

National Symposium on Hydrology and Meteorology-2015

**December 24, 2015
Kathmandu**

ABSTRACTS



**Society of Hydrologists and Meteorologists - Nepal
SOHAM-Nepal**

National Symposium on Hydrology and Meteorology-2015

**December 24, 2015
Kathmandu, Nepal**

Organized by



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(SOHAM-Nepal)**

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ABSTRACTS

**National Symposium on Hydrology and Meteorology-2015
(December 24, 2015)
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**Society of Hydrologists and Meteorologists - Nepal
(SOHAM-Nepal)**

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Editors

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ORAL PRESENTATIONS

PRELIMINARY STUDY OF THE HYDROGEOLOGICAL CHARACTERISTICS OF WATER SOURCE AND DRINKING WATER SUPPLY SYSTEM OF KYANGJING VILLAGE, LANGTANG, NEPAL

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ABSTRACT

Spring water is a dominant source of water in the mountain region and used for household purposes widely. It is necessary to understand the characteristics and availability of spring water to make better use of water. Rainfall, land use, vegetation, grazing incidence and geomorphology of the recharge zone in the mountain watershed controls the spring discharge. Limited knowledge is present about the nature of the spring in response to rainfall, recharge zone, role of the vegetation, and land use in spring recharge. The study focus on the understanding and analysis of hydrogeological characteristics of water sources and drinking water supply system in the Kyangjing village, Langtang. Hydrological analysis of the study area using volumetric gauging method shows the discharge of the 3 different springs is 0.0243 lps, 0.0133 lps, 0.255 lps, respectively. Spring inventory has been done to study the hydrogeological characteristics of the water source. Quartzite and Gneiss are most dominant rock present in the study area. Feldspar as a dominant mineral and sand, silt, clay are also found in the springs. Among 5 springs 4 of them are identified as contact spring and remaining as the depression spring. Hydrogeological mapping has been done by using Arc GIS 9.3 to identify the recharge area of the water sources and its area. Questionnaire survey is also done to identify the water consumption pattern in the study area. The comparative study of the water consumption pattern in the tourist season and off season has been done. The average water consumed is 211 liters and 1117 liters per a household during off and tourist season, respectively. Water scarcity problem is observed during the winter season.

KEYWORDS: Hydro geological characteristics, Spring, Water consumption pattern

ASSESSMENT OF HYDROLOGICAL RESPONSE UNDER CLIMATE CHANGE SCENARIOS USING SWAT MODEL- A CASE STUDY OF SINA CATCHMENT, INDIA

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ABSTRACT

This study implicates Geographical Information System (GIS) and hydrological modelling tools, namely, Soil and Water Assessment Tool (SWAT), to various scenarios of climate change such as the change in temperature and precipitation, to estimate the potential impact of climate change on annual water balance components like precipitation, evapotranspiration and water yield, in a typical catchment in the Sina Catchment, Bhima Basin, India. Discharge was also analyzed at the outlet point for validation of the model output. Sequential Uncertainty Fitting Program (SUFI-2) in SWAT- Calibration and Uncertainty Programs (SWAT-CUP) was used for automatic calibration. Model performance was evaluated using several statistical parameters, such as the Nash–Sutcliffe coefficient and the normalized objective function. For calibration (1981-85), R² was obtained as 0.92 and for validation (1986-1990) it was 0.76. Similarly, NSE during calibration was 0.88 and during validation was obtained as 0.76. Calibration and validation results showed good agreement between simulated and observed data.

Hydrological Simulations were conducted for Base Line, A2 and B2 scenarios using HadRM3 data. The overall investigation carried out during this study indicates that the simulated Sina catchment is very sensitive to climatic variations. Precipitation trend is decreasing in A2 as compared to Base Line with slight overall increase whereas in B2 precipitation is increasing significantly. While only little changes can be observed in the rate of evapotranspiration, water yield is increasing drastically. The study of the discharge for a thirty year period under climate change scenarios showed that there was an increase in river discharge in future scenarios. Compared to the Base Line scenario (1961-1990), A2 and B2 scenarios (2071-2100) have much higher minimum and maximum annual discharges.

KEYWORDS: Climate change, Water Balance Component, SWAT Model, SWAT CUP, PRECIS, Flow analysis

SPATIAL AND TEMPORAL VARIATION IN PRECIPITATION IN PANCHASE REGION OF NEPAL

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ABSTRACT

Time series statistical tests were applied to examine the spatial and temporal trends and four seasons (Pre-monsoon; Monsoon; Post-Monsoon and Winter) during the period 1979–2013 in Panchase region. Pre-monsoon, Monsoon and Post-monsoon rainfall was observed to follow positive trends where as the winter rainfall depicts negative trend. The non-parametric Mann-Kendall test was used to determine whether there is a positive or negative trend in data with statistical significance. The test, applied on a seasonal basis to the precipitation revealed no statistically significant trends over the past 33 years. The 24 hours rainfall analysis indicates the increasing trend but not statistically significant. The extreme event analysis for >100mm was performed in two segments (1979-1990, 1991-2009). The result shows increasing trend in later segment 1991-2009. The results highlighted a mix of positive (increasing) and negative (decreasing) trends in monthly, seasonal, and annual precipitation. The study provides major evidence that rainfall is highly variable within local settings. The findings were use in resilience planning at local level in which the community members envisioned future scenario. The scenarios emphasised in proposing ecosystem based adaptation measures.

