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Environmental impact assessment for small-scale irrigation schemes in Kaduna State, Nigeria

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ABSTRACT

This study was carried out to examine the Environmental Impact Assessment (EIA) of two small-scale irrigation schemes in the Northern Zone of Kaduna State of Nigeria, by a team of experts composed of National Open University of Nigeria, staff and government experts, together with target communities. The irrigation schemes are proposed to serve 130 households for Wuciciri and 94 households for Barakallahu village in the command area of 60 and 21.2 hectares of land respectively.. The methods used during field data collection consisted of site observation and measurement, household interviewing and focus group discussions. By the assessment, the identified major impacts of irrigation development on the environmental aspects are verified for their significance by statistical methods. The result of the assessment shows that groundwater quality, soil salinity problems, soil stability, water use conflict, aquatic habitats, and biodiversity of the aquatic ecosystem and vegetation covers have a significant negative environmental impact, while efficient utilization of domestic labour, creation of income opportunities, promotion of women economic empowerment, ensuring household food security and improving nutrition are the major positive impacts of irrigation development in study areas. There was no non-reversible impact identified and all negative impacts can be mitigated by proper irrigation water and environmental management activities when it was subject to The Environmental Impact Matrix analysis. The study recommends mitigation measures for every identified significant environmental impact to happen and indicates the monitoring and mentoring of every stage of the project activities.

1.0. Introduction

Environmental Impact Assessment is an instrument to forecast and consider both positive and negative environmental and social consequences of a proposed development project. It is a tool by which possible benefits of a project is analyzed and considered by full involvement of all project stakeholders. EIA provides a unique opportunity to demonstrate ways in which the environment will be improved as part of the development process. It also predicts the conflicts and constraints between the proposed projects and its environment. It provides an opportunity for mitigation measures to be incorporated to minimize problems. It enables monitoring methods to be established to assess future impacts and provide data on which managers can take informed decisions to avoid environmental damage (FAO, 1995).

According to the Federal Republic of Nigeria, Environmental Protection Authority (2000); irrigation projects has been screened for its impacts on downstream users, soil chemical properties, water quality, change in river morphology, sedimentation, social conflict, vegetation cover and human health.

According to Environmental Proclamation Number, (181/2011); "Environmental Impact assessment is to be a process which indicates the impact assessment starting from the plan up to completion during the preparation of development proposals, selecting places, operating, revising and terminating.

Environment Impact Assessment (EIA) has been adopted worldwide in different jurisdictions and everywhere it is expected to have an impact on planning and decision making (Christensen and Kørnøv, 2011; Jay et al., 2007). After decades of development and debate, the gap between high expectations and poor practical performance is still signifi-

cant (Nykvist and Nilsson, 2009).

EIA is sometimes perceived as a bureaucratic add-on, and functions as one of the many unavoidable barriers for a project to be approved (Cashmore, 2004; Pischke and Cashmore, 2006). The positive values that EIA brings to the decision-making process are not well recognized, accepted or even agreed upon. One reason behind this is that numerous factors influence how EIA achieves its objective of making an impact on decision-making. Many influences can be identified, including the practitioners and their interpretations based on the ambiguous wording of guidelines and regulations, the political will and the willingness of the public to influence the agenda (Christensen and Kørnøv, 2011; Lyhne, 2011), as well as street level bureaucrats innovating in delivering the policy to target groups. The challenge of how to make sure EIA has an effect on decision-making has now been on the research agenda for decades. An extensive literature has developed covering different aspects of how EIA is implemented. In contrast with Strategic Environment Assessment (SEA) (Zhang et al., 2013), limited attention has been given to a systematic and comprehensive analysis of EIA critical factors. The factors mentioned in the literature are far from systematically grouped, which leaves their search fragmented and vaguely comprehended especially when it comes to understanding the causation between these factors and their impact on the EIA implementation process (Cashmore et al., 2008).

A study carried out by the Environmental Protection Agencies showed that there were significant changes to projects during the EIA process, marked improvements in environmental protection measures and net financial benefits, (Wathern, 1988).

Environmental assessment is appropriate for both site-specific projects and wider programs or plans covering projects activities over a wide geographic area (Tiffen, 1989).

