



Nepal Geographical Society (NGS) Webinar Series - I

Nepal Geographical Society Successfully Organized First Webinar

Nepal Geographical Society (NGS) has successfully organized first webinar on 8 August 2022 based on its plan of organizing webinars series in different crosscutting contemporary issues from geographic perspective. Dr. Bhagawat Rimal was the speaker of the event and had presented his research work “**Evidencing Climate Vulnerability of Land-Water Partitioning using Remote Sensing Technology**”. Over three dozen participants from Nepal, China, Switzerland and USA including professional geographers/geoscientists, universities professors/faculties, researchers working in different sectors, and students actively participated on the event. Following the presentation, interesting discussion was held. Dr. Rimal responded queries and comments raised by the participants.

Mr. Tibendra Raj Banskota, Joint Secretary of NGS hosted the event and welcoming to the speaker and all the participants. The next, Dr. Basanta Paudel, the General Secretary of NGS has delivered vote of thanks and appreciations to the speaker and all the participants of the event. Finally, Dr. Bipin Kumar Acharya, President of the NGS had stated concluding remarks of the event with appreciations to the speaker as well as all the participants. Next episode of webinar series will be held on first week of September, 2022 on another geographic theme.

Once again Nepal Geographical Society express sincere gratitude to the event presenter Dr. Rimal and the all the participants of the event.

About Speaker and Abstract

Title: Evidencing Climate Vulnerability of Land-Water Partitioning using Remote Sensing Technology

Abstract: Nepal Has been vulnerable to the adverse effect of climate change, leading to shrinking and expansion of landmasses respectively due to melting of glaciers and evaporative losses in the upper Himalayan regions, mainly due to the rising temperature. This work presented effective implementation of remote sensing technology for monitoring evolutionary patterns of mountain lakes under climate stress in hard to reach glacial terrains.

Surface water content for three mountain glacial lakes (Kapuche, Dona, Tilicho), ranging between 2500-5000 meters above the mean sea level in the Gandaki region of Nepal, were evaluated on the basis of Modified Normalized Different Water Index (MNDWI) technique. Our longitudinal analysis (1988 – 2020), utilizing satellite data from Landsat Thematic Mapper (TM), Enhanced Thematic Mapper (ETM+) and Operational Land Imager (OLI), shows an increment in surface water pixel for Dona and Kapuche lakes (mean pixel value of 30 meter resolution), implying expansion of these glacial lakes over this period. The expansion of the studied lakes show positive correlation with the annual temperature rise in the region; the highest annual temperature rise of 0.158C is estimated over the study period. The study demonstrates potential for remote sensing technology for in situ pervasive monitoring of the spatiotemporal climate change impacts on topographically complex landscape.

Key words: glacier; MNDWI; remote sensing; mountain lake; surface water

Bhagawat Rimal has acquired his Master's degree in Geography from Tribhuvan University, Kathmandu Nepal in 2002 and Obtained the PhD degree from Wroclaw University in 2011 in Geography. He has completed his Postdoctoral Research from the institute of Remote Sensing and Digital Earth (RADI), Chinese Academy of Science (CAS) in 2018. More than 40 research articles on different national and international scientific journals are under his credit as lead and co-author.. He has been contributing in several research and development projects with a national and international team of expert. He has been enrolled as teaching staff in College of Applied Science (CAS) Nepal since 2013 to date. Dr. Rimal has actively participated in various national and international seminars, workshops, conferences and training programs in the related fields.



Speaker:

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Some Glimpse of the First Episode of NGS Webinar Series

Evidencing Climate Vulnerability of Land-Water Partitioning using Remote Sensing Technology

Abstract: Nepal has been vulnerable to the adverse effect of climate change, leading to shrinking and expansion of landmasses respectively due to melting of glaciers and evaporative losses in the upper Himalayan regions, mainly due to the rising temperature. This work presented effective implementation of remote sensing technology for monitoring evolutionary patterns of mountain lakes under climate stress in hard-to-reach glacial terrains.

