Research Article

Designs and Blueprint for Sustainable Projects: A Climate Policy Using Markovian and Bayesian Models, Benin Owena Basin

Luke Chika Eme[1*], Ikhazuagbe Ohiwere[2]

[1]Department of Civil Engineering, Faculty of Engineering, Chukwuemeka Odumegwu Ojukwu University, Uli, Campus, Anambra State, Nigeria

[2]Department of Civil Engineering, Auchi Polytechnics, Auchi, Edo State, Nigeria

[*]**Correspondence to: Luke Chika Eme, PhD, Professor,** Department of Civil Engineering, Faculty of Engineering, Chukwuemeka Odumegwu Ojukwu University, Uli, Campus, Anambra State, Nigeria; Email: Leeworks2002@yahoo.com

Abstract

Objective: The objectives of the study are: to develop blueprint / layout plan that will address the problems of climate change crises and management lapses which use green energy for solution, to develop a model that tackles the climate change crisis in the Benin-Owena River basin, Nigeria using Markovian and Bayesian models and to assess the net benefits of River projects such as hydropower, water supply, irrigation, flood control, etc.

Methods: The methods of the study involved: dynamic programming models and a Bill of Engineering Measurement and Evaluation.

Results: The results of the Markovian models showed that, the optimal solutions from year 2015 to 2025 for the Benin-Owena River basin would not require maintenance (k*=1), the total expected revenues or return for the ten years of minimum utilization of the basin's assets were; F1 (1) = N5.309 Billion(B) if the state of the project in year 1 was very excellent, F1 (2) = N5.495B if the state of the project in year 2 was excellent, F1(3)=N5.481B if the state of the project in year 3 was very good, F1 (4) = N5.764B if the state of the project in year 4 was good, etc. When the results of the Bayesian decision models were compared, these showed that the Expected Monetary Values from year 1 to 10 respectively were: irrigation=N5.270B, water supply=N7.822B, hydropower=N2.733B, flood control=N2.553B, etc.

Conclusion: The study concluded that, the tests for hypothesis confirm that the performance of the Benin-Owena River basin (prototypes) versus the (models) was at 100% with high component interactions. If the allocation for five years by the federal government to the river basin authority of N5.54B naira is deducted from the N52.997B naira generated, then it will make a profit margin of N47.457B naira as a return from the investment. This creates job opportunities for youth employment and security of lives, property, etc.

Keywords: hydro & wind powers, river projects, optimization models

1 INTRODUCTION

Numerous aspects of human production, activities, social development, and surviva. For example, multi-purpose water resources and environmental engineering development projects planning with respect to optimization modeling, ecosystem structure, ecological process, and regional ecological environment, have been severely impacted upon and altered as a result of the imbalance brought by climate change. The hydrologic cycle has historically been very regular, such that in the past, Nigeria had two distinct seasons: the rainy (wet) and the harmattan (dry) and each season lasted six months. The wet season typically begins from the month of April to September each year, while the (dry) season begins from the month of October to March, but recently as a result of human activities: such as urbanization and industrialization with the use of brown energy or fossil fuels and massive emissions of carbon dioxide to the atmosphere, temperatures have risen, both at sea level and in the atmosphere, which had led to ozone layer depletion and resulted in global warming such as what we are seeing today according to Eme and Okodugha (2022)[1], Hovi (2002)[2] and Ogbuabor & Egwuchukwu (2017)[3].

Consequently, from these human activities it was discovered that the water cycle had varied over time. For example, today, the dry season occurs only in January and February while the rainy season typically lasts from March to December. This indicates that the water cycle is very inconsistent. The rainy season lasted ten months, from March to December, with January and February being the driest months. Most crops will not survive during the dry season requiring irrigation for two months. Similarly, during the wet season because it rains more than necessary, flooding becomes a major problem in the region destroying property and taking life. Climate change is the term most researchers use to describe this alteration or crisis in the water cycle. Due to the usage of fossil fuels for transportation, agriculture, industry, and other purposes, the seasons have changed resulting from climate change. The smoke that is released by automobiles, industrial layouts, etc., in these areas to the atmosphere into the clouds, deplete the ozone layer. This ozone layer depletion, which had led to extreme dryness, heat, or flooding, wetness in some regions of Africa or the entire world, was initiated by the Global North, because of their industrial expansion caused by the usage of fossil fuels. North America, has the world's largest concentration of industrial centers, has been in the forefront of this ozone depletion. Nigeria and other nations in the Global South suffer as a result of these activities.

