Irrigation Newsletter

Triannual Publication from Nepal on Water Resources & Irrigation

No. 109 *www.dwri.gov.np* *Mid July – Mid Nov. 2019*

NEWS UPDATE

New Secretary at MoEWRI

Er. Rabindra Nath Shrestha has been appointed as new secretary for Ministry of Energy, Water Resources and Irrigation (MoEWRI) on September 16th, 2019. On the following day a special function was organized welcoming newly appointed secretary of MoEWRI at DWRI. On the occasion, high ranking officials of MoEWRI and DWRI including Director General of the DWRI were present. On the occasion, the newly appointed Secretary Er. Shrestha expressed his wishes for timely implementation and successful completion of all the projects under DWRI and also. emphasized the designing of cost effective structures in irrigation projects. During the function, DG of DWRI Ms. Sarita Dawadi presented the current progress report/scenario of DWRI. Irrigation Newsletter Editorial Board also expresses its best wishes for the successful tenure of newly appointed Secretary Er. Rabindra Nath Shrestha in MoEWRI.

New Director General Appointed at DWRI

As of ministrial level decision made on 16thOctober, 2019, Joint Secretary of Ministry of Energy Water Resources and Irrigation, Mr. Madhukar Prasad Rajbhandary has been appointed as Director General of Department of Water Resources and Irrigation. Department of Water Resources and Irrigation (DWRI) organized a special program to welcome newly appointed DG of the Department.

During the program, newly appointed DG Mr. Rajbhandary expressed his desire for getting cooperation from coworkers and employee of the organization and directed all the staffs to involve seriously in completing ongoing projects within its targeted period and perform according to achieve best possible result.. Editorial Board of Irrigation Newsletter expresses congratulation to newly appointed DG and wishes him successful tenure in the department.

DDGs and Project Director/Managers of DWRI Assigned with new responsibility

As per the ministry level decision on 16thOctober, 2019, former DG of DWRI, Ms Sarita Dawadi has been transferred as joint secretary of Ministry of Energy Water Resources and Irrigation. DDGs Mr Krishna Belbase and Mr. Shishir Koirala have been also transferred to the post of Joint Secretaries at Water and Energy Commission Secretariat. Project Director of Integrated Energy and Irrigation Special Program Mr. Shiva Kumar Basnet has been appointed as new DDG (Multipurpose and Inter basin transfer Division) of DWRI. Similarly, Joint Secretary Mr. Kaushal Kishore Jha has been appointed as DDG (Management Division) of DWRI. As decided by MoEWRI in various dates Project Manager of Rani Jamara Kulariya Irrigation Project Mr, Madhukar Rana, has been transferred as the Project Director of Babai Irrigation Project. Project Manager of Narayani River Training Project Mr Mohan Shakya has been transferred to the post of Project Director of Rani Jamara Kulariya Irrigation Project. Likewise Project Manager of

Highlights of the Issue

Editorial

Energy and Irrigation

In Nepali context, hill farmers cultivating crops on the tars faces severe water scarcity to irrigate their crop particularly during dry seasons, looking down to perennial streams and rivers flowing down just below their flat land with no means to lift that valuable resource to irrigate their field. Despite the idea of pumping and lifting water to their field, but without electricity and resources, they were helpless and just only had to dream about it. After the innovation of solar water pumps and gradually increasing the central grid connection for electricity, the idea of lifting is now a reality in through many schemes.

The scenario of the country was pessimistic as most of the urban areas including capital were facing heavy load shedding of 21 hours a day during dry season and even 8 hours in wet seasons. The factories could hardly run and industries were almost in dark phase of their operation. Most of the youth were forced to leave their natives for foreign employment. The economy of the country seemed to be operated with the help of remittance sent from the overseas. Gradually, less youth labor force were available in the field to cultivate crops. From the last three years, people are feeling changes in that scenario with continuous supply of electricity throughout the country from its national grid. Industries are running back to gain their previous performance level and new hopes are being raised among people to invest in various industries within the country. Technicians and high level policy makers are working hard in making of more hydro power projects and related infrastructures in the country. It is estimated that, by next fiscal year, Nepal will be generating around 3,000 MW of power, which is more than the demand of the internal consumer including household, offices and industries. So if possible such a surplus amount of power should not be shed away and must be utilized with various industrial works to consume it and make valuable rural infrastructures in those areas where electricity is not accessed through making farmers able to pump water resources from flooded streams and rivers during rainy season and store them in ponds with a concept to develop at least one ponds per village and restore existing ponds. These stored water bodiescould be used for irrigation during drought season crops and also during winter. Furthermore, rural electrification will help to consume more electricity in village with small food and agriculture production processing units, which will create employment opportunities in their locality with other facilities like markets and roads.

