ENVIRONMENTAL IMPACT ASSESSMENT OF IRRIGATION PROJECTS

A CASE STUDY OF ZAURO POLDER PROJECT PILOT IRRIGATION SCHEME BIRNIN KEBBI

BY

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CERTIFICATION

This is to certify that, this project (ENVIRONMENTAL IMPACT ASSESSMENT OF IRRIGATION PROJECT. A CASE STUDY OF ZAURO POLDER PROJECT PILOT IRRIGATION SCHEME BIRNIN KEBBI was conducted by SULAIMAN AJIKOBI, during 1998/99 academic year in partial fulfillment of the requirement for the award of Post graduate Diploma (PGD) in Agric Engineering (Soil and Water Option), Federal University of Technology, Minna.

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ABSTRACT

This study focus on the Environmental Impact Assessment (EIA) of Irrigation project with particular reference to Zauro polder pilot Irrigation Scheme as a case study. In pursuance of this, questionnaires were administer as well on the spot assessment of some notable phenomena were carried out in order to assess the magnitude and significant of the impact of the project on the environment. The impact on physical phenomena such as vegetation, soil, water and general land uses were analysed and assessed accordingly. It was discovered that a great modifications and alterations has been done to those physical features –at post project period compared with what operates during pre-project period. Climate such as rainfall and temperature were equally assessed. The results of the assessment revealed that there was decreased rainfall at post project period. The result of the study shows a lot of negative impact such as erosion, water logging, increase water related diseases such as malaria, yellow fever, Diarrhea/Dysentery, cholera and Trypanosomiasis and incessant occurrence of floods down stream as well as up stream, moreover, it has been discovered that the project has great impact in economic activities of the inhabitants of the study area in terms of creation of jobs, crop yield, fishing and animal rearing. This has

yield, fishing and animal rearing. This has brought about increase per capital income to the inhabitants of the area. In respect to the above discussed recommendations were made towards a sustainable development of the project. The water from main canal, tertiary canal and main drain with mean TDS 110mg/L, EC 100 Umhos/CM, SAR 9.7 and pH7.6, belongs to C1 S1 – low salinity, low sodium water category. They are free from salinity, acidity problems and suitable for irrigation purposes.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 GENERAL

Irrigation is one of the most important means for the expansion of Agricultural production, particularly in the semi arid ecosystem.

This contention find support from the fact that irrigation land area world wide has increased from 16 x 10^6 hectares at the end of the nineteen century to 203 x 10^6 hectares in 1975; it is expected to increase to 300 x 10^6 hectares by 2000 AD (Kovda et al 1973).

A sustainable use of the natural resources call for appropriate methods to collect base line information to assess environmental impacts and to monitor environmental changes.

In the last few decades Nigeria has embarked on a rapid expansion of irrigated agriculture especially in the semi arid northern States through various River Basin Development Authorities. Under the Sokoto, Rimer River Basin Development Authority (SRRBDA). Two such projects were established in the erst while Sokoto State for dams based scale irrigation farming. They are:-

1. Wurno Irrigation project (WIP) in Sokoto State, along River Rima under the command of Goronyo Dam.

2. Bakolori irrigation project (BIP) now in Zamfara State along River Sokoto under the command of Bakolori Dam.

Therefore it becomes imperative to develop and manage this scarce resources (water) very well problems have been created through a myriad of development project because Environmental impact Assessment (EIA) appraisals were not made, while poor performance may be associated with inadequate data input which could have been given to EIA report or not taking into consideration the "local" environment and associated environmental problems. If it has been adopted to the local environment and its problems EIA would more rapidly have become a useful tool for environmental management and planning. One of such problem is the imminent threat of flooding, desertification over cultivation, erosion, water logging and water quality down stream e.t.c.

For the purpose of this project our main concern is the Sokoto Rima River where the irrigation project Zauro polder project pilot irrigation scheme Birmin Kebbi is situated.

The Zauro polder project was designed to irrigate over 11,000 hectares from which 7790 farmers are expected to benefit. This pilot scheme is designed for the SRRBDA to be used as a model for farmer on irrigation water management. The scheme is 100 hectares gross and it is

sited on the Northern part of Birnin Kebbi along the southern Bank of Sokoto Rima River valley.

The pilot scheme is equipped with a 2.65 Km flood protective dyke of 3.5m height, a temporary pumping station with a stand by generator, a main canal which is connected to a compensation reservoir, four lateral canals and a collector drain. These infrastructures are expected to enhance water distribution and management living in Birnin Kebbi, Argungu Marina zauro including more villages.

The soil of the area are part of the Sokoto Rima Basin flood plain, they are mostly clay with some sandy areas and some mixed sandy clay areas. They are particularly suitable for rice cultivation through basin and border irrigation (Wakuti 1979). The scheme has a main canal of 545m long covering a discharge of 404L/S, with four lateral take off of 940m, 1470m, 1165m and 1715m respectively. The off take of the lateral canal is through 400mm diameter pipe with sluice values are used to discharge water and control the discharge respectively.

These study aims at assessing the environmental impact of water development project such as irrigation projects with particular reference to zauro polder project pilot irrigation scheme.

1.2 JUSTIFICATION

If the trend of environmental degradation, loss of Natural habitats continues the impact of such a declining ecological balance on man may be disastrous hence there is need to carry out environmental impact assessment of the zauro polder pilot irrigation scheme of this magnitude, so as to be able to prefer lasting solution towards its negative impact and improve on its positive pastures.