In view of the above, it was resolved at the 2015 Paris Club Agreement in France that research should be supported based on these issues, challenges, etc., related to climate change and should be fully funded by the Global North. Consequently, basins all over the planet are the centre of the climatic or hydrological changes. Each cycle has an effect on the basin; for example, Nigeria has twelve River basins, which means that water is of high yield in twelve separate basins within Nigeria. The distinctive records concerning this transformation are covered in chapter four of this inquiry into climate crisis policy: a comparative analysis utilizing Markovian and Bayesian decision models for Owena river basins, Nigeria. For these reasons, the basin needs a green revolution, where the focus will be on the sustainability of facilities and infrastructures, as well as proper management of this variation. The river basin projects are multi-purpose and multi-objective in nature; as a result, they call for a model that can handle the multi-objectivity, which includes climate change, which is a set of natural factors that can cause sudden flooding or sudden dryness and is a very useful example showcasing uncertainty. For decision or policy implementation with a blueprint, this type of climate condition calls for a comparative analysis employing Markovian and Bayesian optimization models, Eme and Ikhazuagbe (2023)[4].

1.1 Background of the Study

The best use of a country's water resources typically has a significant impact on the development of its infrastructures and natural habitats along its watersheds. These are necessary for better living conditions, increased output, and social economic growth. Therefore, Nigeria as a country may struggle to achieve her objective of becoming a major economic power or reaching vision 2050 goal, which is to make her one of the 20 most developed economies in the world by the year 2050, unless there is a significant improvement in her water resources management. In the management of water resources, Nigeria has great economic potential. It has the largest economy in the West African sub region but has made little progress that can be seen. This caused the management's actions to decline starting in

1985. Nearly all of the ambitious projects that had been previously planned started, and personnel strength across all cadres significantly failed. Recently, neither on an annual basis nor in the national development plan, were there specific budgetary allocations for management. The only activities allowed are standard agricultural farming according to the Federal Ministry of Water Resources (2010)[5], and the US Congress (1971)[6].

The "experimental" problems during the third (1975-1980) and fourth (1981-1985) National Development Plan periods only included a near total lack of any inherited prior experiences, political and socio-economic considerations, institutional and organizational shortcomings, acute storage of administrative and technical manpower, and insufficient reliable records of hydrological, hydro geological, and climatologically data. As the tasks in the multi-purpose water resources development planning started to take shape, all of these factors came together to provide a number of issues. Nigerians began developing their resources for several purposes without having inherited any management expertise. The Civil Service Commission was one of the British legacies that were operational in Nigeria, although it was mostly used for domestic water delivery and a few modest irrigation agriculture projects, with little to no administration of multipurpose water resources. Most of the individuals hired to hold positions when basin authorities were formed had no formal training or real-world expertise in watershed management. When placed in their current situation, these employees were unable to take many independent actions and were forced to rely on several feasibility studies that were primarily contracted out to foreign consultants. Some of these studies' reports, which cost the country millions of Naira, were afterwards destroyed or shelved after they had caused numerous planned projects to be underestimated or exaggerated. A British Council Report in 1982 agreed that even the three major northern irrigation schemes (the Bakalori, Kano River project (phase 1), and south Chad already close to completion) had ten years as absolute minimum to achieve the target, and 25 to 30 years would be an appropriate amount of time. For instance, all River Basin Development Authorities (RBDAs) together planned for a total of 1.4 million hectares (ha) of irrigated agriculture to be completed during the Fourth National Development Plan (1981-1985) alone according to Ojiako (1989)[7].

According to Diaz and Fontanne (1989)[8] and Eme (2019)[9] Nigeria's RBDAs are governmental organizations that manage water resources for use in hydropower and agriculture with other purposes. Every authority oversees the territory that falls under its geomorphologic zone, and one of their main responsibilities is to ensure that irrigation is used to improve agriculture and rural development,

prevent human activity from polluting rivers, and assist farmers in growing and processing food. Nigeria's political and economic situation has an impact on how RBDAs operate. After the Sahel drought in the early 1970s and a decline in agricultural output as a result of Nigeria's oil-dependent leadership's belief in investing in the sustainability of food security and returns from water resources, there are some concerns about sustainable food reliance in Nigeria. Government entities have been created in all geopolitical regions of the country to build drainage systems within river basins. Two river basin authorities, including those for the Sokoto River and the Lake Chad basin, were established in 1973. The RBDAs then enlisted eleven agencies with mandatory water resource development in order to increase agricultural sustainability in 1976. One of the major priorities of the RBDAs was the management of water resources to help irrigated crops. The Federal Government issued the RBDAs decrees Nos. 32 and 33 on August 14, 1973, giving the creation of the Chad and Sokoto-Rima RBDAs a proper and legal standing. As of now, Nigeria has twelve RBDAs. Additionally, to provide more formal legal support, the RBDAs decree No. 25 of June 15, 1976, and the Niger Delta RBDAs decree No. 37 of August 3, 1976 were both established. Eleven RBDAs were established as a result of these decrees. The Niger RBDA was split into Upper and Lower Niger RBDAs in January 1994, bringing the total number of RBDAs to 12, as listed below:

