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Project report

MEKONG RIVER MONITORING USING SATELLITE RADAR ALTIMETRY AND VALIDATION WITH IN-SITU DATA

Special thanks to G-POD and Earth Console team for completing this project

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Phd Student: US.Pakistan Center for Advanced Studies in Water, MUET, Pakistan

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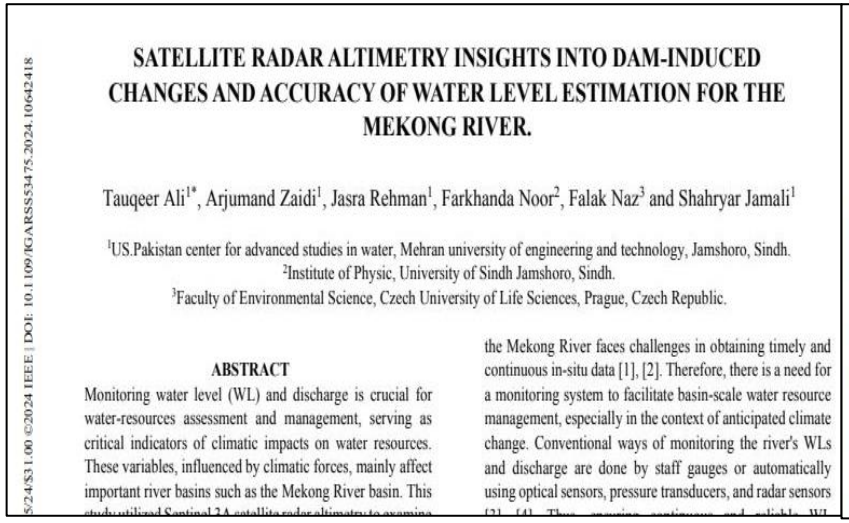

SATELLITE RADAR ALTIMETRY INSIGHTS INTO DAM-INDUCED CHANGES AND ACCURACY OF WATER LEVEL ESTIMATION FOR THE MEKONG RIVER.

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ABSTRACT

Monitoring water level (WL) and discharge is crucial for water-resources assessment and management, serving as critical indicators of climatic impacts on water resources. These variables, influenced by climatic forces, mainly affect important river basins such as the Mekong River basin. This

the Mekong River faces challenges in obtaining timely and continuous in-situ data [1], [2]. Therefore, there is a need for a monitoring system to facilitate basin-scale water resource management, especially in the context of anticipated climate change. Conventional ways of monitoring the river's WLs and discharge are done by staff gauges or automatically using optical sensors, pressure transducers, and radar sensors

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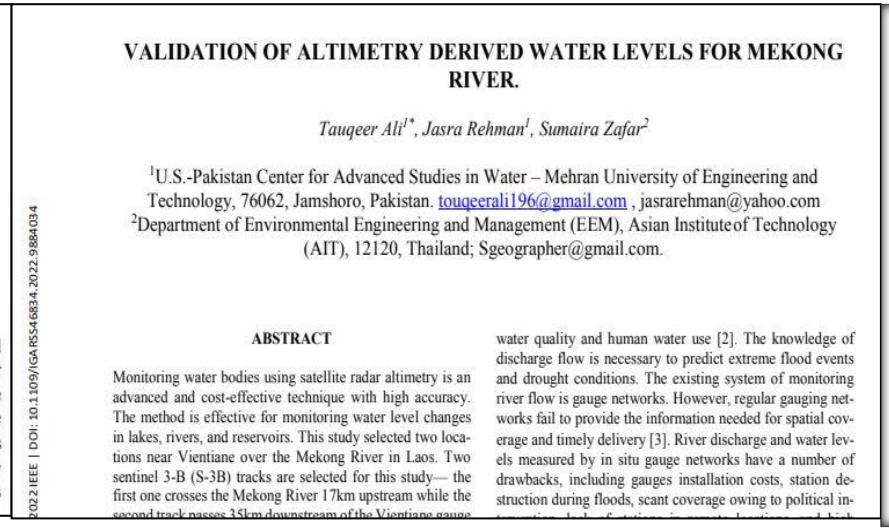

VALIDATION OF ALTIMETRY DERIVED WATER LEVELS FOR MEKONG RIVER.

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ABSTRACT

Monitoring water bodies using satellite radar altimetry is an advanced and cost-effective technique with high accuracy. The method is effective for monitoring water level changes in lakes, rivers, and reservoirs. This study selected two locations near Vientiane over the Mekong River in Laos. Two sentinel 3-B (S-3B) tracks are selected for this study— the first one crosses the Mekong River 17km upstream while the second track passes 35km downstream of the Vientiane gauge

water quality and human water use [2]. The knowledge of discharge flow is necessary to predict extreme flood events and drought conditions. The existing system of monitoring river flow is gauge networks. However, regular gauging networks fail to provide the information needed for spatial coverage and timely delivery [3]. River discharge and water levels measured by in situ gauge networks have a number of drawbacks, including gauges installation costs, station destruction during floods, scant coverage owing to political in-

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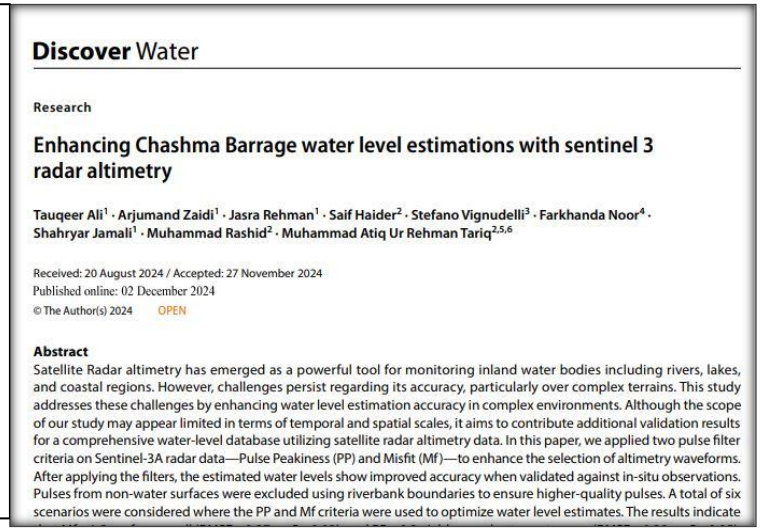