1.3 OBJECTIVES

The present study was undertaken with the following major objectives:-

1. To examine the socio-economic, cultural and health implications of the project on the people within the environment with particular reference to human activities such as agriculture (irrigation, cropping and fishing).
2. To assess the environmental impact of the project before and after construction.
3. To recommend appropriate management strategies for maintaining the resources in a reasonable good state for sustainable crop production in the locality with special

emphasis on human activities under the large scale irrigation project.

1.4 SCOPE

Environmental impact assessment is a wide scope of study and as a result of this, we shall limit the areas of assessment on this study to social economic and ecological impact of the project on the environment, the impact on vegetation, rainfall and other natural habitat. This study will look into those areas such as the type of agriculture practised (irrigation) in the area whether subsistence or commercial and the viability.

CHAPTER TWO

2.0 REVIEW OF LITERATURE

2.1 REASONS FOR IRRIGATION

Irrigation can be defined as the application or artificial supply of water to the soil for benefits of crops planted. Irrigation has been practiced for some years but it has been improved and increased in practice to get one or more of the following:-

(a) To supply moisture essential for plants growth

(b) To provide crop insurance against short duration drought.

(c) To leach or dilute undesirable salts in the soil

(d) To control the environment of growing plants by preventing frost action.

2.2 METHODS OF IRRIGATION

Irrigation water may be applied to crops by flooding it on the field surface by applying it beneath the soil surface, by spraying it under pressure or by applying it in drops. The common methods of irrigation are indicated below:-

(a) Surface irrigation

(b) Sub-surface irrigation

(c) Sprinkler irrigation

(d) Drip (Tricle) Irrigation

The water-supply, the type of soil, the topography of the land and the crop to be irrigated determines the correct method of irrigation to be used. Whatever the method of irrigation, it is necessary to design the system for the most efficient use of water by the crop (Micheal 1978).

(a) SURFACE IRRIGATION METHOD

In the surface methods of irrigation, water is applied directly to the soil surface from a channel located at the upper reach of the field. Water may be distributed to the crops in border strips, check basin or furrows. Two general requirements of prime importance method to obtain high efficiency in surface method of irrigation are properly constructed water distribution system to provide adequate control of water to the fields and proper land preparation to permit uniform distribution of water over the field.

(b) SUB-SURFACE IRRIGATION METHOD

In Sub-surface irrigation, water is applied below the ground surface by maintain an artificial water table at some depth depending

upon the soil texture and the depth of the plant roots. Water reaches the plants roots through capillary action. Water may be introduced through open ditch or underground pipelines such as tile drains or mole drains. The water application system consist of field supply to cover the adequately and drainage dictches for the disposal of excess water.

c. SPRINKLER IRRIGATION METHOD

In the sprinkler methods of irrigation, water is sprayed into the air and allowed to fall on the around surface somewhat resembling rainfall. The spray is developed by the flow of water under pressure through small orifices or nozzles. The pressure is usually obtained by pumping. With careful selection of nozzle size, operating irrigation water required to refill the crop root zone can be applied nearly uniformly at a rate to suit the infiltration rate of the soil, thereby obtaining efficient irrigation.

d. DRIP IRRIGATION METHOD

Drip or trickle irrigation is one of the latest methods of irrigation which is becoming increasingly popular in areas with water

scarcity and salt problems. It is a method of watering plants frequently and with a volume of water approaching such conversional losses as deep percolation run off and soil water evaporation. In this method, irrigation is accomplished by using small diameter plastic lateral lines with devices called "emitter or drippers" at selected spacing to deliver water to the system. This applied water slowly to keep the soil moisture within the desired ranged for plant growth. (Michael 1978).

2.3 SURFACE IRRIGATION SYSTEMS

The surface irrigation could be of the following methods (Michael 1978):-

(a) Border method

(b) Basin method

(c) Furrow method

(d) Corrugation method

(e) Wild flooding method

(a) Border Method

In this method of irrigation parallel ridges to guide a sheet of flowing water as it moves down the slope in making use of this method is suited for:-

(i) where soil depth and topography permits the required land leveling at a reasonable cost without reduction in soil fertility or production.

(ii) Moderately low to moderately high infiltration

(iii) All close growing crops like wheat, folder crops and legumes, etc but it is not suitable in coarse sandy soil and for crops like rice.

(iv) For large field of four hectarage or more.

(b) Basin Method

This method of irrigation which makes use of bunds or ridges around. which water is filled to the desired depth and retained until it infiltrates into the soil, is suitable for:-

(i) Soil having moderately slow infiltration rates

(ii) Both row crops and close growing crops, as inundation or is planted in beds so that it will remain above the water level. It is mostly used on grains like rice, and fodder crops

(iii) Vary permeable soils which must be covered with water rapidly to prevent excessive deep percolation, looses at the upstream end, and in heavy soils where water is absorbed very slowly and is required to stand for a relatively long time to ensure adequate irrigation.

(iv) When leaching is required to remove salts from the soil profile.

(c) Furrow Method

The furrow method of irrigation which is used in irrigation of row crops with furrows developed between the crop rows during the planting and cultivating processes, and upon which irrigation water is supplied to, is suitable for:-

(i) Deep, moderately permeable soils with uniform, relatively flat slope (30%) to reduce erosion.

(ii) Crops cultivated in rows such as maize sugar-cane, potatoes, vegetables e.t.c and crops that cannot tolerate standing in water.

(iii) Any size of field or plot

(a) CORRUGATION IRRIGATION METHOD

This consist of running water in small furrow called corrugation that direct the flow down the slope. This is suitable for:-

(i) Non-cultivated, close growing crops such as small grains and for pastured growing on steep slopes.

