# Study Area:

The Silai and Joypanda river sub-basins are situated in the south-western part of the West Bengal state of India. It covers three districts Purulia, Bankura and West Medinipur of West Bengal partially. The study area lies between 22 ͦ47’37.82” N to 23 ͦ14’18.03” N and 86 ͦ38’46.08” E to 87 ͦ12’32.22” E (Figure). The area of the Silai sub-basin is about 723.43 km2 and the area of the Joypanda river basin is about 375.89 km2. Hence, the total area of the Silai-Joypanda sub-basins is about 1099.32 km2. This area belongs to degraded plateau region of the western part of the state. The study area is extremely drought-prone; average drought intensity and duration of the drought is also very high (Ghosh 2019). Most of the aquifers in this area are semi-confined types. The monthly average rainfall of the study area is 141 to 155 mm. The average monthly temperature of the Silabati basin is 37 ͦC (Halder et al. 2020). In the study area, the Silabati river flows through a hard rock region. Hard rocks and excessive undulations encourage more runoff and groundwater recharge. Basically, in the Joypanda river basin, groundwater availability is very less and peoples are completely dependent on rainwater for agricultural purposes. Also, Silabati is a non-perennial river and most of the time in a year river carries a very low discharge. So, at that time, people are completely dependent on groundwater for domestic and commercial purposes. Increasing population pressure, uneven distribution of rainfall throughout the year (Most of the precipitation occurs in monsoon) and low groundwater recharge due to the hard rock region influences the groundwater system of the region. That’s why effective management of groundwater is required in the study area.

# Materials and Methodology:

## Data Sources:

The delineation of the groundwater potential zones has been executed using fourteen surface and subsurface parameters which influence the groundwater recharge system. These are Drainage Density, Geology, Geomorphology, Land Use and Land Cover, Distance from Lineament, Porosity, Runoff, Rainfall, Soil, Distance from Wells, Relative Relief, Permeability, Slope and Water Holding Capacity. The Sources of data for different parameters have been mentioned in table.

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| Serial no | Parameters | Data Sources | Scale/ Resolution | Website link |
| 1 | Rainfall raster  map | Prepared from Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) dataset | 0.05 ͦ | [https:/www.chc.ucsb.edu/data/chirps](https://www.chc.ucsb.edu/data/chirps) |
| 2 | Well map | By digitizing the hydrogeological maps obtained from the website of the Public Health Engineering Department, Government of West Bengal having the sheet numbers 73I/12, 73I/16, 73J/13, 73M/4, and 73N/1 | 1:50000 | [https://maps.wbphed.gov.in](https://maps.wbphed.gov.in/) |
| 3 | Geology map | Obtained from Geological Survey of India (GSI) website. sheet numbers 73I/12, 73I/16, 73J/13, 73M/4, and 73N/1 | 1:50000 | [https://www.gsi.gov.in](https://www.gsi.gov.in/) |
| 4 | Geomorphology map | Downloaded from SRTM (Shuttle Rader Topographic Mission) DEM having a resolution of 30 m and some other works of literature. | 30m | [https://earthexplorer.usgs.gov](https://earthexplorer.usgs.gov/) |
| 5 | Lineament | By digitizing the hydrogeological maps obtained from the website of the Public Health Engineering Department,  Government of West Bengal having the sheet  numbers 73I/12, 73I/16, 73J/13, 73M/4, and 73N/1 | 1:50000 | [https://maps.wbphed.gov.in](https://maps.wbphed.gov.in/) |
| 6 | Slope | Using spatial analyst tool of ArcGIS on SRTM (Shuttle Rader Topographic Mission) DEM. | 30m | [https://earthexplorer.usgs.gov](https://earthexplorer.usgs.gov/) |
| 7 | Land use and  land cover | Landsat 8 OLI of path 139 and row 40 downloaded  from the USGS Earth Explorer website | 30m | [https://earthexplorer.usgs.gov](https://earthexplorer.usgs.gov/) |
| 8 | Drainage Density | Using spatial analyst tool of ArcGIS on SRTM (Shuttle Rader Topographic Mission) DEM. | 30m | [https://earthexplorer.usgs.gov](https://earthexplorer.usgs.gov/) |
| 9 | Relative Relief | SRTM (Shuttle Rader Topographic Mission) DEM. | 30m | [https://earthexplorer.usgs.gov](https://earthexplorer.usgs.gov/) |
| 10 | Soil | National Bureau of Soil Survey and Land Use  Planning (NBSSLUP) |  |  |

