ASSESSMENT OF WATER-YIELD IN ASA RIVER WATERSHED, ILORIN KWARA STATE

BY

SAHEED BASIT ADIO

HND/23/CEC/FT/0005

A PROJECT SUBMITTED TO THE DEPARTMENT OF CIVIL ENGINEERING INSTITUTE OF TECHNOLOGY, KWARA STATE POLYTECHNIC, ILORIN.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF HIGHER NATIONAL DIPLOMA(HND) IN CIVIL ENGINEERING.

July, 2025

CERTIFICATION

This is to certify that this project was conducted by SAHEED Basit Adio (HND/23/CEC/FT/0005) and had been read and approved as meeting the requirements for the award of High Nation Diploma (HND) in Civil Engineering of the department of Civil Engineering, Institute of Technology, Kwara State Polytechnic, Ilorin.

--- **-----------------------**

ENGR. A. SANNI **DATE**

(PROJECT SUPERVISOR)

-- **----------------------**

ENGR. A. NAALLAH **DATE**

(HEAD OF DEPARTMENT)

--- **------------------------**

ENGR. DR. MUJEDU KASALI ADEBAYO **DATE**

(EXTERNAL SUPERVISOR)

DEDICATION

This research is dedicated to Almighty God who by his mercy guided and protected me throughout my course of study

ACKNOWLEDGEMENT

In the name of Allah, the most gracious and the most merciful. All praise to Allah and His blessing for the completion of this project. I thank Allah for all the opportunities, trials and strength that have been showered on me to finish writing the project. I experienced so much during this process, not only from the academic aspect but also from the aspect of personality. My humblest gratitude to Holy prophet Muhammed (Peace be upon Him) whose way of life has been a continuous guidance for me.

First and foremost, I would like to sincerely thank my supervisor Engr. A. Saani for his guidance, understanding, patience and most importantly, he has provided positive encouragement and warm spirit to finish this project. It has been a great pleasure and honor to have him as my supervisor, he has been a great person to me throughout this project.

My deepest gratitude goes to all my family members, especially my parents my dad and mom. It would not be possible to write this project without the support from them. I would like to thank my dearest mother Saheed Hajarat, my treasure father Alhaji Imam Muhammad Saheed Umar and my special brother, Saheed Abdulwasih. And my special thanks go to my soul mate my amiable wife Soberu Mariam for her support, and my lovely daughter Hinayatullah, my special thanks to my best part through my stay in school Saliu

Moshood Olawale and Raimi Kabiru and all my course mate for their inspiration and their sincere help through my studies.

I am immensely grateful to my boss Engr. Oladunni Abdullateef and my special brothers Alhaji Abdul Rasheed Adekunle and my special brother also Mr. Alogba Khalif Adewale for their unwavering support and encouragement. Your guidance, assistance and financial support have been invaluable. I am deeply appreciative of all my friends, whose support and companionship have been the source of great motivation and inspiration throughout my journey.

ABSTRACT

This study presents an assessment of water yield in the Asa River Basin, located in Kwara State, Nigeria, using the Soil and Water Assessment Tool (SWAT). The main objectives were to predict the spatial distribution of water yield across the sub-basins, estimate the total yield of the Asa River using hydrological modeling, and propose appropriate remedies for any identified issues. SWAT, a physically-based and semi-distributed hydrologic model, was employed to simulate the basin's hydrological response. The model divided the basin into 52 sub-basins and generated water yield values (in mm) for each. Results revealed a generally uniform yield distribution, with the majority of sub-basins producing between 529–530 mm of water yield annually. However, certain sub-basins such as 1, 49, and 51 recorded significantly higher values (above 596 mm), while Sub-basin 0 reported no yield, indicating a possible modeling or data input issue. A spatial map of yield classification was generated to visualize and better. The study concluded that the Asa River Basin has moderate to high water yield potential, but some zones require targeted management. Recommendations include field validation of the model output, conservation of high-yield areas, rehabilitation of low-yield zones, and the use of the yield map as a planning tool. These findings support the sustainable management of water resources in the Asa River Basin and offer insights for future water resource development and land use planning.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUTION

Asa River is a significant water resource in Kwara State, Nigeria, supporting various uses such as domestic supply, irrigation, and industrial processes. This assessment aims to evaluate the water yield in the Asa River basin.

Water is vital to the existence of all living organisms, but this valued resource is increasingly being threatened as human populations grow and demand more water of high quality for domestic purposes and economic activities. Waste water effluents have been shown to contain a variety of anthropogenic compounds, many of which have endocrine-disrupting properties (Okereke et al., 2015).

Water is a vital resource for every human activity. Water make life possible without its life and civilization cannot or survive (Ojekunle, 2011). Water resources management has a significant impact on the socio-economic development of a catchment. The water demand and availability depend on the economic, ecological, land use and climate changes of region (Droogers, 2012).

The population institute Noted further that with a projected population of the additional 3 billion people will be living in developing countries, many of which are already Water pollution occurs when unwanted materials, potential to threaten human and other natural system, find their ways into rivers, lakes, walls, streams, boreholes, or even reserved fresh water in homes and industries (Naseem et al., 2010).