(ii) Loamy soils in which the lateral movement of water takes place readily, and not use in clay soils due to low infiltration rates on deep sandy soils due to excessive loss of water by deep percolation before the entire surface is wetted, and on saline soils or use of saline irrigation water.

(e) WILD FLOODING

The wild flooding or uncontrolled flooding method of irrigation in which water is applied from the field ditches without any levels to guide or restrict its movement, is suitable for:-

(i) Where irrigation water is abundant and is expected inexpensive

(ii) Lands that have such irregular surface that the other methods are impracticable.

Close growing crops, particularly where slopes are steep (Micheal 1987).

2.4 IRRIGATION EFFICIENCIES

Adequate control and management of irrigation water requires that methods be available to evaluate irrigation practices from the time water leaves the point of diversion until it is utilized by the plants (Egharevba 1988; Micheal 1987)

2.4.1 Reservoir storage efficiency (ES)

$$ES = \frac{WS}{Wso} \times \frac{100\%}{1}$$

where Ws = amount of water diverted for irrigation

Wso = amount of water delivered to the storage

2.4.2 Water conveyance Efficiency (EC)

$$EC = \frac{WF}{Wr} \times \frac{100\%}{1}$$

Where WF = water delivered to the farm

Wr = water diverted from the river or reservoir

2.4.3 Water application Efficiency (Ea)

$$Ea = \frac{Wr_3}{Wf}$$

Where wr_3 = water stored in the soil root zone during the irrigation

Wf = water delivered to the farm

N.B Common source of loss of irrigation water from the farm during water application are represented thus:

RF = Surface run off from the farm

DF = Deep percolation below the farm root zone soil

Neglecting evaporation losses during the time water is being applied and immediately after, it F allows that

$$Wf = ws + RF + DF$$

$$\text{Therefore } Ea = \frac{100\ wf - (RF + DF)}{ws}$$

2.4.4 Overall Irrigation Efficiency

$$E = \frac{ES}{100} \times \frac{EC}{100} \times \frac{Ea}{100} \times \frac{100\%}{1}$$

2.4.5 Water distribution Efficiency

The formula for water distribution efficiency, which evaluates the extent to which water is uniformly distributed is shown below

$$Ed = (1 - \frac{y}{d})\ 100$$

Where

Ed = water distribution efficiency

Y = average numerical deviation in depth of water stored from average depth stored during the irrigation.

(Egharevba 1988; Micheal 1978)

2.5 FREQUENCY AND AMOUNT OF IRRIGATION

Three major considerations influence the time of irrigation and how much water should be applied, viz;

(a) Water needs of crop
(b) Availability of water with which to irrigate and
(c) Capacity of the root-zone to store water.

How frequently water should be applied to soil of different properties in order to best supply crop needs is a question of real and practical significance. A factor of major importance in arriving at the desirable frequency and time of irrigation is the water need of the crop. (Egharevba 1998; Micheal 1978).

2..5.1 Methods of determining Irrigation Frequency

Meteorological method:- Determine consumptive use (C.U) or evapor transpiration (ET) for a crop. Hence we can find out the frequency of irrigation.

2.5.2 Plant Index Method

(b) The crop itself i.e physical observing the plant.

(c) Use of an indicator plant i.e crops that will exhibit symptoms more sensitively.

(d) Change in leaf colour:- Due to lack of water this more than others.

2.5.3 Plant physiological Index

Using plant of certain physiological index to known when to apply water.

Methods:-

(i) Measure suction force of the cell

(ii) Measure the concentration of the cell sap

(iii) Measure the osmotic pressure of the plant under irrigation

(iv) The degree of stomata opening

(Egharevba 1998; Micheal 1978)

2.6 IRRIGATION WATER QUALITY

A knowledge of water quality is important in judging its suitability for irrigation. Irrigation water may consist of surface or ground water, regardless of its source soluble salts are always dissolve in it which could affect the physical and chemical properties of soil. (Van Hoorn, 1971 a; Paliwal, 1972; Yaron 1973; London; 1991.

2.6.1 PARAMETERS USED FOR ASSESSING WATER QUALITY

Various parameters have been used by different workers to assess the suitability of irrigation water. Paliwal and Yaday (1976) expressed the suitability of irrigation water a function of physico-chemical properties. The salt tolerance characteristics of crop at different stages. The drainage condition and the climatic parameters. They argued that all this factors interact and it is difficult to suggest a single water quality criterion even a given agro-climatic zone.

The electrical conductivity (EC) determine at 25°C is used for assessing the irrigation water quality U.S. salinity laboratory. Staff (1954) Yaron, 1973; London 1991) the EC is a measure of salinity hazards and expresses the soluble salt content in water, the total salt content in water would determine the extent of salt accumulation in the soil.

2.7 CRITERIA/LIMITS FOR WATER QUALITY

In terms of salinity hazards, U.S. salinity laboratory staff (1954) grouped irrigation water into four (4) classes. The criteria used were the electrical conductivity (EC) and the total dissolved solid (TDS). The classes were:-

C_1 - Low salinity water EC 250 and TDS < 200

C_2 - Medium salinity water EC 250 – 750 and TDS 200 – 500

C_3 - High salinity water EC 750 & TDS 500 – 1500

The sodium adsorption ratio is used when classifying irrigation water in terms of sodium hazards. The classes are:-

S_1 - Low sodium water with SAR<10

S_2 - Medium sodium water with SAR 10 – 18

S_3 - High sodium water with SAR 18 - 26

S_4 - Very high sodium water with SAR >26.