This explains why many irrigation projects are constructed at excessive costs and remained with social conflicts by compromising minimum permissible water flow in the natural waterways, Debebe. (2010).

Results are also easily understood and interpreted in the light of prevailing policies. According FAO, (2000/53); Policies and regulations are sometimes conflicting and may contribute to degradation. Assessments could be within the scope of EIA to highlight such conflicts and detail their consequences in relation to the irrigation and drainage proposal under study.

The overall aim and Objective of the Study was however to evaluate the environmental impact assessment of two small scale irrigation schemes in Wuciciri and Barakallahu villages in Zaria and Igabi local government areas respectively with the specific objectives of; To insure sustainable management of natural resources by the project target communities, To protect and enhance quality of all forms of life, To assess the project's environmental positive and negative impacts and provide mitigation measures for the negative impacts and to promote local communities and insure public participation,

2.0. Materials and Methods

Like any empirical studies, this EIA approach has followed standard procedures to find important environmental impacts and recommend mitigation measures for impacts that could happen during implementation of the irrigation activities. Hence, this section focuses on description of the study area, base line environmental information and the study design.

3.1. Description of the Study Area

Kaduna State occupies part of the Central position of the Northern part of Nigeria (with Kaduna as its capital) and shares common borders with Zamfara, Katsina, Niger, Kano, Bauchi and Plateau States. To the South-West, the State shares a border with the Federal Capital Territory, Abuja. The global location of the State is between longitude of 30E2 east of the Greenwich meridian and also between latitude 0900 and 11 30E2North of the equator. The State has a land area of approximately 48,473.2 square kilometers.

The intervention areas namely Barakallahu and Wuciciri Village are located within 6 km and 84 km distances from the Kaduna town respectively. The area altitude ranges between 2,200-1,850 m.a.s.l and average temperature varies between 20 and 35^0c. The Rainfall range is between 950 to 1,400 mm per year. Agroecologically the project Village are categorized under dry tropical climate, with annual rainfall and spatial distribution not sustaining plant growth and maintain to maturity. The whole land form has an undulating Plateau with visible rivers including River Kaduna, River Wonderful in Kafanchan, River Kagom, River Gurara and Galma. The State has two recognized seasons, the Dry windy season and the Rainy (wet) Seasons. The wet season is usually from April through October with great variations as you move North-Wards. On the average, the State enjoys a rainy season of about five (6) months. Heavy rainfall in the southern parts, such places as Kafanchan and northern parts like in Zaria with an average rainfall of about 1016mm. The State extends from the tropical grassland known as Guinea Savannah to the Sudan Savannah in the North. The grassland is a vast region covering the Southern part of the State to about Latitude 1100E2 8099E2 North of the equator. The prevailing vegetation of 20 tall grass and big trees are of economic importance during both the = wet and dry season. The population of Kaduna State is 3,935,618 and 6,066,562 based on 2003 and 2006 population census. Although majority live and depend on the rural areas, about third of the State's population are located in two major urban centers of Kaduna and Zaria. However, except in the northwestern quadrant, the rural population concentration is moderate, reaching a high of over 500 persons per sq. km. in Kaduna/Zaria and the neighboring villages; 350 in Jaba, Igabi and Giwa and 200 in Ikara LGAs. However, the number of population and households living in the targeted two Village is shown in the table below.

Table 1: Distribution of Demography of the Study Areas

No	Name of	Household size			Population size		
	Village	Male	Female	Total	Male	Female	Total
1.	Barakallahu	1,245	486	1,731	2,641	2,789	5,430
2.	Wucicciri	764	253	1,017	2,129	2,275	4,404
	Total	2,009	739	2,748	4,770	5,064	9,834

Livelihood of communities of the two target Village is based on subsistence crop production predominantly carried out under rain-fed conditions. It can be found in every household an at least three livestock, six goats and a donkey. Opportunities for off-farm income are very limited and most people thus rely to a large extent on agriculture for their subsistence. The major crops grown in Barakallahu are maize and rice. Maize is the most preferred crop, while sorghum and rice rank the second major crops grown in Wuciciri and Barakallahu areas respectively. Farmers usually grow maize, rice, beans and sorghum in Wuciciri areas.

