CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Description of the study area

The **Ogunpa River** river system is a third-order stream with a channel length of 21.5 kilometres (13.4 mi) and a drainage basin covering 73.3 square kilometres (28.3 sq mi) draining the densely populated eastern part of Ibadan, Nigeria. The city of Ibadan in southwestern Nigeria (7º23' N, 3º5' E) is the largest urban centre in Africa south of the Sahara. Ogunpa River is known to contain 49 species of zooplankton. western part.

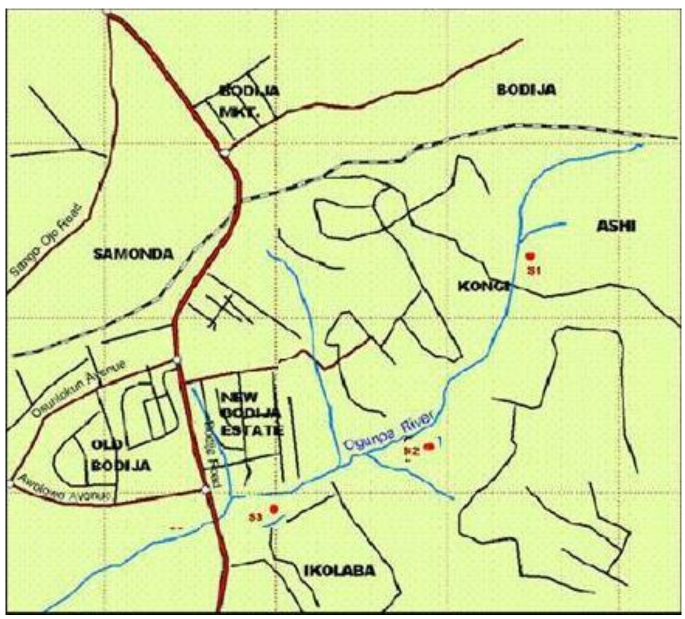


Figure 1: Map of Ogunpa River, Ibadan, Oyo State

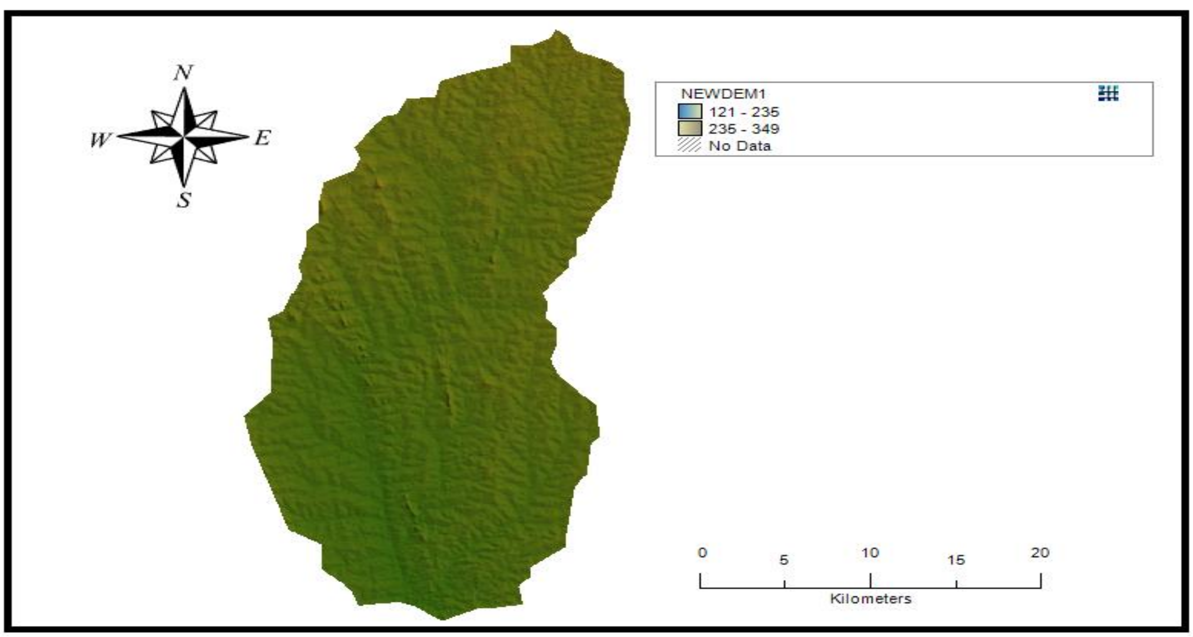
3.2 Model Selection and Description

Selecting an appropriate model is crucial for accurately assessing the effect of Spatial and temporal variations on water quality parameters. In this study, the Soil and Water Assessment Tool (SWAT) was chosen due to its capability to simulate the hydrological processes and water quality dynamics within a watershed. SWAT is widely used for watershed-scale assessments, offering comprehensive features for simulating various land management practices and their impacts on water resources.

