

Mapping of Inundation Extent from Spaceborne Optical Sensor along River – Kaduna, Nigeria

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Presentation Outline



- ❖ Introduction
- ❖ Study Area
- ❖ Methodology
- ❖ Results
- ❖ Conclusions

Introduction

- Flood is an extreme hydrologic event, one of the most recurring and widespread of all weather-related natural disasters known to man.
- Flooding is caused by heavy precipitation, ocean waves coming onshore, fast melting snow, the breaking of dams or levees, and the likes.
- It can occur as fluvial flood (river floods), pluvial flood (flash floods and surface water) or coastal flood (storm surge).
- In Nigeria, most urban floods occur because of inordinate rainfall pinned to high intensity and aided by shallowness of river, poor or blockage of drainages.

Introduction

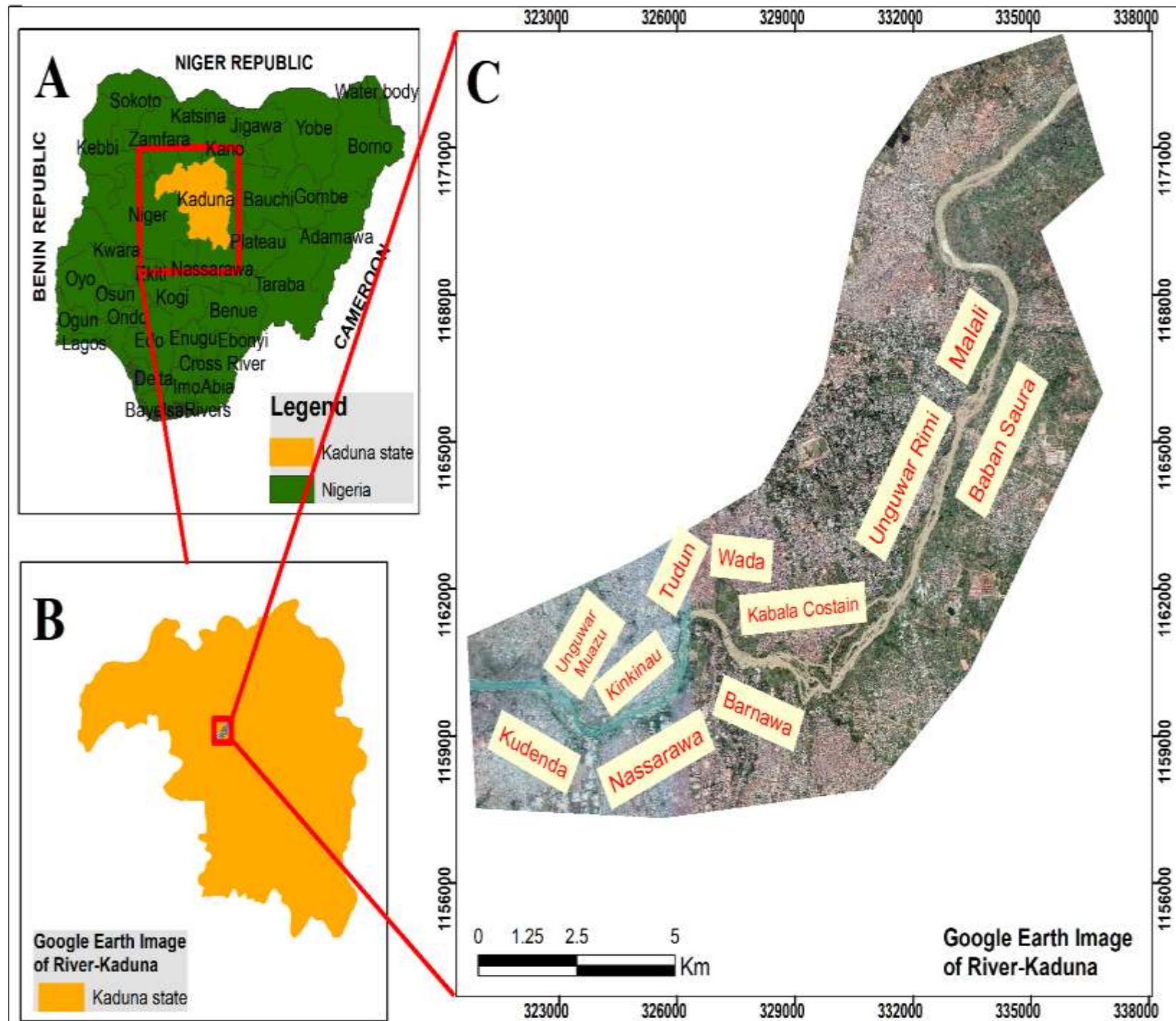
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- River-Kaduna, which spans through Kaduna metropolis and cutting certain neighborhoods, often inundates its banks during heavy rainfall, therefore, coming in the activities of man causing devastation.
- The River is ungauged and these contiguous neighborhoods have structures that have encroached less than 50m away from the river banks.
- Prominent cases of inundation took place in August 23, 2003; September, 2018 and recently in September, 2020.
- Some research efforts have been carried out previously on flood along River-Kaduna, namely: flood vulnerability mapping (Isma'il and Saanyol, 2013) and flood hazard modelling (Jeb and Aggarwal, 2008).
- However, as of the duration of this study, no study has specifically addressed mapping the extent of the flood incidents along River Kaduna. it is important that periodic investigations are conducted to ascertain the extent of flood incidents along River-Kaduna.

