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ASSESSMENT OF CLIMATE CHANGE IMPACT ON WATER RESOURCES WITH RESPECT TO ENERGY ECONOMIC INFRASTRUCTURE IN THE COUNTRIES OF CENTRAL ASIA

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Analysis of the climate change impact on water resources with respect to energy economic infrastructures of the countries of Central Asia: prospects

Executive Committee IFAS with support of USAID (United States Agency for International Cooperation) has made contribution to the analysis of climate change vulnerability and adaptation assessment for the sectors of economy.

This study focuses on conducting the climate change vulnerability assessment for the energy sector in three countries: Kazakhstan, Kyrgyzstan and Turkmenistan, with aim to integrate two parallel studies on Uzbekistan and Tajikistan into the regional analysis for Central Asia.

As climate change intensifies the Central Asian region can expect further widespread increases in temperature, which would lead to higher evaporation, melting ice and snow, quantitative changes in rainfall and river flow regime, as well as increasing frequency of extreme weather events.

Managing the climatic risks for the countries' energy sector will require proper analysis and forward planning by government and private sector stakeholders, to establish optimal adaptation strategies for existing and new energy infrastructure in line with projected climate change impacts (including impact of changing water flows) in the context of the countries' economic development.

Definition "Energy economic infrastructure" within each subject country, in the context of this study, includes facilities directly associated with the production of natural energy resources (fossil fuels and renewables); facilities and rivers associated with supply of water that are used, or could reasonably be used, for production of electricity; electricity generation plants (existing and applicable new technologies); energy transmission and distribution systems; and, the main energy consuming sectors of the economy".

Source: American Institute of Chemical Engineers

How can the countries of Central Asia best manage their future security of energy supply in the face of a changing climate?

I.e., how to ensure optimal balance between financial, environmental and social objectives of the energy development ?

To address this question the following activities were performed within the study:

·Developing the risk assessment system and identifying the priorities of hazards and vulnerabilities from climate variability for the energy sector from the present day to the 2050s.

·Identifying options for adaptation actions to increase level of infrastructure safety.

·Undertaking high-level cost benefit analyses for individual power generation technol ogies and overall approaches to future energy policy.

The analysis is aimed at facilitating decision making process by governments with respect to the future development prospects. The analysis does not imply support for a particular position or option and more designed to compare a variety of adaptation strategies and technologies for existing and planned infrastructure.
Evaluation focuses on comparison of options and recommendation of the most advantageous option for each country from a wide range of future economic, environmental and social conditions.

Support of USAID

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Consultations with national experts

A SWOT (strengths and weaknesses, opportunities and threats) analysis undertaken with experts from stakeholder organizations at the country workshops, helped to highlight the current vulnerabilities in the economy from the energy system perspective. The workshop participants reviewed all types of existing energy assets, their sensitivity to climatic conditions and events taking into account the characteristics of the energy sector of each country.

Climate change and water resources – impact on energy sector: Kazakhstan

Over 50% of Kazakhstan's water resources stem from upstream neighbouring states. Climate change in combination with upstream water use is regarded as the main problem of water supply.

More than 70% of Kazakhstan's hydro resources are used in agriculture for irrigation of key crops and also in stock raising.
In addition, significant water losses associated with inefficient use of irrigation system. Changes in runoff of the main rivers and as a result the challenge of supplying adequate amount of water to critical energy assets due to climate variability, can further constrain increased competition for water use between various water users having certain impact on the energy supply safety.

Taraz Energy centre, 2012

Climate change and water resources – impact on energy sector: Turkmenistan

Appropriately managing Turkmenistan's energy sector in the face of a changing climate requires a clear understanding of its climate-related vulnerabilities and future risks and mitigation opportunities.

Turkmenistan has the eighth highest vulnerability rating in the region of Europe – Central Asia (out of a total of 28 countries) along with neighbours Tajikistan, the Kyrgyz Republic and Uzbekistan. This results from a combination of the country's high sensitivity to climate change and low adaptive capacity.
Turkmenistan's high sensitivity is explained by its large dependency on river flow from the Amudarya river, high exposure to drought, observed significant temperature increases.

Finally, climatic changes will affect thermal power plants as the temperature increases affecting the effectiveness of turbines.
Increased losses in the agricultural sector due to reduce in the efficiency of irrigation system, and in turn, an increase in demand for electricity will hamper optimal allocation of water resources between sectors.

Karakum canal, Great Soviet Encyclopedia

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Climate change and water resources – impact on energy sector: Kyrgyzstan

As climate change intensifies Kyrgyzstan can expect further widespread increases in temperature, which would lead to higher evaporation, melting ice and snow, quantitative changes in rainfall and river flow regime. By about mid-century, the amount of runoff in the Syrdarya river basin, where most major hydro power stations are located, will get dramatic reduction.