3.3 Model Data Requirement

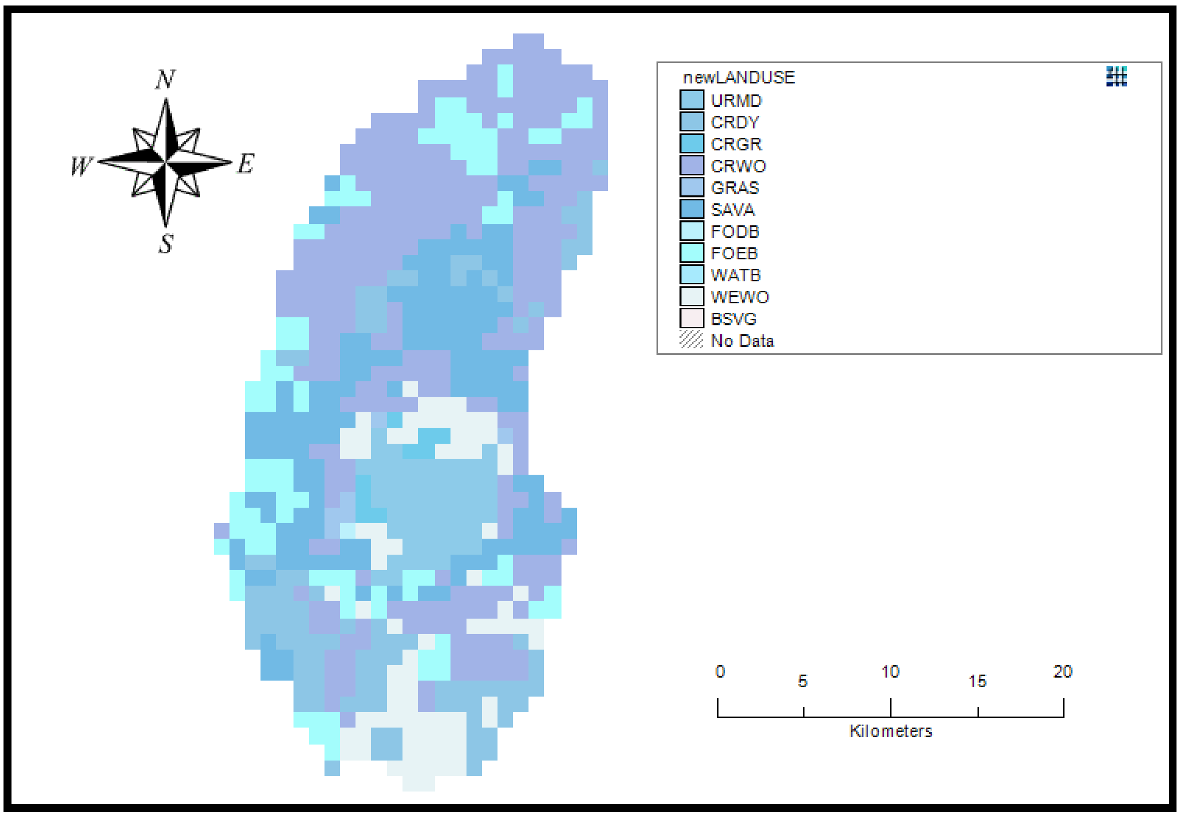
3.3.1 Digital Elevation Model (DEM):

A Digital Elevation Model (DEM) is a digital representation of the Earth's surface topography. It provides elevation data for each grid cell within a study area, typically in the form of a raster dataset. DEMs are essential for delineating watershed boundaries, estimating slope and aspect, and modeling surface water flow. They are 15 commonly derived from remote sensing technologies such as satellite imagery or airborne LiDAR (Light Detection and Ranging) systems.



3.3.3 Land Use/Land Cover (LULC):

Land use/land cover data classify the types of land cover and land use activities within a geographic area. This dataset categorizes land into classes such as forest, agriculture, urban, water bodies, etc. Land use/land cover data are crucial for characterizing the spatial distribution of human activities and their impacts on hydrological processes and water quality. They are typically derived from satellite imagery, aerial photography, or field surveys.