The RBDAs are (i) Anambra-Imo RBDA, (ii) Benin Owena RBDA, (iii) Chad Basin Development Authority, (iv) Cross RBDA, (v) Hadejia Jama're RBDA, (vi) Lower Benue RBDA, (vii) Lower Niger RBDA, (viii) Niger Delta Basin Development Authority, (ix) Ogun-Osun RBDA, (x) Sokoto-Rima RBDA, (xi) Upper Benue RBDA, and (xii) Upper Niger RBDA. Therefore, the Benin-Owena RBDA is one of the River basins investigated in this study. The Benin-Owena River Basin Development Authority (BORBDA), assumed its present functions as an entity courtesy of Decree No. 87 of 28th September (1979). Functions: The functions of the BORBDA as spelt out by section 41(a)-(e) of the RBDAs Act; cap R9, LFN, 2004 are as follows: (i) to develop surface and subterranean water resources thoroughly for a variety of uses, with a focus on irrigation infrastructure, erosion control, and watershed management, as well as the prevention of floods; (ii) the creation, management, and transfer to farmers of all areas to be farmed under the irrigation plan and any other water resources required for the Authority's duties; (iii) to provide water from the Authority's finished storage projects to all users for a cost that will be decided by the Authority with the Minister's consent; (iv) construction and management of infrastructure, such as roads and bridges, connecting project locations, provided that such infrastructure is a

part of the list of authorized projects; and (v) to gather and compile sufficient amounts of water resources, water use, socioeconomic, and environmental data from the River Basin in order to develop and maintain an up-to-date comprehensive water resources master plan that identifies all water resources requirements in the Authority's area of operation, according to Federal Military Government (1976)[10].

1.2 Statement of Research Problem

Without the advantages of resource development and usage, a country with the economic potential and vast water resource potential like Nigeria cannot flourish according to Ojiako (2001)[11] and U. S. Water Resources Council Special Task Force (1977 & 1970a & b)[12-14].

To avoid a repetition in the next phase whenever it begins, the issues that plagued the River Basins Development Authority and climate change must be thoroughly reviewed and solutions must be implemented right now. The majority of issues are decision-making challenges for the decision maker in relation to: (i) climate change which had caused imbalance of ecosystems, affecting both nature and people such as rivers, lake, stream etc., (ii) climate change which had caused large areas of land to be flooded with associated losses of agricultural land or gullies and displacements of communities, (iii) changing climate on reservoirs which led to a range of evaporation imbalance and socio-economic impacts, (iv) climate change which had caused depletion in hydroelectric power generation, reservoir water for hydropower, water supply, drought impact etc., (v) non-continuity of previous awarded contract by the present management is a decision problem due to non application of logical models, (vi) the release of insufficient funds by the Federal Ministry of Water Resources to BORBDA is a decision problem, and (vii) the un-standardized method of funds allocation by the Federal Ministry of Water Resources to river basins is a decision problem due to lack of logical models.

1.3 Aim and Objectives of the Study

The study is aimed at designing and producing a Blueprint for sustainable projects: a climate policy using Bayesian and Markovian decision models at Benin Owena River Basin, Southern, Nigeria. The objectives of the study are: (i) to develop a model that tackles the climate change crisis in the Benin-Owena River basins, Nigeria using Markovian and Bayesian models, (ii) to assess the net benefits of projects in the Benin-Owena River basin, including: hydropower, water supply, irrigated agriculture, dredging, erosion management, flood control, and climate-related deforestation, (iii) to provide framework that covers the climate change-related issues of hydropower, water supply, irrigated

agriculture, dredging, erosion management, flood control, and deforestation, (iv) to develop blueprint / layout or master plan that will address the problems of climate change crises and management lapses, for optimal solution in Benin-Owena River basin, and (v) to use Markovian and Bayesian decision theories in analyzing and optimizing the economic benefits of the Benin-Owena River basin projects.

2 METHODS

The methodology involved: dynamic programming models, questionnaires were developed and distributed, and data were collected. The Bill of Engineering Measurement and Evaluation was developed. The experiments evaluated the performance of the Benin-Owena river basin as a technique of solving the problem of climate change crises (Prototype). This experiment was based on some behavior and actions of the Gardener / Farmer as the decision maker in terms of his application of Markovian and Bayesian Models in selecting the most suitable project among alternatives that would give highest yield or production according to Handy (2008)[15] and Hiller & Lieberman (1995)[16] respectively.

Thus, this action as the decision maker results in gains or losses depending on the state of the soil condition / nature or the system for the season / period. Therefore, it could be said that the method for productivity of the season is dependent on the soil condition: (very excellent, excellent, very good, good, very fair, fair, weak, very weak, poor, and very poor) as a scale of measurement. The state of the soil condition in a particular year helps the Gardener / Farmer in his action to apply or not to apply fertilizer in the next farming season.

Consequently, the above Gardener's / Farmer's example is an experimental model which was used to evaluate the performance of the prototype (River Basin Engineering Development Projects) in Planning and Management as a solution to the climate change crisis. The Farmer's / Gardener's example or the gardener's problem is a decision problem to either apply or not to apply fertilizer (to maintain or not to maintain) within the season. If the same conception of model is used to evaluate the performance of the maintenance of the River basin sustainable projects in Edo and Ondo southern, region of Nigeria, that had suffered absence of inherited management experience, shortage of administrative and technical man power, lack of basic plan technical data, organizational inadequacies, financial constraints, etc., which led to flooding of Edo and Undo, southern region, Nigeria, destruction of trees / forest, degradation of the environment, causing gullies all over the region.