(U.S. salinity laboratory staff 1954)

2.8 EFFECT OF SALINITY/SODICITY ON CROP PERFORMANCE

When the concentration in the soil or root environment reaches levels in excess of those need for normal growth and yield (Slatyer 1967). Soluble salts affect crops through an increase in the osmotic pressure of the solution in the root zone and the specific effect due to particular lons they contains (Van Hoorn, 1971b; Black 1969; Rowell 1988; Millar and Donahue 1990) plants effect by salinity show in general, stunted growth, a large variability size, a deep blue-green foliage, reduction in yield and a

waxy coating on the leave (VanHoorn, 1971b; mein and Shalhevert, 1973; Rowell 1988).

2.9 MANAGEMENT OF IRRIGATION SOILS

Management of irrigation soils involve special agronomic practice which helps to prevent salt accumulation. It is importance in any irrigation scheme that the ground water be kept below 1m from the surface. In case of permeable soil the ground water can simply be pumped out but if the profile is not permeable, deep drainage ditches need to be installed (Elgabaly, 1971; Arar et al, 1971; Rowell, 1988). Irrigation water should be applied lightly but frequently during the germination and seedling stages of salt sensitive crops. This is done to maintain the soil at a moisture content near the field capacity. This dilutes the salts and lessen their osmotic effect (Brady; 1990; Miller and Danahue, 1990). According to Rowell (1988), ridging the land and running the irrigation water along the furrows can be used to encourage the salts to concentrate in definite bands and then placing the seeds far away from these bans will allow the root of the young plant to grow in a low salt solution. The irrigation method employed can be influenced the salt accumulation in a soil. Sprinkling with saline water can cause appreciable damage due to leaf burn

but drip irrigation has provided good results even when using highly saline water. With furrow irrigation, salt may accumulate at extremely high level at he soil surface between furrows, thereby affecting germination (Arar et al 1971; Shalhevert 1973).

(iii) The choice of crops is also important in salinity management. Advantage can be taken of the fact that crops very in their level of salt tolerance (Uriyo et al, 1979) crops like cotton, sorghum and barley have a high salt tolerance while most citrus species have low salt tolerance (U.S Salinity laboratory staff 1984; Micheal 1978; Brady; 1990; Miller and Donahue 1990; London, 1991).

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 THE STUDY AREA

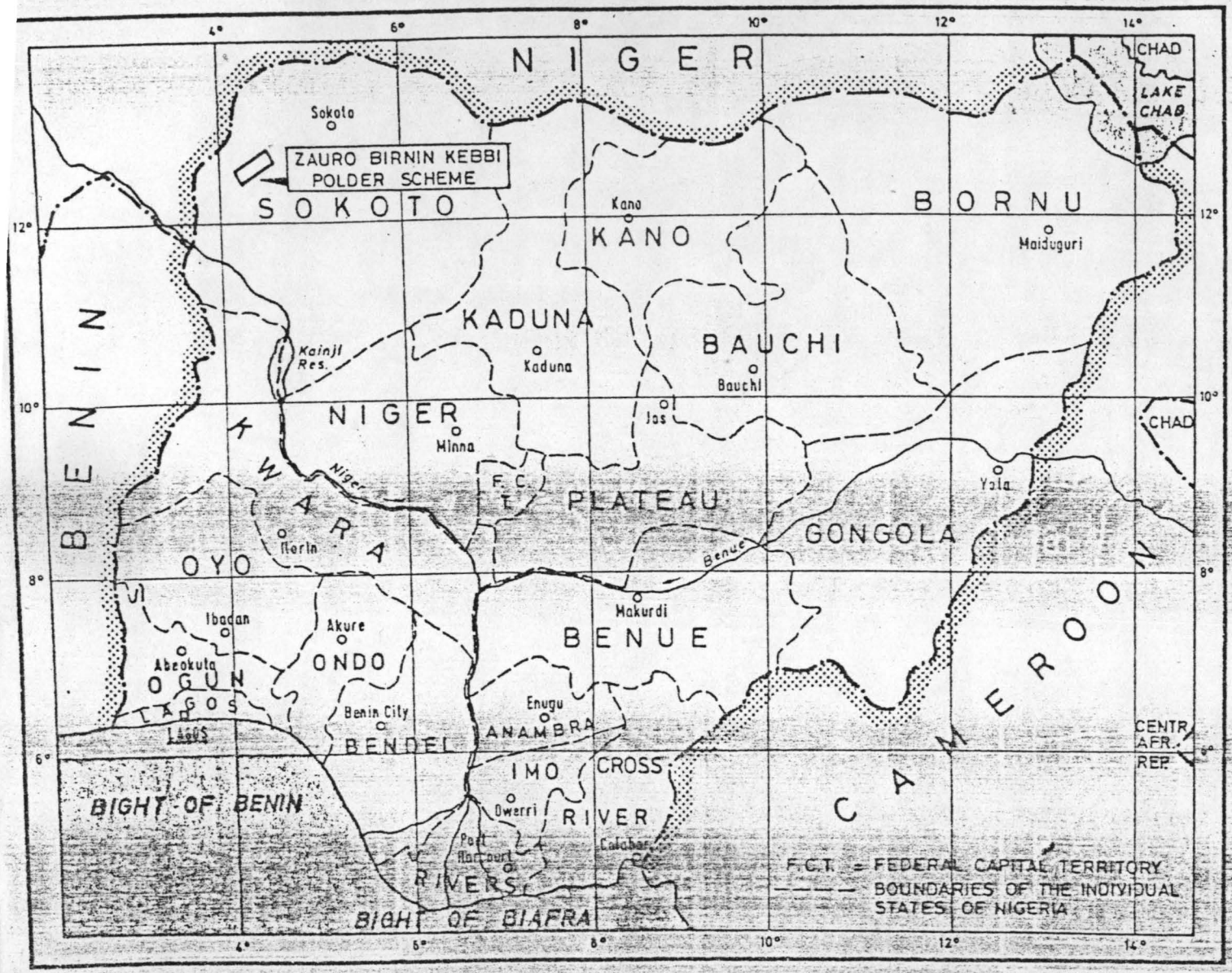
3.1.1 LOCATION

The zauro polder project scheme, (F.g. 3.1.1) is located within the Fadama areas of the Rima River between Argugu up stream and Birnin Kebbi down stream from the geographical co-ordinates it is located between latitude 12^{o} 27' to 12^{o} 42' Northings.