The rate of land degradation is also high in the areas mainly due to limited natural resource conservation activities practiced. However, the recent efforts by the government of community mass mobilization in natural resource soil and water conservation activities carried out on hillsides and other degraded lands seems to bring some positive changes in raising awareness of the target communities of Barakallahu and Wuciciri Village. In this regard, farmers usually used to practice farm terracing, soil and stone bunds in farmlands located on steep/slope terrain areas to combat soil and water erosion problems. Some farming communities in Barakallahu village also observed using Eucalyptus plantation for its economic importance despite of its ecological costs by scavenging soil nutrients and water resources.

2.2. Baseline Information on Bio-Physical and Socio-Economic Situation

Table 2 showed the baseline information in terms of biophysical and socioeconomic environmental variables. A qualitative rating scale of low, medium, high of the variables was obtained through physical observation and public opinions.

Table 2: Results of Base-line status of Biophysical Environment

No	Environmental Variables	Name of the Irrigation Projects and their some Biophysical and Socioeconomic status. (Wuciciri) Galma Irrigation Site	(Barakallahu) NOUN Irrigation Site
A	Biophysical Variables		
1.	Soil Fertility	Medium	Medium
2.	Soil Stability	Low	Low
3.	Soil Erosion	Medium	Medium
4.	Soil productivity	Low	Medium
5.	Silt accumulation	Low	Low
6.	Water logging problems	Low	Low
7.	Vegetation cover change	Low	Low
8.	Wild life	Low	Low
B	Socio Economic Variables		
1.	Resource use complain	Low	Medium
2.	Human Health	Good	Good
3.	Income generation status from irrigation resources	Not at all	Poor

2.3. Study Design

The study was designed as empirical descriptive type that provides comprehensive information about environmental situations and public concerns with respect to the possible biophysical and socio-economic environmental variables because of the project interventions. Data was collected from sample population for both biophysical and socio-economic variables and analyzed statistically for their significant environmental impacts so that mitigation measures are recommended for the possible negative environmental impacts of the project.

2.3.1. Sampling Technique

Sample households were taken from direct beneficiaries of the proposed irrigation schemes using non probability sampling of purposive type. The study area, that is, the irrigation sites has a total household population of 130 for Wuciciri and 94 for Barakallahu irrigation sites. Accordingly, a total of twenty sample households were selected randomly proportional to size from each irrigation sites.

2.3.2. Tools for Data Collection

In this assessment, both primary and secondary data were collected. The required primary data for the assessment was collected from 20 sample respondents through household interviewing, focus group discussions, and site observation and direct measurements of some physical environmental variables such as river flow rate, train or slope, altitude and temperature. While applicable secondary data was also collected from relevant government line offices. Further, telephone conversations were used with different officials to triangulate data from secondary sources for some consistency barriers.

2.3.3. Data Analysis

Statistical analysis was used to measure significance of negative impacts by the proposed irrigation projects on biophysical and socio-economic environmental variables. From sample statistics, an inference was made by statistical inferential model we called Chi-square using SPSS software. For this analysis, any expected negative impact coming into the irrigation project activities were analyzed and rated using all the environmental variables.

3.0. Result and Discussions

From the formula of Chi-Square; $-x^2 = \sum(\frac{Of-Ef}{Ef})$------ (1);

where, X^2 is Chi-Square, of is Observed frequency; Ef is Expected frequency with respect to degree of freedom (df) of variables; there calculated X^2 value and probability of getting the value is taken from Chi-Square table (Table 3). The following table shows significance of environmental impact from the irrigation projects on proposed biophysical and socio-economic components based on P values. If probability (P) values are less or equals to 0.05 at the specified degree of freedom (df), the null hypothesis is to be refused and the impact is insignificant. If P value is greater than 0.05; the null hypothesis is to be accepted and mitiga-

