/debris flows, avalanches, strong winds/wind storms and extreme temperatures; and technological hazards, including transport, miscellaneous and industrial accidents. Figure 35 shows the hazard-specific distribution of the various disasters that occurred in the region for the period 1988-2007.

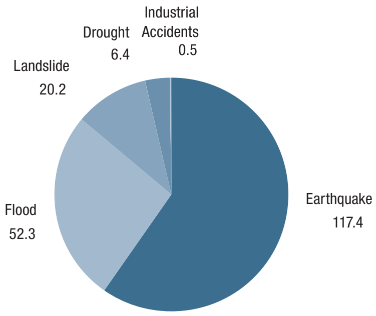
Figure 35:
Percentage distribution of reported disasters in Central Asia



Disaster Risk Statistics (1988-2007)

Disaster type	No. of disasters / year	Total no. of deaths	Deaths/ year	Relative vulnerability (deaths/year/ million)
Earthquake	1.20	6,683	334	5.64
Flood	1.35	1,512	76	1.28
Drought	0.10	0	0	0.00
Landslide	1.00	700	35	0.59
Avalanche	0.35	135	7	0.11
Extensive Temperature	0.05	11	1	0.01
Epidemic	0.50	240	12	0.20
Transport Accidents	0.65	377	19	0.32
Miscellaneous Accidents	0.45	213	11	0.18
Industrial Accidents	0.20	98	5	0.08

Figure 36:
Average annual economic loss ($ million) of Central Asia



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	3,489	2.39
5.0%	1,192	0.81
20.0%	401	0.27

As discussed in the country profiles, the earthquake hazard is moderate to very high in the Central Asia sub-region (GSHAP, 1998). Due to the mountainous terrain, with very high steep slopes, the region also suffers from other hazards such as floods, landslides, avalanches, mudslides, strong winds, wind storms and extreme temperatures. The drought hazard is also significant.

The analysis of disaster data show that Central Asia is severely affected by earthquakes, floods, landslides and droughts. Some notable recent disasters in the sub-region can be seen in Table 3.

Central Asia has also suffered from various epidemic hazards, such as bacterial infection and typhus fever. The region has also suffered from many technological disasters, including 13 major transport accidents, 4 major industrial accidents and 9 serious miscellaneous accidents.

Risk profile

Vulnerability indicators such as the number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year intervals covering the 20-year period (1988-2007). Figure 37 (a, b, c) plots the total number of deaths, affected population and economic losses against each hazard type, while Figure 38 (a, b, c) presents the same variables plotted against 5-year periods.

Table 3: Some notable recent disasters events in Central Asia

Date	Type of disaster	Number of deaths	Affected population	Economic Loss ($ million)
26 April 1966	Tashkent earthquake, Uzbekistan	10	100,000	300
13 October 1985	Mag. 5.9 earthquake, Tajikistan		8,080	200
19 August 1992	Mag. 7.3 Dshalal-Abad earthquake, Kyrgyzstan	54	86,806	130
25 May1992	Tajikistan flood	1,346	63,500	300
8 May 1993	Dushanbe region flood, Tajikistan	5	75,357	149
June 2000	Central Asia region drought		3,600,000	107

Figure 37 shows that among natural hazards, earthquakes caused the largest number of deaths (6,683), followed by floods (1,512) and landslides (700). Droughts affected the largest number of people (70 per cent of the total affected population in the region), followed by floods (19 per cent) and earthquakes (6 per cent). Among technological hazards, transport accidents caused the largest number of deaths (377), followed by miscellaneous accidents (213). Miscellaneous accidents affected the largest number of people (24,786) and industrial accidents caused the highest economic loss ($8 million).

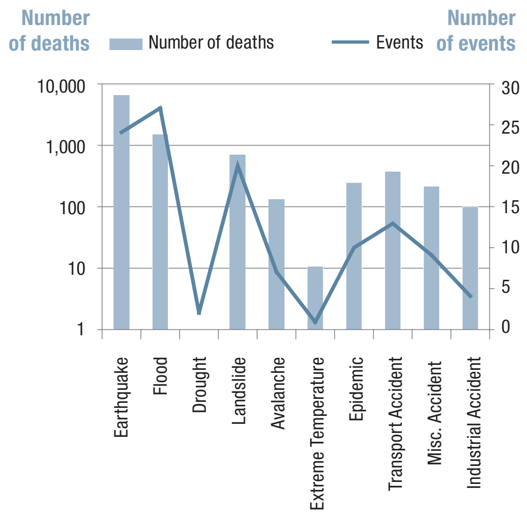
The period 1998-2002 (Figure 38) was the worst for the number of deaths (6,790) as well as affected population (3.7 million). The period 1988-1992 was the worst for economic loss ($530 million), mainly caused by the 1992 flood and earthquake.

Floods have the highest frequency (1.35 per year), followed by earthquakes (1.2) and landslides (1.0). The death rate was highest for earthquakes (334), followed by floods (76) and landslides (35). The relative vulnerability was highest for earthquakes (5.64), followed by floods (1.28) and landslides (0.59).

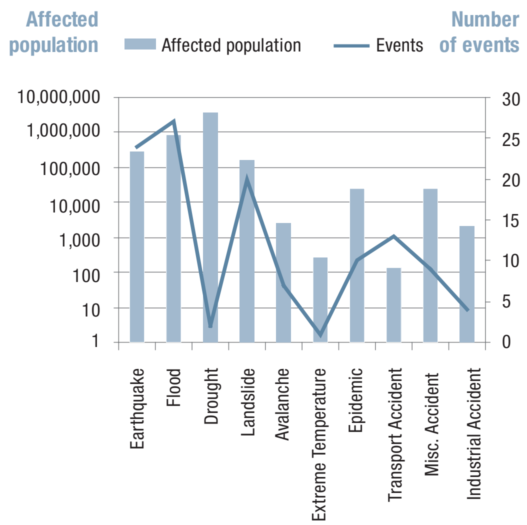
Earthquakes are the dominant risk in Central Asia with an economic AAL of $186 million, followed by floods ($52 million), landslides ($18 million), droughts ($6 million) and industrial accidents ($0.5 million) (Figure 36). The 20-year return period loss for all hazards is $1.19 billion (0.81 per cent of GDP), while the 200-year return period loss is $3.49 billion (2.4 per cent of GDP).

Figure 37: Central Asia sub-region: Disaster events and socio-economic impact by hazard type (1988-2007)

37a Disaster events and number of deaths



37b Disaster events and affected population



37c Disaster events and economic loss

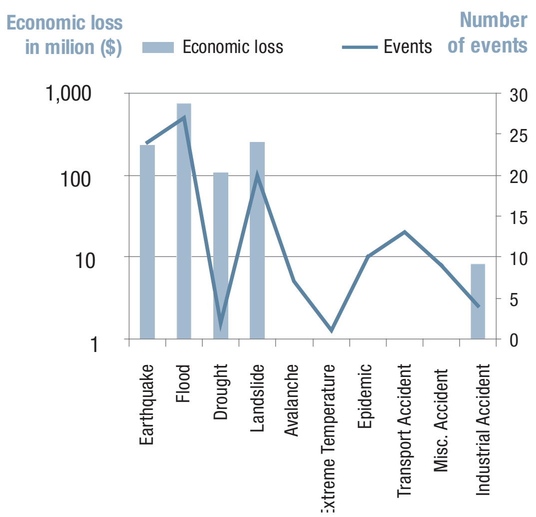
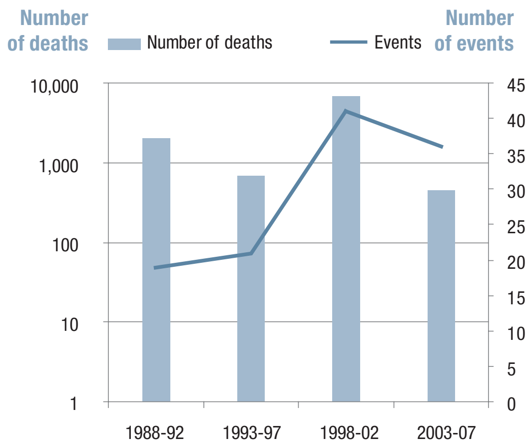
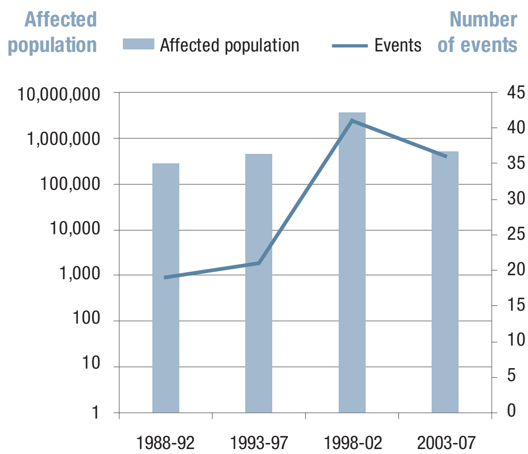


Figure 38: Central Asia sub-region: Disaster events and socio-economic impact by 5-year periods (1988-2007)

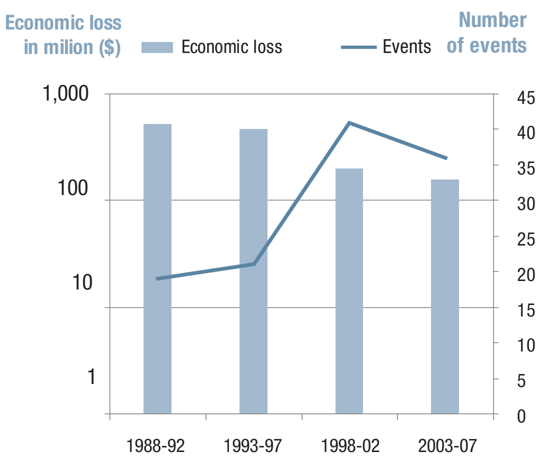
38a Disaster events and number of deaths



38b Disaster events and affected population



38c Disaster events and economic loss



6.2 Caucasus sub-region

Overview

Caucasus Sub-region-level Information (2007)	
Geographic area (km²)	186,100
Population	15,970,000
Population density	86
Population growth (annual %)	0.3
Urban population (% of total)	52.9
Poverty headcount ratio, $2 a day (PPP) (% of population)	26.4
GDP (current $) (billion)	50.61
GDP growth (annual %)	16.8
GNI per capita, PPP ($)	5782
Agricultural GDP (%)	9.2
Industry GDP (%)	51.1
Service GDP (%)	39.7
Human Development Index (HDI)	0.762 (2006)

Regional setting
The Caucasus sub-region consists of the three post-Soviet states Armenia, Azerbaijan and Georgia and sits between the Black Sea to the west and the Caspian Sea to the east. The territory of the Caucasus has an area of 186,100 square kilometres and the sub-region has a population of 16 million. The Caucasus Mountains are the dividing line between Asia and Europe. The highest and the lowest elevations of the sub-region are 5,201 metres (Mount Shkhara) and -28 metres above mean sea level, respectively. There are many rivers in the southern Caucasus region, the largest being the Mtkvari and the Rioni, with lengths of 1,564 kilometres and 527 kilometres, respectively. The climate in the region is extremely diverse, varying both vertically (according to elevation) and horizontally (by latitude and location). Temperatures in the region range from -33ºC to +46ºC. Precipitation increases from east to west in most of the region and is mostly orographic in nature.

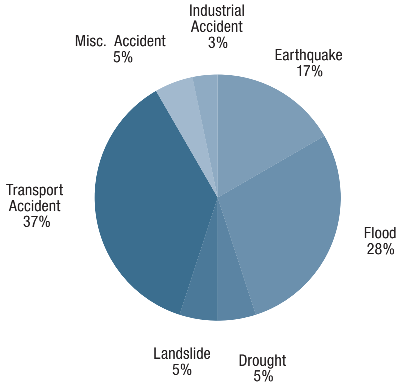
Hazard profile
The Caucasus sub-region is vulnerable to a number of disasters due to both natural hazards, including earthquakes, floods, landslides/mudslides/debris flows, avalanches, strong winds and extreme temperatures; and technological hazards, including transportation, miscellaneous and industrial accidents. Figure 39 shows the hazard-specific distribution of various disasters that occurred in the region during the period 1988-2007.

As discussed in the country profiles, the earthquake hazard is moderate to very high (GSHAP, 1998). Due to the mountainous terrain, with very high steep slopes, the region also suffers from other hazards including landslides, floods, avalanches, mudslides and extreme temperatures. The drought hazard is also significant.

The analysis of disaster data show that the Caucasus is severely affected by earthquakes, landslides, droughts and floods, as detailed in the country profiles. Some notable recent disaster events in the sub- region include (Table 4):

There have been several technological disasters in the Caucasus since 1988, including 22 transport accidents, 2 major industrial accidents and 3 serious miscellaneous accidents.

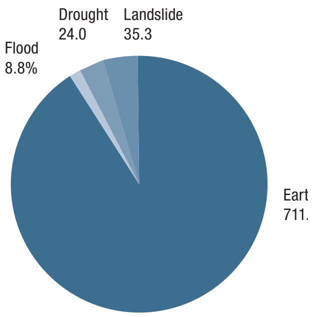
Figure 39:
Percentage distribution of reported disasters in Caucasus



Disaster Risk Statistics (1988-2007)

Disaster type	No. of disasters / year	Total no. of deaths	Deaths / year	Relative vulnerability (deaths/year/ million)
Earthquake	0.50	25,151	1,258	78.74
Flood	0.85	31	1.55	0.10
Drought	0.15	-	0	0.00
Landslide	-	109	-	-
Transport Accidents	1.10	1,126	56.30	3.53
Miscellaneous Accidents	0.15	31	1.55	0.10
Industrial Accidents	0.10	46	2.3	0.14

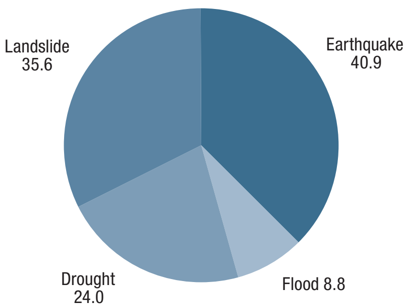
Figure 40:
Average annual economic loss ($ million) of Caucasus



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	12,386	24.47
5.0%	4,041	7.98
20.0%	1,233	2.44

Figure 41:
Average annual economic loss ($ million) of Caucasus after Spitak earthquake removal



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	1,357	2.68
5.0%	549	1.09
20.0%	198	0.39

Risk profile

Vulnerability indicators such as the number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year intervals covering the 20-year period 1988-2007. Figure 42 (a, b, c) plots the total number of deaths, affected population and economic losses against each hazard type, while Figure 43 (a, b, c) presents the same variables plotted against 5-year periods.

Figure 42 shows that among natural hazards, earthquakes caused the largest number of deaths (25,151), followed by landslides (109). Earthquakes also affected the largest population (47 per cent of the total affected population of the region), followed by floods (34 per cent) and droughts (19 per cent). Earthquakes also caused the highest economic loss ($14.6 billion), followed by landslides ($427 million) and droughts ($400 million). Among technological hazards, transport accidents caused

Table 4: Some notable recent disaster events in the Caucasus

Date	Type of disaster	Number of deaths	Affected population	Economic Loss ($ million)
12 December 1988	Mag. 6.9, Spitak earthquake, Armenia	25,000	1,642,000	14,200
25 April 2002	Mag. 4.8, Tbilisi earthquake, Georgia	6	19,156	350
18 July 1997	Mag. 4.2, Noyemberyan city earthquake, Armenia		15,000	33
29 April 1991	Mag. 7.0, Racha-Imereti earthquake, Georgia	100	100,000	10
14 February 1987	Tbilisi region flood, Georgia	110	36,000	546
10 March 1989	Adzharia region landslide, Georgia	98	2,500	423
16 April 2003	Ismayilli–Gobustan region flood, Azerbaijan		31,500	55
June 2000	Caucasus sub-region drought		993,000	400

the largest number of deaths (1,126), followed by miscellaneous and industrial accidents (77 deaths).

The period 1988-1992(Figure 43) was the worst in terms of number of deaths (25,622) as well as economic loss ($14.6 billion). The periods 1988-1992, 1993-1997 and 1998-2002 were the worst in terms of population affected.

Floods had the highest frequency (0.85 per year), followed by earthquakes (0.50), and droughts and miscellaneous accidents (0.15). The death rate was highest for earthquakes (1,300). The relative vulnerability was highest for earthquakes (79), followed by transport accidents (3.5) and industrial accidents (0.14).

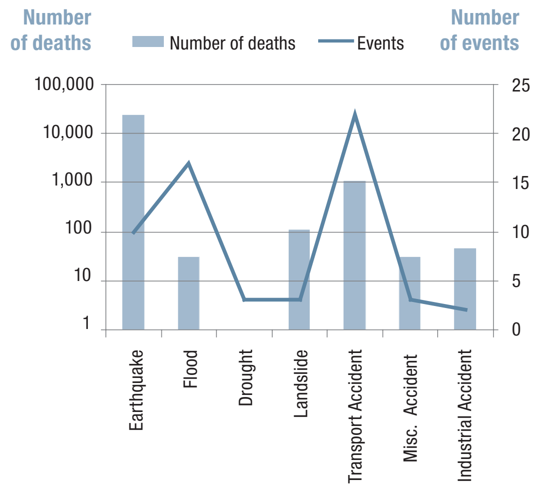
Earthquakes are the dominant risk in the Caucasus sub-region, with an economic AAL of ($712 million), followed by landslides ($35 million) (Figure 40). The 20-year return period loss for all hazards is $4.04 billion (7.98 per cent of GDP), while the 200-year return period loss is $12.39 billion (24.47 per cent of GDP).

It may be noted that the above analysis is 'biased' due to December 1988 Spitak earthquake in Armenia (Figure 41).

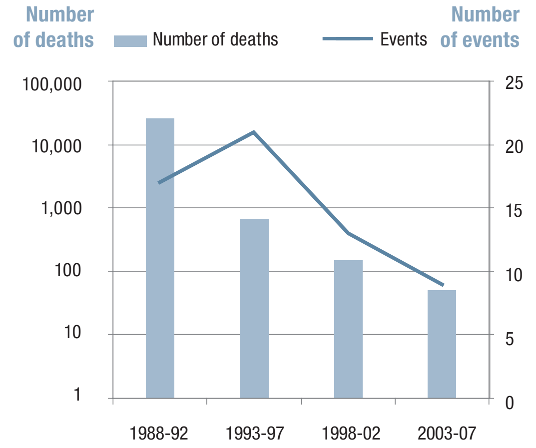
Figure 42: Caucasus sub-region: Disaster events and socio-economic impact by hazard type (1988-2007)

Figure 43: Caucasus sub-region: Disaster events and socio-economic impact by 5-year periods (1988-2007)

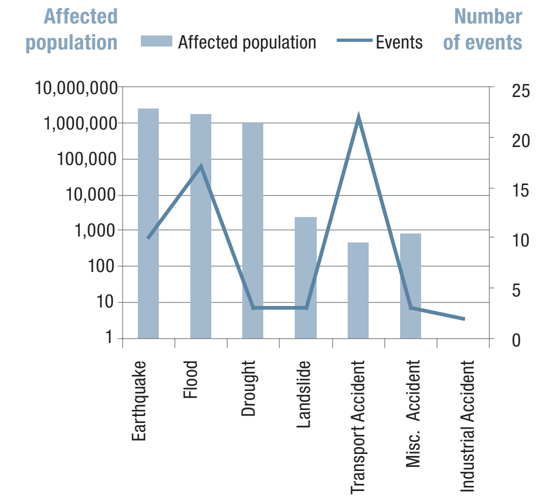
42a Disaster events and number of deaths



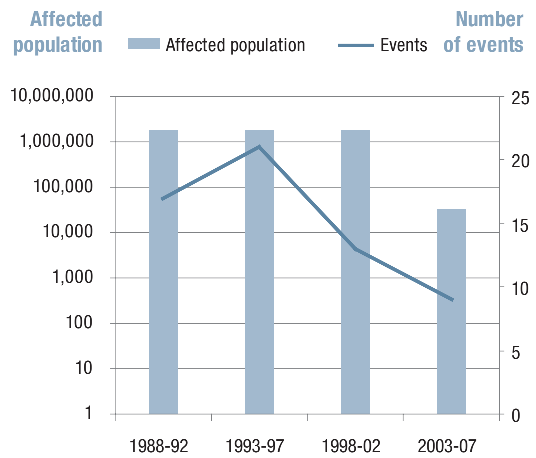
43a Disaster events and number of deaths



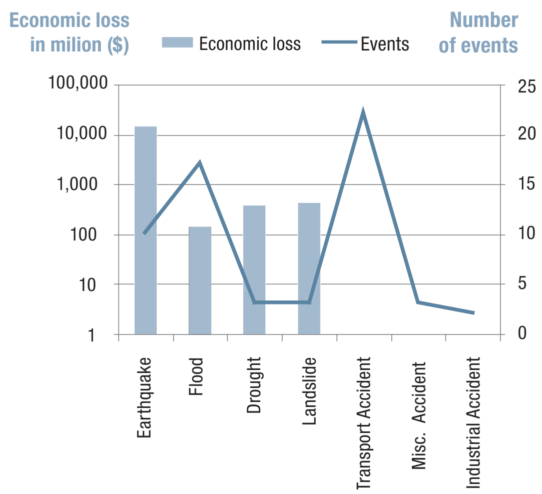
42b Disaster events and affected population



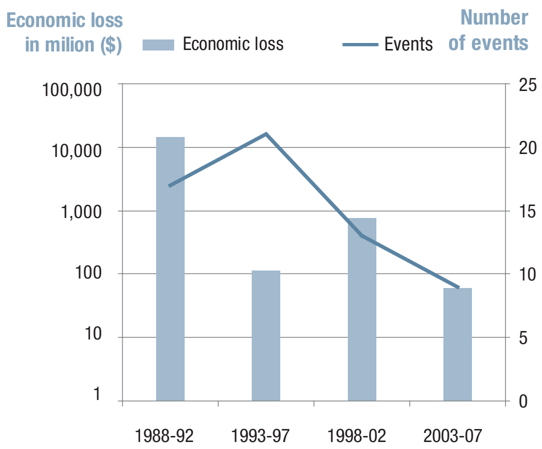
43b Disaster events and affected population



42c Disaster events and economic loss



43c Disaster events and economic loss



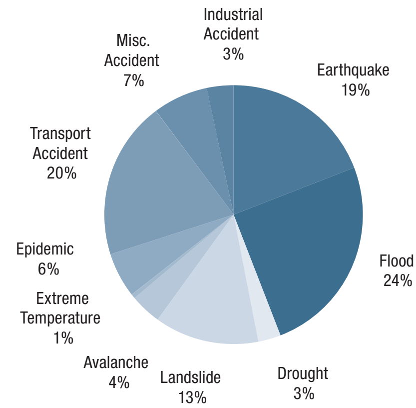
Chapter 7

CAC regional profile

7.1 Overview

CAC Regional-Level Information (2007)	
Geographic area (km^2)	4,189,000
Population	75,260,000
Population density	18
Population growth (annual %)	1.1
Urban population (% of total)	43.1
Poverty headcount ratio, $2 a day (PPP) (% of population)	30.4
GDP (current $) (billion)	196.9
GDP growth (annual %)	10.9
GNI per capita, PPP ($)	4728
Agricultural GDP (%)	10.5
Industry GDP (%)	43.0
Service GDP (%)	46.5
Human Development Index (HDI)	0.735 (2006)

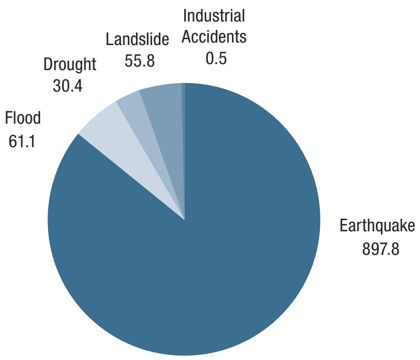
Figure 44: Percentage distribution of reported disasters in CAC



Disaster Risk Statistics (1988-2007)

Disaster type	No. of disasters / year	Total no. of deaths	Deaths/ year	Relative vulnerability (deaths/year/ million)
Earthquake	1.70	31,834	1,592	21.15
Flood	2.20	1,543	77	1.03
Drought	0.25	-	-	0.00
Landslide	1.15	809	40	0.54
Avalanche	0.35	135	7	0.09
Extensive Temperature	0.05	11	1	0.01
Epidemic	0.50	240	12	0.16
Transport Accidents	1.75	1,503	75	1.00
Miscellaneous Accidents	0.60	244	12	0.16
Industrial Accidents	0.30	144	7	0.10

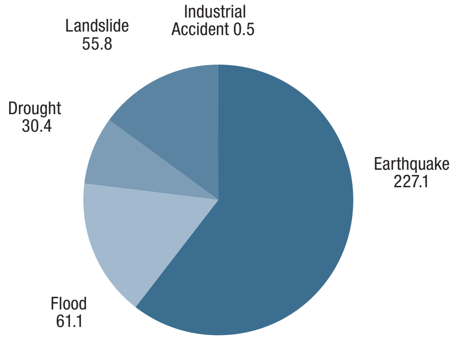
Figure 45: Average annual economic loss ($ million) of CAC



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	17,340	8.81
5.0%	5,246	2.66
20.0%	1,577	0.80

Figure 46: Average annual economic loss ($ million) of the CAC region after Spitak earthquake removal



Economic Loss Potential

Annual exceedance probability	Economic loss ($ million)	Percentage to GDP (2007)
0.5%	4,210	2.14
5.0%	1,553	0.79
20.0%	552	0.28

7.2 Regional setting

The CAC region consists of the eight former Soviet republics of Armenia, Azerbaijan, Georgia (Caucasus), and Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan (Central Asia). The region extends from the Black Sea in the west to central China in the east, and from southern Russia in the north to Afghanistan and Iran in the south. CAC covers an area of 4.2 million square kilometres and has a population of 75 million (Table 1). Kazakhstan is the geographically largest country in the region, covering 65 per cent of the total area. Turkmenistan and Uzbekistan are the second and third largest, accounting for 12 per cent and 11 per cent of the total area, respectively.

CAC is an extremely large area of varied geography, including high passes and mountains such as Tian Shan, vast deserts and treeless, grassy steppes. This region is one of the most sparsely populated in the world. Major rivers include the Amu Daria, Syr Daria, Mtkvari and Rioni. Major bodies of water include the Aral Sea and Lake Balkhash, both of which are part of the huge west/central Asian endorheic basin that also includes the Caspian Sea. The temperature variations in the region are very large, ranging from -40ºC to +46ºC.

7.3 Socio-economic setting

The population of CAC is heavily concentrated in the south (Figure 47), with two-thirds of the population (40 million) concentrated in the mostly mountainous southern quarter, which is twice the area of California and is highly prone to various hazards.

In Central Asia, Uzbekistan is the most populated country with a sub-regional share of 36 per cent of the total population, followed by Kazakhstan, which accounts for 21 per cent. In southern Caucasus, Azerbaijan is the most populous country with a sub-regional share of 54 per cent of the total, followed by Georgia and Armenia, which account for 27 and 19 per cent respectively.

Armenia is the most densely populated country (101 people per square kilometre), while Kazakhstan is the most sparsely populated country (6 people per square kilometre). The average population density for the region is low, at just 18 people per square kilometre (Table 1).

All the countries of Central Asia have a positive population growth rate, varying from 1.0 to 1.5 per cent. In southern Caucasus, both Georgia and Armenia have negative population growth rates of -0.8 and -0.3 per cent, respectively (Table 1).

Tajikistan is the poorest country in CAC, with 60 per cent of the population living below the poverty line (earning less than $2 per day). It is followed by Kyrgyzstan, with 40 per cent of the population below the poverty line. Both Tajikistan and Kyrgyzstan are the poorest countries, with Gross National Products (GNP) per capita of $1,710 and $1,950, respectively (Table 1). More than 30 per cent of the population in CAC lives below the poverty line.

Figure 47: Population density map (Source: Landscan, 2005)

7.4 Disasters overview

CAC is vulnerable to a number of disasters due to both natural and technological hazards. These include earthquakes, floods, landslides/mudslides, droughts, avalanches, extreme temperatures and epidemics; and transport, miscellaneous and industrial accidents. Wind storms are also present, but are not covered in this review because of the lack of data.

The percentage distribution of various disasters that occurred in CAC during the period 1988-2007 is shown in Figure 44, and the disaster matrix by country is presented in Table 5.

