ISSN 2348-3156 (Print)
International Journal of Social Science and Humanities Research ISSN 2348-3164 (online)
Vol. 4, Issue 2, pp: (182-188), Month: April - June 2016, Available at: www.researchpublish.com

Geo-Spatial Assessment of Environmental and Socio-Economic Impacts of Owena Dam on the Downstream Settlement of Owena, Ondo State, Nigeria

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***Abstract*: Water been an essential commodity has been described as the source of life on planet earth. The body of man is said to be 70% of water and as such he begins to feel thirsty after a loss of only 1%. Similarly, the major component of plant protoplasm is water. In the concept of dam building, there are many purposes for which dams are required. It could be built for navigational purposes, domestic purpose, and it even goes as far as been built for the generation of electricity. Dam construction usually involves one form of risk or the other of which the people that would be most affected are not told fully of the consequences that comes up after the construction of the dam. This study carried out an analysis of the Environmental and Socio-economic impacts of the Owena Dam on the downstream Settlement of River Owena. It shows that majority of the settlement suffered a great deal as a result of the construction of the dam. From the loss of their homes to erosion on their farmland due to the fluctuations of the river level, flooding, channel degradation and to mention but a few. The work however recommends ways by which these problems could be mitigated and how the Government can render help as regards these impacts.**

***Keywords:* Environmental and Socio-economic impacts, Geo-Spatial.**

I. INTRODUCTION

Right from the advent of human civilization, water spawned life on the earth and has since sustained it. It possesses the powers of life and death controlling the fate of everything from micro-organisms to man. Water, which covers about 70% of the earth surface, fills the ocean, lakes, rivers, and also the ground and air that we breathe in. It is the most important substance on earth and it contributes to the economic and social development of a society in several ways. It is one of the most abundant natural resource of the world. Compared to other liquids, water plays a universal role in all spheres of life ranging from physiological needs to plants and animals in space. It is a basic need on which the existence of all living things has been tied from time immemorial. The importance of water cannot be overlooked because it is responsible for the biochemical functioning of all living organisms. A person uses about 1.5litres of water per day, it serves as a habitat for aquatic animals about 8,500 species of fishes and is a breeding ground or temporary habitat for reptiles and amphibians about 4,200 species Oparin, (1923) in Faniran and Ojo, (1980). Water can neither be created nor destroyed but can be moved from one place to another changing forms either from liquid to gas to solid. Its transparency to sunlight allows it to house photosynthetic and minute organisms below its surface. Everything originates from water and is sustained by it Avril, (1967) in Chapman (1976).

Botkin and Keller, (1995) gave the statistical percentage of the earth's water in the oceans as 97%, 2% in glaciers and icecaps thereby making it 99%. It should be noted here that both sources are generally unsuitable for human consumption due to their high level of salinity. Thus all living things compete for less than 1% of the remaining earth's water. It is also

fascinating that 0.001% of the total water on the earth is located in the atmosphere at any particular point in time. This relatively small amount of water in the global water cycle with an average atmospheric residence time of only 9days produces all our fresh water resources through the process of precipitation. The development of reservoirs or dams has greatly increased over the years both in the developed and developing countries Thorn, (1980).

A dam is a structure that blocks the flow of a river, stream, or other waterway. Some divert the flow of river water into a pipeline, canal, or channel. Others raise the level of inland waterways to make them navigable by ships and barges. In ancient times, the construction of dams was as a result of drought and flood occurrences and also for the same reason in the modern times, in bid to preserve water during the rainy season and release it for use during the dry season. This occurrence can be traced to Egypt and Mesopotamia in the early 18th and 19th centuries. The generation of power particularly during the industrial revolution encouraged the construction of large dams in the industrialized countries Thorn, (1980).