KEYWORDS: Panchase, Rainfall, Trend Analysis, Mann Kendall

WATER BALANCE OF NEPAL AND CLIMATIC CLASSIFICATION BASED ON MOISTURE REGIMES

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ABSTRACT

An attempt has been made to prepare the climatic map of Nepal based on moisture regime as defined by Thornthwaite. All together 97 meteorological stations throughout Nepal are selected for analyses. In order to calculate water balance, Modified Penman method is used to estimate potential evapotranspiration. Due to the limitation of available meteorological parameter necessary for the computation, multiple regression formulae based on elevation, latitude and longitude is used. This paper also describes in detail the computation of potential evapotranspiration. Water balance of all the stations are calculated to obtain moisture index and other parameters viz. Actual Evapotranspiration, Water Deficit, Water Surplus and their corresponding maps are prepared and its parameters discussed. Finally climatic map based on the moisture regime is presented.

KEYWORDS: Evapotranspiration, Water balance, Moisture Index

COMPARISON OF AUTOMATIC AND MANUAL PRECIPITATION: A CASE STUDY ON NEPALGUNJ STATION

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ABSTRACT

A comparison of data was carried out in Nepalgunj station for 2011-2014 periods and manual recorded precipitation is used as reference. This study has attempted to quantify and understand the differences in precipitation amounts between manual and automatic. In addition, the possible causes behind the disparity of automatic and manual observational data are also discussed. Automatic measurement with high temporal resolution is very important for study of short-duration extremes, now-casting and, increasingly, for real time weather monitoring whereas there is need to continue manual network for climate monitoring purpose and checking the reliability of automatic network. This study has just taken Nepalgunj station as representative station and limited to precipitation data. In case of Nepalgunj station, the data quality is fairly satisfactory. In normal operation the precipitation measured by tipping bucket is underestimated by around 10-15%. The importance of meteorological data usage needs to be in high priority.

KEYWORDS: precipitation, manual station, automatic station, comparison

ACTIVITIES AND ACHIEVEMENTS OF MOUNTAIN ENVIRONMENTAL VIRTUAL OBSERVATORY (MEVO) PROJECT, NEPAL.

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ABSTRACT

The Mountain EVO project entitled "Adaptive Governance of Mountain Ecosystem Services for Poverty Alleviation enabled by Environmental Virtual Observatories" is a joint research initiatives implemented in Nepal, Peru, Ethiopia and Kyrgyzstan. The main objective of the project is to reduce the poverty by providing the better information on ecosystem services on which local livelihood is depended. The upper mustang region is climatically rain shadow and arid. The major ecosystem services of the region are water, agriculture and pasture land. Changes in precipitation and temperature pattern have severely affected snow accumulation and water yield for irrigation. In this context, the project aims to address the knowledge gap especially on water availability and its proper management mainly based on the citizen's knowledge and scientific measurements. It is an effort of coproduction and co-sharing of knowledge. For achieving the goal, the project has installed scientific instruments for water flow monitoring and precipitation on its case study site. The output of the results will be shared to local community and local level decision makers through various means so that they can better informed on the existing ecosystem services and enhance their livelihood.

KEYWORDS: Ecosystem services, livelihood, precipitation, temperature

IMPACT OF CLIMATE CHANGE ON PRECIPITATION IN THE KARNALI BASIN, NEPAL

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ABSTRACT

This study highlights the impacts of climate change on precipitation in the Karnali Basin of Nepal. Long term trend analysis of precipitation was performed by RClimDex using historical time series data from 32 Department of Hydrology and Meteorology (DHM) stations. The analyses included observing decadal trends as well as that for a period of 30 years (1981-2010). The latest projections for climate change scenarios prescribed by the Fifth Assessment report of Intergovernmental Panel for Climate Change (IPCC) AR5 were used in this study for climate change analysis. GCM from Canadian Earth System Model (CanESM2) was used for generating future climate data which was downscaled using Statistical downscaling model (SDSM) for Representative Concentration Pathways (RCPs) scenarios 2.6, 4.5 and 8.5 representing low loading, average loading and high loading case respectively. Analysis of future climate change was carried out for three time windows - near future (2011-2040), midterm future (2041-2070) and long term future (2071-2100). Trend analysis of past precipitation data did not show any distinct pattern or trend towards any particular direction, although natural climatic variability was clearly observed. Further, comparison of the annual mean precipitation for the future (2011-2100) with the baseline period (1981-2010) showed increasing pattern in all the stations for the three RCP scenarios 2.6, 4.5 and 8.5 for all the time windows.