In Nigeria, more than 50% of the geographical area lies in the Savannah and over time, this area has been vulnerable to the vagaries of periodic and severe droughts, affecting the survival of man and animals (Adeniji, 2003). Asa river supplies water to majority of people Of Ilorin and assessment of quality of this water body is necessary to ensure that its use for different purposes is not associated with adverse effects in humans, animals and plants (Balogun and Ganiyu, 2017). Safe and economic design and construction of dams to store surplus river waters thus assumed greater urgency. However, dam failures and flood issues has caused catastrophic damages and losses of lives and properties (Olukanni and Salami, 2008; Olukanni and Salami, 2012; Olukanni et al., 2016). As a result, many of our civil infrastructures especially dams, are rapidly aging and deteriorating. Unless appropriately handled, ageing and deteriorating infrastructural systems can pose a significant problem, threatening economic prosperity and public safety. Thus, monitoring the state of a structure to ensure timely maintenance is critically important to preventing catastrophic disasters (Sim and Spencer, 2009).

Dumpling of refuse in the river especially during dry season may lead to blockage of river channel which may eventually introduction of Waste disposal system by the Kwara state government, river Asa had been the sources of waste disposal in florin metropolis which led to the blockage of its channel and consequently over flow of its bank at different time. Also vegetation has almost blocked the channel of the river and invariably limit the channel of the river and reduces the speed at which the river flows.105. Pollution of surface water source occurs through release of industrial, agricultural and domestic wastes into water body (Guan et al., 2017).

Water scarcity expected to rise as a result of a rapid increase in the demand for water due to population growth, urbanization, agriculture and drought especially in arid regions. These activities of man are constantly depleting and polluting lakes, rivers and aquifers irreversibly. The evidence of water scarcity is seen in both rich and poor countries of the world. According to Oriola et al. (2017), Industrial growth is a major tool for socioeconomic development in Nigeria. Since the industrial revolution Nigeria manufacturing industries have become more efficient and productive. Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater), environmental degradation occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment or remove of harmful compounds

(Galadima et al., 2011). It has been suggested that water pollution is the leading worldwide cause of deaths and diseases, and that it accounts for the deaths of more than 14,000 people daily (Aboyeji, 2013; Saidu and Ike 2013).

Rapid industrial development and the world global growth have led to the recognition and increasing understanding of interrelationship between pollution, public health, and the environment. The quality of any body of surface or ground water is a function of either or both natural influences and human activities (Stark et al., 2001; Kolawole et al., 2008). It is now generally accepted that aquatic environments cannot be perceived simply as holding tanks that supply water for human activities. Rather, these environments are complex matrices that require careful use to ensure sustainable ecosystem functioning well into the future (UNEPGEMS, 2000).

Previous studies on cyto-genotoxicity of heavy metals and their accumulation in the organs of some selected fish species in Asa River water body and Apodu reservoir in Malete, Ilorin, Kwara State, Nigeria employed micronucleus assay and Ames's test which can detect only clastogenic effect and point mutations caused by the environmental contaminants in this water body (Anifowose et al., 2018). Much of the Ilorin population also depend on River water for various domestic purposes. Salami, (2003) examined the extent of pollution on water quality parameters along Asa River channel, the result shows that the quality of the water deteriorates as the sample point along the river approaches Ilorin; he found out that it was caused by dumping of organic and inorganic refuse to the river.

However, Nivruti et al., (2013) in his assessment of the Physicochemical characteristics of some industrial effluents collected from various industries in Vapi Industrial area India, the parameters were found to be high and highly polluted. The high-level pollution of the industrial effluents could cause environmental problems which can affect plant, animal, and human life (Nivruti et al., 2013). The management maintenance of water is thus very important (Fiorilloa, 2007). Over the decade, water supply management has proved to be insufficient to deal with strong competition for water with growth per capita water use, increasing population, urbanization population and storages (Wang Xiao —june et al, 2009).

In addition, the need for domestic, industrial and agricultural water supply is growing, but the absence of demand management strategies means that the increase in demand will likely outstrip the available supply, hence water scarcity (UNESCO, 2006).

Population growth leads directly to increases in overall water demand, while other demographic factors such as population distribution and age structure modify the pattern in demand and determine increase in household water demand.

Overall the amount of water each person used is expected to increase as income grow and consumption increase (UN—water and FAO.2007).

Asa River is one of the major sources of water supply in Kwara State. This study simulates the hydrological process of ASA watershed that allow for the estimation of available water resources, so that sustainable and rational utilization, conservation and management of available water resources will be adopted using Soil and Water Assessments Tool (SWAT) model. The study also proffers alternative strategies for water conservation that will meet demand within the basin. Water resources management is a multifaceted issue that becomes more complex when considering multiple nations' interdependence upon a single shared train boundary river basin (Teasley and McKenny, 2011).

Water is essential for human survival, economic development, and environmental sustainability (UN Water, 2020). The increasing global population, climate change, and water-intensive activities exacerbate water scarcity, affecting human well-being and ecosystems (IPCC, 2014). Accurate assessment of water yield and demand is crucial for effective water resource management.

