CLIMATE CHANGE RISKS AND VULNERABILITY OF UZBEKISTAN'S ENERGY SECTOR

WORKSHOP BRIEFING NOTE

1. Introduction

The energy sector is sensitive to changes in seasonal weather patterns and extremes[1] that can affect the supply of energy, impact transmission capacity, disrupt oil and gas production, and impact the integrity of transmission pipelines and power distribution. Most infrastructure has been built to design codes based on historic climate data and will require decisions in coming years regarding rehabilitation, upgrade or replacement. This poses both a challenge and an opportunity for adaptation. To ensure the resilience of energy infrastructure to current climate variability and projected future climate change, enable the continued provision of basic services to the public and industry, and enhance the quality of decision making, governments will need to understand the inherent vulnerabilities in their energy sector and develop flexible adaptation strategies for existing and planned infrastructure. Consideration will need to be given to the capacity of energy systems to sustain cumulative impacts; the redundancy at peak periods; the sensitivity of regulators to climate change pressures on infrastructure and the possible need for redundant capacity; and demand management and energy conservation strategies.

The overall objectives of this assignment are to:

a) undertake an assessment of the vulnerability of the energy sector in Uzbekistan to current climate variability and projected climate changes over the period 2030-50;

b) assess options to adapt to projected risks, for better management of climate vulnerability in the energy sector.

Much of the ongoing dialogue on climate change has focused on climate mitigation and carbon trading and there has been limited exploration of the synergies between climate mitigation and adaptation[2]. This country-based review of Uzbekistan's energy sector vulnerability and adaptive capacity is the second review which the Bank has initiated in Europe and Central Asia. The first was undertaken in Albania in 2009. The approach is consistent with external best practice initiatives in recent years in the UK's energy sector[3], in Australia[4], within key oil and gas companies[5] and major power companies such as EDF in France. All these have been exploring the energy sector vulnerability to current and projected climate change as a basis for understanding uncertainties and developing strategies for risk management.

The Bank aims to facilitate the transfer of best practice to Uzbekistan through this assignment, by engaging international expertise for program implementation and its convening power to support well targeted and

[1] Floods, droughts, fire, storm and landslide

[2] E.g. energy efficiency to reduce greenhouse gas emissions and energy demand as a mitigation strategy is a key adaptation option in tackling growth in demand for summer cooling – especially when energy supply might be constrained due to, for example, drought conditions in the case of hydropower.

[3] http://www.metoffice.gov.uk/energy/climatechange.html

[4] See also the Australian Government's work on Climate Change Risk and Vulnerability: Promoting an Efficient Adaptation Response in Australia[4], final report, March 2005 and other similar adaptation work done that may have been conducted in other countries.

[5] E.g. Schlumberger led initiative in conjunction with Reading University to examine impact of climate (current and projected) on their business environment.

broad engagement of on these issues in country. This program will set the stage for future support and operations/ activities through the identification of climate vulnerabilities and adaptation priorities and adaptation needs/ options[6] in Uzbekistan.

2. What trends in Uzbekistan's climate have been observed?

There has been a trend of warming temperatures across the whole of Uzbekistan since the 1950s. The rate of warming in Uzbekistan in the last 50 years (about 0.3˚C per decade) is more than twice the global average.

Figure 1 shows that the numbers of very hot days (when temperatures exceeded 40°C) has more than doubled near the Aral Sea (in other territories they have increased by 32% to 70%), whereas the number of very cold days (temperature lower than -20 °C) reduced by more than a factor of 1.5[7]. There are regional and seasonal differences in warming; in the area around the Aral Sea, the rate of rise of maximum temperatures is very high.

