



# RESEARCH ACTIVITIES ON GNSS LAB AT PASHCHIMANCHAL CAMPUS, TRIBHUVAN UNIVERSITY, POKHARA, NEPAL

**United Nations/Philippines Workshop on the Applications of  
Global Navigation Satellite Systems**

**Manila, Philippines  
22 - 26 April 2024**

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# Outline of the Presentation

- Background
- Goals
- Research activities in GNSS Lab
- Future plan



# Background

- Tribhuvan University established in 1959
- Highest number of full time students 482,541 students worldwide in 2023/2024 , 1124 campuses all over the country.
- Pashchimanchal Campus, Tribhuvan University established in 1981
- Bachelor Degree in Geomatics Engineering in 2013
- Master of Science in Geospatial Engineering in 2020
- For research activities, Center for Space Science and Geomatics Studies (CSSGS), at Pashchimanchal Campus has initiated in 2018



## Background

- Pashimanchal campus devoted for the human resources for the country in the field of Engineering
- The center is devoted to space science research and Geomatics education.
- This center response in terms of specific needs country and society's economics, and the environment in the field of land monitoring, disaster research, agriculture planning, atmospheric analysis and GNSS Applications.



## Goal of Center for Space Science and Geomatics Studies (CSSGS)

CSSGS established GNSS Lab to promote the application of GNSS technology in Nepal.

### *Our Goal is:*

- *Become a Center of Excellence in GNSS applications, system development, research and capacity development for academic, industry and government organizations both at academic and decision-making levels.*



# Pashchimanchal campus, Tribhuvan University in Geomatics Engineering

- Every year 48 Under graduate students
- Every year 20 Master's level students
- Joint survey camp and summer school with international and national university



# Center for Space Science and Geomatics Studies Research Activities



# Establishment of CORS station at Pashchchimanchal Campus



CORS Antenna



CORS Receiver: PolaRx5

Capable to receive all GNSS signals in all frequencies  
Data from this receiver is available for R&D





## Collaborative Research Activities

- CSSGS has collaboration with national and international institutes for the establishment and development of the GNSS lab.
- CSSGS has been providing GNSS training in collaboration with
  - International Committee on GNSS (ICG)
  - Center for Spatial Information Science (CSIS), The University of Tokyo
  - University Grants Commission (UGC), Nepal



- CSSGS has established
  - A CORS at Pashchimanchal Campus
  - Pillar Benchmarks to calibrate and study of GNSS Receiver and Antenna performance analysis
- Conducts joint research projects in collaboration with universities
- We welcomed international institute to join in collaborative research projects



## Activities with Provincial Government in Nepal

- We conducted the precision farming research project using Global Navigation Satellite System (GNSS) Receiver and Machine Learning in Gandaki Province , Nepal
- Policy Level talk programs for establishment of CORS in Gandaki Province, Nepal
- Formation of task committee for Natural Disaster Reduction and Management based on GNSS Technology in Gandaki Province ,Nepal



## Collaboration with Center for Spatial Information Science (CSIS) The University of Tokyo

- Conduction of Pilot Projects in the fields of GNSS applications
  - Low-Cost High-Accuracy Position Assessment using MADOCA-PPP
  - Traffic congestion analysis
  - Dynamic Air Quality Monitoring using Low-Cost GNSS receiver systems



# Statistics of UTOKYO/ICG GNSS Training Program-2022 hosted by CSSGS Pashchimanchal Campus, Tribhuvan University, Pokhara , Nepal

Training Mode / Location	Hybrid-Training Venue: Nepal	
	11 – 14 Jan 2022 3 days	28 Jan 2022 1 day
Date and Duration	11 – 14 Jan 2022 3 days	28 Jan 2022 1 day
Course Type	Course A	Course B
(A) ICG Funded International (travel only)	(5 awarded but Cancelled due to Corona Situation, attended online)	NA
(B) Other Funding (travel only)	NA	NA
(C) Self Funded International	(3 but cancelled due to Corona Situation, attended online)	NA
(D) Self-Funded Domestic (Thailand or Nepal)	30 (On-site Nepal)	NA
(E) Online Participants	45	25
<b>Total (A + B + C + D + E)</b>	<b>75</b>	<b>25</b>
Number of Applicants	90	40
Number of Resource Persons	13	3
Number of Countries	16	10
Resource Persons' Countries	7	2





# Center for Space Science and Geomatics Studies (CSSGS)





# Statistics of UTOKYO/ICG GNSS Training Program-2023 hosted by CSSGS Pashchimanchal Campus, Tribhuvan University, Pokhara , Nepal

Training Mode/ Venue	Hybrid Nepal	
Date and Duration	3-6, January, 2023 4 days	9 January ,2023 1 day
Course type	A	B
(A) ICG funded	N/A	N/A
(B) Other funding (Travel only)	N/A	N/A
(C) Self funded international	3	N/A
(D) Self funded Domestic	47	N/A
( E) Online Participants	200	20
Total (A+B+C+D+E)	250	20
Number of Applicants	350	30
Number of resources persons	13	3
Number of countries	16	5
Resource persons' countries	5	3









# Statistics of UTOKYO/ICG GNSS Training Program-2024 hosted by CSSGS at Institute of Engineering , Pulchowk, Lalitpur, Nepal

Training Mode/ Venue	Hybrid Nepal	
Date and Duration	12-16, Feb, 2024 5 days	12-14 February ,2024 3 day
Course type	A	B
(A) ICG funded	8	N/A
(B) Other funding (Travel only)	N/A	N/A
(C) Self funded international	2	N/A
(D) Self funded Domestic	40	3
( E) Online Participants	200	20
Total (A+B+C+D+E)	250	20
Number of Applicants	350	30
Number of resources persons	13	3
Number of countries	16	5
Resource persons' countries	5	3







# Joint survey Camp jointly organized by the Center for Space Science and Geomatics Studies and The University of Southern Queensland, Australia

- 27 November to 1 December 2023
- Venue: Pashchimanchal Campus, Lamachaur Pokhara
- 10 students and three professor from The University of Southern Queensland, Australia
- 10 students and 3 professors from Center for Space Science and Geomatics studies , Pashchimanchal campus , Pokhara , Nepal





# Master Thesis on GNSS Applications

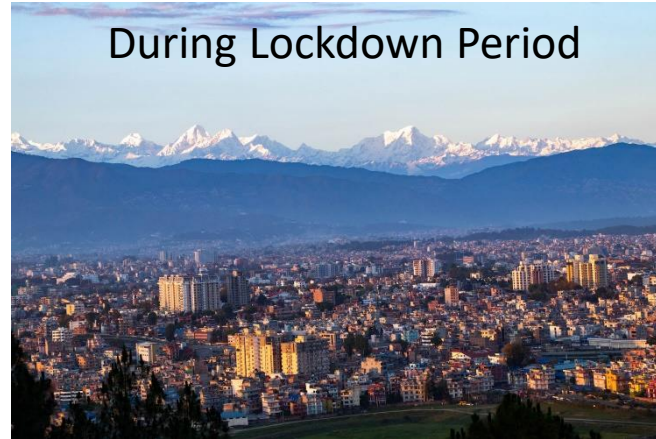
- **Master students have selected GNSS as a part of their Master Thesis.**
  - Air Quality Monitoring Using Low-Cost GNSS Receivers and Air Quality Sensors in Urban Environment.
  - Analysis of Perceptible water vapor using Global Navigation Satellite System Observation
  - Total Electron Content Estimation and Comparison Using Multi-GNSS Constellations