From the foregoing, the application of the model

to fertilize or not to fertilize on the system / prototype means to maintain or to not maintain the system. Based on the literature reviewed, a nation with the economic and great water resources potentials as Nigeria cannot proffer solution to the climate change crisis without maintenance of sedimentation, (dredging) of the rivers / drainages, and the benefits of the full capacity utilization of the resources development.

Thus, maintenance of the river basins, will result in ecosystem balance generating an efficient economy with green energy project revolution like hydro / wind power generation, water supply, irrigated agriculture, tourism / recreation, drainages / dredging of rivers, flood / erosion control, plantation / forestry and reservoir / gullies prevention.

2.1 Finite-stage Method of the Markov Optimization Solutions for Maintenance Program of the Multi Projects of Benin-owena River Basin Scheme

(a) Let us evaluate a case of gross benefit in which the model of using the Gardener's problem of no fertilizer or maintenance application is (K=1) as in the computation of V.k1.

V^1_1=(0.10×1.9)+(0.10×2.8)+(0.11×0.9)+(0.10×0.9)+(0.10×2.8)+(0.10×09)+(0.05×3.8)+(0.11×0.9)+(0.10×0.9)+(0.07×2.8)=1.60B Irrigation

V^1_2=(0×2.5)+(0.13×3.8)+(0.10×1.3)+(0.11×1.3)+(0.10×3.8)+(0.10×1.3)+(0.11×5.0)+(0.10×1.3)+(0.13×1.3)+(0.12×3.8)=2.58B Water supply

V^1_3=(0×8.5)+(0×12.7)+(20×4.2)+(0.13×4.2)+(0.11×12.7)+(0.14×4.2)+(0.10×16.9)+(0.11×4.2) + (0.11×4.2)+(0.10×12.7)=7.26B Hydro-electric power generation

V^1_4=(0×191.7)+(0×28.8)+(0.95.8)+(0.25×9.6)+(0.17×28.8)+(0.13×9.6)+(0.12×38.3)+(0.11×9.6)+(0.11×9.6)+(0.11×28.8)=18.5B Flood control

V^1_5=(0×0.04)+(0×0.06)+(0×0.02)+(0×0.02)+(0.35×0.06)+(0.15×0.02)+(0.15×0.08)+(0.12×0.02)+(0.12×0.02)+(0.11×0.06)=0.047B Drainages

V^1_6=(0×13)+(0×19.4)+(0×6.5)+(0×6.5)+(0×19.4)+(0.40×6.5)+(0.10×25.9)+(0.10×6.5)+(0.15×6.5)+(25×19.4)=11.67B Navigation / water transportation

V^1_7=(0×2.4)+(0×3.5)+(0×1.2)+(0×1.2)+(0×3.5)+(0×1.2)+(0.40×4.2)+(0.23×1.2)+(0.13×1.2)+(0.24×3.5)=3.15B Recreation / tourism

V^1_8=(0×0.07)+(0×0.1)+(0×0.04)+(0×0.04)+(0×0.1)+(0×0.04)+(0×0.14)+(0.45×0.04)+(0.34×0.04)+(0.21×0.1)=0.24B Erosion control

V^1_9=(0×0.04)+(0×0.06)+(0×0.02)+(0.02)+(0×0.06)+(0×0.02)+(0×0.08)+(0×0.02)+(0.55×0.02)+(0.45×0.06)=0.04B Plantation / forestry

V^1_{10}=(0×9.3)+(0×14)=(0×4.7)+(0×4.7)+(0×14)+(0×4.7)+(0×18.7)+(0×4.7)+(0×4.7)+(1×14)=14.0B reservoir / gullies

Therefore, if the Benin Owena River Basin Engineering Development Project is very excellent, a single transition will yield 1.60B for that year; if it is excellent the yield will be 2.58B; if it is very good the yield is 7.26B; if it is good the yield is 18.4B; if it is very fair the yield is 0.05B; if it is fair the yield is 11.67B; if it is weak the yield is 3.15B; if it is very weak the yield is 0.24B; if it is poor the yield is 0.04B; and if it is very poor the yield is 14.00B. In this method of solving the Gardener's problem of without application of fertilizer, the decision problem is solved using the data summarized in the matrices given a horizon of 10 years only (N=10) because the model developed has ten minimum number of stationary policies.

(b) Let us similarly evaluate the case of net benefit in which the model uses the Gardener's problem of application of fertilizer / maintenance is (K=2) as computed below for V^K_i.