KEYWORDS: Precipitation, Trend Analysis, Climate Change, Downscaling, Karnali, RClimDex

THE CHANGING FREQUENCY OF DROUGHT IN NEPAL

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ABSTRACT

Drought is a disastrous natural phenomenon that has significant impact on socio-economic, agricultural, and environmental aspects. Recent and potential future increases in global temperatures are likely to be associated with impacts on the hydrologic cycle, including changing pattern and shifting in precipitation which enhances the frequency in drought occurrence. Based on 76 meteorological stations, which cover the period of 1982-2012, we analyzed the presence of trends and frequency of drought over Nepal. In order to define drought conditions we used the Standardized Reconnaissance Drought Index (RDI_{st}). It has been revealed that all the three kinds (moderate, severe and extreme) of droughts occurred in Nepal. During the year 1989, 1992, 1994, 2005, 2006, 2010 and 2011, most of the stations in all five development regions experienced moderate drought condition. More than 43% of the stations were affected with extreme drought conditions during the year 1982, 1984, 1987, 1988, 1989, 1990, 1991, 1992, 1994, 1998, 1999, 2000, 2004, 2005, 2006 and 2010, and were located mainly on the eastern and western development regions of Nepal. Most of the drought events that affected the great portion of Nepal were recorded during 1990s and 2000s, although prolonged period of drought were recorded during 2004-2011. A linear trend analysis between 1982 to 2012 showed increase in drought frequency in latter stage, mostly in western region of Nepal.

KEYWORDS: Drought, Nepal, Frequency, Standardized Reconnaissance Drought Index (RDI_{st})

BOUNDARY LAYER CHARACTERISTICS ASSOCIATED WITH NORTHWESTERLY GAP WIND FLOW OVER THE KATHMANDU VALLEY

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ABSTRACT

Kathmandu valley is an elevated broad circular valley located in the middle hills of Central Nepal Himalaya. It is completely enclosed by mountains and hills but it has low-mountain passes in the western and eastern rim and a river gorge in the southwestern part of the valley. The northwesterly and southwesterly winds that, respectively, intrude from the western low-mountain pass and the river gorge constitute the prominent wind system of the valley. Understanding the boundary layer characteristics over an area of interest is very important as it plays a deterministic role in the nature of the air mass circulation over the area. In this paper, we will present the boundary layer characteristics over Ain Danda low-mountain pass from where the northwesterly wind intrudes into the valley and at the center of the valley where it merges with southwesterly as revealed by two-weeks long field measurements at each site by deploying a Monostatic Flat Array Sonic Detection and Ranging (sodar). The study shows that the Ain Danda pass channels northwesterly winds into the valley during the daytime whereas it drains air mass out of the valley during nighttime. The speed of the daytime wind often exceeds 6.5 m/s during the late afternoon. Nighttime stable layer was highly fluctuating with an average around 300 m and daytime mixing layer height was suppressed limiting it in between 285-350m above the ground in early part of the day but reduced to 140 m during the late afternoon. Comparison of diurnal variation of mixing layer height at Ain Danda with that of the central area of the valley floor strongly suggests that air mass intruding into the Kathmandu valley through this pass is a cool density flow over the weakly stratified mixed layer of the valley. Further investigations on the boundary layer characteristics associated with southwesterly wind and with the wind channeling out into the eastern valley and their implications on the air pollution dispersion over the valley will also be discussed.

KEYWORDS: Sodar, Boundary layer, Gap flow, Mixing layer

ALL NEPAL SUMMER MONSOON RAINFALL VARIABILITY, ITS DYNAMICS AND ASSOCIATED TELECONNECTION WITH TROPICAL PACIFIC AND INDIAN OCEAN OSCILLATION

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ABSTRACT

The inter-annual variability of Nepalese monsoon is largely affected by tropical Pacific and Indian Ocean oscillations because these large scale oceanic dynamics have pronounced impact on regional circulation over South Asia. In this research we have tried to establish statistical relationship among Pacific and Indian Ocean Oscillations and All Nepal Summer Monsoon Rainfall (ANSMR), and finally unravel the dynamics of ANSMR. Appropriate indices for El Niño Southern Oscillation (ENSO), Indian Ocean dipole (IOD), Walker and Hadley circulations have been applied and their connection with ANSMR was investigated. Furthermore, to understand the moisture transportation mechanism during monsoon season, moisture budget analysis was carried out using the Moisture Flux Divergence Equation.

Analysis of ANSMR using APHRODITE data for the period 1979-2007 suggested the great spatial and temporal variation with 9 to 11 years cyclic oscillation, however, no clear trend was observed over the study period. Strong negative correlation was observed between ANSMR and Nino3.4 index ($r=-0.50$, $p<0.01$). IOD events have significant impact on Nepalese monsoon with countering effect over ENSO. The impact of El Niño (La Niña) on ANSMR is largely reduced by PIOD (NIOD) when composite of co-occurring El Niño-PIOD and La-Niña-NIOD was considered.