# Pilot Projects: Dynamic Air-Quality Monitoring



Before Lockdown Period

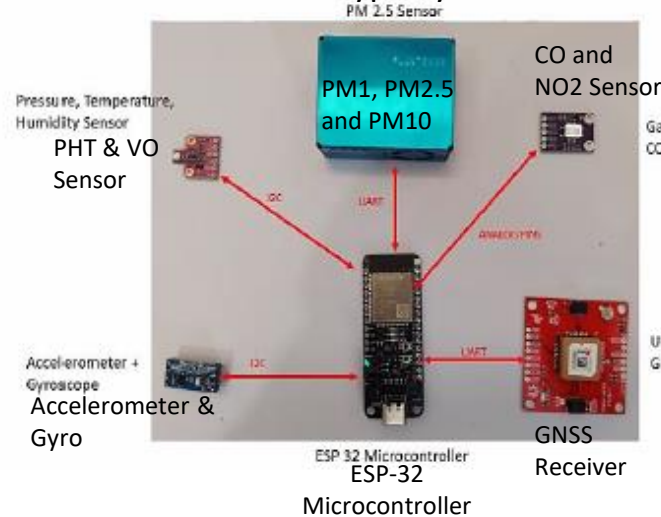


During Lockdown Period

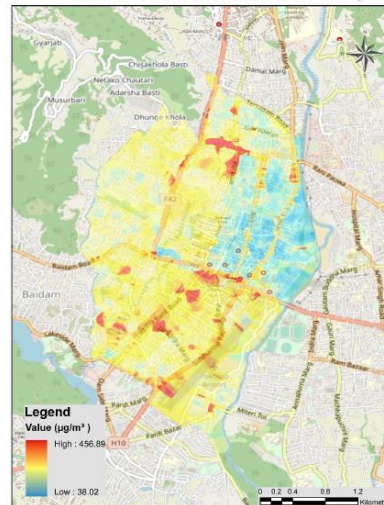


Photo Sources: [https://www.nepalitimes.com/here-now/nepals-smoky-mountains/?fbclid=IwAR31xbeCKSSj9\\_gNOAU7BKMquQAzTg0Z6J-LUTmtsZu9o7o9ozsddu8Z5Vo](https://www.nepalitimes.com/here-now/nepals-smoky-mountains/?fbclid=IwAR31xbeCKSSj9_gNOAU7BKMquQAzTg0Z6J-LUTmtsZu9o7o9ozsddu8Z5Vo)

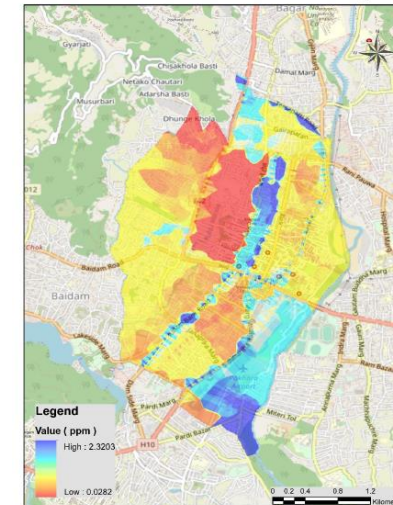
## Prototype System



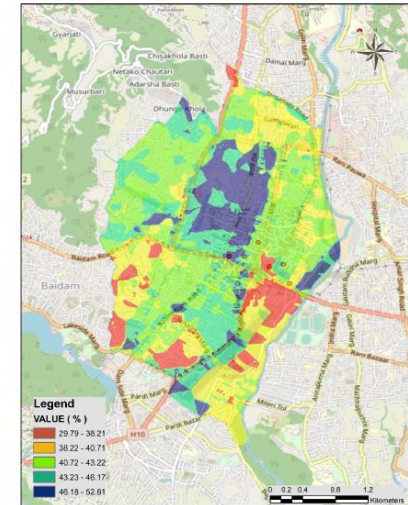
## PM<sub>2.5</sub> Concentration in Pokhara Valley



## NO<sub>2</sub> Concentration in Pokhara Valley



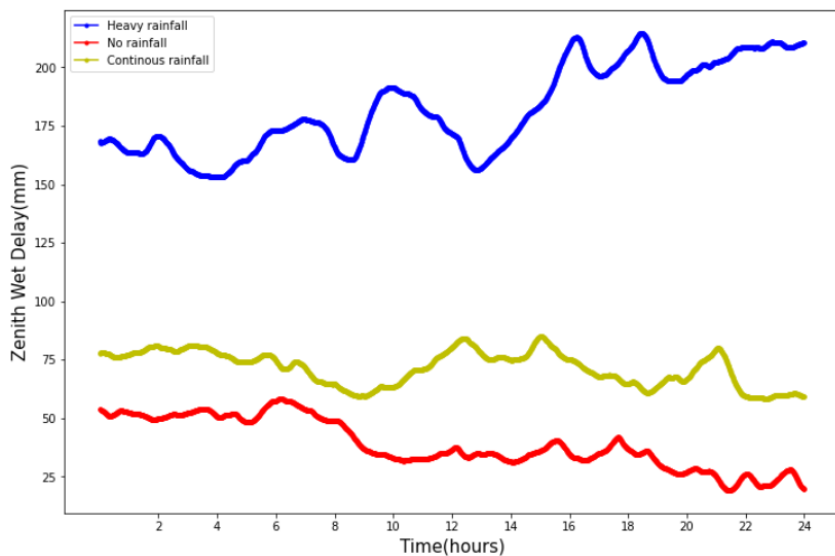
## Humidity Distribution Map of Pokhara Valley





# Analysis of Perceptible water vapor using GNSS Data

Site	Type	Date	Geographic Location
1. WRC CORS station	PolaRx5e	2022/7/1-2022/7/31 (rainy month)	28°15'18.36''mN, 83°58'35.04''E
2.Nagarkot CORS station	NetR9	2021/12/1 -2022/12/31 (cold month) 2022/4/1 - 2022/4/31 (dry month)	27°41'33.68'N, 83°31'15.80'E



Comparison of Zenith Wet Delay during heavy rainfall, no rainfall, and continuous rainfall day- Nagarkot GNSS Station.