V^1_1=(0.12×1.7)+(0.10×2.5)+(0.11×0.8)+(0.10×0.8)(0.10×2.5)+(0.08×0.8)(0.11×3.4)+(0.13×0.8)+(0.09×0.8)+(0.06×2.5)=1.64B Irrigation

V^1_2=(0.10×2.3)+(0.15×3.4)+(0.10×1.2)+(9.11×1.2)+(0.07×3.4)+(0.08×1.2)+(0.13×4.5)+(0.11×1.2)+(0.08×1.2)+(0.07×3.4)=2.38B Water supply

V^1_3=(0.09×7.7)+(0.09×11.4)+(0.15×3.8)+(0.12×3.8)+(0.12×11.4)+(0.10×3.8+(0.12×13.2)+(0.12×3.8)+(0.05×3.8)+(0.04×11.4)=7.42B Hydroelectric power generation.

V^1_4=(0.10×17.3)+(0.11×25.9)+(0.10×8.6)+(0.06×8.6)+(0.10×25.9)+(0.08×8.6)+(0.09×34.5)+(0.20×8.6)+(0.10×8.6)+(0.06×25.9)=16.5B Flood control

V^1_5=(0.07×.03)+(0.06×05+(0.07×0.01)+(0.07×0.01)+(0.07×0.01)+(0.15×0.039)+(0.15×0.01)+(0.20×0.07)+(0.11×0.01)+(0.04×0.01)+(0.08×0.05)=0.03B Drainages / dredging of rivers

V^1_6=(0.08×11.7)+(0.08×17.5)+(0.10×5.9)+(0.10×5.9)+(0.10×17.5)+(0.11×5.9)+(0.25×23.3)+(0.06×5.9)+(0.06×5.9)+(0.05×17.5)=13.38BNavigation / water transportation

V^1_7=(0.10×2.2)+(0.07×3.2)+(0.06×1.1)+(0.07×1.1)+(0.15×3.2)+(0.15×1)+(0.10×4.2)+(0.10×1.1)+(0.10×1.1)+(0.10×3.2)=2.19B Recreation / tourism

V^1_8=(0.05×0.06)+(0.06×1.09)+(0.06×-0.03)+(0.07×-0.03)+(0.15×-0.09)+(0.10×-0.03)+(0.10×-0.12)+(0.25×-0.03)+(0.08×-0.03)+(0.09×-0.9)=-0.049B Erosion control

V^1_9=(0.06×-0.03)+(0.10×-0.05)+(0.08×-0.01)+(0.07×-0.01)+(0.10×-0.05)+(0.08×-0.01)+(0.15×-0.07)+(0.07×-0.01)+(0.06×-0.01)+(0.10×-0.05)=- 0.04B Plantation / forestry

V^1_{10} =(0.10×8.4)+(0.08×12.6)+(0.07×4.2)+(0.07×4.2)+(0.07×12.6)+(0×4.2)+(0.25×16.8)+(0.10×4.2)+(0.10×4.2)+(0.09×12.6)=9.79B Reservoir / gullies

Consequently, if the case of application of maintenance to the Benin Owena River basin Project is very excellent, a single transition yields 1.64B for that year; if it is excellent, the yield is 2.38B; if it is very good the yield is

7.42B; if it is good the yield is 16.4B; if it is very fair the yield is 0.032B; if it is fair the yield is 13.38B; if it is weak the yield is 2.19B; if it is very weak the yield is -0.049B; if it is poor the yield is -0.04B and if it is very poor the yield is 9.79B. In this method of solving the Gardener's problem of application of fertilize, the decision problem is solved using the data summarized in the matrices, given a horizon of 10 years only (*N*=10) because the model developed has also ten minimum number of stationary policies.

3 RESULTS AND DISCUSSION
3.1 Presentation of Results of the Markovian and Bayesian Models

This section presents the results of the Markovian and Bayesian models for comparison on Table 1 below.

3.1.1 Discussion and Interpretation of Results in Table 1

Discussion and interpretation of Table 1 which shows comparison of the performance results of the Markovian experimental model versus Bayesian expected monetary value as follows: (i) Markovian model makes a total profit returns on investment of ₦53B annually after ten years, minimum capacity utilization, and (ii) Reservoirs / gullies make the highest total profit returns on investment of ₦6.14B annually followed by, Flood control - ₦5.76B, Plantation / forestry ₦5.52B, Water supply - ₦5.50B, Hydropower - ₦5.48B, etc., since the Markovian decision model is based on logical allocation of water resources projects.

Bayesian optimization model on the other hand makes expected returns as follows: (i) Bayesian makes a total profit return on investment of ₦58.42B annually after ten years, minimum capacity utilization of assets, and (ii) Drainages / dredging of rivers make the highest total profit returns on investment of ₦9.43B annually followed by, Water supply - ₦7.83B, Reservoir / gullies ₦6.41B, Plantation / forestry - ₦5.52B, Navigation / water transportation - ₦5.52B, etc., since Bayesian decision model is based on project prioritization, which means the projects with the highest returns will raise the highest gross and net benefits, and consequently, Drainages, Water supply and Reservoirs / gullies projects are selected as the most important to be invested on, in a case of an insufficient available fund.