Naryn river, EurasiaNet

According to the forecast (MES KR, 2009) climate change will have significant negative impact on the glaciers of Kyrgyzstan in the coming decades.
In recent years the energy system of Kyrgyzstan faces significant challenges trying to balance the energy and peak demand in winter, due to the low ratio of available generating capacity and climate change related extreme weather conditions (such as drought), which leads to periodic load restrictions and cutoff in the electricity supply.

Glaciers, snow melting, river runoff and water resources

Over the next 50 years river runoff in Central Asia is projected to decline and, according to the World Bank (2009a), the reduction could be in the order of 20%. However, river runoff may increase in the short term, due to increasing rates of glacial melt and higher precipitation rates.

The retreat of the Abramov glacier in Kyrgyzstan from 1971 to 2008, Zoï environment network, 2009
A study by Bolch (2007) found that glacier extent in the northern Tien Shan mountains decreased by more than 32% between 1955 and 1999 (Aizen and Aizen, 2009). Glaciers in the Pskemsky range in the western Tien Shan region have shrunk by 16.8% during the past 20 years (glacial volume or glacial extent not specified) (RCH EC IFAS, 2009). Overall in the 20th century glaciers in the Tien Shan mountains have decreased by 25 to 35% in area (Roy, 2009). The Abramov glacier located in the Alay range of southern Kyrgyzstan has shrunk by at least 500 meters and lost 20% of its ice mass since the 1970s.

Hydropower is the most exposed part of the energy sector to the risks caused by climate change.
On the basis of available projections of climate models, data on water and energy production a high-level quantitative assessment of threats that the climate change challenges hydropower sector, was prepared within the study.
Adaptation options for Kazakhstan and Kyrgyzstan have been identified in accordance with the role of hydropower in the overall sector.

Adaptation strategies

In the context of future climate change and the energy resources reduce the best options and technologies which are most perspective in terms of cost-effectiveness are considered within the study, in order to determine the best value adaptation scheme.

The analysis by country, and Kazakhstan in particular, showed that all options other than solar energy provide a positive return on investment. However, while considering the financial, social and environmental factors in the full life cycle, all technologies are becoming less favorable. This becomes evident if we consider the costs related to nonfinancial assets.

From the point of view of the full economic life cycle, options for power plants using gas (combined cycle gas turbines), and small hydropower plants provide optimum benefit. Large hydro and wind stations present cost options. Solar energy is considered among the most preferred variants while the solar technologies progress (including reduction of capital expenditure on concentrated solar power and solar photovoltaic sources at mass production).
The use of nuclear power is one of the secondary economic opportunities.

Effectiveness of infrastructure

Optimal adaptation strategy for existing and new infrastructure shall include activities and technologies of increasing the energy efficiency.
While operation of the old and overloaded equipment continues, and it is not replaced, technological losses of energy persist to grow every year.
Power transmission and distribution system as old as ineffective is characterized by high technological and commercial losses and consequently are highly vulnerable to extreme climate-related hazards.

In order to ensure continuity of supply and, thus, resilience to the impacts of climate change it is necessary to continue implementation of **strategies for energy sources diversification.**

Kyrgyzstan's high sensitivity to climate change stems in part from its reliance on hydropower, which is affected by precipitation variability and long-term changes.

Increase in the number of extreme weather events is an additional adverse factor. Extreme droughts reduce annual hydro energy production, which leads to cutting off the power supply across the country. The frequency of hazardous events such as flooding, mudflows, landslides, avalanches and glacier lakes outburst floods also pose a risk to energy generation and transmission capabilities across the country.

In addition Kyrgyzstan's low adaptive capacity is compounded by the further deterioration of its already inefficient energy generation, transmission and distribution network, as well as the poor state of national hydrometeorological services. Coupled with the fact that 93% of Kyrgyzstan's electricity is generated by HPPs, robust hydrometeorological information plays a critical role in the country's energy supply.

Glaciers, glacial lakes and glacier lakes outburst floods (GLOF) risk areas in Kyrgyzstan, Zoï environment network, 2009
Between 1952 and 2007 approximately 70 GLOFs occurred in Kyrgyzstan causing several hundred deaths and substantial damage to settlements and infrastructure including power lines and pipelines (UNDP BCPR, 2011).
The processes driving the formation of glacial lakes have been accelerating since monitoring of the lakes began in the 1960s (UNDP BCPR, 2011).