7.5 Major natural hazards overview and vulnerability assessment

Earthquakes, floods, landslides and droughts are the four major natural hazards that occur in CAC. This section provides a high-level picture of the regional hazards in the form of intensity maps and tables charting the percentage of areas under the categories of low, moderate, high and very high hazards.

In detailed risk analyses performed for economic loss estimation or emergency response planning, vulnerability is usually disaggregated into loss to buildings and infrastructure, business interruption loss, and social impact quantified in terms of number of fatalities and casualties. In this analysis, a rapid assessment approach was followed where a simple proxy was used to quantify the vulnerability. The selected proxy was the population at risk. This assumption is robust for two reasons: Firstly, most of the buildings and the infrastructure are concentrated in populated areas and, secondly, the population itself is quite vulnerable to hazards in CAC. The hazard maps reflective of hazard severity were overlaid with gridded population data (Landscan, 2005) and analyzed using GIS to identify the population at risk from various hazards. The vulnerabilities are presented in tables, identifying the percentage of the populations in each country potentially impacted by hazards of increasing severity.

Table 5: Disaster matrix by country (1988-2007)

Country	Hazards									
	Earthquake	Flood	Landslide	Drought	Avalanche	Extreme Temp.	Epidemic	Industrial Accident	Transport Accident	Misc. Accident
Armenia	XXX	XX		X				X	XX	X
Azerbaijan	X	XX	X	X				X	XX	
Georgia	XX	XX	X	X					XX	X
Kazakhstan	XXX	XXX	X			X	X	X	X	X
Kyrgyzstan	XXX	XX	XX		X		X	XX	X	X
Tajikistan	XXX	XXX	XXX	X	X		X	X	X	
Turkmenistan	XXX	XX							XX	
Uzbekistan	XXX	X	X	X	X		X		X	X

Scale: Disaster incidence ranges from XXX 'high' to X 'low'.

Earthquakes

The seismicity in CAC is generated by the collision of the Indian plate with the Eurasian plate. The seismotectonics of the region are very complicated, and it is one of the most highly seismic geo-structural areas in the world. Geologically, Central Asia consists of the highly active orogenic areas of Tien-Shan and Djungaria; the Turan segment of a young platform; and the alpine mountain folded structures of Kopetdag and Pamirs. The zones of high seismicity in the sub-region are Pamir, Altai, Kopetdag, Gissar-Karakul, East Fergana, Chatkul, north Tien-Shan, Djungaria and the Pamir-Hindukush zones of deep focus earthquakes (Nurmagambetov et al, 1999). The southern Caucasus is one of the most active segments of the Alpine-Himalayan seismic belt and marks the junction between the African, Arabian and Indian plates to the south, and the Eurasian continent to the north. Vulnerability to disasters has increased in CAC as urbanization and other development has led to the occupation of more areas that are prone to the effects of significant earthquakes. The scale of devastation caused by earthquakes in Armenia in 1988, Georgia in 1991, and Turkey and Georgia in 1992 are testament to this increased vulnerability.

GSHAP has categorized CAC into four earthquake zones – low, moderate, high, and very high hazard – based on the expected 475-year return period peak ground acceleration (PGA). As discussed in the country and sub-regions profiles, the earthquake hazard in CAC is moderate to very high (Figure 45). Large parts of Kyrgyzstan, Tajikistan and Uzbekistan fall in the very high hazard zone (Table 6). Furthermore, even though only small parts of Kazakhstan, Armenia and Turkmenistan fall in the very high hazard zone, these countries have experienced some of the most catastrophic earthquakes of the world.

Except for the northern two-thirds of Kazakhstan, no other area in CAC can be considered free from earthquakes. The population of the region is heavily concentrated in the southern part, with about two-thirds of the population (40 million) concentrated in the mostly mountainous southern quarter, which is highly prone to various hazards (King et al, 1999). There is a roughly 40 per cent probability that an earthquake will occur near one of the capital cities in Central Asia within the next 20 years (King et al, 1999). Such an earthquake will potentially cause a large number of deaths and could leave as many as 100,000 people seriously injured.

The risks to the populations of Caucasus countries are similar to, or even worse than, those to the populations of Central Asia. The 1988 Spitak earthquake in southern Caucasus, for instance, caused significant loss of life, major property

Figure 48: Earthquake hazard map of CAC (Source: GSHAP, 1998)

Note: Map based on peak ground acceleration for 10 per cent probability of exceedance in 50-year (corresponds to 475-year return period) hazard zones are classified into low (0 -0.08 g); moderate (0.08 g – 0.24 g); high (0.24 g – 0.40 g); very high (0.40 g or greater).

Table 6: Percentage area and population in each earthquake hazard category

	Percentage Area in each Category				Percentage Population in each Category			
Country	Low	Moderate	High	Very high	Low	Moderate	High	Very high
Armenia	-	5.7	89.8	4.5	-	2.3	97.0	0.7
Azerbaijan	-	13.5	78.4	8.1	-	13.4	84.1	2.5
Georgia	-	11.7	80.0	8.3	-	31.9	65.2	2.9
Kazakhstan	86.3	8.7	1.8	3.3	56.4	14.2	8.8	20.5
Kyrgyzstan	-	0.5	6.6	92.9	-	0.1	3.2	96.7
Tajikistan	-	3.3	32.0	64.8	-	11.8	63.2	25.1
Turkmenistan	22.3	50.6	26.1	0.9	3.0	59.2	37.3	0.5
Uzbekistan	29.7	35.4	20.3	14.6	0.5	19.2	31.1	49.3

Source: Potential population computed from Landscan 2005 and GSHAP map

damage and triggered a huge migration of people from the meizoseismal zone. Given the extent of the risks, it is safe to conclude that the majority of the CAC population is vulnerable to earthquakes.

Floods

The flood hazard (Figure 49) is the next most significant natural hazard in CAC. Due to its mountainous terrain, the region is crisscrossed by several rivers and their tributaries. Floods in these rivers are often accompanied with large mud flows. Recently, the 2005 floods in the Amu Daria and Syr Daria rivers caused significant damage to agriculture and infrastructure. The Syr Daria, originating in the Tian Shan Mountains, is the longest river in Central Asia, although in terms of water flow the Amu Daria is the largest in the region.

The flood hazard map (Figure 49) shows that, with the exception of Tajikistan (Table 7), less than 5

Figure 49:
Flood hazard map of CAC

(Source: The hazard map adapted and modified from Dilley et al., (2005) Natural Disaster Hotspots: A Global Risk Analysis, World Bank, Washington DC, http://www.ldeo.columbia.edu/chrr/research/hotspots/coredata.html).

Note: The flood hazard map presented in the Natural Disaster Hotspots Study categorized flood hazards into 10 deciles. Based on the reported flood disaster data and the hazard map, it can be broadly derived that 'low' zones have an average annual incidence of less than one; 'moderate' between 1 and 2; and 'high' more than 2.

per cent of CAC is in the category of high flood hazard. However, it should be noted that the map has limitations since there is no data for a large percentage of the area.

The flooding risk is compounded by the fact that, since agriculture is the major sector in most of the CAC countries, populations tend to concentrate in areas with access to water. Consequently, the valleys and banks of major rivers in the region have high population densities, making them vulnerable to floods.

The flood hazard map (Figure 49) shows that about 40 per cent of the population of Tajikistan is in the category of high flood hazard.

It should be noted that the percentages in (Table 7) do not reflect the complete picture of the flood hazard since data is absent for a large area of the region.

Landslides

Landslides are the next most prevalent natural hazard in CAC, with the larger events often triggered by earthquakes or floods. The high prevalence of landslides is due to the fact that mountain chains are young and high (Figure 50).

Droughts

Droughts are the next major natural hazard in CAC (Figure 51). A drought event in 2000 caused huge economic losses.

The drought hazard map shows that 27 per cent of Armenia and 17 per cent of Azerbaijan fall under the high drought hazard category (Table 9). It should be noted that the hazard map shown in (Figure 51) has limitations since there is no data for a large percentage of the total area.

The 2000 drought in Central and south-west Asia and the Caucasus region affected about 60

Table 7: Percentage area and population in each flood hazard category

Country	Percentage Area in each Category				Percentage Population in each Category			
	Low	Moderate	High	No Data	Low	Moderate	High	No Data
Armenia	39.17	-	-	60.83	21.90	-	-	78.10
Azerbaijan	31.05	0.02	3.52	65.41	25.07	0.00	5.17	69.76
Georgia	78.61	15.60	4.47	1.32	91.23	3.68	2.42	2.67
Kazakhstan	12.13	0.12	-	87.76	19.48	1.70	-	78.82
Kyrgyzstan	27.52	2.17	-	70.31	43.62	2.42	-	53.95
Tajikistan	22.67	23.20	21.83	32.30	20.25	37.06	40.59	2.10
Turkmenistan	13.57	0.98	2.17	83.29	34.05	0.39	4.18	61.38
Uzbekistan	35.00	3.66	2.11	59.23	75.87	8.06	3.65	12.42

Table 8: Percentage area and population in each landslide hazard category

Country	Per cent Area in each Category					Per cent Population in each Category				
	Low	Moderate	High	Very High	No data	Low	Moderate	High	Very High	No data
Armenia	42.10	30.34	6.67	-	20.90	52.09	5.28	0.41	-	42.22
Azerbaijan	31.11	14.10	1.64	-	53.15	13.43	1.82	0.06	-	84.69
Georgia	24.20	31.98	22.23	0.31	21.28	20.26	4.53	0.81	0.00710	74.40
Kazakhstan	2.48	0.93	0.07	-	96.52	6.32	0.21	0.00	-	93.46
Kyrgyzstan	36.66	38.98	7.80	-	16.56	28.26	1.77	0.02	-	69.95
Tajikistan	41.11	20.91	14.85	0.03	23.09	22.83	2.16	0.39	0.00001	74.62
Turkmenistan	1.48	0.14	-	-	98.39	3.23	0.01	-	-	96.76
Uzbekistan	5.44	2.39	0.28	-	91.89	4.74	0.32	0.04	-	94.90

Source: Potential population computed from Landscan 2005 and NGI, 2004 landslide hazard map.

million people and caused very high economic losses. The significant economic impact of drought on individual CAC countries is presented in the country profiles. In Kazakhstan, the country worst affected by drought according to percentage population, about 13 per cent of the population is categorized as living under a high drought hazard (Table 9). Desert covers large parts of the country.

It should be noted that the percentages in the table do not reflect the complete picture of the hazard since there is no data for large areas of the region.

7.6 Disaster risk profile

Vulnerability indicators such as the number of disaster events, deaths, affected population and economic losses have been plotted against hazard types as well as for 5-year intervals covering the 20-year period 1988-2007. Figure 54 (a, b, c) plots the total number of deaths, affected population and economic losses against each hazard type, while Figure 55 (a, b, c) presents the same variables plotted against 5-year periods.

Figure 54 shows that among natural hazards, earthquakes caused the largest number of deaths (31,834), followed by floods (1,543) and landslides (809). Earthquakes caused the highest economic loss ($15 billion), followed by floods ($897 million), landslides ($679 million) and droughts ($507 million). Among technological hazards, transport accidents caused the largest number of deaths (1,503).

The period 1988-1992 (Figure 55) was the worst in terms of number of deaths (27,700) and economic

Figure 50:
Landslide hazard map of CAC

Source: NGI (2004). NGI landslide hazard data received through personal communication with NGI, 2008).

Note: The categorization is based on NGI data. Area computation presented in low and low to moderate are grouped into low; moderate and medium are grouped into moderate; medium to high and high are grouped as high; and very high was kept as very high. NGI classified hazard values ranging from 0 – 1750 and has grouped hazards into low, low to moderate, moderate, medium, medium to high, high and very high classes. In simple terms, classes are related to average annual incidence of landslide hazard events based on the reported disaster and it can be derived that 'low' zones have an average annual incidence of less than 0.1; 'moderate' of 0.11 – 0.3; 'high' of 0.31 – 0.8; and 'very high' of greater than 0.8. For area computation and further analysis these classes were further grouped into low (low and low to moderate), moderate (moderate and medium), high (medium to high and high) and very high (very high).

Table 9:
Percentage area and population in each drought hazard category

Country	Percentage Area in each Category				Percentage Population in each Category			
	Low	Moderate	High	No Data	Low	Moderate	High	No Data
Armenia	18.8	-	27.2	54.1	7.69	-	10.253	82.06
Azerbaijan	31.1	48.9	17.0	2.9	29.01	55.75	11.989	3.25
Georgia	18.4	-	0.7	80.9	11.06	-	0.003	88.94
Kazakhstan	10.5	17.2	7.8	64.5	21.94	39.01	12.941	26.11
Kyrgyzstan	41.2	45.3	-	13.5	19.38	79.94	-	0.67
Tajikistan	31.3	37.0	-	31.7	13.25	85.15	-	1.61
Turkmenistan	0.5	10.3	7.0	82.2	0.24	10.00	10.464	79.30
Uzbekistan	0.6	25.3	-	74.1	1.46	76.29	-	22.24

Source: Potential population computed from Landscan 2005 and drought hazard map of the World Bank Natural Disaster Hotspots Study, Dilley et al., (2005).

Figure 51:
Drought hazard map of CAC

Source: Hazard map adapted and modified from Dilley et al., (2005), Natural Disaster Hotspots: A Global Risk Analysis, World Bank, Washington DC, http://www.ldeo.columbia.edu/chrr/research/hotspots/coredata.html).

Note: For the drought hazard analysis, uninhabited and non-agricultural areas were masked and are shown as 'no data' on the map. Such areas were also not considered for area computation.

losses ($15.1 billion). The period 1998-2002 was the worst in terms of affected population (5.4 million).

Floods have the highest frequency (2.20 per year), followed by transport accidents (1.75), earthquakes (1.70) and landslides (1.15). Earthquakes have the highest death rate (1,600). The relative vulnerability is the highest for earthquakes (21.2), followed by floods (1.03), transport accidents (0.99) and landslides (0.54).

Earthquakes are the dominant risk in CAC with an economic AAL of $898 million (Figure 45). The 20-year return period loss for all hazards is $5.25 billion (2.66 per cent of GDP), while the 200-year return period loss is $17.34 billion (8.81 per cent of GDP).

It may be noted that the above analysis is 'biased' due to December 1988 Spitak earthquake in Armenia (Figure 46).

7.7 Social and economic vulnerability analysis

Social vulnerability is a complex set of characteristics that include personal well-being, livelihood and resilience, self-protection, social protection, social and political networks, and institutions (Cannon et al., 2004). The number of people killed in a disaster is one of the major indicators of SV in a country. In this study, the SV of a country was estimated based on the average number of people killed per year, and SV ranking was estimated based on the average number of people killed per year per million (relative social vulnerability). Table 10 presents the SV and relative SV at country, sub-regional and regional level from natural as well as technological hazards.

The table shows that in terms of relative SV, Armenia is the most vulnerable country, followed by Tajikistan, Georgia, Azerbaijan, Kyrgyzstan,

Table 10: Comparative analysis of social vulnerability for CAC countries

Country	Population	Total Killed (1988-2007)	Combined Disaster Risk from Natural and Technological hazards	
			Killed per year	(Killed per year) per million
Armenia	3.00	25,124	1,256	418.7
Azerbaijan	8.57	7 60	38	4.4
Georgia	4.40	610	30	6.9
Kazakhstan	15.48	282	14	0.9
Kyrgyzstan	5.24	446	22	4.2
Tajikistan	6.74	8,863	443	65.7
Turkmenistan	4.96	40	2	0.4
Uzbekistan	26.87	338	16	0.6
Caucasus	15.97	26,494	1,324	82.9
Central Asia	59.29	9,969	498	8.4
CAC	75.26	36,463	1,823	30.7

Table 11: Comparative analysis of social vulnerability for CAC countries after removal of 1988 Spitak earthquake

Country	Population	Total Killed (1988-2007)	Combined Disaster Risk from Natural and Technological hazards	
			Killed per year	(Killed per year) per million
Armenia	3.00	124	6.2	2.1
Azerbaijan	8.57	7 60	38	4.4
Georgia	4.40	610	30	6.9
Kazakhstan	15.48	282	14	0.9
Kyrgyzstan	5.24	446	22	4.2
Tajikistan	6.74	8,863	443	65.7
Turkmenistan	4.96	40	2	0.4
Uzbekistan	26.87	338	16	0.6
Caucasus	15.97	1,494	74.7	4.7
Central Asia	59.29	9,969	498	8.4
CAC	75.26	11,463	573.2	7.6

Kazakhstan, Uzbekistan and Turkmenistan. From a sub-regional perspective, the average number of people killed per year in the Caucasus is 2.7 times the number killed in Central Asia. In terms of relative SV the difference is even more pronounced, with the average number of people killed per year per million in the Caucasus being more than 9.8 times the number in Central Asia. The analysis shows that Caucasus countries are more vulnerable than those of Central Asia.

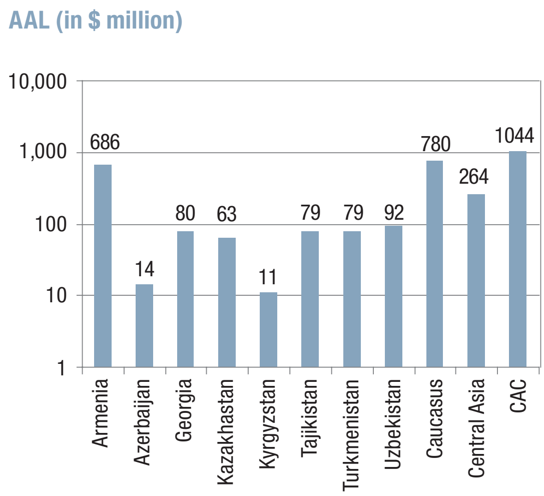
However, it is important to note that the very high relative SV of Armenia, and consequently the Caucasus in general, is 'biased' because of the 1988 Armenia earthquake, in which 25,000 people died (Table 11).

The economic vulnerability (EV) of a country can be measured in terms of the likelihood of economic losses resulting from disasters. The relative EV of a country can be measured by the economic losses as a percentage of that country's GDP. AAL (Figure 52 and Figure 53) and economic loss potential for different probabilities of exceedance have been estimated for both natural and technological hazards (Table 12 and Table 13). In order to rank CAC countries on the basis of relative EV, the economic losses as a percentage of GDP for 0.5

Table 12: Comparison of economic losses in CAC countries, sub-regions and region

Country	Average Annual Loss (AAL) $ millions	Economic Loss ($ millions) Annual exceedance probability 0.5%	5%	20%	Per cent of GDP Annual exceedance probability 0.5%	5%	20%
Armenia	686	12,162	3,942	1,170	132.5	42.9	12.7
Azerbaijan	14	179	71	25	0.57	0.23	0.08
Georgia	80	951	398	146	9.34	3.91	1.43
Kazakhstan	63	1,136	348	100	1.09	0.34	0.1
Kyrgyzstan	11	160	49	15	4.57	1.4	0.42
Tajikistan	79	776	355	139	20.92	9.56	3.75
Turkmenistan	79	1,564	433	115	12.1	3.35	0.89
Uzbekistan	92	2,128	623	177	9.5	2.8	0.8
Caucasus	780	12,386	4,041	1,233	24.47	7.98	2.44
Central Asia	264	3,489	1,192	401	2.39	0.81	0.27
CAC	1,044	17,340	5,246	1,577	8.81	2.66	0.8

Figure 52: AAL for different countries, Central Asia and Caucasus sub-regions and CAC region



per cent of exceedance (Table 12) have been taken as a benchmark. In terms of relative EV, Armenia has the highest ranking, followed by Tajikistan, Turkmenistan, Uzbekistan, Georgia, Kyrgyzstan, Kazakhstan and Azerbaijan.

However, as discussed above, this analysis is 'biased' due to December 1988 Spitak earthquake (Table 13), in which reported economic losses may be overestimated.

Figure 53: AAL for different countries, Central Asia and Caucasus sub-regions and CAC region after removal of 1988 Spitak earthquake

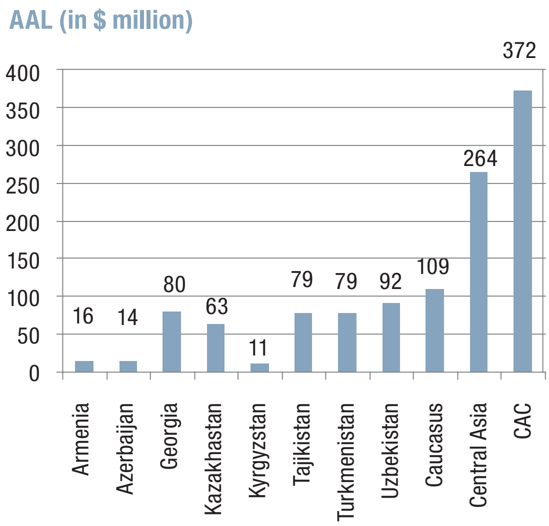
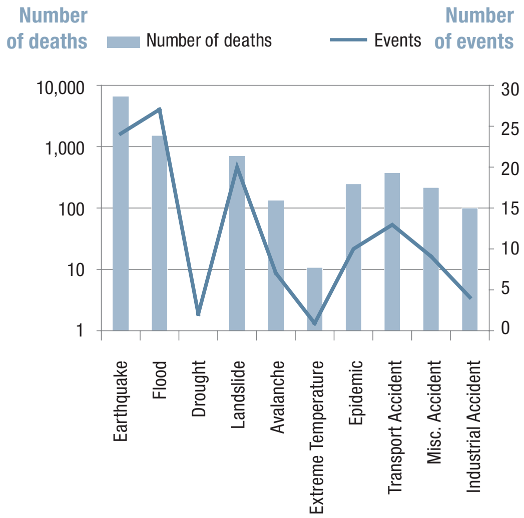


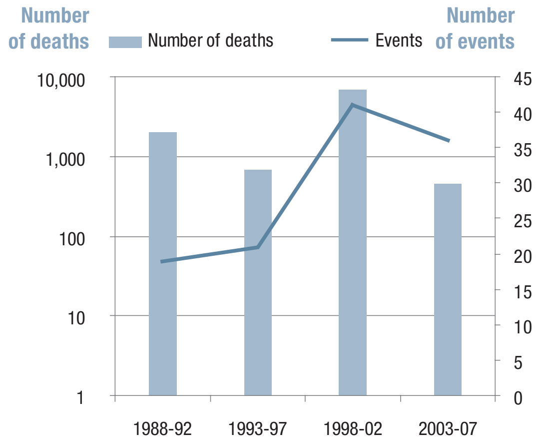
Figure 54: CAC: Disaster events and socio-economic impact by hazard type (1988-2007)

Figure 55: CAC: Disaster events and socio-economic impact by 5-year periods (1988-2007)

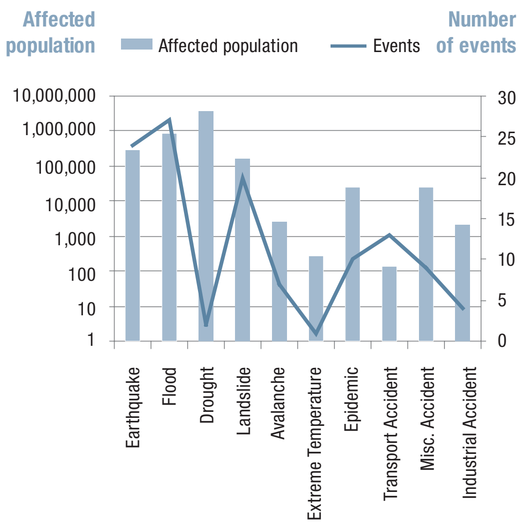
54a Disaster events and number of deaths



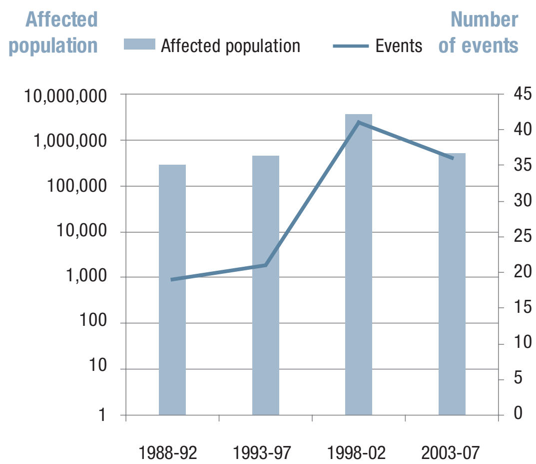
55a Disaster events and number of deaths



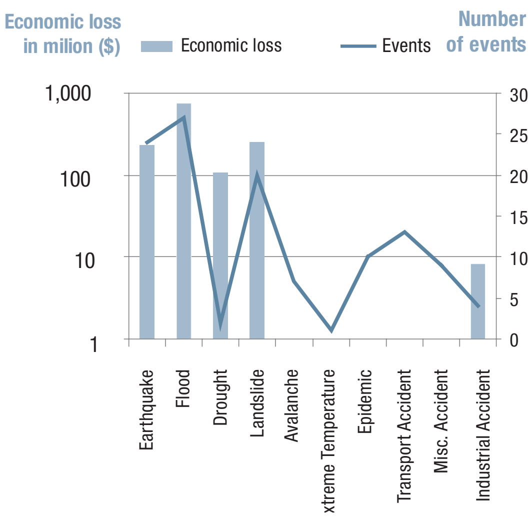
54b Disaster events and affected population



55b Disaster events and affected population



54c Disaster events and economic loss



55c Disaster events and economic loss

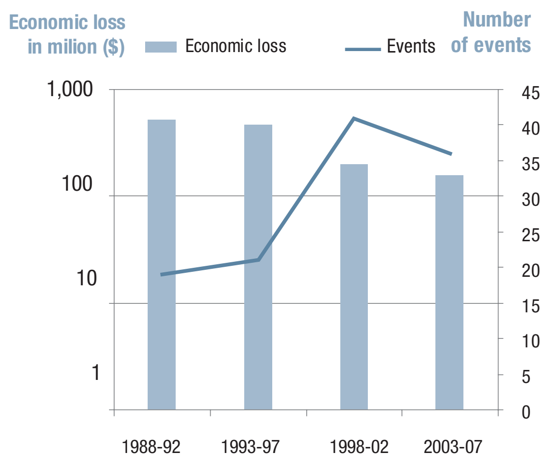


Table 13: Comparison of economic losses in CAC countries, sub-regions and region after removal of 1988 Spitak earthquake

		Economic Loss ($ millions)			Per cent of GDP		
	Average Annual Loss (AAL) $ millions	Annual exceedance probability			Annual exceedance probability		
Country		0.5%	5%	20%	0.5%	5%	20%
Armenia	16	220	71	23	2.4	0.8	0.2
Azerbaijan	14	179	71	25	0.57	0.23	0.08
Georgia	80	951	398	146	9.34	3.91	1.43
Kazakhstan	63	1,136	348	100	1.09	0.34	0.1
Kyrgyzstan	11	160	49	15	4.57	1.4	0.42
Tajikistan	79	776	355	139	20.92	9.56	3.75
Turkmenistan	79	1,564	433	115	12.1	3.35	0.89
Uzbekistan	92	2,128	623	177	9.5	2.8	0.8
Caucasus	109	1,357	549	198	2.68	1.09	0.39
Central Asia	264	3,489	1,192	401	2.39	0.81	0.27
CAC	372	4,210	1,553	552	2.14	0.79	0.28

Chapter 8

Trans-boundary disaster risks and their effects

There is a significant risk from trans-boundary hazards such as earthquakes, floods, droughts, radioactive waste and pollution in CAC. The effects of a number of such events are outlined below:

8.1 Spitak earthquake, Armenia

The Spitak earthquake, on 7 December 1988, was one of the most disastrous earthquakes in the southern Caucasus sub-region. The epicentre was located 40 kilometres north of Leninakan, Armenia, in the mountainous area of the Lesser Caucasus. The earthquake caused serious damage throughout Armenia and caused limited damage in parts of the Republic of Georgia, eastern Turkey and Iran. The tectonics of the region are dominated by the northward motion of the Arabian plate relative to the Eurasian plate and the region has been hit by destructive earthquakes for thousands of years (http://causin.org/cms/). There have been several major earthquakes of magnitudes 6.5 to 7.0 over the last two decades, and the consequences have been catastrophic to both the populations and economies of the sub-region. Earthquakes include the Spitak, 1988; Racha, 1991; Barisakho, 1992; eastern Turkey, 1976, 1983, 1992; and northern Iran, 1990, 1997.

The border area of Armenia, Georgia, Iran and Turkey (Figure 56 a) has high to very high seismic hazard (GSHAP, 1998).