Surface water content for three mountain glacial lakes (Kapuiche, Dona and Tilicho), ranging between 2500-5000 meters above the mean sea level in the Gandaki region of Nepal, were evaluated on the basis of Modified Normalized Difference Water Index (MNDWI) technique. Our longitudinal analysis (1988-2020), utilizing satellite data from Landsat Thematic Mapper (TM), Enhanced Thematic Mapper (ETM+) and Operational Land Imager (OLI), shows an increment in surface water pixel for Dona and Kapuiche lakes (mean pixel value of 30 meter resolution), implying expansion of these glacial lakes over this period. The expansion of the studied lakes show positive correlation with the annual temperature rise in the region; the highest annual temperature rise of 0.158 °C is estimated over the study period. The study demonstrates potential for remote sensing technology for in situ pervasive monitoring of the spatiotemporal climate change impacts on topographically complex landscape.

Keywords: glacier; MNDWI; remote sensing; mountain lake; surface water

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Study Area

The study area is located in the Gandaki Province of Nepal. This site is appropriate for the scoped evaluation as it is characterized by unique topographical features ranging between 2500-5000 meters

Objectives

The analysis applied Modified Normalized Difference Water Index (MNDWI) as a metric to identify the alteration in the expansion of glacial lake using longitudinal time-series Landsat images.



Tibendra Raj Ba...

Tibendra Raj Banskot...

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Suresh Balayan

Methodology

- The maximum cloud free Landsat time series level 1 data, including: Landsat 5 Thematic Mapper (TM); Landsat 7 Enhanced Thematic Mapper Plus (ETM+), and Landsat 8 Operational Land Imager (OLI) for the years between 1988 and 2020 were acquired from the US Geological Survey (USGS) website (<https://earthexplorer.usgs.gov>)

Time series Landsat 5, 7 and 8 imagery applied (Path/Row 142/040).

Year	1988	1991	1995	1999	2002	2005	2009	2013	2016	2018	2020
Months	19-Oct	12-Dec	8-Nov	13-Dec	3-Nov	18-Oct	29-Oct	24-Oct	1-Nov	7-Nov	Oct-11
Sensor	TM	TM	TM	TM	ETM	TM	TM	OLI	OLI	OLI	OLI

- All the images were registered and their accuracy were verified considering <0.5 pixel RMS errors. The digital number (DN) of Landsat Level 1 data values of all images were converted into radiance and further atmospheric corrections of all the images were conducted using ENVI software v5.3 and map was prepared in ArcGIS v10.4.

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Method con...

- As a first step, cloud free Google Earth images for 2020 were used for evaluation of lake extent, mainly boundary delineation of the water area of all the Three lakes.



Tilicho lake Lake, 10-5-2020



Kapuche lake, 10-30-2020



Dona lake, 10-12-2020

Method...

- The analysis with the MNDWI threshold values is based on the changes in those water features extracted using band ratio threshold values.

$$MNDWI^{TM} = \frac{Green(Band 2) - SWIR(Band 5)}{Green(Band 2) + SWIR(Band 5)} \quad \text{Equation 1}$$

$$MNDWI^{OLI} = \frac{Green(Band 3) - SWIR1(Band 6)}{Green(Band 3) + SWIR1(Band 6)} \quad \text{Equation 2}$$

MNDWI (Zhai et al. 2015)

NDSI (Zhang et al. 2019, Yan et al. 2020).

- The extracted pixels were classified into two different parts - water and non-water, according to their respective thresholds. For the water body extraction process, initially the positive threshold values were set for all years' images.
- Thereafter, positive water pixel value (0 to 1) was evaluated using MNDWI, the topographical variance of the entire region map was prepared and presented.



Walter Leimgruber



Til Prasad Pangali S.

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Tika Linkha, Dhankuta



Krishna Sharma

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Damman Singh Pujara

Chhabi Lal Chidi

Chhabi Lal Chidi

Basanta Neupane

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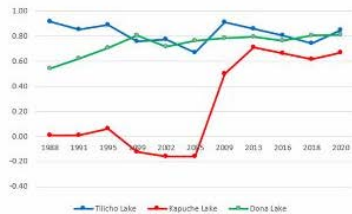


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Result:

- Based on the MNDWI analysis, water pixel mean values for Dona and Kapuche lakes showed an increment while Tilicho lake showed a marginal change. The water cover for Kapuche and Dona lakes showed a longitudinal increase as follows - during 1988, 1991, 1995, the MNDWI values of Dona lake were below 0.70, however, the values increased gradually reaching maximum of 0.79 in 2013. On the other hand, the water level of Kapuche Lake was very low before 2009 but the MNDWI reached 0.67 in 2020.