There was a negative association ($r=-0.589$, $p<0.01$) between zonal Walker and meridional Hadley circulation. Both of those of tropical circulation were found to be tightly coupled with ANSMR. In particular ANSMR was positively correlated with Walker circulation ($r=0.69$, $p<0.01$) and negatively correlated with Hadley circulation ($r=-0.632$, $p<0.01$). Interestingly, the correlation between western Nepal rainfall and these two tropical circulations was significantly low compared to eastern and central region rainfall, indicating the limited influence of the tropical circulation on western region precipitation.

The inter-annual variability of ANSMR was consistent with north-south shift in the position of monsoon trough. Particularly, northward shift in the position of trough was associated with high rainfall in Nepal and southward shift in the position of trough was associated with less rainfall in Nepal. Analysis of moisture flux divergence revealed that there was dipolar nature of moisture convergence during the high and low ANSMR years. Moreover, moisture convergence occurred around Arabian Sea and western coast of India in high ANSMR years, while moisture convergence occurred around eastern coast of India in low ANSMR years. Similar pattern was observed in the case of La Niña and El Niño years. In summary, the dynamic behavior and inter-annual variability of ANSMR is largely affected by tropical Pacific and Indian Ocean oscillation and associated atmospheric teleconnections.

KEYWORDS: ANSMR, El Niño, La Niña, IOD, trough

ASSESSING WIND POWER POTENTIAL OVER THE EXTREME TERRAIN OF NEPAL HIMALAYA

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ABSTRACT

Assessing wind power potential over the extreme terrain of Nepal Himalaya is a challenging task. However, as techniques of wind resource assessment have improved greatly in recent years, it is possible to assess regional-scale wind power potential at desired spatial grid resolution and accuracy taking advantages of advanced mesoscale meteorological models and geographic information system. In this paper, we will present an integrated methodology that can be utilized for an accurate wind power assessment over the complex terrain of Nepal Himalaya with a demonstrative case study over the world's deepest river gorge, the Kali Gandaki River Valley, in Mustang District of Nepal. Imposing the geographic, social, economic, and technological restrictions under Multi-criteria Decision Making procedures, the annual theoretical wind power potential over the valley turns out to be around 9500 GWh. However, practical power production depends on the efficiencies and physical limitations of wind turbines. Possible power productions in reference to power curves available for different types of and company make turbines will also be presented. Present projection of wind power production over the Kali Gandaki valley, to the best of our knowledge, is the most realistic one as we have, for the first time, assessed regional wind power potential at the horizontal grid size of 1 km² with the adoption of Multi-criteria Decision Making procedures.

KEYWORDS: Himalaya, Mesoscale Meteorological Model, Geographic Information System, Multi-criteria Decision Making

MOUNTAIN WAVE EXCITATIONS IN AND AROUND THE KATHMANDU VALLEY

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ABSTRACT

The mountains waves are undulations developed in the atmosphere when stably stratified air is constrained to pass through a topographic barrier. Depending upon the scale of topographic complexities and the atmospheric conditions, mountain waves may either remain trapped within the shallow layer of lower troposphere or propagate vertically up to great heights. The trapped waves occasionally manifest in the form of wave clouds or rotor clouds in parallel bands. The energy associated with trapped mountain waves generally dissipate very slowly downwind and may continue downstream for many wavelengths spanning many tens of kilometers. Wave clouds are often seen over the Kathmandu valley initiated from the southern and western mountain ridges extending beyond the respective mountain gaps of the valley. The southern and western mountain gaps are the major gateways of Tribhuvan International Airport (TIA). As the flow beneath the wave crests is often turbulent that poses significant hazards to the low-level aviation activities, it is very important to understand, model and predict the mountain wave excitations over the area so that possible aircraft accident or flight discomfort can be avoided. In this paper, we will present the successful numerical reproduction of temporal evolution and spatial distribution mountain wave excitation over the southern gateways of TIA on 31 December 2014 using the Weather Research and Forecasting (WRF) modeling system. Present study over the Kathmandu valley along with other parts of the middle hills of Nepal Himalaya indicate that mountain wave excitations and possible impacts on low-level aviation activities can be successfully predicted.