## Field Survey and sample collection:

Water and soil samples were collected from 19 different sites of Silai-Joypanda basin. The latitude, longitude, elevation, geology and land use of those sampling sites has been mentioned in table. Core cutter method and sand replacement method were used to collect the soil samples. Groundwater samples were collected from the tube wells of those sites and the sampling location was marked using a hand-GPS. Water samples for iron testing were collected in a separate container and 2 ml of conc. HCl was added to it to prevent the oxidation of ferrous ion. Total Dissolved Solid (TDS), Electrical Conductivity (EC) and pH of the water samples were measured at the field level using ‘combined pH and EC probe made by HANNA’. Groundwater levels of Some of the wells located in the basin were measured using Temperature Level Conductivity (TLC) meter.

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| --- | --- | --- | --- | --- | --- |
| **Village Name** | **Latitude** | **Longitude** | **Elevation (m)** | **Geology** | **LULC** |
| Aralbara | 23.114875 | 86.784225 | 161 | Pink granite/ biotite-granite gneiss | Dry fallow |
| Bansidi | 23.126744 | 86.885300 | 141 | Pink granite/ biotite-granite gneiss | Dry fallow |
| Baragram | 23.249288 | 86.578916 | 196 | Granite gneiss,  migmatite |  |
| Baramesya | 23.025297 | 87.081917 | 74 | Sand, Silt and Clay | Dry fallow |
| Bara Metala | 22.935355 | 86.841319 | 112 | Mica schist, occasionally  granetiferrous |  |
| Dumuria | 22.764150 | 87.169440 | 81 | Quartz phyllite, granite peebles and gravels |  |
| Gharpathar | 23.109581 | 86.985367 | 113 | Pink granite/ biotite-granite gneiss | Dry fallow |
| Guniada | 23.144322 | 86.729753 | 182 | Pink granite/ biotite-granite gneiss | Dry fallow |
| Kantapal | 22.847150 | 87.280690 | 40 | Quartz phyllite, granite peebles and gravels |  |
| Kawabasa | 23.111169 | 87.114178 | 95 | Sand, Silt and Clay |  |
| Kolaboti | 22.865431 | 87.080486 | 85 | Sand, Silt and Clay | Dry fallow |
| Kusumdunri | 22.934267 | 87.082664 | 93 | Sand, Silt and Clay | Open Forest |
| Kharjuria | 22.935864 | 86.982953 | 98 | Sand, Silt and Clay | Dry fallow |
| Metyal | 22.757136 | 87.114964 | 94 | Quartz phyllite, granite peebles and gravels |  |
| Niasa | 23.203150 | 86.692944 | 186 | Granite gneiss,  migmatite | Dry fallow |
| Pachaparar | 22.937640 | 87.183350 | 74 | Sand, Silt and Clay | Open Forest |
| Poradi | 23.118642 | 86.664542 | 167 | Mica schist |  |
| Rampur | 23.028070 | 86.988270 | 100 | Pink granite/ biotite-granite gneiss | Dry fallow |
| Upar Maity Bandh | 23.035840 | 86.882261 | 134 | Mica schist, occasionally  granetiferrous | Open Forest |

## Laboratory Experiments:

### For Soil:

Three index properties of soil viz. permeability, porosity and water holding capacity were determined in the laboratory to introduce them as thematic layers to delineate final groundwater potential map. Sieve analysis for the soil samples was carried out by a mechanical sieve to find the grain size distribution. Permeability values were calculated from soil grain characteristics using different empirical relations of grain size and permeability namely Hazen, Slichter, Terzaghi, Beyer, Sauerbrei, Kruger, Kozeny, Zunker, Zamarin and USBR formulas. Then an average of all the applicable permeability values was calculated to get the permeability of a soil sample. Porosity values of the soil samples were determined by saturation method. Water holding capacity of the soil samples was determined by saturating the samples and percolating excess water through a watman filter paper.

### For water:

Seven different water quality parameters were determined in laboratory namely chloride, total hardness, alkalinity, iron, sulphate, phosphate and nitrate. Adding other three parameters viz pH, TDS and EC which were determined during sample collection, all the 10 parameters were used to determine the final WQI values. The methods used to determine the water quality parameters have been listed in table.

To measure the total hardness, Eri chrome black T indicator has been added in the water sample in slightly alkaline condition (pH 10±0.1) and the solution has been titrated using standard EDTA titrant (0.01 N). Total alkalinity of water samples was determined by mixing 2-3 drops of mixed bromocresol green- methyl red indicator has been added to 50 ml of water sample and titrated with 0.02 N H2SO4.