3.1.2 Discussion of the Sustainable Project Designed on the Above Figure 1 Blueprint / Layout Plan for Benin Owena River Basin as a Solution that Necessitated the Following Climate Change Policy

From the data, calculations, analysis and designs summarized in Figure 1 using the Markovian and Bayesian decision theories, the blueprint / layout plan for the Benin Owena River basin was produced in the quest to provide optimal solutions to climate change crisis as identified in each of the problems and objectives of the study in section 1.

Irrigated Agriculture: The benefits of irrigated agriculture are numerous in the region; however, the Owena river basin will help to improve economic sustainability through irrigated agricultural productivity (food supply), provides a balanced landscape and harnessed imbalance vegetation, feasible solution to eroded soil etc. Irrigated agriculture should be practice in the designated areas of Edo and Ondo states, as this will help to solve the problem of scarcity of food, youth employment, preservation of agricultural products and transportation to earn the region surplus foreign reserve from the sales of the produce. This process will help to remove pollution by the use of Wind turbines to irrigate the farms.

Hydro-electric power generation: The turbine in complete revolution through water, as a clean source of energy has no form of pollution to the air like power plants that burn fossil fuel. Hydroelectric power is a domestic source of energy allowing each state of Edo and Ondo to produce their own energy without being dependent on fuel as practiced before in all the areas of the states. With power (electricity) generated, this will eliminate the use of fossil fuel that pollute the air, provide employments for the youth, increase foreign reserve and reduce the import of fuel, reduce insecurity, mass movement to urban areas and this will help to reverse the climate change in the region.

Navigation / Transportation: When the rivers (water bodies) are properly dredged, it will help to provide a good source of transportation and economic strength as sea ports will be built for goods and services from foreign countries which can be shipped through this ports, this will help to solve unemployment, create jobs for both gender (male and female) for the areas such as the Owena, Igbekebo, Abudu, Igbokoda and Ode-Irele could be useful to the region when the water bodies are properly dredged.

Plantation and Forestry: Through photosynthesis the trees and plants in the forest provide most of the oxygen that humans and animals breathe. Forests also absorb and reduce carbon dioxide, greenhouse gas and are a major contributor to climate change. Plantation / forestry such as palm, plantains, banana, mango, orange and coconut etc., are to be in areas such as Iguobazuwa, Igbokoda, Sabongida-Ora, Owo, Ifon and Afuze to revamp this region. This will help to restore our climate, provide jobs and security through employment.

Recreation / Tourism: Areas such as Abudu, Inugbo, Oredo, Ore and Iguobazuwa could be used as a good

Table 1. Comparison of Results of the Markovian Performance on Experimental Models Versus Bayesian Expected Monetary Value