8.2 Ashgabat earthquake, Turkmenistan

The Ashgabat earthquake (M = 7.3), on 5 October 1948, caused extreme damage in Ashgabat (Ashkhabad) and nearby villages, where almost all brick buildings collapsed, concrete structures were heavily damaged and freight trains were derailed. Damage and casualties also occurred in the Darreh Gaz area of Iran. Surface rupture was observed both north-west and south-east of Ashgabat. EM-DAT reports a death toll of 110,000. However, in 2008 Turkmenistan marked the sixtieth anniversary of this earthquake and released an even higher death toll of 176,000 people [in other words, 80 per cent of the Turkmenistan capital's population (ADB, 2008)]. The area bordering Turkmenistan and Iran (Figure 56 b) is an area with high to very high seismic hazard (GSHAP, 1998).

8.3 Kemin earthquake, Kazakhstan

The Kemin (Kebin) earthquake (M = 8.2), on 3 January 1911, in northern Tien-Shan (Kazakhstan and Kyrgyzstan) formed a complex system of surface ruptures. Six fault segments of the Kemin-Chilik and Aksu fault zones with different strikes, dips and kinematics had been activated. Damage occurred in the Chong-Kemin (Bol'shoy Kemin) valley as well as at Anan'yevo and Oytal, Kyrgyzstan. The city of Almaty in Kazakhstan was almost flattened. Faulting, fractures and large landslides

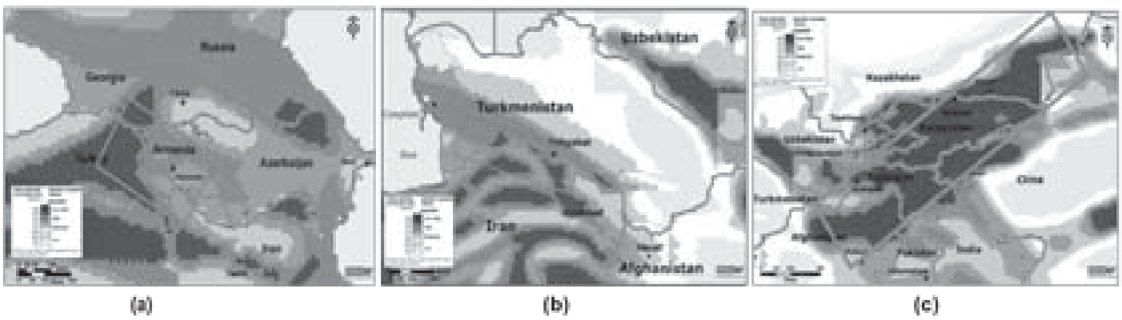
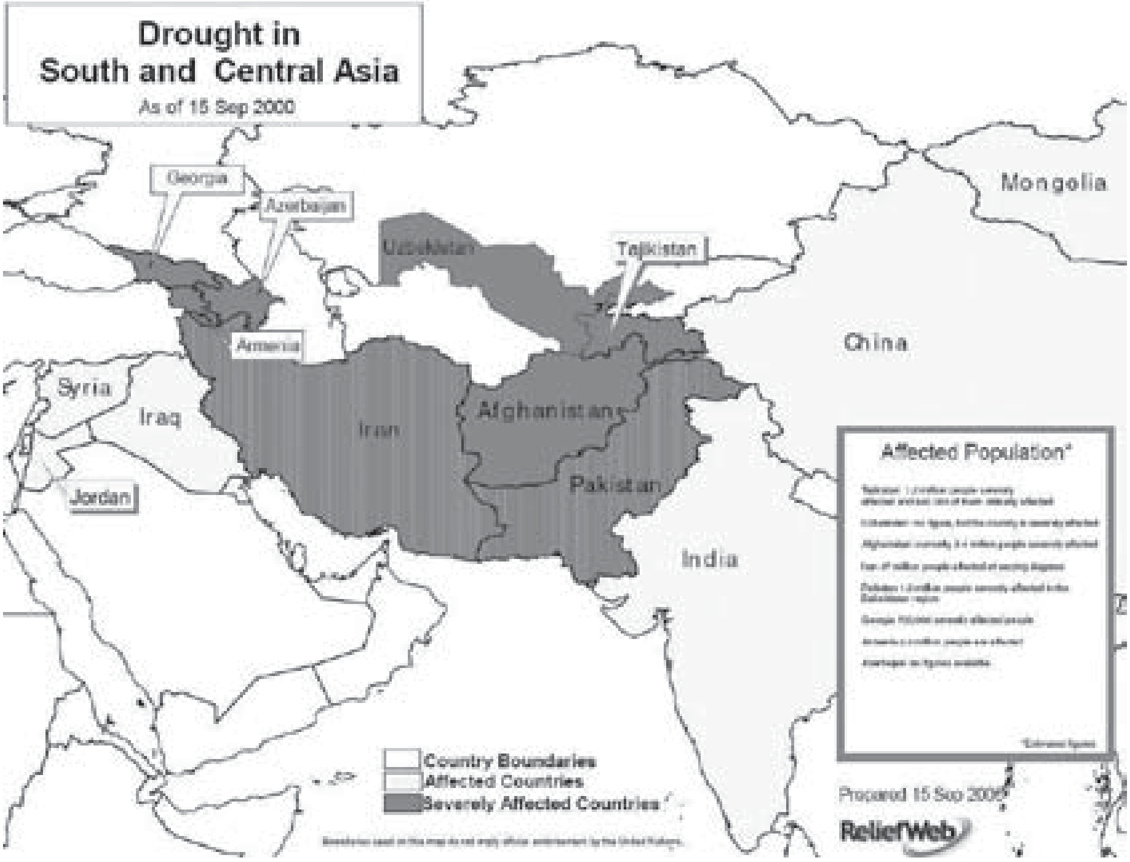


Figure 56: Trans-boundary areas with high to very high earthquake hazards

Figure 57:
2000 drought
in CAC



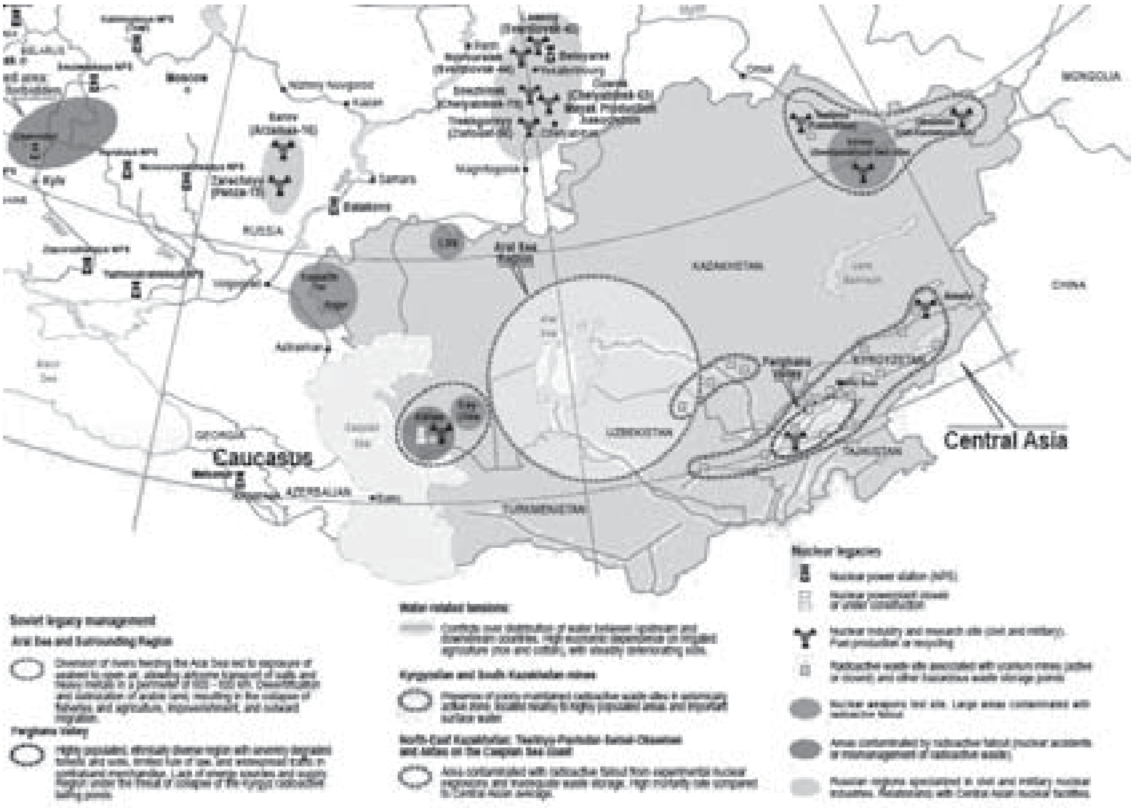
were observed over an area 200 kilometres in the Chong-Kemin and Chilik valleys and along the shore of Lake Issyk-Kul. The earthquake was felt more than 1,000 kilometres away in Kazakhstan and Russia.

The Kemin earthquake was one of the strongest events of a sequence of seismic catastrophes that affected the Kungei and Zaili-Alatau mountain ranges between 1887 and 1938 (http://www.sibran.ru/psb/show_text.phtml?eng+3349+9). According to experts, highly damaging earthquakes in this area tend to occur every 80 to 100 years. The last period of seismic activities was 1885-1911. During that period, several damaging earthquakes occurred at Belovodskye (1885), Verneskoye (1887) and at Keminskoye (1889). Since then, there has been no large damaging earthquake and there is high possibility of another series of such earthquakes within the next 10-15 years (IRIN, 2004).

8.4 2008 earthquake, Nura, Kyrgyzstan

On October 5, 2008, a powerful earthquake of magnitude 6.6 hit the southeast of Kyrgyzstan, 220 kilometres from the main city of Osh, near the borders of Tajikistan and the People's Republic of China, an area which is prone to earthquakes. The next day, on 6 October 2008, the US Geological Survey recorded an earthquake of magnitude 5.9 in central Afghanistan, 70 kilometres south of Kabul. Five years earlier, in February 2003, a magnitude 6.8 earthquake in north-west China, with an epicentre close to Kyrgyzstan, claimed 268 lives and destroyed 20,000 houses. There is strong potential for earthquakes of magnitude 8 to 9 in this area (Figure 56 c) and about 40 per cent of the population (5.24 million) lives in the 20 per cent of the country with a potential for magnitude 9 earthquakes; a further 7.5 per cent of the country is at risk of magnitude 8 earthquakes (ADB, 2008).

Figure 58: Radioactive waste and trans-boundary pollution in CAC



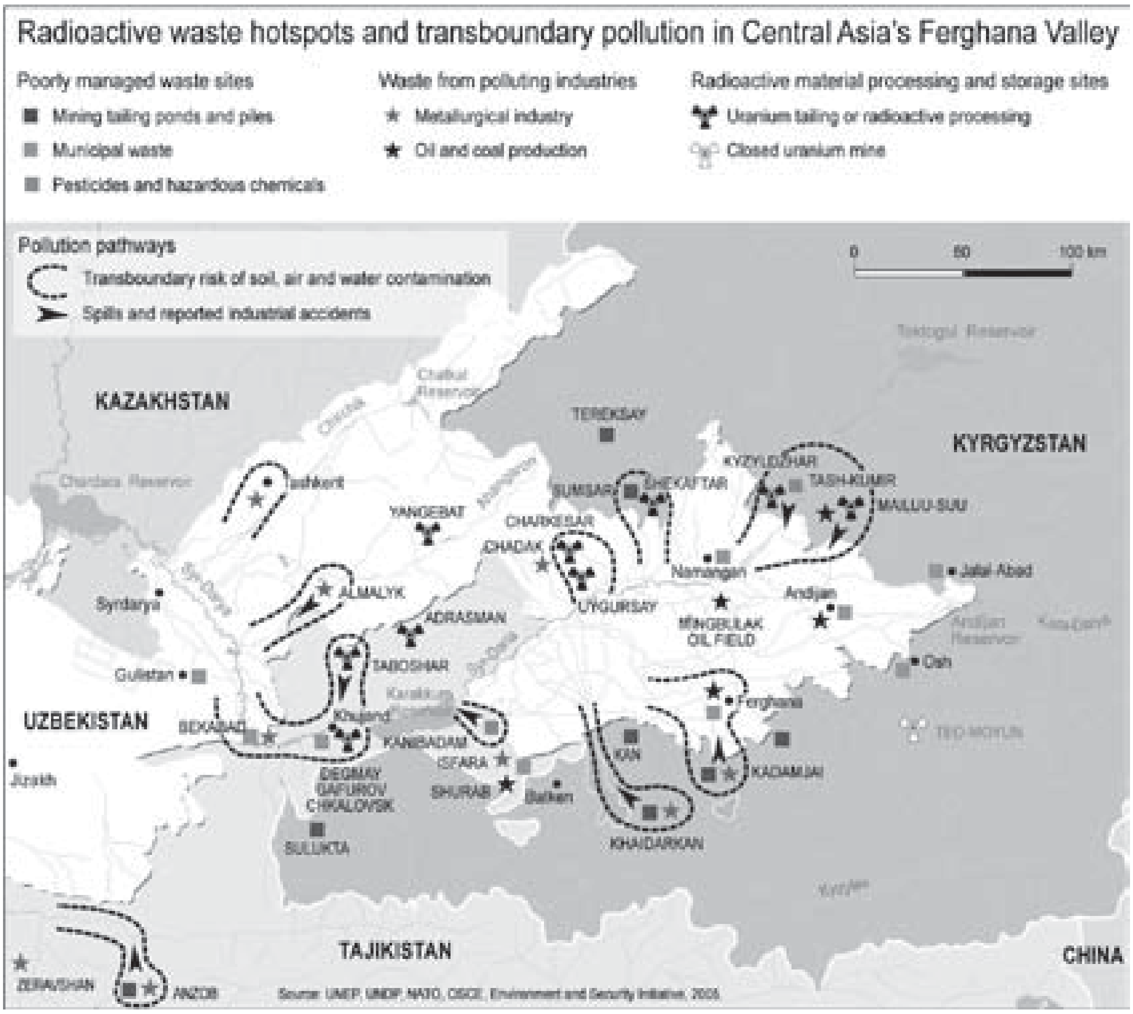
8.5 2000 drought in Central Asia and Caucasus

A single multi-year drought event, starting in 2000 in Central and south-west Asia and the Caucasus region, affected 60 million people and caused huge economic losses. The occurrence of this event was related to large-scale variations in the climatic conditions across the Indian and Pacific Oceans and its effects were aggravated by chronic political instability in many parts of the region. From a regional perspective, the drought was the most severe in CAC for the past several decades. Significant shortfalls in precipitation had widespread social and economic impacts, not only in Iran, Afghanistan, western Pakistan and the Caucasus sub-region, but also in Tajikistan, Uzbekistan and Turkmenistan (Figure 57). Agriculture, animal husbandry, water resources and public health throughout the region were strained.

8.6 2005 Amu Daria flood

The Amu Daria is the largest river in the region and its major catchment area is in Tajikistan. From Tajikistan, it flows along the border between Uzbekistan and Afghanistan and crosses to Turkmenistan, flows back into Uzbekistan and on into the Aral Sea. During June and July 2005, the Amu Daria and its tributaries flooded, causing significant damage in Tajikistan, Afghanistan and southern Kyrgyzstan. Most of the areas along the Amu Daria were damaged due to floods and mud flows, including the inundation of thousands of hectares of fields in the regions of Khamadoni and Khatlon and the districts of Hamadoni and Farkhor, in Tajikistan; the provinces of Badakhshan and Balkh, in Afghanistan; and the provinces of Osh, Batken and Jalalabat, in southern Kyrgyzstan. Huge losses were inflicted when storms repeatedly struck the provincial capital and eight other districts of Afghanistan. Highways and bridges were severely affected in Afghanistan (Dartmouth, 2005).

Figure 59:
Radioactive waste hotspots and trans-boundary pollution in the Ferghana valley



(Source:http://maps.grida.no/library/files/storage/radioactive_waste_hotspots_and_trans-boundary_pollution_in_central_asia_s_ferghana_valley.pdf).

8.7 2005 Syr Daria flood

The Syr Daria originates in the Tian-Shan mountains and is the longest river in Central Asia. The river's major catchment area is in Kyrgyzstan, from where it crosses to Uzbekistan and Tajikistan and flows into the Aral Sea in Kazakhstan. During February and March 2005, heavy flooding along the Syr Daria caused significant damage in Kazakhstan and Uzbekistan. Farmland and settlements were destroyed in the Kyzylorda area of Kazakhstan and the districts of Konimex and Nurota, in Uzbekistan (http://www.dartmouth.edu/~floods/images/2005024SyrDarya.jpg).

8.8 Radioactive waste and trans-boundary pollution

CAC is vulnerable to radioactive pollution. There are many uranium tailing or radioactive processing sites across the region and there are fears, in the Caucasus, of a nuclear radiation hazard originating from the nuclear plant at Metsamor, Armenia (Figure 58). This plant is considered dangerous by the IAEA because of its location in an earthquake zone and its type (Anagnosti, 2008). In Central Asia, there are many hazardous and poorly-maintained radioactive waste sites located in highly populated areas of the region (Figure 58). Most of these plants lie in the border area, thus posing trans-boundary risks of soil, air and water contamination

Figure 60:
Aral Sea Basin and shrinkage of Aral Sea

(http://maps.grida.no/library/). There are also several nuclear weapons test sites in the region, such as Semey, Lira, Say-Utes, Kapustin Yar and Azgyr (Figure 58). Furthermore, the number of metallurgical industries, oil and coal production units across the region make it vulnerable to toxic industrial waste. Moreover, there are many poorly-managed municipal waste, pesticide and hazardous chemical waste sites. The Ferghana valley, where there are several radioactive waste sites and trans-boundary population centres, is under the threat of the collapse of the Kyrgyzstan radioactive tailing ponds (Figure 59).

8.9 Aral Sea crisis

Located in the lowlands of Turan, the Aral Sea is situated in the centre of the Central Asian great deserts: the Kara-Kum, Kyzyl-Kum and Betpakdala. Kazakhstan and Uzbekistan share an approximately equal length of shoreline. In 1960, the Aral Sea was the fourth largest body of inland water in the world, but by 2007 it had shrunk to just 10 per cent (Figure 60) of its former size (Micklin and Aladin, 2008). Since the 1960s, the water level has been systematically and drastically reduced because of the diversion of water from the Amu Daria and Syr Daria rivers for the purposes of agricultural irrigation in Uzbekistan, Kazakhstan and Turkmenistan. By the 1980s, during the summer months, the two great rivers virtually dried up before they reached the Aral Sea. The effect was that the Sea began to quickly shrink through the evaporation of its un-replenished waters. In the late 1980s, the lake had lost more than half its volume and the sea level had dropped so much that the water had separated into two distinct bodies: the Small Aral (north) and the Large Aral (south). By 2007 the south had split into a deep western basin, a shallow eastern basin and a small, isolated gulf.

The evaporation of the un-replenished Aral Sea vastly outpaced any rainfall, snowmelt or groundwater supply, leading to reduced water volume and raised salinity. The volume of the Large Aral Sea dropped from 708 cubic kilometres to only 75 cubic kilometres and salinity increased from 14 grams per litre to more than 100 grams per litre (Micklin and Aladin, 2008). The salt and mineral content of the lake rose so drastically that it made the water unfit to drink and killed off the once abundant supplies of fish in the lake. The fishing industry along the Aral Sea was thus virtually destroyed. In the late 1990s, the Aral Sea crisis gained global attention as one of the greatest man-made ecological disasters in the world. An estimated five million people have been severely affected by the Aral Sea crisis.

Exposed sea beds led to dust storms that blew across the region, carrying a toxic dust contaminated with salt, fertilizer and pesticides. Health problems occurred at unusually high rates from throat cancers to anemia and kidney diseases. Infant mortality in the region was probably among the highest in the world. The shrinkage of the Aral Sea also made the local climate harsher, with colder winters and hot summers (Micklin and Aladin, 2008).

Climatically, the Aral Sea area is characterized by a desert-continental climate with a large variation in temperatures, including hot summers and cold winters with sparse rainfall. The Aral Sea crisis has created severe risks of environmental instability through intensification of the desertification process in the Aral Sea coastal zone (including the formation of a new Aral-Kum desert), decreased land productivity due to increased salinity and increased erosion risk of mountain foothills due to deforestation, grazing and irrigation erosion. According to a rough estimate, direct and indirect socio-economic losses as a result of environmental disasters in the Aral Sea region are estimated at $145 million per year (Dukhovny and Stulina, 2005).

In response to the crisis, the governments of the states surrounding the Aral Sea tried to institute policies to encourage less water-intensive agricultural practices in the regions south and east of the lake, thus freeing more of the waters of the Amu Daria and the Syr Daria to flow into the lake and to stabilize its water level. These policies succeeded in reducing water usage somewhat, but not to the level necessary to have a significant impact on the amount of water reaching the Aral Sea.

Other improvements were gained through repairs and improvements to the irrigation works on the Syr Daria, which helped to further increase its water flow. Since the completion in August 2005 of the Kokaral Dyke, a concrete dam separating the two halves of the Aral Sea, the water level in the north Aral has risen and its salinity has decreased. The dam helped the water levels in the north Aral Sea to rise swiftly from a low of 30 metres to 38 metres, with 42 metres considered the level of viability (Greenberg, 2006). There are plans to build a new canal to reconnect Aralsk with the sea and a new dam is planned to be built, funded by a World Bank loan to Kazakhstan (http://www.worldbank.org.kz).

As discussed in section 12.1 on regional initiatives, the largest effort to address the issues has so far been conducted by the World Bank and the United Nations with goals to stabilize the Aral Sea level, rehabilitate the region and improve its water management (Owen, 2001). As mentioned above, the dam built in 2005 has helped the northern-most lake expand quickly and salinity levels drop substantially. Fish populations and wetlands are returning and with them signs of economic revival.

However, the two big southern lakes could become dead seas unless the Amu Daria river, which once fed them, is substantially re-engineered, a project which would require tens of billions of dollars and difficult political agreements (Micklin and Aladin, 2008).

Chapter 9

Migration patterns and economic highlights

"Migration never occurs in a vacuum and people rarely leave their 'home' environment unless they are pushed or pulled to do so"

(ICMH)

9.1 Background

Migration has always been an integral part of social and economic development and very much a function of the social and political environment. There are several factors affecting migration, including the gap between poor and rich countries; the gap between the poor and rich within the country; the demand for a more mobile young work force due to globalization; and political instability and social unrest. Improved communications throughout the world, better quality of life, and better and faster transport systems are additional factors facilitating migration.

As discussed earlier in the report, CAC covers an area of 4.2 million square kilometres and has a total population of 75 million. In spite of having ample agricultural land, natural resources and industries human migration is not new to CAC. During the Soviet era, movement between republics was to some extent promoted and the type of movement that preceded the breakup of the Soviet Union was carefully managed through a variety of means, including centralized planning (Horbaty et al., 2006). Since the break-up of the Soviet Union, migration can be described in three relatively discrete phases (Horbaty et al., 2006):

- Following the collapse of the Soviet Union, there was a relatively acute 'spike' in population mobility, prompted by the movement of people from the newly-independent states living in Russia or elsewhere in the region who were afraid that they might lose their political and legal status in their home states. Moreover, the return of demobilized soldiers from the military establishment to civil life was another element that sparked migration, involving more than 2 million people.
- Another significant phase of migration occurred from 1993 to 1995 when large numbers of ethnic Russians returned to Russia pushed by growing nationalism within the newly-independent states and an insistence on national official languages as opposed to Russian.
- In the third more recent and subsequent phase, the economic and political conditions of the region have helped to stabilize migration at relatively high rates. The migration involves both internal rural-urban and cross-border movement, but mainly within the region, making migration somewhat of a circular model. Migration has also involved the seasonal movement to western Europe for more opportunities of improved livelihoods.

9.2 Newly-emerging factors behind migration in CAC

The newly-emerging migration patterns in CAC are dependent on several factors and are closely linked to changes in the global economic system. A few of them are described below:

Economic factors: The break-up in the early 1990s of the Soviet Union led to an excess of both unskilled and skilled labour, and high levels of unemployment. During this period, people migrated for short work periods, due to which a temporary 'circular migration' system evolved. Immediately following the break-up, the traditional attraction of Russia in terms of employment opportunities remained, and even intensified to the point that by the end of 1994 net migration from former Soviet Republics to Russia was almost six times higher than it had been during the period 1986-1990 (Horbaty et al., 2006). However, in recent times it has been observed that workers from southern parts of CAC have found equally good work opportunities in Kazakhstan (Patzwaldt, 2004). Consequently, along with Russia, Kazakhstan has also become a favourite destination for migrant labour.

Demographic factors: With the exception of forced migration, migration has always been a relatively selective process and has involved people who were motivated, willing and able to move. Migration in CAC is increasingly characterized by the relatively young age of migrants and by the fact that people tend to move more as single individuals and not as families. While this trend is not so different from migration in other parts of world, there are reasons to believe that the

Figure 61:
Flow of migrants in CAC during 2000 – 2005

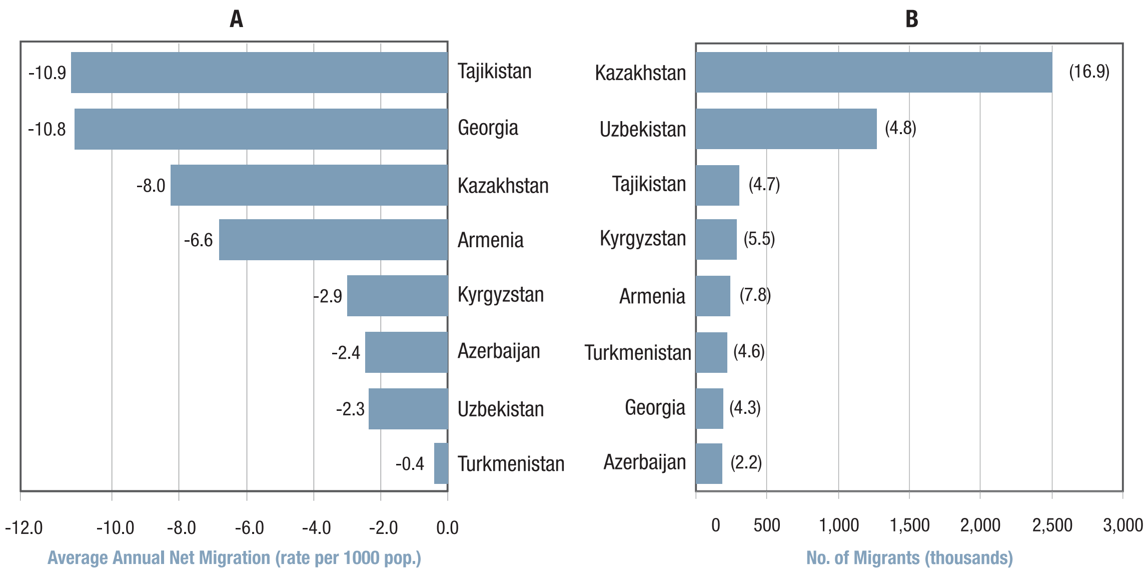
levels of vulnerability of migrants in CAC may be considerably higher than elsewhere because of the lack of available social safety nets.

Environmental factors: Environmental factors are a prime mover in certain cases of migration. Because such factors usually have a direct impact on the economy, they can be indirectly classified as economic factors. Environmental migration is clearly observable in a number of places in CAC. In the case of the Aral Sea crisis, environmental migration was significant in Zhambyl, which was once a flourishing fishing port on Kazakhstan's western coast of the Aral Sea. Similarly, significant environmental migration took place from the country's Kyzylorda Province, which had major water resource issues, and from Atyrau, which experienced deforestation, flooding from the Caspian Sea and radioactivity in Kurmangasy. The landslides in the Ferghana Valley and the high levels of oncological diseases and high death rates associated with radiation exposure to nuclear waste at the 18,500-square-kilometre Semipalatinsk Nuclear Testing Polygon (site) also caused significant environmental migration. However, it should be noted that Atyrau recently experienced a population increase due to a rise in jobs associated with the oil industry.

In summary, the above-mentioned forces emerge as factors behind the migration both within and outside CAC. The migration is a mix of internal, external and transit migration, as well as permanent and temporary (labour) migration. Within CAC (Figure 61), many people are seasonal labour migrants in neighbouring countries. These types of migrations impose serious burdens on individuals and families because they do not engage families as units. Rather, they tend to split families up in indefinite and poorly-defined ways over periods of time. The fragile social and familial conditions are further accentuated by the fact that the work situation is characterized by the following: highly flexible but poorly-defined occupational security; irregularity of work and stay in the countries people move to; irregularity and unpredictability of contact with the family; human trafficking; and growing institutionalization of remittances as a source of family support.