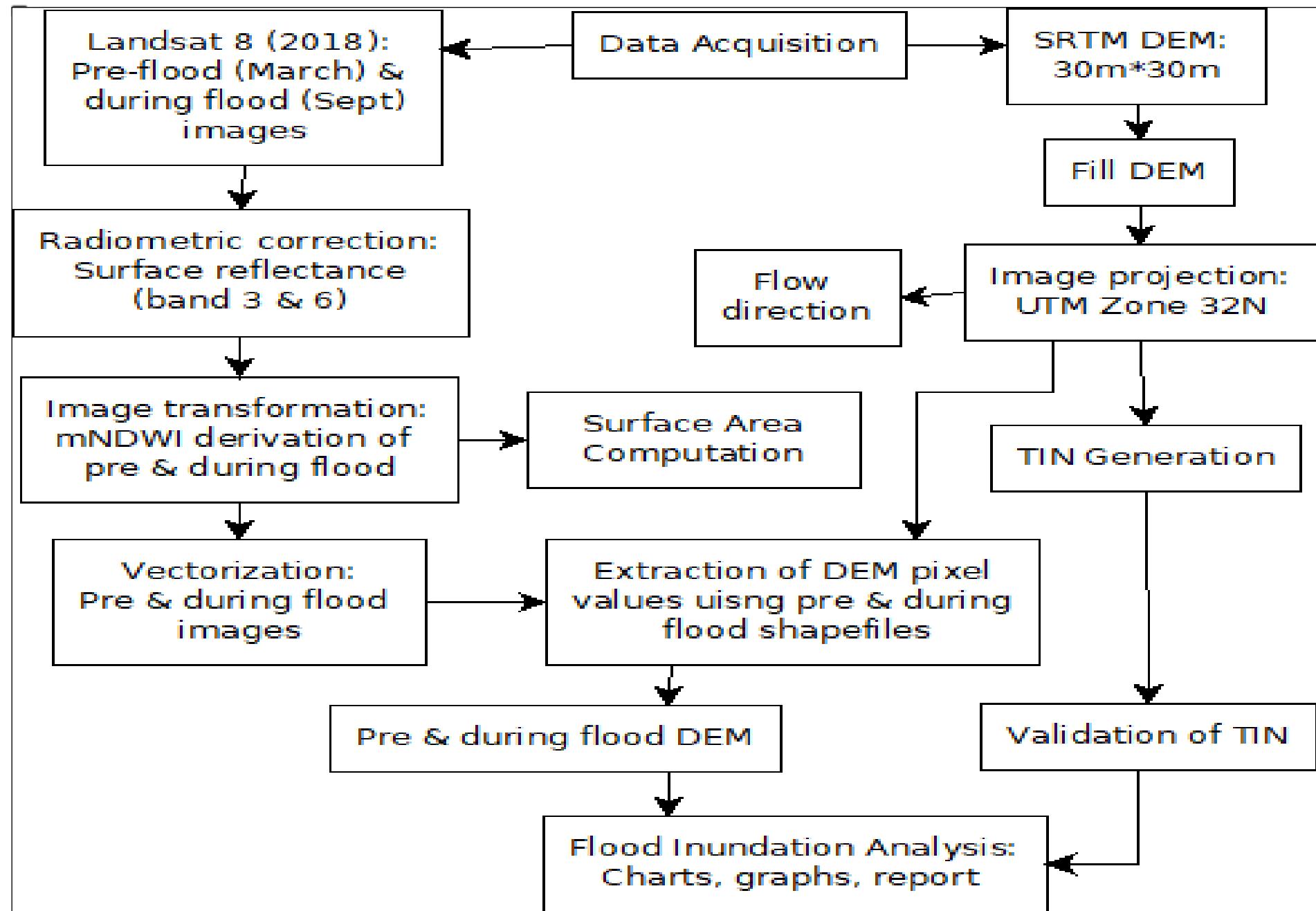
Study Area

- Kaduna: a state in north-west geopolitical regions in Nigeria .
- River-Kaduna: a tributary of River-Niger, 550 Km.
- Longitude $7^{\circ}21'48''E$ and $7^{\circ}29'36''E$ and Latitude $10^{\circ}27'15''N - 10^{\circ}13'5''N$.
- It cuts across many neighborhoods, 28.6Km stretch.

• **Figure 1:** Inset map of study area.