The oldest known man-made dams were built more than 5,000 years ago in arid parts of the Middle East to divert river water to irrigate crops. Today there are more than 500,000 dams worldwide. The vast majority of these are small structures less than 3m (10ft) tall. Engineers regard dams that measure more than 15m (50ft) high as large dams. About 40,000 large dams exist in the world today. People build dams to divert water out of rivers for use in other locations or to capture water and store it for later use. The volume of water flowing in any given river varies seasonally. In the spring and early summer, rivers typically swell with water from rainstorms and mountain snowmelt. In the drier months of late summer and autumn, many rivers slow to a trickle. Storage dams impound seasonal flood water so it can be used during periods of little or no rainfall. The water that backs up against a storage dam forms an artificial lake, called a reservoir. Release of water from the reservoir can be controlled through systems of pipes or gates called outlet work

In recent times, there has been increasing recognition by both dam opponent and proponents that the impacts of dams are complex and can be far fetching. Impacts can be positive for example, improved welfare resulting from new access to irrigation water or negative for example, resettlement, decline of downstream fishing due to flood control. Downstream impacts have been the issues of debate about dams because it is unrecognized, misunderstood and often times misinterpreted by planners. One major reason for this is the fact that they occur in remote areas, far from the dam sites, and are all too easily ignored. These impacts involve a change in a dynamic element of the environment rather than a gross change. Significant impacts are often remote geographically from the dam, beyond the boundary of planning, and are therefore unperceived by project developers. The spatial and temporal boundaries within which environmental impacts are assessed can have significant environmental impacts on the outcome of an assessment. Its major aim is to ensure that potential risks are foreseen and necessary measures to avoid, mitigate or compensate for environmental damages are estimated and taken care of. Generally, the construction of dams represents one of the most significant human intervention on the hydrological cycle, although it has some positive impacts, the negative impacts of damming is felt mostly at the downstream of the river.

AIM:

The study aimed at assessing the environmental and socio-economic impacts of Owena dam on the downstream settlement of Owena community, Ifedore Local Government area of Ondo state of Nigeria.

OBJECTIVES OF THE STUDY:

The following are the set objectives;

i. Assess the spatial reorganization and socio-economic impacts of the dam on the Owena community.

ii. Examine the impact of the construction of dam on employment characteristics, occupational changes, income level, and way of life and culture of the downstream settlements.

iii. Proffer solutions to the problems identified

STATEMENT OF HYPOTHESIS:

Ho= There is no significant relationship between farm yield and means of increase in farmland.

H1= There is a significant relationship between farm yield and means of increase in farmland.

II. RELEVANT LITRATURE

The nature of hydrological effects of dams varies with its purpose and the season regime of the river. Dams come in many different sizes and shapes. A criteria distinction between the types of dams reflects their purpose. Dams for flood control exacerbate peak flow moderation effects, particularly in such seasonal torrential rivers. Hydroelectric dams are designed to create a constant flow through turbines and therefore tend to have a similar effect on discharge patterns. However, if the intention is to provide power at peak periods, variations in discharge of considerable magnitude can occur over short time scales, creating artificial flood downstream. Dams for irrigation cause moderate variations in flow regime on a longer time scale, storing water at seasons of high flow for use at times of low flow. Discharge beyond storage capacity is usually spilled, allowing some floods to pass downstream, albeit in a routed and alternated form. Dams are usually built to have multi-purpose functions in which case their impacts will be a combination of the forms. Oxford Advanced Learners Dictionary, (1995) defines the environment as the "natural condition of land, air and water in which plants and animals live" Diverse plant and animal species in different ecosystems interact with each other in ways that they benefit and provide for the support of themselves in a process called symbiosis or commensalisms.

A project such as damming of a river has significant impacts on the environment and man himself. This impact may include sedimentation, erosion, pollution, flooding due to spillage of the dam, prevalence of water related diseases and to mention but a few. Dam building involves the construction of artificial barriers across a flowing river channel to create an artificial blockage in other to retain a large volume of water upstream for usage. It is an activity that affects channel morphology, channel flow, causing erosion and expositional characteristics affecting both the spatial and temporal distribution of water and sediments in a river system. Thus Strahler and Strahler (1970), noted that a river system interrupted by a dam is an example of an energy system in which man alters an existing pathway and varies output. He noted further that dam construction interrupts stream flow and reduces water output. Morisawa, (1972) observed also that river systems are changed directly when dams are built blocking their channel during the hydrological regime by regulating the flow, decreasing peak and low flow. This in turn modifies the sediment transport capacity, indirect erosion and deposition and affecting the environment. After maturation, dams can like natural lakes act as nutrient sinks. For example in comparison to the inflow, mean concentration of orthophosphate in the inflows from the Callahan Reservoirs, Missouri USA, were reduced by 50% Schreiber and Rausch, (1979). Chapman, (1976) also stated that the eutrophication of a dam may occur as a consequence of large influxes of organic material and nutrients, often arising from a result of anthropogenic activity in the catchments. Zakova et al, (1993) argued that the quality of water released from a stratified reservoir is determined by the elevation of the outflow structure relative to the different layers within the reservoir. In contrast water released from the bottom is usually cold, oxygen-depleted nutrient-rich that may be high in oxygen-sulphide, iron and manganese.