Time Series Mean Pixel Values (MNDWI) for extracted water and snow/resources



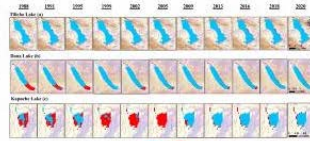
Years	Tilicho Lake	Kapuche Lake	Dona Lake
1988	0.91	0.01	0.54
1991	0.85	0.01	0.62
1995	0.89	0.06	0.70
1999	0.76	-0.12	0.80
2002	0.77	-0.16	0.72
2005	0.67	-0.16	0.76
2009	0.91	0.50	0.78
2013	0.85	0.71	0.79
2016	0.80	0.66	0.76
2018	0.74	0.62	0.80
2020	0.85	0.67	0.81

The time-series graph for the MNDWI mean water pixels values in each extracted water and snow/resource.

Water content Analysis

- In the early phase, between 1988-1999, the annual expansion level of Tilicho lake was 0.09% (3905 to 3942 pixels) and the corresponding annual growth rate of Dona lake was 3.81% (743 to 1054 pixels). At this stage Kapuche lake was non-existence. However, between 2000-2009, the water content of each lake showed relatively higher annual expansion levels; Tilicho lake was 0.38% (3841 to 3942 pixels), Dona lake 1.38 % (922 to 1011 pixels) and Kapuche lake 108% (12 to 103 pixels). Between 2013 and 2020, the annual growth rate of Tilicho lake was 0.07% (3863 to 3882 pixels), Dona was 0.52 % (968 to 1003 pixels). In particular, the expansion of Kapuche lake has interesting pattern - its existence is barely noticeable until 2005, however, it gradually increased and reached to a noticeable form beyond 2009, rising from 50 pixels to 105 pixels, and it has been growing

Year	Tilicho Lake	Dona Lake	Kapuche Lake
1988	3905	743	0
1991	3942	1054	0
1995	3896	879	0
1999	3942	1014	12
2002	3841	922	12
2005	3875	968	50
2009	3942	1011	103
2013	3863	948	105
2016	3942	968	105
2018	3744	990	104
2020	3842	1004	105



Water content of selected Three lakes MNDWI: (a) Tilicho Lake, (b) Dona Lake, (c) Kapuche Lake

Upendra Paudel

Upendra Paudel

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Dr. Basanta Paudel (Me)

BR Bhagawat Rimal (Host)

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BN Basanta Neupane

BK Bindra Kumar Tamang

BK Bipin Kumar Acharya, PhD

BG Bishal Gnyawali

BS Bishnu Sharma

CL Chhabi Lal Chidi

Dammar Singh Pujara

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HP Homanath Pangeni

JW Jin Wang

JK Jyoti Karki



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Climate Change

- The recorded temperature and precipitation data over 29 years (1988 to 2017) was analyzed to evaluate the change in temperature and precipitation levels of the study area. This analysis showed the trend of annual mean temperature and the total annual rainfall over this period. Overall, the annual mean temperature is found to rise by 0.0123° C and the rainfall is reduced by 49.856 mm per year.

The annual temperature rises for all three meteorological stations and the highest temperature growth rate was found at the Chame station of 0.158 °C. For the other two metrological stations at Lumle and Jomsom, the annual temperature growth rates were 0.073 °C and 0.046 °C respectively.

Bhagawat Rimal

Dr. Basanta Paudel

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Jyoti Karki

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Dammar Singh Pujara

Rajeev Upadhyay

Homanath Pang

Chet Narayan giri

Bindra Kumar T...

Shreejana Khadka

Tej Prasad Sigdel

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Lumle Station

Chame Station

Jonmuna Station

The annual temperature rises for all three meteorological stations and the highest temperature growth rate was found at the Chame station of 0.158 °C. For the other two meteorological stations at Lumle and Jonmuna, the annual temperature growth rates were 0.073 °C and 0.046 °C respectively.

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1988	TM								
1990	TM								
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