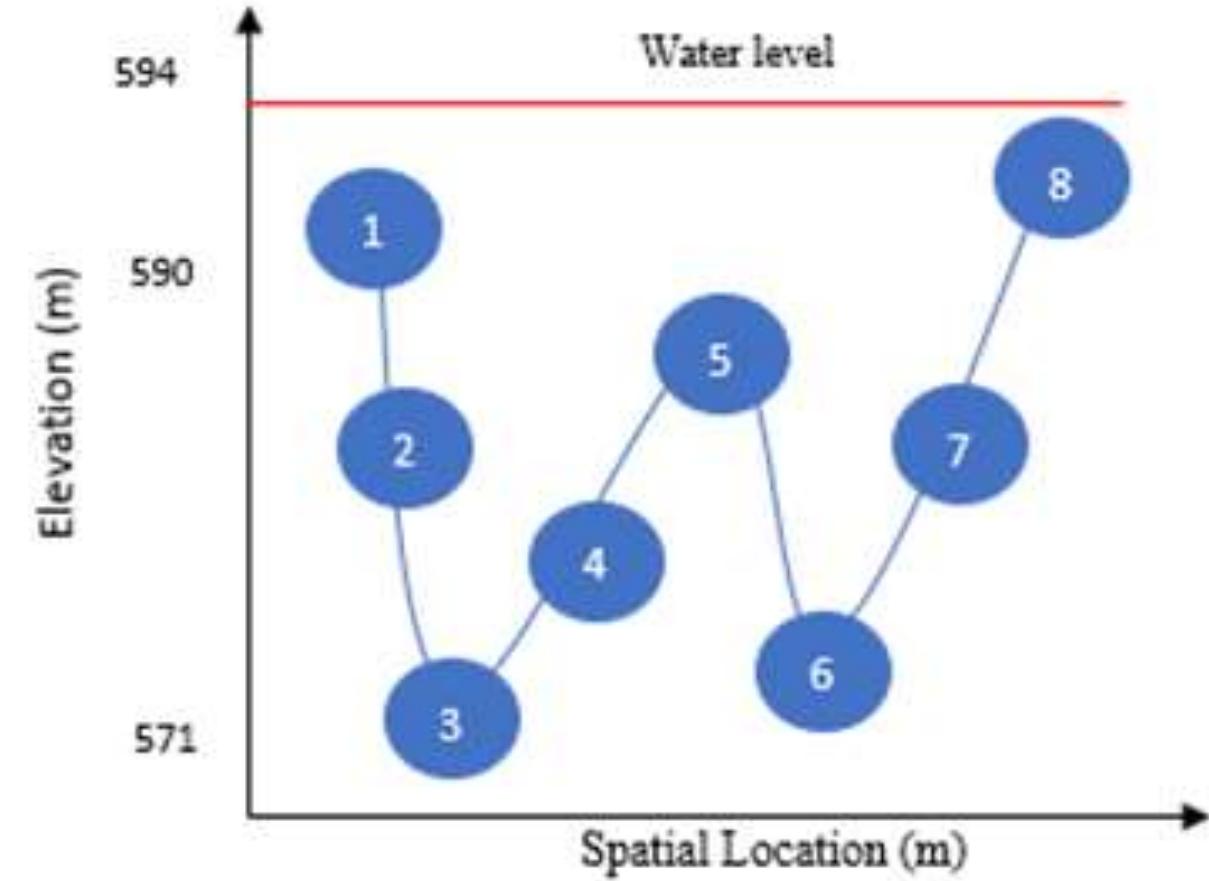
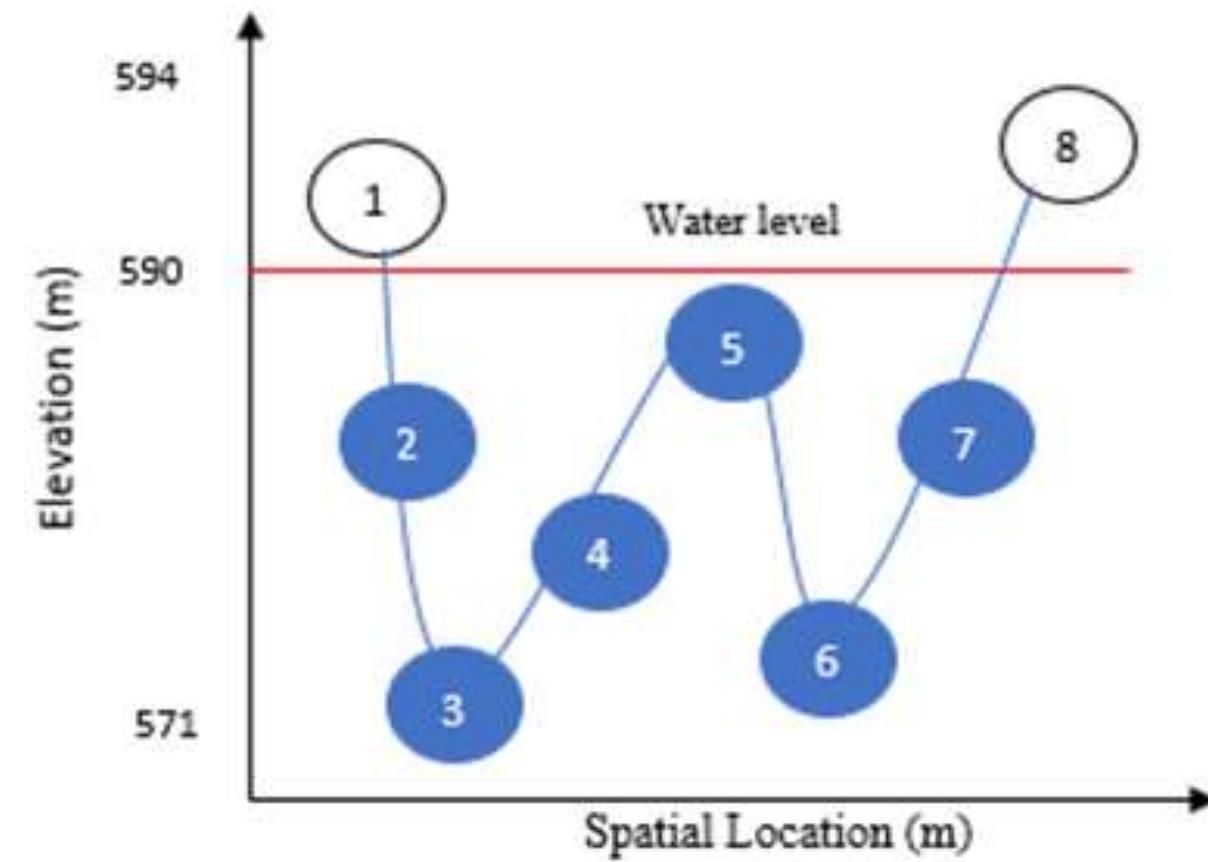
Methodology



• **Figure 2:** Workflow diagram

Methodology

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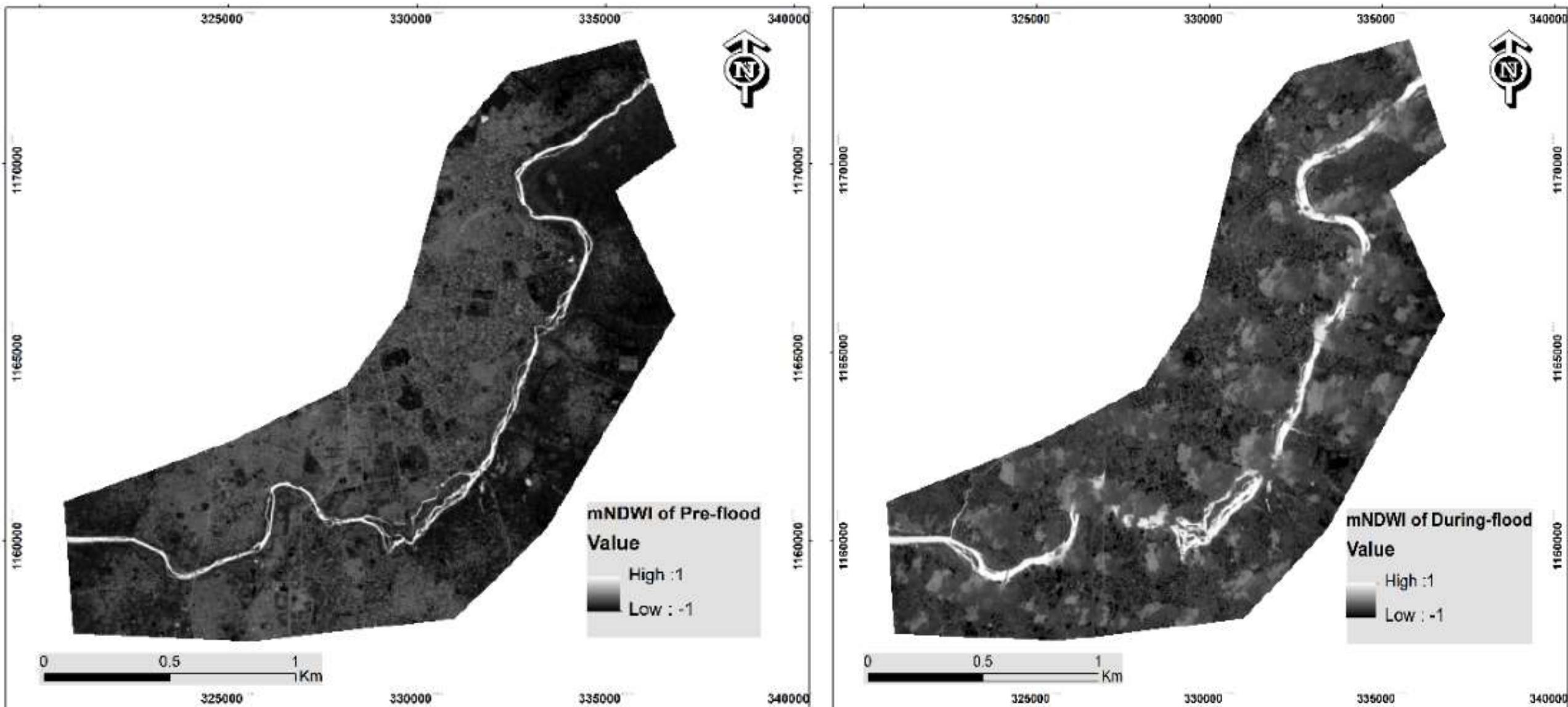
- **Figure 3:** Elevation of the waterbody. (a) Pre-flood (March). (b) During-flood (September).