3.1.2 Description of Zauro Polder Project

At full development the zauro polder project is expected to produce some 42,000.00 tonnes of rice 4,800 tonnes of wheat and 33,000 tonnes of vegetable.

Irrigation is operated in the area as a test case of a pilot project which is 100 hectares was mapped out of the project scheme. This pilot scheme was developed and put into rice mostly during the irrigation season cowpea and vegetable are also cultivated. The pilot scheme is expected to provide data upon which the idea for full development of zauro polder project will be based.



FEDERAL
REPUBLIC OF NIGERIA

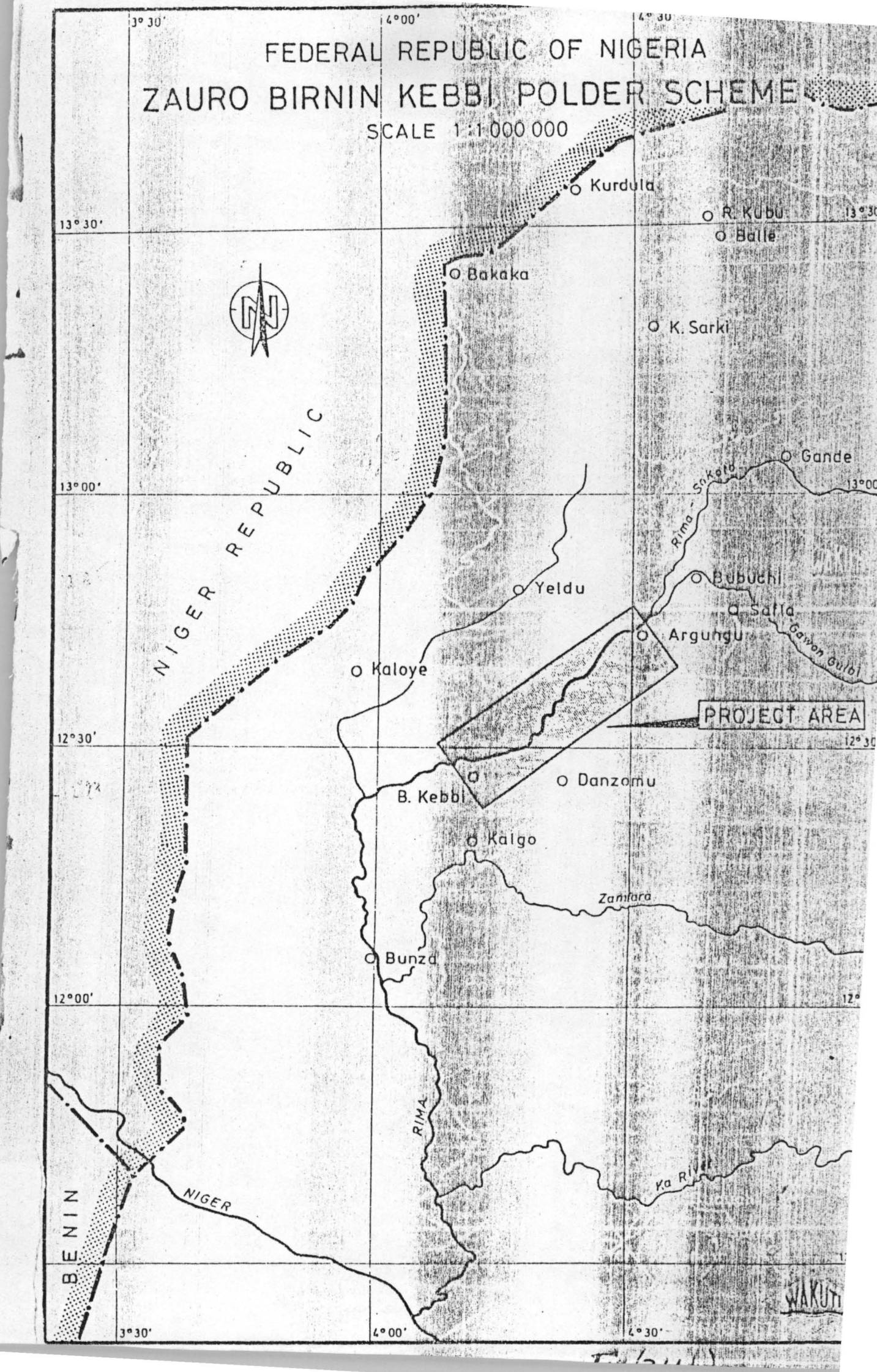
GENERAL MAP OF NIGERIA

SCALE APPROX. 1:8 000 000

WAKUTI

CONSULTING ENGINEERS

Fig (3-1a)


