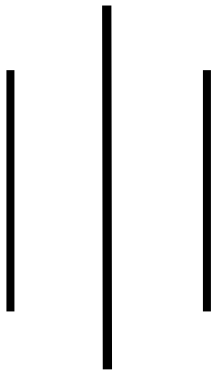
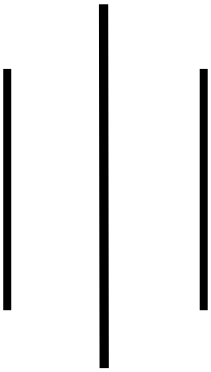
THE IMPACT OF CLIMATE CHANGE ON RUNOFF GENERATION IN LANGTANG BASIN NEPAL



Dissertation submitted to the Central Department of Hydrology and Meteorology in partial fulfillment of the Master's Degree of Science in Meteorology



By
Gopi Adhikari

Central Department of Hydrology and Meteorology
Institute of Science and Technology
Tribhuvan University, Kirtipur
Kathmandu, Nepal
April, 2014

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY & METEOROLOGY
Phone No.: 4-331418, 4-333887
Office of the Head of Department
Kirtipur, Kathmandu, Nepal
Fax No.: 977-1-4331964

Ref. No.:

Date: .....

Letter of Recommendation

This is to certify that Mr. Gopi Adhikari has prepared the dissertation entitled "**THE IMPACT OF CLIMATE CHANGE ON RUNOFF GENERATION IN LANGTANG BASIN"** to fulfill the partial requirement for the award of the degree of Master of Science in Meteorology of the Tribhuvan University. It is the record of the candidate's own work carried by him under my supervision and guidance.

Dissertation Supervisor

…….

Mr. Tirtha Adhikari
Associate professor
Central Department of Hydrology and Meteorology
Tribhuvan University, Kirtipur Kathmandu, Nepal

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF HYDROLOGY & METEOROLOGY
Phone No.: 4-331418, 4-333887
Office of the Head of Department
Kirtipur, Kathmandu, Nepal
Fax No.: 977-1-4331964

Ref. No. :

Date: .....

Letter of Approval

The dissertation entitled **"THE IMPACT OF CLIMATE CHANGE ON RUNOFF GENERATION IN LANGTANG BASIN"** submitted by Mr.Gopi Adhikari has been approved as a partial fulfillment for the Masters of Science in Meteorology.

…….	…….
Prof. Dr. Lochan Prasad Devkota (Internal Examiner) Head Central Department of Hydrology and Meteorology Tribhuvan University Kathmandu, Nepal	Mr. Tirtha Adhikari (Dissertation Supervisor) Associate professor Central Department of Hydrology and Meteorology Tribhuvan University Kathmandu, Nepal

……
Dr. Dibas Shrestha
(External Examiner)
Scientific Officer, NAST

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Gopi Adhikari

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ABSTRACT

Climate change has potential impacts on economy, ecology, and environment of Himalayas. Climate change studies in Himalayan regions have focused mainly on glacier melting and retreating, Glacial Lake Outburst Flood (GLOF) etc. Changing temperature has direct impacts on glaciers and snow that affects the snowmelt and river discharge. Hence, this research has been carried out to understand the impact of climate change on runoff generation of Langtang basin. This runoff is important for planners and designers in the aspect of irrigation, hydropower, and drinking water supply and so on. So, the runoff estimation study is essential. This study is carried out using monthly Thornthwaite water balance model. Thornthwaite monthly water balance model is one of the popular model developed by USGS for the runoff estimation and can be applied to estimate the runoff of snow and glacier bound catchment. This study also focuses on the runoff estimation of past, present and future scenario at Langtang region of Nepal by using the Thornthwaite model. The outputs of the analysis on temperature trend revealed a faster warming trend in Langtang area (i.e. 0.084 ºC/year). The mean annual soil moisture storage is increasing pattern (i.e.0.71mm/year).The precipitation and runoff are also observed increasing (i.e.10.59mm/year and0.8mm/year).The coefficient of determination of calibration and validation are 0.926and 0.996 that implies that the model is well validated and calibrated as well. The increase/decrease in temperature and runoff has proportional relationship and increase/decrease in rainfall and runoff has also proportional relationship. The projected runoff by the model is slightly decreasing from 2001 to 2060 this result shows that the chances of flood in summer and possible drought in winter may further enhanced in the future. The main outputs of this study help to implement appropriate strategy for water resources management and hydropower development and provide a strong message on the scenario of the Global impact of warming in the Himalayan region.

Keywords: Climate change, Thornthwaite, temperature, precipitation, runoff, Soil-moisture.

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ACRONYMS AND ABBREVIATIONS

AET	Actual Evapotranspiration
ASL	Above Sea Level
BBC	British Broadcasting Council
CCCM	Climate Change Circulation Model
CDHM	Central Department of Hydrology and Meteorology
CIG	Climate Impact Group
CO	Carbon Monoxide
CO2	Carbon Dioxide
DCC	Double Cumulative Curve
DEM	Digital Elevation Model
DHM	Department of Hydrology and Meteorology
DRO	Direct Runoff
GCMs	Global Climate Models
GIS	Geographical Information System
GLOFs	Glacier Lake Outburst Floods
GSM	General Circulation Model
HAD	High Aswan Dam
HadCM3	Hadley Centers Third- Generation General Circulation Model
HKH	Hindu Kush Himalaya
HVB	Hydrologiska Byrans Vattenbalansaveling
ICIMOD	International Center for Integrated Mountain Development

IPCC	Intergovernmental Panel on Climate Change
MODIS	Moderate Resolution Imaging Spectrodiometer
MOS	Model Output Statistics
NCEP	National Center for Environmental Program
NRB	Nanjing River Basin
PDD	Positive Degree Day
PET	Potential Evapotranspiration
RCMs	Regional Climate Models
RO	Runoff
SCA	supervisory Control Acquisition
SDSM	Statistical Downscaling Model
SRM	Snow Melt Runoff Model
STW	Soil-Moisture Storage Withdrawal
T-max	Maximum Temperature
T-mean	Mean Temperature
T-min	Minimum Temperature
TU	Tribhuvan University
USGS	United States Geological Survey
WMO	World Meteorological Organization