$$\diamond \text{ Flood Extent} = \text{Surface area (during - flood)} - \text{surface area (pre - flood)} \quad (1)$$

$$\diamond \text{ Flood Extent} = \text{Volume (during - flood)} - \text{Volume (pre - flood)} \quad (2)$$

Results

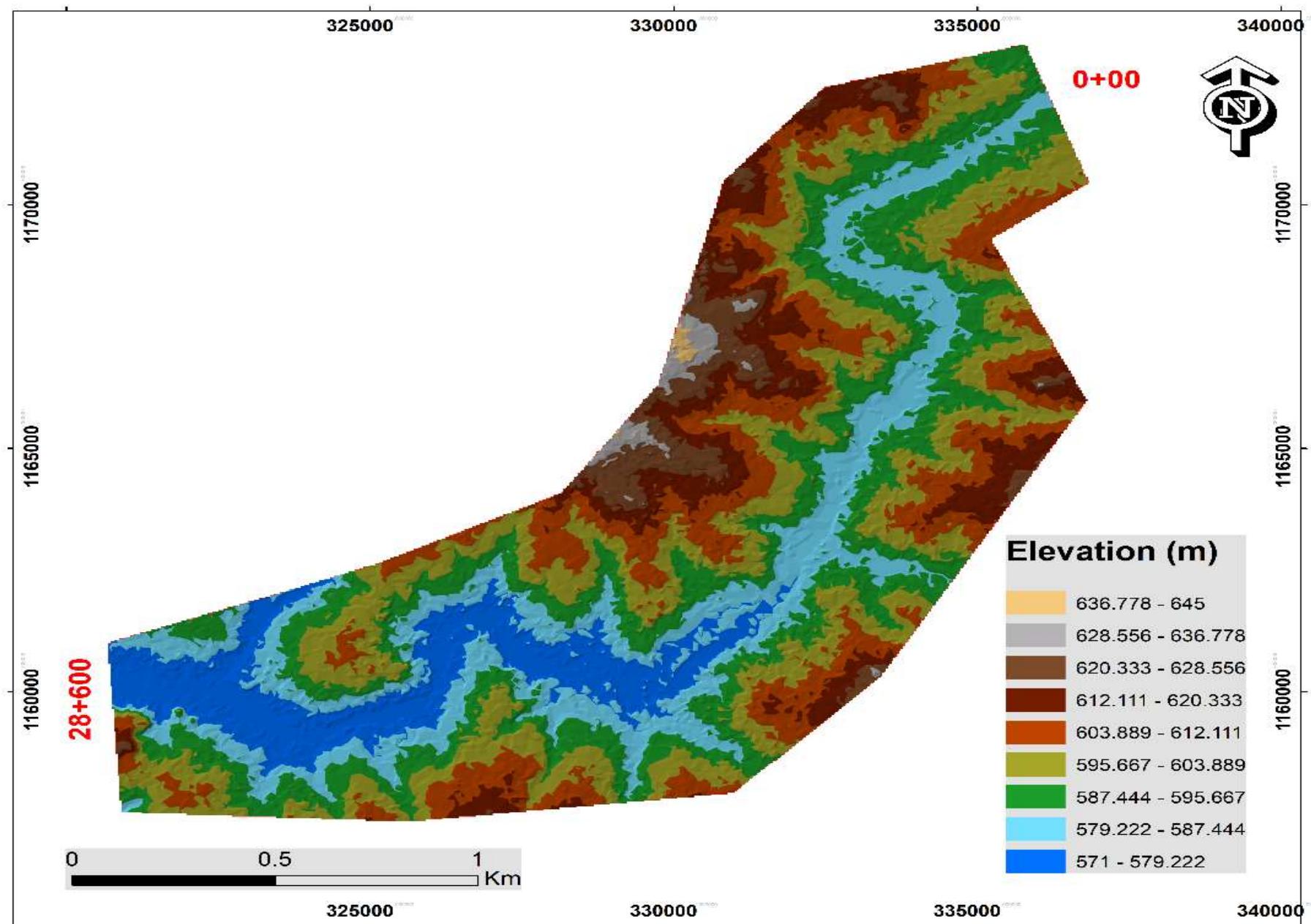
1. Extracted Waterbody



• **Figure 4:** mNDWI of River-Kaduna. (a) Pre – flood (b) During – flood.