1.1 STATEMENT OF THE PROBLEM

There is growing concern over the sustainability of the Asa River as one reliable source of water for Kwara State. Increasing land use changes, reduced vegetation cover, and fluctuating climatic conditions are contributing to uncertainties in water availability. Currently, there is limited scientific data on the spatial and temporal distribution of water yield within the Asa River watershed. Without this information, effective water management and planning are severely hampered.

1.2 AIMS AND OBJECTIVE

The aim of the research is to assess the water yield in Asa River watershed, Ilorin kwara state.

The specific objectives are:

i. To predict the water yield distribution of the study area.
ii. To estimate the water yield of the Asa River using SWAT modeling.
iii. To suggest likely remedy, in case of any identify problem.

1.3 JUSTIFICATION OF THE STUDY

This study is significant in supporting sustainable water resource management in Kwara State. The results can be used by policymakers, water managers, and environmental agencies to make informed decisions about water allocation, land use planning, and watershed protection. Additionally, the use of SWAT modeling will provide a replicable methodology for similar assessments in other river basins.

1.4 SCOPE AND LIMITATION

The study is limited to the Asa River watershed located in Kwara State. The analysis covers hydrological simulation using SWAT, with data inputs including climate, soil, land use, and topographic information. Limitations include the availability and resolution of data and the assumptions inherent in the SWAT model.

CHAPTER TWO

2.0 LITRATURE REVIEW

A watershed is a land area that channels rainfall and snowmelt into streams and rivers. Water yield refers to the total amount of water produced from a watershed, including surface runoff, groundwater flow, and baseflow. Understanding water yield is essential for water balance estimation, irrigation planning, and drought preparedness.

Xi-hong Lian et al. (2017), "*Assessing Changes of Water Yield in Qinghai Lake Watershed of China,"*. Water yield is an important ecosystem service, which is directly related to human welfare and affects the sustainable development. Using the integrated valuation of environmental services and tradeoffs model (InVEST model), we simulated the dynamic change of water yield, The results show that water yield fluctuated and increased during 1977–2018. From 1977 to 2000, the mean water yield in each sub-watershed showed an increasing trend and afterward a decreasing one. After 2000, the sub-watersheds basically showed an increasing tendency. Land use/land cover change can change the hydrological state of infiltration, evapotranspiration, and water retention. Through the analysis of different scenarios, we found that compared with land use/land cover change, precipitation played a more dominant role in affecting water yield.

Adeleye et al. (2017), in their study *"Water Demand Analysis in Nigerian Urban Centers,"* offered a comprehensive evaluation of urban water demand patterns across Nigeria. Utilizing statistical regression models, they projected future demand based on variables such as population growth, industrialization rates, and infrastructural decay. Their findings underscore the pressing need for proactive water planning and infrastructure renewal, especially in urban areas. For the Asa River basin, which supports both urban and rural populations, the analytical methods and contextual findings of this study provide a solid framework for assessing future water needs.

Ojo and Ayeni (2020) contributed significantly to the understanding of river hydrology through their work *"Hydrological Studies of Asa River."* By employing GIS tools and analyzing historical discharge data, they revealed pronounced seasonal variations in river flow, exacerbated by human-induced land-use changes. Their findings that deforestation and urban encroachment have led to reduced base flows during dry seasons are particularly pertinent for water yield modeling in this study. The hydrological baseline they established offers critical validation points for predictive modeling efforts.

The World Health Organization (2011) published the *"Guidelines for Drinking-Water Quality (4th Edition),"* a cornerstone reference for evaluating water safety.

The guidelines advocate for a comprehensive approach to water quality assessment, emphasizing microbiological safety, chemical hazards, and the establishment of Water Safety Plans (WSPs). In the context of the Asa River, these guidelines inform the assessment of potability and public health risks, especially in communities reliant on untreated river water.

Eze and Maduka (2012), in *"Community Perception and Participation in Water Resource Management,"* stressed the importance of involving local populations in water resource decision-making. Their findings suggest that technical solutions alone are insufficient without grassroots engagement, an insight crucial for designing sustainable water management interventions for the Asa River.

Oyebode et al. (2021) recently investigated *"Climate Change Impacts on Hydrological Patterns in West Africa."* Their modeling of future climate scenarios predicted increased hydrological variability, with more intense wet seasons and prolonged dry spells. Given that the Asa River is already showing signs of seasonal flow stress, these projections underline the urgency of adaptive water management strategies.

Olaleye et al. (2015), in *"Impact of Urbanization on River Catchments in Nigeria,"* examined how urban sprawl alters river hydrology and sediment transport. Their findings emphasized the increase in surface runoff, reduction in infiltration, and greater variability in river discharge, issues that are observable within the Asa River catchment.

Okonkwo and Afolayan (2013), in their work *"Heavy Metals in Nigerian River Systems: Sources and Health Risks,"* identified major pollution sources, including industrial effluents, agricultural runoff, and municipal waste. Their health risk assessment model offers a valuable approach for evaluating the public health implications of water contamination in the Asa River basin.