KEYWORDS: Mountain wave, WRF model, stratified atmosphere

STUDY OF ANNUAL MASS BALANCE (2011-2013) OF RIKHA SAMBA GLACIER, HIDDEN VALLEY, MUSTANG, NEPAL

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ABSTRACT

Little is known about the Himalayan glaciers due to lack of reliable and consistent data, although they are of particular interest in terms of future water supply, regional climate change and sea-level rise. There is thus an urgent need of monitoring the glaciers to bridge the knowledge gap. Therefore, glaciological observation has been carried out by the Cryosphere Monitoring Project (CMP) since September 2011 on the Rikha Samba Glacier in Hidden valley, Mustang district in western Nepal in order to study the annual mass balance. There are ten glaciers in Hidden Valley named G1, G2, G3 up to G10 out of which G5 is the Rikha Samba Glacier having the largest area of 5.37 km² in this valley and the highest and lowest altitudes of the glacier are 6476 m a.s.l. and 5392 m a.s.l. respectively. The glacier mass balance using glaciological method and Equilibrium Line Altitude (ELA) are calculated in this study. The glacier shows a net mass balance of -1.80 ± 0.097 m w.e. for the lower part of the glacier from 10 September 2011 to 3 October 2012 and -0.206 ± 0.019 m w.e. for the whole glacier from 4 October 2012 to 30 September 2013 indicating shrinkage of the glacier. The Equilibrium Line Altitude (ELA) of Rikha Samba Glacier is estimated at 5800 m a.s.l. in 2013. The magnitude of net mass balance for 4 October 2012 to 30 September 2013 is lower than that from 10 September 2011 to 3 October 2012 because we consider only ablation area for period September 2011 to October 2012. The result obtained from this research suggests that the glacier is showing negative mass balance for two years from 10 September 2011 to 30 September 2013 which can be attributed to warming in this region. These results are the preliminary results of scientific study initiated by the CMP which aims to give an account of meteorological and glacio hydrological observations in the glacierized Sangda River basin. This information can also be of great use in determining the ultimate state of the cryosphere of the Himalayan region.

KEYWORDS: Ablation, accumulation, climate change, glacier mass balance, Himalayan glacier

ESTIMATION OF DISCHARGE FROM GILGIT RIVER BASIN, KARAKORAM PAKISTAN USING A GLACIO-HYDROLOGICAL MODEL

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ABSTRACT

The Hindu Kush, Karakorum and Himalayan (HKH) mountain ranges contain some of the largest glaciers, extensive perennial snow and ice covered areas of the world outside the Polar Regions and nourishes large Asian river basins with significant amounts of snow and glacier melt. In scarcity of hydro-meteorological and cryospheric data in these mountainous regions, the temperature index model or degree day model often serves as a powerful tool in ice and snow melt computations on a catchment scale. This study uses modified positive-degree day model (MPDDM) to estimate daily discharge of Gilgit River basin (drainage area: 13,471 km²) geographically, extends from 35.80°N, 72.53°E to 36.91°N, 74.70°E, a sub-catchment of upper Indus basin in the high Karakorum region. The modified positive-degree model is based on the relation that the melting of snow or ice during any particular period is proportional to the positive degree-days linked by the positive-degree day factor involving a simplification of complex process that are more properly described by the energy balance of the glacier surface and overlaying atmospheric boundary layer. The degree-day factors used in the current study are taken from the field studies carried out by the Pakistan Meteorological Department to Hinarchi Glacier, Bagrot Valley, Gilgit in 2008. The degree-Day factor was measured for different type of glaciated ice and snow, which includes debris covered ice, firn, bare ice cliffs and snow bestowed by summer snowfalls. These values ranges from 1-6 mm/°C/d. The degree-day factors estimated in the Karakorum region by different authors for snow and ice ranges from 1-14 mm/°C/d and debris cover ice ranges from 1.13 – 7.73 mm/°C/d. The model is calibrated from 2001 to 2005 and the validation period of the model is from 2006 to 2010. The observed and simulated average discharges for the calibration years are 307.07 m³/s and 298.79 m³/s and for validation years are 316.59 m³/s and 302.92 m³/s, respectively. The Nash – Sutcliffe model efficiency coefficient values and volume differences are 83 % and ~2.7 % in the calibration years and 74% and ~4.3%, respectively in the validation years. Similarly, the relative contribution of snow and ice melt in the total discharge in the calibration and validation years are 24 % and 22%, respectively. The results obtained from the MPPDM showed that this model is good enough to estimate daily discharge from glacierized river basins. It can also be used in climate sensitivity studies and other hydrological and ice dynamic modelling. It is also helpful in the prediction of future discharge.

KEYWORDS: Modified Positive degree day model, climate sensitivity, prediction of future discharge

COMPARISON OF DEPENDABILITY OF THE POROSITY, PERMEABILITY AND DENSITY ON GRAIN TEXTURE OF THE GLACIOFLUVIAL AND GLACIOLACUSTRINE SEDIMENTS, CHANDRA BASIN

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ABSTRACT

Permeability, porosity and density the three factor greatly influence many geological processes. Permeability is one of the important parameter measured to understand the storativity and passage of the water, snow, etc. through the sediments. Although many methods have been developed by geologist, soil scientist and engineers to estimate the permeability of sediment and rock but still there is a lack of adequate understanding. Insufficient data exist for measuring the permeability especially in the glacial environment where poorly sorted sediment are common. The texture of the sediments is an important tool to measure the permeability of sediment. Several studies also measure the permeability of sediment through proxies like grain size, texture etc. Porosity and bulk density greatly affects the permeability of sediments.