Bacterial decompositions of materials in reservoirs can transform inorganic mercury into methyl-mercury, a toxin that attacks central nervous system. In fishes, it brings about the bioaccumulation of salt of methyl mercury in their tissues especially those at the top of the food chain, several times higher in concentration compared to the small organisms at the bottom of the food chain, Bodaly et al, (1984). This can have serious effect on the people who depend on the fishes from such a dam as part of their diets. For example, mercury levels in the hair samples of Cree Indians, in the James Bay region of Quebec in Canada, were found to be above the World Health Organization recommended upper limit, (that is 6ppm by weight) as a result of eating fishes from reservoirs Dumont, (1995). Building a dam changes the ecology of the surrounding area and among the most affected animals are fish that depend on free-flowing water to live. Some kinds of salmon, trout and other fish species migrate downstream to spend part of their lives in the open ocean. As adults, they return upstream to lay their eggs in the gravel bottoms of the rivers where they were born. Large dams block the passage of such migratory fish. Water released from behind dams usually comes from close to the bottom of the reservoirs, where little sunlight penetrates. This frigid water significantly lowers the temperatures of sun-warmed shallows downstream, rendering them unfit for certain kinds of fish and other wild life. Natural rivers surge and meander, creating small pools and sandbars that provide a place for young fish, insects, and other river-dwelling organisms to flourish. But dams alter the river flow, eliminating these microhabitats and, in some cases, their inhabitants. It prevents nutrient-laden silt from flowing moving river carries tiny particles of soil and organic material.

The socio-economic impacts of dam construction cannot be over looked. This includes the settlement of farmers and villagers thereby creating a new life style to the people in the local community. The downstream impacts are very significant. Adrian Adam (1999) reports that in 1989, the opening of a dam in Senegal inflicted heavy losses on the

farmers in the lower Senegal valley through the double-peaked flood, the first opening did not have much effects because of the unregulated tributaries of the river but the second flood discharge drowned seedlings in low lying areas and most of the farmers for want of seedlings and labor could not afford a second sowing. Dams have been acknowledged for providing electricity and also for the provision of water for various human usages. Within recent decades, the effects and importance of dams has been debated by various scholars. Dams, while performing important functions has its side-effects, McCartney, (1979) in Thorn, (1980). He further classified it by the type of material used in their construction and by their shape. Dams can be constructed from concrete, stone masonry, loose rock, earth, wood, metal, or a combination of these materials. Engineers build dams of different types, depending on the conditions of the riverbed, the geology of the surrounding terrain, the availability of construction materials, and the availability of workers.

III. STUDY AREA

The study area is located in Ifedore Local Government in Ondo State. It lies between longitude 5 01' and 5 45'E and Latitude 7 17' and 8 15'N. Owena town found in Ondo State South-Western part of Nigeria falls within the sub-equatorial region which is characterized by a monsoon climate. The temperature is relatively high throughout the year with an annual daily range of 27 Celsius, with a marked seasonal change in rainfall and relative humidity. Owena like every other tropical area of Nigeria has an abundant annual rainfall of over 1500metrs. It is bounded in the Northern hemisphere by Igbara-Oke, in the south by Eyin –Owena, in the west by Ile-Oluji. The Owena Multipurpose dam is designed to provide portable water to the major towns in Ondo State, including Akure, Ile-Oluji, Idanre, Ondo, Owena, Ita-Ogbolu, and Iju. In addition, the dam provides water for the irrigation of over 5000 hectares of farmland. It has a storage capacity of 135-5 million cubic meters at the top water levels, 310 ordinance datum and 1670meter and distributes about 60,000cm of water daily.