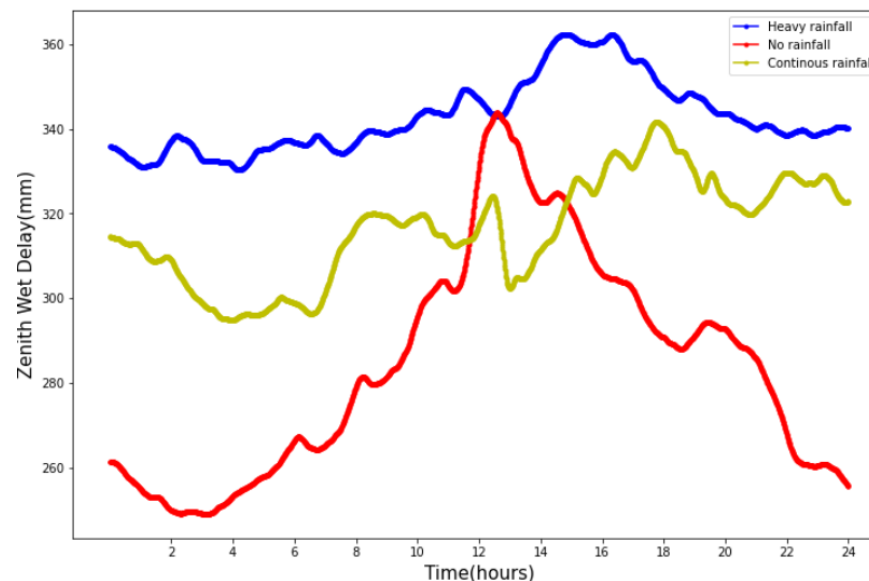
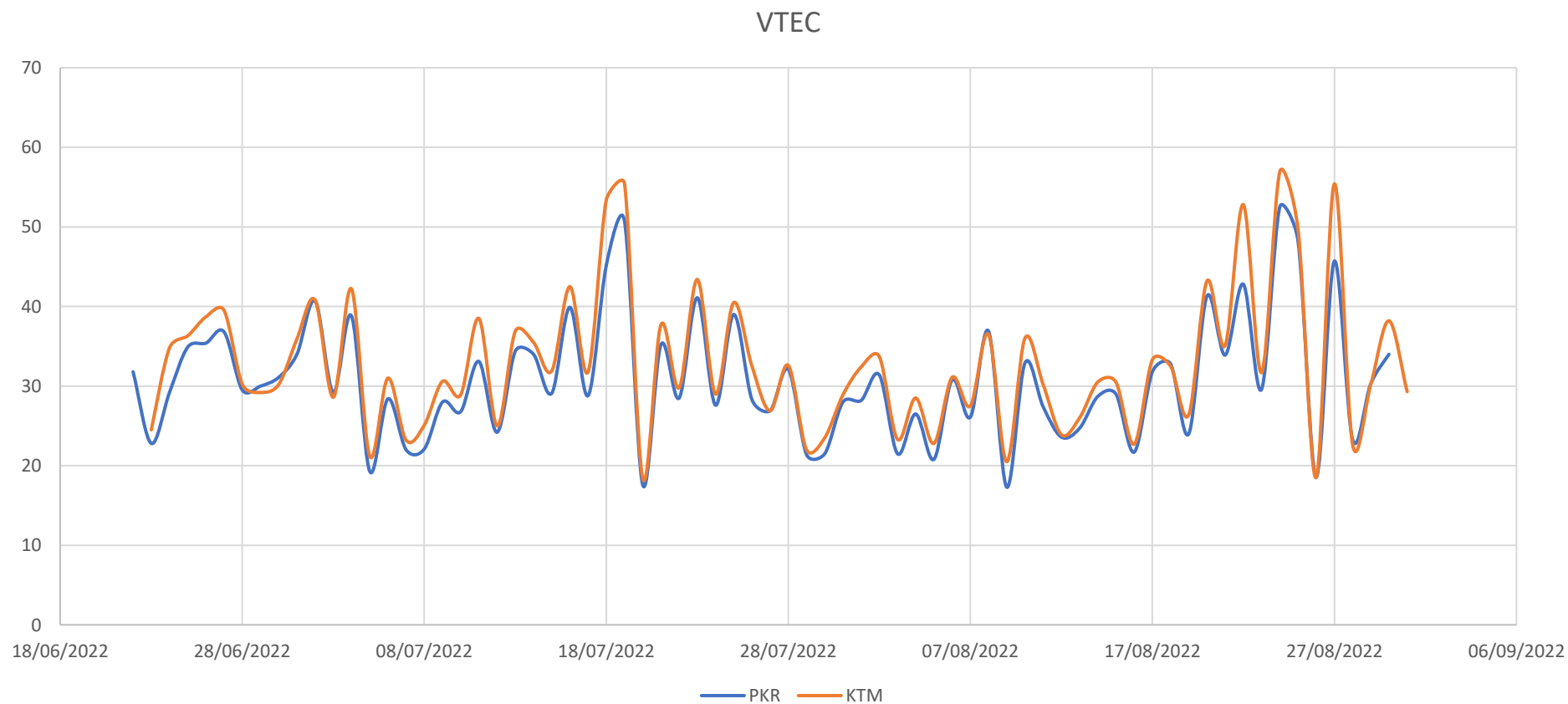


Figure : Comparison of Zenith Wet Delay during heavy rainfall, no rainfall, and continuous rainfall day- Pachimanchal Campus GNSS Station.