Discover Water

Research

Enhancing Chashma Barrage water level estimations with sentinel 3 radar altimetry

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Abstract
Satellite Radar altimetry has emerged as a powerful tool for monitoring inland water bodies including rivers, lakes, and coastal regions. However, challenges persist regarding its accuracy, particularly over complex terrains. This study addresses these challenges by enhancing water level estimation accuracy in complex environments. Although the scope of our study may appear limited in terms of temporal and spatial scales, it aims to contribute additional validation results for a comprehensive water-level database utilizing satellite radar altimetry data. In this paper, we applied two pulse filter criteria on Sentinel-3A radar data—Pulse Peakiness (PP) and Misfit (Mf)—to enhance the selection of altimetry waveforms. After applying the filters, the estimated water levels show improved accuracy when validated against in-situ observations. Pulses from non-water surfaces were excluded using riverbank boundaries to ensure higher-quality pulses. A total of six scenarios were considered where the PP and Mf criteria were used to optimize water level estimates. The results indicate

https://link.springer.com/article/10.1007/s43832-024-00179-6

PROBLEM STATEMENT

- Insufficient monitoring and sharing of hydrological data are among the major challenges of countries sharing Mekong River water including Cambodia, Lao PDR, Myanmar, Thailand and Viet Nam.
- Water related disputes of transboundary water resources could be resolved by continuous monitoring of the river.
- Validation of altimetry data in different regions and in different regimes of water body can help to use this data with confidence for ungauged river basins **such as the Indus River**.

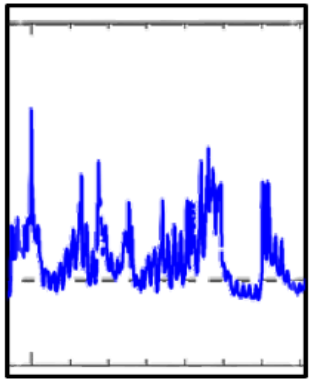
RESEARCH QUESTION

1. How well do satellite-derived levels match with observations collected on the ground?

2. What will be the error in free river flowing areas of Mekong compared to the locations with Barrages over Indus River?