FEDERAL REPUBLIC OF NIGERIA
ZAURO BIRNIN KEBBI POLDER SCHEME
SCALE 1:1 000 000
3° 30'
4°00'
4° 30
13° 30'
13°00'
12°30'
12°00'
Kurdula
R. Kubu
Balle
Bakaka
K. Sarki
Gande
Sokoto
Rima
Bubuchi
Yeldu
Safia
Argungu
Gawon Gulbi
Kaloye
PROJECT AREA
Danzomu
B. Kebbi
Kalgo
Zamfara
Bunza
RIMA
Ka Ri
NIGER
BENIN
NIGER REPUBLIC
WAKUR

3.1.3 Layout

The pilot scheme is a 100 hectares plot which is surrounded with a dyke. The scheme has a main canal of 545M long counting a discharge of 404 L/S, with four lateral take offs of about 940M, 1.470M, 1.16M and 1,715M long respectively (F.g. 3.1.3). The off take of the lateral canals is through 400mm pipes, sluice valve are used to discharge water and control the discharge water respectively. Water is supplied to the main canal by the temporary pumping station through a compensation reservoir equipped with special out let facilities.

3.1.4 Source of Irrigation Water

The source of water for the pilot scheme is the Sokoto Rima River during the raining season when the flood is at peak point. In the dry season there will be a periodic release from Bakolori and Goronyo Dams to ensure efficiency dry season irrigation. At each release enough water is supplied to meet the demands of local farmer down stream and the pilot scheme as well.

3.1.5 Cropping Pattern

The zauro polder project pilot scheme is engaged in growing Rice, Cowpea and vegetable.

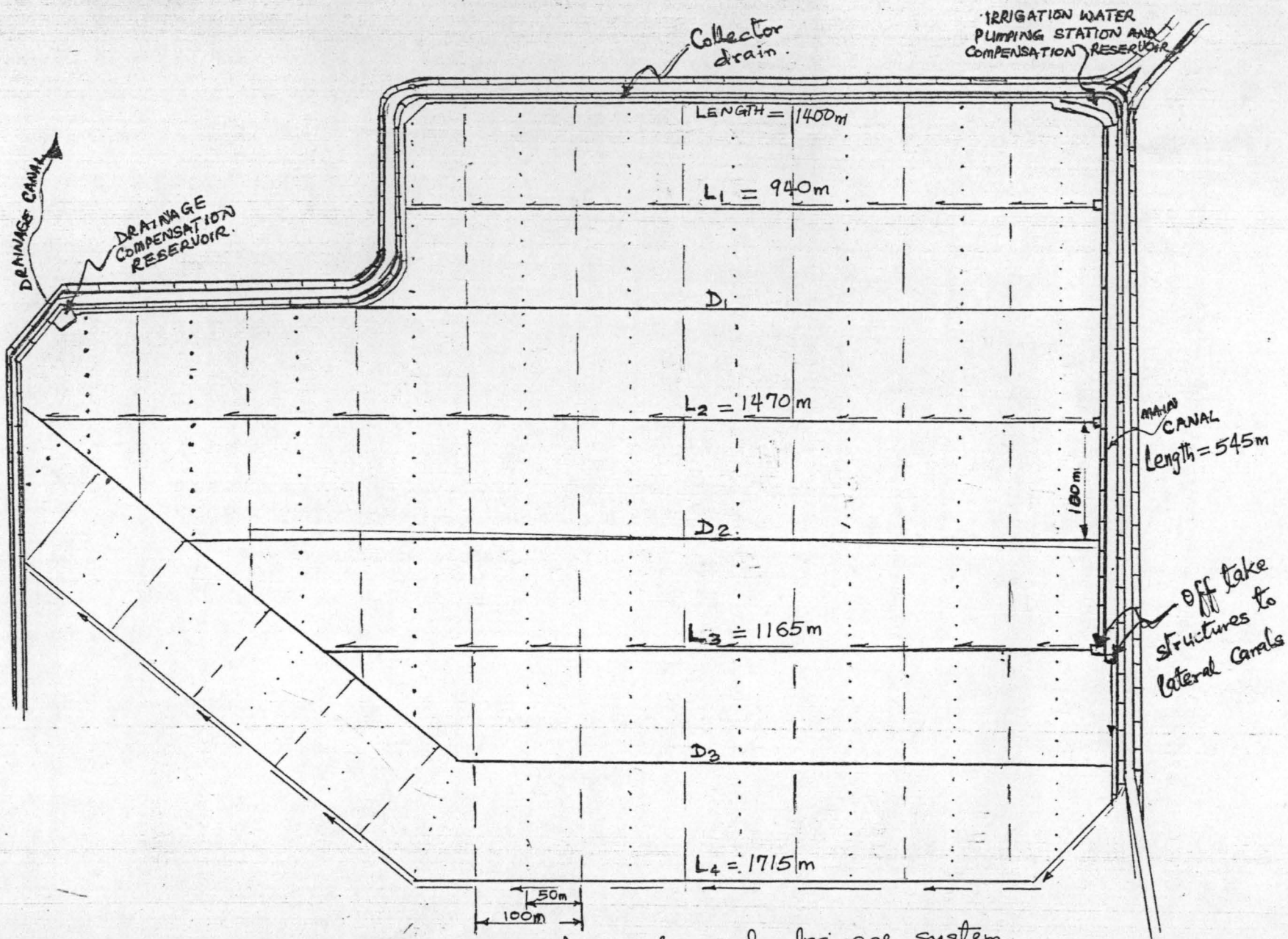


Figure 3.13 Layout of canals and drainage system.