# Total Electron Content Estimation and Comparison Using Multi-GNSS Constellations

- Variation of VTEC over Pokhara and Kathmandu

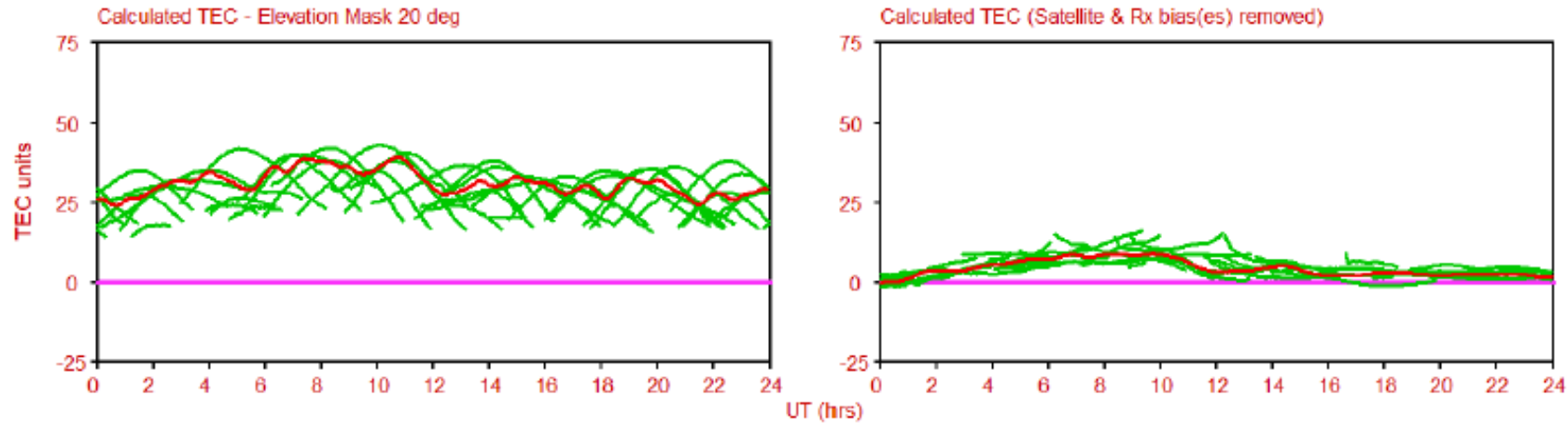




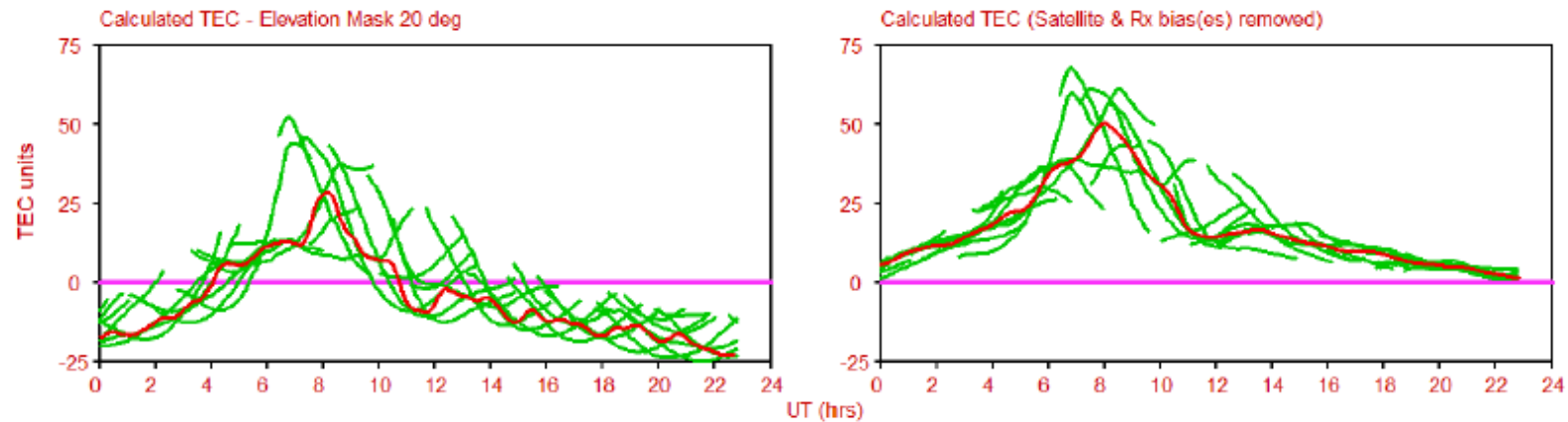


# Total Electron Content Estimation and Comparison Using Multi-GNSS Constellations

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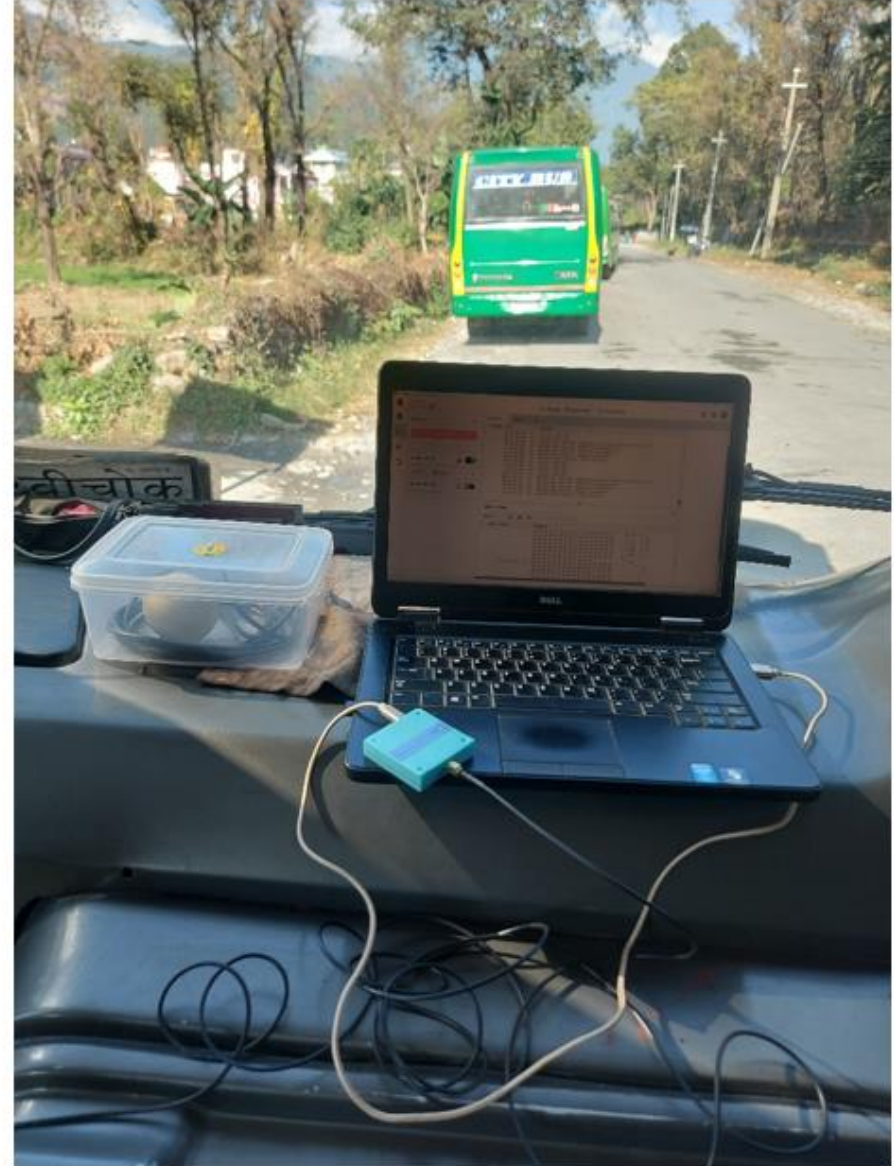
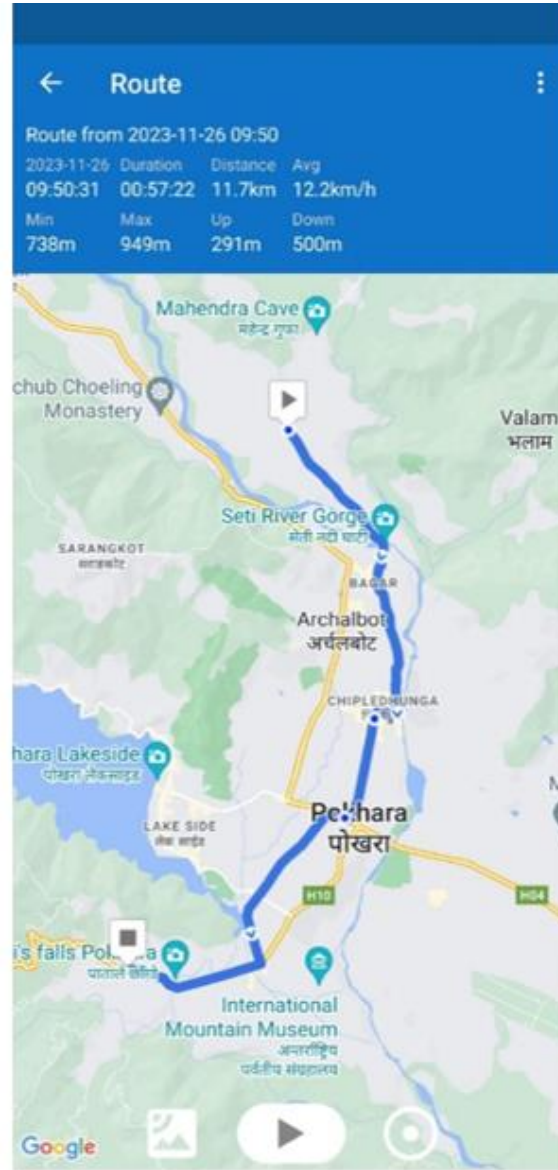


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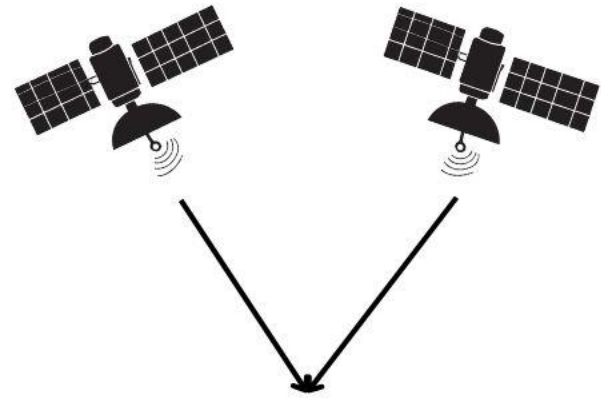


# Mero Bus Navigator: A Comprehensive Mobile App for Seamless Commuting in Pokhara with GNSS Tracking and Fare Integration



Data collection

# Schematic Diagram



**SAM-M8Q**

Captures Real Time location of the device

1



**ESP-WROOM-32**

coordinates the operation of the entire system and manages data flow

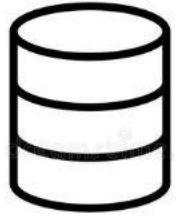
2



**GSM 800L**

enables communication over cellular networks, extending the system's reach beyond Wi-Fi coverage areas.

