Study area and literature review

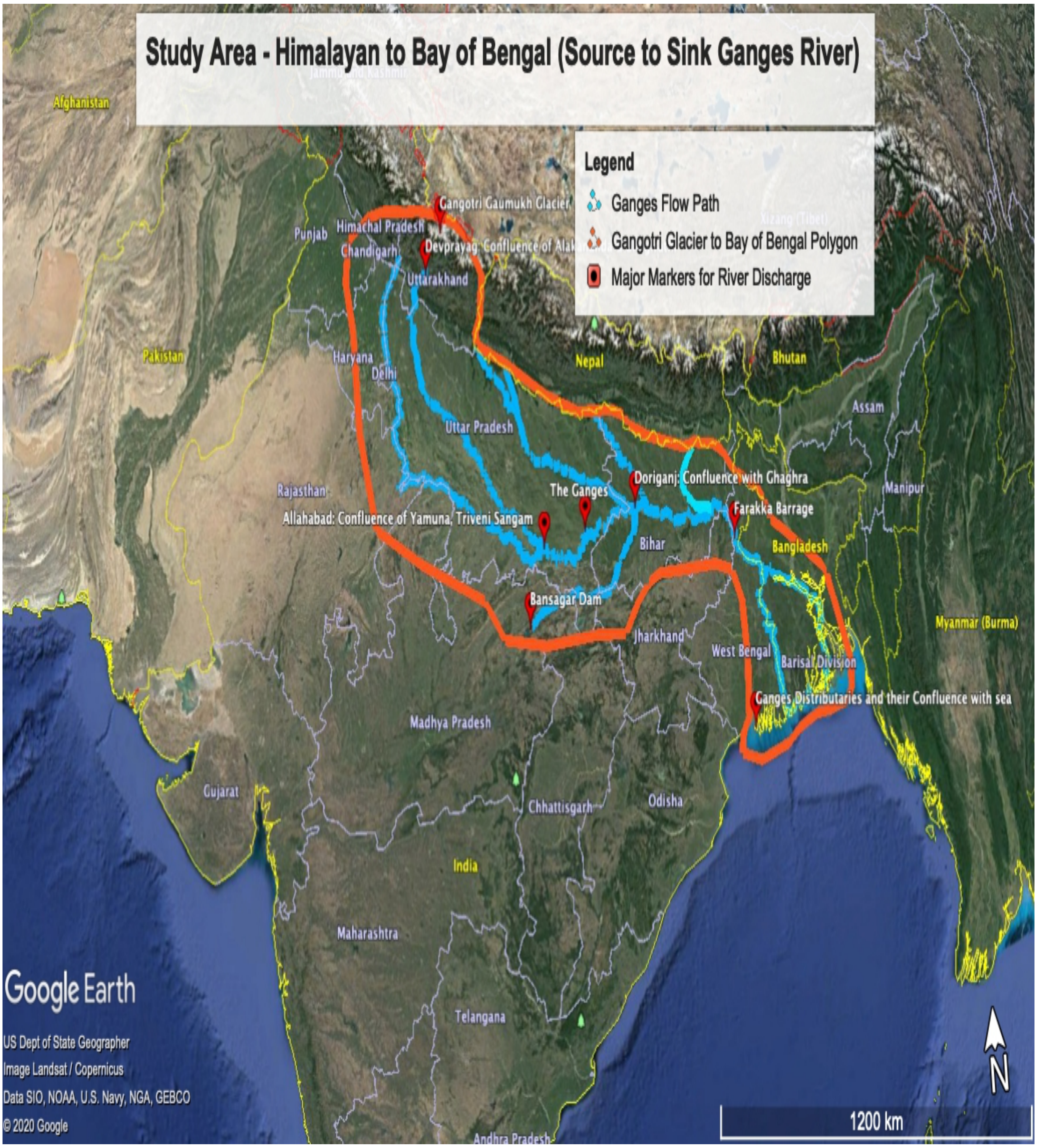

Figure 1: Source to Sink Polygon with Major Marker points shown in the above figure.

