PEOPLE PERCEPTION TO TEMPERATURE AND PRECIPITATION FLUCTUATION AND ITS ADAPTATION IN THE HINDUKUSH MOUNTAINS, SWAT RIVER CATCHMENT AREA, NORTHWEST PAKISTAN (2003-2013)

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ABSTRACT

This work aims at the people perception to climate change impacts and adaptation to different environmental sectors in Swat river catchment area, Northwest Pakistan. Two types of climate that is humid and undifferentiated highlands prevail in the area. People perception to temperature fluctuation has been collected through questionnaire survey from Kalam and Utror valleys. The local's have the opined that the climate is changing. They have believed that past climate of the valley has cold as compared to current weather condition. Almost all people judge that the area is getting warmer with passage of time due to a rise in the temperature condition both in summer and winter seasons. Moreover, the majority have deemed that precipitation increased since last five years in summer (after flood) with certain declined in snowfall in winter season. As regarding fall in watertable, the respondents have voted for the depletion in watertable, and seasonal decrease in the flow of water from springs and Swat River (after flood). Generally, the participants have believed that this deterioration in the climate is due to increase in deforestation, population growth, water demand, fall in the snow during winter season, glacier retreat, natural disasters, poor irrigation system, water supply and transportation network, non-availability of power resources, rare agriculture activities and food supply chain, access of local's to national market, and ignorance of Holly Sunnah and Islamic ideological approach. The local government is required to invest on the improvement of the stated sectors massively to control the climate change and to secure the lives of the inhabitants against the natural hazards. To overcome the power resources insufficiency and flood control, this will be appreciated if the government constructs small dams in the valleys and grow up the tourism and education system in the area.

Keywords: Precipitation, Temperature, Water resources, Glaciers, Permafrost, Adaptation.

1. Introduction

Climate change and its impacts on the water sector have attracted interest of the researchers on local as well as international level. Anthropogenic activities, socio-economic growth, as well as environmental changes are closely related with the phenomenon of climate change and water resources. Moreover, climate and environmental conditions like aridity, drought, floods, land sliding etc have impacts on the agriculture, food security, water resources and well being of humans in the Kalam valley, Swat district, Northwest Pakistan.

The current work deals with the Kalam and Utror valleys, which extends northeast to southwest from latitude 35-18`$^0$N into 35-53`^{0}N and longitude 72-12`^{o}E to 73^{o}East. The study area extends from the Bahrain union council of Swat district in the south to Ghizar and Gilgit districts of Gilgit-Baltistan province in the North, Upper Dir in the west, Kohistan, and Chilas districts in the east.

Khan (2001) has discussed the searching evidence for climate change based on analysis of hydro-meteorological time series in the upper Indus basin. Hayat, Bari, Sheikh, and Chaudhry in 2001

have studied the history's worst drought conditions prevailed over Pakistan and it impacts as compared to other disasters like floods, tropical storms etc. Akhtar, Tushaar, Qureshi in 2003 have presented a report on the groundwater economy of Pakistan. Shrestha and Shrestha (2004) have conducted study on the recent trends and potential climate change impacts on glacier retreat/glacier lakes in Nepal and potential adaptations. Rome (2005) has presented a study on the Forestry in the Princely State of Swat and Kalam (North-West Pakistan). The other workers are; Basuray, Rao, and Gosain (2006), Haque (2007), Ramamasy (2007), Ali, Khan, Jam and Nafees (2008), and Roohi (2009) etc.

2. Material and methods

The present study has been proposed to conduct detail survey and to know the perception about climate change impacts on different environmental sectors in Swat River catchments area. The second target is to identify the existing coping strategies of communities and to recommend suggestions for improvement using questionnaire surveys and public interviews. The hypothesis that has been tested is, "Changes in climate and weather in the Swat river catchment area has affected different environmental sectors severely and adaptation strategies are needed to cope with the problem using the people perception." Generally, human are the consumer of the physical environment and their perception is of a prime importance to cope with the changing climate issue on local as well as international level.

3. Results and discussion

The section discusses the main findings of the study with special reference to people perception to precipitation, temperature, water resources, forests, landuse, socio-economic growth, irrigation, agriculture, climate change impacts, and adaptation in the Swat river catchment area, Swat district, Northwest Pakistan.

3.1. Perception to Precipitation

The results of the survey show increasing awareness: 100% believe that the climate is changing. Generally, 88% of the participants have believed that it has moderately, while 12% have opined for rigorously change with passage of time. About 93% of the people have speakout that climate of the valley felt cold but 100% of the sample has opined that the current climate has twisted warmer than it was in 2003. Moreover, 98% of the people have judged alteration in the rainfall of the valley. Among them, 85% have marked for the increase in rainfall and decrease in the snowfall (100%) during 2010 to 2013 (after flood). More than 90% among them have their views that this fluctuation in the precipitation has affected the area both in summer and winter seasons.