3



**DATABASE**

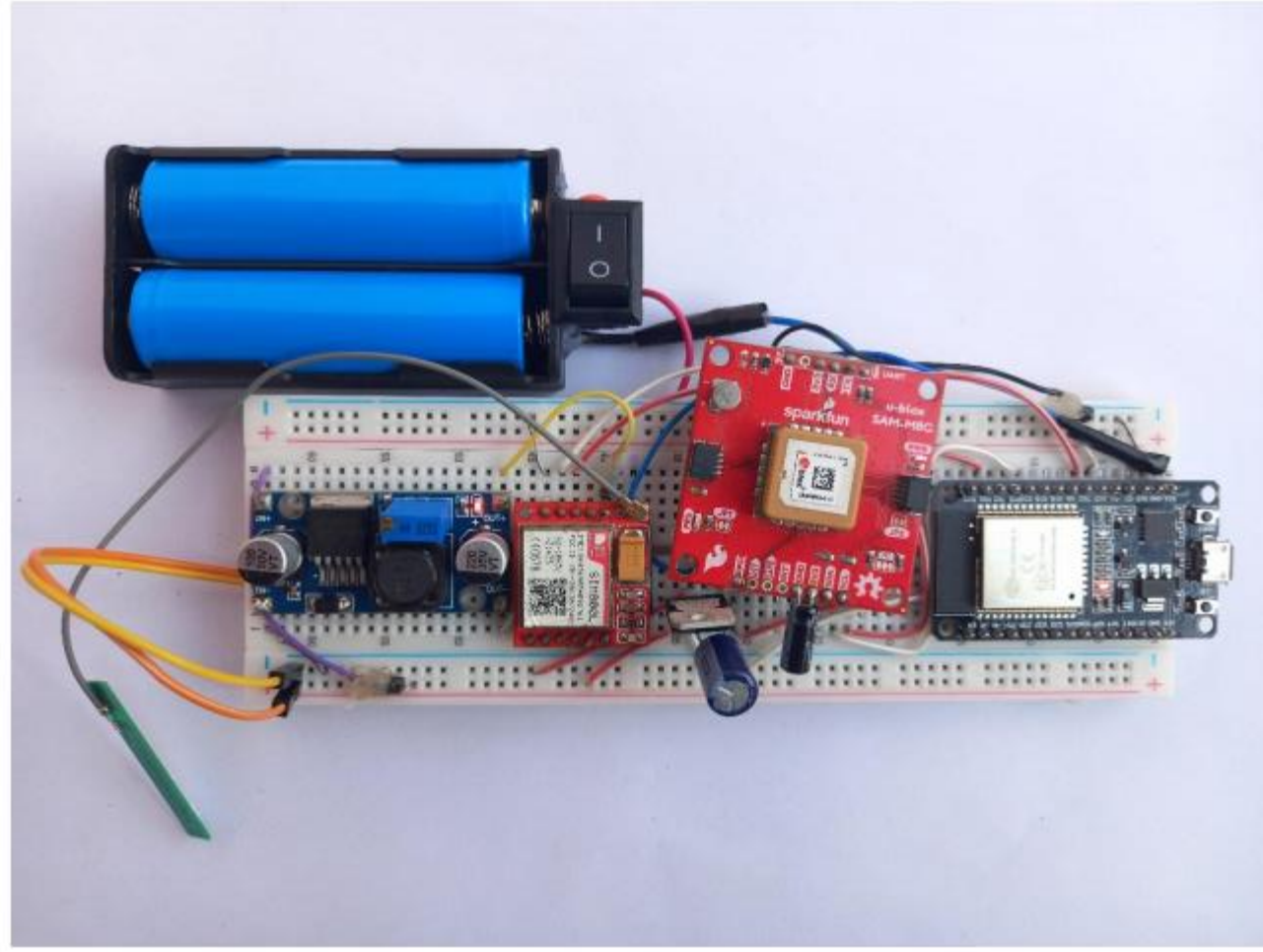
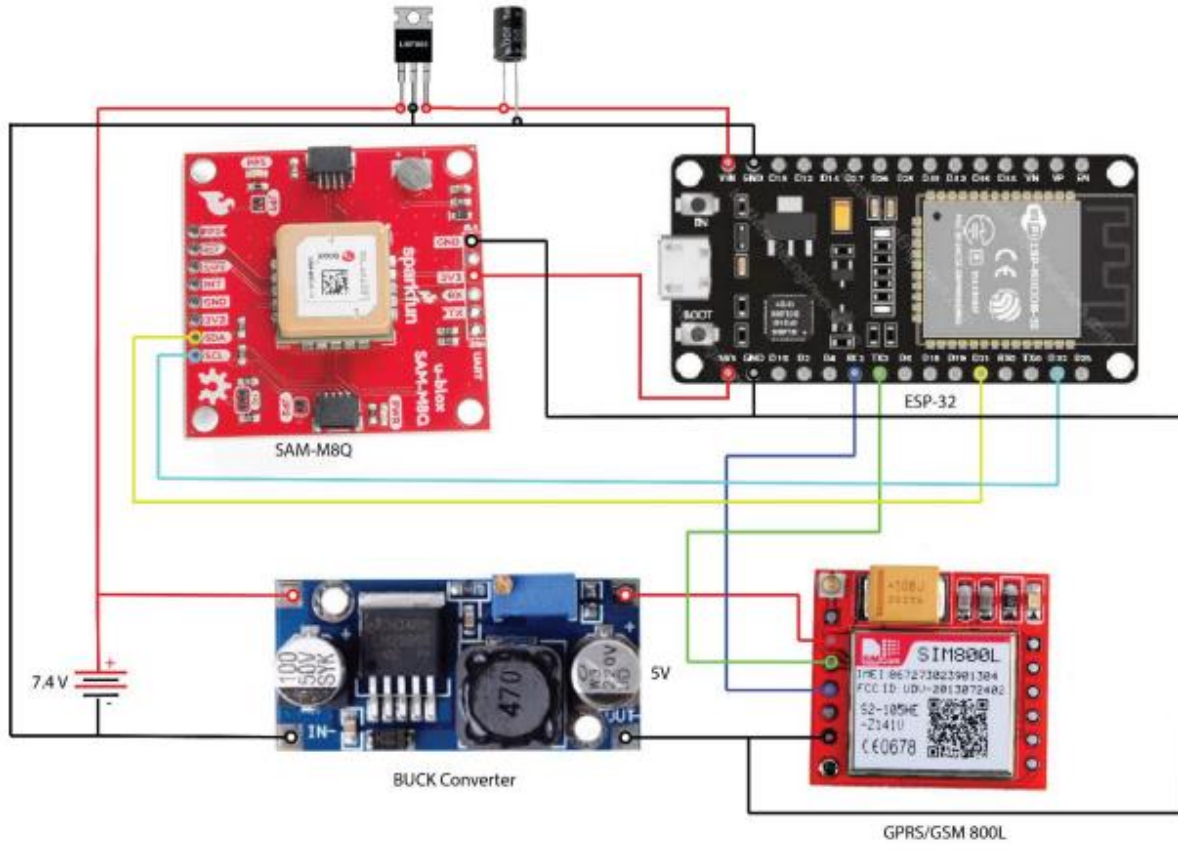