Figure 62a indicates that all the countries studied have negative net migration rates. The average

Figure 62:
a: Average annual rate of net migration in CAC; b: Number of migrants and percentage of total population



annual net migration during 2000–2005 is the highest in Tajikistan (-10.9 people/1,000 pop.), followed by Georgia (-10.8 people/1,000 pop.) and Kazakhstan (-8.0 people/1,000 pop.). Turkmenistan is in a more balanced state (-0.4 people/1,000 pop.), with a low emigration rate.

Figure 62b shows the migrant stock of each country. The migrant stock is defined as the mid-year estimate of the number of people who were born outside the country. For countries lacking data on places of birth, the mid-year estimate is taken as the number of non-citizens. In either case, the migrant stock includes refugees, some of whom may not be foreign-born (International Migration, 2006). Kazakhstan and Uzbekistan accounted for 48 per cent and 24 per cent of the total migrant stock among CAC countries in 2005.

9.3 Armenia

Armenia has a population of 3 million with a negative growth rate of 0.3 per cent, due partly to migration resulting from political instability after the dissolution of the Soviet Union and subsequent independence. The urban population accounts for 63.8 per cent of the total population (UN Urban and Rural Areas, 2007).

Economy

Armenia is a low middle income country with Gross National Income (GNI) per capita of $2,640 (Atlas method, World Bank, 2007), GDP of $9.18 billion and GDP annual growth rate of 13.7 per cent (World bank, 2007). The population and GDP variations over time are shown in Figure 63.

The agricultural sector output (18.3 per cent of GDP) consists of a range of fruits (especially grapes), vegetables and livestock.

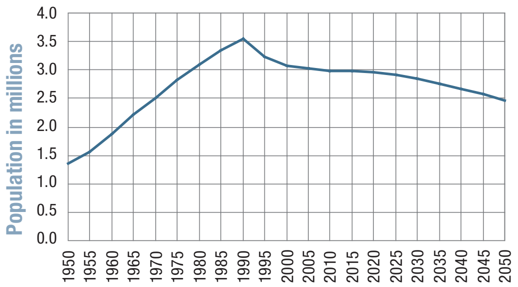
The industrial/manufacturing sector output (43.6 per cent of GDP) includes diamonds, scrap metal, machinery and equipment, cognac, copper ore, zinc and gold.

The services sector (38.1 per cent of GDP) is concentrated in public administration and trade.

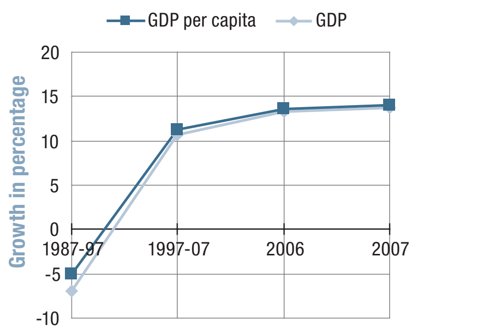
As a small developing economy, Armenia depends critically on external markets for sustaining high growth and reducing poverty. Economic growth accelerated during 2001-2007, which was mainly driven by export growth and expansion in the construction and services sectors. The economy

Figure 63: Population and GDP growth trend in Armenia (1950-2050)

Population trend in Armenia



Average annual growth rates of economic indicators



was expected to continue its strong performance during 2008 and real GDP growth was expected to be in the range of 9 to 10 per cent (World Bank).

Migration

The intensity of the systemic crisis of the Soviet economy during 1988-1994 had a direct impact on Armenia. Economic growth reduced to zero and was even negative in the late 1980s. The slowdown of the economic growth rate created tensions in the labour markets, especially in small cities and rural areas. This in turn led to both seasonal migration (people temporarily working, mostly in the construction sector, in other republics of the former Soviet Union) as well as intensive emigration, mainly to the United States of America (USA) (Yeghiazaryan et. al., 2003). As a consequence, at least 0.8 million Armenians (25 per cent of country's total population) left the country in the 1990s (Migration News, 2001).

The effect of natural hazards and cross-border conflicts also played an important role in the migration of Armenians. The migration from Armenia intensified after the devastating magnitude 6.9 Spitak earthquake in December 1988. The earthquake left 25,000 people dead, and in 1988-1989 some 145,000 people emigrated (Yeghiazaryan et. al., 2003).

A second wave of migration was caused by the Nagorno-Karabakh conflict (February 1988 to May 1994). During the conflict in 1989-90, 170,000 Azerbaijani people left Armenia and 360,000 Armenian people left from Azerbaijan. The bulk of the people returning to Armenia again migrated and settled, mostly in Russia and the USA (Yeghiazaryan et. al., 2003).

A third major migration followed the declaration of independence in 1991; independence resulted in a severe economic crisis, significant cuts in income for most of the population, the collapse of the energy supply and a sharp deterioration in living conditions (Yeghiazaryan et. al., 2003).

Recent emigration of Armenians is still mainly linked to economic factors such as scarcity of jobs and low salaries (NSS, 2001). The country's net migration during 2000-2005 was -6.6 per 1,000 population (International Migration, 2006). As per the United Nations Department of Economic and Social Affairs (UN DESA), the total migrant stock in Armenia in 2005 was 235,000 people, representing 7.8 per cent of the population

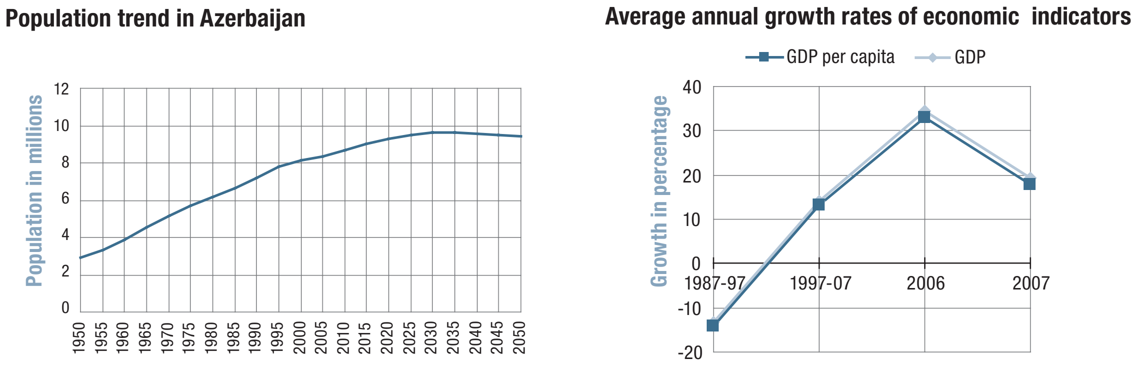
9.4 Azerbaijan

The total population of Azerbaijan is 8.57 million and the country has a growth rate of 1 per cent (World Bank, 2007). However, it is estimated that the current growth rate will fall to zero by around 2030. The urban population accounts for 51.7 per cent of the total population (UN Urban and Rural Areas, 2007).

Economy

As per World Bank (2007), Azerbaijan is a low

Figure 64: Population and GDP growth trend in Azerbaijan (1950 -2050)



middle income country with a GNI per capita of \$2,550 (Atlas method), a GDP of \$31.25 billion and an annual GDP growth rate of 19.2 per cent (CIA World Fact book, 2007). The population and GDP variation for Azerbaijan are shown in Figure 64.

The agricultural sector output (6.3 per cent of GDP) consists of a range of fruits (mainly grapes and citrus fruits) and vegetables, cotton, tobacco, tea, livestock and dairy products.

The industrial/manufacturing sector output (61.6 per cent of GDP) is dominated by the oil and gas industry, chemicals, oil-field equipment and textiles.

The services sector (32.1 per cent of GDP) is concentrated in public administration and trade.

Azerbaijan's economic growth is polarized by two discrete sectors: the urban sector – dominated by the oil industry, Government and a few big businesses – which provides economic opportunities and comfortable incomes to a relatively small number of individuals; and the rural sector – dominated by small and medium agri-businesses and non-urban-focused services and industries – which provides limited economic opportunities and constitutes the major share of the country's workforce (USAID, 2002). In 2006 and 2007, Azerbaijan experienced a sharp increase in economic growth due to growing oil exports.

Migration

Azerbaijan was the first among the former Soviet countries to face population displacement problems. The first flow of refugees (250,000 ethnic-Azerbaijanis) arrived from Armenia during 1988-1992. In the meantime, some 50,000 Meskhetian Turks were displaced from Uzbekistan and granted asylum in Azerbaijan (IOM Azerbaijan, 2004).

Since then, Azerbaijan has had both a heavy inflow and outflow of migration, with a resulting negative net immigration. On the one hand, many ethnic Azeries between the ages of 20 and 40 years, of different professional and educational backgrounds, are moving from the country, mainly for economic reasons, and choosing Europe and North America as their preferred destinations. However, on the other, the number of foreigners on the internal labour market is increasing following improvements to economic development. Another major characteristic of migration in Azerbaijan is the transit migration originating from Central Asian and Middle Eastern countries to Western Europe.

The rate of net average annual migration during 2000-2005 was -2.4 per 1,000 population (International Migration, 2006). As per UN DESA, the country's migrant stock in 2005 was 182,000 people, representing 2.2 per cent of the total population.

9.5 Georgia

The total population of Georgia is 4.4 million with a negative growth rate of -0.8 per cent (World Bank, 2007). The country's population increased continuously until the late 1980s, when – following independence and due to political instability, internal and external conflicts, and a large outflow of migration – the total started to decline significantly. The urban population of the country accounts for 52.6 per cent of the total population (UN Urban and Rural Areas, 2007).

Economy

As per World Bank (2007), Georgia is a low middle income country with a GNI per capita of $2,120 (Atlas method), a GDP of $10.18 billion and an annual GDP growth rate of 12.4 per cent. The population and GDP variation for Georgia are shown in Figure 65.

The agricultural sector output (10.9 per cent of GDP) consists of a range of fruits and vegetables, livestock, dairy products, nuts and tea.

The industrial/manufacturing sector output (24.1 per cent of GDP) includes manganese, iron, coal, copper, gold, granite, limestone, marble and mineral waters.

The services sector (65 per cent of GDP) is concentrated in public administration and trade.

Georgia's economy had a sustained GDP growth of 10 per cent in 2006 and 12 per cent in 2007, as a result of large inflows of foreign investment and robust Government spending. However, poverty remains a major problem in both rural and urban areas. Despite recent strong economic growth (Figure 65), there has been no improvement in poverty reduction or social welfare activities. According to an International Monetary Fund (IMF) study, absolute poverty increase from 27 per cent in 2004 to 31 per cent in 2007.

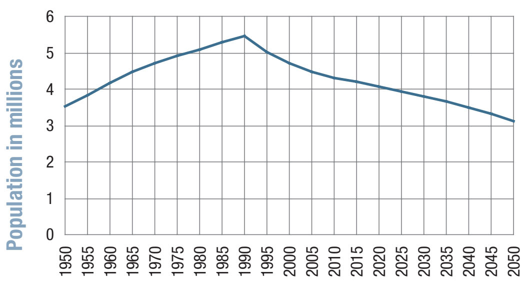
Migration

Georgia, situated at the dividing line between Europe and Asia, is a south Caucasus country with a favourable geopolitical location and pleasant climatic conditions. Migration from Georgia has traditionally not been as intensive as from neighbouring countries. However, following independence in 1991 and similar to many post-communist countries, Georgia also suffered from an economic crisis and civil unrest, which caused unprecedented levels of emigration. Unfortunately, the migration database until 2000 is inadequate for Georgia, although it is estimated that from 1990-2005 between 0.4 million and 1 million people emigrated from the country (Shinjiashvili, 2005). Due to instability, there are still requests for asylum in Europe from Georgians. Moreover, transit migration through Georgia is an increasing concern for the EU and cross-border movement is a further source of unease (Selm, 2005).

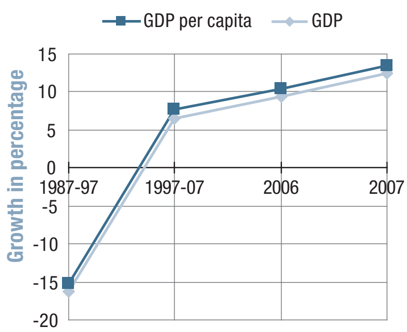
The rate of net average annual migration during 2000-2005 was -10.8 per 1,000 population (International Migration, 2006). As per UN DESA, the migrant stock of Georgia in 2005 was 191,000 people, representing 4.3 per cent of country's population.

Figure 65: Population and GDP growth trend in Georgia (1950-2050)

Population trend in Georgia



Average annual growth rates of economic indicators



9.6 Kazakhstan

The total population of Kazakhstan is 15.48 million with a growth rate of 1.1 per cent (World Bank, 2007). However, it is estimated that the growth rate will decrease to zero around 2040. The country's urban population accounts for 57.5 per cent of the total (UN Urban and Rural Areas, 2007).

Economy

As per World Bank (2007), Kazakhstan is a middle income country with a GNI per capita of $5,060 (Atlas method), a GDP of $103.84 billion and an annual GDP growth rate of 8.5 per cent. The population and GDP variation for Kazakhstan are shown in Figure 66.

The agricultural sector output (6.6 per cent of GDP) consists of 13.5 million tons of wheat, along with other food crops such as barley, maize, rice, potatoes, soybeans, sugar beets, cotton, tobacco, sunflower, flax and mustard. Kazakhstan is rich in land resources. More than 74 per cent of the country's territory is suitable for agriculture and the natural and climatic conditions are highly favourable to growing a wide variety of crops.

The industrial/manufacturing sector output (44.3 per cent of GDP) is dominated by energy, which is the leading economic sector. Production of crude oil and natural gas condensate amounted to 51.2 million tons in 2003, which was 8.6 per cent more than in 2002.

The services sector (49.1 per cent of GDP) is concentrated in public administration and trade.

The country's GDP growth has been stable for the last five years, at a rate slightly higher than 9 per cent (Figure 66). The Government of Kazakhstan planned to double its GDP by 2008 and triple it by 2015 as compared to 2000 (CIA World Fact book, 2008).

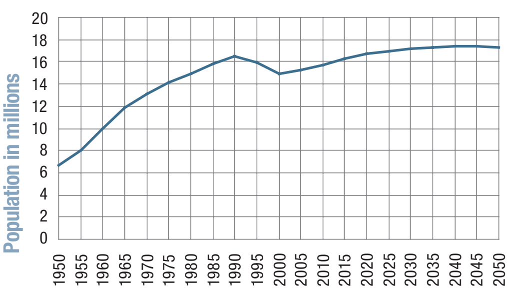
Migration

Kazakhstan, like other Central Asian countries, has experienced similar migration patterns to those of other states of the former Soviet Union. From the beginning of the 1990s, when the political and economic transition started, a large number of people have left Kazakhstan due to an economic crisis, high unemployment and social and ethno-cultural reasons. UNDP estimated that some 1.2 million people emigrated from Kazakhstan between 1995 and 2005 (Shormanbayeva and Makhmutova, 2008). Significant numbers were people who had earlier migrated from within the states of the former Soviet Union and were returning to their countries of origin (mostly Russia, Belarus and Ukraine).

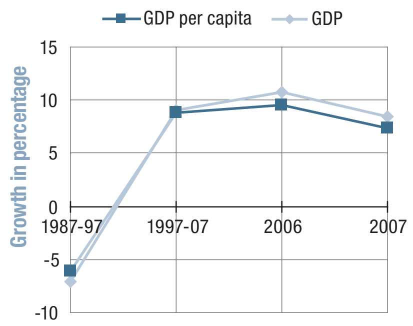
The reasons behind emigration from Kazakhstan are mainly economic (scarcity of work and low wages) and environmental. The environmental problems are acute: degraded land and impoverished landscapes account for 66 per cent of the territory undergoing different degrees of desertification; drinking water is subject to physical, chemical and biological pollution; in particular, the Aral Sea region and Semey nuclear testing regions are environmentally highly vulnerable and have been declared zones of ecological disaster (Shormanbayeva and Makhmutova, 2008).

Figure 66: Population and GDP growth trend in Kazakhstan (1950 -2050)

Population trend in Kazakhstan



Average annual growth rates of economic indicators



Kazakhstan is subject to both strong emigration and immigration, although it had a negative net migration balance between 2000 and 2006. The rate of net average annual migration during 2000-2005 was -8.0 per 1,000 population (International Migration, 2006). As per UN DESA, the migrant stock in Kazakhstan in 2005 was 2.5 million people, representing 17 per cent of the population.

Since 2004, the improving economic situation and relative stabilization in Kazakhstan has stopped the net outflow of migrants and consequently changed the balance of migration. Labour migrants from other countries of Central Asia (mainly from Uzbekistan and Kyrgyzstan) are now settling in Kazakhstan. It is estimated that in 2007 there were half a million migrants from other countries, with Russians representing the bulk of the migrant population in Kazakhstan (Laruelle, 2008).

9.7 Kyrgyzstan

The total population of Kyrgyzstan is 5.24 million with a growth rate of 1.0 per cent (World Bank, 2007). It is estimated that this growth rate will remain steady until 2035. The country's urban population accounts for 36.1 per cent of the total (UN Urban and Rural Areas, 2007).

Economy

As per World Bank (2007), Kyrgyzstan is a low income country with a GNI per capita of $590 (Atlas method), a GDP of $3.5 billion and an annual GDP growth rate of 7.4 per cent. The population and GDP variation for Kyrgyzstan are shown in Figure 67.

The agricultural sector output (33 per cent of GDP, 2006) is dominated by animal husbandry, tobacco, cotton, fruits (grapes and berries), vegetables, and wheat and barley.

The industrial/manufacturing sector output (20.1 per cent of GDP, 2006) includes gold, agricultural products, and hydropower. The latter constitutes most of the country's exports. More recently, sectors such as construction and services have shown strong development and have started contributing substantially to the country's GDP growth.

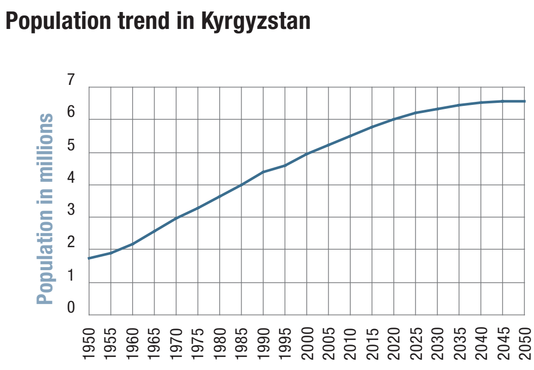
The services sector (46.9 per cent of GDP, 2006) is concentrated in goods and trade.

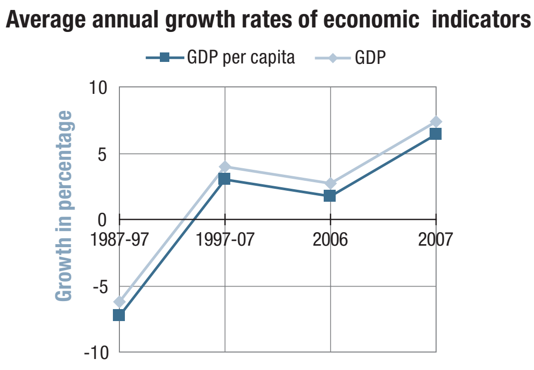
Following independence, the breakup of most State and collective enterprises and the drastic decline in public budgetary resources caused a sharp deterioration in most social and economic infrastructure facilities, particularly in rural areas. The country has made considerable progress in attaining macro-economic stability in the past few years. Average GDP growth was 5 per cent a year between 2003 and 2007 and the high poverty rates have shown declining trends since 2000. The worldwide food price increase has affected the country significantly, which may also slow the progress of poverty reduction.

Migration

Migration became a major issue in Kyrgyzstan as a consequence of economic and political instability

Figure 67: Population and GDP growth trend in Kyrgyzstan (1950 -2050)





in the 1990s. High rates of unemployment, a fall in living standards and a lack of social protection are the main factors causing high-scale spontaneous migrations, both internal and external. Most of this population, especially from southern Kyrgyzstan, moves to Russia and Kazakhstan and is employed as labourers. Emigration still remains high today, caused by the extreme poverty of 25 per cent of the population (Nasritdinov et.al., 2008, Tishin, 2007). The most favourable destinations of Kyrgyz emigrants are Russia, Kazakhstan, Tajikistan and Uzbekistan.

The net average annual migration was recorded as -2.9 per 1,000 population in the country during 2000-2005 (International Migration, 2006). UN DESA estimated that the total migrant stock in Kyrgyzstan in 2005 was 288,000 persons, or 5.5 per cent of the population.

9.8 Tajikistan

The total population of Tajikistan is 6.74 million with a growth rate of 1.5 per cent (World Bank, 2007). It is estimated that this rate will remain steady until 2035. The country's urban population accounts for 26.4 per cent of the total population (UN Urban and Rural Areas, 2007).

Economy
As per World Bank (2007), Tajikistan is a low income country with a GNI per capita of $460 (Atlas method), a GDP of $3.71 billion and an annual GDP growth rate of 7.8 per cent. The population and GDP variation for Tajikistan are shown in Figure 68.

The agricultural sector output (21.4 per cent of GDP) is dominated by cotton.

The industrial/manufacturing sector output (27.5 per cent of GDP) includes production of aluminum from imported alumina. The country has one of the world's largest alumina smelters, near Dushanbe, and is rich in other metal deposits such as gold and silver.

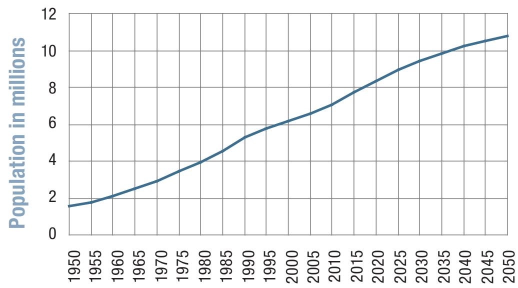
The services sector (51 per cent of GDP) is concentrated in banking, public administration and trade.

Immediately after its independence, Tajikistan suffered from a five-year civil war (1992 to 1997) in which the country lost more than 60 per cent of its GDP (Figure 68). The country's economy began to recover in 1998, allowing the Government to focus on administration and implementing an economic and social development agenda.

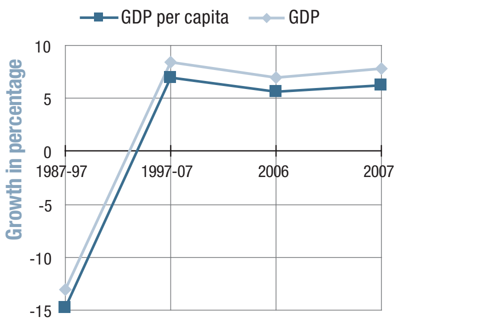
Migration
Throughout the 1990s, displacement triggered by the civil war was the predominant reason for migration from Tajikistan. However, since 1997 labour migration has been increasing and a survey conducted by the International Organization for Migration (IOM) and NGO Sharq in 2003 indicated that 18 per cent of the adult population, or 632,000 people, worked outside Tajikistan during 2000-2003.

Figure 68: Population and GDP growth trend in Tajikistan (1950-2050)

Population trend in Tajikistan



Average annual growth rates of economic indicators



The prime motivation behind the country's migration is low earning potential and the inability to find jobs at home or to finance further education. In addition to the economic aspects, other reasons include environmental degradation, such as extreme temperatures and reduced precipitation levels, and an increase in 'forced' migration (Khakimov and Mahmadbekov, 2008). Russia, followed by Kazakhstan, are the favourite destinations for Tajik migrants.

The rate of net average annual migration during 2000-2005 for the country was -10.9 per 1,000 population (International Migration, 2006). UN DESA estimated the Tajik migrant stock to be 306,000 people in 2005, representing 4.7 per cent of the population.

9.9 Turkmenistan

The total population of Turkmenistan is 4.96 million with an annual population growth rate of 1.3 per cent (World Bank, 2007), which is expected to stabilize by 2050. The country's urban population accounts for 48.2 per cent of the total (UN Urban and Rural Areas, 2007).

Economy

As per World Bank (2007), Turkmenistan is a lower middle income country with an estimated GNI per capita in the range of US$936 – US$3,705 (Atlas method), a GDP of $26.92 billion and an annual GDP growth rate of 11.5 per cent (CIA World Fact book, 2007). The population and GDP variation for Turkmenistan are shown in Figure 69.

The agricultural sector output (per cent GDP not available) consists of cotton, which is cultivated in half of the country's irrigated land. It is a major contributor to the country's economic growth.

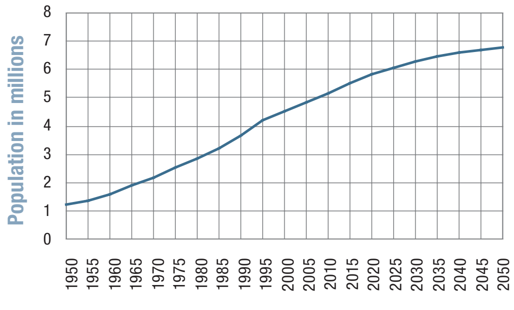
The industrial/manufacturing sector output (per cent GDP not available) is dominated by the oil and gas, food processing and cotton processing industries.

The services sector (per cent GDP not available) is concentrated in insurance, servicing heavy industry, hotels and banking.

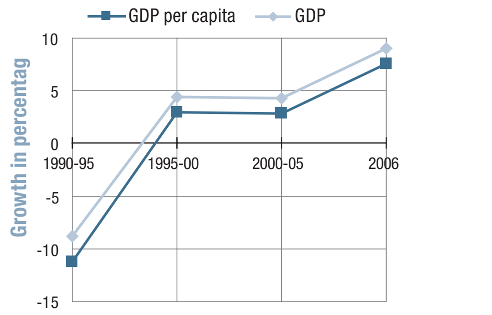
Turkmenistan's recoverable natural gas reserves rank among the top 10 in the world. The country also has significant oil reserves and is endowed with an extensive irrigation system. Soon after its independence in 1991, Turkmenistan underwent an economic decline, which was caused by the break-up of traditional economic ties, poor harvests and problems related to energy exports. The country's economy was severely affected in 1997 when non-payments by the Commonwealth of Independent States (CIS) countries forced a suspension of almost all natural gas exports. However, the economy recovered with the resumption of natural gas exports to Ukraine and Russia during 1998-2000. Turkmenistan benefited greatly from the recent high world oil prices.

Figure 69: Population and GDP growth trend in Turkmenistan (1950 -2050)

Population trend in Turkmenistan



Average annual growth rates of economic indicators



Migration

The geographic location of Turkmenistan makes the country very attractive as a transit or final destination. Apart from the outflow of small numbers of Russians immediately following Turkmenistan's independence, neither out-migration nor in-migration is a significant factor for Turkmenistan's population.

During the period 2000-2008, the net migration rate in Turkmenistan remained negative. Though the trend of net migration was declining until 2006, a sharp increase in the net migration rate followed, particularly once Turkey relaxed its visa requirements. Currently, Turkey and Russia are the favoured destinations for migrants from Turkmenistan.

The rate of net average annual migration during 2000-2005 was -0.4 per 1,000 population (International Migration, 2006). UN DESA estimated that the total migrant stock of Turkmenistan in 2005 was 224,000 people, representing 4.6 per cent of the population.

9.10 Uzbekistan

The total population of Uzbekistan is 26.87 million with a growth rate of 1.4 per cent (World Bank, 2007), which it is estimated will remain steady until 2025. The country's urban population accounts for 36.7 per cent of the total (UN Urban and Rural Areas, 2007).

Economy

As per World Bank (2007), Uzbekistan is a low income country with a GNI per capita of $730 (Atlas method), a GDP of $22.31 billion and an annual GDP growth rate of 9.5 per cent (CIA World Fact book, 2007). The population and GDP variation for Uzbekistan are shown in Figure 70.

The agricultural sector output (24.4 per cent of GDP) is dominated by cotton production (the country is the fourth-largest producer worldwide). The other major agricultural products are vegetables, fruits, grain and livestock. Agriculture continues to be the major contributor to economic growth.

The industrial/manufacturing sector output (26.9 per cent of GDP) includes oil and natural gas, metals, machinery and equipment, textiles and chemical products.