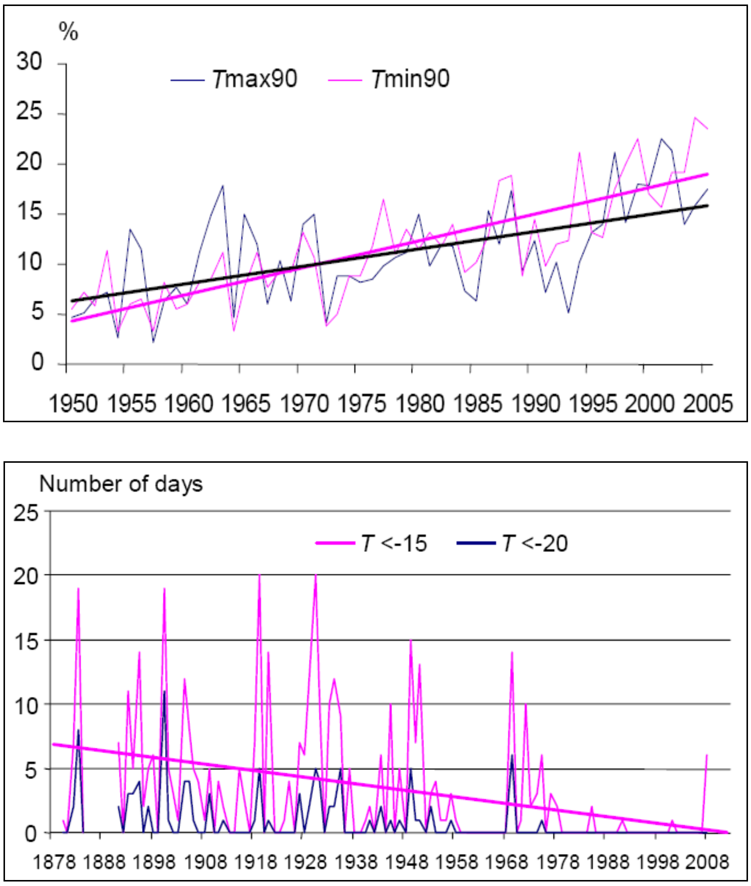
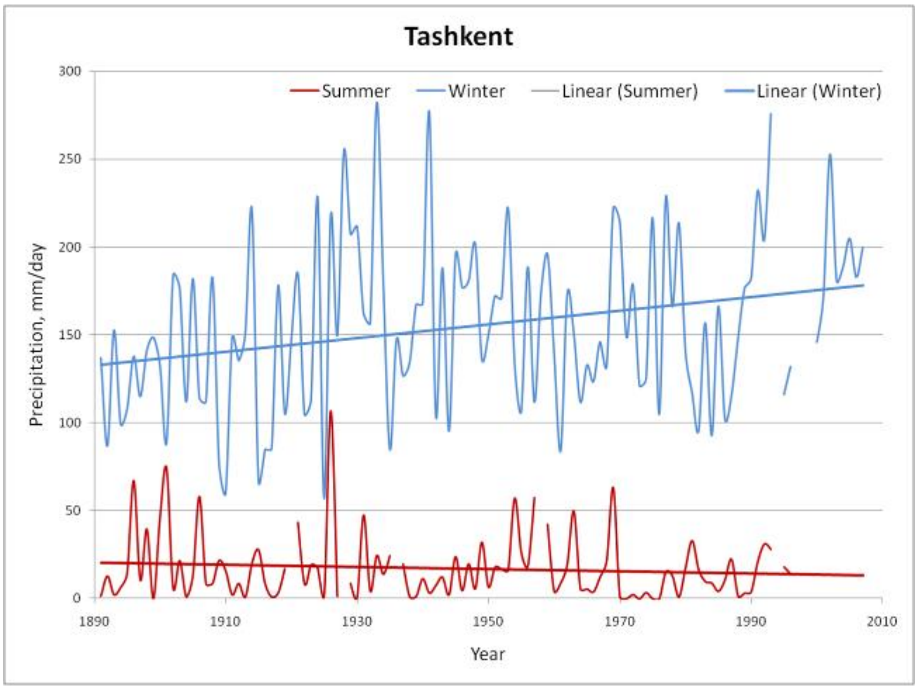


Figure 1. Observed changes in maximum and minimum temperatures in Samarkand and Tashkent: change in extreme maximum and minimum temperatures in the Fergana Valley (top); number of days with low temperatures in Tashkent (bottom). [Source: Second National Communication of the Republic of Uzbekistan, 2008]

[6] Adaptation options can include those that are autonomous and those requiring planning or public intervention
[7] Uzbekistan's Second National Communication under the United Nations Framework Convention on Climate Change (2008) Centre of Hydrometeorological Service under the Cabinet of Ministers of the Republic of Uzbekistan. Available at: http://unfccc.int/resource/docs/natc/uzbnc2e.zip

Figure 2 shows trends in summer and winter precipitation over the last century in Samarkand and Tashkent. These graphs show that in both locations, there has been a clear increase in winter precipitation, while summer precipitation has decreased slightly (Tashkent) or remained stable (Samarkand).