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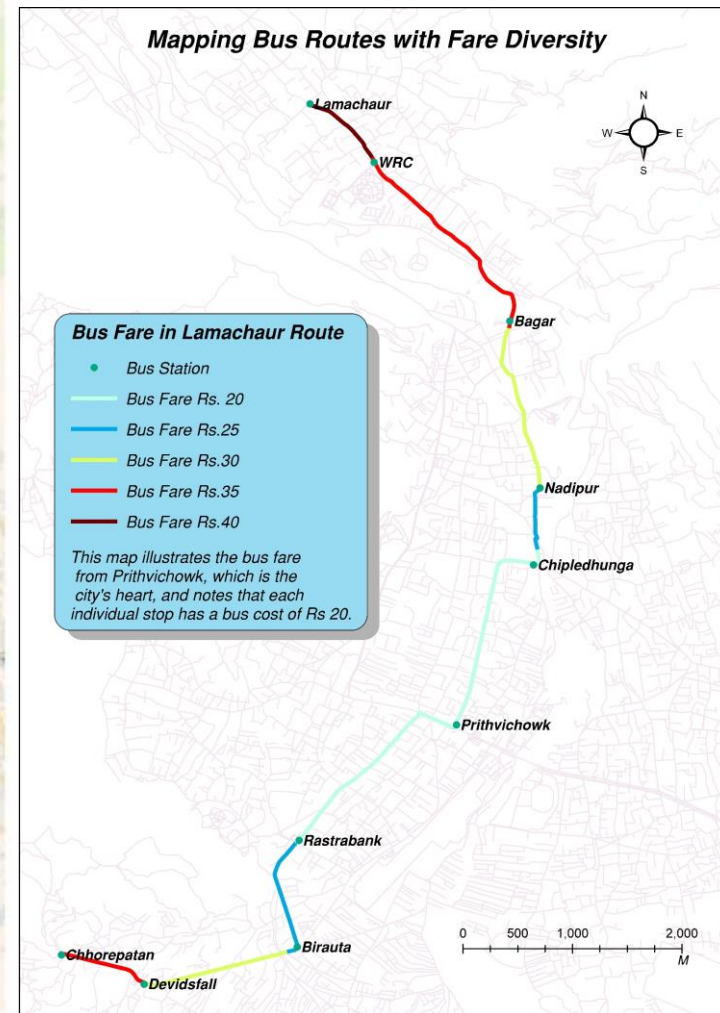
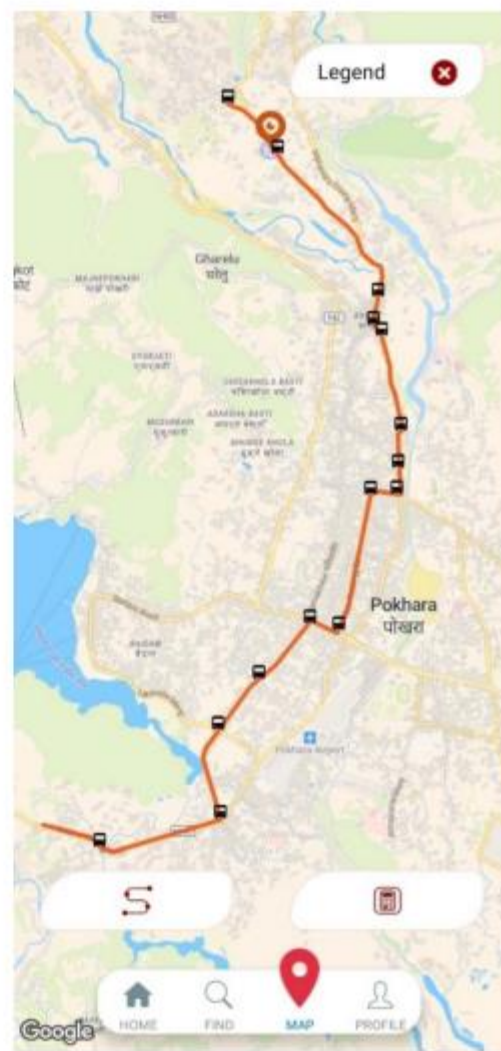
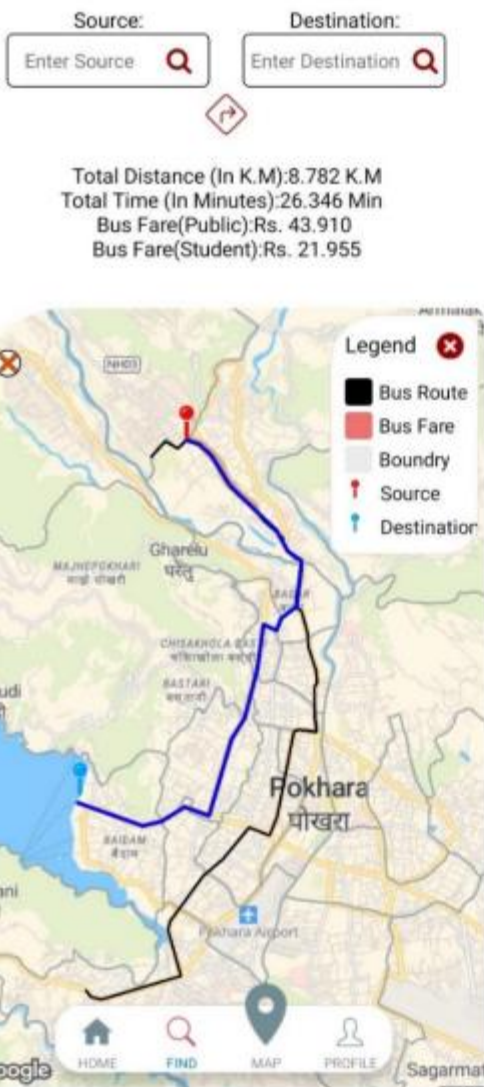