3.3.2 Soil Map:

A soil map provides information on the spatial distribution of soil types, properties, and characteristics within a study area. It delineates soil units based on factors such as texture, drainage, depth, and fertility. Soil maps are essential for understanding soil-water interactions, infiltration rates, and nutrient cycling processes. They are typically derived from soil surveys conducted on the ground and are represented as polygonal or raster datasets.

3.3.4 Weather Data

Meteorological data including temperature, rainfall, humidity, solar radiation, and wind speed were collected from weather stations within or near the study area. These data were used as input for SWAT to simulate hydrological processes and water quality parameters.

i. Temperature: Temperature refers to the degree of hotness or coldness of the atmosphere. In the context of hydrological modeling, temperature data is essential as it influences various processes such as evaporation, snowmelt, and vegetation growth. Temperature data is usually measured in degrees Celsius (°C) or Fahrenheit (°F) and is recorded at regular intervals (e.g., daily, hourly). It provides insights into seasonal variations and climate patterns, which are crucial for understanding hydrological processes.

ii. Rainfall: Rainfall represents the amount of precipitation, typically in the form of rain, which falls over a specific area during a given period. Rainfall data is measured using rain gauges or radar systems and is expressed in units such as millimeters (mm) or inches. It is a primary driver of surface runoff, infiltration, and groundwater recharge within watersheds. Temporal patterns of rainfall, including intensity, frequency, and duration, influence hydrological response and water quality dynamics.

iii. Humidity: Humidity measures the amount of water vapor present in the air. It is an important meteorological parameter that affects evaporation rates, plant transpiration, and atmospheric stability. Relative humidity, expressed as a percentage, indicates the moisture content of the air relative to its maximum capacity at a given temperature. High humidity levels can enhance evapotranspiration rates, while low humidity levels can lead to increased water stress in vegetation.

iv. Solar Radiation: Solar radiation refers to the electromagnetic radiation emitted by the sun. It includes both direct radiation from the sun and diffuse radiation scattered by the atmosphere. Solar radiation plays a crucial role in driving various environmental processes, including photosynthesis, evaporation, and temperature regulation. Solar radiation data is typically measured in watts per square meter (W/m^2) and is influenced by factors such as time of day, season, cloud cover, and atmospheric conditions.

v. Wind Speed: Wind speed measures the rate at which air moves horizontally across the Earth's surface. It is an important meteorological parameter that affects evaporation, dispersion of pollutants, and wind-driven erosion. Wind speed data is usually recorded in meters per second (m/s) or kilometers per hour (km/h) and is measured using anemometers or weather stations. Wind direction, in conjunction with wind speed, influences the distribution of pollutants and the transport of airborne particles within the atmosphere.

3.4 Model Parameterization and Prediction of Water Quality Parameters

Model Parameterization

SWAT Model Setup: Configure the Soil and Water Assessment Tool (SWAT) by defining model parameters, land use categories, soil types, and management practices. Calibrate model parameters such as curve number, soil hydraulic properties, and crop coefficients using observed data to improve model performance.

Hydrological Components: Specify parameters related to hydrological processes such as evapotranspiration, infiltration, surface runoff, and groundwater flow. Ensure that these parameters accurately represent the physical characteristics of the study area and hydrological processes within the watershed.

Prediction of Water Quality Parameters

Water quality parameters such as nutrient concentrations (e.g., nitrogen, phosphorus), sediment yield, and pollutant loads were predicted using the calibrated SWAT model. The model incorporated algorithms to simulate the transport and transformation of pollutants within the watershed, accounting for factors such as land use, soil properties, and hydrological processes. Prediction of water quality parameters enabled the assessment of how changes in watershed declination affect the overall water quality status of the Ogunpa River in Oyo State.

3.7 Visualization of the Result

Visualization of the results is a critical component of any research project, including watershed and hydrological analysis. Effective visualization techniques enable researchers and stakeholders to interpret complex datasets, identify spatial patterns, and communicate findings in a clear and concise manner. In the context of watershed management, visualization tools can enhance understanding of hydrological processes, watershed characteristics, and the impacts of management interventions on water resources.

One commonly used visualization tool is geographic information systems (GIS), which enable researchers to integrate, analyze, and visualize spatial data layers within a geospatial framework. GIS software provides a range of visualization techniques, including overlay analysis, 3D visualization, and interactive mapping, to explore relationships between different datasets and extract meaningful insights (Fisher & Tate, 2006). For instance, researchers can use GIS to overlay results with land use maps, soil maps, and hydrological modeling outputs to assess the impacts of land use changes on water resources and ecosystem services.