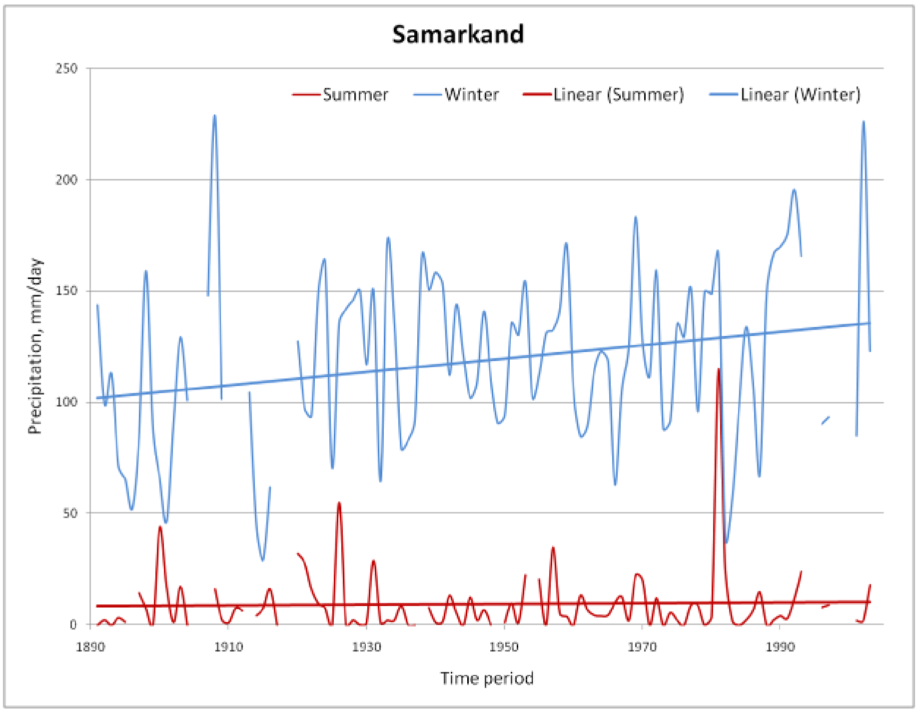


Figure 2. Changes in seasonal precipitation (summer and winter) in Tashkent from 1891 to 2007 (top) and Samarkand from 1891 to 2003 (bottom) [Source: KNMI Climate Explorer: http://climexp.knmi.nl/]

3. What future changes in climate are projected?

Projected climatic changes in Uzbekistan and the Central Asia region over coming decades include:

- Average temperatures are expected to increase by 1 to 2°C by the 2020s and by 2 to 4°C by the 2050s over the Central Asia region (
- Figure **3**).
- Warming in Uzbekistan is expected to be greater in the summer months (June, July, August) than in the winter months (December, January, February) (
- Figure **4**).
- Increased risk of heat-waves.
- Climate models indicate that precipitation will increase in the winter and decrease in the summer.
    - By the 2050s, there will not be a great change in winter precipitation, although an increase of 10 to 15% is expected by the end of the century. However, the agreement between climate models is poor over the whole country.
    - Summer precipitation is expected to decrease over most of Uzbekistan by 5 to 15% by the 2050s, and by up to 20% by the end of the century, and the model agreement for such a change is good (about two thirds of the models show decreases in precipitation).
- More frequent and longer droughts.
- Increased risk of days with heavy precipitation, with consequent increased flash flood and mudflow risk in the lower areas of the river valleys.
- Increased risk of lake outbursts in the mountainous zones of Uzbekistan[8].