3.2. Perception to Temperature Fluctuation

People perception to temperature fluctuation has been collected through questionnaire survey from eight revenue villages of the Kalam and Utror valleys. All of the locals believe that the area is getting warmer with passage of time due to rise in the temperature condition. Among the people interviewed, 80% believe that the temperature is changing both in summer and winter seasons. Some of the people have the opined that because of climate change, the breeding of mosquitoes and flies increased since last five years in Gujjar Gabral area. The change has been more severed after flood that hit the area in 2010.

3.3. Perception to Climate Change and Water Springs

As regards the fall in watertable, 80% of respondents have opined that the underground water and watertable decreased with passage of time. The fall in underground water has been observed since the flood of 2010, when most of the area was destroyed and the cracks of the springs cut-down due to valley erosion caused by the flood water. The widening and deepening processes of the valleys have changed the floor of the valleys and the channels/pores of the springs elevated from the water

discharge and resulted in the declined of water flow from springs or changed it into seasonal. This has affected the irrigation system that in return caused change in the economy of the area. Generally, 70% of the participants have believed that this deterioration in the watertable is a result of deforestation, population growth, water demand, and decrease in winter snowfall (2 to 5 feet). Regarding a question has asked about the solutions to the problem of water scarcity and shrinking of flow from the springs; almost all people have suggested that reforestation and to improve the water supply and sanitation system. Moreover, 98% of the perceptions have shown willingness to the change in the cropping pattern and production in the area since 2010. The climate of the area has suitable for the growing of one crop before 2010, but now the local's have the ability to cultivate two crops, which is positive sign for the development of agriculture and food supply chain in the area.

3.4. Perception to Glaciers and Lakes

Reference to people perception about climate change and glaciers; 100% of the respondents have believed that the glaciers of the area shrunk with passage of time. About 95% have the opined that the glaciers in the area retreated since 2010 and the rate of melting of fresh snow remained higher in summer season. The valleys have no capability to store a year's snow till next year.

3.5. Adaptation to climate change and water resources

The major adaptive steps to the ongoing climate change and its impacts on the water sector in Kalam and Utror valleys per people perception are summarized as follow:

3.5.1. Water Conservation and River Embankments

To overcome the insufficiency of running water, caused by climate change, it is needed to construct water reservoirs that will help in the shortage of the water resources in future supplies to different parts of the valleys and recharging of watertable. During interviews, the locals are recommended the construction of Khushkhaba, sailaba, and cheek dams in the valleys and also to dig wells for water supply instead of water springs.

3.5.1.1. Improvement in the Irrigation System

Being an agriculture economy, Kalam and Utror valleys are extraordinarily dependent on its water infrastructure, and it has invested in it massively. Due to time factor, much of the infrastructure in the study area is collapsing or destroyed during the flood disaster of 2010 and requires investment of the Government for the re-establishment and improvement.

3.5.1.2. Early Warning System and Monitoring:

Due to increase in the climate hazards, the government has to improve its early warning system and monitoring network to enhance adaptive capacity in vulnerable sectors such as agriculture, natural disasters, water scarcity, glacier avalanches, and moraines lakes etc. To counter flood and storms, local government is required to develop Kalam flood control and water drainage plans and to introduce advance technologies for the monitoring and early warning system of flood, normal flow, glacier retreat, earthquakes, and weather forecasting.

3.5.1.3. Raising Public Awareness

The public needs to be made aware of the climate issues with respect to the impacts on the locals, physical, cultural, and socio-economic environment. To encourage public and private participation, increase the transparency of decision-making processes related to climate change issues, public awareness, social groups, non-government organizations to play active roles in the adaptation of climate change and to strengthen international cooperation.

3.5.1.4. Adaptation to Water Springs and Glaciers

Following are some recommendations for the adaptation of glaciers and springs in the study area.

- Strengthen glacial research and trans-national collaboration with emphasis on mass calculation and the effects of glacial recession on biodiversity and water resources availability downstream.
- Prioritize support to and development of adaptation to water-related disasters.
- Improve efficiency of current irrigation systems through the use of green technology and agricultural knowledge.

4. Conclusion and recommendations

People perception to temperature fluctuation has been collected through questionnaire survey from eight revenue villages of the Kalam and Utror union councils. The general opinion of the locals about climate change show an increasing awareness: Most of the participants said that it has changed moderately, while some of them believed that it is more sever. The people believed that past climate of the valley has cold as compared to current weather condition. Moreover, the majority have deemed that rainfall increased since last five years in summer (after flood) with certain declined in snowfall in winter season.

Almost all people believe that the area is getting warmer with passage of time due to a rise in the temperature condition both in summer and winter seasons. Some of the people have opined that because of climate change, the breeding of mosquitoes and flies increased since last five years in Gabral valley. This change has been more sever after flood that hit the area in 2010.

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