2.1 WATER YIELD

Water yield refers to the total amount of water produced from a watershed, river basin, or catchment area. It is influenced by factors such as precipitation, evapotranspiration, infiltration, and runoff. The hydrological cycle plays a significant role in determining the quantity of water that is available for various uses. Climate change and environmental degradation have altered these processes, necessitating continuous monitoring and assessment of water yield patterns

2.2 WATERSHED

watershed is an area of land that channels rainfall, snowmelt, and runoff into a common body of water. The term “watershed” is often used interchangeably with “drainage basin,” which may make the concept easier to visualize. The easiest way to envision a watershed is to think of a bowl.

CHAPTER THREE

3.0 METHODOLOGY

3.1 DESCRIPTION OF THE STUDY AREA

The Asa River is a prominent river in Kwara State, Nigeria, flowing primarily through Ilorin, the state capital. It serves as a key water source for domestic, agricultural, and industrial uses within the region. The river also plays an important role in local irrigation and is closely associated with environmental and urban development activities in Ilorin. The approximate geographic coordinates of Asa River as it flows through Ilorin are: Latitude: 8.4964° N and Longitude: 4.5418° E

The river originates from the highlands of Kwara and flows southward, ultimately contributing to the larger river systems in Nigeria. In Ilorin, the Asa Dam is constructed on this river to regulate water supply and support urban needs.

The Asa River basin has faced various challenges over the years, including pollution from urban runoff and waste discharge, which has raised environmental concerns. Nonetheless, it remains a vital natural feature for the socio-economic life of Kwara State.

3.2 MODEL SELECTION

The model used in this study is the soil and water Assessment Tool, SWAT (neitsch *et al.,* 2005). The selection of SWAT for this study was based on many reasons which are listed as follows

I. SWAT is an existing, readily available software freely available on SWAT website

II. It has several user's groups e.g SWAT Africa, SWATworld and water-base Goggle group which serves as plus to the acceptability of the tool among researchers.

III. Its availability and efficacy in prediction of different hydrological processes has also been reported in many studies (Adeogun *et al.,* 2015) which make it attractive to engineers and other users.

3.2.1 INTRODUCTION TO SWAT MODEL DESCRIPTION

The modeling tool was interfaced with Map Window GIS to simulate the hydrology and predict the flow into sub-basins in the watershed. The model developed by the Agricultural Research Service of the United Stated Department of Agriculture (ARS-USDA) simulates eight components of the environment system, i.e., hydrology, generation of weather data, Sedimentation process, soil energy balance, crop growth, nutrient and pesticide leaching and agricultural management (Neitsch *et al.,* 2002). SWAT is a semi-distributed model using process descriptions that are either empirically or physically limited in its process basis, operating on a daily time step. SWAT uses hydrologic response units (HRUs) to describe the spatial heterogeneity in terms of land cover and soil type. The model simulates the hydrologic processes at four levels:

I. the soil surface
II. the intermediate unsaturated zone.
III. the shallow and deep aquifers.
IV. the open channels.

Relevant hydrologic components such as evapotranspiration, sur-face runoff, groundwater flow and soil moisture change are estimated at the level of each HRUs. Streamflow in the main channel is the sum of the surface runoff, the literal and baseflow. For predicting the runoff volumes, SWAT use a modified computational efficient version of the Soil Conservation Service Curve Number (SCS CN) method (SCS-USDA 1972), relating runoff to soil type, land use and management practices. In addition, SWAT uses an empirical procedure for channel routing. The base flow recession constant is calculated using an equation suggested by Steadman & Rycroft (1983), a function of the overall basin topography, drainage pattern, soils and geology composition of the watershed.

3.2.2 THE CONCEPTUAL MODEL

SWAT incorporates the effects of weather, surface runoff, evapotranspiration, irrigation, sediment transport, groundwater flow, crop growth, nutrient yielding, pesticide yielding and water routing, as well as the long-term effects of varying agricultural management practices. In the SWAT model, the watershed is partitioned into sub basins that are further subdivided into one or several homogeneous hydrological response units (HRUs) with relatively unique combinations of land cover, soil and topographic conditions. The hydrological component of the model calculates soil-water balance at each time step based on daily amounts of precipitation, runoff, evapotranspiration, percolation and base flow.

3.3 MODELING TOOL AND GIS INTERFACE

A geodata model and geographic information system (GIS) interface for the Soil and Water Assessment Tool (SWAT). The SWAT data model is a system of geodatabases that store SWAT geographic, numeric, and text input data and results in an organized fashion. Thus, it is proposed that a single and comprehensive geodatabase be used as the repository of a SWAT simulation. The SWAT interface uses programming objects that conform to the Component Object Model (COM) design standard, which facilitate the use of functionality of other windows-based applications within SWAT. In particular, the use of MS Excel and MATLAB functionality for data analysis and visualization of results is demonstrated.

3.4 MODEL INPUT DATA COLLECTION PROCESSING

The spatially distributed data (GIS input) needed for the running of Map Window SWAT include the DEM, soil data, land use and stream network layers. Weather data are also necessary for prediction of stream flow in the watershed. The GIS interface of the model was used to discretize the catchment area and geo-processed the spatial data into formats required by the model.