The concept and slogan of the government "नदी माथिका गरा सदा हराभरा" will of course be realized soon. ●

Sunsari Morang Irrigation Project Mr. Hari Ram Shrestha has been transferred as Program Director of Integrated Energy and Irrigation Special Program. Senior Divisional Engineer Dr Krishna Raj Pathak has been posted as Director of Water Resources Research and Development Center.

Further, Mr. Ananda Prakash Dhami, Mr. Mitra Baral, Mr. Dinesh Rajauriya and Mr. Mekhnath Sharma have been appointed as Project Director of Sunsari Morang Irrigation Project, Bagmati Irrigation Project (BIP), Water Resources Project Preparatory Facilities (WRPPF) and Narayani River Management Project respectively.

Annual Progress Review Meeting Organized

Annual progress review meeting for the fiscal year 2075/76 was organized on 25th- 26th July, 2019 in the main hall of the Department. The program was chaired by Director General of DWRI Ms.SaritaDawadi. All the high level officials from the ministry of energy, water resources and irrigation and the department including project managers, project coordinators and project directors attended the review meeting.. DDG Mr. Krishna Belbase, presented the overall progress achieved during the period of the last trimester (Chaitra-Asar) and the annual progress of FY 2075/76. It was reported that the annual financial and physical progress were about 78% and 85.24% respectively. Out of total allocated budget NRs 22.89 Billion, only NRs. 18.04 Billion has been expended during the FY. During the various sessions of the review meeting, DDGs and Project Directors of various Irrigation Projects running under the department presented the progress reports of respective divisions and projects. In his key note remark, Joint secretary of MoEWRI, Mr Sushil Chandra Tiwari, expressed his views over the satisfactory condition of the overall progresses of the department, From the chair, DG, Ms Sarita Dawadi expressed thanks to all the project directors and managers for their remarkable performances to achieve the target set by the department through development and construction of respective projects over the period.

TRAININGS/WORKSHOPS/SEMINARS

3rd World Irrigation Forum and 70th IEC of ICID Organized at Bali, Indonesia

The Third World Irrigation Forum (WIF3) under the banner of "Development for water, food and nutrition security in a

Chief Editor Kaushal Kishor Jha
Editors Rajendra Bir Joshi
Dr. Rajan Bhattarai
Birendra Kumar Yadav
Santosh Kokh-Shrestha
Hem Raj Bhusal
Ananda Raj Aryal
Dipendra Laudari
Sadiksha Rai

competitive environment" was organized by ICID in cooperation with the host Indonesian National Committee on Irrigation and Drainage (INACID) and the partners Food and Agriculture Organization (FAO) of the United Nations (UN), Asian Development Bank (ADB), World Bank, International Water Management

Institute (IWMI), and UNU-FLORES, in Bali of Indonesia from 1st – 7thSeptermber, 2019.. Three sub-themes were covered under the Main Theme as 1. Enabling policy environment for water, food and energy; 2. Role of civil society and NGOs with focus on farmers and extension facilities; 3. Improving agricultural water productivity with focus on rural transformation. In addition there was a Meeting of the High Level Working Group (HLWG) consisting of Ministers and Senior Officers from Member and Non-Member countries., Farmers' Roundtable, Youth engagement, 6 Workshops with 57 accepted papers, 15 Supporting Events, Exhibition, Technical Tours, and Social Programmes were also organized during the forum.These events included: Key-note speeches, paper and shortcommunication presentations during the sessions, Technical papers were presented as posters, and displays.

In total more than 1500 participants from60 countries, including Ministers from 9 countries and heads, or representatives of 10 International Organizations attended the Forum. Based on this the following statements were formulated and supported by the participants at the concluding session of the Forum. In a week long forum, 7 members Nepalese delegation headed by honorable minister Barsha Man Pun participated in the event. Other members included were Joint Secretary of Minsitry of Energy, Water Resources and Irrigation (MoEWRI) Mr. Sushil Chadra Tiwari, Director General of Department of Water Resources and Irrigation (DWRI), MsSaritaDawadi, Deputy Director Generals of DWRI Mr. Krishna Belbase and Mr. BashudevLohane and SDE of MoEWRI Mr.Pramod Kumar Shrestha.

WIF3 was to address global food security, poverty alleviation and environment protection, through sustainable, economically and socially viable irrigation and drainage development and management.

The forum mainly focuses on the following six points.