IV. METHODS OF DATA COLLECTION AND ANALYSIS

Data is the fact received about an object which can become useful information if processed. The data used for this research work is of two types which are primary and secondary data. The primary data were collected through these means; reconnaissance survey and administration of questionnaire. The reconnaissance survey was carried out to determine the location of the dam, the vegetation surrounding it, its topography, drainage pattern, geology, relief and climate of the study area. The other source of data which was the secondary source was used to complement the primary one collected. This source includes data gotten from textbooks, magazines, newspapers, internet, government documents and other related publications. The administration of questionnaire alongside the personal interview was used to collect information from the community on the socio-economic impact of the Owena dam in their environment. A total of 120 questionnaires were distributed to four chosen settlements along the downstream and were completed and returned with a response rate of 100%. The settlement includes; Igbelese, Cyril, Esibiri and Shokoto. Descriptive statistics such as tabulation and simple percentage was used in the arrangement of the data and also chi-square, a parametric test was used to test scientifically the earlier stated hypothesis.

V. ANALYSIS AND DISCUSSION

Table 1.0 below represent Socio-cultural and Socio-economic characteristics of respondents and it shows that total numbers of singles were 21.6%, the percentage of the married was 64.2% while that of the divorced was 14.2% of respondents in the study area. Also, that 57.5% of the total respondents were male while 42.5% of them were female. The ratio of male respondents to that of the female respondent is higher. The tables also shows the ages of respondents as 30% of them are within the ages of 20-35 years, 48.4% falls between the ages of 36-50years and 21.6% falls within the ages of 50 years and above. Noticeably however, is that the number of people that fell within the independent age is greater than that of those that are within the range of dependent age, therefore the economy is a thriving one. From the table, 42.5% of the respondents were farmers, 40.8% of them were fishermen, and 10.8% were traders while the remaining 5.8% were civil servants. Deductively, majority of the settlers in the study area are involved in agricultural activities. The table depicts, 26% of the respondents earned 5000- 10,000 monthly, 38% of them earned between 10,000- 20,000, 20% of them earned between 20,000-30,000 and those who earned 30,000 and above were 16% which means income was low.

Also, table 2.0 represent Environmental Impact of Dam construction in the area and it shows response to flooding within the study area. 65% of the respondent said their area is prone to flooding while 35% said their area wasn't liable to flooding. This shows that a large percentage of land within the study area is subjected to flooding as a result of overflow

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of water from the reservoir and the river bank due to the construction of the dam. 82.5% of the respondents said their farmland was liable to erosion and 17.5% said their farm is not liable to erosion after the construction of the dam. 16.7% of the respondents did not experience high erosion while 33% of them experienced high erosion. However, as high as 50% of the respondents experienced very high erosion in the study area. 33.3% said the dam has positive impacts, 63.4% said the impact was negative while 3.3% said there were no effects. 37.6% of the respondent said that the construction of the dam help increase their farm productivity, 39.1% agreed that since the construction of the dam their produce was fairly high while 23.3% of them said the rate of farm yield increase was relatively high. 77.5% of the respondent (fishermen) were affected, 19.1% were not affected. This implies that more than half of the respondent whose occupation is fishing was affected. 29.2% said it helped in the increase of their income while 70.8% said it contributed negatively to their income. This means that since the construction of the dam, the quantity of their usually catch had reduced drastically. 45.8% said it added slightly to their income, 37.5% said the increase was much while 16.7% said the increase was very much. 20.8% of them are not connected. Majority of the respondent are connected to the main source of water supply. 66.7% said the quality was good while the remaining 33.3% said the quality is not good.