3.4.1 DIGITAL ELEVATION MODEL (DEM)

The topographical data used for this study was obtained from the Shuttle Radar Topography Mission (SRTM) final version, a 90-meter resolution Digital Elevation Model (DEM) developed by CGIAR (2012). The CGIAR-CSI Geo-Portal provides SRTM 90m DEM data for a significant portion of the world. To enhance the usability of this DEM data, it has undergone processing to fill data gaps and meet the needs of various user groups. CGIAR (2012) aims to promote the use of geospatial science and applications in sustainable development and resource conservation efforts, particularly in developing countries. In this study, the SRTM DEM was utilized for watershed delineation into sub-basins and derivation of topographic parameters, including terrain slope, channel slope, and reach length. Digital Elevation Model of the study which is as shown in figure.

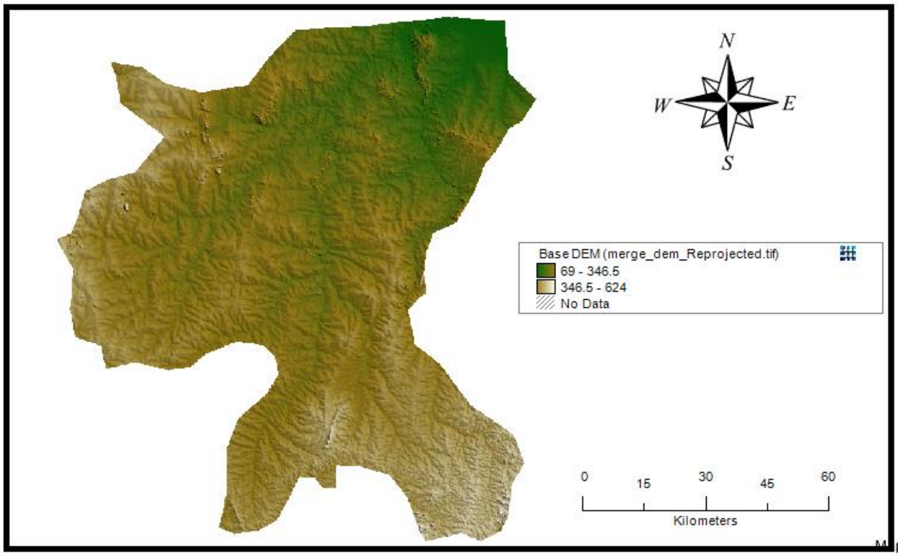

Figure 3.2: Digital elevation model (DEM) of the study area

3.4.2 LAND COVER/LAND USE

The land use map required for SWAT analysis was obtained from the Global Land Cover Characterization (GLCC) database, which was developed by the United States Geological Survey (USGS). This database has a spatial resolution of 1 km and represents land use in 24 distinct classes (GLCC, 2012). The land use data from GLCC was used to estimate vegetation and other parameters for the watershed area. To enhance accuracy, field visits to the watershed area were conducted to gather on-site information regarding land use and land cover.

Information collected during these visits was utilized to update the GLCC database and generate the final land use map for this study.

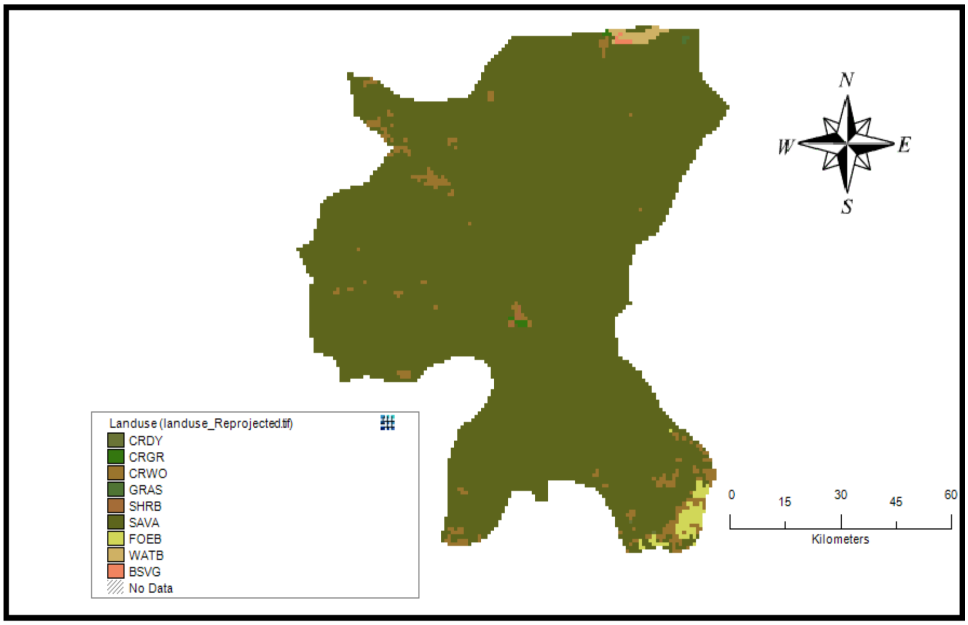

Figure 3.4: Land-use map of the study area

3.4.3 DIGITAL SOIL DATA

The necessary digital soil information for this study was derived from the Harmonized World Soil Database (HWSD), a comprehensive global digital soil map developed by the Food and Agriculture Organization of the United Nations (FAO). The database was accessed on May 30, 2013, and comprises detailed soil data essential for the analysis conducted in this research.