The services sector (48.7 per cent of GDP) is concentrated in information technology and communications.

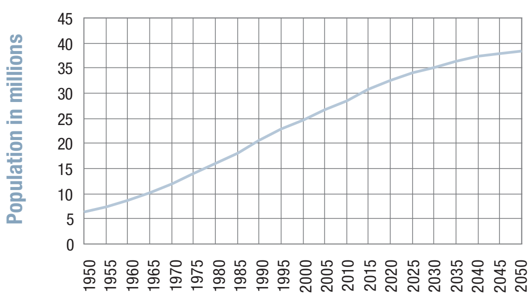
Uzbekistan's economy has been growing steadily since 2003 (Figure 70). However, this growth has failed to create sufficient employment in the country and there has not been a consistent improvement in living standards, especially in rural areas. Most rural households still lack basic facilities. Social and economic development has brought about a steady process of urbanization.

Migration

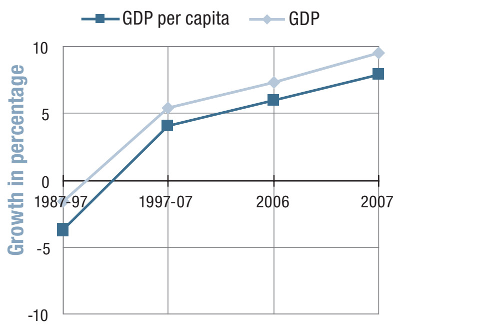
Under Soviet rule, Uzbekistan's population was

Figure 70: Population and GDP growth trend in Uzbekistan (1950 -2050)

Population trend in Uzbekistan



Average annual growth rates of economic indicators



characterized by relatively low geographical mobility. The situation changed dramatically in the post-Soviet era, mainly due to freedom of movement – and new opportunities associated with this freedom – and a decline in domestic living standards (Ilkhamov, 2006). Though most Uzbek migration is guided by unemployment and other economic reasons, the outflow of political migrants and refugees is also growing.

The majority of migrants are well-educated young people who have potential for capacity development (IOM, 2005).

The Kazakh people constitute a large share of Uzbek emigrants. In particular, ethnic Kazakhs from Karakalpakstan are moving to Kazakhstan permanently and applying for citizenship. According to official statistics, more than 50,000 Kazakhs emigrated from Uzbekistan in the post-Soviet period (Ilkhamov, 2006). Kazakhstan and Russia are the favoured destinations for Uzbek emigrants. On the other hand, Tajikistan and Armenia are important sources of immigration for the country.

The rate of net average annual migration during 2000-2005 was -2.3 per 1,000 population (International Migration, 2006). UN DESA estimated that the total migrant stock of Uzbekistan in 2005 was 1.27 million, representing 4.8 per cent of the population.

Chapter 10

Climate change assessment

Climate change is a long-term issue that is likely to cause extreme temperatures, floods, droughts, intense tropical cyclones and higher sea levels. Based on recent studies, climate change is expected to lead to:

- A rise in temperatures. Studies show that global average temperatures are likely to rise by between 0.5ºC and 1.7ºC by the 2050s.
- Variations in precipitation. The largest changes are anticipated in equatorial regions and South-east Asia.
- Extreme weather events such as tropical cyclones. They are likely to become increasingly frequent and more intense, involving heavy rainfall, high winds and storm surges.
- A rise in sea levels. This is expected to have severe implications for coastal areas and low-lying islands in particular.

Such climatic changes can influence people's vulnerabilities, adversely affecting livelihoods and in turn contributing to increased poverty. Vulnerability to these hazards is also increasing due to continuing poverty, poorly-planned urbanization, environmental degradation and population growth.

Climatic variability has both a short-term and a long-term impact. In the short term it can increase the vulnerability of society by causing sudden losses in income and assets, sometimes on a periodic basis. In the long term, it can cause such losses on a more gradual basis.

Many summits calling attention to these issues have taken place at international, regional and national levels, including the Bali Conference, in 2007, and the Oslo Policy forum meeting, in 2008. The mainstreaming of climate risk management and disaster risk reduction into development policy and planning is now a key priority for the international community. Adaptation strategies need to ensure that environmentally-sensitive methods are used to address the potential impact of climate change, both in the short and long terms.

10.1 Climate models

This analysis details a set of key indicators to describe the potential impact of climate change on CAC countries.

A number of climatic models have been developed in the last few years to estimate the degree of climate change that can be expected under present conditions. These models can be broadly classified into three categories:

- Global Circulation Models (GCM): These models consider the whole earth circulation at a resolution level of 350-kilometre grid cells. Twenty-one models have been recognized as robust and their results were summarized in the Fourth Assessment report (AR4) of the Intergovernmental Panel on Climate Change (IPCC, 2007).
- Regional Circulation Models (RCMs): These models consider a region at a higher level of resolution and use results of the GCMs to model the boundary conditions of the region of interest. PRECIS, also called HadRM3, is such a model with a horizontal resolution of 50 kilometres. It is driven by the atmospheric winds, temperature and humidity output of the atmosphere-ocean model HadCM3.
- High-resolution models: These models operate at an even higher resolution. The Meteorological Research Institute model (MRI) generates data at 20 kilometres horizontal resolution.

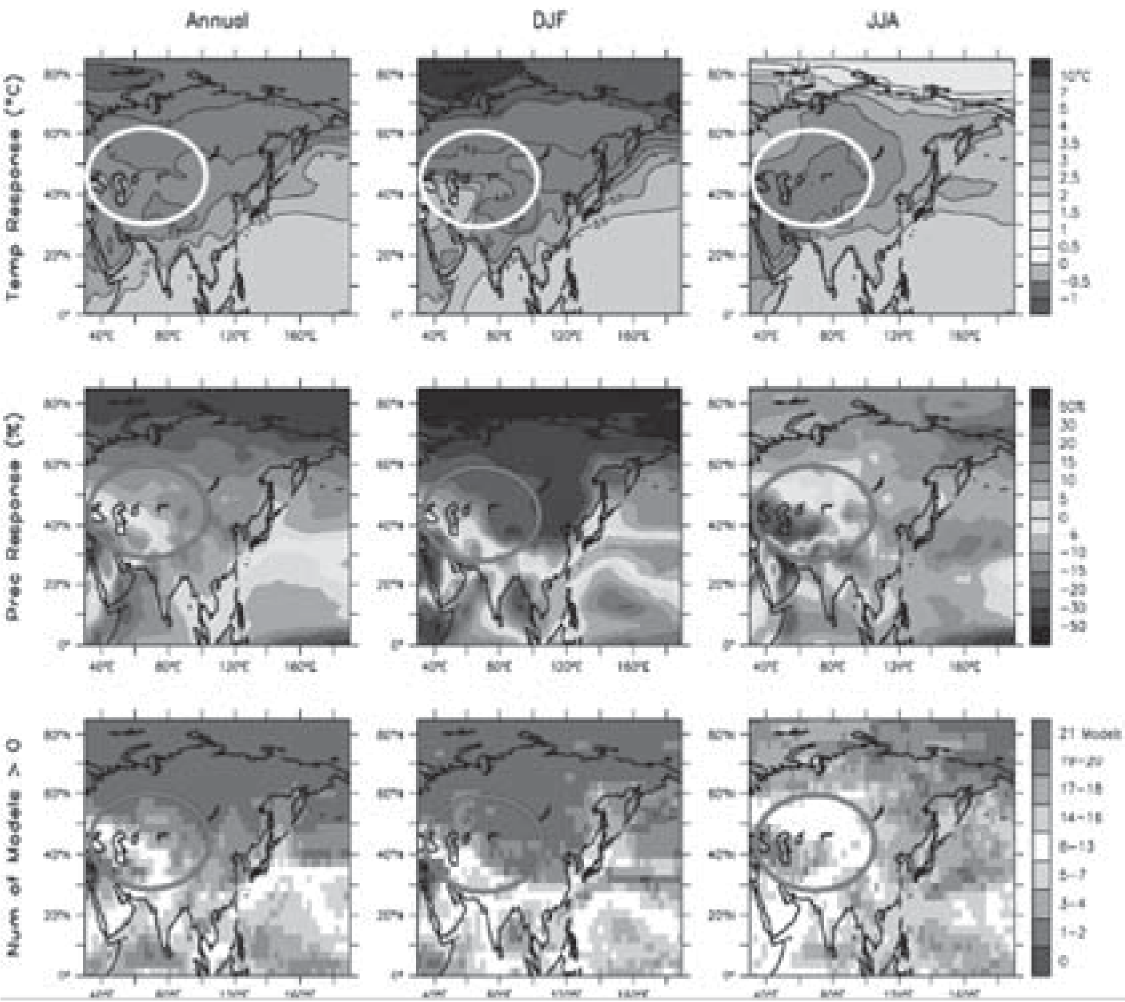
All these models use a baseline simulation (for the period 1961-1990) generated by the model as a reference point and generate future estimates (for the period 2081-2100). The future estimates are based on two carbon emission levels: A1B and A2 scenarios (IPCC, 2001). The baseline simulation can be used at the regional level to determine how well the models are able to estimate historic climatic conditions.

10.2 Climate change trends

Climate science suggests that the influence of climate change be measured with respect to the baseline and expressed in the form of changes in temperature and rainfall. These changes are likely to lead to extreme weather and climate hazards in the form of accentuated drought and flood events in the region. In the following sections the significance of climate change and its expected impact on various sectors in CAC countries are discussed.

Global circulation models IPCC AR4 climate trends Figure 71 highlights the climate projections for temperature and precipitation changes based on the results of the 21 global models summarized in AR4 (IPCC, 2007) for CAC countries. The ensemble suggest that the average temperature increase in Central Asia is expected to be 3.7°C by the end of the twenty-first century. The maximum increase is expected in the winter months of December, January and February (DJF). Precipitation estimates in most models show an increase during DJF but a decrease in other periods. By 2100, it is expected that there will be a 3 per cent annual decrease in precipitation. This is due to a 4 per cent increase in precipitation during DJF months and a 13 per cent decrease in the summer months of June, July and August (JJA).

Figure 71: Temperature and precipitation changes in Central Asia (circled) from the IPCC AR4 multi-model ensemble simulations for emissions scenario A1B



(Source: Chapter 11 of IPCC AR4 pg. 883)
Note: Top row: Annual mean, DJF, and JJA temperature changes between 1990s and 2090s. Middle row: as above, but fractional changes in precipitation. Bottom row: number of models, out of 21, that project a decrease in precipitation.

The third row of Figure 71 indicates the number of models that are consistent with the rainfall estimates presented in the second row of Figure 71. It shows that more than 13 models (out of 21 models) project consistent estimated annual and DJF precipitation results for Central Asian countries. However, variability in precipitation projections increases for the Caucasian countries.

Overall, the number of models estimating similar precipitation projections for JJA months decreases for CAC countries.

MRI climate trends

The following section examines some of the key climate change projections of the Meteorological Research Institute (MRI) model.

On average, the model projects temperatures to increase by as much as 2.5°C to 3°C by the end of twenty-first century, which is consistent with other GCM projections for the region. The warming is spread across the region, though it is less pronounced towards the northern part, as shown in Figure 72 (b).

The change in precipitation under present and future climatic scenarios is presented as the amount of precipitation per day Figure 73 (a) and (b). It shows an increase of 18 per cent in areas of high precipitation and no change in areas of low precipitation. This leads to spatial differences in the projected precipitation for the region as compared to other GCMs. This is primarily due to the difference in scale between the two types of models. The MRI model benefits from the higher resolution representation of the spatial patterns of present-day scenarios. However, since it is only a single model and because most of the available results from analyses are based on the global circulation models, the remainder of this section will report the GCM estimates.

10.3 Climate change impacts on CAC

The United Nations Framework Convention on Climate Change (UNFCC) in 2007 listed the regional impacts of climate change and the corresponding vulnerabilities in CAC countries. It projected a decrease in summer precipitation and an increase in average annual temperatures in Central Asia as the principal climate change impacts. Yohe et al. (2008) asserted that a strong statistical anthropogenic signal of climate change has been detected in Asia. The vulnerability of sectors in various sub-continental countries of Asia were tabulated, and the food and fibre sector (agriculture), land, water resources and human health areas were projected as highly vulnerable in the CAC countries.

The following sections summarize the projected climate changes and the consequent impacts on the CAC countries based on GCM estimates assuming an increase of the CO2 concentration in the atmosphere by a factor of two.

Armenia

A national inventory of Greenhouse Gases (GHG, which comprises CO_2, CH_4, N_2O, Ozone and CFC), was conducted for 1990. The UNFCC (1998a) reported that the total GHG emissions in 1990 were 24.7 million tons, with the energy sector generating 87 per cent.

Based on the analysis of meteorological records from 56 stations and covering 1935-1990, the UNFCC (1998a) reported that mean annual temperature variations were within +/- 0.5°C and average annual precipitations also showed no significant variance.

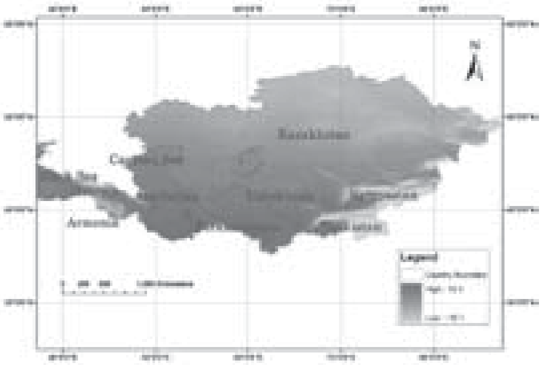
Estimates from GCM analyses indicate that by 2100 annual precipitation is likely to decrease by 10 per cent, or 59 mm, and temperatures increase by 2ºC (UNFCC, 1998a).

Armenia signed the UNFCC and ratified it in 1993.

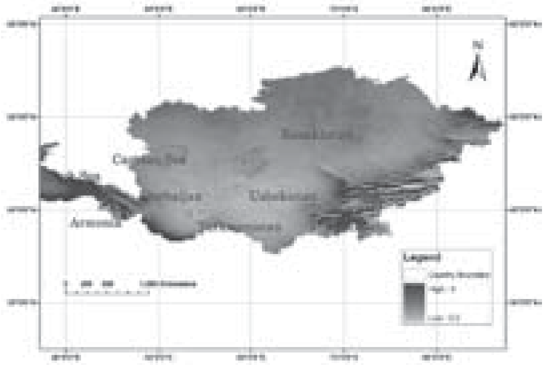
Azerbaijan

A national inventory of GHG was conducted for the four-year period 1991–1994. The UNFCC (1998b) reported that the total GHG emissions (1990) were 60.8 million tons (CO_2), with the energy sector generating 74 per cent.

Figure 72:
a: Current scenario of annual mean surface temperature (ºC); b: Future scenario of annual mean surface temperature (ºC)

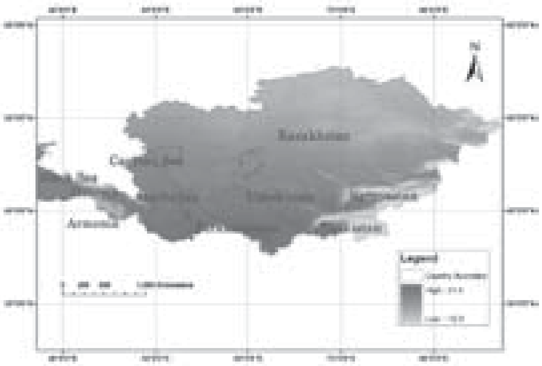


72a

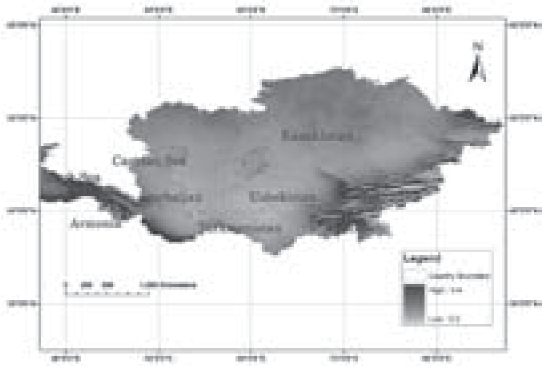


73a

Figure 73:
a: Present scenario of annual mean precipitation (mm/day); b: Future scenario of annual mean precipitation (mm/day)



72b



73b

Based on the analysis of meteorological records from 16 stations and covering 100 years, the UNFCC(1998b) reported a 0.5°C–0.6°C increase in the mean annual temperature over most of the country.

Estimates from GCM analyses indicate that by 2100 the mean annual temperature is expected to increase by 4.3°C–5.1°C, while mean annual precipitation is not expected to change significantly. However, according to all models there will be significant variance between seasons, with an expected increase in winter precipitation and a decrease in summer precipitation of between 23–62 per cent (UNFCC,1998b). Azerbaijan signed the UNFCC in 1992 and ratified it in June 1995.

Georgia

A national inventory of GHG emissions was conducted for the 18-year period 1980–1997. The UNFCC reported that the total GHG emissions in 1980 were 45.2 million tons (equivalent CO_2), falling to 14 million tons by 1997. However, total CO_2 emissions are projected to be in the order of 35.5 million tons by 2010 (UNFCC, 1999a). The burning of fossil fuels by the energy sector contributed 92 per cent of the total CO_2 emissions in 1987.

Based on the analysis of meteorological records from 90 stations and covering 1906–1995, the UNFCC (1999a) reported a marginal decrease in the mean annual temperature of 0.1°C–0.5°C, with a precipitation increase of 5–10 per cent in the Kolkhida Lowland and significant decreases of between 10–15 per cent in the mountainous region of Ajara and the eastern sector of the Great Caucasus.

Estimates from GCM analyses indicate that a decrease in annual precipitation and an increase in annual temperature of 1°C–2°C are expected (UNFCC, 1999a).

Georgia signed the UNFCC in 1992 and ratified it in July 1994.

Kazakhstan
A national inventory of GHG was conducted for the period 1991–1995. Perelet (2007) listed the GHG emissions and reported that the country's energy sector consumes significant amounts of coal, generating 80 to 90 per cent of the emissions.

Based on the analysis of meteorological records covering more than 100 years, the UNFCC (1998c) reported a 1.3°C increase in the mean annual temperature and a decrease of 17 mm in mean annual precipitation.

Estimates from GCM analyses indicate that by 2075 the average annual temperature is expected to increase by between 4.5°C and 6.9°C, accompanied by a decrease in annual precipitation of 12 per cent (Perelet, 2007; UNFCC, 1998c).

Kazakhstan signed the UNFCC in June 1992 and ratified it in 1995.

Kyrgyzstan
An 11-year inventory study of GHG emissions was conducted for the period 1990–2000. The UNFCC (2003) reported that the total GHG emissions in the base year, 1990, amounted to 36.6 million tons (of equivalent CO_2). In 2000, the energy sector was responsible for 74 per cent of the emissions. The country is expected to increase its GHG emissions by a factor of five by 2100 (UNFCC, 2003).

Based on the analysis of meteorological records from nine stations covering 70 to 120 years, the UNFCC (2003) reported a 1.6°C rise in the mean annual temperature and an increase in annual precipitation in three regions, with a significant decrease in the fourth.

Estimates from GCM analyses indicate that by 2100 the average annual temperature is expected to increase by 3°C–4.4°C, with an increase in annual precipitation of 1.17 mm to 54 mm (UNFCC, 2003).

Kyrgyzstan signed the UNFCC in January 2000.

Tajikistan
A nine-year inventory study of GHG emissions was conducted for the period 1990–1998. The UNFCC (2002) reported that the total GHG emissions amounted to 31 million tons (of equivalent CO_2) in 1991, falling to 6.3 million tons by 1998 owing to economic decline. The industrial sector was responsible for most emissions (12–32 per cent), followed by the energy sector (8–27 per cent).

Based on the analysis of meteorological records from 10 stations covering 1961–1990, the UNFCC (2002) reported an 0.7°C–1.2°C (1.2°C–1.9°C in urban areas) increase in the annual mean temperature. In terms of annual precipitation there was significant variance, with upper elevations recording a 14–18 per cent increase compared to a 1–20 per cent decrease in the valleys.

Estimates from GCM analyses indicate that by 2050 the average annual temperature is expected to increase by 1.8°C to 2.9°C. Owing to the complexity of the landscape conditions in Tajikistan, precipitation model projections were given only a 'medium to low confidence' rating, with some models predicting an increase and others a decrease (UNFCC, 2002).

Tajikistan signed the UNFCC in 2002.

Turkmenistan
A national inventory of GHG was conducted and the UNFCC (2000) reported that the total GHG emissions in 1994 were 52.3 million tons, with the energy sector contributing 60 per cent.

Based on the analysis of meteorological records from 30 stations covering 1930-1995, the UNFCC (2000) reported a 0.2°C average increase in the mean temperature, with a 1.2 mm increase in annual precipitation.

Estimates from GCM analyses indicate that by 2100 the average annual temperature is expected to increase by 4.2°C–6.1°C. In general, there is considerable variation expected in annual precipitation.

Turkmenistan signed the UNFCC in May 1995 and ratified it in June 1995.

Uzbekistan

A national inventory of GHG was conducted for the period 1990-1994. The UNFCC (1999b) reported that the GHG emissions in Uzbekistan amounted to 163,000 tons (CO_2 equivalent) in 1990, which had decreased to 154,000 tons by 1994.

Based on the analysis of meteorological records from 40 stations covering 90-100 years, the UNFCC (1999b) reported gradual increases in the mean annual temperature and mean annual rainfall.

Estimates from GCM analyses indicate that by 2100 the average annual temperature is expected to increase by 3.1°C–9.0°C. There was also a large degree of variation in the precipitation projections of various models.

Uzbekistan signed the UN Framework on Climate Change in 1995.

Table 14 presents a summary of the estimated temperature and precipitation changes predicted by the global circulation models.

Table 14: Temperature and precipitation change estimates

	Armenia	Azerbaijan	Georgia	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
ΔT (°C)	Unreported	+ (4.3 – 5.1)	+ (1.0 – 2.0)	+ (4.5 – 6.9)	+ (2.2 - 4.4)	+ (1.8 – 2.9)	+ (4.2 – 6.1)	+ (3.0 – 9.0)
ΔP (%)	- 10	Unchanged	Decrease	-12 to increase	+ (1.2 - 1.5)	High variability	High variability	High variability

Table 15: Summary of climate change vulnerability and impacts on CAC countries

Country	Vulnerability to Climate Change
Armenia	Water Resources Like in other parts of this region, a reduction in snow cover is expected. The water reserves in the snow have decreased by 5%-10%. For future climate scenarios (double CO_2 concentration and mean temperature increase of 1.5°C) atmospheric precipitation is likely to reduce by 10%-15%, and the total annual river flow may decrease by 15%-20%. In case of temperature increases of 2° C, the average annual evaporation from Lake Sevan is likely to increase by 13%-14%.
	Agriculture Soil moisture is expected to decrease by 10%-30%. As a result, crop yields are likely to reduce by 8%-14%. The productivity of crops, cultivated in hot and arid zones, is expected to reduce by 10%-14%, and those cultivated in moderate zones may reduce by 7%-10%. The productivity of cereals is expected to decrease by 9%-13%, vegetable crops by 7%-14%, and potatoes by 8%-10% and horticultures by 5%-8%.
	Grazing Productivity of grazing lands is likely to fall by 4%-10%; low-yield pastures of the semi-desert belt could fall by 17%; high-yield pasture areas in the sub-Alpine belt could fall by 19%; those in the Alpine belt could fall by 22%; and the productivity of mountain grasslands could fall by 7%-10%.

Country	Vulnerability to Climate Change
Azerbaijan	Water Resources A rise in air temperature between 4.0°C-4.5°C could result in a reduction in stream flows by 10%-15%.
	Agriculture The negative effect of the air temperature rise is expected to double the recurrence of dry winds and the number of arid days might reach 50-60. These would be more prevalent in the warmest regions of the Kura-Araz lowlands during the cotton-growing season. Moisture deficiency is expected to increase 350-450mm during the vegetation period of cotton in the warmest and driest regions. In the traditional crop areas the vegetation period of winter wheat is expected to fall by 13-40 days. In the dry-farming zone, winter wheat yield is expected to fall by 3%-4%. The productivity of dry-farmed vines could fall by 10%.
	Pastures Productivity of winter pastures is expected to decrease by 2% and that of spring pastures by 1.2%.
Georgia	Water resources Runoff is expected to increase in the Bzipi, Enguri, and Rioni rivers by 7%-14% and it is likely to decrease by 2%-4% in the Acharis-Tscali river flows. This may be due to the upward movement of the permanent snow line to higher altitudes caused by increases in the mean annual temperature of 1˚C.
	Agriculture Wheat productivity is expected to decrease by 30%-60%. Maize could be highly vulnerable in eastern Georgia, since the temperature increase could cause corresponding changes in the periods between phases of maize development, resulting in decreased maize yields of between 20%-30%. Temperature increases could also cause a decrease in vine productivity of 6%-15%.
Kazakhstan	Water Resources According to the scenario of maximum warming, the surface water resources of the Ishim river basin are expected to reduce by 73%. The surface water resources of the other basins are likely to reduce by 9%-29%. According to the minimum warming scenario, an increase of 6% in the surface water resources is expected in most river basins.
	Agriculture Wheat yields are most vulnerable to climate change. The spring wheat yield could decrease by 27%-70%, depending on the region. The winter wheat yield may increase slightly, but the area of cultivation is likely to decrease.
	Grassland According to the scenario of maximum warming, grassland vegetation productivity may decrease by 30%-90%, although under another scenario a 10%-40% increase in grassland vegetation productivity can be expected in spring due to precipitation increases.
Kyrgyzstan	Water Resources The glacier-fed river basins of Kyrgyzstan are critical sources of potable and irrigation water for the Central Asian region. As the glaciers begin to recede significant reduction in water availability should be expected.
	Agriculture Climate change is likely to decrease the cropland for cereals while increasing crop yields by 33% (to 35 centners/ha from 26.4 centners/ha - 50 kg=1 centner approximately).
	Public Health A significant correlation between the urolithiasis rate and temperature has been determined. This could lead to increased incidence of infectious diseases malaria, tropical fevers, salmonellosis, escherichiosis, cholera and parasitic diseases.

Country	Vulnerability to Climate Change
Tajikistan	Water Resources An increase in the annual mean temperature of 1.8°C is likely to cause a 50% decrease in ice cover in the Gissar-Alai region and to a lesser degree in the Pamirs (15%-20%). Under such conditions the contribution of glaciers as a source of water to many rivers will be reduced by between 20%-40%; and the annual river flow by 7%. A 3°C-4°C temperature increase would cause a decrease in water resources of 30% or more. Even an optimistic increase in precipitation by 14%-18% will not be able to offset this impact. Projected decreases in stream flow by 2050 are between 7%-10%.
	Agriculture An increase in cotton productivity of 5% is expected to take place in the Vakhsh and Gissar regions. However, cotton productivity is likely to reduce by 5% in the Kulyab and Sogd regions.
	Public Health Temperature rise and lack of rainfall will lead to an increased incidence of cardiovascular pathology and decreased incidence of respiratory diseases. Temperature and humidity in some cases can create favourable conditions for the reproduction of pathogenic organisms and transmitters of infectious and vector-borne diseases.
Turkmenistan	Water Resources A reduction in glacial areas may become more severe and affect surface water resources. The glacier areas of Pamir-Altai, feeding the Amu Daria river, are likely to decrease by 40%. The river flow of the following three rivers is likely to decrease: Tedzhen, by 36%; Atrek, by 51%; and Murgab, by 17%.
	Agriculture In order to sustain the present cotton yield, 71% more water will be required under climate change scenarios.
	Public Health Climate change, especially temperature fluctuations, may negatively influence human health and could cause several kinds of diseases. Heat stress is likely to be a major health issue for the population.
Uzbekistan	Water Resources The contribution of snow to snow-fed rivers is expected to decrease by 15%-30%.
	Agriculture Under high temperatures, cotton crop production is expected to decline between 9%-15%. The effect of increased temperatures on the non-irrigated dry foothill regions may cause a fall in cereal crop production. Similarly, due to higher temperatures, rice production is expected to decrease 10% - 20%.
	Natural Pastures The rise in temperature and an earlier start to the grazing season is expected to decrease the formation of autumn forage reserves by 20%-44%. The decline in desert pasture capacity and an increase in the number of hot days will negatively affect grazing conditions.

