Chapter 3
Materials and Methods

The research methodology involves a number of activities to achieve the aim and objectives. These all are well congruent to conduct research. This chapter described the detail about data used and data collection, field investigation, instruments for data collection and research methods.

3.1 Materials

During the study of literature it was found that many scientists, researchers have used satellite data and geospatial technology for land resource analysis and mapping. The field data, government published secondary data, satellite data such as multispectral and Digital Elevation Model (DEM) data etc were found extremely useful for site selection analysis. A variety of datasets and materials used in this research work are mentioned below (Table 3.1 and 3.2).

Table 3.1 Satellite data derived information

Satellite sensor	Acquired date	Uses	Sources
Sentinel-2B	Jan, 2018	LULC mapping	ESA
Landsat 8 (OLI)	Feb, 2017	LULC mapping	USGS GloVis
SRTM	Feb, 2000	Elevation information	USGS GloVis
ASTER	01st Feb, 2006	Elevation information	USGS GloVis
Google earth image data	2010, 2014, 2018	Water body	Google earth

Table 3.2 Topographic and Collateral data

Data Used	Sources
Soil	Soil Survey Report of State Soil Survey
Geomorphology	NRDMS centre, Purba Medinipur
Administrative information	NRDMS centre, Purba Medinipur
Toposhet (1: 50000)	Survey of India (SOI)
Statistical data	District Statistical Hand book, WB
Rainfall data	IMD & Accuweather
Field survey data	

USGS GloVis : https://glovis.usgs.gov/
GLCF : http://glcf.umd.edu/
ESA: https://scihub.copernicus.eu/
https://www.accuweather.com

3.1.1 Sentinel-2

The Copernicus Sentinel-2 is an Earth observation mission of European Commission (EC) and the European Space Agency (ESA) comprises with two polar-orbiting satellites i.e. Sentinel-2A and 2B, placed in the same sun-synchronous orbit (Sentinel-2, 2012). The Sentinel-2A satellite sensor was launched on 23rd June 2015 and Sentinel-2B was launched on 7th March 2017. The objectives of the mission are the systematic acquisition of high-resolution multispectral imagery over land and coastal waters with high revisit frequency (Table 3.3). Sentinel-2 B data (01st January 2018) are utilized to obtain LULC and water body information.

Table 3.3 Detail band specification of Sentinel-2 data

Sentinel-2 bands	Sentinel-2A		Sentinel-2B		Spatial resolution (m)
	Central wavelength (nm)	Bandwidth (nm)	Central wavelength (nm)	Bandwidth (nm)	
Band 1 – Coastal aerosol	442.7	21	442.2	21	60
Band 2 – Blue	492.4	66	492.1	66	10
Band 3 – Green	559.8	36	559	36	10
Band 4 – Red	664.6	31	664.9	31	10
Band 5-Vegetation red edge	704.1	15	703.8	16	20
Band 6-Vegetation red edge	740.5	15	739.1	15	20
Band 7-Vegetation red edge	782.8	20	779.7	20	20
Band 8 – NIR	832.8	106	832.9	106	10
Band 8A – Narrow NIR	864.7	21	864	22	20
Band 9 – Water vapour	945.1	20	943.2	21	60
Band 10 – SWIR – Cirrus	1373.5	31	1376.9	30	60
Band 11 – SWIR	1613.7	91	1610.4	94	20
Band 12 – SWIR	2202.4	175	2185.7	185	20

Source: Sentinel-2, 2012

3.1.2 Landsat 8 (OLI)

The Landsat 8 is an American Earth observation satellite was launched into the sun-synchronous orbit on February 11, 2013 with 5–10 years life planned (Landsat 8 data users handbook, 2016). The payload of this satellite consists with two science instruments i.e. Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). OLI provide 30 meters (visible, NIR, SWIR) multispectral data (12-bit dynamic

range) with 15 meters (panchromatic) and TIRS 100 meters thermal image (Landsat 8 data users handbook, 2016) (Table 3.4).

