THESIS

PREDICTION OF SNOWMELT RUNOFF DUE TO IMPACT OF CLIMATE CHANGES: A CASE STUDY OF GILGIT CATCHMENT

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ABSTRACT

Climate change is a significant and long lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. The climate change impact is taken in terms of global warming means, increase in average temperature of earths near surface air. The Himalaya-Karakoram-Hindu Kush region that has world's third largest ice mass has warmed up about 1.5 °C that is almost double than remaining parts of the Pakistan (0.76°C) during last thirty years (Rasul, 2012).

The impact of climate change on snow melt runoff of Gilgit catchment was studied. The LARS-WG stochastic model was used to predict future change in climate parameters and snow depletion rate of Gilgit catchment during different months (Jan to Dec). The snow covered area was estimated using remote sensing and GIS techniques. The snowmelt runoff simulation of Gilgit River basin was done using temperature index approach.

The necessary research data was taken from Pakistan Meteorological /department (PMD) and Surface Water Hydrology Project (WAPDA). MODIS Terra product MOD 10 A1 has been employed for the investigation. The daily MODIS was used in this study. The MODIS data was processed in Arc GIS for the estimated of snow covered area into Gilgit Catchment. The SRTM DEM of 90 meter resolution was used to delineate Gilgit watershed. The Snowmelt Runoff Model (SRM) was used for calibration, simulation and prediction of snowmelt runoff of Gilgit River basin under changed climate scenarios. The LARS-WG stochastic weather generator was used for future projections of climatic data like temperature and precipitation of Gilgit catchment. The Mann-Kendall and Sen's slope methods were used to see the past and future trends of rainfall, minimum, maximum and average temperature of

Gilgit catchment. The data generated by LARS-WG did not show any significant change in temperature and precipitation that could be used in SRM to predict future flows. The data of future projections of (PRECIS_25km resolution) regional climate model was used in SRM for prediction of future flows under changed scenarios of temperature and precipitation.

The SRM was calibrated on four years 2001 to 2004 and it has shown good correlation between observed and simulated flows with coefficient of model efficiency 0.89, 0.94, 0.95 and 0.944 respectively. The calibration of LARS-WG showed good correlation between observed and synthetic weather data with Pearson's correlation coefficient 0.995, 0.997 and 0.77 for maximum, minimum temperature and rainfall respectively. The results showed that during past 50 years from 1961 to 2010 summer flows of Gilgit River were increased by 15% and winter by 12 %. The GCM HadCM3 and emission scenario SRA2 was used and predictions were made for three future scenarios, 2040, 2070, 2099.The results developed by LARS-WG showed that annual maximum, minimum and average temperature will increase by 1.12°C, 0.61°C and 0.85°C respectively from 2011 to 2099. The results showed that total annual rainfall will increase approximately 36.77mm from 2011 to 2099.

The climate change scenarios made by regional climate model (PRECIS_25km resolution) showed that average annual temperature of Gilgit River basin will increase by 0.30°C till 2030, 1.30°C till 2050 and 3.1°C till 2099 and these values were used in SRM, it was predicted that summer flows in Gilgit River will increase about 4%, 18% and 42% respectively. There was observed increasing trend in annual maximum and minimum temperature of Gilgit catchment from 2011 to 2099. It was observed more increase in winter maximum and minimum temperature as compared to annual and summer temperature. The climate change scenarios 10%

and 20% increase in cryosphere area were used in SRM and it predicted that due to this increase in cryosphere area, summer flows in Gilgit River will increase by 13% and 27% respectively in Gilgit River.