- Recognize the fact that the world is facing rapid population growth and urbanization, landusechanage, climate and diets, increasing droughts and floods, environmental degradation, etc.;
- Real firm of sustainable development and management of agricultural water is a priority issue for achieving food security and poverty alleviation;Recognize the need to achieve water security. To this end it is vital to course-correct and increase water productivity by improving agricultural water management at all levels, with respect to the specific challenges facing least developed and emerging countries, in meeting the sustainable development goals (SDG) and maintaining rural development.
- Encourage the adoption of land and water policies that provide an effective environment for sustaining water resources, delivering of appropriate services and improving resilience in agricultural water, and incentives for sustainable agricultural water use;
- Support the implementation of integrated water resources management (IWRM) at the levels of river basin, irrigation and drainage schemes and on farm through international cooperation to achieve sustainable water management; Contribute to the building of new and maintaining, strengthening and improving existing infrastructure for multiple purposes, including water storage, irrigation and drainage, application of water saving and information technologies, rural water supply, energy production, environmental water use, and disaster prevention, that are economically sound, environmentally sustainable and socially equitable;
- Endeavour to improve water productivity for agriculture by clarifying roles and responsibilities in irrigation and drainage system operation and maintenance, where applicable reforming of irrigation and drainage management institutions, improved agricultural water service provision to farmers, and encouraging engagement of private sector and civil society organizations; Intend to support farmers in improving their individual irrigatedand rainfed agriculture to increase crop productivity and conserve water with a view to achieve sustainableproduction of enough food for the rapidly increasing urban population; Promote increased and effectiveuse of financial resources, including encouraging international financing institutions, development partners and governments to enhance support for agricultural water management;
- Scientific research, education,development and adoption of innovative practices: Support increased collection, use anddissemination of data to improve performance of the sector and support of evidence-based policymaking. Strengthening, training and education for young professionals: Contribute to the creation of an environment in which the young generation and women are encouraged and capable to engage in agriculture, and to empower young professionals to contribute with new skills to agricultural water management.

Along with the agreement by high level national representatives,the meeting brought them together to share their views and ideas towards improvements inpolicies, initiatives and implementationexperiences at national level concerningirrigation and water management undervarious constraints. The interactions at

the highest political and official have the potential of exchanging theconcerns and networking to bringtogether partnerships for implementationof the common goals of bringing forth aprosperous rural society. In the meeting,following issues were discussed:

- importance of irrigated agriculture and water management as foundation stone for poverty alleviation
- platforms for the multi-stakeholdersto share and learn by engaging inissues of interest at the global level
- multi disciplinary discussions towards sustainable water management solutions in agriculture through:
- exchange of latest irrigation and drainage policies, practices, with
  - ✓ innovations and technologies,
  - ✓ exploring and formulating concrete inter-disciplinary proposals,
  - ✓ development of liaison/collaboration among various
  - ✓ national and international institutions,
  - ✓ organizations and private sector working for agricultural water management and
  - ✓ advocacy for political commitments.

During the Farmers Round Table Meeting on strengthening farmers groups incompetitive environment for global food security discussed on the following sixthemes:

1. the usage of organic fertilizer in horticulture can give great impacts to the farmers in terms of production, environment protection, and market opportunity;
2. water management iscrucial for optimizing agricultural production, consequently promoting farmers' incomes through, participatory approach, exchange of knowledge;
3. marketing of agricultural products can alsoplay an important role in achieving better incomes for farmers;
4. rotational scheduling of irrigation water at secondary level, as well as at farm level can be effective;
5. use of ICT systems to improve water productivity;
6. role of government, NGOs, universities, and market actors need to be encouraged to have a better understanding to strengthen farmers

Based on these discussions, the following recommendations were formulated:

- subsidy for agricultural input needs tobe encouraged by various methods, and based on the locations
- facilitating ICT development tosupport farmers on production and marketing and introducing irrigation
- local wisdom to have better environmental impacts

Two Young Professionals Training workshops were held. Following recommendations were made through the workshops:

- o climate projections by agenciesneed to be coordinated to reduceuncertainties,
- o adaptive measures/technologies need to be made widely available through social media,
- o valuation of water is context specificand needs to consider social, culturaland economic factors,
- o capacity building of youth andsimultaneously of leaders on water technologies

FEATURE ARTICLES

Estimation of Discharge using Glacio-hydrological Degree day model (GDM) in Seti River Basin, Kaski, Nepal