Table 3.4 Detail band specification of Landsat 8 data

Sensor	Bands	Wavelength	Resolution
Operational Land Imager (OLI)	Band 1 Visible	0.43 - 0.45 µm	30 m
	Band 2 Visible	0.450 - 0.51 µm	30 m
	Band 3 Visible	0.53 - 0.59 µm	30 m
	Band 4 Red	0.64 - 0.67 µm	30 m
	Band 5 Near-Infrared	0.85 - 0.88 µm	30 m
	Band 6 SWIR 1	1.57 - 1.65 µm	30 m
	Band 7 SWIR 2	2.11 - 2.29 µm	30 m
	Band 8 Panchromatic (PAN)	0.50 - 0.68 µm	15 m
	Band 9 Cirrus	1.36 - 1.38 µm	30 m
Thermal Infrared Sensor (TIRS)	Band 10 TIRS 1	10.6 - 11.19 µm	100 m
	Band 11 TIRS 2	11.5 - 12.51 µm	100 m

Source: Landsat 8 data users handbook, 2016

These data are used for LULC mapping. The data acquired on 27th Feb 2017 and Standard FCC at 1:10,000 scales was generated for visual interpretation of earth features.

3.1.3 Shuttle Radar Topography Mission (SRTM)

SRTM is an advanced 3D (Three dimension) imagery that launched in February 2000. The mission was a joint effort by the National Image and Mapping Agency (NIMA) and National Aeronautics and Space Administration (NASA). In November 2003, the NIMA was renamed to the National Geospatial-Intelligence Agency (NGA). NASA plays the role of global ground legitimacy and NIMA acts as a broad global ground campaign on that project. The Jet Propulsion Laboratory (JPL) is product the Digital Elevation Model (DEM) of less than 60^{o} latitude (Rodriguez et al., 2005).

The SRTM DEM data of the study area were downloaded from USGS site with TIFF data format (http://earthexplorer.usgs.gov/). This data is used to generate the slope of the study area.

3.1.4 ASTER GDEM

Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) is another important DEM product, produce by stereo-correlation process. ASTER GDEM was developed jointly by the Ministry of Economy, Trade and Industry (METI) of Japan and NASA, was launched on December 1999. It has an along-track stereoscopic capability and covers the land surfaces from 83°N to 83°S latitude (ASTER User Handbook, Version 2 and gisat.cz, 2019). The ASTER GDEM data of the study area were downloaded from USGS site with Geo TIFF data format (http://earthexplorer.usgs.gov/). This data is used as an alternative option of SRTM DEM.

3.1.5 Google earth image data

Google Earth is a computer program base 3D representation of the earth using high resolution satellite imagery. The initial release of data was on June 11, 2001. The geo-referenced satellite images, aerial photography GIS data, and geo-tagged photos are superimposed onto a digital 3D globe, allowing users to see cities and visualized the landscapes from different angles. The high resolution time series (2010, 2014 and 2018) google earth's data are used to map and generate the water information of the study area.

3.1.6 Collateral Data

A. Survey of India (SOI) toposheets of 1:50,000 and Google earth data have been used to generate the road, rail and location information etc of the study area.

B. The government published administrative maps were used to create the administrative boundary like district, blocks.

C. Geomorphology map of NRDMS with the scale of 1:50,000 have been used for creating the database of the study area.

D. Soil data of each block of the study area acquired from Soil Survey Report of State Soil Survey.

3.2 Field data collection

Data Collection and field survey is an important part of any kind of research study. Inaccurate data collection can impact the outcome of a study and ultimately lead to invalid results (Leedy and Ormrod, 2010; Oberiri, 2017; ndcompass.org, 2019). Quantitative data collection confides on data collection device, random sampling and user experiences. Depending on the present research aim and question, the survey strategy was modified. Common quantitative data collection strategies are including:

1. Experiments.
2. Observing and recording readings (counting, location, specified times of the day etc).
3. Obtain the relevant data and information.
4. Closed-ended administering surveys with questions.
    a. Face to face personal interviews
    b. Telephonic interviews

The qualitative methods were used to improve the quality of survey information. The base hypothesis, method and results; the document review, observation procedures and in-depth interview etc were improved to clarify the findings of quantitative evaluation. In the present study all data were collected with spatial location and place. The detail about data collections of water quality sample, fish species information etc. is described further in the respective chapters.