# Smart Bus Tracking System (SBTS)





# Mero Bus App Demo

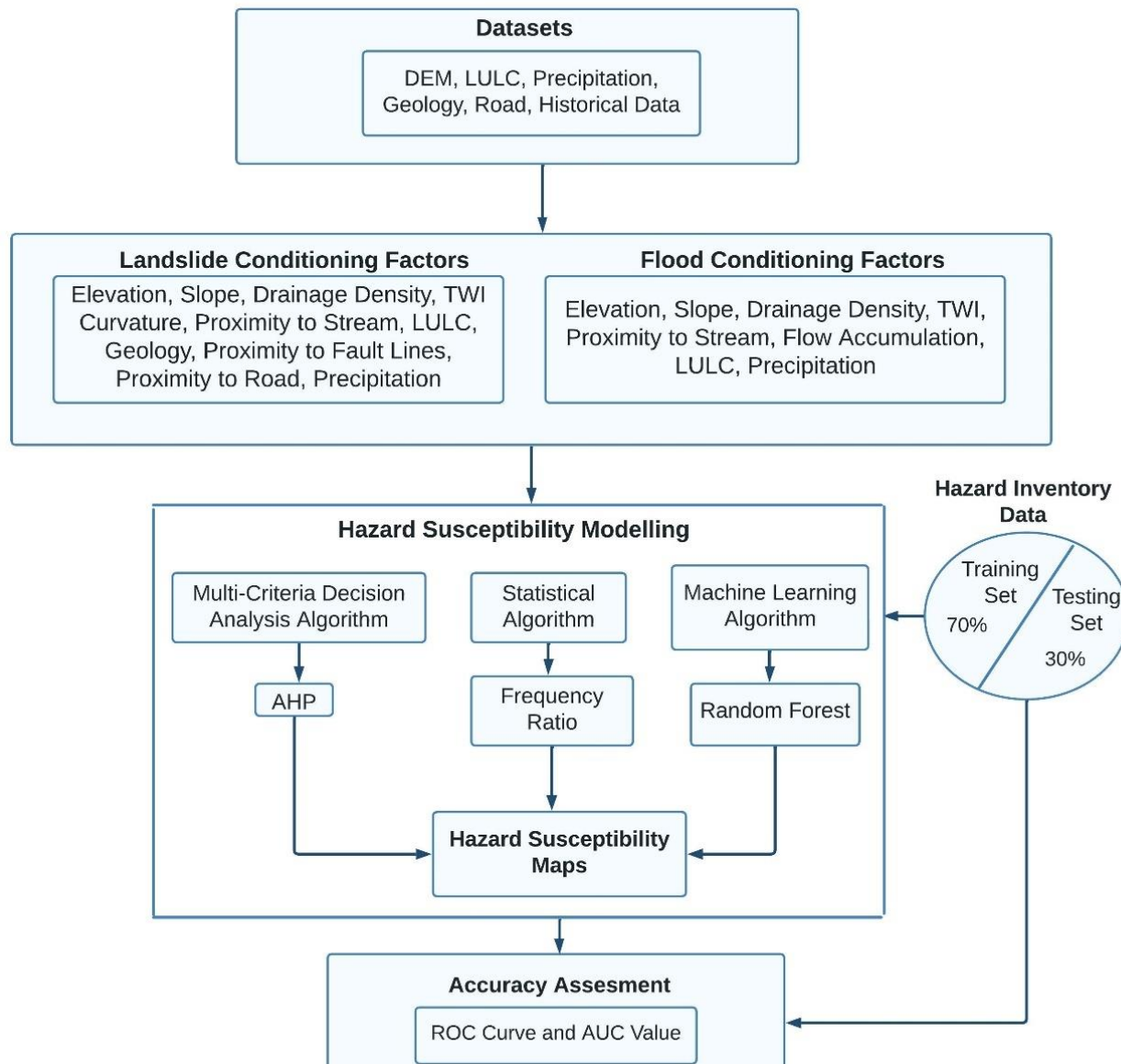




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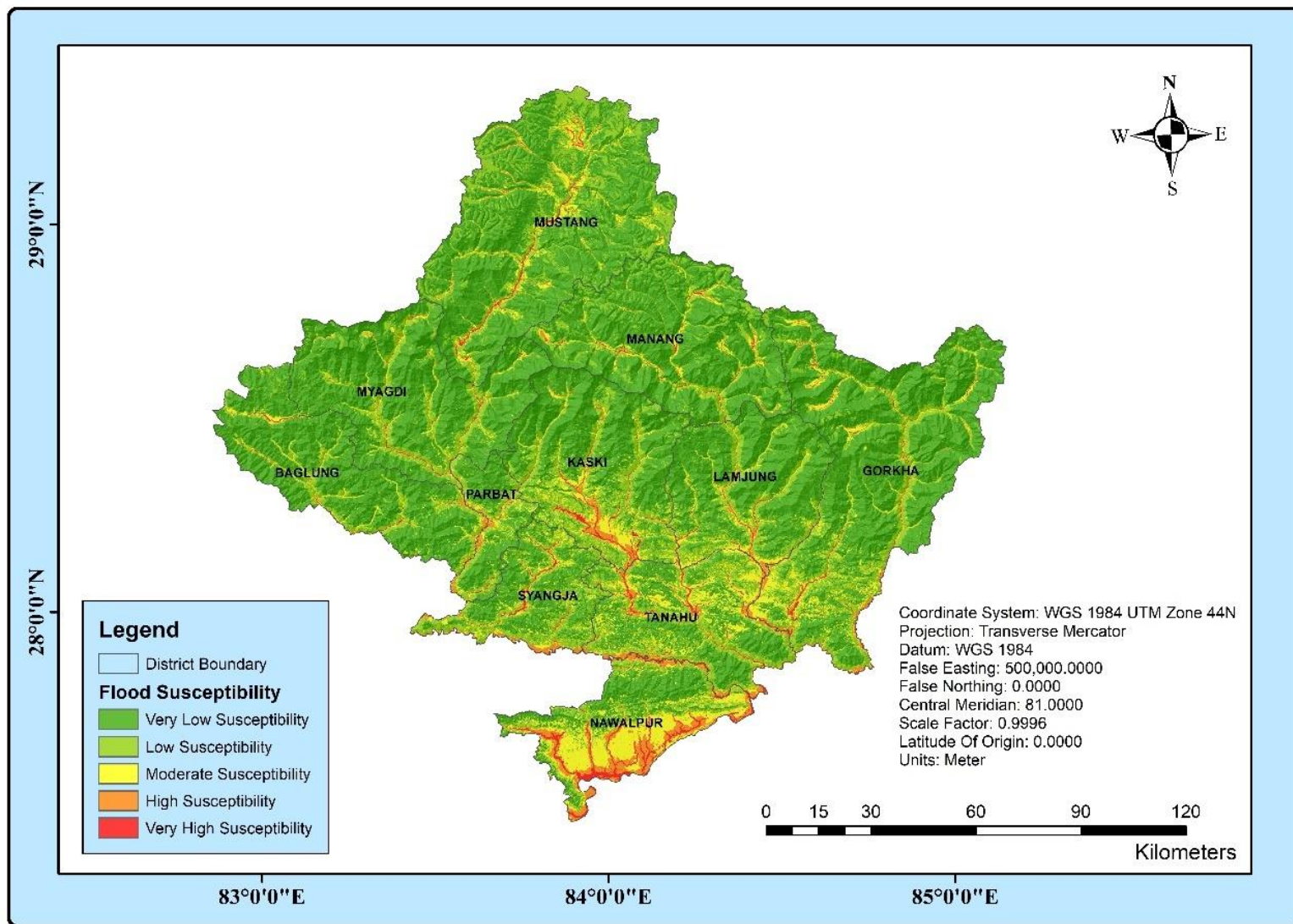


# Remote Sensing and GIS in Natural Hazard Susceptibility Mapping Using Primitive to Modern Approach- A Case Study of Gandaki Province, Nepal





# Flood Susceptibility Map Using Frequency Ratio

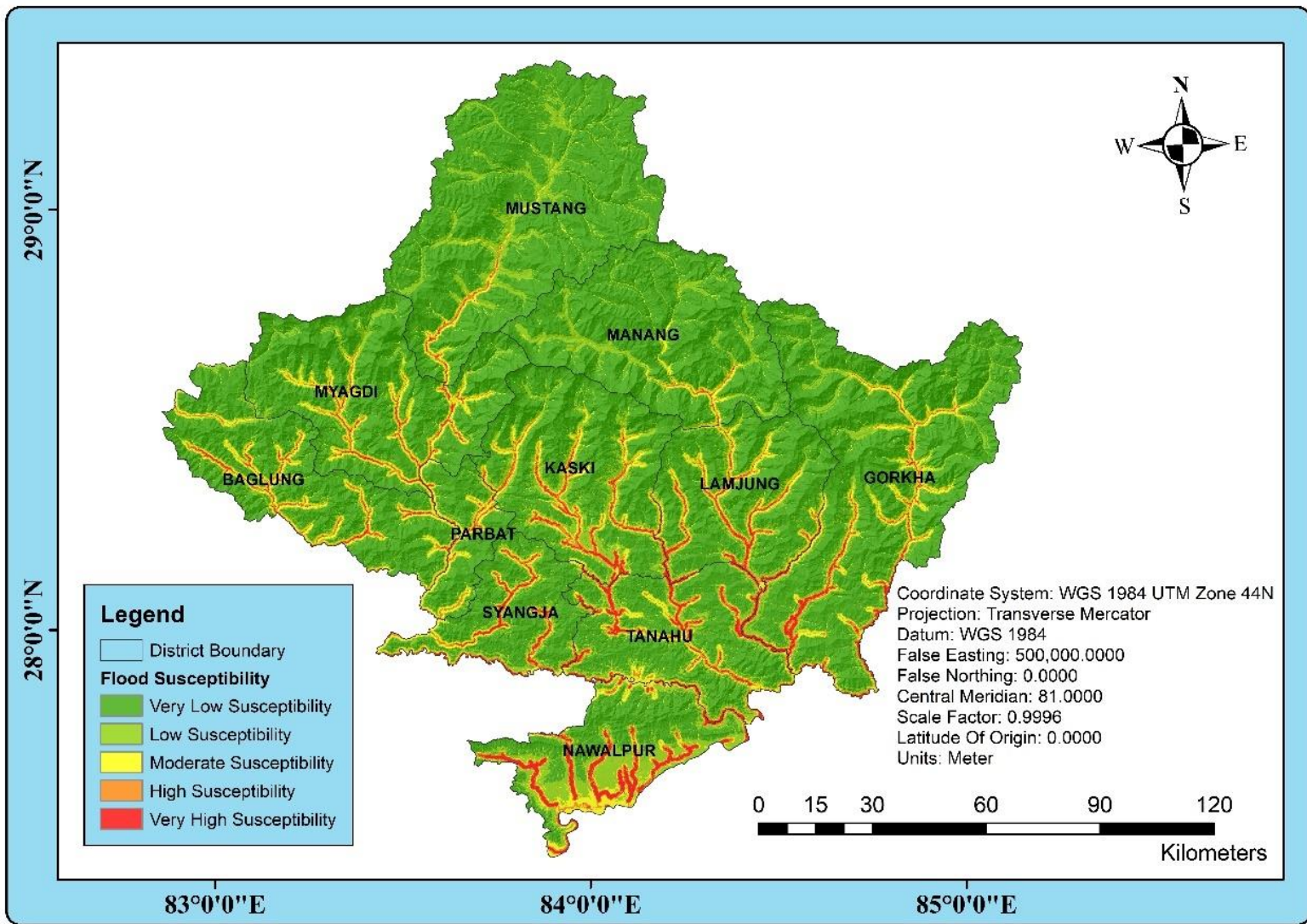


S. No.	Flood Susceptibility	Area (sq km)	Percentage
1.	Very Low Susceptibility	14164.69	64.36
2.	Low Susceptibility	5021.09	22.81
3.	Moderate Susceptibility	1875.81	8.52
4.	High Susceptibility	547.61	2.49
5.	Very High Susceptibility	400.37	1.82
<b>Total</b>		<b>22,009.57</b>	<b>100.00</b>