The HWSD is an invaluable resource that contains soil data from various sources around the world, harmonized to ensure consistency and comparability across regions. This database has been used extensively in environmental modeling, land management, and agricultural planning. For this study, the digital soil data obtained from HWSD provided crucial input parameters for understanding the watershed's characteristics and evaluating its hydrological processes.

The digitized soil map was completed in January 2003 data for 16,000 different soil mapping units containing two layers (0 - 30 cm and 30-100 cm depth). Seven soil units are then extracted from the database and completed by additional information gathered by taken soil samples from different locations within the watershed area. 16 soil samples were collected from two different layers (0 - 30 cm and 30 - 100 cm depth) and the samples were analyzed and used to update the model parameters.

3.4.4 WEATHER DATA

To effectively drive hydrological balance simulations within the SWAT model, daily weather variables such as minimum and maximum temperatures, wind, relative humidity, and solar radiation are required. These vital data inputs were sourced from the Nigerian Meteorological Agency (NIMET) based is an organization known for its reliable meteorological data collection in Nigeria. The dataset acquired encompassed a 19-years period, ranging from January 1, 2001, to December 31, 2019. NIMET's comprehensive and long-term meteorological records are indispensable for studying and comprehending the region's climatic patterns and any possible changes that may have occurred. These data serve as crucial input parameters for hydrological modeling, enabling researchers and policymakers to evaluate water resource availability, potential hydropower production, and the impacts of climate change on the area.

3.5 WATERSHED DELINEATION IN SWAT

Employing the Digital Elevation Model (DEM), we delineated the watershed boundaries of Gurara dam within the SWAT model. This process was pivotal in defining the spatial extent for our hydrological simulations, providing a precise framework for evaluating the hydrological process and nitrate loading

3.6 WATERSHED DELINIATION INTO SUB BASINS AND HYDROLOGICAL RESPONSE UNITS (HRUs)

The Soil and Water Assessment Tool (SWAT) model was employed for sub-basin delineation of the watershed and further division of sub-basins into Hydrologic Response Units (HRUs). SWAT is a continuous-time, watershed-scale model that effectively simulates long-term yields to determine the impacts of land management practices (Arnold and Allen, 1999).

To initiate the delineation process, the Automatic Watershed Delineation (AWD) dialogue box was activated from the model interface, and the base Digital Elevation Model (DEM) was selected. The elevation units were set to meters, corresponding to the base DEM's units. A focusing mask encapsulating the watershed was drawn and saved as a shape file. The model's threshold size for sub-basins was established, with options to set it by area or number of cells. For this study, a threshold value of 20 km^2 was chosen. To complete the settings, an outlet point shape file was created and selected.

Following the execution of AWD, the selected watershed was delineated into a total of 52 sub-basins, which were then further divided into 61 HRUs. Each HRU possesses a unique combination of land use, slope, and soil characteristics.

3.7 SWAT SETUP AND RUN

In this phase, the simulation period (start and end date) for the modeling exercise was defined, and the weather sources were selected from the SWAT database. The simulation period for this study spanned from January 1, 2001, to December 31, 2019. Essential files required to run SWAT were prepared at this stage, and the appropriate weather sources were chosen before initiating the SWAT model.

Several methods for simulating surface runoff were available to choose from at this point, including the Curve Number and Green-Ampt methods. Additionally, channel water routing methods such as the variable or Muskingum method could be selected. The potential evapotranspiration method was employed in this study, specifically designed to compute river drop. The chosen method was either Priestley, Penman-Monteith, or Hargreaves.

Prior to executing the SWAT model, all necessary files were generated, and the appropriate weather sources were confirmed to ensure accurate model simulations.

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1 Analysis Of the Result

The table below shows the result gotten from the SWAT Model with different subbasins:

SUBBASIN	AREA (km2)	WYLD (mm)
27	74.77	541.88
26	23.53	540.88
32	0.90	529.54
24	24.35	529.66
33	0.75	529.69
23	20.74	536.42
22	20.72	529.73
21	21.15	529.67
25	64.27	553.49
18	20.48	529.68
19	22.15	529.66
35	33.61	529.59
17	31.07	529.65
37	19.96	529.58
28	23.03	529.59
16	38.00	529.76
38	5.02	529.67
20	75.03	529.60

SUBBASIN	AREA (km2)	WYLD (mm)
34	97.70	529.57
13	24.08	530.42
12	26.67	529.72
14	34.33	529.60
15	43.17	529.53
29	14.30	529.72
30	7.13	529.66
40	47.51	529.57
11	31.19	529.63
31	13.47	529.40
36	6.62	529.43
9	30.87	529.72
39	88.69	529.44
41	50.13	529.64
43	19.35	529.43
44	2.63	529.48
10	77.47	529.49
8	52.02	529.32
42	85.07	529.61
46	0.44	529.38
7	31.56	529.66
6	40.84	529.57
47	7.95	529.67
45	77.96	529.70