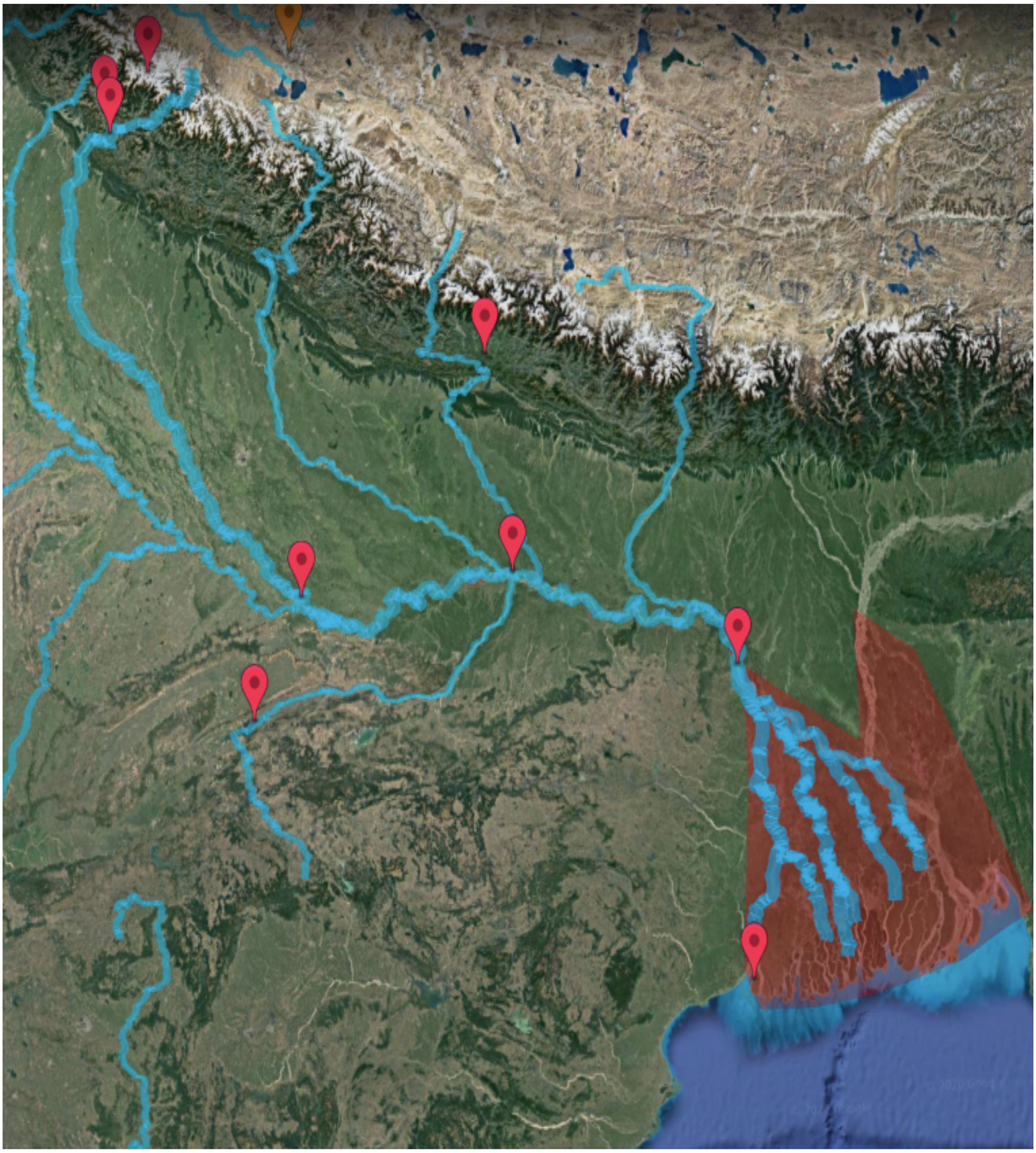

Figure 2: Red Area shown in the above figure is used for the calculation of Tidal Prism.