Chapter 11

Hazard risk management framework – status of CAC countries

International organizations such as the World Bank and UNISDR are now promoting a proactive and strategic approach to disaster risk reduction across the world. An important part of the approach is providing assistance to prepare for and recover from disasters caused by natural as well as technological hazards that can result in great human and economic losses. It has been observed that developing countries suffer more when a disaster hits. As per the World Bank, more than 95 per cent of all deaths caused by disasters occur in developing countries, and losses due to disasters caused by natural hazards are 20 times greater, as a percentage of GDP, in developing countries than in industrialized countries (World Bank, 2008).

The hazard risk management approach is based on the notion that disaster-prone countries should not be caught by surprise. Disasters happen, and technological, social, organizational and financial remedies exist. The fact is that poorly-planned development can turn a recurring natural phenomenon into a human and economic disaster. The risk of disaster increases with faulty planning, such as allowing densely-populated settlements on floodplains, permitting poor construction without following building codes in high earthquake hazard zones, or allowing the degradation of natural resources.

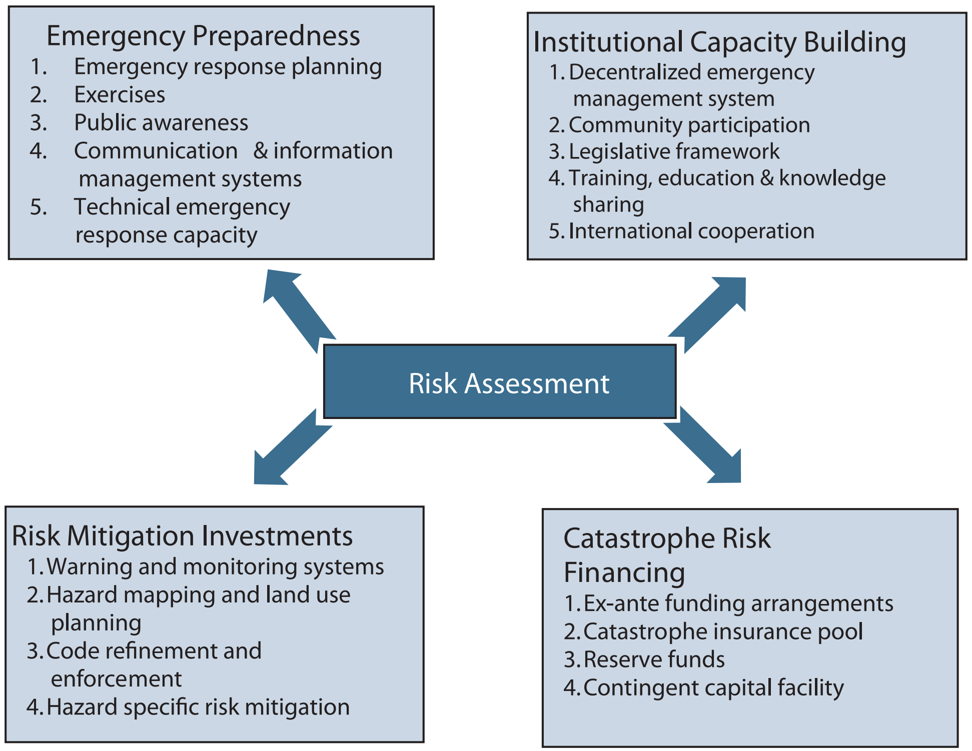
To reduce risks, targeted assistance needs to be provided before disasters strike such high-risk areas. To achieve this, hazard risk management in such areas needs to be mainstreamed into the national, regional, sub-regional and local economic development process through gradually upgraded institutional, technical and financial capacity building for risk mitigation and emergency preparedness.

The following exercise is an attempt to assess the present hazard risk management framework of CAC countries. The exercise has been prepared based on country-level information from various international entities. They include the World Bank, UNDP country programme document, United Nations Disaster Assessment and Coordination (UNDAC), UNISDR, ADRC country report, CAREC, IFRC and UNICEF. Variables in the framework were rated qualitatively into four categories: good, satisfactory, needs improvement or not available, and under construction. The framework includes all CAC countries (Figure 74) and is designed to provide a concise representation of the levels of preparedness of each country and to facilitate the planning of disaster risk reduction activities in the region.

Figure 74:
Hazard risk management framework – status of CAC countries

Country	1	2	3	4	5
Armenia	G	S	G	U	U
Azerbaijan	U	U	N	U	U
Georgia	U	N	N	N	N
Kazakhstan	S	S	U	U	U
Kyrgyzstan	U	N	U	U	U
Tajikistan	U	S	S	S	S
Turkmenistan	N	N	N	N	N
Uzbekistan	U	S	U	U	S

Country	1	2	3	4	5
Armenia	S	U	S	S	G
Azerbaijan	N	N	N	U	S
Georgia	N	N	U	U	S
Kazakhstan	U	S	S	S	S
Kyrgyzstan	U	U	U	U	G
Tajikistan	N	S	S	S	G
Turkmenistan	N	N	N	U	U
Uzbekistan	N	S	N	S	G



Country	1	2	3	4
Armenia	U	U	N	S
Azerbaijan	N	N	N	N
Georgia	N	U	N	N
Kazakhstan	N	N	S	N
Kyrgyzstan	U	N	N	N
Tajikistan	S	S	S	S
Turkmenistan	N	N	N	N
Uzbekistan	S	U	S	S

Country	1	2	3	4
Armenia	N	N	U	N
Azerbaijan	N	N	N	N
Georgia	S	U	S	N
Kazakhstan	N	N	N	N
Kyrgyzstan	N	N	N	N
Tajikistan	N	N	N	N
Turkmenistan	N	N	N	N
Uzbekistan	N	N	N	N

Key
G Good
S Satisfactory
N Need improvement/not available
U Under construction

Chapter 12

Regional and international initiatives

12.1 Regional initiatives

CAC is vulnerable to a variety of disasters caused by both natural as well as technological hazards. Such disasters, particularly those caused by natural hazards, occur frequently and are often large-scale events that cause considerable human casualties and very high economic losses. The quantitative risk assessment, including of trans-boundary disasters, carried out in this review confirms that disasters caused by natural hazards can have significant consequences on the economic performance of CAC countries.

More than 91 per cent of loss potential in CAC is from earthquakes alone. Floods, landslides and droughts are other significant natural hazards affecting the countries and there is a history of disasters transcending national boundaries. To drastically reduce disaster risk in the CAC region, sub-regions and countries it will be necessary to further promote the exchange of information and expertise by strengthening coordination and cooperation to enhance the capacity of governments and communities to cope with disasters. Despite certain trans-boundary issues related to political history and migration that exist in the region, there is nevertheless already a degree of coordination and cooperation among CAC countries on disaster management activities.

Disaster preparedness and prevention initiative
ADRC, in cooperation with UNESCO and UNISDR, organized a meeting on 3 December 2003 in Kobe to discuss disaster reduction for CAC. The objectives of the meeting were:

1. To introduce the basic concept of Total Disaster Risk Management (TDRM) to be promoted in CAC.
2. To discuss how better to apply TDRM in CAC countries and how ADRC, UNISDR and UNESCO could encourage the process.
3. To establish a collaborative network of participants from CAC countries and of those interested in the region for information.

TDRM is a comprehensive approach that embraces all the phases of the disaster management cycle. The enormity of the disaster problem today and in the foreseeable future calls for a more proactive approach that ensures effective disaster reduction at all levels towards sustainable development (ADRC, 2003). ADRC and the UN OCHA Asian Disaster Reduction Unit (Kobe) jointly developed TDRM through a series of consultative forums and workshops in the Asia region, in collaboration with major partners in Asia such as UNDP regional disaster reduction advisors and ADPC.

TDRM integrates and complements existing knowledge and techniques on disaster reduction and risk management. It promotes effective integration of stakeholders' actions and facilitates broad-based participation in policy and programme development in disaster reduction and response as they relate with other development concerns, such as poverty reduction, land-use planning, environmental protection and social security, among others. Through strengthened cooperation, collaboration and networking among governments, non-governmental organizations, international and regional organizations, and other critical sectors – including the private sector, academia and media – TDRM is expected to become an important strategy for effective disaster reduction and response in the region. TDRM shares the similar concept and approach developed and promoted in other regions such as CHARM, by the Scripps Orbit and Permanent Array Center (SOPAC) in the Pacific, and CDM, by the Caribbean Disaster Emergency Response Agency (CDERA) in the Caribbean (ADRC, 2003).

ADRC, UNISDR and UNESCO, in collaboration with partners such as the International Institute of Earthquake Engineering and Seismology (IIEES) and Asian Seismological Commission (ASC), are currently developing a programme for CAC countries in disaster reduction with the aim of contributing to sustainable development by applying the TDRM approach to the local context. Governments, academic institutions, NGOs and the private sector from the CAC countries have been invited to join.

The participants recognized that lack of awareness and preparedness is a common problem in CAC. Considering the local context, adoption of TDRM is considered key to raising the disaster awareness of societies and communities in both sub-regions. TDRM also advocates the development of a coordination mechanism and enabling instruments at different levels, both of which are presently lacking across the region. Further discussions between the concerned bodies are important to find the best way for each country to introduce and adapt TDRM in the pursuit of the sustainable development of the region.

The following actions were suggested for the adaptation of TDRM in the regional context:

- Building capacity, training and public support for disaster management and mitigation.
- Assistance in development of national disaster management plans.
- Development of a national disaster information system.
- Improving legislative and institutional arrangements and enhancing political will.
- Integration of disaster risk reduction into the national development process.
- Scientific and technical inputs for disaster management.

Ministries of emergency situations

All CAC countries, with the exception of Georgia and Turkmenistan, have their own ministries to deal with emergency situations, usually called the Ministry of Emergency Situations (MoES). In Georgia, the emergency situation and civil safety services are controlled by the Ministry of Internal Affairs (MIA), while in Turkmenistan by the Ministry of Defense.

Usually the ministries have disaster management departments on national as well as province level and, in some cases, district level. Disaster management is well institutionalized, as it was during the Soviet period. However, a common problem is the general lack of equipment and finance available to these bodies. Furthermore, despite the large amount of, mostly analogue, information that is available to these agencies, resources and working practices are outdated (SDC, 2008). Due to a severe lack of local capacity in disaster management, humanitarian assistance is often needed in case of emergencies. A whole system of national and international institutions supports the respective ministries.

Another issue involves forecasting departments, which although they are included within the ministries and have a good technical understanding of disaster prevention and preparedness, lack a practical approach.

One of the major drawbacks of this region is the lack of comprehensive national contingency plans. Hence, relocation of people is often the only preventive measure applied by the MoES.

Central Asia Regional Economic Cooperation (CAREC)

The Central Asia Regional Economic Cooperation programme was initiated in 1997 with the mission of development through cooperation. CAREC is a unique and robust development partnership of eight countries, namely Afghanistan, Azerbaijan, China, Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan and Uzbekistan. The CAREC programme is in partnership with multilateral and other international agencies such as the ADB, European Bank for Reconstruction and Development, IMF, Islamic Development Bank, UNDP and the World Bank. The objective of the CAREC programme is to promote economic growth and raise living standards by encouraging economic cooperation between partner countries. The basic focus is on financing infrastructure projects and improving cross-border activities in the areas of transport, energy, trade policy and trade facilitation (CAREC, ADB, 2008).

River basins initiatives

There have been several regional initiatives using a basin approach in CAC, particularly in the Central Asian countries. Important initiatives include natural resource and ecosystem management and conservation, and integrated disaster management in basin areas.

Some of the main regional initiatives focusing on a basin approach are:

- Aral Sea basin initiatives
- Amu Daria river basin initiatives

- Syr Daria river basin initiatives
- Lake Sarez risk mitigation initiatives
- Kura–Aras river basin initiatives

Aral Sea basin initiatives
As discussed in section 8.9, the drying out of the Aral Sea, once the fourth largest lake in the world, is the biggest threat to the climate and biodiversity of the surrounding region. Since 1977, the Aral Sea volume has decreased by almost 90 per cent, its surface by over 20 per cent, and the sea level by 28 metres (International Conference on 'Problems of Aral', Tashkent, 2008). Since the early 1990s, there have been various initiatives; a few of the important ones are described below.

The World Bank Aral Sea Basin Program:
This was the first major initiative in the management of the trans-boundary water resources in the Aral Sea basin. The Bank formulated an Aral Sea Basin Program (ASBP) to be carried out over 15 to 20 years at a cost of $250 million, which was later increased to $470 million. The main goals of the programme were:

- Rehabilitation and development of the Aral Sea disaster zone.
- Strategic planning and comprehensive management of water resources of the Amu Daria and Syr Daria.
- Building institutions for planning and implementing the above programmes (Roll, 2005).

Interstate Commission for Water Coordination:
In 1992, the Heads of States of the Central Asian countries approved the proposal to establish the Interstate Commission for Water Coordination (ICWC). The ICWC has three executive agencies. These include the Basin Water Organization (BWO) of Amu Daria and Syr Daria, and the Scientific Information Center (SIC). Jointly, they held responsibility to determine and implement the strategy of trans-boundary water resources management in the Aral Sea Basin (Moigne, 2003).

Comprehensive Aral Sea Basin Program: In 1994, the Heads of States of the Central Asian countries approved the comprehensive ASBP, which was a collaboration between the World Bank, UNEP, UNDP and the five Central Asian countries. The projects to be implemented at the regional level under this programme were:

- Stabilization of the Aral Sea at a sustainable level.
- Socio-economic development of the affected areas.
- Strategy and management of the water resources of the Amu Daria and the Syr Daria.
- Installation and strengthening of institutions for planning and implementing these measures.

International Fund for the Aral Sea:
On 28 February 1997, the Heads of States of the Central Asian countries approved the final organizational structure of the International Fund for the Aral Sea (IFAS). The principal task of this organization is to attract resources from the five Central Asian countries as well as the international community and donor countries to provide financial support for the Aral Sea Basin Programme (ASBP) and inform the international community about the catastrophic situation in the Aral Sea area (Aslov, 2003).

Trans-boundary Water and Energy Project:
The Trans-boundary Water and Energy Project, set up in 2002, is an initiative that supports activities to develop and agree on measures to improve water and energy cooperation in Central Asia (Moigne, 2003). The other initiatives on water and environment in the region include: i) The Water and Environment Management Project (WEMP) – to promote coherent national and regional water and salt management policies; ii) Natural Resources Management Project – to increase water management capabilities of the region; iii) Regional Environment Action Plan for Central Asia – to address the ecological and socio-economic development of the basin (Boisson de Chazournes, 2003); and Millennium Development Goals (MDGs) – to tackle poverty and hunger, education and health, gender quality and the environment.

The international donor organizations for the Aral Sea region include the World Bank, UNDP and UNEP, the US Agency for International

Development (USAID), several national development agencies (for example, Switzerland and Canada) as well as the Technical Assistance to the Commonwealth of Independent States (EU-TACIS) programme. The ADB has also increased its involvement in the region (NeWater Report, 2005).

In addition to the budget funds allocated by the countries of the region, different kinds of grants were awarded by international organizations for $47.7 million and $278 million, and other funds in the form of different types of loans. In most cases the grants were used to finance activities for scientific and research purposes (Aslov, 2003), such as the Water and Environment Resource Management Project in the Aral Sea, under ASBP, which was implemented with the financial support of the Global Environment Facility (GEF) and the Dutch and Swedish governments with a total budget of $21.5 million.

The Amu Daria river basin initiatives

The Amu Daria river basin initiative in Central Asia has gained importance because of the growing threat of water scarcity, and the problems of salinization and large-scale water pollution in irrigated agriculture. The trans-boundary water conflict between upstream countries, such as Tajikistan and Kyrgyzstan, and downstream countries, such as Turkmenistan and Uzbekistan, is a major problem in Central Asia. To manage such issues, the BWO for the Amu Daria was installed in 1986 during the Soviet era and is still operational in the area. Currently, the executive committee of the IFAS, the executive bodies and the Scientific Information Centre of the ICWC, and the BWO of the Syr Daria and Amu Daria have emerged as the main organizations in managing trans-boundary regimes (NeWater Report, 2005). The ICWC held prime responsibility for short- and long-term water development and allocation planning, water quality control, and conservation and environmental protection in the basin area. Apart from that, the European Environment Agency developed the Driving Forces-Pressures-State-Impacts-Responses (DPSIR) framework for this river basin, which analyses the information requirements to manage trans-boundary water issues. The Scientific Information Centre, responsible for data processing and information distribution in the Amu Daria river basin area, works on the development of river basin models and future scenarios such as the 'Globesight' methodology, which uses tools for devising water strategies and sets priorities along international river basins.

The Syr Daria river basin initiatives

The Syr Daria river basin covers an area of 444,000 square kilometres and upstream passes through Kyrgyzstan and Tajikistan, and downstream through Uzbekistan and Kazakhstan. Like the Amu Daria river basin, the BWO for the Syr Daria basin was also installed in 1986 during the Soviet era (IWMI, 2003). This is the main organization for managing trans-boundary regimes in the Central Asian region. Within ICWC legislation, the State ministers of Central Asian countries signed interstate agreements on water sharing, water conservation and use, and water financing and management soon after independence. The BVO in the Syr Daria basin is operational under the ICWC and is responsible for water allocation, distribution, and management among the Central Asian republics. Syr Daria, being an integral part of the Aral Sea basin initiative, has gained importance with international organizations like the World Bank, UNDP and UNEP (Murray-Rust et.al. 2003).

Lake Sarez risk mitigation initiatives

In 1911, Lake Sarez was formed in Tajikistan by a massive earthquake-triggered landslide that obstructed the Murgab River. Although the safety of the lake had been studied over many years, there existed significant gaps and inconsistencies in the available data. Furthermore, the risk to the downstream population could be unacceptably high (World Bank, 2008a). In June 1998, an international assessment mission to the area was conducted with the support of the World Bank and the International Strategy for Disaster Reduction (ISDR, formerly IDNDR). In 2000, the Lake Sarez Risk Mitigation Project (LSRMP) was launched by the World Bank with funding from USAID, the Aga Khan Foundation, the Government of Switzerland and the Republic of Tajikistan. The components of LSRMP are: i) to design and install a monitoring system and an early-warning system; ii) social training and safety-related supplies, which is the social component; iii) studies to assess possible long-term solutions to the Sarez outburst flood hazard; and iv) institutional strengthening. This project was successfully implemented in December 2006 and has fully achieved its objectives (UNISDR, Dushanbe, 2007).

Kura–Aras river basin initiatives

The Kura-Aras river system, with its tributaries, is the principal source of water for the southern Caucasus countries: Armenia, Georgia and Azerbaijan. The basic objective behind the Kura–Aras river basin initiatives is to maintain the water quality and quantity in the basin to meet the requirements of communities and the ecosystem, as well as to reduce contaminant load into the Caspian Sea (Jincharadze, 2005). The TACIS-funded Joint Rivers Management Programme (JRMP) 2002-2004 aimed mainly at application of the United Nations Economic Commission for Europe guidelines and to monitor the water quality. Besides the JRMP, many international organizations are engaged in different initiatives. These include the German Federal Ministry for the Environment, with projects focusing on pollution prevention and early warning; UNDP/GEF, with a similar intervention for reducing hot spots of pollution; USAID, with local implementation of river basin management and water quantity and quality monitoring; and the World Bank.

The total project budget as of 2005 was $1.56 million. Of this, UNDP/GEF contributed $698,328, UNDP/Rural Employment Generation Programme $100,000, UNDP/Trans-boundary River Basin Initiative $25,000, Swedish International Development Cooperation Agency (SIDA) $594,427 and national governments $145,000 (Jincharadze, 2005). Recent initiatives in the basin include Trans-boundary Integrated Water Resource Management in the south Caucasus, by USAID (2005), and Development of the Trans-boundary Cooperation for Hazard Prevention in the Kura-river Basin, which is a pilot project by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2006).

Table 16: International involvement in CAC

Organizations	Countries							
	Armenia	Azerbaijan	Georgia	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
The World Bank	✓	✓	✓	✓	✓	✓	✓	✓
IFRC	✓	✓	✓	✓	✓	✓	✓	✓
UNDP	✓	✓	✓	✓	✓	✓	✓	✓
UNISDR	✓	✓	✓	✓	✓	✓	✓	✓
UNICEF	✓	✓	✓	✓	✓	✓	✓	✓
USAID	✓	✓	✓	✓	✓	✓	✓	✓
OCHA	✓			✓		✓		
UNHCR	✓	✓	✓	✓	✓	✓	✓	✓
ADB	✓	✓	✓	✓	✓	✓	✓	✓
ADRC	✓			✓	✓	✓		✓
WHO	✓	✓	✓	✓	✓	✓	✓	✓
IMF	✓	✓	✓	✓	✓	✓	✓	✓
IOM	✓	✓	✓	✓	✓	✓	✓	✓
UN-HABITAT				✓				
Eurepean Union	✓	✓	✓	✓	✓	✓	✓	✓
ECO		✓		✓	✓	✓	✓	✓
Other		IDA, ReliefWeb		IRIN, IATP, IREX	UNESCO ACTED	Caritas, CARE, IICA, GTZ, ECHO		World Vision, Handicap International

12.2 International initiatives

Table 16 shows the major international agencies and their presence in various CAC countries (see Annex A for more detailed information on their specific involvement in the CAC countries and the projects they are involved in, or focus areas they concentrate on).

Table 17 provides a snapshot of the number of projects under various categories sponsored or initiated by some of the international agencies mentioned in Table 16, above. It should be noted that the project/focus area counts include only those quoted in subsequent tables in this review and are classified approximately on the basis of their titles. The large count in category K is due partly to the fact that it is broader than other categories.

Table 17: Types of projects/ focus areas in CAC

Project Categories	Countries							
	Armenia	Azerbaijan	Georgia	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
A	1	0	0	3	9	4	3	7
B	0	0	0	1	1	1	1	2
C	3	2	2	3	2	2	1	1
D	5	4	4	5	3	3	2	3
E	2	2	2	2	3	2	2	2
F	3	3	3	3	4	6	4	5
G	2	1	1	2	1	2	2	1
G	7	4	3	5	7	8	4	7
I	7	8	8	9	10	14	8	8
J	5	4	3	3	3	3	0	0
K	16	13	14	17	14	16	13	15

Legend to Table

A. Agriculture, Water Resources, Irrigation, Forestry, Agro-cooperatives
B. Climate, Weather Forecasting/Modelling
C. Economic Development, Reconstruction Programmes, (Private Sector Development)
D. Economic /Financial Policy/Reforms, Planning, Monitoring (Market Reforms)
E. Education
F. Emergency, Humanitarian, Economic Aid/Rehabilitation
G. Energy, Environment, Ecology, Environmental/Energy Governance/Policy
H. Health Care (Child and Mother care, HIV/AIDS or other Epidemic Related)
I. Mitigation Projects/Plans/Reforms
J. Poverty Reduction, Employment, Rural Development
K. Social and Political Policy, Reform, Legislation, Social Planning/Development (Government and Political Institutions, Institutions, Public Sector, Social Services, Regional Cooperation, Human Rights, Law Reforms, Migration related)

Chapter 13

Priority areas for detailed risk assessments

Risk mitigation and management activities should be focused on areas where hazard frequency, exposure and vulnerability are high in order to optimize resources to decrease economic losses and casualties. Probabilistic risk analyses provide the necessary tools to make the types of decisions necessary for such activities. As part of such analyses, the expected economic loss is quantified in terms of probability of exceedance and AAL, quantities commonly used in the financial and political arena to guide decisions. The usefulness of mitigation plans can be tested in these analyses in terms of economic loss reduction and provide the input for cost-benefit analyses. Advanced probabilistic analyses go beyond economic loss assessment and address the social impacts of the hazards, which can be measured in terms of number of deaths, injured and total affected, and even emergency response requirements. Decision makers in possession of economic and social impact estimates have the proper tools to identify optimum solutions.

Short of having this type of information, this analysis attempts to identify priority areas for investigation based on the data gathered.

13.1 Selection of indicators to define priority areas

The World Bank Natural Disaster Hotspot Study used a multi-hazard index to identify disaster hotspots (Dilley et al., 2005). The study considered hazard frequency, economic loss and mortality to identify hotspots for disasters caused by natural hazards. The analysis was performed at the grid level for the whole world, resulting in each grid being assigned a risk index. The approach followed in this review is less quantitative as the event and loss data were gathered at the country level and not discretized within individual countries.

In detailed risk analyses, vulnerability is usually disaggregated into loss to buildings and infrastructure, business interruption loss and social impact quantified in terms of number of deaths and total number of people affected.

In this analysis, a rapid-assessment approach was followed where a simple proxy was used to quantify vulnerability. The selected proxy was the population at risk. This assumption is robust, firstly because most of the buildings and the infrastructure are concentrated in populated areas, and secondly because the population itself is quite vulnerable to hazards.

It could be argued that an increase in population is not directly correlated to an increase in vulnerability because the resilience of the population can be increased through awareness and better planning. However, in general it has been observed that rapid development in most developing countries increases population growth, intensifies economic activities and increases vulnerability to natural hazards. This holds true for CAC countries.

The major natural hazards considered are earthquakes, floods, droughts and landslides. For hazards to be considered critical, they must cause relatively frequent disasters which impact large areas and are potentially extremely destructive. However, of the four major hazards in CAC, only three cause rapid-onset disasters: earthquakes, floods and landslides. The fourth, droughts, cause slow-onset disasters; even though their consequences may be severe and impact millions of people, there is time to respond to such disasters and limit their impacts. Although it is generally possible to predict floods, except perhaps for certain types of flash floods, warnings in CAC are often either not properly disseminated, not responded to, or else the affected population lacks the means or capability to evacuate affected areas. Consequently, floods are considered here as rapid-onset hazards, even though they are less sudden than earthquakes.

It is the three rapid-onset disasters that are considered for further investigation. Historical losses indicate that these hazards are the most devastating in CAC. Their locations are as follows:

- The most seismically active regions are in the mountain chains of Pamir, Altai, Kopetdag, Gissar-Karakul, East–Fergana, Chatkul, north

Tien-Shan, Djungaria, Pamir-Hindukush and lesser Caucasus.

- The areas highly vulnerable to rainfall floods are the flood plains of the four major rivers the Amu Daria, the Syr Daria, the Mtkvari and the Rioni.
- The areas highly vulnerable to landslides are the mountainous regions of lesser Caucasus, Pamir, Kopetdag, Hindukush, Tien-Shan, Djungaria and Altai.

13.2 Population at risk

The increasing urbanisation of CAC is adding to the risks associated with disaster events. Urban areas have higher population densities, more concentrated infrastructure and are key contributors to economic growth. The consequences of a catastrophic event occurring in an urban area are generally far greater than they are in rural areas. Figure 75 shows that, except for a brief period towards the end of the twentieth and beginning of the twenty-first centuries, there has been a general increase in the urban population throughout the region, and the percentage is projected to increase further.

The high concentration of populations in urban areas increases vulnerabilities because a single event affects a large number of people. This is the case for all hazards, but is particularly true for earthquakes.

Figure 75: Population trend of urban population in CAC countries

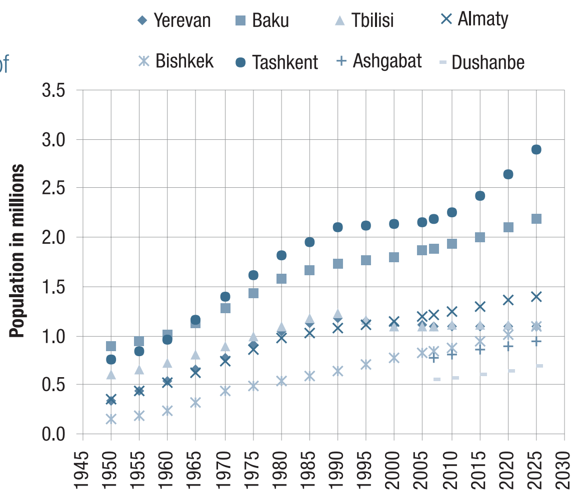
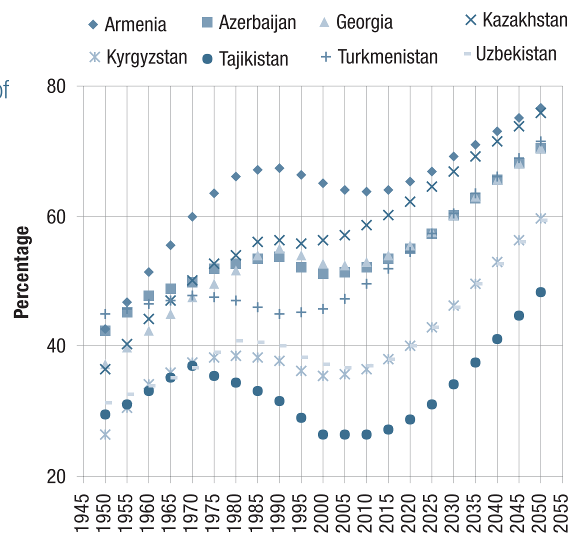


Figure 76: Population trend of major cities



Major cities

Major cities are not only conglomerations of intense economic activities but are also areas of very high population densities (Figure 76). This simple study addresses the situation in the nine major cities of CAC, namely Almaty, Ashgabat, Astana, Baku, Bishkek, Dushanbe, Tashkent, Tbilisi and Yerevan. All these cities are vulnerable to one or more natural hazards. A high-level risk assessment attempt is made here on the basis of the population and hazard maps presented in sections 7.3 and 7.5. The rate of occurrence of hazards is not considered in this ranking.