A lot of the local rice varieties have been in the pilot scheme 1980 when the scheme started operation, but gradually the local farmers were introduced to modern irrigation method and improve seed varieties. Thus about 75% of the rice seeds planted in the scheme are developed varieties as IR, Ex-China, BG 90, BG 90– 2, furrow 8 and furrow 9. All the varieties are short duration and their growing period vary from 100 – 135 days. Rice is usually planted in last week of June (around 25th June) and harvested in the first week or November (around 5th November). The period between December and January is embarked for land preparation and administrative activities for dry season irrigation.

Cowpea variety introduced to the pilot scheme irrigation farmers is the TV x 326: this is a short duration variety with growing period of 6o days; planted on February 15th and harvested in the last week of April (around 25th April). (Wakuti 1980).

3.1.6 **Growth Period**

(a) **Rice**

The species of rice being planted at zauro polder project pilot scheme are as mention earlier in cropping pattern (3.1.5) and has an average growth period of 135 days as reported by Wakuti

Consulting Engineers the design report Volume 6. The stages of growth and period as shown below table 3.6.1 A.

Table 3.6.1A

(i)	Initial stage	35 Days
(ii)	Crop development	40 "
(iii)	Mid season	15 "
(iv)	Late " "	25 "
(v)	Harvesting stage	20 "

(a) **Cowpea**

The variety of cowpea seed being used in the pilot scheme is TV X 326 as stated earlier in section (3.15), the average growth period of this beans variety is 60 days.

The stage of growth are:-

Table 3.6.1B

Initial stage	10 days
Crop development	20 "
Mid season	15 "
Late "	15 "
Harvesting Stage	5 "

3.1.7 Irrigation Frequence

The Technical Officer indicated that during the irrigation season, irrigation is practised four (4) hours daily.

3.1.8 Climate/Vegetation

The project is located in the sudden Savanna vegetation zone. The climate in this region consist of a long dry (October – May) and short Wet (June – September) season. The rain falls in short intense shower and is even in distribution. The mean annual rainfall is about 580mm average 1985 – 1995 (Singh, 1995). This is far exceeded by the potential evapo-transpiration of 1770mm (Kowal and Knabe 1972). The temperature fluctuated between 15°c minimum and 40°c maximum (Arnborg, 1988).

3.1.9 Soil/Geology

The soil of the project area is part of the Sokoto Rima River Basin flooded plain. The entire flood plain is under lained by precanbrian basement complex in a relatively flat topography.

Based on the soil sample analysis carried out by Wakuti 1980, the following important soil texture type were recommended:-

(1) Clay soil

(2) Sandy clay soil

(3) Clay loam soil

(4) Sandy clay soil

(5) Sandy loam soil

(6) Loamy sand soil

(7) Sandy soil

The seven texture classes of soil were recorded against the entire zauro polder project area. But considering the pilot scheme alone sandy clay loam soil has dominated almost all the areas it carries out 75% of the total soil of the area.

3.2 METHOD

The first approach was to find out sources of published and unpublished information relevant to the study with reference to the established zauro polder project pilot irrigation scheme.

The information obtained from such secondary sources includes climate, geology, vegetation, map and existing infrastructural facilities.

Approach was also centre on the establishment and identification of environmental impact consideration areas through the administration of questionnaires. The questionnaire was of two parts, was designed to provide detailed information on the socio-economic characteristics of the people and the impact of project on the environment as well on the general

development of its environs, both beneficial and negative impact were given due consideration.

The results of the analysis were used in determining of impacts and their magnitude on the socio-economic life of the people.

The percentages of occurrence of the various elements during the pre project period were compared with the occurrence during the post project period to ascertain whether or departure from the normal trend.

The impacts of such departure were greatly assessed to bring out the actual impact either beneficial or other wise. The respondents totaling 130 of the farmers were randomly selected in the following settlement: Birnin Kebbi, Argungu and Kalgo. They were all interviewed by questionnaires.

3.2.1 Water Sampling

Three water samples of two-litre each were collected in he project area. They were collected from the main irrigation canals, the tertiary canals and the main drains for laboratory analysis.

3.2.2 Water Analysis

The water was analised for total dissolved solids (TDS), ph, electrical conductivity (EC) calcium (Ca^{+2}), magnesium (Mg^{+2}), potassium (K^{+2}) and sodium (Na^{+}) by the methods described by chopra and Kanwar (1991).

The TDS was determined by the evaporation and dry method. The ph and EC were read on a ph meter and conductivity meter, respectively.Mg^{2+} was read on atomic absorption spectrophotometer. While Ca^{2+}, Na^{+} and K^{+} by flame photometry.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 BACKGROUND INFORMATION

Survey show that most of the farmers were between the age 31 and 50 years, that means most of them belong to the active labour age and are married.

It is also observed that 5.71% to 42.86% of the farmers are educated. In this study crop farming still remain the most popular primary occupation of the Fadama since the introduction of the irrigation project, as it indicated 67.71% to 71.43% engaged in crop farming.

4.2 AGRICULTURAL OUTPUT

4.2.1 Crop Production

Production data of crops cultivated in the project were examined, the major crops under irrigation farming in the project is rice, cowpea and vegetable.

4.2.2 Crop Yield Before and after construction of the project

Table 4.2.2 crop yield before and after construction of the project:-

VILLAGE/TOWN	BEFORE	%	AFTER	%
BIRNIN KEBBI	5	14.29	30	85.71
ZAURO	8	22.86	27	77.14
ARGUNGU	5	14,29	30	85.71
KALGO	3	12	22	88

Table 4.2.2 show that percentage distribution of number of farmers that responded to crop yield before and after the construction of the project. This indicated that the crop yield is higher after the construction of the project and the yield are for commercial purposes.

