Chapter- 4

METHODOLOGY

This chapter provides an outline of the materials and techniques employed in the research focused on riverine wetlands, although specifics of the methodology have been mentioned in each chapter separately. This section offers a broad view, and Figure 4.1 illustrates the systematic approach followed in this study.

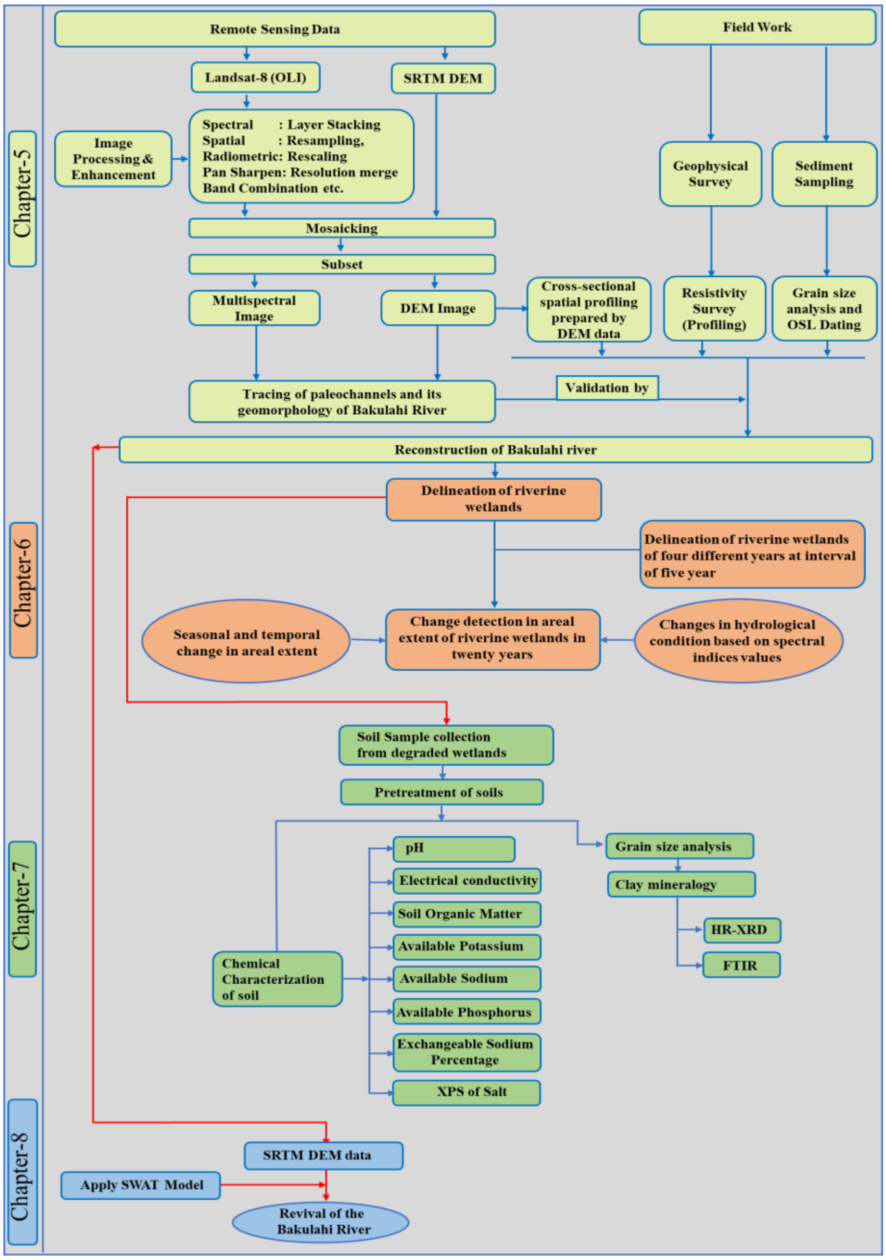

Fig. 4.1 Illustrates the systematic approach followed in this study.

4.1 Delineation of riverine wetlands

4.1.1 Remote sensing data and image processing

The remote sensing data, i.e., Landsat 8 OLI (Operational Land Imager) satellite image, Shuttle Radar Topography Mission- Digital Elevation Model (SRTM- DEM) data and Sentinel image downloaded from USGS website (https://earth explorer.usgs.gov), were used as primary data for the delineation and extraction of the paleochannels of the study area. All the image processing and the on-screen work were performed using ERDAS Imagine-2014 and ArcGIS-10.6 software in the GIS environment. For the digital image processing and enhancement of the image, techniques such as layer stacking of necessary bands, pan sharpening (hyperspherical colour space resolution merge), resampling pixel size, rescaling, histogram equalisation (enhancement of overall contrast in the image), colour composites, band combinations, mosaicking etc., were used and finally, multispectral satellite image of the study area was prepared.