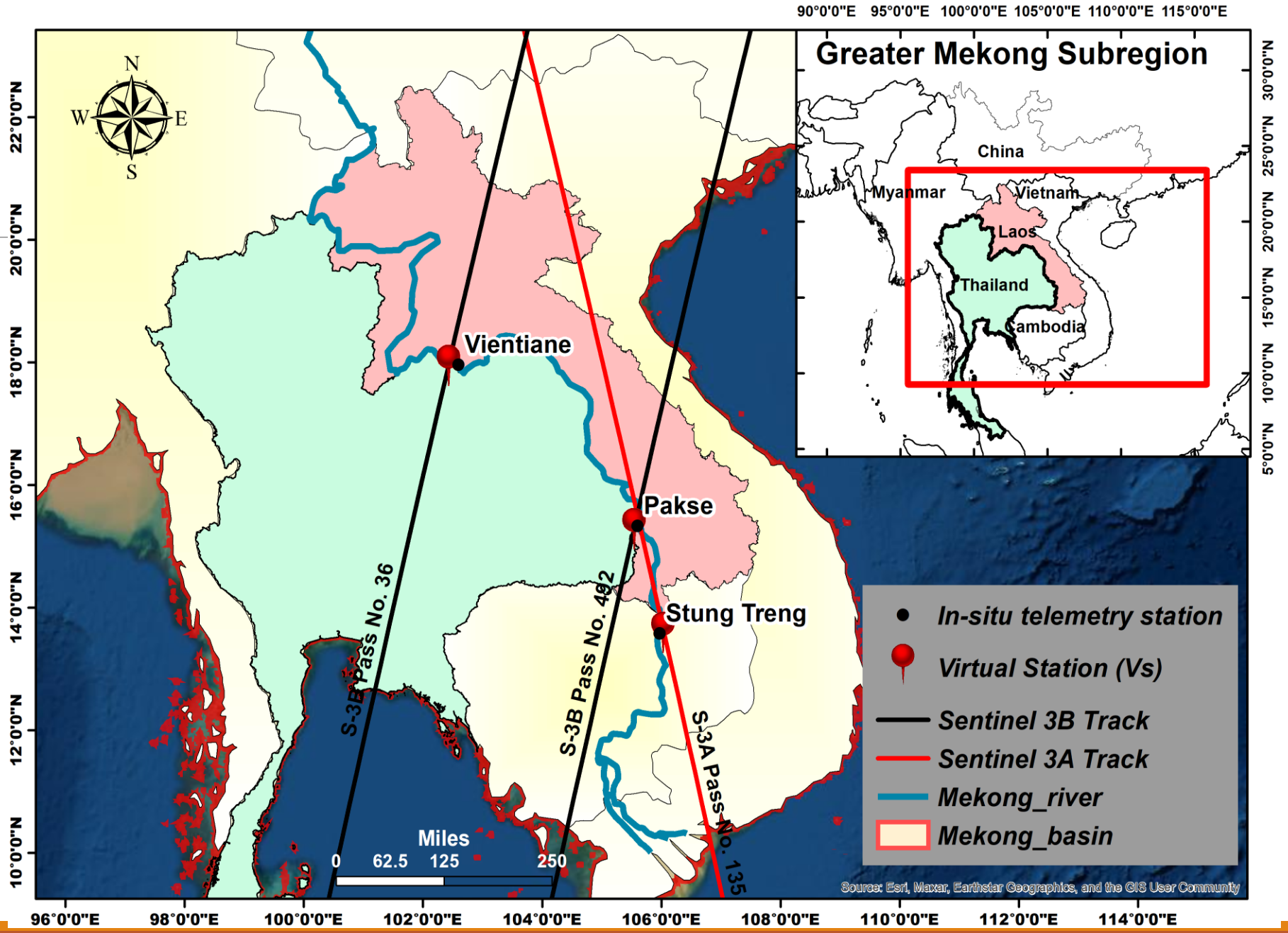
RESEARCH OBJECTIVE

1. To validate the altimetry derived water levels with in-situ data.

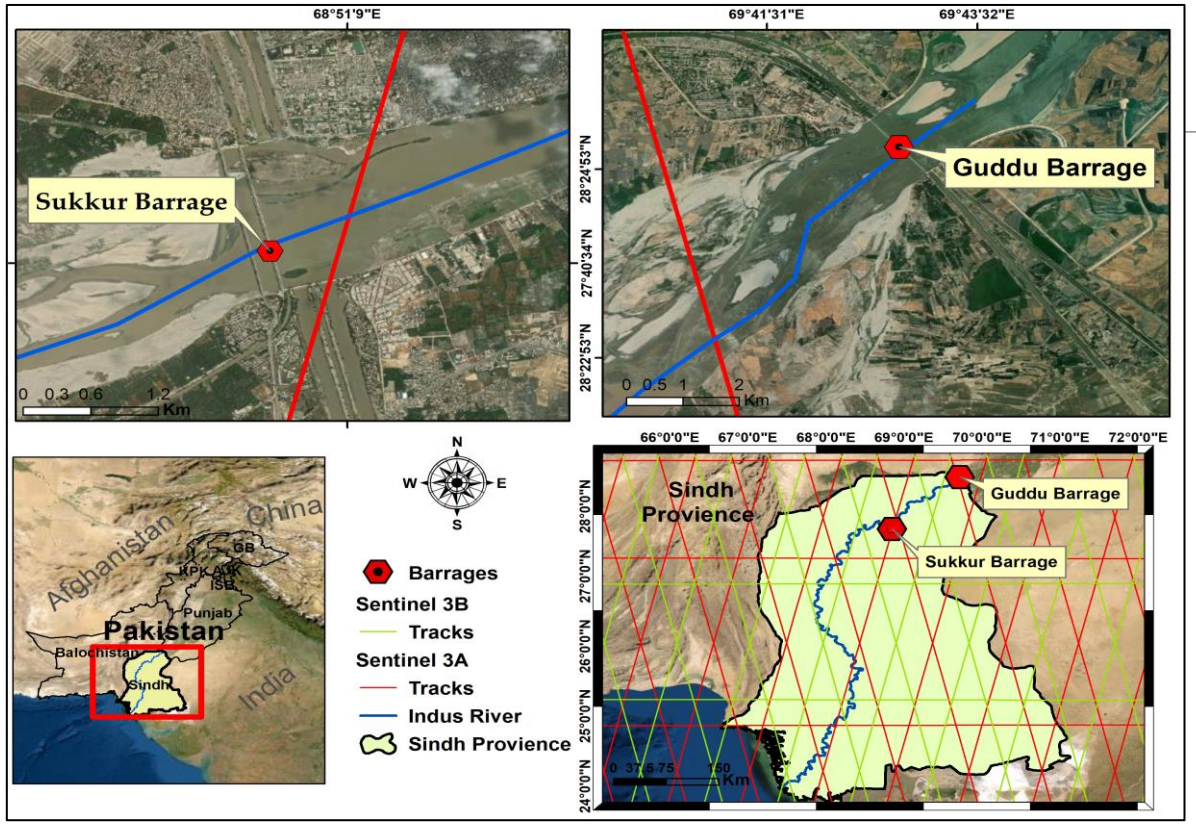


2. To compare the error between barrages__(Indus river) vs. free flowing__(Mekong river).