Glaciolacustrine and glaciofluvial sediments were studied from Chandra Basin, Himachal Pradesh, India. Chandra-Bhaga is the sub-basin of Chenab basin, lying on the northern ridge of Pir Panjal range of the Himalaya with an elevation range between 2400 m above sea level and 6400 m above mean sea level. This region is important as it falls in the monsoon-arid transition zone and marks the boundary of wet climate to its south and a dry climate to its north. The glaciers of this region are influenced by South Asian monsoons in the summer and westerlies in the winter. The region is composed of metamorphic rocks with their sedimentary cover. The glacial sediments were collected from near the base camp and snout of Chhota Shigri Glacier (western Himalaya, Lahaul-Spiti valley, Himachal Pradesh). The lake sediments were also collected from within the periphery of Chandratil Lake (Lahaul-Spiti valley, Himachal Pradesh). The glaciofluvial and glaciolacustrine sediment is analysed for the statistical and physical parameters i.e. mean, standard deviation, skewness, kurtosis, porosity, permeability and bulk density. Grain size distribution is analysed through the mechanical sieving. The porosity of the sediment is measured through the column saturation method. Correlation among the different parameters tried to explain through the regression analysis. The correlation between permeability and mean grain size shows a good regression coefficient ($R^2 = 0.829$ and $R^2 = 0.581$ for glaciofluvial and glaciolacustrine sediments respectively). Correlation of the density and porosity is also established against mean grain size with a good regression coefficient. Hence the study of sediment grain size and texture were found to be a useful tool to understand the permeability, porosity etc. and movement and mobility of water, snow etc. through the glaciofluvial and glaciolacustrine sediments. The correlation study also shows that the mean grain size could be used as factor for predicting the physioempirical model in that region.

KEYWORDS: Himalayan glaciers, permeability, porosity, bulk density, glaciofluvial, glaciolacustrine, mean, standard deviation, skewness, kurtosis

APPLICATION OF MODIFIED POSITIVE DEGREE DAY MODEL (MPDDM) FOR ESTIMATING DISCHARGE FROM GLACIERIZED HUNZA RIVER BASIN, KARAKORAM, PAKISTAN

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ABSTRACT

Pakistan, an agriculture-based country is highly dependent on the Indus irrigation system. The Indus River is the main source of water in Pakistan. The upper Indus basin includes the Gilgit, Hunza, Shigar, Shyok, Zaskar, Shingo, Astor, and Upper Indus sub-basins. A major proportion of flow in the Indus River is contributed by its snow and glacier-fed river catchments situated in the Karakoram Range. It is therefore essential to estimate the discharge from the catchment for water resources management. The present study conducted in the Hunza River basin (drainage area: 13,713 km²) geographically, extends from 36.05°N, 74.04°E to 37.08°N, 75.77°E situated in the high-altitude central Karakoram region, with a mean catchment elevation of 4,631 m. Approximately 4,463 km² of catchment area is at an elevation above 5,000 m and almost the same area (33%) is glaciated. The total numbers of glaciers in basin are 1,500 approximately. The clean glacier area is 3,673 km² and the debris cover area is 479 km². This study analyses an opportunity to estimate the daily discharge, snow and ice melt contribution from the debris free area as well as ice melt under debris layers based on the positive degree-days calculated from daily mean temperature and precipitation from glacierized Hunza River Basin for 1995 - 2004 using Modified Positive Degree Day Model (MPDDM). This model is based on the relation that the melting of snow or ice during any particular period is proportional to the positive degree-days linked by the positive degree day factor involving a simplification of complex process that are more properly described by the energy balance of the glacier surface and overlaying atmospheric boundary layer. This approach is appropriate in region with scarce data as it requires less input data and uses simple equation to estimate melt. Daily temperature and precipitation data from the Naltar climate station of Water and Power Development Authority (WAPDA), Pakistan is used in the model as input. The model has been calibrated for 1995 – 1999 and validated for 2000 – 2004. It has revealed that the observed and simulated daily average discharge for the calibration years are 275.13 m³/s and 267.29 m³/s and for validation years are 292.88 m³/s and 271.37 m³/s, respectively. In addition the model results a good agreement between observed and simulated discharge. The Nash-Sutcliffe Efficiency is 86.2% for calibration and 85.8% for validation years and the differences in volume are 2.85% and 7.34%, respectively in the calibration and validation years. The snow and ice melt contribution for calibration and validation years are 39.38% and 38.65%, respectively. The obtained results enable us to conclude that the MPDD Model can be used to estimate the discharge of snow and glacier fed mountainous catchments like Hunza River basin and can also be used to study the impact of climate change in such basins and also useful for the future prediction of discharge to define hydro-power potential and other water resource management in the area which is the next step of this study.

KEYWORDS: Modified positive degree day model, Upper Indus Basin, water resource management, future discharge projection

POSTER PRESENTATIONS

FREQUENCY ANALYSIS AND FLOOD FORECASTING USING RCM DATA IN HEC-HMS FROM DUDHKOSHI BASIN NEPAL

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ABSTRACT

Rivers from Nepal are poorly gauged specially in the high altitudinal area. In this study seven rainfall stations and one gauged Rabuwa and another ungauged Thotna Khola were taken to our hydrological modelling purpose in DudhKoshi River basin, Nepal. The observed and future projected Providing Regional Climates for Impact Studies (PRECIS) data were taken from DHM. Future precipitation bias corrected data were used to determine the characteristics of high flow events in the basin, in which snowmelt runoff was not taken into consideration. This research investigates the potential changes on discharge and flood events in future in DudhKoshi Basin. Long term hydrology, Flood frequency analysis were carried out. In case of ungauged basin where no historical data was available, regional flood frequency analysis is considered as a viable means to approximate at-site flood characteristics by exploiting the information available at neighboring sites. For this study, a lumped hydrological model developed in HEC-HMS 4.0 is implemented over the study area (3849 km²) for calibration and validation of the model. Calibrated parameter from Rabuwa station were used to determine the discharge of Thotne Khola. The result shows that HEC-HMS has the best fit among the methods used. The projected simulation depicts a slightly increasing trend of discharge for middle centuries (2030-2060). Hence, Hydrological modeling is a powerful technique in planning and development of integrated approach for management of water resources.