3.3 Methods

The methodology adopted in this study includes image data processing, visual classification, database generation (for base map preparation), error correction etc, to analyse the impounded water body classification, distribution and potential suitable sites mapping. The outline of the methodology confers to fulfill the objectives are follows:

3.3.1 Field data Verification and base map preparation

Field investigation and verification of base map and data sample collection is another important part of this study. LULC information derived from multispectral imagery and base maps of road-railway networks, ground truth verification was conducted with the

help of GPS receiver. The details about base maps preparation are described in chapter 2.

3.3.2 Water body distribution analysis

The detail distributions of water bodies were delineated from high resolution satellite images in GIS platform for three periodic years (2010, 2014 &2018). The time series vector layers of water body are categorized based on their area for further analysis (Figure 3.1). The detail about methods and results has been mentioned in chapter 4. Growth Rate (G.R), kernel Density (K.D) and entropy analysis techniques has also been adopted to assess the characteristic of spatial and temporal distribution of waterbody throughout the study area.

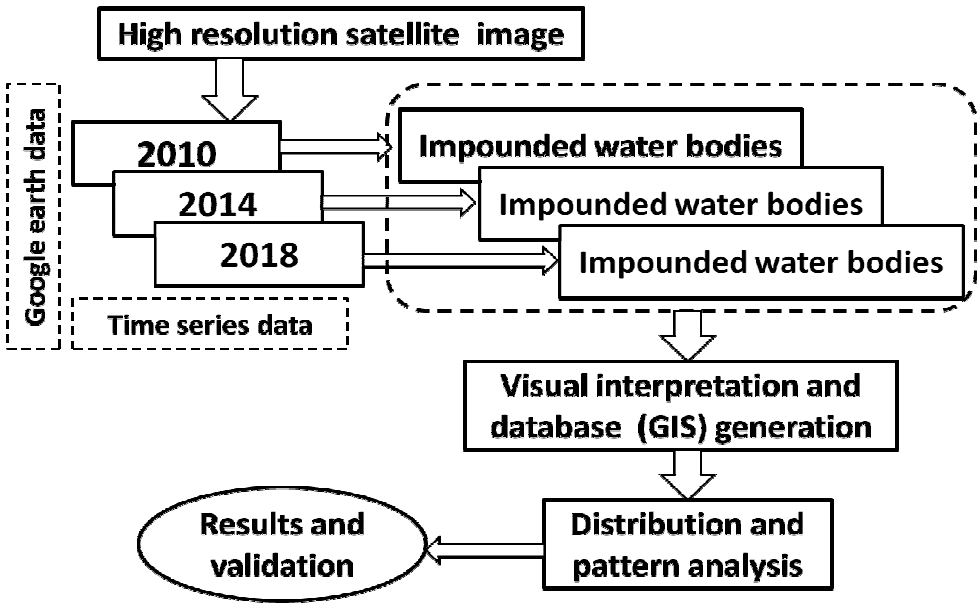

Figure 3.1 Methodological flow chart to extract and analysis of impounded water body

3.3.3 Fish diversity status

The detailed survey of fish species, aquatic habitat and aquaculture farm throughout the region were adopted to know the actual scenario of fish germplasm status. The block wise survey information collected from the local fish seller, fish farmer, Govt. fishery extension officers, fishery field assistant and also from the local peoples of the region. The surveyed fish specimens are identified and categorized with the help of standard methods (Talwar and Jhingran, 1991; Talwar 1991; Jayaram, 1999, 2002).

3.3.4 Site suitability analysis

The site suitability for potential fish farming area analysis has been broadly categorized into two models (1) Site Suitability for Fish Farming (SSFF) and (2) Site Suitability for Commercial Fish Farming (SSCFF). SSFF and SSCFF are mainly categorized based on their Socio-environmental nature.