Table 3: Analysis of Chi-Square and Probability of Significance

S/N	Environmental Variables proposed to be affected	df	For Wuciciri IRRIGATION SCHEME X^2 Value	Status	FOR BARAKALLAHU IRRIGATION X	df	Value	Status
1.	Climate	3	8.333 <0.05	Insignificant	8.333	3	0.05	Insignificant
2.	Air Quality	2	6.667 <0.05	Insignificant	6.667	2	<0.05	Insignificant
3.	Ground water quality	1	1.000 >0.05	Significant	1.000	1	>0.05	Significant
4.	Surface water quality	1	5.444 <0.05	Insignificant	5.444	1	<0.05	Insignificant
5.	Surface water quality	1	5.444 <0.05	Insignificant	5.444	1	<0.05	Insignificant
6.	Soil salinity	2	2.000 >0.05	Significant	2.000	2	>0.05	Significant
7.	Soil stability	2	1.444 >0.05	Significant	1.444	2	>0.05	Significant
8.	Train	1	5.444 <0.05	Insignificant	5.444	1	<0.05	Insignificant
9.	Water use conflict	1	1.000 >0.05	Significant	1.667	2	>0.05	Significant
10	Vegetation cover	1	5.444 <0.05	Insignificant	4.667	3	>0.05	Significant
11	Wetland	1	5.444 <0.05	Insignificant	5.444	1	<0.05	Insignificant
12	Aquatic habitats	2	1.667 >0.05	Significant	1.667	2	>0.05	Significant
13	Fish stock	2	6.000 <0.05	Insignificant	6.000	2	<0.05	Insignificant
14	Terrestrial habitats	1	5.444 <0.05	Insignificant	5.444	1	<0.05	Insignificant
15	Wild life aquatic	1	5.778 <0.05	Insignificant	4.778	1	<0.05	Insignificant
16	Wildlife Terrestrial	1	5.444 <0.05	Insignificant	5.444	1	<0.05	Insignificant
17	Forest resource	1	5.444 <0.05	Insignificant	5.555	1	<0.05	Insignificant
18	Biodiversity	1	2.778 >0.05	Significant	2.555	1	>0.05	Significant
19	Ecosystem function aquatic		2.778 >0.05	Significant	2.444	1	>0.05	Significant
20	Ecosystem function terrestrial	1	5.444 <0.05	Insignificant	5.4441	1	<0.05	Insignificant
21	Rear species	1	5.000 <.05	Insignificant	6.000	1	<0.05	Insignificant
22	Protected area	1	5.444 <0.05	Insignificant	5.000	1	<0.05	Insignificant
23	Human health	1	5.778 <0.05	Insignificant	5.777	1	<0.05	Insignificant
24	Socio-Economic	1	3.778 <0.05	Insignificant	3.454	1	<0.05	Insignificant
25	Cultural Heritage	1	5.444 <0.05	Insignificant	5.444	1	<0.05	Insignificant

tions measures are recommended. The following table is to show significance of impact of the proposed irrigation projects on biophysical and socio-economic environmental elements.

The data in table 3 above shows the identified environmental components for which negative impacts from the proposed irrigation projects are significant. These are ground water quality, soil salinity, soil stability, water use conflict, aquatic habitat, bio diversity and aquatic ecosystem functions for irrigation projects and impact on vegetation cover is also significant for Barakallahu irrigation scheme.

3.1. Determination of Environmental Impact Statement

The study assessed possible environmental impacts of the two irrigation schemes at Wuciciri and Barakallahu Villages. The result of the study from Chi-square analysis showed that environmental components that could be negatively affected by the irrigation projects are soil physical and chemical properties and water use regime of communities especially with upper stream users and even among the same schemes within the river ecosystem. However, all negative impacts found significant can be mitigated and avoidable if provided that proper environmental management plan could be implemented proactively.

Results of the study also identified environmentally positive impacts of the irrigation projects. From focus group discussion of both irrigation projects, the irrigation has significant contribution of income creation, efficient utilization of domestic labors, ensuring household food security and improving nutrition and promotion of women economic empowerment. Irrigation is generally considered as an effective way of increasing agricultural production (more land under crops, more crops per hectare per year, more crop production per hectare per season). As production increases, per capita income increases; and thus, the socio-economic condition and livelihood improve. Thus, the access to irrigation or development of irrigation facility has a positive impact and profound role to play on poverty reduction.