KEYWORDS: Frequency analysis, HEC-HMS, Flood, Bias correction

PRELIMINARY FINDINGS FROM GLACIER RESEARCH INITIATIVES IN PHU VALLEY, MANANG

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ABSTRACT

Himalayan glaciers are water towers for the downstream region and it is important to study the meteorological condition, field measurement of ablation, discharge estimation to understand glacier response to changing climate. Glaciers in the Himalayan region are often covered by the extensive debris in ablation areas, hence it is essential to assess the effect of debris on glacier ice melt. The contribution of glacier and snow melt runoff is very important because livelihood of the downstream depends on those resources. Taking those task in mind Himalaya.n Cryosphere, Climate and Disaster Research Center (HiCCDRC) under the Department of Environmental Science and Engineering, Kathmandu University initiated the project entitled ‘The Contribution to High Asia Runoff from Ice and Snow – (CHARIS)’ designed by The Cooperative Institute for Research in Environmental Sciences (CIRES), National Snow and Ice Data Center (NSIDC), University of Colorado at Boulder and Institute of Arctic and Alpine Research (INSTAAR) under the project fund from United States Agency for International Development (USAID) to access snow and glacier contribution to water resources originating in the high mountains of Asia that saddle 10 countries.

Pangri Glacier lies in the Upper Manang region in Manang district of western Nepal within the Annapurna Area Conservation Project (ACAP) area. Upper Manang in ACAP region border with Tibet is also known as “Lost valley” and a popular tourist destination for the Nar- Phu trek. Pangri Glacier is the biggest glacier in the valley with an area of 28.55 sq. km ranges from 4484 to 7087 m elevation from sea level is chosen for the study to understand the meteorological, temperature profile of the supra-glacial debris and ice ablation under the different thickness of debris of the Pangri Glacier. To understand the meteorological condition HOBO U30 Automatic Weather Station (AWS) is installed on the glacier at coordinate (N 28.78820, E 084.29293). Two sets of thermistors with three temperatures sensor are installed at only six different depths (0 cm, 10 cm 20 cm, 30 cm, 40 cm and 50 cm). One Smart button at the Phu village and another Smart button at Meta are also installed. Similalry, discharge measurement is also caried out from one of the outlets from the Glacier is measured and if found 0.332 m³/s. Therefore, this study will helpful for the water resource management in this Valley through understanding the glacial processes.

KEYWORDS: Pangri glacier, debris, climate change, Glacio-hydrologycial modelling, water resource management

COMPARISON OF SEASONAL AND ANNUAL MASS BALANCES OF 3 GLACIERS IN THE EVEREST REGION SINCE 2007

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ABSTRACT

Understanding climate-glacier relationship is of a great interest since glaciers play an intrinsic role in water availability, sea level rise and act as an indicator of climate change. Observations in Himalayan region show shrinkage of glaciers in an accelerated rate, however, the key climatic understanding behind this mass loss is minimum in the presence of a very few glaciological. In this study, 5 years glaciological mass-balance (MB) measurement of Changri Nup Glacier from 2010 to 2015 with updated mass balance of Mera (2007 to 2014, 7 years) and Pokalde (2009 to 2014, 5 years) Glaciers of Nepal are presented and analyzed. Cumulative mass balance of Changri Nup Glacier from November 2010 to November 2014 is -4.88 ± 0.31 m w.e., with a mean annual glacier-wide MB of -1.22 ± 0.31 m w.e. Equilibrium line altitude (ELA0) for steady state condition is calculated as 5550m a.s.l. corresponding to an accumulation area ratio (AAR0) of 59%. Meanwhile, glacier wide mass balance of Pokalde Glacier averaged over 5 years and Mera Glaciers averaged over 7 years are -0.64 ± 0.28 m w.e. and -0.02 ± 0.28 m w.e., respectively. These glaciers affected by the Indian monsoon in summer and influenced by the dry west winds in winter, show an annual mean vertical mass balance gradient of 2.06, 1.33, 0.45 m w.e. (100 m)⁻¹ for Changri Nup, Pokalde and Mera Glaciers, respectively and belong to the summer accumulation type glaciers, where ablation is not negligible during summer as well as in winter but less.