The level of hazard is classified as very high, high, medium and low with corresponding severity of 4, 3, 2 and 1. The population impacted in the cities is assumed to be 100 per cent for earthquakes, 20 per cent for floods and 1 per cent for landslides. The combined hazards risk ranking is calculated as the sum of the hazard severity multiplied by the impacted population (in millions) (Table 18).

The following are brief profiles of the nine cities, including the principal hazards faced by each.

Almaty: The financial capital of Kazakhstan – population 1.2 million in 2007 – lies in a region characterized by very high seismic hazard, low flood hazard and high landslide hazard. Its close vicinity to the mountains makes it vulnerable to landslides and earthquake-induced landslides.

Baku: The capital of Azerbaijan – population 1.9 million in 2007 – lies in a region characterized by high seismic hazard. Since the city lies on the shores of the Caspian Sea, it is prone to moderate flood hazard. Moreover, the city is also subject to low landslide hazard.

Bishkek: The capital of Kyrgyzstan – population 0.83 million in 2007 – lies in a region characterized by very high seismic hazard, low flood hazard and moderate landslide hazard.

Tashkent: The capital of Uzbekistan – population 2.2 million in 2007 – lies in a region characterized by high seismic hazard, low flood hazard and low landslide hazard.

Tbilisi: The capital of Georgia – population 1.1 million in 2007 – lies in a region characterized by high seismic hazard, and moderate flood and landslide hazard.

Yerevan: The capital of Armenia – population 1.1 million in 2007 – lies in a region characterized by high seismic hazard, low flood hazard and low landslide hazard.

Dushanbe: The capital of Tajikistan – population 0.55 million in 2007 – lies in a region characterized by very high seismic hazard as well as high flood hazard. Moreover, its close vicinity to the mountains makes the city vulnerable to high landslide hazard.

Ashgabat: The capital of Turkmenistan – 0.77 million in 2007 – lies in a region characterized by high seismic hazard, low flood hazard and moderate landslide hazard.

Astana: The capital of Kazakhstan – population 0.58 million in 2007 – lies in a region characterized by low seismic hazard, and low flood and landslide hazard.

Table 18 shows that in terms of earthquake hazards, Almaty, Bishkek and Dushanbe are the most vulnerable. Dushanbe is the most vulnerable to floods, and Almaty and Dushanbe to landslides. Earthquakes represent a substantially greater risk than the other hazards. The table shows that Tashkent, Baku and Almaty form the highest risk group, followed by Tbilisi, Bishkek and Yerevan, which have about half the level of risk of the top group. Dushanbe and Ashgabat have about a third of the risk of the top group, while Astana faces a significantly lower level of risk compared to the other cities.

Hazard and vulnerability trends

This section assesses the trends in future risks from such factors as climate change, population growth, internal and external migration patterns, and economic development. The following matrix (Table 19) identifies how levels of hazard and vulnerability would increase from changes in these phenomena assuming that no mitigation or adaptation measures are put in place to modify their impact.

Population growth and migration patterns

Considerable variations are expected in the patterns of population growth within CAC over the next several decades. Projections indicate that by 2050, the total population of the Caucasus is expected to fall by 6 per cent to 15 million, compared to the figure for 2007. However, the population of Central Asia is expected to grow by 33 per cent over the same period to a total of 80 million.

The urban population as a percentage of the total is expected to remain roughly constant for most countries until 2015. The only exceptions are Turkmenistan and Kazakhstan, where the figures are expected to increase. However, between 2015 and 2020 the figures for CAC are expected to start increasing, up to a rate of around 6 per cent a year, which will remain between 2020 and 2050. Taking the overall growth patterns into account, the total urban population is expected to increase by 10 million by 2025 and by 27 million by 2050. This will represent a more than doubling of urban populations for half of the CAC countries. The exceptions are Azerbaijan and Kazakhstan, where urban populations are expected to increase by just 50 per cent, and Armenia and Georgia, where they will remain constant or even decrease a little (Table 21).

Such a rapid increase in the numbers of people living in urban areas will significantly increase the levels of vulnerability associated with high population concentrations.

13.3 Climate change

There is a strong degree of agreement between the predictive models that a temperature increase of several degrees Celsius is to be expected. Such an increase will lead to a general reduction of water availability and a retreat of glaciers. However, there is significant uncertainty between models regarding the expected variations in precipitation. Even assuming no change in precipitation levels, climate change is expected to lead to an increase in droughts, extreme temperatures and potential for epidemics.

13.4 Economic and physical development

The GDP growth rate in 2007 was greater than 7 per cent in all countries and on average was 15.1 per cent in the Caucasus and 8.4 per cent in Central Asia (Table 22). Such a strong growth rate will increase the incidence of industrial and transport accidents, create a large demand for water and energy, and put significant pressure on the environment. The latter two consequences are not covered by this review.

Table 18: Risk ranking for nine largest cities in CAC

City	Country	Hazard Level Earthquake	Hazard Level Flood	Hazard Level Landslide	Population (million)	Earthquake Risk	Flood Risk	Landslide Risk	Overall Risk	Rank
Tashkent	Uzbekistan	3	1	1	2.18	6.55	0.44	0.02	7.0	1
Baku	Azerbaijan	3	2	1	1.89	5.68	0.76	0.02	6.5	2
Almaty	Kazakhstan	4	1	3	1.21	4.84	0.24	0.04	5.1	3
Tbilisi	Georgia	3	2	2	1.10	3.30	0.44	0.02	3.8	4
Bishkek	Kyrgyzstan	4	1	2	0.84	3.35	0.17	0.02	3.5	5
Yerevan	Armenia	3	1	2	1.10	3.31	0.22	0.02	3.5	6
Dushanbe	Tajikistan	4	3	3	0.55	2.21	0.33	0.02	2.6	7
Ashgabat	Turkmenistan	3	1	2	0.77	2.32	0.15	0.02	2.5	8
Astana	Kazakhstan	1	1	1	0.59	0.59	0.12	0.01	0.7	9

Table 19: Matrix shows increase in hazard and vulnerability due to change in phenomena

Hazard	Change in phenomena	Vulnerability
Earthquake	Unchanged	Population growth
Flood	More rain	Population growth
Drought	Less rain/ high temperature	Population growth
Landslide	More rain	Population growth
Avalanche	More snow	Population growth
Extreme temperature	High/low temperature	Population growth
Epidemics	High temperature/ humidity	Population growth
Transport accident	High population/ urban population; economic growth	Population growth
Industrial accident	Economic growth	Population growth
Miscellaneous accidents	Population growth	Population growth

Table 20: Population (in millions) variation and percentage change between 2007, 2025 and 2050

	Armenia	Azerbaijan	Georgia	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	Caucasus	Central Asia
Population 2007	3.00	8.57	4.40	15.48	5.24	6.74	4.96	26.87	15.97	59.29
Population 2025	2.91	9.51	3.95	16.99	6.21	8.93	6.07	33.96	16.36	72.16
Population 2050	2.46	9.40	3.13	17.31	6.57	10.76	6.78	38.39	15.00	79.80
Change 2007-2025	-3.07%	10.95%	10.34%	9.74%	18.47%	32.48%	22.34%	26.40%	2.45%	21.70%
Change 2007-2050	-18.07%	9.73%	28.77%	11.83%	25.31%	59.64%	36.69%	42.86%	-6.10%	34.60%

Table 21: Urban population (in millions) variation and percentage change between 2007, 2025 and 2050

	Armenia	Azerbaijan	Georgia	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	Caucasus	Central Asia
Population 2007	1.92	4.39	2.32	8.90	1.92	1.79	2.39	10.07	8.63	25.08
Population 2025	1.95	5.45	2.27	10.96	2.66	2.78	3.48	14.57	9.67	34.45
Population 2050	1.89	6.64	2.21	13.14	3.92	5.20	4.85	22.76	10.74	49.87
Change 2007-2025	1.23%	24.07%	-2.02%	23.12%	38.52%	55.47%	45.50%	44.63%	11.97%	37.38%
Change 2007-2050	-1.90%	51.19%	-4.59%	47.66%	103.89%	190.97%	102.79%	125.95%	24.38%	98.89%

Table 22: GDP growth rate in Caucasus and Central Asia in 2007

GDP growth rate in 2007									
Armenia	Azerbaijan	Georgia	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	Caucasus	Central Asia
13.7%	19.2%	12.4%	8.5%	7.4%	7.8%	9.0%	9.5%	15.1%	8.4%

Chapter 14

Conclusions and summary recommendations

14.1 Conclusions

Disasters

The report finds that the geographically-diverse CAC region is prone to a number of disasters caused by both natural and technological hazards. These include earthquakes, floods, landslides/mudslides, avalanches, extreme temperatures and epidemics; and transport, miscellaneous and industrial accidents. The country-wise disaster matrix for the period 1988-2007 is shown in Figure 44.

Earthquakes are identified as the dominant disaster risk in CAC, followed by floods, landslides and droughts. Industrial accidents, transport accidents, miscellaneous accidents and epidemics are other significant hazards. During the 20-year period 1988-2007, the reported 177 disasters caused 36,463 deaths. Out of the reported disasters, 19 per cent were earthquakes, 25 per cent were floods, 13 per cent were landslides and 3 per cent were droughts. Earthquakes caused the largest number of deaths: 32,834.

The risks are exacerbated by the fact that two-thirds of the region's population is concentrated in the mountainous southern quarter, which is very prone to all kinds of hazards. The diverse geography and extreme weather conditions – coupled with climate change – intensify the risks from disasters. On a regional basis, more than 30 per cent of the population lives below the poverty line, making it highly vulnerable to the adverse consequences of these disasters.

Social vulnerability

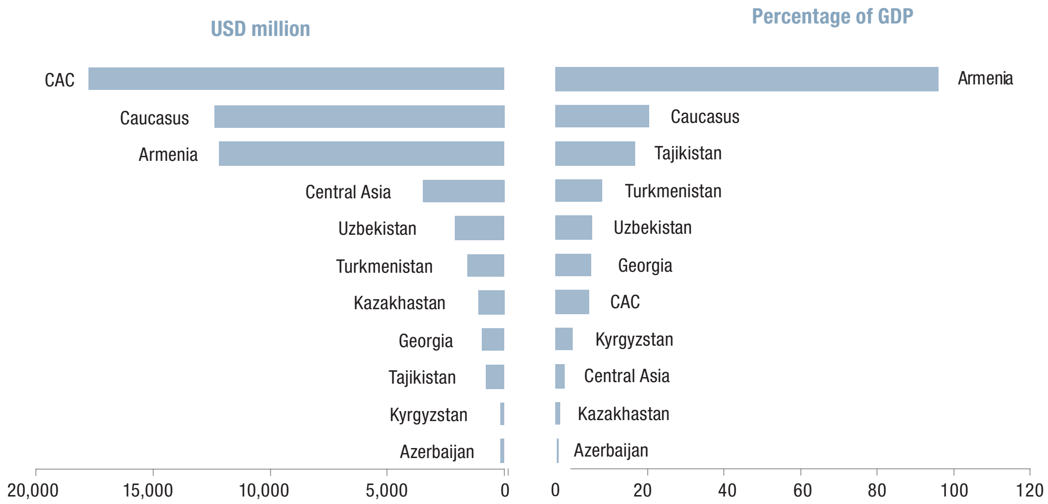
The relative SV ranking of each country shows that the average number of people killed per year per million is highest in Armenia, with more than 6.3 times the total of Tajikistan (the second highest). Georgia has the third highest ranking, followed by Azerbaijan, Kyrgyzstan, Kazakhstan, Uzbekistan and Turkmenistan. From a sub-regional perspective, the average number of people killed per year per million in the Caucasus is more than 9.8 times that of Central Asia. Thus, in terms of SV, southern Caucasus countries are more vulnerable than those of Central Asia.

However, as discussed in the CAC regional profile, the analysis is 'biased' due to the December 1988 Spitak earthquake in Armenia, in which 25,000 people died.

Economic vulnerability

The quantitative risk assessment performed in this report confirms that a catastrophic event with a 200-year return period (0.5 per cent annual probability of exceedance) would have a major impact on the already-fragile economies of CAC countries.

Figure 77: Economic Loss Potential for annual probability of exceedance of 0.5 per cent*



*Note: Armenia all hazards damage is 132.5% of GDP (2007)

To gauge the potential economic impact, the EV ranking of each country was estimated in terms of likely economic losses that an event with a 200-year return period would cause as a percentage of that country's GDP (Figure 77). According to this categorization, Armenia has the highest EV ranking in the region, followed in descending order by Tajikistan, Turkmenistan, Uzbekistan, Georgia, Kyrgyzstan, Kazakhstan and Azerbaijan.

However, as discussed in the CAC regional profile, the analysis is 'biased' due to the December 1988 Spitak earthquake in Armenia (Figure 78).

The size of economic losses and the number of disasters are not well correlated. For example, although the number of earthquake disasters in CAC is much lower than floods, the economic losses caused by those earthquakes are much higher.

The quantitative risk assessment confirms the following risk patterns:

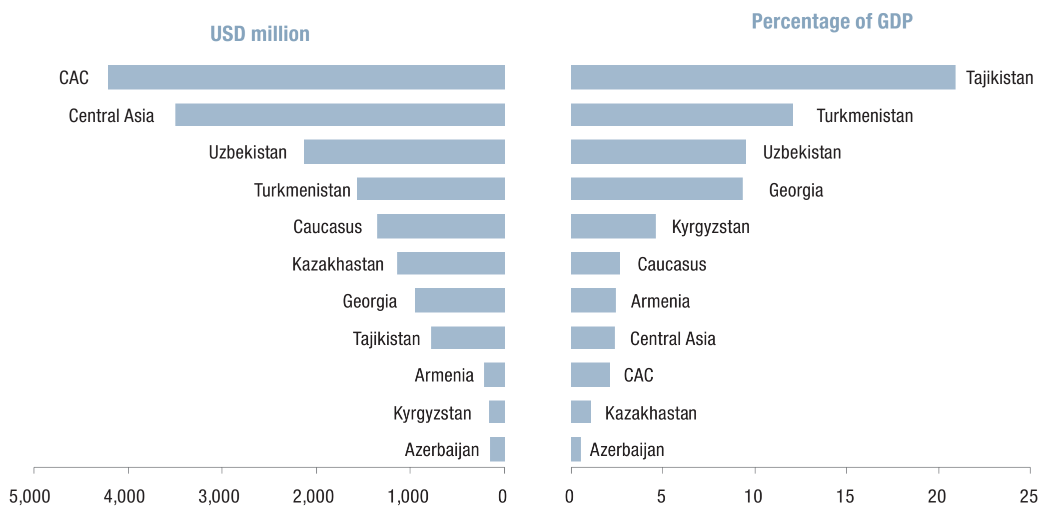
- Armenia: earthquakes represent the dominant risk followed by droughts and floods;
- Azerbaijan: droughts, floods and earthquakes are significant risks;
- Georgia: landslides and earthquakes are significant risks;
- Kazakhstan: earthquakes are the dominant risk followed by floods;
- Kyrgyzstan: earthquakes are the dominant risk followed by landslides and floods;
- Tajikistan: floods are the dominant risk followed by earthquakes and landslides;
- Turkmenistan: earthquakes are the dominant risk followed by floods;
- Uzbekistan: earthquakes are the dominant risk followed by droughts.

Urban vulnerability

Urban areas are especially vulnerable to the adverse impact of disasters. The most populated cities of CAC – Tashkent, Baku, Almaty, Tbilisi, Bishkek, Yerevan, Dushanbe, Ashgabat and Astana – are all are undergoing intense economic activity. With the exception of Tbilisi and Yerevan, all are experiencing high population growth. All these cities, with the exception of Astana, are highly vulnerable to earthquakes and all nine are potentially vulnerable to floods. In a simple risk assessment, taking into account the cities' hazard zonation and populations, earthquakes emerge as by far the major risk, while the risks posed by floods and landslides are far less significant.

Tashkent, Baku and Almaty form the group with the highest risk, followed by Tbilisi, Bishkek and Yerevan, which face about half of the risk of the former group. The single most important factor affecting vulnerability is the increase in population

Figure 78: Economic Loss Potential for annual probability of exceedance of 0.5 per cent after removal of December 1988 Spitak earthquake in Armenia



sizes, particularly the high-density populations concentrated in the cities.

Migration impact
The study identifies migration as a factor influencing population distribution across CAC. During the Soviet era, human migration between republics was promoted as well as controlled by the State. There was a sharp spike in migration prompted by the major socio-political upheavals that were brought about by the disintegration of the Soviet Union. Due to the ensuing recession, several support mechanisms that were part of the highly-structured social welfare support system failed.

The next wave of migration occurred between 1993 and 1995 when ethnic Russians returned to Russia due to growing nationalism. In more recent times, migration has taken socio-economic overtones. This involves both internal (rural-urban) and cross-border movement, although it is mainly within the region. The newly-emerging factors affecting migration are economic, demographic, environmental and religious.

Poverty impact
Tajikistan is the poorest country in CAC, with 60 per cent of its population living below the poverty line (earning less than $2 per day). It is followed by Kyrgyzstan, with 40 per cent of its population living below the poverty line. On a regional basis, more than 30 per cent of the population of CAC lives below the poverty line.

Climate change impact
The review finds that global circulation models addressing climate change do not present a uniform view of the potential impact of climate change on CAC, except for predicting a general increase in temperature. A high-resolution climate change model of the region appears to be more stable and predicts a temperature increase of 4°C to 6°C over the next 80 years and a potential for minor increases in maximum rainfall in the Caucasus region. The main impact will be a decrease in water availability and potential for droughts.

14.2 Recommendations

Based on this analysis, the review makes the following recommendations to reduce disaster risk in CAC:

Additional analyses
Three levels of analyses are envisioned to refine the result presented in this report. These analyses should be limited to earthquakes and floods as they are the most damaging quick-onset disasters.

Level 1: An analysis similar to this one based only on historical records should be repeated at a higher level of resolution. Instead of limiting the resolution of the analysis at the country level, a high resolution grid (for example a 100-kilometre grid) should be considered. Risk aggregation by hazard type and area would provide, at low cost, a much more refined picture of the risk than is offered by the present analysis.

Level 2: On a second level, using the same methodology, worst-case scenarios should be considered for the highly-populated cities. This simple analysis would provide a reasonable quantification of loss, given the occurrence of a particular disaster scenario. The uncertainty around the risk could then be bracketed by scientifically estimating the range of probability of occurrence of such scenarios.

Level 3: On a third level, fully probabilistic analyses containing all the elements of standard risk analysis should be performed for the hazards and regions identified as high risk in levels 1 and 2.

Drought hazard should be addressed in the context of climate change and long-term adaptation strategies should be considered.

Analysis of accident-related hazards should focus on large industrial accidents such as radioactive material release and chemical contamination.

Facilities such as nuclear power plants and chemical processing plants should be identified, their safety assessed both in terms of construction/equipment and procedures, and their risk quantified.

Coordinated approach to disaster response
The trans-boundary nature of the disaster-prone mountain chains of the Caucasian (lesser Caucasus) and Central Asian (Kopetdag, Pamir, Pamir-Hindukush, Tien-Shan, Djungaria and Altai) countries call for a planned and coordinated approach towards disaster response for efficient rescue and relief operations.

The capacity for enhanced coordination exists and is facilitated by the fact that all CAC countries, except Georgia and Turkmenistan, already have their own ministries to deal with emergency situations, usually called Ministries of Emergency Situations. However, in Georgia the emergency situation and civil safety services are controlled by the Ministry of Interior and Administration and in Turkmenistan by the disaster management department within the Ministry of Defense. Usually the Ministry has disaster management departments at national as well as province and, in some cases, district levels. The forecasting departments are included within individual ministries.

Community-based disaster response also needs to be strengthened because, whenever a disaster occurs, the local community is the first-responder.

Nodal organizations such as the International Federation of Red Cross and Red Crescent Societies could play a key role in facilitating coordination among these ministries and departments to reduce trans-boundary hazards. The coordination, capacity and efficiency of these types of networks could be enhanced and their focus expanded to address disaster risk reduction. The achievement of such goals could be facilitated through human and financial resource augmentation, skill improvement and infrastructure development, carried out with the participation of all the CAC countries to ensure future sustainable use of the networks.

Centralized database
Improving access to information could enhance the capacities of all the CAC countries to prepare for and deal with the impact of disasters. The centralization and coordination of data gathering both within and between countries, particularly information relating to earthquakes and hydro-meteorological events, could facilitate this. Indeed, the presence of trans-boundary zones of high seismic activity and rivers whose flow or dam management has a direct impact on neighbouring countries makes such coordination imperative.

With the exception of earthquakes, the onset of major hazards such as flooding can normally be predicted. Consequently, measures such as public education and early-warning mechanisms could significantly reduce the number of deaths and other losses caused by disasters. Again, trans-boundary cooperation and coordination could significantly enhance current capacities, especially through mechanisms such as flood early-warning systems.

Strengthening institutions
In conjunction with greater regional cooperation, the strengthening of relevant institutions is crucial for developing strategies towards hazards of a trans-boundary nature. Decentralizing those institutions and carrying out strengthening according to a commonly-accepted framework could be a way of maximizing the potential benefits of such enhancements.

To ensure participation of all stakeholders, hazard management strategies should be judiciously selected after considering the local and regional situational factors as well as the developmental needs of the region. By considering the characteristics of the terrain and size of the countries involved, different strategies can be merged with the development planning process to work towards disaster risk reduction.

Improvement in disaster risk assessment
Although all the CAC countries have disaster management plans in place, they could each benefit from greater refinement as they tend to lack the detail necessary to reflect ground realities. This could be efficiently achieved through

establishing plans based on the kind of level 2 and level 3 analysis recommended earlier in this chapter (section 14.1), reflecting realistic scenarios and associated responses. In addition, the disaster risk management plans could be integrated into local development plans, which in turn could be further assimilated within regional, sub-regional and national programmes.

Carrying out disaster risk management activities within a common framework would facilitate their integration at the national or trans-national level.

Poverty alleviation and awareness generation

Poverty significantly exacerbates the impact of hazards on both a human and an economic level. Poverty usually implies that resilience is low, that constructions are inadequate to resist disasters such as earthquakes, or that land-use planning is insufficient to mitigate the impact of catastrophes such as floods. The large scale of devastation typical when disaster strikes a poor area is testament to the effects of poverty.

Furthermore, poverty is associated with an absence of pre-emptive responses to hazards, either because the authorities do not have the appropriate information to warn the population of the imminence of the event or because of the unwillingness or inability of local people to evacuate their area and abandon their land and livelihoods.

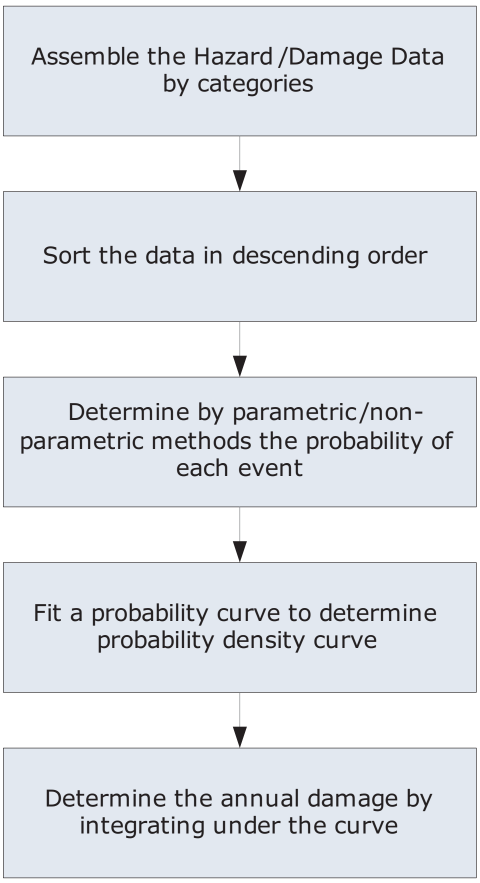
Poverty reduction is indeed a much broader issue and is clearly outside the scope of this study. However, continuous steps to increase awareness of major hazards can be managed with limited resources at a local level to obtain quick and effective results.

Annexes

Annex 1: Risk assessment methodology

An objective basis for decision making about risk management should include a quantitative assessment of the size and likelihood of the occurrence of different hazards present in the country, based on historical data. Such a basis helps in planning risk mitigation strategy and in convincing stakeholders of the need to invest in risk mitigation measures. The method of quantitative economic risk assessment used here is in accordance with the World Bank publication (Pusch, 2004) 'Preventable Losses: Saving Lives and Property through Hazard Risk Management, A Comprehensive Risk Management Framework for Europe and Central Asia, Working Paper series no. 9' and reveals the level of risk in each country and the probability of loss exceedance as a function of the level of economic loss.

Figure 79: Quantitative risk assessment methodology (based on Pusch, 2004)



Determining risk

The method of quantitative risk is presented in Figure 79. The objective of the risk assessment is to determine the probability that aggregate economic losses over a one-year period exceed a given amount. This probability is presented as a function of the level of loss and the curve generated is called the loss exceedance curve.

As explained in Pusch (2004), several methods can be used to generate the loss exceedance curve. The method that is used in this report is as follows:

The economic loss data is tabulated against its year of occurrence. In case of a reported event where no economic loss is given, a very small value of economic loss is considered. This is done in order to account for the missing loss data to some extent and maintain the occurrence of the events in the analysis. The economic loss values ($) that occurred in various disasters have been calibrated for the year 2007 ($) by using the factor for the corresponding year (http://www.measuringworth.com/ppowerus/). If each year is associated with a rank i (where i = 1 signifies the year of most severe losses, i = 2 the second most severe, and so on), then the year of lowest losses receives a rank i equal to the number of years over which there is a record, n. Weibull's equation, generally accepted to provide the best 'fit' for natural hazard events, was used to calculate the recurrence interval r (and its inverse: the probability of occurrence p) as a function of i:

$$r = (n+1)/i \text{ and}$$

$$p = i/(n+1).$$

Empirical distribution of economic losses is plotted against the recurrence interval. A typical distribution curve looks like the one presented in the Figure 80. Probability distributions are tested for their suitability for the estimation of economic losses for various return periods. Candidate distributions considered in this analysis are 2 Parameter Log Normal, 3 Parameter Log Normal, and Gumbel and Pearson Type III. By looking at the best-fit distribution and the other three distributions' fitted values, a weighted average has been calculated to arrive at the return period losses.

Return period losses for 0.5 per cent, 5 per cent and 20 per cent of annual exceedance probability were calculated. An AAL is determined as the sum of loss of each event (Li) multiplied by their rate of occurrence (pi) (Grossi et al., 2005).

$$AAL=\sum pi\ Li$$

A best-fit relationship for these data points is obtained using standard analytical methods.