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Status of hydrometeorological services

Energy sector is one of the most climate-dependent sectors of the economy, and is highly dependent on quality and accurate climate information for forward planning and management. Demand and supply issues are projected to adjust with a changing climate. In order to adapt to these changes, better hydrometeorological information services are needed, including strong basic forecasting, long range forecasting, satellite imaging and climate change projections covering changes in average and extreme climatic conditions.
The current poor state of hydrometeorological network in the mountainous parts of the basin reflects
the general situation in NMHS of the Central Asian countries, where dramatically reduced funding in 1990s led to decline in hydromet services.

Hydrometeorological monitoring in the mountainous parts of the Aral Sea basin

Current state of national climate change research at regional level

A number of organisations in the Region are conducting climate change relevant research.
They include the National Academy of Sciences of the Republic of Kyrgyzstan, the Central Asian Institute of Applied Geosciences (CAIAG), Regional Centre of Hydrology based on research activities undertaken by experts of NHMSs of the countries.

The agricultural sector is by far the largest consumer of water resources in Turkmenistan, consuming around 92% of all surface water resources in the country. Increasing water losses in agricultural sector as a result of growing temperatures, reducing efficiency of irrigational system and, in turn, growing energy needs in future will constrain optimal allocation of water resources between sectors.

Climatic changes will produce an impact on thermal power plants as the temperature rises which reduces the turbines' efficiency. Availability of water resources for cooling thermal power plants and effectiveness of water resources management constitute a key concern for Turkmenistan's energy sector in the context of climate change.

Recommendations for reducing water losses in agricultural sector considering climate conditions include the following:

·Increasing effectiveness of irrigation system

·Improving irrigation techniques

·Improving land reuse

·Research development and cultivation of crops which are more resistant to dry conditions
·Use of treated domestic wastewater

Domestic and industrial demand
Power consumption for cooling will change in the future as a result of warmer winters and summers, as a result of the cooling needs of residential and non-residential buildings and industrial installations.
The oil and gas production and transmission facilities, as well as the supporting infrastructure used to transport these hydrocarbons, are already affected by climate in certain way (WorleyParsons and Acclimatise, 2011):

Analysis of costs and benefits of possible strategies for energy production showed that Turkmenistan has considerable potential for solar energy generation in the eastern and south-eastern areas of the country. Besides, over 40% of Turkmenistan's territory has wind potential suitable for producing power, making it one of the countries with the highest wind energy resource potentials in the region (EBRD RDI, 2010)

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General conclusions

Choice of the most effective adaptation option for economic infrastructure depends on the awareness of responsible persons on the prospects of the future development and the availability of a complete analysis of opportunities.

Enlarged **cost and benefit analysis on individual technologies of energy production and general approach to future energy policy** has been conducted as part of the study.
The opportunities for structural change in the energy sector, and relevant technological, economic and financial aspects were considered as possible adaptation strategies.

Based on the cost and benefit analysis the concrete steps were proposed for the purpose of improving sustainability of the economy including resistance to climate change.
They are divided into **three categories: informational, institutional and natural/ technological activities.**
To ensure the reliability of policies and projects aimed at the energy supply security in the face of climate uncertainty, these policies should be comprehensively implemented.

The assessment methodology of the study can be applied in the following directions:

•Energy system capacity (including availability of generation capacities during peak periods) with respect to their ability to sustain cumulative environmental impact;

•Capacity of regulatory bodies to react properly to the climate change pressure on infrastructure and possible needs for additional generation capacities;

•Demand as subject to regulation (reduction) and appropriate strategies for energy saving activities;

Interesting fact is that demand management presents the best method for reducing energy costs to society and environment;

•Activities and technologies increasing energy efficiency for existing and new energy infrastructure.

While operation of the old and overloaded equipment continues, and it is not replaced, technological losses of energy persist to grow every year.

The climate change effects can lead to lowered effectiveness, increased operational expenditures and losses in production for existing not adapted energy assets.
Increasing frequency and duration of extreme climatic events can lead to disruptions in energy supply and erode power transmission and distribution systems.

Modernization of existing infrastructure will require assessment of capital expenditures for adaptation improvements. Future new energy assets would benefit from incorporating climate change resilience into their designs, as this can often be undertaken at lower cost at the design stage rather than during operations.

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Information about the study

Set of activities on performing the analysis was accomplished on behalf of the Executive Committee IFAS and USAID by a project team consisting of experts from Worley Parsons and Acclimatise.

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Information about project is available on the Internet at the website of Executive Committee of IFAS (www.ec-ifas.org) in the ASBP section, Projects: http://rus.ec-ifas.org/asbp/projects/regional-twd-support-in-ca-countries/

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