3.2. Determination of Significant Environmental Impacts

The data reveals in Table 3 above shows the identified environmental variables that are negatively affected by the two irrigation projects. The table below shows the determined significant environmental impacts with corresponding impact profile.

Table 4: Distribution of Significant Environmental Impacts with corresponding the Impact Profile

No.	Significant Environmental Impacts	Impact Profile
1.	Ground water quality	• Increase in water turbidity • Raising in saline water table • Addition of toxic chemicals
2.	Soil salinity	• Raise in saline water table • adjustment in soil physics and discharge of salt from soil micro pores during inappropriate time of irrigation • danger of silt deposit form upper catchment to irrigation water and irrigable field as there are no vegetation cover and trapping mechanisms on the catchments
3.	Soil stability	• During construction of irrigation infrastructures and flood irrigation, as the soil is fragile and young it could easily liable to disturbance
4.	Water supply and usage conflict	• This is a disturbing issue if good control area is not separated from possible minimum canal flow during design. It is difficult to shorten control area after once included. It causes social conflict, economic loss.
5.	Aquatic habitat	• Aquatic habitat will be damaged if minimum permissible flow is not maintained in natural water flow. • Addition of chemicals could damage aquatic habitats
6.	Bio-Diversity	• Addition of chemicals could affect biodiversity
7.	Aquatic ecosystem function	• Addition of chemicals could affect aquatic ecosystem function
8.	Vegetation cover	• Construction of irrigation infrastructures will affect the vegetation cover especially for Barakallahu irrigation.

3.3. Determination of Environmental Impact Matrix

Preferably, all development activities costs environment. However, it is important to get the lower opportunity costs by mitigating significant environmental impacts indicated in Table 3 above. The table 5 below display the status of significant environmental impacts by environmental impact matrix

Table 5: Presentation of environmental impact matrix

DESCRIPTION CODE

Significant Environmental Effect that can be Mitigated
Potential Significant Negative Environmental Effect unknown
Significant Public Concern
Significant Negative Environmental Effect that Cannot be Mitigated
No Significant Negative Environmental Effect
Positive Environmental Impact

	Environmental Components Negatively Affected by the Irrigation Projects										
	Groundwater quality	Soil Salinity	Soil Stability	Water use	Aquatic Habitat	Biodiversity	Climate	Aquatic Ecosy Stem Function	Human Health	Vegetation Cover	HH Economy
Project Undertakings	E	E	A	C	A	E	E	A	E	E	E
Construction of headwork	A	E	A	E	E	E	E	E	E	A	D
Construction of Canals	A	A	E	C	A	A	E	A	A	A	D
Irrigation Agronomy	E	F	F	E	E	E	E		F	E	F
Post-Harvest	A	E	A	C	A	E	E	A	E	A	D
Interactive effects											
Cumulative effects	A: Significant Environmental Effect that Can be Mitigate										

3.4. Identification of Mitigation Measures

The study also identified mitigation measures for identified potential environmental negative impacts of the irrigation projects. The following table is to show the mitigation measures per every significant impact.

Table 6: Impact Mitigation Measures

No.	Impacts	Identified Mitigation Measures
1.	Ground water quality	• Practice of organic farming • Use of appropriate furrow length to irrigate vegetables • Adjusting time of irrigation
2.	Soil salinity	• Adjust time of irrigation • Appropriate drainage lines at every edge of farm field • Silt clear up from canals and treatment of upper catchment
3.	Soil stability	Construction of retain wall during irrigation infrastructure construction especially for sensitive and slid-able soil Avoid flood irrigation Allow appropriate amount of water per territory canal outlet based on furrow length and slop
4.	Water use conflict	Predetermination of control area based on crop annual water requirement and available water without compromising natural waterway. Water scheduling and determination crop type during critical water shortage Treatment of upper catchments to increase side recharge to river
5.	Aquatic Habitat	• Use of organic farming
6.	Bio Diversity	• Use of organic farming
7.	Aquatic Ecosystem Function	• Use of Organic farming • Catchment treatment to encourage drawdown
8.	Vegetation Cover	• To substitute another plantation site out of irrigation • To substitute multipurpose ecologically friendly trees than eucalyptus trees

3.5. Identification of Environmental Management Plan

The identified significant and negative impacts of irrigation development on environmental aspect are ground water quality, soil salinity, soil stability, water use conflicts, aquatic habitats, biodiversity, aquatic ecosystem function and vegetation cover. The following table is to show adverse impacts with respect to the project stages and proposed mitigation measures and implementation schedules.