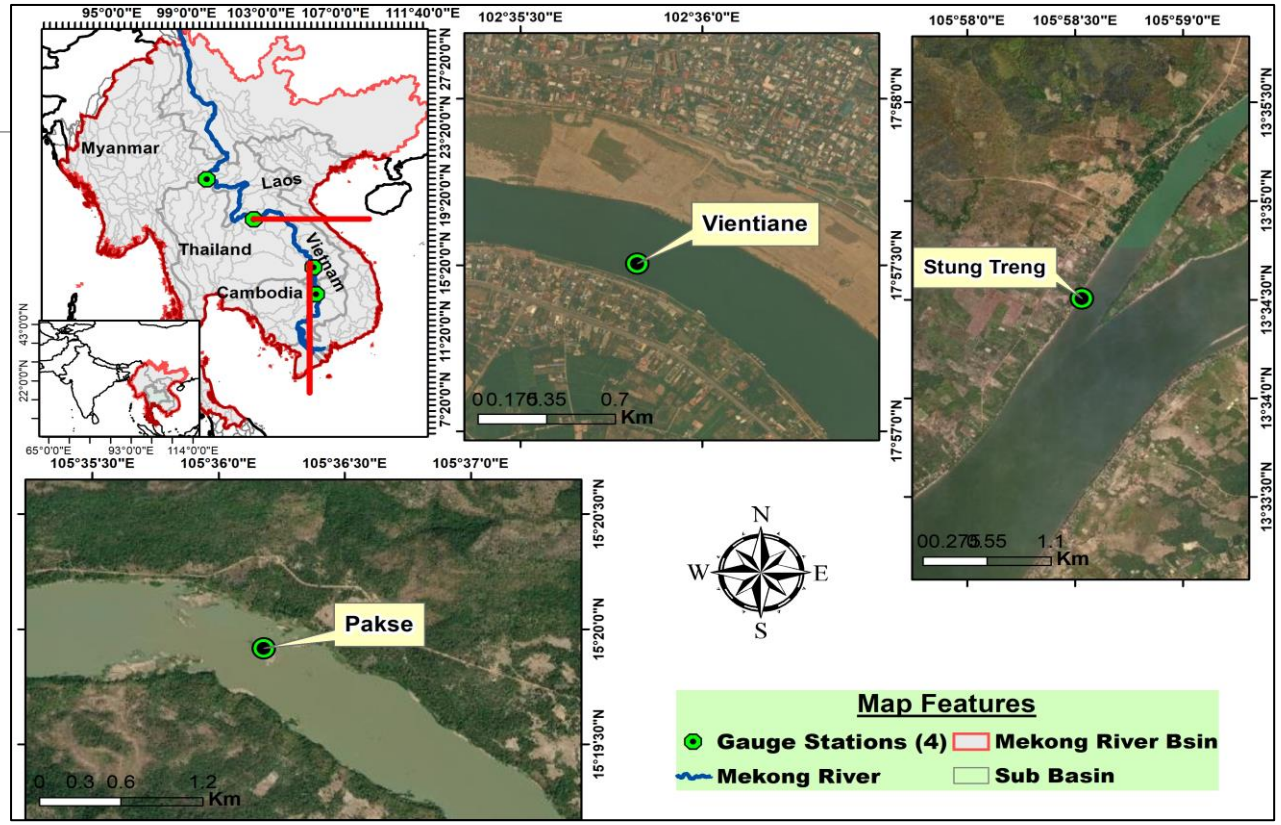
Map of Study Area



Map of Study Area

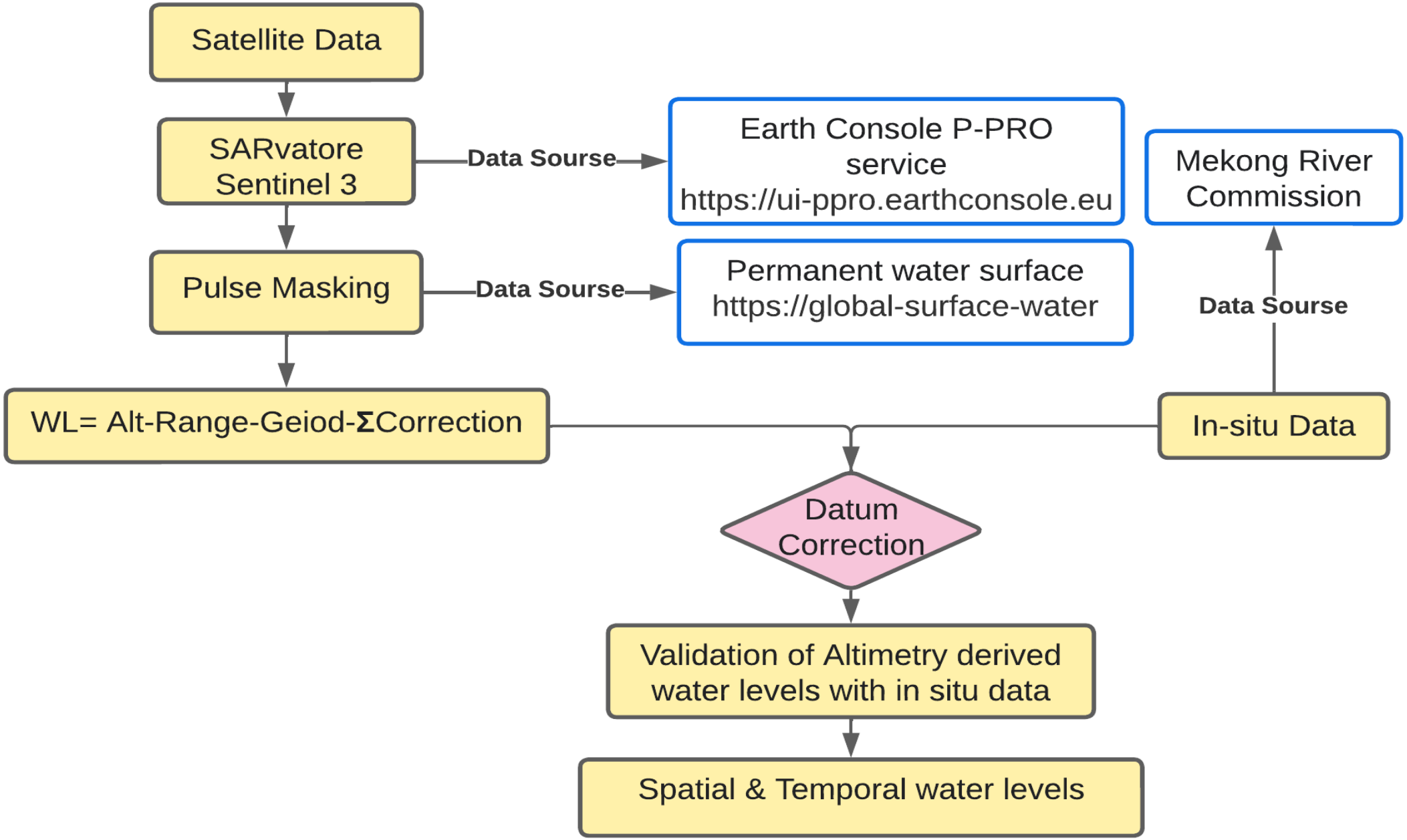


Location of Guddu and Sukkur barrage



location of gauge station on Mekong river

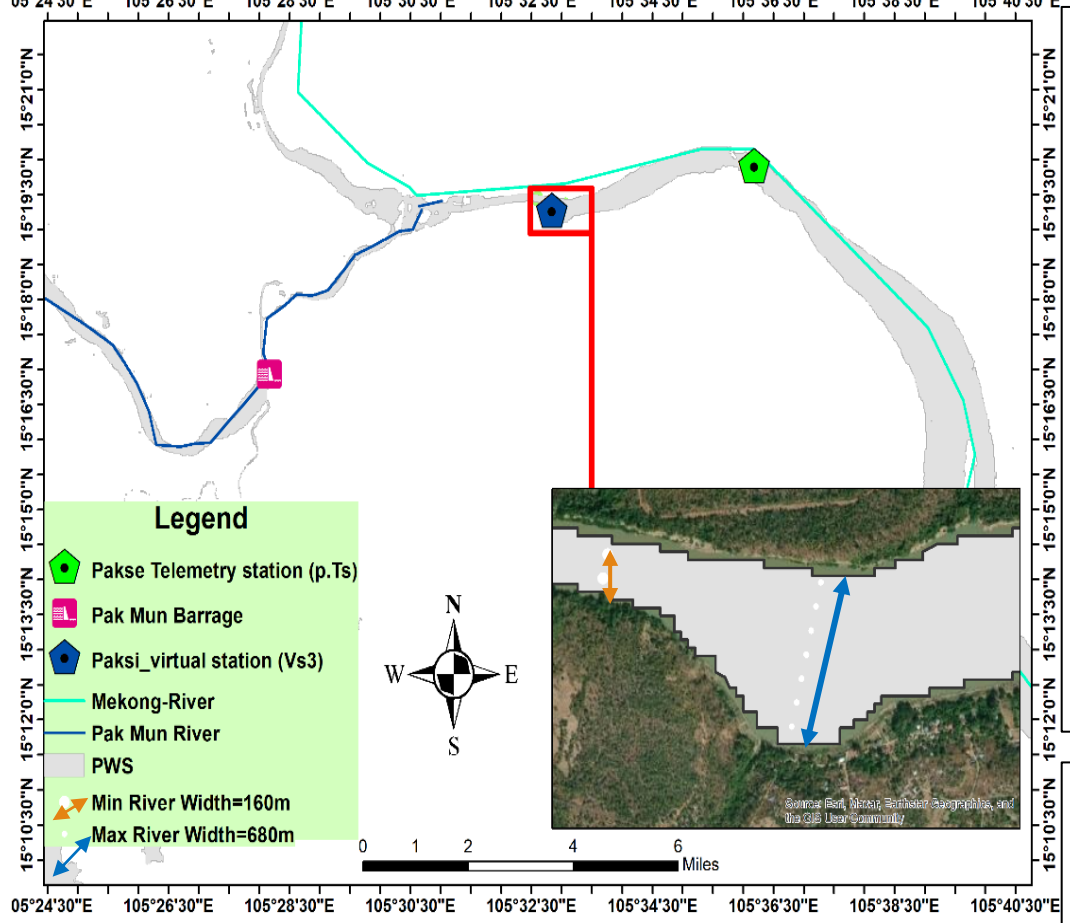