S/N	Markovian Decision Model	Bayesian Decision Model
1	F1 ₦5.31B, if the state of the project in year 1 is very excellent	₦5.27B Irrigation
2	F2 ₦5.50B, if the state of the project in year 2 is excellent	₦7.83B Water supply
3	F3 ₦5.48B, if the state of the project in year 3 is very good	₦2.73B Hydropower
4	F4 ₦5.76B, if the state of the project in year 4 is good	₦2.55B Flood control
5	F5 ₦4.42B, if the state of the project in year 5 is very fair	₦9.43B Drainages / dredg
6	F6 ₦5.33B, if the state of the project in year 6 is fair	₦5.33B Navigation
7	F7 ₦4.69B, if the state of the project in year 7 is weak	₦4.69B Recreation / tourism
8	F8 ₦4.85B, if the state of the project in year 8 is very weak	₦4.85 B Erosion control
9	F9 ₦5.52B. if the state of the project in year 9 is poor	₦5.52BPlantation / forestry
10	F10 ₦6.14B if the state of the project in year 10 is very poor	₦6.14B Reservoir / gullies
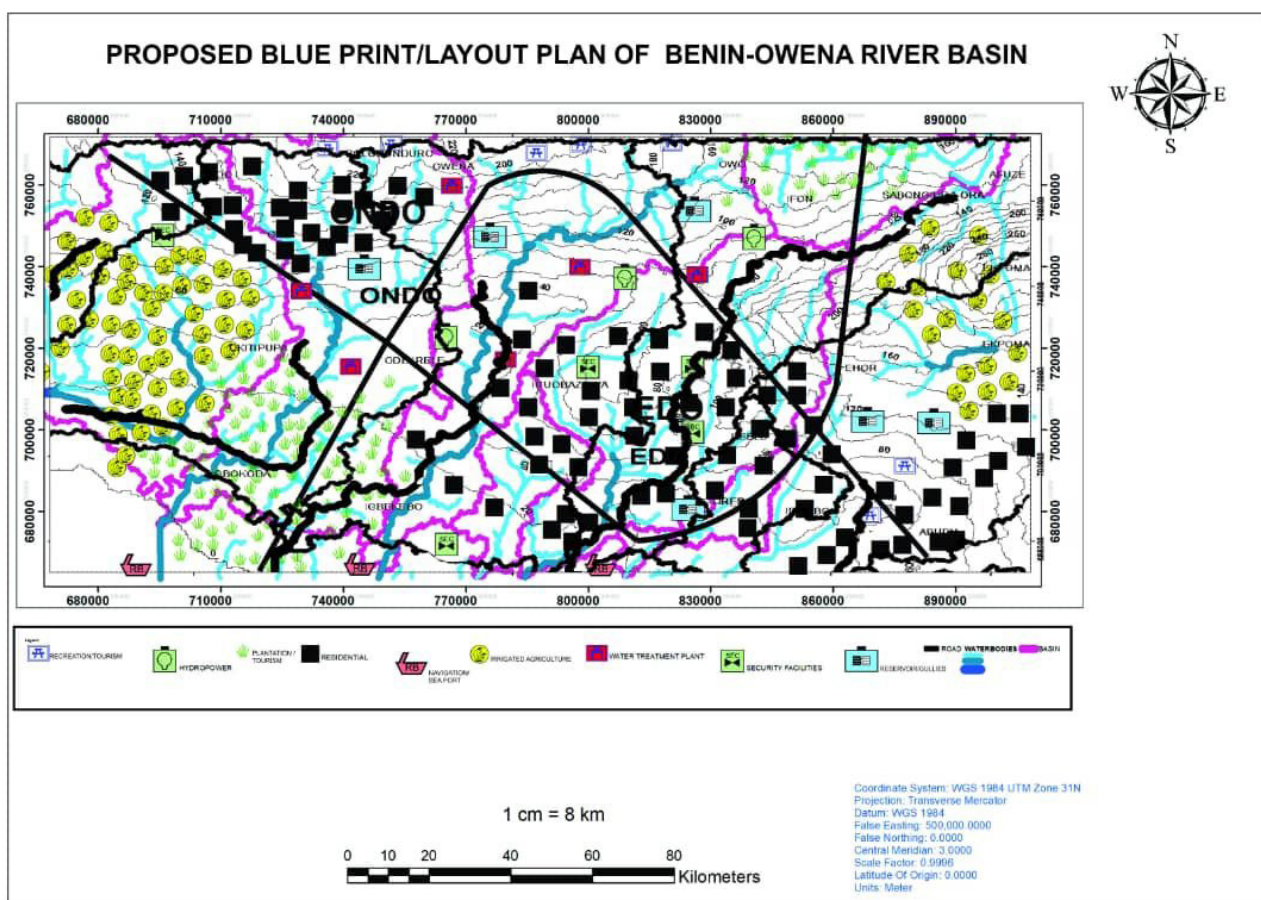
Figure 1. Proposed blueprint / layout plan for the benin owena river basin, Southern Region, Nigeria.

recreation / tourism center, this will help to generate revenue for the region and reduce unemployment and End SARS protest alike.

Reservoirs / Gullies: Areas where there are gullies such as Auchi, Ehor, and Ondo could be converted to reservoirs, good structural works could be done and the water in forms of floods / erosion is stored and the water is further treated for use for irrigation or water supply. This will help to maintain the climate.

Flood control: When proper drainages are constructed in areas such as Irrua, Ifon and Auchi, and the water bodies properly dredge, this will help to transport and accommodate the excess water from rainfall thereby preserving our arable lands and properties and in turn maintain the climate.

Gender equality: With all these investments, women and children will be happy, there is irrigated agriculture for food, hydro power is generated, gullies are converted to

reservoirs, floods are controlled properly, and all these will bring a balance to the ecosystem, thereby maintaining the climate.

Erosion control: When gullies are converted to reservoirs, the rivers are properly dredged and plantation / forestry established, erosion problems will be solved thereby maintaining the climate.

Security: When the citizens are gainfully employed, with food security, and financial security from the producers of agricultural food / cash crops and flood / erosion shortages of water supply is taken care of, there will be security of lives and property. Youth restiveness will be a thing of the past. All these will lead to sustaining and maintaining the climate. No more use of fossil fuel since there are Hydropower and Wind turbines for power generation in the region.

4 CONCLUSION

The work concludes that: (i) The optimal solutions in Markovian decision theory, show that from year 2015 to 2025, the Benin Owena River basin in Edo and Ondo states of Nigeria will not require maintenance (k*=1), and (ii) The total expected annually revenue or return for ten years, minimum capacity utilization of the basin's assets are: F1 (1) = N5.31B, if the state of the project in year 1 is very excellent, F1 (2) = N5.50B, if the state of the project in year 2 is excellent, F1 (3) = N5.48B, if the state of the project in year 3 is very good, F1 (4) = N5.76B, if the state of the project in year 4 is good, F1 (5) = N4.42B, if the state of the project in year 5 is very fair, F1 (6) = N5.33B, if the state of the project in year 6 is fair, F1 (7) = N4.68B, if the state of the project in year 7 is weak, F1 (8) = N4.85B, if the state of the project in year 8 is very weak, F1 (9) = N5.52B, if the state of the project in year 9 is poor, F1 (10) = N6.14B, if the state of the project in year 10 is very poor.