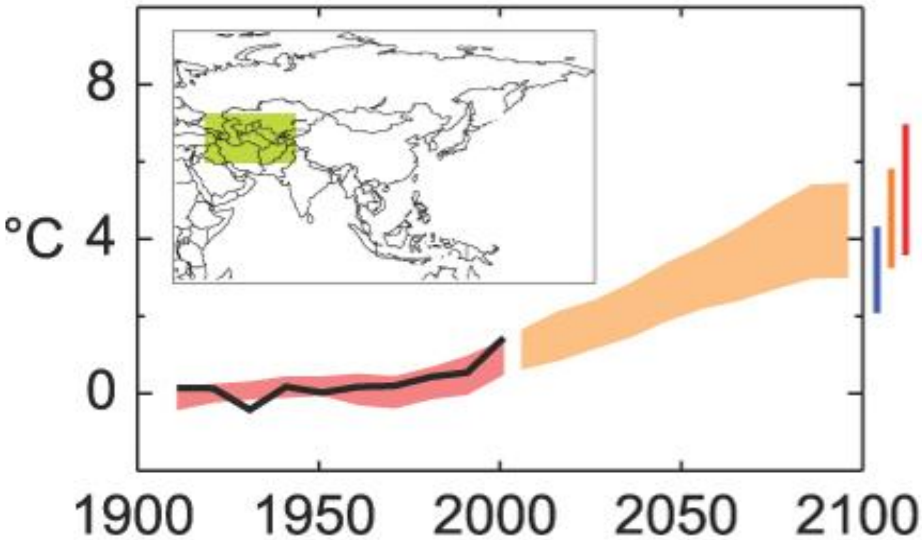


Figure 3. Changes in temperatures (relative to 1901-50) across Central Asia: Observed from 1906-2005 (black line), simulated by climate models from the IPCC Fourth Assessment Report (AR4) (red envelope), and projected from 2001-2100 by IPCC AR4 climate models, for the A1B emissions scenario (orange envelope). [Source: IPCC Fourth Assessment Report, Working Group 1, 2007]

[8] Uzbekistan's Second National Communication under the United Nations Framework Convention on Climate Change (2008) Centre of Hydrometeorological Service under the Cabinet of Ministers of the Republic of Uzbekistan.

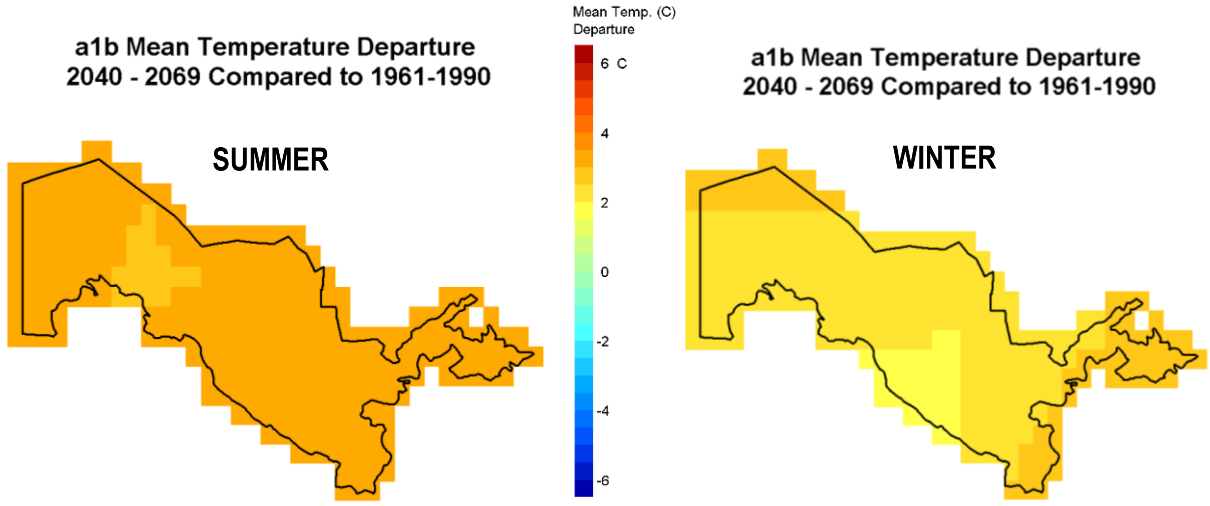


Figure 4. The average across 16 GCMs of future increase in average summer temperature (left) and average winter temperature (right) in Uzbekistan from 2040 to 2069 relative to the 1961-1990 baseline, under the A1B emissions scenario. [Source: Climate Wizard, http://www.climatewizard.org/]