Methodological Framework

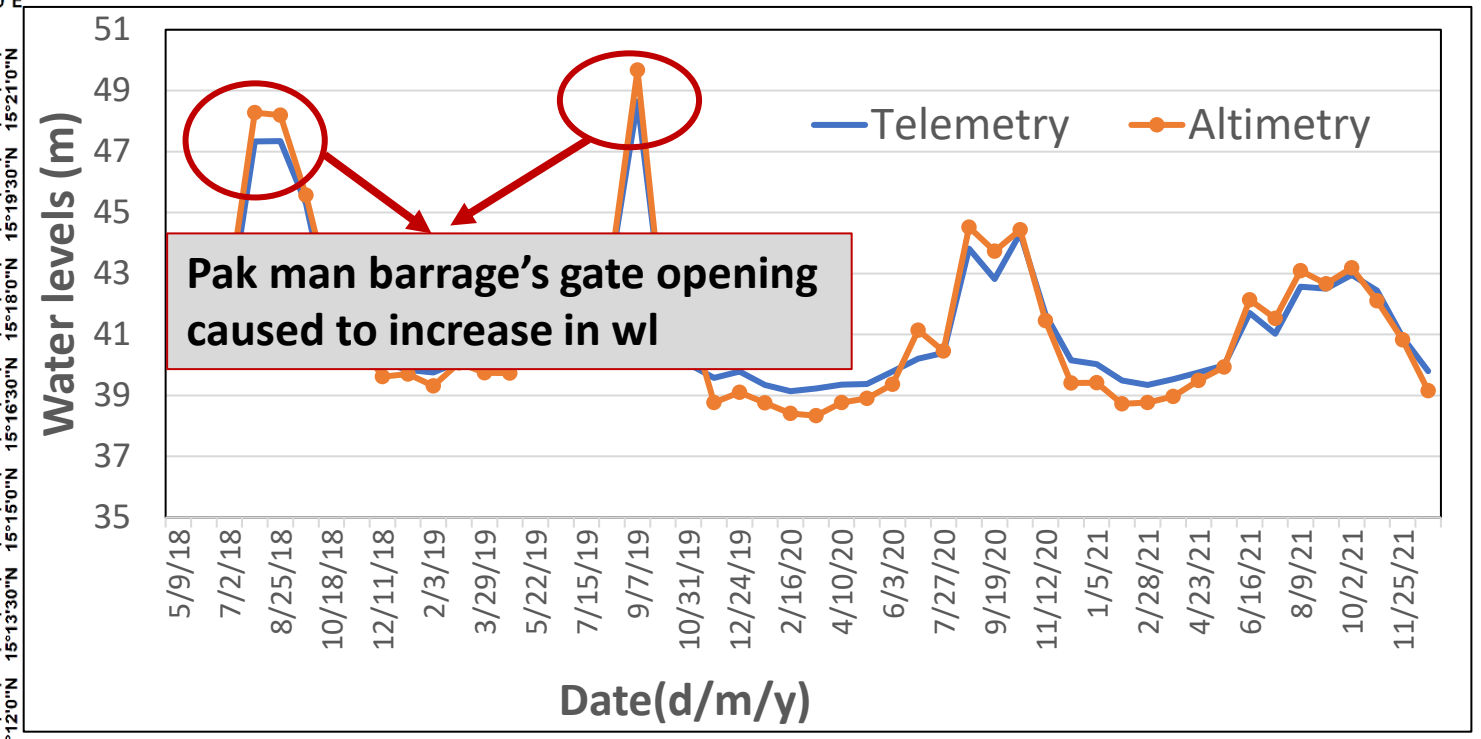


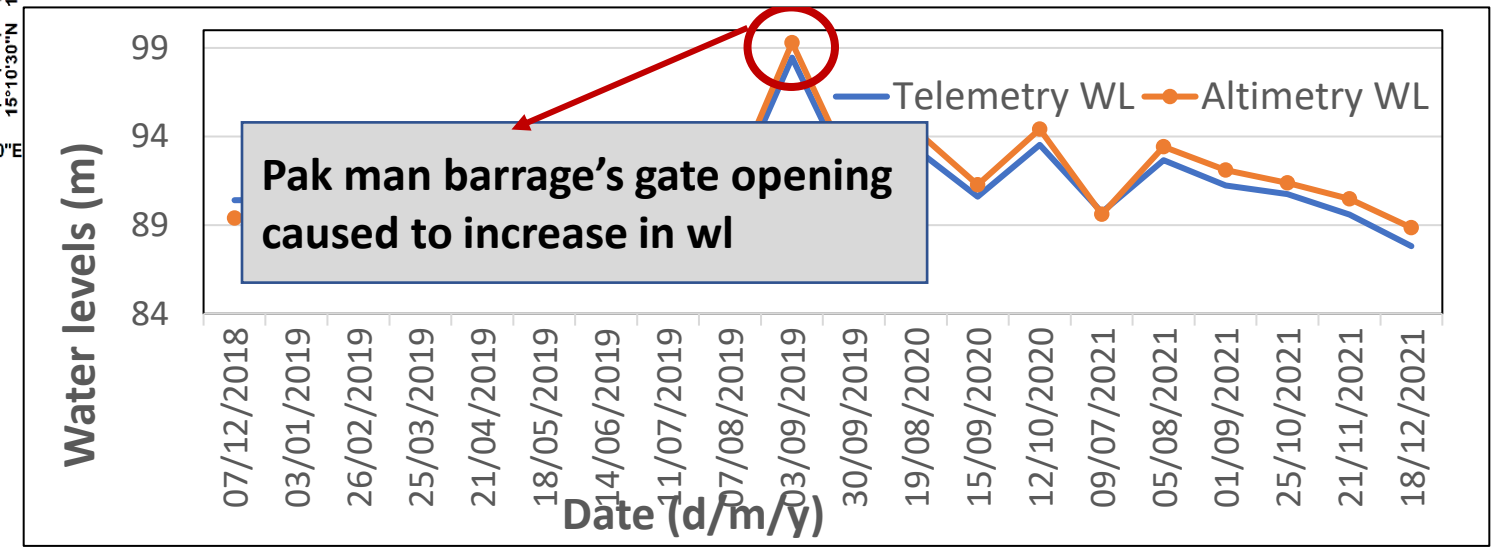
Results and discussion

Objective 1

- To align altimetry water level data with in-situ telemetry water level data, it is necessary to remove the bias due to different in references datum for both datasets.
- After the reference datum correction, the altimetry derived spatiotemporal water levels timeseries for the three virtual station (Vs) along Mekong river is presented and plotted against the on-ground observation.