2.1 Triangular Irregular Network (TIN)

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- Water level is 571m amsl, which is close to 572.91m used by Alayade and Agunwamba (2010)

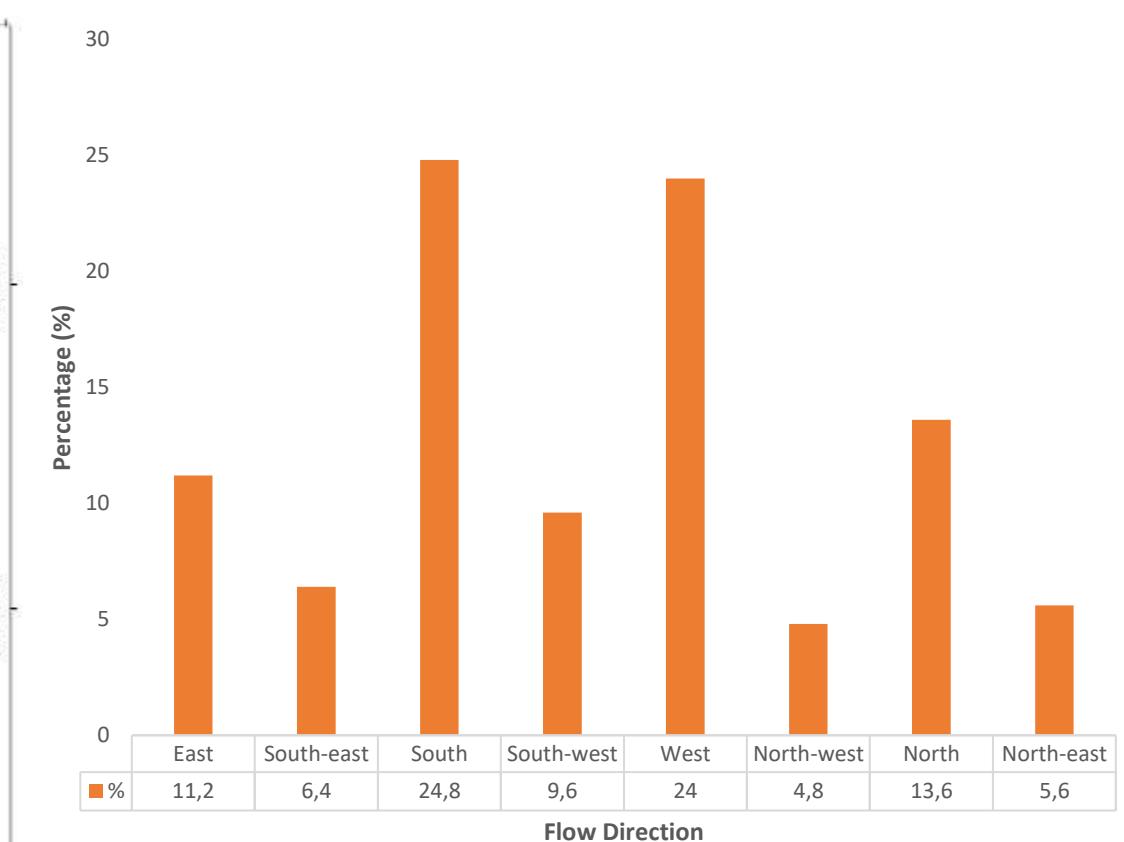
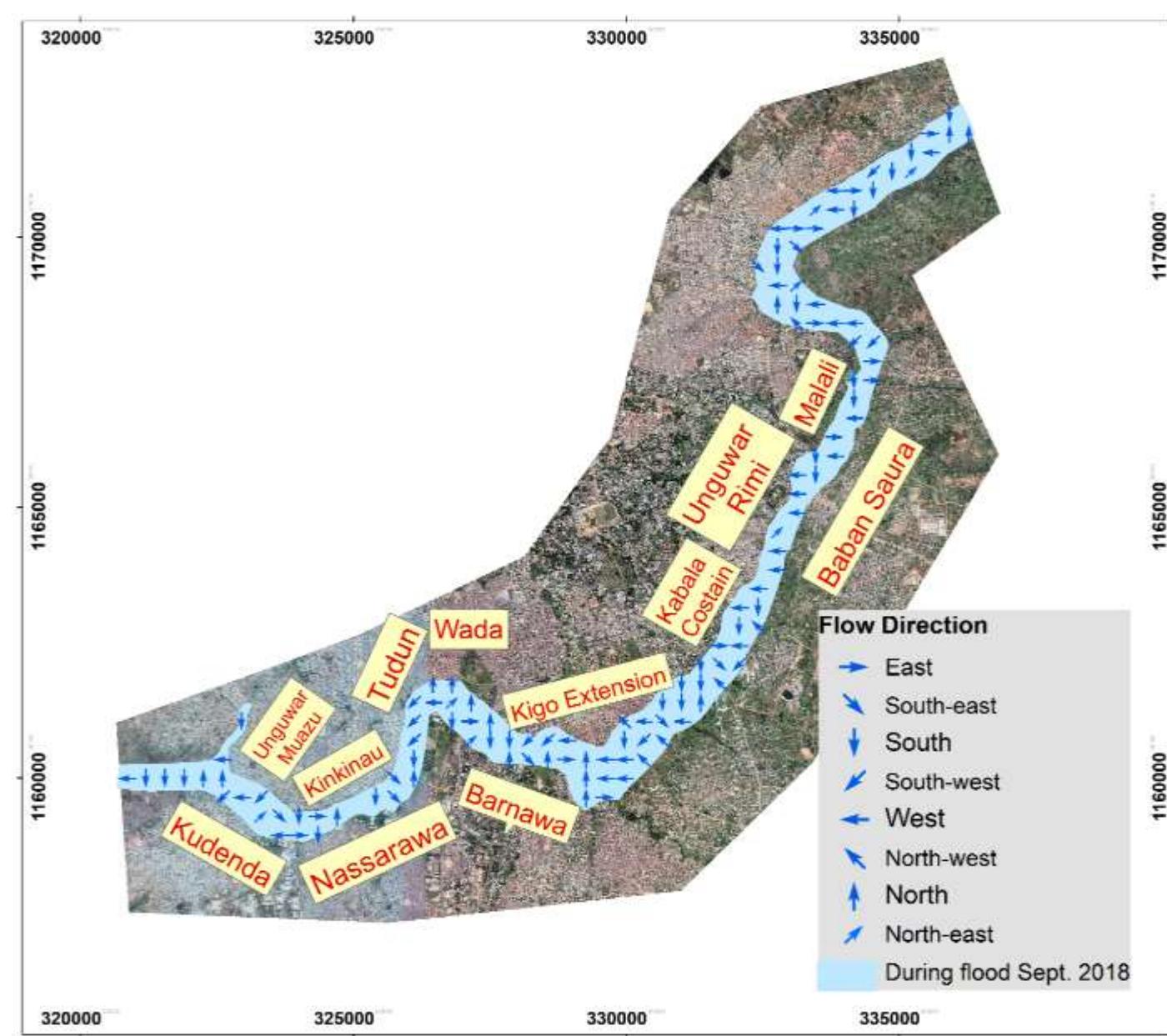
➤ TIN Validation

- Count = 500
- Min (m) error = 0
- Max (m) = 1.843
- Mean (m) = 0.650
- MAE (m) = 0.602
- RMSE (m) = ± 0.806
- StDev (m) = ± 0.420

• **Figure 5:** mNDWI of River-Kaduna. (a) Pre – flood (b) During – flood.