Sadiksha Rai*

Background

Water is the most plentiful natural resources in Nepal, major sources being glaciers, rivers, rainfall, lakes, and ponds. 42% of the people reside in major basins, 18% in medium and 40% in Terai covered by Southern rivers, this basin wise distribution of population and water availability has resulted in some basins having excessively surplus water availability and some with water deficit (WECS, 2011). The facts like: poor performance in Environment Performance Index, massive deforestation and destruction of resources along the Chure range, massive disasters, loss of biodiversity, etc. have become our eternal problems. And, climate change has become an undeniable issue at present impacting nook and corners of our country. In fact, Climate Change Risk Atlas 2010 has ranked Nepal as the fourth most vulnerable country in terms of the impacts of climate change. Though its impacts are observed in several sectors of Nepal, water resources are one of the hardest hit sectors. 70

% of the worlds freshwater is frozen in glaciers. Glacier melt buffers other ecosystems against climate variability. Very often it provides the only source of water for humans and biodiversity during dry seasons. Moreover, it covers 2.86% of Nepal's area (Basyal, 2017).

Glacier melt-water plays important role in water resources of Nepal as these resources are utilized in various purposes such as hydropower production, irrigation and water supply. The snow and glacier dominated stream contributes as reservoir which stores the water and release them as discharge, and significantly affecting the hydrological characteristics of the stream (Jansson & Schneider, 2003). Global rise in temperature hugely influence glacerized catchment due to acceleration in (Akhtar, 2008) as a result the Himalayan region presents a huge threat for future water availability. The widespread glacial retreat in Nepal can have two direct consequences: 1) changes in the hydrological regime and 2) glacial lake outburst floods (MoEST, 2010).

Objectives of the Study

The general objective of the study is to estimate discharge using GDM in Seti River basin, Kaski, Nepal. The specific objectives of the study are:

- To estimate the discharge at intake site in Seti River using Glacio-hydrological Degree-day Model (GDM).
- To estimate the hydrological component viz; snowmelt, icemelt, rain and baseflow contributions on river discharge.

Methodology

Description of the Study Area

The Seti Gandaki River, also known as the Seti River or the Seti Khola, is a river of western Nepal, a left tributary of the Trishuli River. It is one of the holiest rivers of Nepal, worshipped in Hinduism as a form of Vishnu. Figure 3.1 is the location map of the study area of Seti River Basin in Gandaki.

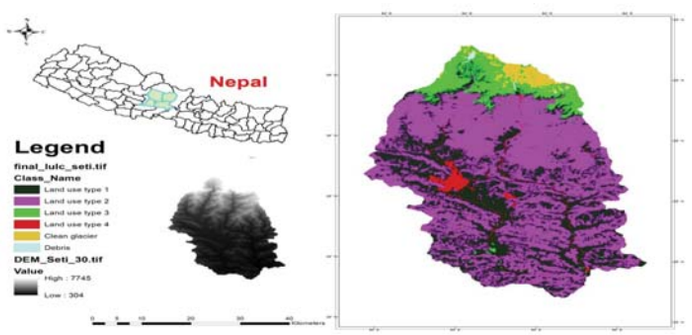

Figure 3.1. Location Map of the Study Area of Seti River Basin in Gandaki.

Topographic Data

Freely available ASTER DEM of 30m resolution is used for this research which can be easily downloaded from USGS website (http://www.usgs.org). The DEM of all the countries of the world is available in both ArcInfo ASCII and Geotiff format to facilitate the user to perform image processing and spatial analysis by using various GIS application tools. Downloaded data was first projected to WGS 1984 UTM Zone 45N and then clipped to obtain the DEM of the study area by using Arc GIS. Then the clipped DEM is filled the pits and sinks present in the dataset followed by creation of flow direction and flow accumulation maps.

Climatic Data

First of all the primary and secondary data are required to meet the objective of the study. It will help to obtain the general objective of the study which is to estimate the discharge of the Seti River basin. The process of data collection includes collection of primary data, as well as secondary data. The data collected from DHM is presented in table 3.1. below which shows the list of Meteorological station at Seti River basin and table 3.2. shows the hydrological station.

Table 3.1. List of Meteorological Station at Seti River basin.

S.N.	Station Name	Index No.	Types of Station	District
1	Pokhara Airport	0804	Aeronatical	Kaski
2	Malepatan (Pokhara)	0811	Agrometeorology	Kaski
3	Khairini Tar	0815	Agrometerology	Tanahun
4	Damauli	0817	Climatology	Tanahun
5	Lamachaur	0818	Precipitation	Kaski
6	Siklesh	0824	Agrometeorology	Kaski

Table 3.2. List of Hydrological Station at the Seti River Basin.