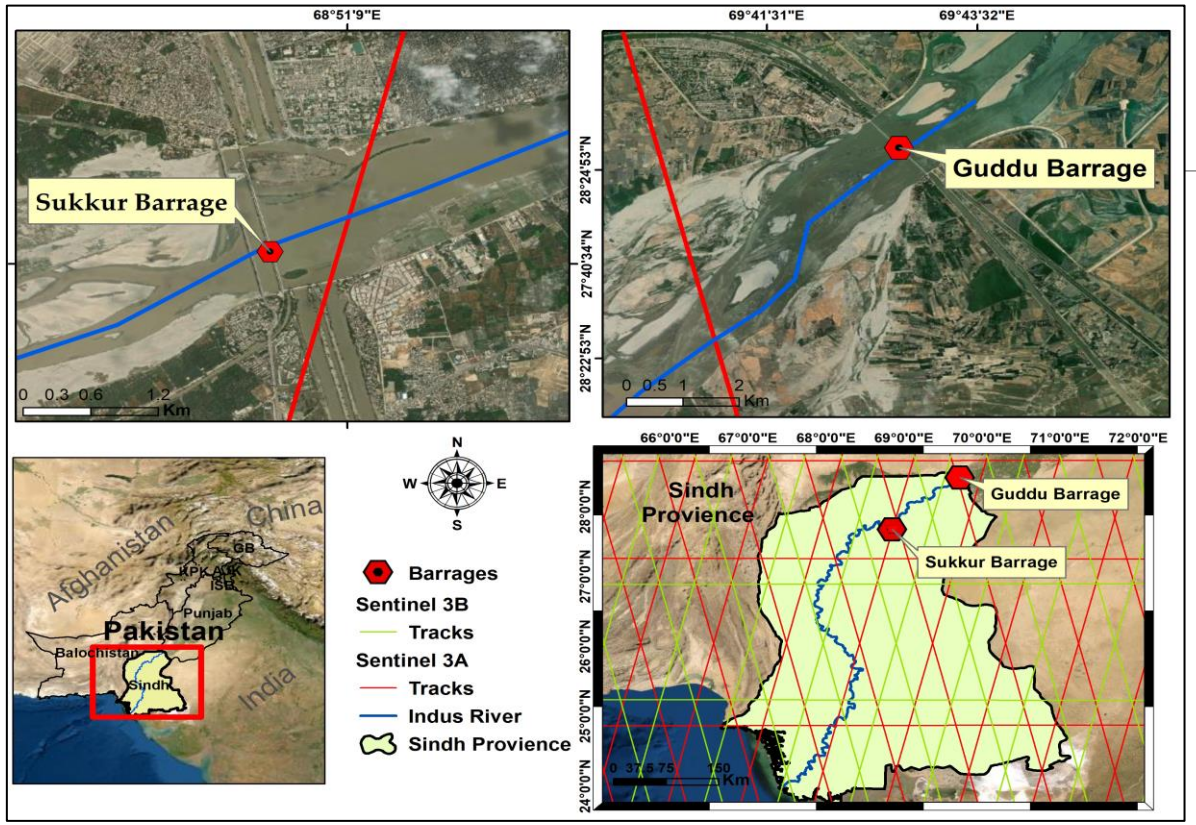


Dam gate opening year	Time range
2018	21st July to13th Oct.
2019	2nd Sep 8th Oct.

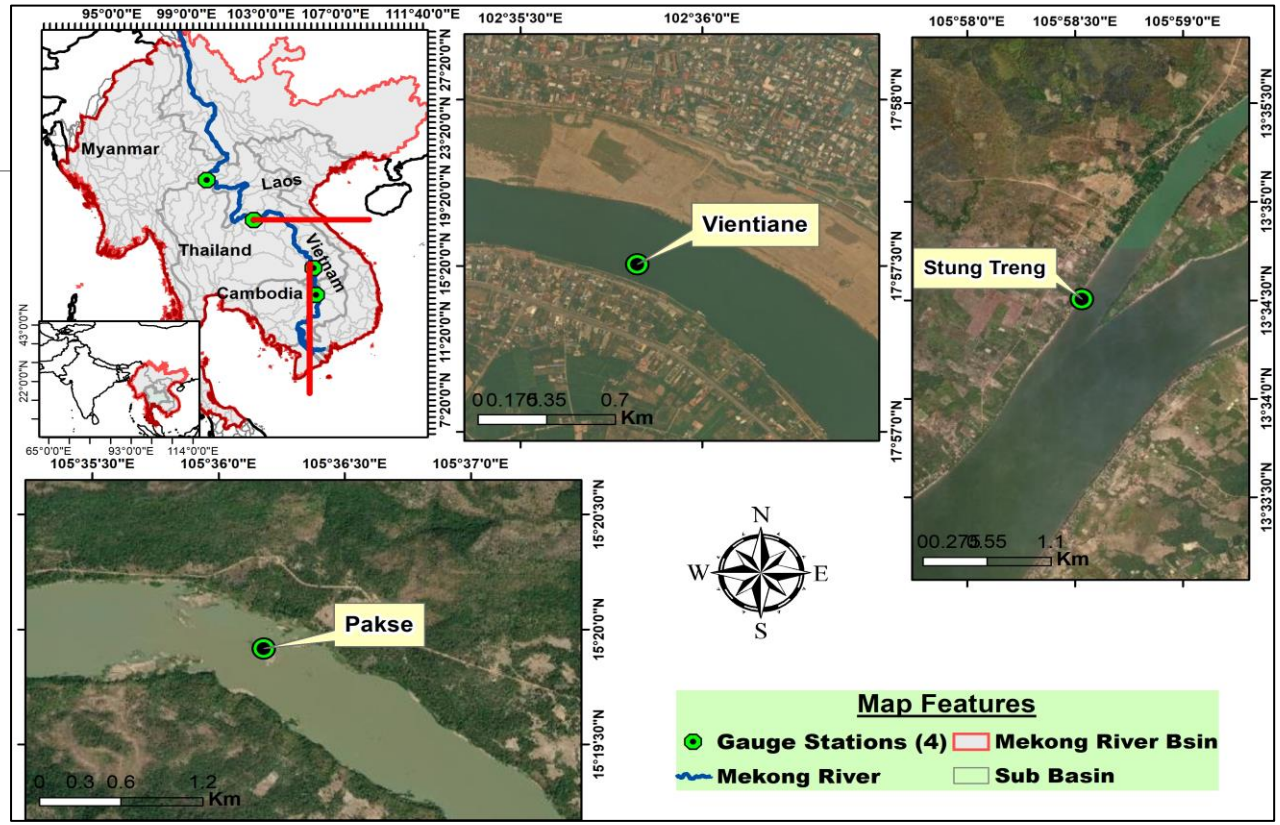
Statistical Analysis

Platform		Earth Console			DAHITI		
Study Region		Vientiane (Vs#1)	Stung Treng (Vs#2)	Paksi (Vs#3)	Vientiane	Stung Treng	Paksi
No of observations		32	50	20	22	49	20
Study Period		2019-2021	2018-2021	2018-2021	2019-2021	2018-2021	2018-2021
Statistics	R	0.972	0.980	0.93	0.97	0.98	0.933
	RMSE(cm)	52.56	60.83	90.4	51.21	45.1	88.41
	ubRMSE(cm)	52.56	60.8	89.4	51.08	45.1	87.94
	NSE	0.896	0.92	0.80	0.892	0.95	0.811
	MD(cm)	0.36	-1.5	-0.13	-3.6	-0.58	-9.08
	SDE(m)	1.63	2.19	1.98	1.56	2.24	2.03
	Max.Diff	0.92	1.62	1.73	1	1.01	1.27

Objective 2



Location of Guddu and Sukkur barrage



location of gauge station on Mekong river

Objective 2

To compare the error between barrages__(Indus river) vs. free flowing__(Mekong river).