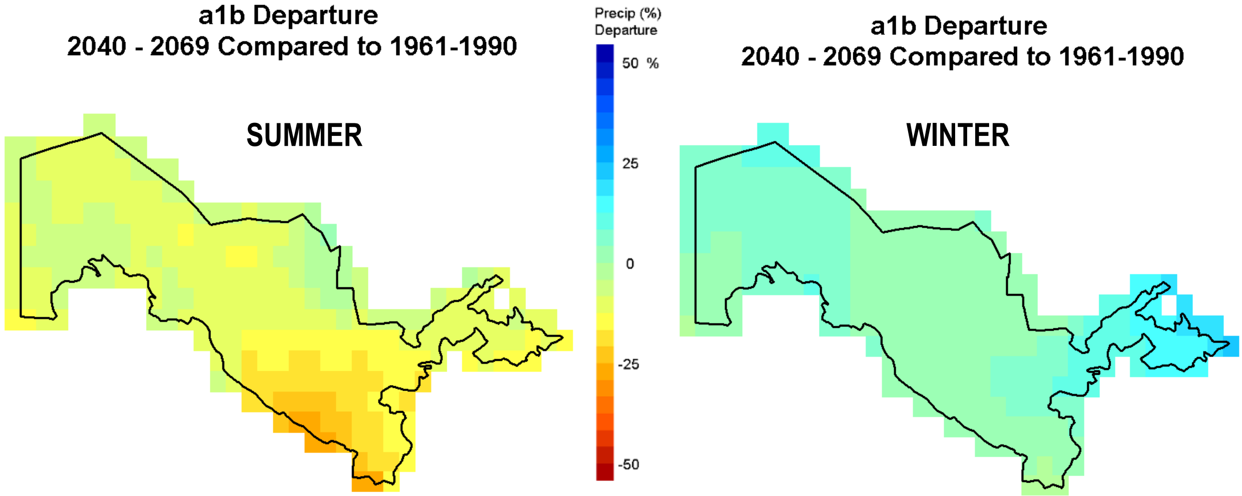


Figure 5. The average across 16 GCMs of future change in average summer precipitation (left) and average winter precipitation (right) in Uzbekistan from 2040 to 2069 relative to the 1961-1990 baseline under the A1B emissions scenario. [Source: Climate Wizard, http://www.climatewizard.org/]