S.N.	Station Name	Index No.	Types of Station	District
1	Seti River	430.5	Gandaki	Tanahun

Modeling Approach

A Glacio-hydrological Degree-day Model (GDM) Version 1.0 is a gridded distributed glacio hydrological model to simulate the contribution of hydrological components in the river discharge. The GDM is based on the positive degree- day approach which calculates snow and ice melt using positive degree-day factors and then estimates total discharge from a glacierized river basin. A positive degree day factor is a simplification of complex process that are more extensively described by the energy balance of the glacier surface and overlaying atmospheric boundary layer (Braithwaite & Olesen, 1989). It estimates snow and ice melt from the debris-free areas as well as ice melt under debris layers with minimal requirements for incorporation of field data. This approach is appropriate in regions with scarce data as it requires less input data and uses simple equations to estimate melt (Kayastha R. e., 2000a); (Hock, 2003). The detailed methodology and processes involved in GDM is shown in figure 3.2.

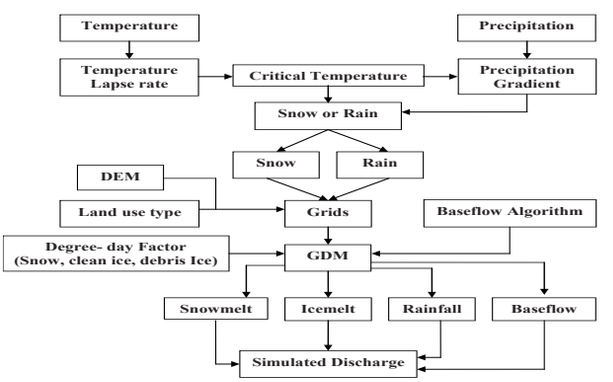

Figure 3.2 Flowchart of GDM.

Modeling Process

The GDM model was calibrated with 7 years observed data from

2000 to 2007 using Pokhara Airport Station as base station. The calibrated parameters of the model were then used to validate the observed data 2008 to 2015. The calibrated model after validation was then used to project future discharge of Seti River basin from 2021 to 2100 using bias corrected daily temperature and precipitation data. The relative contribution of snow and ice melt in the future was calculated and decadal hydrograph analysis was done. The details parameter of calibration and validation are as below in the table 3.3

Table 3.3. Details of calibration and validation Parameters for GDM.

PARAMETERS		Values
Critical temperature		2˚C
Temperature lapse rate		0.63˚C
Precipitation gradient		I ≤ 4000 m
		30 % increased > 4000m
Recession coefficients, X& Y		0.95 & 0.001
Land constants	Land use type 1 (Grass land) (Agriculture land)	0.14 (Rest of month) 0.5(June, Jul Aug & Sept)
	Land use type 2 (Shrub land) (Forest)	0.08 (Rest of month) 0.25(June, Jul Aug & Sept)
	Land use type 3 (Barren land)	0.01 (Rest of month) 0.3(June, Jul Aug & Sept)
	Land use type 4 (Settlement) (Water bodies)	0.7 (Rest of month) 0.95(June, Jul Aug & Sept)
Degree day factor	Snow melt	6 to 10 mm/˚C/day
	Ice melt	4 to 8 mm/˚C/day
Rain coefficients		0.001 to 0.1
Snow coefficients		0.001 to 0.1
Ground water constants	$\square_{gw,sh}$	10
	$\square_{gw,sh}$	0.5
	$\square_{gw,dp}$	85
	$\square_{gw,dp}$	0.97
	$\square_{dp}$	0.8
Initial recharge		20 mm

For the precipitation gradient and temperature lapse rate for the model input, data of climatological stations installed within the Seti River basin was used. Department of Hydrology and Meteorology (DHM) data are processed and used for the precipitation gradient and temperature lapse rate.

Results & Discussion

Observed climatic data trend analysis

Temperature

The temperature data of the Seti River basin are collected from the Department of Hydrology and Meteorology (DHM) for the input of the GDM. The main three stations of Pokhara Airport station (804), Malepatan (811) and Khairini Tar (815) is used for trend analysis of the temperature and further study.

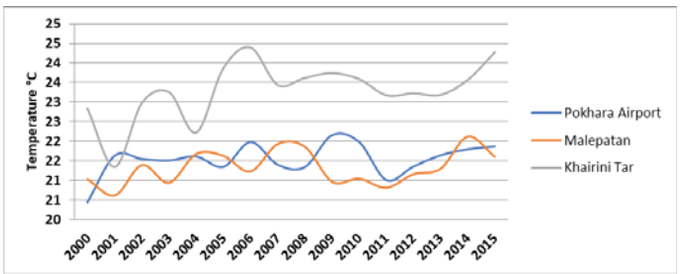

Figure 4.1. Variation of observed annual temperature from 2000 to 2015.