Statistics	Indus River (obstructed flow)			Mekong River (free flow)		
	Guddu Barrage	Sukkur Barrage	Tarbela Dam	Pakse	Vientiane	Streng Treng
RMSE(cm)	43	44.8	141	90.4	52.56	60.83
UbRMSE(cm)	41.8	37.1	125	89.4	52.56	60.83

DISCUSSIONS

- In this study statistically significant results were found between altimetry derived water levels and in-situ telemetry records for all virtual stations.
- Overall, the maximum difference in measurements was found in Pakse virtual station (Vs#3) due to limited number of observations, complex terrain, narrow river width and different time of data acquisition.
- Furthermore, the river width within small extent (2km) abruptly changed on the location where Pakse altimetry pulses were found. The river width vary from 160 meters to 680 meter within 2km alongside of river due to which the waveform may contimated .

CONT..

- The other possible reason for this is limited number of waveform on river due to narrow river width and possibly the waveform may be contimated due to non-water surface as it happened many time in past studies (Tourian et al.2016)
- Only two to three number of waveform were found on river for some date due to narrow width of river.
- Moreover, in this study the DAHITI datasets available shows better results as compared to manually derived water level from altimetry data in term of statistical outcomes contrary to study that were carried for Indus river monitoring by (Zaidi et al. 2021).

CONCLUSION

The following statements are concluded:

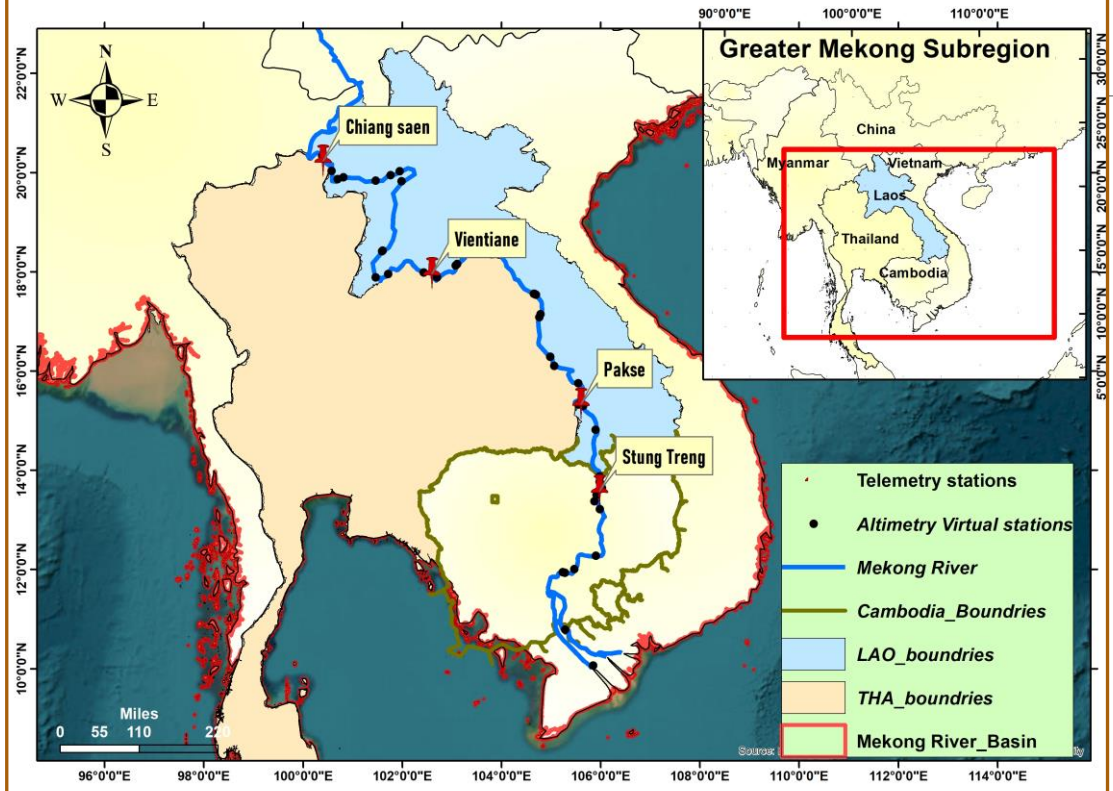
- ✓The timeseries water level for Mekong river are derived i.e., Sentinel-3A &3B, DAHITI dataset and Permanent water surface data.
- ✓ The altimetry derived water levels are cross checked with Telemetry water levels records.
- ✓ The annual time series from 2018 to 2021 for all virtual stations reveal increasing tendency of water levels in rainy seasons and decreasing in dry seasons.
- ✓ The estimated water level precession is found <1m for all virtual station on Mekong river.

Recommendations/Benefits in the Future

- The following recommendation are put forwarded for future work.
- ✓ Over 40 VSs are located along Mekong river, stretching from China to Vietnam delta, and their water level time series can be calculated.
- ✓ The approach that were opted in this study can be utilized for those virtual station which are found on free-flowing rivers when the river width is not less than 270m.
- ✓ This technique is strongly recommended for monitoring periodic events like barrage operations and to find the seasonal water level trends.

Recommendations

Sentinel 3A-3B Virtual station on Mekong River



Virtual station selected for study on Indus river