2.2 Flow Direction

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➤ **Figure 7:** Percentage of the flow direction.

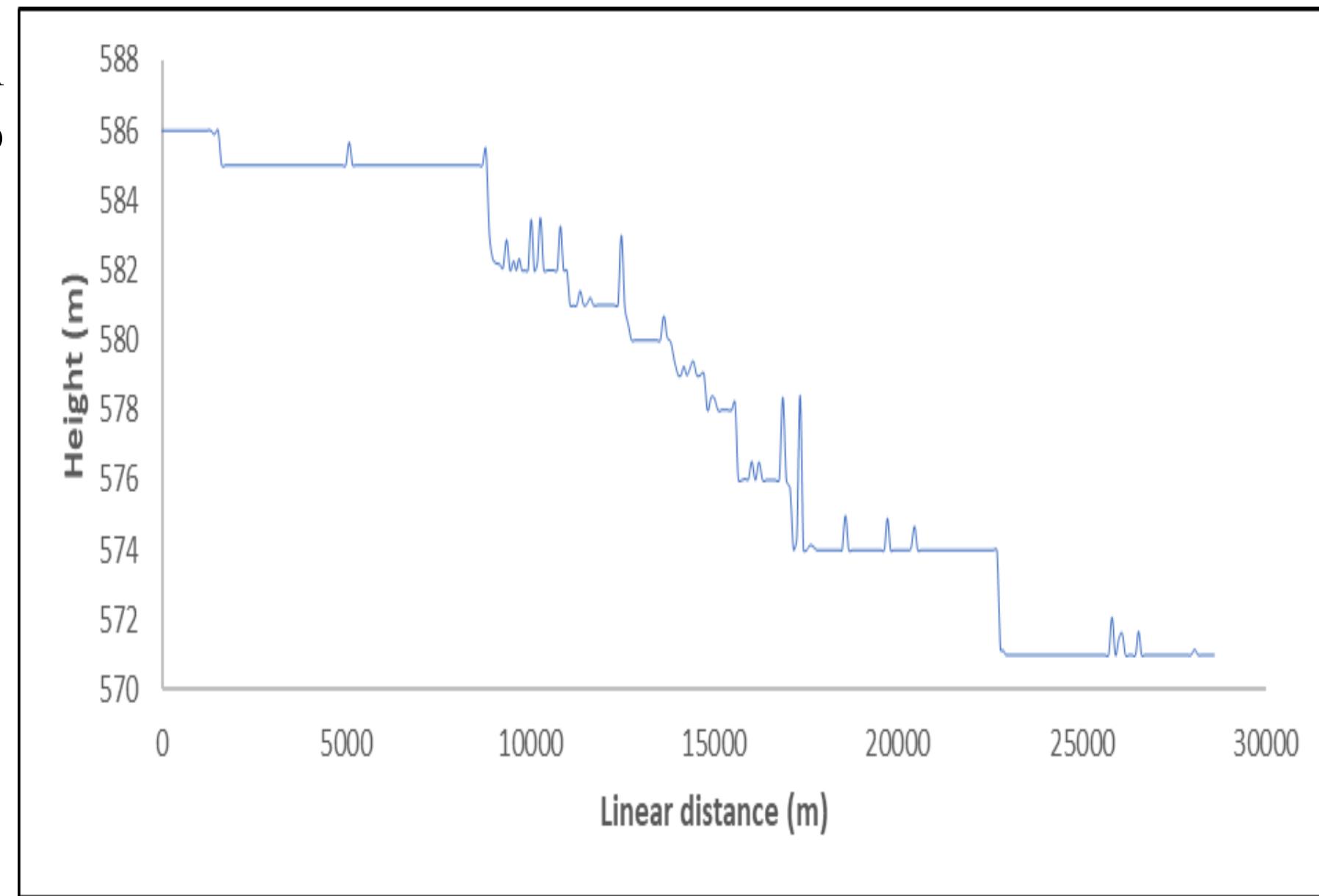
- **Figure 6:** Flow direction of the during-flood (September 2018) overlaid on Google image.

Results

2.3 Profile of River-Kaduna

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- Near flat ground: 0m to 9000m and 2400m to 2600m.
- Drops: 5000m to 17000m.
- Spikes can be seen within the River. They are as a result of rock outcrops that are within the River.