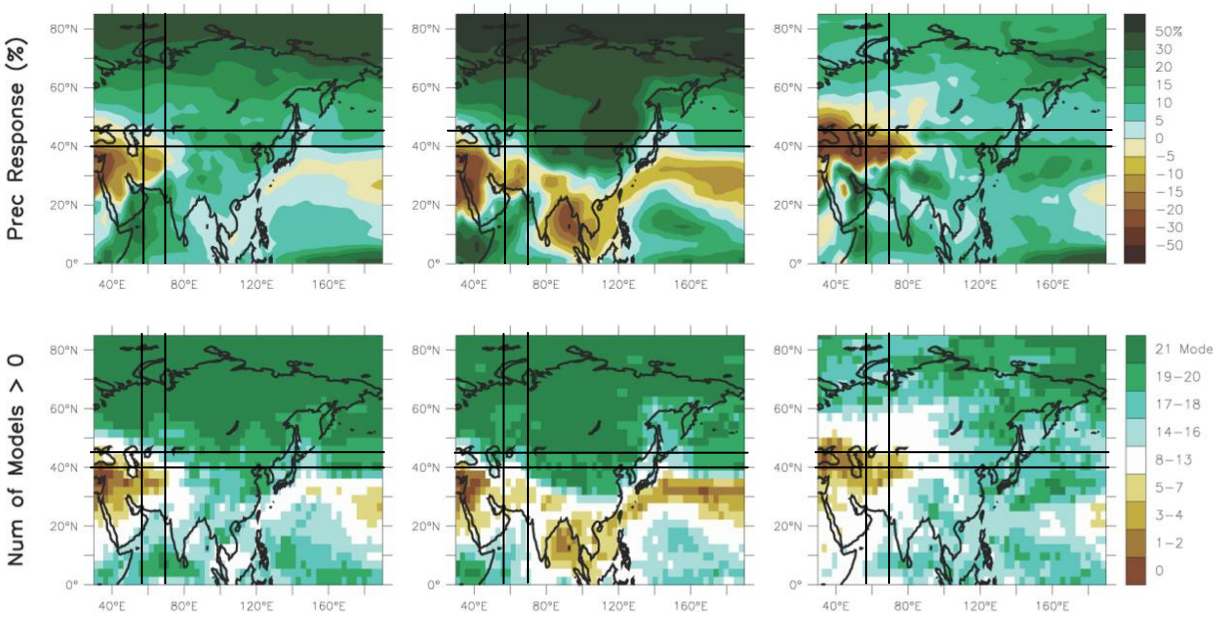


Figure 6. Projected changes in precipitation over Asia across a range of climate models under the A1B greenhouse gas emissions scenario. Top row: Annual mean (left), winter (middle) and summer (right) precipitation change between 1980 to 1999 and 2080 to 2099, averaged over 21 climate models. Bottom row: number of models showing an increase in precipitation. [Source: IPCC Fourth Assessment Report, Working Group 1, 2007]

4. Potential impacts of climate change on the energy sector

Over 30% of Uzkbekistan's energy infrastructure (generation, transmission and distribution systems) is outdated and inefficient[9]. However, renovation of the energy sector is a priority for the Government of Uzbekistan and the Government has already made several decisions to replace and upgrade energy generation and transmission assets[10].

Uzbekistan's Second National Communication to the United Nations Framework Convention on Climate Change (2008) highlighted some key impacts of climate change on the country's energy sector. The National Communication identified the effects of rising temperatures on energy demand for space heating and space cooling. It estimated that rising temperatures under greenhouse gas emissions scenario A2 could shorten the average duration of the heating season by 8% to 9% by 2030, compared to the baseline 1971-2000. The duration of the cooling season would increase by 16% by 2030 as compared to the baseline, which will affect energy consumption for air conditioning. It will be important to identify specific adaptation measures that need to be considered in the energy sector. For instance, the National Communication refers to considering climate change when revising energy consumption rates and encouraging the manufacture and import of machinery and equipment better suited to a warmer climate.

A key issue relating to climate change impacts on Uzbekistan's energy sector is water availability. A significant proportion of the country's water resources come from mountains located in neighbouring

[9] Uzbekistan's Second National Communication under the United Nations Framework Convention on Climate Change (2008) Centre of Hydrometeorological Service under the Cabinet of Ministers of the Republic of Uzbekistan.

[10] President Decree #1072 from March 12, 2009, based on October 2008 Decree #4058.

countries (notably Tajikistan and Kyrgyzstan), where glaciers supply a majority of total river runoff in Central Asia[11]. These glaciers produce water in the summertime, which is the hottest and driest period of the year, compensating for low precipitation. Observations over the last 50 years indicate that these glaciers are melting: their surface area has decreased significantly[12]. Although this may mean that water resources increase in the short term, in the long term river runoff will decrease as glaciers gradually shrink and eventually disappear. This could affect the production of electricity from water cooled thermal power plants and hydropower plants.

Some of the climate vulnerabilities and potential risks to energy assets in Uzbekistan can be summarised as follows:

- Uzbekistan's reliance on thermal power plants that produce about 90% of its electricity makes the country vulnerable to reductions in availability of cooling water.
- Turbines in thermal power plants are slightly less efficient under higher temperatures.
- Hydropower also constitutes a portion (about 10%) of electricity produced. Hydropower is vulnerable to decreased river flows and reduction in water availability.
- Railroads used to transport Uzbek oil refinery products (diesel, heating oil, kerosene, lubricants and other products), as well as gas pipelines and electricity transmission lines may be affected by increased risk of landslides in hilly areas. Rails can also buckle under extreme temperatures.
- If the potential of solar and wind power are developed in the future, they would be sensitive to changes in sunshine hours (cloud cover) and wind speeds.