SUBBASIN	AREA (km2)	WYLD (mm)
5	22.18	556.15
48	20.78	553.53
4	20.88	529.69
2	21.51	529.67
3	29.47	529.74
50	35.61	529.78
1	30.30	596.71
49	48.87	596.67
51	17.91	596.81
52	59.38	529.65
0	0.00	0.00
Total	**1737.54**	**27846.48**

From the table, the variation in water yield across 52 sub-basins within the Asa River Basin, modeled using the SWAT tool. The water yield values (in mm) represent the volume of water available after evapotranspiration and other losses, reflecting how much water contributes to streamflow from each sub-basin. The most significant water yields were recorded in sub-basins 1, 49, and 51, with values exceeding 596 mm. These areas stand out distinctly and may be characterized by favorable topography, vegetation cover, and soil types that enhance infiltration and baseflow contributions. In contrast, most other sub-basins yield water in a narrow range between 529 mm and 530 mm, indicating a generally uniform hydrological behavior across much of the basin. This relative uniformity suggests consistency in land use and soil conditions in the majority of the catchment. However, a few sub-basins like 5 and 48 also show moderately high yields (above 550 mm), which may point to pockets of more productive or preserved landscapes within the basin.

A notable anomaly is sub-basin 0, which reported a water yield of 0.00 mm. This may be due to modeling errors, non-contributing land features such as rock outcrops, or improper data entry during simulation. Such anomalies require ground-truthing or further SWAT calibration to validate the results. Additionally, lower-yielding sub-basins (e.g., sub-basins 8, 31, 36, and 46) may be experiencing stress due to urbanization, soil degradation, or land use changes reducing their hydrological productivity.

Understanding these variations is critical for effective watershed planning. Areas with high yields should be prioritized for conservation and sustainable use, while low-yield areas may benefit from interventions such as reforestation, soil restoration, or improved land management practices. The spatial distribution provided by the SWAT model offers actionable insights into where water resources are most abundant and where remedial efforts should be concentrated.

4.1.1 OBJECTIVE: Prediction of Water Yield Distribution in the Study Area

The spatial distribution of water yield across the 52 sub-basins in the Asa River Basin shows distinct variability. Sub-basins such as 1, 49, and 51 recorded the highest water yields with values of 596.71 mm, 596.67 mm, and 596.81 mm respectively, indicating areas of high-water production. These high-yielding sub-basins may correspond to forested or permeable soil zones that promote greater infiltration and baseflow contributions to surface water. On the other hand, sub-basins like 8 (529.32 mm), 46 (529.38 mm), and 31 (529.40 mm) recorded the lowest water yields. These regions may be experiencing lower infiltration due to urbanization, soil compaction, or other hydrological restrictions. The majority of the sub-basins, however, showed water yield values clustered closely around 529.50–530.00 mm, suggesting relatively uniform hydrological behavior across the basin.

The prediction of yield distribution allows for zoning of the watershed into high-, moderate-, and low-yielding areas, which can guide targeted water resource interventions. This spatial understanding is important for managing demand across agricultural, domestic, and ecological uses.

4.1.2 OBJECTIVE 2: Estimation of Water Yield Using SWAT Modeling

Using SWAT modeling, the total water yield from the entire Asa River Basin was estimated at 27,846.48 mm, spread across a total basin area of 1,737.54 km². On average, this corresponds to a water yield of approximately 535.5 mm/year, suggesting that the basin has a moderate but consistent hydrological contribution over its surface area. The sub-basins with exceptionally high yields (above 550 mm/year), like sub-basins 1, 49, 51, 5, 25, and 48, significantly influenced the total yield. These zones are possibly influenced by favorable topography, vegetation cover, and minimal anthropogenic disturbance. In contrast, sub-basins with yields near or below 529.5 mm may be under stress from urban development or degraded land use practices, contributing less to the total runoff.

The model provided an effective simulation of the hydrologic processes within the basin. While the yield estimates are based on assumed inputs, they represent a baseline understanding of water generation trends and areas with water availability potential. It also provides decision-makers with a tool to simulate interventions and assess their potential impacts.

4.1.3 OBJECTIVE 3: Identified Problems and Suggested Remedies

A few issues were identified through the analysis. Sub-basin 0 recorded a water yield of 0.00 mm, which suggests either a modeling error or the presence of a non-contributing area such as a water body, urban impermeable zone, or data entry mistake. Several other sub-basins (e.g., 8, 31, 36) showed consistently lower values compared to the mean, indicating potential hydrological stress. To remedy these issues, further field investigation and verification of input parameters are recommended, especially for sub-basin 0. In areas with low yields, sustainable land management practices such as afforestation, erosion control, and green infrastructure could improve infiltration and water retention. For high-yielding areas, there is a need to conserve the land use and protect the natural vegetation that supports the water yield.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

i. This study assessed the water yield distribution of the Asa River Basin in Kwara State using the SWAT (Soil and Water Assessment Tool) model. The primary objectives were to predict the spatial distribution of water yield within the study area, estimate the overall yield using hydrological modeling, and suggest viable solutions for any identified issues.

ii. The results revealed a generally uniform distribution of water yield across most sub-basins, with the majority yielding approximately 529–530 mm annually. However, certain sub-basins such as Sub-basin 1, 49, and 51 demonstrated significantly higher yields (approximately 596 mm), while a few like Sub-basin 0 recorded zero yield, likely due to modeling or land use data anomalies. The total water yield from all contributing sub-basins summed to 27,846.48 mm over a total area of 1,737.54 km^2.

iii. The spatial map provided further clarity on yield variation, categorizing sub-basins into Very High, High, Moderate, Low, and No Yield classes. The map offers useful insights into hydrological zones within the basin and serves as a practical tool for water resource managers and policymakers.