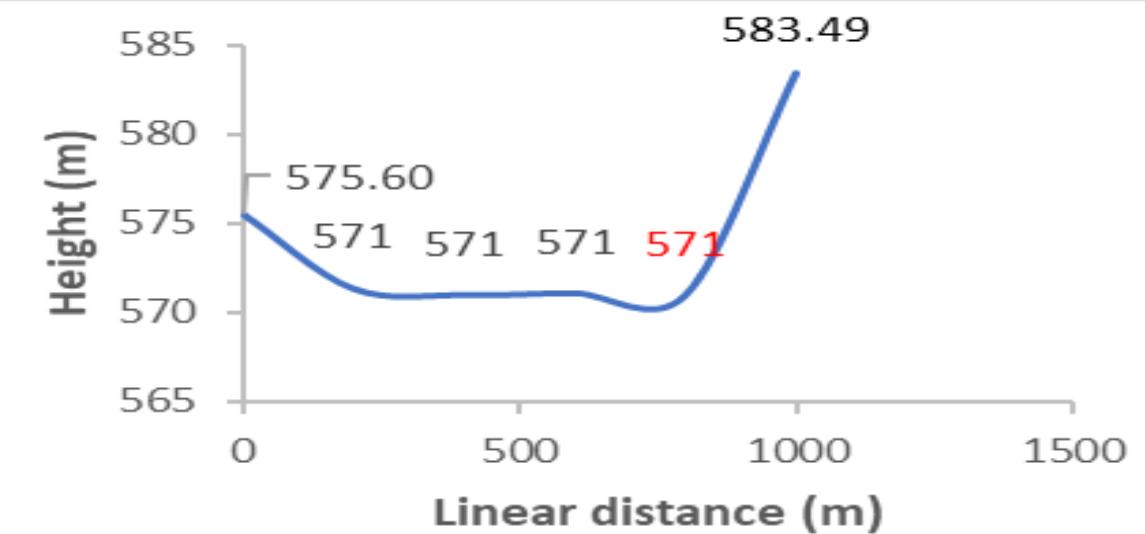
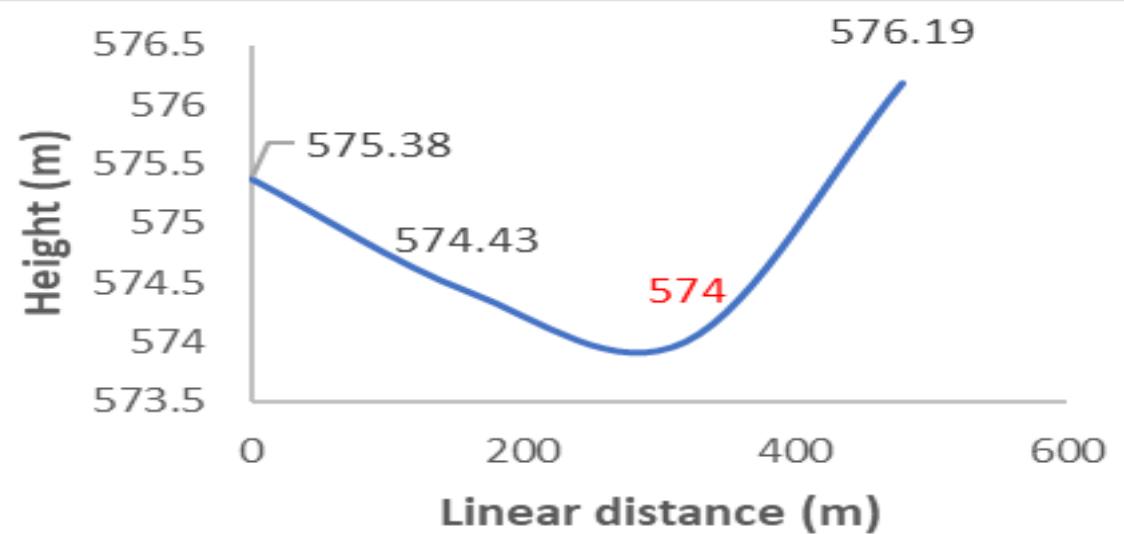
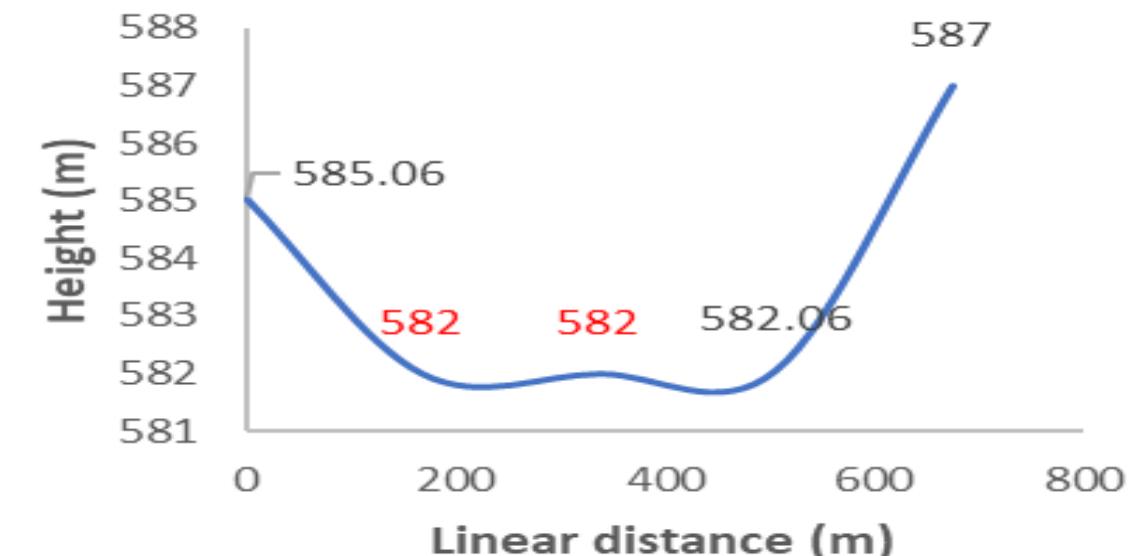
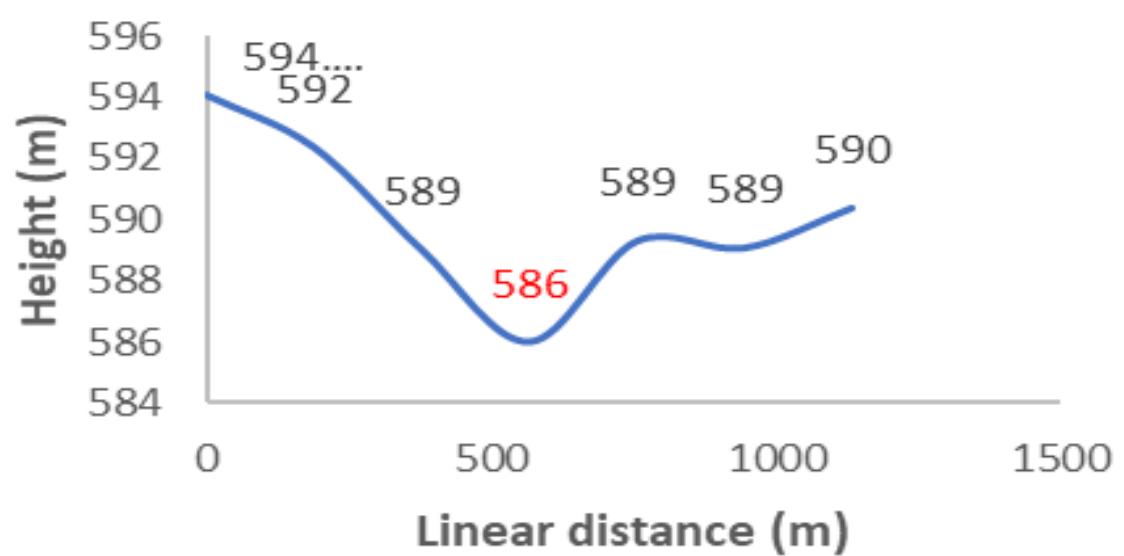


- **Figure 8:**Profile of River-Kaduna chainage 0m (0+00) to chainage 28,600m (28+600).