1. Justify choice behind the study area?

My Topic is Geospatial database creation for Indo-Gangetic delta for source-to-sink relation mapping. For this, I have considered the study area from the origin of Ganges that is Gomukh Gangotri Glacier which is my source and eventually emptying into Bay of Bengal which is my Sink. Now, for this I created a polygon surrounding the major markers considered along the flow of Ganges river. These are

a) Gomukh: Gangotri Glacier
b) Devprayag: Confluence of Alakananda & Bhagirathi
c) Allahabad: Confluence of Yamuna, Triveni Sangam
d) Doriganj: Confluence with Ghaghra
e) Farakka Barrage
f) Ganges Distributaries and Confluence with Sea

I will be using these markers for measuring the River discharge calibrating with closest ground station. The major idea behind it is to calculate the river discharge at the marker points. The markers which I have considered are mostly the origin, and the confluence region and the finally the depositional area. This would ensure that the river discharge calculated would not be hindered by any presence of narrow tributaries.

Now coming to the methodology as in the previous docs I have mentioned about procedure for the measurement of river discharge, so a quick summary of this is as follows:

First I would measure the river velocity by considering the virtual stations from the two marker points, Using the time lag and the distance separation between marker stations A and B, the average river velocity (assuming a uniform velocity) can be computed. The time and distance separation allow the average propagation speed to be computed.

Now roughness coefficient will be computed from the satellite images using the Chow (1959), roughness coefficient table and River reach slope will be calculated using the SRTM DEM data.

For the computation of the River width I will using the Machine Learning Hierarchical classification which would classify the satellite images as two separate classed on for water body and other for any land feature.

After that I will be using the Manning's Equation to Calculate the River discharge.

Now coming to the Tidal Prism for that I will be considering the Area from Farakka Barrage to Bay of Bengal. The area is marked in the red colour and shown in the image above. The procedure will be same as mentioned in the before.

2. How will this study boundary help to achieve your objectives?

My Proposed objectives were:

a) To measure the river velocity of the Ganges River and combined with measurements of river slope with other flow parameters to estimate the river discharge.

b) Increasing the efficiency of the methods behind determining discharge variables to determine the river morphology on a larger scale using Machine Learning Algorithm to measure the river width.

c) To calibrate the virtual station discharge data to the closest ground data to minimise the RMSE error in discharge estimation.

d) Estimation of Tidal Prism using the river discharge and volume of ocean water coming into estuary's on the flood tide

Now for the first objective it is already mentioned above the methodology by which I will be measuring the Ganges river discharge so the given polygon above would ensure to give the river discharge for the Ganges river with the measurement of flow parameters.

Now for the second objective I have proposed for using the Machine Learning Algorithm for calculation of River width so, for this the confluence marker points would be helpful as the width classification would be narrowed down to overall width.

Now for the third objective that is to calibrate the virtual station discharge data to ground data to minimise the RMSE error, the marker points would have considerable discharge data for comparing the discharge of the river with discharge computed using remote sensing and also the comparing the flow parameters data.

Now for the fourth objective that is estimation of Tidal Prism I mentioned above the area considered for measurement of the Tidal Prism also the same is shown in the above image. The Farakka Barrage to Bay of Bengal would be most significant for the use of estimation of Tidal Prism.

3. Literature review on previous work within this study area. Gaps you are planning to fill up for this study area.

“Benchmarking wide swath altimetry-based river discharge estimation algorithms for the Ganges river system” : This was the previous work done within the study area.

The objective of the above study was to compare the effectiveness of three algorithms that estimate discharge from remotely sensed observables (river width, water surface height, and water surface slope) in anticipation of the forthcoming NASA/CNES Surface Water and Ocean Topography (SWOT) mission. SWOT promises to provide these measurements simultaneously and the river discharge algorithms included here are designed to work with these data. Two algorithms were built around Manning's equation, the Metropolis Manning (MetroMan) method, and the Mean Flow and Geomorphology (MFG) method, and one approach uses hydraulic geometry to estimate discharge, the at-many-stations hydraulic geometry (AMHG) method. A well-calibrated and ground-truthed hydrodynamic model of the Ganges river system was used as reference for three rivers from the Ganges River Delta: the main stem of Ganges, the Arial-Khan, and the Mohananda Rivers.