KEYWORDS: Mass Balance, Climate Change, Glaciers, Glaciological study

APPLICATION OF GLABTOP MODEL ON FOUR NEPALESE GLACIER FOR ESTIMATING GLACIER ICE THICKNESS DISTRIBUTION AND BED TOPOGRAPHY, EVEREST REGION, NEPAL

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ABSTRACT

This paper provides the application of computer based software model for estimating the ice thickness, volume and bed topography of four Nepalese Himalayan glacier. Information of ice thickness and volume is essential for present glacier status, future water availability and glacier evolutions. Due to harsh topography, climatic condition, remoteness there is limited information on ice thickness and volume by direct glaciological and geophysical investigations. Generally area volume scaling approach based on empirical relation uses surface area and thickness to estimate ice reserves. Glacier bed Topography (GlabTop) Model applied in this study is a good approach, implemented in ESRI ArcGIS using Digital Elevation Model (DEM), glacier outline and branch lines relating with surface slope, elevation difference, shape factor and basal stress to estimate spatial ice thickness distribution, volume and approximation of bed topography. The GlabTop model is applied on Mera Glacier in Hinku Valley to estimated ice thickness and then compared with field data measured by ground penetrating radar which shows ± 25 % uncertainty in estimated ice thickness. The model is then applied on Imja, Khumbu and Ngozumpa Glaciers of the Everest region. The ice thickness spatially distributed in all studied glaciers is $\sim 0 - 60$ m at the glacier outline or moraine to ~ 509 m in the lower flat region of glacier valley at an elevation range of $4500 - 5500$ m a.s.l., at higher altitude the estimated ice thickness is shallower. The bed topography reveals that there is no large over deepening or possible sites for the formation of large lakes after glacier retreats except in Ngozumpa Glacier, where as in Imja Glacier, existing glacier lake can further expand up to ~ 4 km in the Lhotse Shar Glacier and ~ 2.5 km in the Imja Glacier. More than 65 % of total ice is stored relatively on flat glacier valley. Sensitivity analysis is performed by modifying the two scaling parameters, shape factor by ± 0.1 and basal stress by ± 30 kPa. The model performed very well when shape factor is 0.8 and basal stress is 150 kPa (1.5 bar)

while comparing with field investigated ice thickness data. This GlabTop model though has an uncertainty of $\pm 20 - 30$ %, it estimates ice thickness and approximates bed topography crudely in cost effective ways. This model thus proves to be very useful to fill the large data gap prevalent in ice thickness distribution and volume in the Himalayan region.

KEYWORDS: Glacier ice thickness, ArcGIS, GlabTop Model, Bed topography

APPLICATION OF TEMPERATURE INDEX MODEL FOR ESTIMATING DAILY DISCHARGE FROM THE SHIGAR RIVER BASIN, CENTRAL KARAKORUM, PAKISTAN

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ABSTRACT

The high mountains of Hindu Kush, Himalaya and Karakoram (HKH) contain large masses of flowing ice and snow. These ice masses and snow are the primary source of water for the entire region of HKH so it is very important to have knowledge for the sustainable use of these available fresh water resources. In this study, modified temperature index model has been used to simulate total discharge and contribution of snow and ice in discharge from the Shigar River basin in central Karakoram, Pakistan. Shigar basin covers an area of 6921.429 km²; and 2774 km² (48 %) of the entire basin is glaciated among which 25.5 % of the glaciated part is covered by debris layer and remaining 74.5 % is covered by clean ice and permanent snow. Great variation in altitude exists in the basin which starts from Shigar Bridge, 2204 m a.s.l, and maximum elevation reached by K2 8611 m a.s.l. To simulate discharge, we first divided whole basin into 26 altitude belts, meanwhile zonal area of debris covered ice, clean ice and the rock and vegetation has been calculated. Daily temperature and precipitation from Skardu meteorological station has been used as input variable after correlating the data with the Shigar station data ($r=0.875$). Model has been calibrated for the period 1988 to 1991 and 1992 to 1997 are used for validation. Local temperature lapse rate of 0.0075 °C/m is used in this study. Critical temperature has been used to separate form of precipitation in rain and snow. Precipitation increases by 0.223 % up to 3000 m a.s.l and decreases by 0.627% up to 5500 m a.s.l and again increasing trend has been found. In situ measured ice ablation values and remotely sensed debris covered and clean ice data is gathered, available observed discharge and met data has been analyzed. We used seasonal degree day factors for low and higher elevations. Observed and simulated discharge for the period of calibration and validation was 224.6 (m³/s), 222.85 (m³/s) and 232.28 (m³/s), 232.88 (m³/s) respectively. The Nash Sutcliffe efficiency for the simulated and observed discharge for the year of calibration and validation is 0.815, 0.765 with volume difference of 0.78 % and 0.26% for calibration and validation period respectively. Contribution of snow and ice in total discharge was 37.91 % for the period of calibration and 37.46 % for validation period. The results obtained from the modified temperature index model showed that this model is good enough to estimate daily discharge from glacierized river basins and it can be used in hydrological studies of glacierized river basins.

KEYWORDS: Positive degree day, simulated discharge, Daily temperature and precipitation, Debris covered ice, clean ice, Altitude belts