Glossary

Adaptation

Actions to reduce the vulnerability of natural and human systems to climate change effects. For instance, an adaptation action that can be taken to reduce the damaging effects of rising sea levels is to build higher sea defences. Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned.

AR4

The Fourth Assessment Report of the IPCC, released in 2007.

Baseline

The reference against which change is measured, e.g. 'baseline climate' is normally defined as the period 1961-1990.

Carbon dioxide (CO_2)

CO_2 is a naturally occurring gas, and a by-product of burning fossil fuels or biomass, of land-use changes and of industrial processes. It is the main greenhouse gas produced by man that is driving climate change.

[11] World Bank. (2009). Adapting to Climate Change in Europe and Central Asia. Washington, D.C., USA.
[12] Zoi Environment Network (2009) Climate Change in Central Asia: A visual synthesis. Available from: http://www.zoinet.org/index.php?id=9

Climate change
Climate change refers to any change in climate that lasts for an extended period, typically decades or longer, whether due to natural variability or as a result of human activity.

Climate hazards
Climate variables which have consequences for the system being studied (in this case, Albania's energy sector). The main climate hazards to be discussed at the workshop are temperature, precipitation, relative humidity, sunshine, winds, sea level rise and extreme events such as storms.

Climate impacts
The effects that climate hazards have on a given system (in this case, Albania's energy sector), e.g. reductions in rainfall have impacts on hydropower generation.

Climate variability
Climate variability refers to variations in the average state of climate. Rainfall, for instance, has high natural variability, which makes it difficult to detect a climate change signal.

General Circulation Models / Global Climate Models (GCMs)
A computer-based numerical model of the climate system. GCMs are developed and run by climate modelling centres around the world and are used to project changes in climate.

Greenhouse Gases (GHGs)
Greenhouse gases absorb and emit infrared radiation. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the earth's atmosphere.

Intergovernmental Panel on Climate Change (IPCC)
The Intergovernmental Panel on Climate Change was formed in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), and is the international advisory body on climate change.

Mitigation
Actions to reduce man-made effects on the climate system. These include actions to reduce emissions of greenhouse gases (such as energy efficiency measures or the use of renewable energy resources), as well as actions to increase greenhouse gas sinks (such as planting forests).

Risk
Risk is the product of the *likelihood (or probability) of an event* occurring and the *magnitude of its consequence*.

Scenario
A plausible description of how the future may develop. Scenarios are not predictions or forecasts, but are useful to provide a view of the implications of actions.

Sensitivity
Sensitivity is the amount by which a system is affected, either adversely or beneficially, by climate variability or climate change. For instance, the efficiency of gas turbines is sensitive to temperature. As temperatures rise, efficiency falls.

Special Report on Emissions Scenarios (SRES)
To provide a basis for estimating future climate change, the IPCC prepared the Special Report on Emissions Scenarios in 2000. It provides 40 greenhouse gas and sulphate aerosol emission scenarios

based on different assumptions about demographic, economic and technological factors. The emissions scenarios are fed into Global Climate Models, to project future changes in climate.

Threshold

A property of a system where the relationship between the input and the output changes suddenly. For example, the height of a flood defence represents a critical threshold – if water levels exceed the defence height, flooding will occur. It is important to identify climate-related thresholds as they indicate rapid changes in the level of risk.

Timeslice

Projections of climate change are usually given for three timeslices – the 2020s, 2050s and the 2080s. The projections are a 30-year average, centred around each of the given timeslices, (i.e., the 2020s is 2010 – 2039). Climate models cannot predict what the specific climate will be in any given year, due in part to the inter-annual variability of climate variables, so the projections are 30-year averages of future climate.

Uncertainty

An expression of the degree to which a value is unknown (e.g. the future state of the climate system). Uncertainty can result from lack of information or from disagreement about what is known or even knowable.