4.1.2 Delineation of hydro-geomorphological features and riverine wetlands

The extraction, mapping and delineation of the hydro-geomorphic features such as underfitted rivers, abandoned channels in a meandering pattern, associated ox-bow lakes, and meander scars in the interfluvial zone of the Ganga and Sai Rivers were carried out based on characteristic signatures, i.e., sinusoidal pattern; lensoidal /crescent-shaped forms; well- defined connectivity with the existing channel. Further, the delineated geomorphic features were cross-matched with the DEM image.

The eventually converted abandoned channels, ox-bow lakes, meander scars, etc., into riverine wetlands were identified based on the sinusoidal pattern, vegetation segments along these patterns, well-defined connectivity with the existing channels, and high reflectance in near- infrared (NIR) (Plotzki et al., 2015). The spectral signatures of water and water-vegetation- associated features were used to identify and map the riverine wetlands (Szabo, et al. 2016; Suir and Sasser 2019; Liu, et al. 2014).

The resistivity of soil and rocks is highly susceptible to change with current due to the presence of water content, and therefore the electrical resistivity surveys were carried out at the places where the identification and delineation of paleochannels were not confirmed using remote sensing images. Later, sedimentological studies such as grain size analysis helped trace the channel belts, which were otherwise not identified through remote sensing images.

The luminescence dating technique is based on the time of last exposure of quartz and feldspar minerals to light. The OSL signal is susceptible to light; therefore, it is used for the dating of fluvial sediments to know the last fluvial activity in the extinct river (Aitken 1998).

4.2 Change Detection in the Riverine Wetlands

4.2.1 Based on seasonal and temporal change analysis in areal extent

To analyse the seasonal variation (pre-monsoon and post-monsoon seasons) in the areal extent of riverine wetlands and change detection (quantified expansion, contraction, or no change) in the areal extent of riverine wetlands in the last twenty years (from 2000 to 2019) spatial maps were prepared through satellite images of 2000, 2008, 2014 and 2019 for post-monsoon, and through satellite images of 2001, 2009, 2015 and 2020 for pre-monsoon season were used for change detection. The areal extent was calculated using the geometry methods in Arc GIS 10.6 software. A Boolean (present/not present) raster was created to perform the change detection.

4.2.2 Based on variation in spectral index values

Changes in spectral index values are very significant in understanding the hydrological potentiality of riverine wetlands in the area (Fisher et al. 2016; Ozelkan 2020; Mukherjee and Pal 2021). The land–water threshold values were determined by calculating the average of land–water boundary pixel values for each NDVI and MNDWI image. The theoretical value of the land–water threshold of NDVI and MNDWI is zero. The positive values for MNDWI and the negative values for NDVI indicate water bodies. So, the deviation of land–water threshold values of MNDWI and NDVI from zero indicates the variation in the hydrological condition of the riverine wetlands (Mukherjee and Pal 2021).

4.3 Concurrent impact of riverine wetlands degradation on soil characteristics

Based on the spectral signatures of different soils in remote sensing images, the representative soil samples were collected (at a depth of 15cm, 30cm and 50cm). In the laboratory, the grain size analysis, chemical constituent of soil (pH, electrical conductivity (EC), soil organic matters (SOM), available phosphorous (P), available potassium (K) and available sodium (Na), exchangeable sodium percentage, cation exchange capacity (CEC) and clay mineralogy (FTIR and XRD) have been determined for the analytical study of the soil. Most parameters were derived using Indian Standard Codes (used in civil engineering). To assess the surface composition of salt, X-ray photoelectron spectroscopy (XPS) (Model: K-Alpha) was applied (Yuan et al., 1998).

4.4 Revival of the Bakulahi River

A model has been prepared using SWAT to study what would be the scenario if the extinct Bakulahi River has been revived, i.e., change in watershed, surface runoff, areal extent of the riverine wetlands, etc. For the purpose, the elevation along the delineated traces of channels of the Bakulahi River in the SRTM DEM map (original DEM map - Fig. 8.3(a)), was lowered by 3 meters in the Arc GIS 10.6 software, and a modified DEM map was prepared (Fig. 8.3(b)). A flow chart has been prepared showing the steps followed to create modified DEM (Fig. 8.1). Further, the original DEM and modified DEM (DEM lowered by 3 meters along the delineated path of traces of Bakulahi River) were used in the Soil & Water Assessment Tool (SWAT) (Fig. 8.2) and modelled the watershed of current Bakulahi River and the Revived Bakulahi River respectively and also estimate the all-hydrological component of Bakulahi River.