Precipitation

The precipitation data of the Seti River basin are collected from the Department of Hydrology and Meteorology (DHM) for the input of the GDM. There are total of six numbers of meteorological data which are Index No. 0804, 0811,0815,0817,0818 & 0824 whose station name are Pokhara Airport, Malepatan (Pokhara), Kairini Tar, Damauli, Lamachaur and Siklesh, respectively. The trend analysis of precipitation data of different station are presented as below:

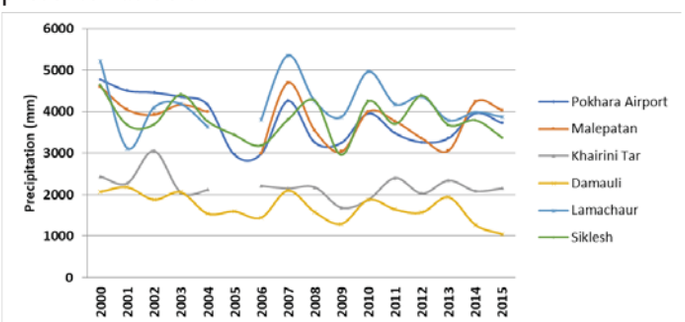

Figure 4.2. Variation of observed annual precipitation from 2000 to 2015 at different stations.

Calibration:

The GDM model is calibrated with observed hydro-meteorological data for the period from 2000 to 2007. The observed and simulation discharges during calibration year are 445.27 m^3/s and 478.84 m^3/s, respectively. During the calibration year, satisfactory model performance was found with 80.5 % Nash Sutcliffe value (NSE) and -6.44%.volume difference (VD). The figure 4.4 shows the distribution of discharge of Seti River during the calibration period.

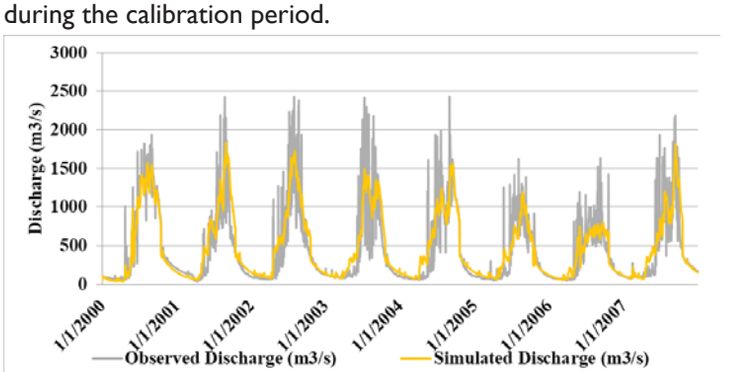

Figure 4.4. Distribution of discharge of Seti River during the calibration period from 2000 to 2007.

Validation

The GDM model is validated with observed hydro-meteorological data for the period 2008 to 20015. The observed and simulation

discharges during calibration year were 401.16 m^3/s and 419.84 m^3/s. Figure 4.5 shows the simulated and observed discharge during the period of validation. During the validation year, satisfactory model performance is found with 80.4 % NSE and -4.66 % VD.

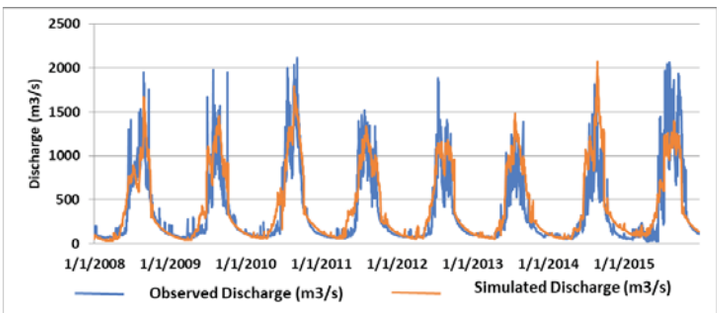

Figure 4.5. Distribution of discharge of Seti River during validation period from 2008 to 2015.

Contribution from Streamflow components for Baseline Period

Glacio-hydrological Degree-day Model (GDM) is able to simulate daily discharge along with rainfall, baseflow, snow and ice melt contributions. Simulated discharge follows the seasonal pattern of basin streamflow, the model shows the extreme peaks during high runoff season. The model also has difficulty simulating discharge during pre-monsoon (March - May) season.

Figure 4.7. Graph showing monthly contribution of snow melt, ice melt, rain and base flow to river discharge for the validation period from 2008 to 2015.