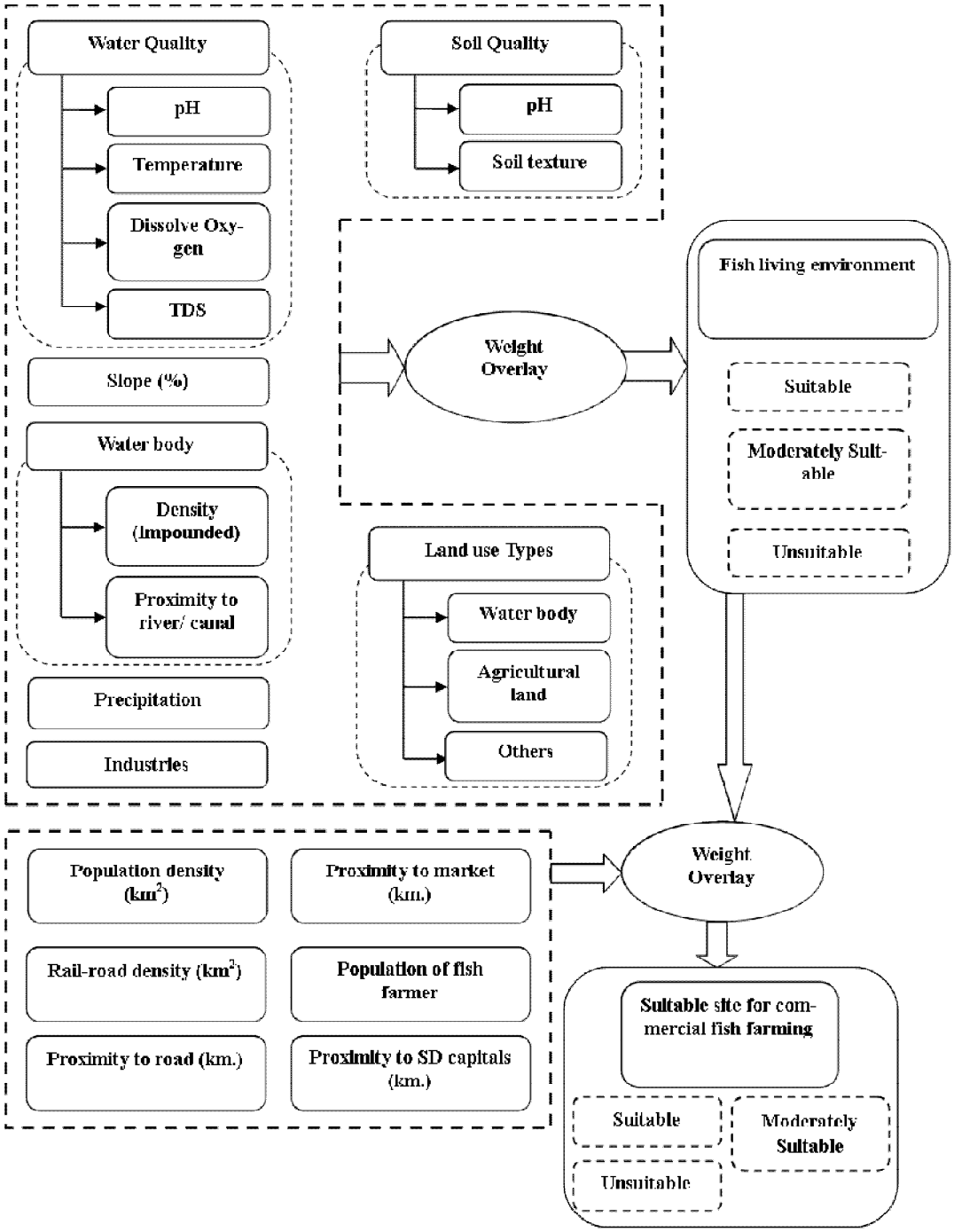

Figure 3.2 Brief methodological flow chart of suitable site selection

The waterbody density (WD), proximity to river (km.), precipitations, water availability, water pH, DO (mg/l), Temperature (˚C), TDS, slope-soil and proximity to industry (km.) were described into SSFF. Population density (km^2), Road-rail way density (km^2), Road proximity (km.), Proximity to market (km.), Population of fish farmer and Proximity to Sub Division capitals (km.) are narrated into SSCFF model. Some field photographs during field visit and water sample data collection are presented in Annexure I. The importance of scale and weight overlay technique has been obtained and fulfills the aim of the study. The overall methods have been presented in Figure 3.2. The detail methods and results have been mentioned in chapter 6.

3.4 Summary

This chapter described about the satellite images and other collateral data sets that are used in this study. It also gives the detail information about the data acquisition and background information of data. This chapter is also narrated the brief methods and field survey strategies. The detailed methods, analytical results and their validation etc, are discussed in further chapters.