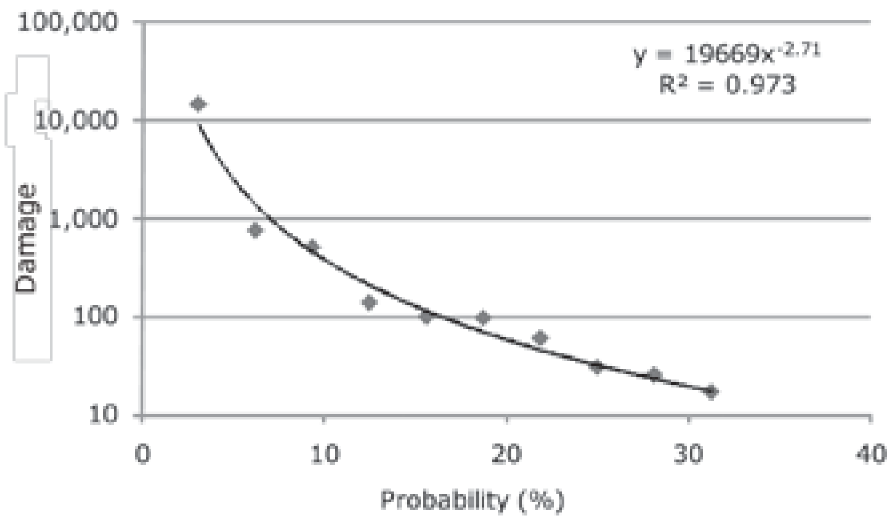
Limitations of the Methodology

The simplified quantitative risk assessments conducted for this study are based on historical economic loss data reported in different data sources such as CRED, World Bank, United Nations, Dartmouth, NGDC, ADRC, InTerragate, Munich Re and national-level data. They illustrate the magnitude of the problems and the broad strategic direction. Except earthquakes, the economic loss data used for the analysis for all hazards are limited to 20 years; a longer duration of more than 100 years has been considered for earthquakes due to their large return periods. A 20-year time span is used due to the accuracy and completeness of the data it provides. It should be noted that issues regarding the accuracy and completeness of data such as loss numbers are a particular challenge in CAC because most of these countries formed only in late 1980s and early 1990s. Prior to the late 1980s, the economic loss data documented are often not complete and are of inferior quality.

High-priority areas for detailed risk modelling and assessment were identified based on identified indicators. For such detailed risk assessment, exposure inventory data (building and infrastructure) need to be collected and analyzed. It also needs simulation modelling of historical events using present buildings and infrastructure data to access risk from an event of a given intensity at a specific location (scenario analysis).

The economic loss probability estimates presented in this report are not intended for designing catastrophe insurance schemes, which require a much more detailed approach that models hazard, exposure and vulnerability of buildings and infrastructure.

Figure 80: Sample distribution of the probability of damage levels: earthquake damage versus probability of occurrence (based on Pusch, 2004)



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List of Organizations and Institutions

Name of Institution	Contact Person/Title	Contact Details	Mailing Address
Armenia			
Armenian Rescue Service	Boris Pakov - Head of Shift Forces, Crisis Management Centre	(37410) 53 15 02, 53 84 74 (099) 27 36 52; emainter@arminco.com; pakov@mail.ru	25 Pushkin Str, Yerevan,0010
HFA Focal Point Institution National Survey for Seismic Protection (NSSP)	Dr Alvaro Antonyan - President	president@nssp-gov.am office@nssp-gov.am http//www.nssp-gov.am	Davidashen 4 Massiv - P.O. Box 375054, Yerevan, Armenia
	Dr Hayk Hakobyan - Head of International Department	alinakop2004@yahoo.com	
Alternative Institution Armenian Rescue Service	Mr. Sergey Azaryan - Colonel, Head of Population and Territories Protection Dept.	emainter@arminco.com http//www.ema.am/	Pushkin 25 Yerevan - Armenia
	Dr Arshavir Avagyan - Chief Scientifical and Technical Specialist	Phone +37410539749 Fax +37410543472	
UN Agency UNICEF		yerevan@unicef.org	14 Adamyan Street, Yerevan 375010, Armenia
Council of Europe European Interregional Centre for Training Rescuers (ECTR)	Mr. S. Badalyan - Counsellor to the Minister of Foreign Affairs of the Republic of Armenia, Director of the European Interregional Centre for Training of Rescuers	ectr@europe.com; badalayans@hotmail.com	10, Byron str., 375009 Yerevan, Republic of Armenia
Azerbaijan			
Ministry of Communications and Information Technologies	Rufat Gulmammadov - Head of Information Society Department	994-125981977 ici@mincom.gov.az	33, Zarifa Aliyeva Str, Baku
HFA Focal Point Institution Civil Protection Department (part of Ministry of Defense)	Mr. Javad Gasimov Shukuroglu - Colonel, Head of Civil Protection	Phone +994124937240 Fax +994124931502	T.Aliyarbeyov Street.4 1005 Baky - Azerbaijan
UN Agency UNICEF		baku@unicef.org	24, Suleyman Dadashov Street, Baku AZ1001, Republic of Azerbaijan
Council of Europe Ministry of Emergency Situations	Mr. Kamaladdin Heydarov - Minister of Emergency Situations	kamil_bagirov@yahoo.com	57, Tbilisi Avenue, Baku, Azerbaijan
	Mr. Rafail Mirzayev - First Deputy Minister	kamil_bagirov@yahoo.com	
European Centre on Training and Information of Local and Regional Authorities and Population in the Field of Natural and Technological Disasters (ECMHT)	Mr. Gulagha babaev - President	babayev@bakinter.net	370012, Azerbaijan, Baku, Moscow Avenue. 69 “A”

Name of Institution	Contact Person/Title	Contact Details	Mailing Address
Georgia			
HFA Focal Point Institution Ministry of Environmental Protection and Natural Resources	Mr. Giorgi Jaoshvili - Adviser to the Minister	gmep@access.sanet.ge	6, Gulua Str. 0114 Tbilisi - Georgia
Alternative Institution Center of Monitoring and Forecast (part of Ministry of Environmental Protection and Natural Resources)	Mr. Jemal Dolidze - Head of Center	geornet@web-sat.com	150, Agmashenebeli Avenue 0112 Tbilisi - Georgia
Institute of Geophysics	Prof. T. Chelidze - Professor in the Institute	chelidze@ig.acnet.ge	1, Alexidze str. 0193 Tbilisi – Georgia
	Dr Z. Javakhishvili - Dr in the Institute	z.javakh@ig.acnet.ge	1, Alexidze str. 0193 Tbilisi - Georgia
Hydrometeorological Department of the National Environmental Agency (NEA)	Dr. Ramaz Chitanava - Head Mr. Muraz Bakhsoliani - Head of the Division on Registration of Natural Hydromet Disasters and Mitigation of Anticipated Results	tel: +995 32 439550, e-mail: ramazchitanava@gmail.com	
Department of Geological Risks and Geological Environment of the NEA	Prof. Emil Tsereteli - Head		
Department of Bank Protection of the NEA	Mr. Tariel Beridze - Head		
Emergency Response Department of the Ministry of Internal Affairs	Temuri Melkadze - Head of the Analytical Division		
UN Agency UNICEF		tbilisi@unicef.org	UN House, 9, Eristavi Street, Floor IV, 380079 Tbilisi, Georgia
Kazakhstan			
Kazakh National Agrarian University	Seitkazy A.Keshuov - Vice-rector for science and international relations, Doctor of technical sciences, Professor	keshuov@kaznau.kz	8 Abai ave., 050010 Almaty Republic of Kazakhstan
	Kuanishbek N.Karabaev - Head of Department of International Relations	tel/fax (7272) 64 19 95 mob.tel (333) 234 78 77	8 Abai ave., 050010 Almaty Republic of Kazakhstan
KazGASA	Amirlan A.Kussainov - President	kazgasa@itte.kz	28 K.Ryskulbekov str., Almaty Republic of Kazakhstan
	Erik T.Bessimbaev - Professor, PhD (techn) Director of Scientific-practical centre on earthquake engineering	erik.bessimbaev@mail.ru kazgasa@itte.kz	85 Dostyk ave., Almaty, Kazakhstan

Name of Institution	Contact Person/Title	Contact Details	Mailing Address
Kazakh Research and Experimental Design Institute on Earthquake Engineering and Architecture (KazNIISSA)	Anvar S.Taubaev - Head of laboratory of system analysis of earthquake consequences	tel/fax (7272) 67 22 74	49 Baiseitova str., Almaty 480013 Republic of Kazakhstan
K. I. Satpaev Kazakh National Technical University	Ondasyn A. Isakov - Professor of construction and architecture	tel (7272) 92 09 16 mob.tel (701) 433 81 54	22 Satpaev str., Almaty Republic of Kazakhstan
	Dulat K.Kalitov - Director of K.Tyrysov Institute of Geological Prospecting	dulat@ntu.kz	Office 325, Main educations building 22 Satpaev str., Almaty 050013 Republic of Kazakhstan
	Erkasyn B.Utepov - Professor Head of chair 'Life and labor safety'	erkasin@ntu.kz	22 Satpaev str., Almaty Republic of Kazakhstan
	Malys Absametov - Vice-Rector for science and international cooperation	absametov@kazntu.sci.kz	22 Satpaev str., Almaty Republic of Kazakhstan
UNDP	Haoliang Xu - UNDP Resident Representative	haoliang.xu@undp.org	67 Tole Bi str.,Almaty 050000, Republic of Kazakhstan
	Victoria Baigazina - Programme Coordinator	victoria.baigazina@undp.org	Astana 38 Bukei Khan ave.,010000, Republic of Kazakhstan
UNCU	Dina Khassenova - UN Coordination officer for Kazakhstan	dina.khassenova@undp.org	67 Tole Bi str. Almaty
UNESCO	Inna Melnikova - Specialist, education programmes	i.melnikova@unesco.org; i.melnikova@unesco.kz	67 Tole Bi str. Almaty
UNOCHA	Gabriella Waajman - Regional disaster response advisor	waaijman@un.org	67 Tole Bi str. Almaty
	Ali Buzurukov - Humanitarian affairs officers	buzurukov@un.org	67 Tole Bi str. Almaty
Ministry of Emergency Situations, Republic of Kazakhstan	Vladimir Karpovich Bozhko - Minister	tel (3172) 94 50 80 fax (3172) 94 49 86	22 Beibitshilik str., Astana 010000, Republic of Kazakhstan
	Ablai K. Sabdalin - Vice-Minister	tel/fax (3172) 94 84 22	
	Natalia V.Kim - Press-secretary of the Minister	kim@emer.kz	
	Syrym G. Gabbasov - Director Department of prevention emergency situations and perspective development Ph D (techn)	shaltekeeva@emer.kz	
	Murat Ablanov - Head of International Cooperation department	ablanov@emer.kz	
IFRC	Drina Karahasanovich - Regional representative	drina.karahasanovich@ifrc.org	86 Kunaev str. Almaty 050010
	Valentina Sosnovaya - Specialist		
Eurasia Foundation	Jeff Erlich - President	jefferlich@efcentralasia.org	10 Kurmangalieva str. Almaty 050010

Name of Institution	Contact Person/Title	Contact Details	Mailing Address
Kazhydromet	Mr Talgat Maratovich Zeinullin - Director-General Ms O.Abramenko	phone:+ 7 7272 67 5271 fax:+ 7 7272 67 64 64 zeinullin@meteo.kz abramenko@meteo.kz	
NGO 'Man and Element'	Svetlana Tuleeva - Director	georisc@yandex.ru www.georisc.kg	470/1 Gornaya str., Almaty Republic of Kazakhstan
Turkmenistan			
UNDP	Richard Young - Resident Coordinator	richard.young@undp.org	40, 1995 (Galkynysh) str. Ashgabat
	Begench Yazliyev - UN Coordination analyst	begench.yazliyev@undp.org; byazliyev@yahoo.com	
IOM	Tahyr Seidov - Senior Programme Assistant	tseidov@iom.int; tseidov@iom.untuk.org	40, 1995 (Galkynysh) str. Ashgabat
UNICEF	Mohamed Waheed Hassan - Representative	whassan@unicef.org	40, 1995 (Galkynysh) str. Ashgabat
WHO	Bahtygul Karriyeva - Head of WHO office	who@untuk.org; bkarrieva@yahoo.com	40, 1995 (Galkynysh) str. Ashgabat
UNICEF	Ayadil Saparbekov - Project Officer, Health and Nutrition	asaparbekov@unicef.org	40 Galkynysh str., Ashgabat 744013, Turkmenistan
Red Crescent Society	Zuhra Kazakovna Yellieva - Chairperson	nrcst@online.tm; crescentinf@online.tm	116/1, 2022 str. Ashgabat
National Committee on Hydrometeorology, Administration of Hydrometeorology	Mr Kakamurat Yazyev - Chairman	phone:+ 993 12 353354 fax: + 993 12 511397 E-Mail:meteo@online.tm	
Ministry of Construction and Construction Industry, Research Institute of Seismology	Murad M.Charyev - Deputy Director of Science research Institute of Seismology	tel (993 12) 39 04 32; 39 06 92 fax(993 12) 36 06 13 mob.tel 30 22 64	20 A, T.Berdiev str., Ashgabat 744000 Turkmenistan
Cabinet of Ministers of Turkmenistan	Hemrakuly I. Italmazov - Senior specialist, Department of State Commission on emergency situations and population protection	tel (993 12) 39 04 32; 39 06 92 fax(993 12) 36 06 13 mob.tel 30 22 64	
Institute of Seismology	Dr. Batyr Nazarovich Gaipov - Director	gaipsr@online.tm; inseit@online.tm	20a T.Berdyev str. Ashgabat
	Guvanch Hummedov	nrcstur@yahoo.com	
NGO Tebigy Kuwwat	Serdar Mamedniyazov - Scientific Secretary	som47@mail.ru; tebigykuwwat@rambler.ru	15 Bitarap Turkmenistan str. Ashgabat National Institute of Desert
Kyrgyzstan			
Swiss Cooperation Office in the Kyrgyz Republic Swiss Consular Agency	Asel Omoeva - National Program Officer	asel.omoeva@sdc.net www.swisscoop.kg	144 Panfilov str., Bishkek 720040 Kyrgyz Republic
	Rahat Yusubalieva - Junior Program Officer	rahat.yusubalieva@sdc.net www.swisscoop.kg	
The Netherlands Red Cross	Bahtiar Mambetov - Regional Project Manager	Nrcs-ast@elcat.kg (996) 312 66 70 43; 66 70 42	10,Erkindik Ave, 720040,Bishkek

Name of Institution	Contact Person/Title	Contact Details	Mailing Address
UNDP	Neal Walker - Resident Coordinator	neal.walker@undp.org	160 Chui ave., Bishkek 720040, Kyrgyz Republic
	Nato Alhazishvili - Deputy Resident Representative	Nato.Alhazishvili@undp.org	96B, 4 floor, Kievskaya str., Bishkek 720001, Kyrgyz Republic
	Muratbek Koshoev - Disaster Management Program Advisor	geflife@elcat.kg www.undp.kg	
	Sanjar Ibragimov - Assistant, disaster management component	si@dgov.undp.kg	
UNICEF	Nurbek Teleshaliyev - Specialist on education	nteleshaliyev@unicef.org	160 Chui ave., Bishkek 720040, Kyrgyz Republic
	Tim Schaffter - Representative	tschaffter@unicef.org	
WHO	Emil Omuraliev - Disaster Preparedness and Response Focal Point for Kyrgyzstan		
UNV	Achim Merlo - UNV programme officer	eom@euro.who.int t achim.merlo@undp.org	62 Toktogul Str., Bishkek 720021, Kyrgyzstan 160 Chuy avenue
IOM	Janna Salieva - Programme assistant	jsalieva@iom.int	245 Chuy avenue (Demir Bank) Bishkek
Netherlands Red Cross	Sacha Bootsma - Regional Disaster Management Coordinator for CA	sbootsma@redcross.nl	10 Erkindik ave Bishkek
World Bank	Gulbara Tagaeva - Project Manager Disaster Hazard Mitigation Project PIU	dhmp-piu@ktnet.kg	2/1 Toktonaliev str., office 215,Bishkek 720055, Kyrgyz Republic
	Asylbek Keshikbaev - Project Manager Disaster Hazard Mitigation Project PIU	akeshikbaev@ktnet.kg; asylbek@bk.ru	2/1 Toktonaliev str., office 206,Bishkek 720055, Kyrgyz Republic
Ministry of Emergency Situations, Kyrgyz Republic	Kamchibek Kydyrshaevich Tashiev - Minister		2/1 Toktonaliev str.,Bishkek 720055, Kyrgyz Republic
	Turatbek Sh.Djunushaliev - Vice-Minister	minister@mecd.bishkek.gov.kg	
	Anarkul M.Aitaliev - Director of Department of Emergencies Monitoring and Forecasting and Mining Tailing Management	aaitaliev@ktnet.kg	
	Taalaibek A.Temiraliev - Head of Department of External Relations and Investment	chief.erid@mecd.bishkek.gov.kg	
	Chinara Berbaeva - Dept of External Relations and Investments	intercoop@mecd.bishkek.gov.kg	
Kyrgyzhydromet Main Hydrometeorological Administration	Mr Muratbek T. Bakanovad	phone:+ 996 312 21 38 62 fax:+ 996 312 21 44 22 E-Mail: meteo@meteo.ktnet.kg	
State Agency on Architecture and Construction	Kanybek Zhaichievich Narbaev - Director	tel: 996 312 61 36 97 fax: 996 312 61 34 52	

Name of Institution	Contact Person/Title	Contact Details	Mailing Address
Ministry of Education	Choro Z.Elemanov - Vice-rector of studies, Candidate of engineering science, Associate professor	kaa@imfiko.bishkek.su	68 Mederov str., Bishkek 720005 Kyrgyz Republic
Kyrgyz State University of Construction, Transport and Architecture (KGUSTA)	Akymbek A.Abdykalykov – Rector, Ph D, Professor	ksucta@elcat.kg www.ksucta.kg	
	Akylbek Chymyrov - Head of Department	akylbek@hotmail.com www.ksucta.kg	
K.I.Skryabin Kyrgyz Agrarian University	Roza S.Bekboeva - Head of Department of Hydraulic Engineering Institute of Natural Resources Management	r.bekboeva@rambler.ru	68 Mederov str., Bishkek 720005 Kyrgyz Republic
Kyrgyz Scientific Research Institute of Building	Seytbek T.Imanbekov - Director Associate member of Engineer Academy of Kyrgyz Republic	kniips@elcat.kg	2, Cholponatinskaya str., Bishkek 720048 Kyrgyz Republic
Central Asian Institute of Applied Geosciences	Bolot Moldobekov - Co-Director	b.moldobekov@caiag.kg	
	Sheishenaly Usupaev - Leading scientist	sh.usupaev@caiag.kg	
Tajikistan			
Ministry of Education of the Republic of Tajikistan	Farhod K.Rahimov - First Deputy Minister	frahimi2002@yahoo.com	13A Nisormuhammad str., Dushanbe Republic of Tajikistan
Ministry of Energy and Industry of the Republic of Tajikistan	Makhmadsharif M.Khakdodov - Deputy Minister Ph D (techn), Professor	ncsa@tjinter.com	22 Rudaki ave., Dushanbe 734012 Republic of Tajikistan
Committee on Emergencies and Civil Defense under the Government of the Republic of Tajikistan	Haibullo Latipov - Chairman	tel: (992 37) 223 17 78, 223 34 37 fax: (992 37) 221 12 42	26 Lahuti str., Dushanbe Republic of Tajikistan
	Kadam Maskaev - Deputy Head of Department of Monitoring and Warning System, ‘Usoy’ Department	tel: (992 37) 221 12 42, 221 31 29 mob.tel: (992 918) 62 71 15	
	Nemat Sh.Abdurasulov - Head of International Cooperation Department	tel: (992 37) 223 24 01; 223 28 18 mob.tel: (992 93) 600 15 30	
	Jamshed Kamolov - Head of Department on Population Protection	tel: (992 37) 221 12 42, 221 31 29 mob.tel: (992 918) 62 71 15	
	Alisho Shomahmadov - Head of the Information and Communication Center	(+992) 907 747394 (cell)	
Tajik Technical University	Anvar A.Abdurasulov - Rector	jnizomov@tajik.net iskandar@tajik.net	
	Khisrav R. Sadykov - Head of Department of Automatic Electric Drive and Electric Stations	khis@tojikiston.com khisrav@tarena.tj	
Institute of Earthquake Engineering and Seismology, Academy of Science, Republic of Tajikistan	Jahongir Nizomov – Director, Ph D (techn), Professor		

Name of Institution	Contact Person/Title	Contact Details	Mailing Address
Institute of Geology, Academy of Sciences of the Republic of Tajikistan	Ali B.Babaev - Deputy Director		
Agency for architecture and construction	A.Kamilov - Chairman		
NGO 'Man and nature'	Svetlana M.Vinnichenko - Head of NGO	Tel: (992 37) 234 97 11, 234 73 63	66 Firdavsi str, apt. 29, Dushanbe Republic of Tajikistan
NGO 'PMP International'	Sabit H. Negmatullaev - Director of NGO Academician	tel: (992 37) 2279161	59 Shevchenko str., Dushanbe Republic of Tajikistan
NGO 'For Earth'	Timur Idrisov - Director	tel: (992 37) 224 12 77	14 Naberezhnaya str., Dushanbe Republic of Tajikistan
'Kuhiston' Foundation	Svetlana Blagoveschenskaya - Technical Director	tel: (992 37) 221 78 31, 231 57 76 mob.tel: (992 91) 905 44 96	5/15 Firdavsi str., apt. 23, Dushanbe Republic of Tajikistan
Agency on Hydrometeorology of the Republic of Tajikistan	Bekmurod Mahmadaliev - Director	office@meteo.tj www.meteo.tj	47 Shevchenko str., Dushanbe
	Anvar Khamidov - Deputy Director Naulya Mustaeva - Senior specialist, Foreign Affairs Department	Foreign-affairs@meteo.tj naulya@meteo.tj	
Mission East	Afzalsho Nasibov - Project Manager	afzalsho_PO@miseast.tojikiston.com	1 Bauman str., Dushanbe 734025 Republic of Tajikistan
FOCUS Humanitarian Assistance	Mustapha Karim - CEO	hhusani@focushumanitarian.org	137 Rudaki ave., Tojikmatlubot, 4 floor, Dushanbe 734003 Republic of Tajikistan
ECHO	Alam Yao - ECHO Correspondent for Central Asia	tel/fax: (992 37) 221 60 83, 223 16 15	25 Tursunzade str., Dushanbe Republic of Tajikistan
SDC	Rudolf Schoch - Country Director Counsellor, Consul	rudolf.schoch@sdc.net www.swisscoop.tj	20 Pavlov str, Dushanbe Republic of Tajikistan
	Matthias Anderegg - Disaster Reduction Programme Officer, Central Asia	matthias.anderegg@sdc.net www.swisscoop.tj	20 Pavlov str, Dushanbe Republic of Tajikistan
	Anvar Sabzaliev - Disaster Reduction Programme Officer	tel: (992 37) 224 73 16, 224 38 97 fax: (992 44) 600 54 55	20 Pavlov str, Dushanbe Republic of Tajikistan
German Technical Cooperation - GTZ	Dr.Peter Thominski - Program Advisor Disaster Risk Management Program in Tajikistan	peter.thominski@gtz.de www.gtz.de	107 Sovetskaya str., Dushanbe 734001 Republic of Tajikistan
UNICEF	Marina Zhukova - Education Project Assistant	tel: 701 14 89, 701 14 90	37/1 Bokhtar str, 7 floor, Dushanbe Republic of Tajikistan
	Rustam Ubaidulloev - Emergency Officer, Disaster Management Project	rubaidulloev@unicef.org	
International Federation of Red Cross and Red Crescent Society	Shamsiddin Muhidinov - Disaster Management Programme Coordinator	Shamsudin.muhudinov@ifrc.org	120,Omar Khayam Str., Dushanbe

Name of Institution	Contact Person/Title	Contact Details	Mailing Address
CAREC (Central Asian Regional Ecological Center)	Malika Babadjanova - Director	(+992) 227 91 61	
World Bank	Bobojon Yatimov - Rural Development Specialist	byatimov@worldbank.org	91-10 Shevchenko str, Dushanbe Republic of Tajikistan
Uzbekistan			
Ministry of Emergency Situations	Mr. Turagalov – Deputy Head		
	Abbos Komilov – Head of International Relations Department and Human Resources Department	(998) 7064784; 239 87 37	
Uzbek Academy of Science Institute of Mechanics and Seismic Stability of Structures	Tursunbay R.Rashidov - Professor, Head of Department	iskan@seismo.ccc.kz tur.rashidov@list.ru	31 F.Hodjaev str., Academgorodok, Tashkent 700125, Republic of Uzbekistan
	Mashrab Akhmedov - Senior researcher, PhD	gulora@yandex.ru	31 F.Hodjaev str., Academgorodok, Tashkent 700125, Republic of Uzbekistan
Red Crescent Society of Uzbekistan	Mannon R. Rahimov - Professor	rcspresident@uzpak.uz	30, Yusuf Hos Hojib str.,Tashkent 100031, Republic of Uzbekistan
Mavlyanov Institute of Seismology	Rashod N. Ibragimov - Professor	tashkent@seismo.org.uz seismo@uzsci.net	3, Zulfiyahonum str.,Tashkent,700128, Republic of Uzbekistan
	Alisher Ibragimov - Head of digital seismic network; head of earthquake physics lab	alisher.ibragimov@yahoo.com	3, Zulfiyaxonim str. Tashkent 100128
Tashkent State Technical University	Sharakhmat A. Shaabidov - Rector	shoobidov@tstu.uz	2 University str., Tashkent Republic of Uzbekistan
	Orunboy Yuldoshev - Head of Life Safety Chair	tel: (998 97) 449 90 19	
Social ecological organization 'Hayot'	Khusan T.Tursunov - Chairman ISDR National Focal Point for Uzbekistan	khusant@dmail.com khusant@yahoo.com	
Tashkent branch of I.Gubkin Russian State University of Oil and Gas	Bakhtiyar S. Nurtaev - Executive Director, Candidate of physics - mathematics sciences	nurtaevb@gmail.com	34 F.Khojaev str., Tashkent 100143 Republic of Uzbekistan
UNDP	Anita Nirody - RC		4, Taras Shevchenko str. 100029 Tashkent Republic of Uzbekistan
	Kyoko Postill - DRR	Kyoko.postill@undp.org	
	Anvar Nasretdinov - Programme Analyst/ Environment & Energy Unit	tel:(998 71) 120-61-67; 120-34-50 fax:(998 71) 120-34-85	
	Gulnara Akramova - Program Assistant/Environment & Energy Unit	tel:(998 71) 120-61-67; 120-34-50 fax:(998 71) 120-34-85	

Name of Institution	Contact Person/Title	Contact Details	Mailing Address
UZLIITI	Hakimov Shamil Abdullaevich – Head of Constructions department	(998-93) 184 01 23 Sh-khakimov@rambler.ru	
UNICEF	Oyunsaihan Dendevnorov - Manager Area-based programme	odendevnorov@unicef.org	43 Istoklol str., Tashkent 100017, Republic of Uzbekistan
	Hushnid Sattarov - Project advisor	hsattarov@unicef.org	
UNESCO	Bakhtiyor Namazov - Education officer, UNESCO	b.namazov@unesco.org	95, Amir Temur str. Tashkent
Centre of Hydrometeorological Service at Cabinet of Ministers of the Republic of Uzbekistan	Prof. Victor E. Chub - Minister, Director-General of Uzhydromet, Ms Malika Nazarova - Chief of International Department	phone:+ 998 71 233 61 80 fax:+ 998 71 233 20 25 E-Mail:uzhymet@meteo.uz	
Ecoforum of Uzbekistan	Dsaidrasul Sanginov - Chairman of council	ecologos@sarkor.uz	13a, Shuhrat str. Tashkent 100084

Relevant internet sites

http://www.aboutgeorgia.net/profile/index.html/Economy
http://www.adb.org
http://www.adrc.or.jp/publications/annual/03/03eng/pdf/4-1.pdf
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http://www.unhcr.org/cgi-bin/texis/vtx/home
http://www.unicef.org/
http://www.unisdr.org
http://www.usaid.gov/locations/europe_eurasia/countries/
http://web.worldbank.org/hazards
http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20535285~menuPK:1192694~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html
http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/ECAEXT/KYRGYZEXTN/0,,contentMDK:20629311~menuPK:305768~pagePK:141137~piPK:141127~theSitePK:305761,00.html
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http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/ECAEXT/0,,menuPK:258604~pagePK:158889~piPK:146815~theSitePK:258599,00.html

THE WORLD BANK

The World Bank,
1818 H Street, NW Washington
DC 20433 USA
Tel.: +1.2024580268
Fax: +1.2025223227
Email: drm@worldbank.org
www.worldbank.org

ISDR
International Strategy for
Disaster Reduction

UNISDR Regional Office Europe
and Central Asia
Palais des Nations,
CH-1211 Geneva, Switzerland
Tel.: +41.229171921
Fax: +41.229178964
Email: isdr-europe@un.org
ww.unisdr.org/europe

CAREC

CAREC Unit Secretariat
6 ADB Avenue, Mandaluyong City
Metro Manila 1550, Philippines
Tel.: + 632 632 5857/6368
Fax: + 632 636 2387
Email: dkruger@adb.org
www.adb.org/carec

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