When compared to the Bayesian decision model, the results showed that, from year 2015 to 2025, the Benin Owena River basin in Edo and Ondo states of Nigeria would not require maintenance and will yield expected monetary values (EMV) as follows: (i) Irrigation gives (EMV*) = ₦5.27B, (ii) Water supply gives (EMV) = ₦7.83B, (iii) Hydropower gives (EMV) = ₦2.73B, (iv) Flood control gives (EMV) = ₦2.55B, (v) Drainages gives (EMV) = ₦9.43B, (vi) Navigation gives (EMV) = ₦5.33B, (vii) Recreation / tourism gives (EMV) = ₦4.69B, (viii) Erosion control gives (EMV) = ₦4.85B, (ix) Plantation / Forestry gives (EMV) = ₦5.52B, (x) Reservoirs / gullies give (EMV) = ₦6.41B.

Consequently, the Expected Value of Perfect Information = ₦3.64B and Expected Profit in Perfect Information = ₦17.66B. A total expected revenue of N53B naira is generated from the river basins as a yearly return. From the investigation, for five years the federal government had

released to the Benin-Owena basin, southern, Nigeria the sum of N5.54B naira and if it is deducted from the N53 generated by the Basin, then the federal government will make a profit margin of N47.46B naira from the investment using simulation of models in Markovian decision theory. Similarly, if the sum of N5.54B naira is deducted from the N58.2 generated by the Basin, then the federal government will make a profit margin of N52.7B naira from the investment using simulation modeling in Bayesian decision theory.

It is therefore clear that simulation modeling in Markovian and Bayesian decision theories in assessing the real-life performance of a system can be effectively applied in: optimum policy decision making, maintenance programming, allocation, conjunctively managed competitive Benin-Owena Basin, sharing of new expansion fund and logical cost sharing in multi-purpose / multi-objective River basin Engineering development.

The experimental tests for hypothesis confirm that performance of the Benin-Owena basin in Edo and Ondo, states, southern, Nigeria, was really higher than the theoretical expected results with high component interaction when additional instrument was used as regression equation - Pearson product moment correlation coefficient, (r) gives r=1.0, which means that the system or basin's assets performed at 100%.

Therefore, with the blueprint / layout plan, the Authority will not only be released from bankruptcy, but will give more employment twice their present staff strength and also pay their Creditors and Contractors with enough foreign reserves. This research work, has provided solutions to the problems and consideration of multi-objectivity involved such as: economic efficiency, federal, regional, state, local economic redistribution, social well-being of the people, youth employment, environmental quality improvement, gender equality and security, under worst possible conditions involved in the following developments: Irrigation, Water Supply, Hydropower, Flood Control, Drainages / Dredging of rivers, Navigation / Transportation, Recreation / Tourism, Erosion Control, Plantation / Forestry and Reservoirs / Gullies. The problems of imbalanced water cycle and ecosystem have been solved with the proposed blueprint / layout plan which improves the environment with new sources of green energy technologies and the restoration of climate change.

4.1 Recommendation

Therefore, to ensure that, Federal Government of Nigeria realized her vision 2050, the work recommended that: (i) Government at all level, should adopt the full implementation of this research work with Markovian and Bayesian optimization models, since it is capable of reversing and solving the crisis and danger created by

climate change, and to stop further occurrence of climate crises, (ii) There should be River Basin Regulatory Council for the implementation of Markovian and Bayessian decision models for the regulations of climate change as it affects Nigeria, (iii) All sectors, agencies and departments should as matter of urgency move into practicing green revolution with the Blueprint, (iv) Sufficient fund should be released to river basins development authorities to enable them perform their functions effectively, and (v) un-standardized methods of fund release to RBDAs should be abolished, since it creates a decision problem in terms of mismanagement of the assets.

4.2 Contribution to Knowledge

The contribution to knowledge is such that: (i) the computational difficulty especially in dynamic programming refers to as the "Curse of dimensionality" is solved through the today's inventory model of Simulation modeling in Markov chains and Bayessian decisions, (ii) the dynamic programming Model is superior and gives possibilities to different policies / strategies for components that have multiple failure modes and redundancy, (iii) the ecosystem, the water cycle imbalance and other irregularities are solved with the proposed blueprint / layout plan which uses green energy for solution to climate change and (iv) the functions and skills of the dynamic programming model, supplied an effective engine for realistically simulating the hazard and reliability of complicated engineered system just like the River basin assets.

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Conflicts of Interest
The authors declared no conflict of interest.

Author Contribution
Both authors wrote, designed and organized the manuscript. Both of them contributed to the manuscript and approved the final version.

Abbreviation List
BORBDA, Benin-Owena River Basin Development Authority
EMV, Expected monetary values
RBDAs, River Basin Development Authorities

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