# Flood Risk Map Using Random Forest

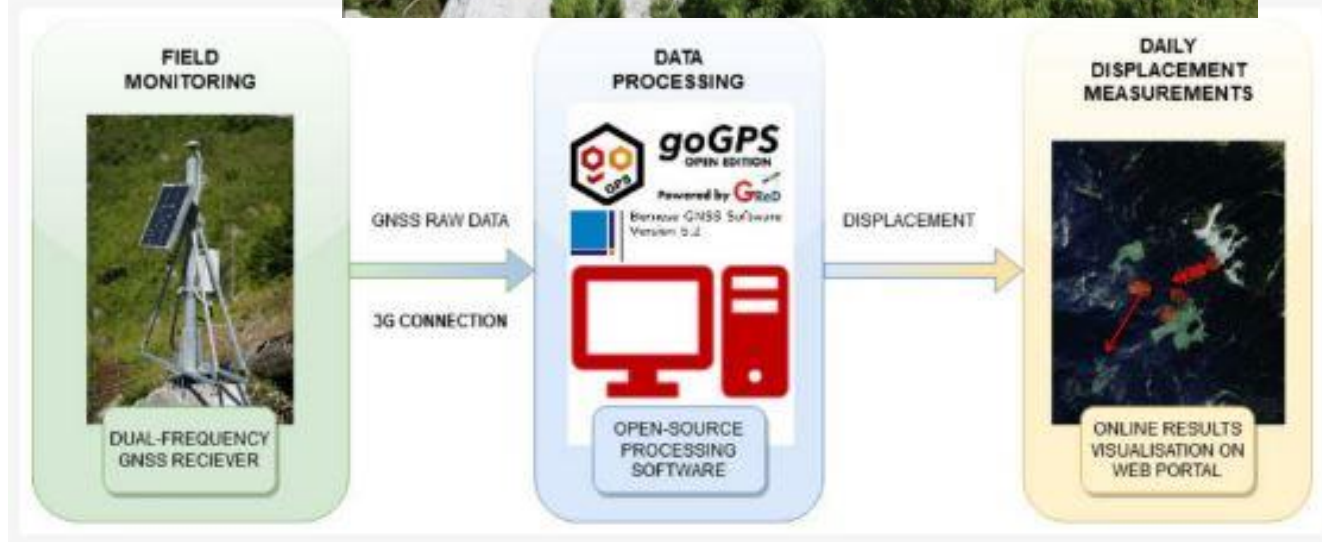


S. No.	Flood Susceptibility	Area (sq km)	Percentage
1.	Very Low Susceptibility	15971.03	72.56
2.	Low Susceptibility	2939.58	13.36
3.	Moderate Susceptibility	1702.48	7.74
4.	High Susceptibility	794.27	3.61
5.	Very High Susceptibility	602.22	2.74
<b>Total</b>		<b>22,009.57</b>	<b>100.00</b>



# Early Warning System

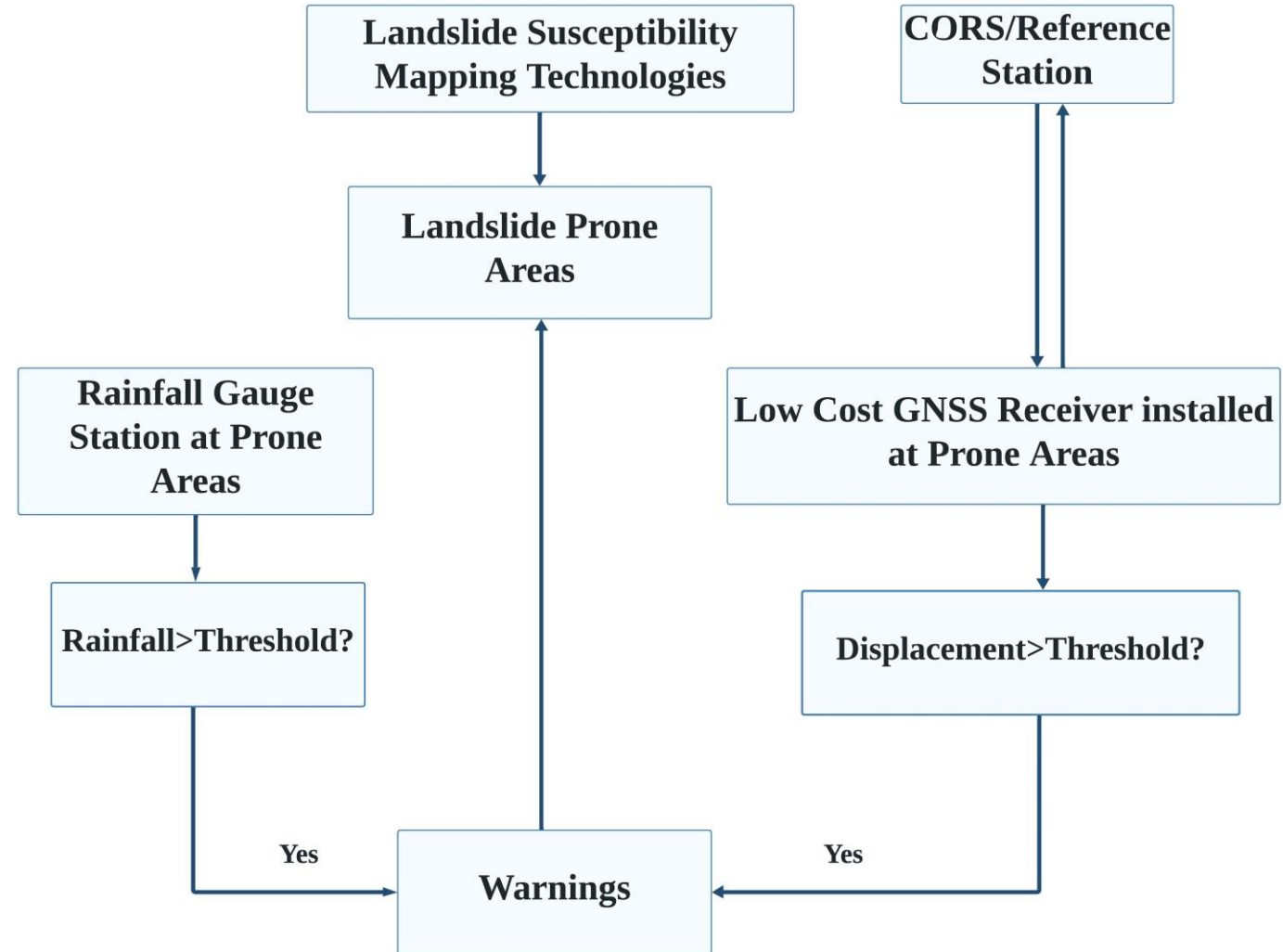
- This could include seismic activity for earthquakes, water levels for floods, ground deformation for landslides or atmospheric conditions for storms.
- GNSS technology can play a role in monitoring ground movement, sea level changes and other relevant parameters.





# Early Warning System

**Flowchart Showing Simple Methodology for Landslide Early Warning System Using Low-Cost GNSS Receiver**





## Future Plans

- Establish and improve infrastructures necessary for GNSS education, research and capacity development.
- We would also like to invite you to join us to achieve our goal together and help promote GNSS technology in Nepal further to improve the socio-economic development of the country.



**Thank You**