Table 1: Socio-cultural and Socio-economic characteristics

Variables	Options	Frequency	Percentage
Marital Status	Single	26	21.6
	Married	77	64.2
	Separated	17	14.2
Gender	Male	69	57.5
	Female	51	42.5
Age group (Years)	25 – 35	36	30.0
	36 – 50	58	48.4
	Above 50	26	21.6
Occupation	Civil Servant	7	5.8
	Farming	51	42.5
	Fishing	49	40.8
	Trading	13	10.8
Income Level (#)	5,000 – 10,000	30	26.0
	10,001 – 20,000	46	38.3
	20,001 – 30,000	26	20.0
	Above 30,000	20	16.6
Total in each Variables		**120**	**100**

Source: Field work 2015

Table 2: Environmental Impact of Dam Construction in the area

Variables	Options	Frequency	Percentage
Areas Liable To Flooding	Yes	78	65
	No	42	35
Farmland Liable To Erosion	Yes	99	82.5
	No	21	17.5
Gravity/Intensity Of Erosion	High	40	33.3
	Not high	20	16.7
	Very high	60	50.0
Impacts of The Dam on Farmland	Positive	40	33.3
	Negative	76	63.4
	No effect	4	3.3
Increases in Farm Yield	A little high	45	37.6
	Fairly high	47	39.1
	Very high	28	23.3
Impact of The Dam on Fishing	Yes	93	77.5
	No	27	19.1
Impact of Dam on The Environment	Positive	35	29.2
	Negative	85	70.8
Extent to Which it Added to their Income	Slightly	55	45.8
	Much	45	37.5

	Very Much	20	16.7
Connection of Settlement to Water Supply	Yes No	95 25	79.2 20.8
Quality of Water Supply	Yes No	80 40	66.7 33.3
Total in each Variables		**120**	**100**

Source: Field work 2015

VI. RESULT FROM TEST HYPOTHESIS

At 0.05 level of significance, the tabulated value is 7.815. Since the calculated is value of 5.777 is less than the tabulated value, H_o therefore is rejected while H_1 is accepted. The implication of which is, there is a significant relationship between the farm yield and means of increase in the farm land.

VII. RECOMMENDATIONS

Based on the fore-going findings, it is necessary that dam construction activities should be comprehensively evaluated in terms of environmental and socio-economic impacts before it is been implemented. At the downstream, there is a need for detailed hydrological study to enable a correct and precise analysis on the prediction of spatial and temporal changes in the flood pattern and also monitor the release of water from the reservoir into the main stream as this affects the temperature of the river which would in turn have an adverse effect on organisms living in it. Other problems that needs to be looked into are the technical defects that may arise at the dam, ranging from the shortage of spillway flood capacity to decrease of effective storage due to the excessive sediment inflow, extraordinary vegetation growth and severe erosion, extensive aquatic weed development over the reservoir area and to mention but a few, when nothing is done to these problems, they may constitute a significant potential hazard to the downstream settlement. The Government on the other hand should assist in the area of financial support to promote the inclusion of environmental protection measures in dam projects. Loans should be given to project developers and engineers so that they can include measure to protect the environment and also develop standards and guidelines in planning and implementation of dams. The measures should include approaches that would include the preservation and conservation of ecologically important area and rehabilitation of previously disturbed ones either around the reservoir or some distances away. The environmental protection measure should be identified through an Impact Assessment so that the adverse effect are minimized from the outset of the project and for already existing dams (Owena dam), attempts to restore or replace already disturbed ones should be made so as to control the loss of bio- diversity. Finally as often said that planning is a pre-requisite for sustainable development and is futuristic in nature, it is therefore essential to conduct an Impact Assessment on the environmental, social and economic modification that a dam can have on an area before its execution and this requires an interdisciplinary thinking and a basic understanding of the complex interactions between the ecological and socio-economic systems because lack of hydro-ecological understanding remains a key constraint to a successful environmental protection.

VIII. CONCLUSIONS

This research has looked into the socio-economic and environmental impact of the Owena dam on the downstream settlements, examining both the positive and negative impacts. It has looked at the impact of the dam on the river system itself and how it has affected the lives of the communities at the downstream. The study shows that the communities at the downstream experiences post dam problems like flooding, erosion, sedimentation due to the fluctuations in the river level, resettlement and displacement from their homes and this plays a major role in the modification of their fishing and farming activities and their lives.

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