Table 7: Environmental Management Plan Schedule

Project Stage	Project Activities	Adverse Impacts	Proposed Mitigation	Institutional Responsibility	Implementation Schedule
Construction stage	Head work & canal construction	Water quantity in river will be at risk	Allow minimum permissible amount of water in river	Follow up and monitoring for proper implementation	At the start of construction
		Soil stability disturbed	Retaining walls of side embankments and catchment treatment	Follow up and monitoring for proper Implementation	At the start of construction
		Aquatic Ecosystem Function affected	Allow minimum permissible amount of water in river and catchment treatment	Follow up and monitoring for proper Implementation	At the start of construction
		Some vegetation plantation will be removed	Support Substitution of plantation sites out of irrigation area	Follow up and monitoring for proper Implementation	At the start of construction
Operation stage	Irrigation Agronomy	Ground water quality	Organic farming and proper irrigation water management	Follow up and monitoring for proper Implementation	During operation
		Soil salinity	Irrigation water management and catchments treatment	Follow up and monitoring for proper Implementation	During Operation
		Aquatic Habitats could be damaged	Organic farming and catchment treatment	Follow up and monitoring for proper Implementation	During Operation
		Effect on bio diversity	Organic Farming and water use efficiency	Follow up and monitoring for proper Implementation	During Operation

The EIA study also assessed capacity of the district office of Environmental Protection and Land Administration. The office has vested the responsibility of implementing and regulating environmental activities by government. To accomplish regulation and implementation of environmental activities, the office has shortage of motor cycle to monitor and follow up field activity implementation, skill gap of geo spatial technologies and lack of computers for data management by database system.

3.6. Nature of public participation

Prior to any project planning, all stakeholders including potential beneficiaries should be consulted and involved. They have to be involved in the identification of problems, planning of activities, implementation, monitoring and evaluation. This is important for developing sense of ownership, on the part of the community, and ensures sustainability. Accordingly, the project involved the target communities and government line offices during the assessment of this environmental impact study and continues throughout the implementation process.

4.0. Conclusion

This Environmental Impact Assessment (EIA) was conducted in two small scale irrigation projects at Wuciciri and Barakallahu Village of Zaria and Igabi Local Government in Northern Zone Kaduna State of Nigeria. The irrigation scheme at Wuciciri village is proposed to irrigate 60 hectares of land and expected to benefit approximately 130 households in irrigated crop production in the command area, whereas the proposed scheme in the Barakallahu is capable to irrigate 21.2 hectares of land and benefits more than 94 households in the command area.

The EIA study was carried out by team of experts composed of NOUN technical staffs and government/district experts together with local communities and field level Development Agents. The approaches applied during field data collection consisted of site observation and measurement, household interviewing and focus group discussions. The discussion involved all segments of the community including women, men, leaders, youth, elders and influential members as well as development agents. By the assessment, the major impacts of irrigation development on environmental aspect are verified for their significance by statistical methods.

The result of the study reveals that ground water quality, soil salinity problems, soil stability, water use conflict, aquatic habitats, and biodiversity aquatic ecosystem and vegetation covers have significant and negative impacts of irrigation development on social and environmental aspect. Environmental Impact Matrix was done to indicate importance of impacts that can affect

environmental components. The matrix analysis shows there was no non reversible impact identified and all impacts identified are impacts that can be mitigated. The study further shows that efficient utilization of domestic labors, creation of income opportunities, promotion of women economic empowerment, ensuring household food security and improving nutrition are the major positive impacts of irrigation development in the targeted intervention Village.

Finally, the study recommends that proper use of irrigation water, promoting organic farming, catchment treatment and water scheduling, maintaining permissible flow in natural water way and clear demarcation of command area and construction of appropriate drainage facilities as a mitigation measures for every significant environmental impact to happen. The study results also indicated monitoring mechanisms and indicators to be mentored at every stage of the project activities.

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