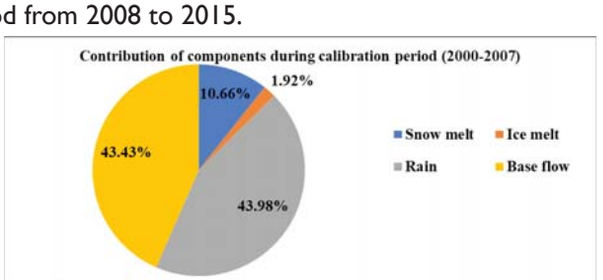

Figure 4.8. Contribution of snow melt, ice melt, rain and baseflow in Seti River during calibration period from 2000 to 2007.

The figure 4.8 shows that GDM estimates the percentage of contribution of different hydrological components like snow melt, ice melt, rain and baseflow in Seti River for the period of calibration during 2000 to 2007. Rain has the higher contribution with 43.98 % and 1.92 % ice melt has the lowest contribution in Seti River during calibration year. This shows that the rain plays the vital role in contribution in discharge during the calibration period.

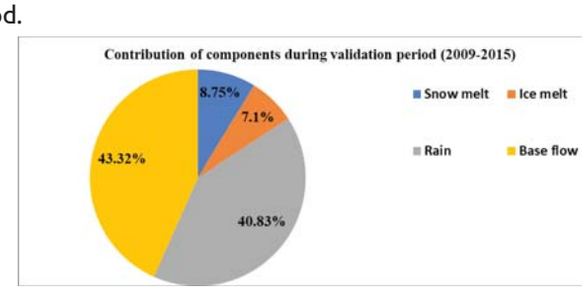

Figure 4.9. Contribution of snow melt, ice melt, rain and baseflow in Seti River during Validation period from 2008 to 2015.

The figure 4.9. shows that GDM estimates the percentage of contribution of different hydrological components like snow melt, ice melt, rain and baseflow in Seti River for the period of calibration during 2008 to 2015. Rain has the contribution of 40.83 % whereas the baseflow has contribution of 43.32 % , 8.75 % in snow melt and 7.1 % of icemelt during the validation period of 2008 to 2015.

CONCLUSION AND RECOMMENDATIONS

The Glacio-hydrological Degree Day model is used to simulate daily discharge with classified basin zones for representing spatial heterogeneity is a good hydrological model which distinguishes runoff components including snow and glacier melt. The model is applied in the Seti River basin and simulated daily discharge fairly well during calibration period from 2000 to 2007 and validation period from 2008 to 2015. During the calibration period, satisfactory model performance is found with average discharge 445.27 m^3/s during calibration period along with 80.7 % Nash Sutcliffe Efficiency Index (NSE) and -7.54 % volume difference (VD). Similarly, during the validation period, satisfactory model performance is found with 401.16 m^3/s during validation period along with 80.4 % NSE and -4.66 % VD. Calibration period contributes 10 % of snow, 1.92 % of ice melt, 43.98 % of rain and 43.43 % of baseflow in the total discharge of the Seti River basin. GDM shows that there is 8.75 % of snow melt contribution, 7.1 % by icemelt, 40.83 % contribution is by rain and 43.32 % is contributed by baseflow in the discharge of the Seti River. The data shows that the rain percentage is highest in all the decadal year and second comes the baseflow and ice melt and then snow melt. The data shows that the monsoon season has higher discharge than in pre-monsoon and post- monsoon seasons. For the future work, this research has used 4.04 km^2 grid size resolutions, thus recommend further to used high resolution for more exact and accurate results.

References

Agrawala, S., & Raksakulthai, V. (2003). Development and Climate Change In Nepal: Focus on Water Resources and Hydropower. Organisation for Economic Co-operation and Development.

Akhtar, M. e. (2008). The impacts of climate change on water resources of Hindukush-Karakorum-Himalayan region under different glacier coverage scenario. Journal of Hydrology 355, 148-163.

Basyal, R. (2017). Climate Change Impacts in Water Resources-A Case of Nepal.

Braithwaite, R., & Olesen, O. (1989). Calculation of glacier abalation from air temperature, West Greenland. Glacier fluctuations and climate change, 219-233.

FutureWater. (n.d.). On Spatially Distributed Hydrological Ecosystems Service; Bridging the Quantitative Information Gap using Remote Sensing and Hydrological Models.

HI-AWARE. (2017). The Gandaki Basin Maintaining Livelihoods in the Face of Landslides, Floods and Drought.

Himalayan Adaptation, W. a.-A. (2016). Selection of Climate Models for Developing Representative Climate Projections for the Hindu Kush Himalayan Region. Kathmandu: HI-AWARE Consurtium Secretariat.