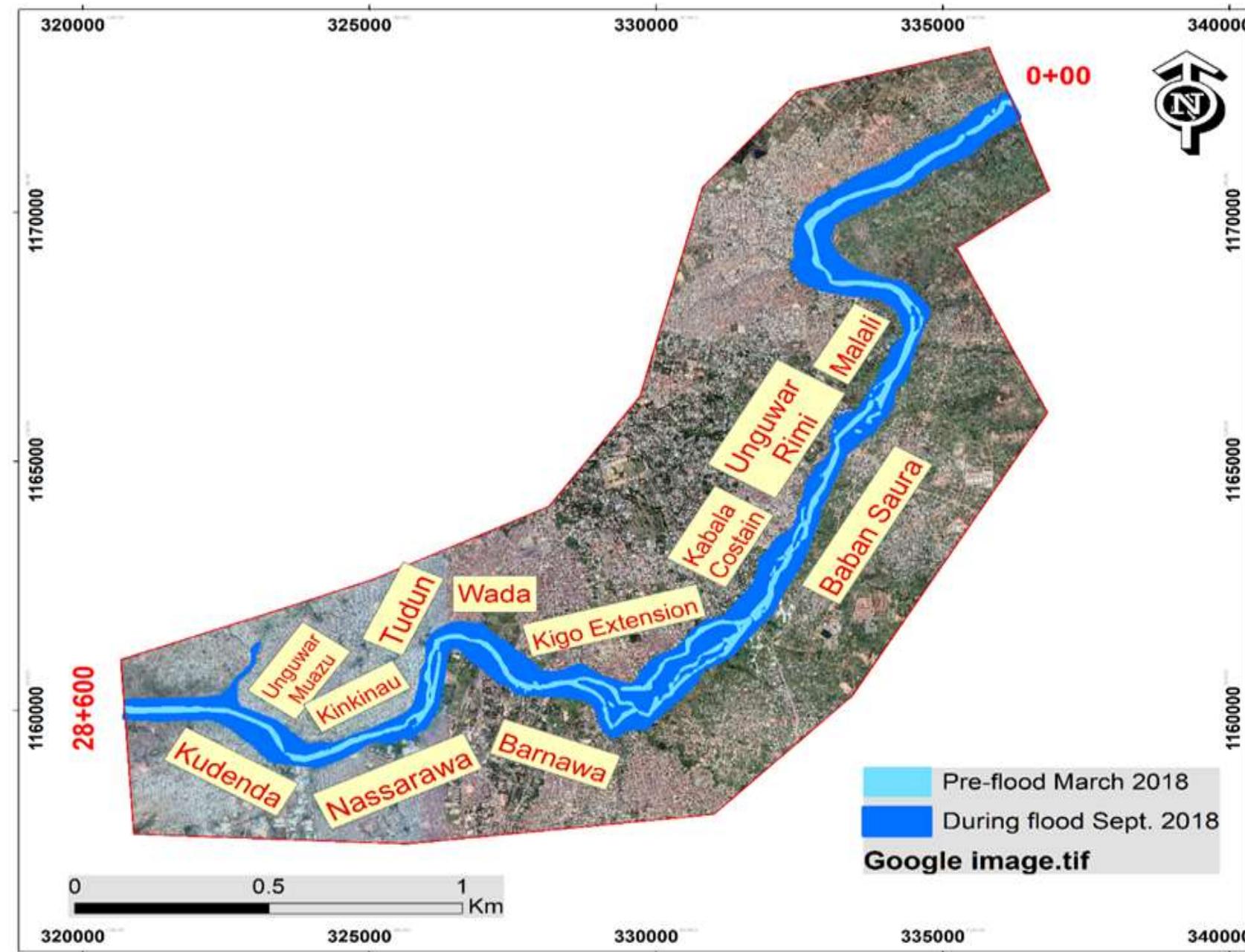
Results

2.3.1 Cross-section of River-Kaduna

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• **Figure 9:** Cross-sections of regular channel. (a) 0+00 (b) 9+533 (c) 19+066 (d) 28+600.



- **Table 1: Metrics of Flood Extent**

| S/ N | River State | Surface Area (Km ²) | Volume (m ³) |
|---------|------------------------------|---------------------------------------|-----------------------------|
| 1 | Pre-flood (March) | 2,748.16 | 17,804,379.17 |
| 2 | During-flood (September) | 15,603.37 | 218,565,875.21 |
| 3 | Flood extent (difference) | 12,855.22 | 200,761,496.04 |

• **Figure 10:** Flood extent of River-Kaduna.

Conclusions

- The extent of inundation along River – Kaduna, Nigeria has been determined and mapped using simple, logical geospatial technique.
- The neighborhoods in the south, north, south-west, north-west, and north-east directions of flow of the River are highly susceptible to inundation.
- The neighborhoods that are situated at the right-hand side of the River are highly susceptible to inundation.
- With a surface area of 12,855.22 Km² and a volume of 200,761,496.04 m³ (200 billion litres) of water, the study concluded that the River overtops its banks and flow into contiguous settlements.

Conclusions

- Dredging should be carried out to allow the River to accommodate more volume of water during heavy rainfall and freely flow through its natural channel.
- Kaduna state government should endeavor to install river gauge to collect daily stages of the water level.
- Embankments, levees or retaining walls should be constructed at the right bank of the River because of their lower elevation.

THANKS FOR LISTENING