It was found that the MFG method provides the most accurate discharge estimations in most cases, with an average relative root-mean-squared error (RRMSE) across all three reaches of 35.5%. It is followed closely by the Metropolis Manning algorithm, with an average RRMSE of 51.5%. However, the

MFG method's reliance on knowledge of prior river discharge limits its application on ungauged rivers.

The AMHG algorithm, while requiring the least prior river data, provided the least accurate discharge measurements with an average wet and dry season RRMSE of 79.8% and 119.1%, respectively, across all rivers studied. This poor performance is directly traced to poor estimation of AMHG via a remotely sensed proxy, and results improve commensurate with MFG and MetroMan when prior AMHG information is given to the method. Therefore, we cannot recommend use of AMHG without inclusion of this prior information, at least for the studied rivers. The dry season discharge (within-bank flow) was captured well by all methods, while the wet season (floodplain flow) appeared more challenging.

So the most challenging part would be to measure the wet season river discharge amount as there will be varied fluctuation of the river flow parameters but the Method I would be using with ML model, it would help to minimise the error as the major marker points are chosen such that the deviation from the actual discharge flow would be minimum. The confluence points would ensure the minimisation of error.

REFFRENCES:

Ackerman, C. T. (2009), HEC-GeoRAS GIS Tools for Support of HEC-RAS Using ArcGIS User's Mannual, Version 4.2, U.S. Army Corps of Eng. Inst. for Water Resour., Davis, Calif.

Bonnema, M. G., S. Sikder, F. Hossain, M. Durand, C. J. Gleason, and D. M. Bjerklie (2016), Benchmarking wide swath altimetry-based river discharge estimation algorithms for the Ganges river system, Water Resour. Res., 52, 2439–2461, doi:10.1002/ 2015WR017296.

Alsdorf, D. E., N. M. Mognard, and D. P. Lettenmaier (2011), Remote sensing of surface water and recent developments in the SWOT mission, Abstract H21J-06 presented at 2011 Fall Meeting, AGU, San Francisco, Calif.

Brunner, G. W. (2015), HEC-RAS River Analysis System: User's Manual, US Army Corps of Engineers, Institute for Water Resources, Hydrologic Engineering Center.

Berthon, L., C. Biancamaria, N. Goutal, S. Ricci, and M. Durand (2014), Towards the estimation of reach-averaged discharge from SWOT data using Manning's equation derived algorithm. Application to the Garonne River between Tonneins-La Reole, paper presented at EGU General Assembly, Eur. Geosci. Union, Vienna.

Smith, L.C.; Isacks, B.L.; Bloom, A.L.; Murray, A.B. Estimation of discharge from three braided rivers using synthetic aperture radar satellite imagery: Potential application to ungaged basins. Water Resour. Res. **1996**, 32, 2021–2034.

Smith, L.C.; Pavelsky, T.M. Estimation of river discharge, propagation speed, and hydraulic geometry from space: Lena River, Siberia. Water Resour. Res. **2008**, 44.

Tarpanelli, A.; Barbetta, S.; Brocca, L.; Moramarco, T. River discharge estimation by using altimetry data and simplified flood routing modeling. Remote Sens. **2013**, 5, 4145–4163.

Papa, F.; Bala, S.K.; Pandey, R.K.; Durand, F.; Gopalakrishna, V.V.; Rahman, A.; Rossow, W.B. Ganga-Brahmaputra river discharge from jason-2 radar altimetry: An update to the long-term satellite-derived estimates of continental freshwater forcing flux into the Bay of Bengal. J. Geophys. Res. Ocean. **2012**, 117, C11021.

Sichangi, A.W.; Wang, L.; Yang, K.; Chen, D.; Wang, Z.; Li, X.; Zhou, J.; Liu, W.; Kuria, D. Estimating continental river basin discharges using multiple remote sensing data sets. Remote Sens. Environ. **2016**, 179, 36–53.