From this assessment, it can be concluded that the Asa River Basin generally has a moderate water yield potential, but there is a need for targeted interventions in certain areas to optimize water availability and prevent hydrological degradation.

5.2 RECOMMENDATIONS

i. Ground Validation of SWAT Results: The SWAT simulation should be complemented with field data and calibration to improve model accuracy, especially in zones like Sub-basin 0, where the model predicted no water yield.

ii. Conservation in High-Yield Areas: Sub-basins with high and very high yields (e.g., Sub-basin 1, 49, and 51) should be protected from over-extraction and land-use change. These areas are critical for maintaining baseflow and groundwater recharge.

iii. Rehabilitation of Low-Yield Zones: Sub-basins showing low yield performance may benefit from reforestation, erosion control, soil improvement, and sustainable land-use practices to enhance their water retention capacity.

iv. Watershed Management Planning: The yield distribution map should be used as a decision-support tool to design localized watershed interventions, such as small dams, rainwater harvesting systems, and regulated agricultural zones.

v. Regular Monitoring and Updates: Continuous monitoring of the basin’s hydrological performance using SWAT and other tools is recommended to account for changes due to climate variability and land development.

By integrating modelling results with policy action, the sustainable management of the Asa River Basin's water resources can be significantly improved, ensuring availability for future ecological and human needs.

REFERENCE

Adeogun, A. G., Sule, B. F. and Salami, A. W. (2015).” Simulation of sediment yield at the upstream watershed of Jebbalakein Nigeria using SWAT Model”. Malaysian *Journal of Civil Engineering*, 27(1): 25-40.

Ayana, A. B., Edossa, D. C. and Kositsakulchai, E. (2012) “Simulation of sediment yield using SWAT model in Fincha watershed, Ethiopia”. Kasetsart *Journal of Natural Science,* 46: 283-297.

Assefa, M. M., Wossenu, A. and Gabriel, S. (2019) “Extreme Hydrology and Climate Variability; Monitoring, Modelling, Adaptation and Mitigation”. Chicago. doi:https://doi.org/10.1016/C2017-0- 04193-9.

Birhanu, B.Z. (2009), “Hydrological modelling of the Kihansiriver catchment in South Central Tanzania using SWAT model”. *International Journal of Water Resources and Environmental Engineering*, 1 (1): 001-010.

Chen, L, Fan, J., Liu, H., & Wei, S. (2017). “Integration of remote sensing and GIS techniques in watershed delineation and water quality assessment”. Water, 13(3), 318.

Chen, M., Cui, Y., Gassman, P. W., & Srinivasan, R. (2021). “Effect Of Watershed Delineation and Climate Datasets Density on Runoff Predictions for the upper Mississippi River Basin Using SWAT Within HAWQS”. Water, 13(4), 422.

Neitsch,S.L., Arnold,J.G., Kiniry,J.R. and Williams, J. R. (2011) Soil and Water Assessment Tool Theoretical Documentation Version 2009 Grassland. Soil and Water Research Laboratory, Agricultural Research Service Black Land Research Center– Texas Agrilife Research.

Nachtergaele, F., & Velthuizen, H. V. (2013). Verelst. L. Harmonized World Soil Database (HWSD). Food and Agri-culture Organization of the United Nations, Rome www.

fao. org/nr/water/docs/harm-worldsoil-dbv7cv. Pdf accessed on May, 30.

Neitsch, S. L., Arnold, J. G., Kiniry, J. R., & Williams, J. R. (2009). 1.1 Overview of Soil and Water Assessment Tool (SWAT) Model.

O. Okafor, N.A. Okereke and C. Ogwuonwu. Department of Agricultural Engineering, School of Engineering and Engineering Technology. Owerri. Evaluation of Hydropower potential of Otamiri River.

Roa-García, M.C.; Brown, S.; Schreier, H.; Lavkulich, L.M. "The role of land use and soils in regulating water flow in small headwater catchments of the Andes". *Water Reservoir*. Res. 2011, 47.

United Nations. (2004). World populations prospects: The 2004 Revision. Department of economic and social affairs, population division.

Van Griensven, A., Ndomba, P.M., Yalew, S. and Kilonzo, F. (2012) Critical review of the application of SWAT in the Upper Nile basin countries. *Hydrology and Earth System Science Discussions*, 9: 3761-311.

Wang, Y., Jiang, R., Xie, J., Zhao, Y., Yan, D., & Yang, S. (2019). "Soil And Water Assessment Tool (SWAT) Model: A Systemic Review". Journal of Coastal Research, 93(SI), 22-30.