Hock, R. (2003). Temperature index melt modeling in mountain areas. . Journal of Hydrology 282., 104-115.

Hua, O. (2009). 'The Himalayas: Water storage under threat.'. ICIMOD Newsletter 56 (Winter 2009): , 3-5.

Jansson, P., & Schneider, T. (2003). The concept of glacier storage;A review. Journal of Hydrology 282(1), 116-129.

Kayastha, & Kayastha, R. (2014). Estimation of discharge from Langtang River basin, Rasuwa, Nepal using glacio-hydrological model.

Kayastha, R. e. (2000a). Positive degree-day factors for ablation on glaciers in the Nepalese Himalayas; case study on Glacier AXIO in Shorong Himal, Nepal. Bulletin of glacier Research 17., 1-10.

MoEST. (2010). National Capacity-Assessment for Global Environment Managemnt.

Pachauria, R. (1992). Global warming impacts and implications for South Asia. In; The regions warming; impacts and response strategies, Oxford University Press, New York, 79-90.

Practical Action, O. (2009). Temporal & Spatial Variability of Climate Change Over Nepal (1976-2005). Practical Action Nepal Office.

Practical, A. (2016). TAAS-0045: Adaptation to Climate Change in the hydro electricity sector in Nepal.

Rango, A. (2008). Relative importance of glacier contributionsto water supply in a changing climate. World Reosurces Review, 20 (3), 3357-3370.

Sayari,N. et al. (2011). Crop Water Consumption and Crop Yeild Prediction under Climate Change Conditions at Northest of Iran. International Conference on Environmental and Computer Science (pp. 122-117). Singapore: IACSIT Press.

Shalamu, A. (2012). Application of snowmelt runoff model (SRM) in mountainous watersheds: Areview. Water Science & Engineering 5 (2), 123-136.

Shrestha, A., Wake, C., Mayewski, P., & Dibb, J. (1999). Maimum Temperature Trends in the Himalaya and its Vicinity; An Analysis BAsed on Temperature Records from Nepal for the Period1971-94. Journal of Climate 12(9), 2775-2786.

Shrestha, M. (2009). Water Quality Assessment & Associated Stressing Factors of Seti River Basin, Pokhara Sub Metropolitian City.

WECS, N. (2011). Water Resources of Nepal in the Context of Climate Change. Kathmandu: WECS, Nepal.

* Ms. Rai is Engineer at System & Integrated Crop Water Management Program of DWRI

Call for Papers of Department of Water Resources & Irrigation (DWRI)

National Irrigation Seminar 2019 On "Water Resources Development and Management in Present & Future Nepal"

The Department of Water Resources & Irrigation (DWRI) is organizing a National Seminar on **"Water Resources Development and Management in Present & Future Nepal"**. Its main objective is to provide a common platform for participants to share experiences, lesson learned and discuss on issues and challenges brought by new technology and innovation on Water Resources mainly focusing on irrigation sector so that it could be integrated into designing and planning of water resources projects on irrigation.

Following are few identified issues on which papers are expected.

1. Management Improvement in Water Resources /Irrigation Services.
2. Modernization and Commercialization of Water Resources/Irrigated Agriculture
3. New approached models and tools in Water Resources /Irrigation Development
4. Private sector intervention in Water Resources/Irrigation
5. Climate SMART Water Resources /Irrigation
6. Governance and GESI in Water Resources /Irrigation Agriculture
7. Multipurpose projects: Scope and Opportunities
8. Information Technology in Water Resources /Irrigation
9. Legal Aspects and Financial Management in Water Resources /Irrigation Development
10. Water Resources /Irrigation Financing in Federal Nepal

Schedule for paper submissions:

- Submission of full text paper: 23th Magh 2076 (6th February 2020)
- Date of Seminar:7-8 Falgun 2076 (19th-20th February 2020)

The abstract should not be more than 250 words and should contain all the features of the main paper in brief. All abstract submission will be peer reviewed and evaluated based on originally, technical content and relevance. The accepted full paper published in the seminar proceedings of DWRI.

For technical guidelines and other information, please contact

Er. Basudev Timisina Ph no: +977-9841516405, basutimilsina@gmail.com

Er. Sadiksha Rai, Ph no: +977-9851176827, email: sadiksha11133@gmail.com

Mailing Address
Irrigation Management Division
P.O. Box 2055
Jawalakhel, Lalitpur, Nepal

Published by the Department of Water Resources & Irrigation, Lalitpur, Nepal, Phone 977 1 5527151, Fax 977 1 5527985, Email: dwri.management@gmail.com