4.3 FADAMA PLANTING BEFORE AND AFTER CONSTRUCTION OF THE PROJECT

Table 4.3 Fadama planting Before and After construction of the project.

VILLAGE/TOWN	BEFORE	%	AFTER	%
BIRNIN KEBBI	12	34.29	23	62.71
ZAURO	4	11.43	31	88.37
ARGUNGU	5	14,29	30	85.71
KALGO	1	4	24	96

In table 4.3, study revealed that more farmers (88.37% to 96%) operated better after the project was constructed than before the introduction of the project. Investigation revealed that farmers reap the benefit of good soil for specific crops.

4.3.1 Animal Rearers Before and After Construction of the Project

Table 4.3.1 Animal rearers Before and After construction of the project.

VILLAGE/TOWN	BEFORE	%	AFTER	%
BIRNIN KEBBI	13	37.14	22	62.86
ZAURO	17	48.57	18	51.43
ARGUNGU	11	31.43	24	68.57
KALGO	7	28	18	72

Table 4.3.1 shows that most of the farmers also engaged in rearing of animals e.g. cattle, sheep and goat, after the construction of the project because of the availability of water in the project area all the year round. Fulanis are also migrating to the project area in search of greener pastures and water for their stock most of the livestock farmers attested to the fact that the construction of the project has reduced considerably the incidence of seasonal rain. The major economics derived from these are milk, hide and skin and animal manure.

4.3.2 **Fishing Before and After construction of the project**

Table 4.3.2 fishing Before and After construction of the project.

VILLAGE/TOWN	BEFORE	%	AFTER	%
BIRNIN KEBBI	11	31.43	24	68.57
ZAURO	12	34.29	23	65.71
ARGUNGU	14	40	21	60
KALGO	9	36	16	64

This study considered the production of fish in the project area. This was done because of the importance of fish to human consumption as its protenous. From this study it was observed that there is an improve level of fish after the construction of the project, due to terminal releasing of water from the Bakolori and Gornonyo dam. It was found out that over 69% of the community combined fishing with their activities after the construction of the project for commercial purposes.

4.4 PROBLMES IN THE PROJECT AREA

Table 4.4.1 flooding in the project area

VILLAGE/TOWN	RESPONDENTS	%
BIRNIN KEBBI	6	17.14
ZAURO	14	40
ARGUNGU	8	22.85
KALGO	1	4

Table 4.4 shows that 17.14% responded in Birnin Kebbi concerning flooding. Flooding is less in this area because of the protective dyke constructed around the pilot scheme againstflooding respondents in zauro to flooding problems is 40%, this is the highest respond in the area. This is due to the fact that zauro is between the upstream and downstream, protective dykes are provided at the downstream and upstream and there is no provision of dyke at zauro, this contributed highly to the flooding problems in zauro, 22.85% responded in Argungu to flooding. This contributed to the forces of River flow as it approaches upstream, although there is a protective dyke but its not enough to reduce the forces from the river flow. Only 4% farmers responded to flooding in Kalgo and this

might be due to the location of the village. The village is located extremely downstream. All the forces of the River flow might have been reduced from the upstream. Survey revealed that there is essessive rainfall last year and water is continuously been released from Bakolori and Goronyo Dam. Before the construction of the project flooding is low but presently flooding is high.

4.4.1 **Erosion in the Project Area**

Table 4.4.1 Erosion in the Project Area

VILLAGE/TOWN	RESPONDENTS	%
BIRNIN KEBBI	5	14.28
ZAURO	8	22.85
ARGUNGU	6	17.14
KALGO	3	12

Table 4.4.1 shows that 17.14% to 22.85% in Birnin Kebbi, zauro and Argungu respectively responded to erosion. This is due to inadequate drainage in the project area for discharging water from the farm land. Moreover run off eroded from the up land to the project area, only 12%

farmers responded in Kalgo, erosion is less in this area due to the topography of the area.

Survey revealed erosion is high before the construction of the project and moderately after the construction of the project.

4.4.2 Water logging in the Project Area

Table 4.4.2 water logging in the project area.

VILLAGE/TOWN	RESPONDENTS	%
BIRNIN KEBBI	11	31.42
ZAURO	4	11.42
ARGUNGU	4	11.42
KALGO	3	12

Table 4.4.2 shows that 31.42% farmers in Birnin Kebbi responded to water logging and is the highest percentage in the area. This may be associated with over irrigation, deep percolation loses due to uncontrolled irrigation water, general rise in water table, excess inflow of water into the farm land or basin, poor out flow of water from farm land. In zauro, Argungu and Kalgo respectively respond is low and this may be associated to proper application of irrigation water and adequate drainage.

Water logging is a phenomenon associated with rise in water table especially when critical limit of 1.5m to 2.0m below ground surface (Davies 1982).

Survey revealed that water logging is higher before the construction of the project but fear or lower after the construction.

4.4.3 Rodants and Birds in the Project Area

Survey revealed that 20% to 44% farmers responded that rodants and birds has increased in the project area after the construction of the project due to the increase in irrigation land.

4.5 CLIMATE

Table 4.7 Annual Temperature Before and After, Construction of the project.

VILLAGE/TOWN	RESPONDENTS		%
	BEFORE		AFTER
BIRNIN KEBBI	2	33	94.28
ZAURO	3	32	91.42
ARGUNGU	1	34	97.14
KALGO	-	25	100

Table 4.5 shows that over 97% farmers responded that before the construction of the project temperature of the environment use to be lower and after the construction of the project temperature is higher. This attributed to evaporation.

4.5.1 Annual Rainfall Before and After Construction of the Project

Table 4.5.1 shows Annual Rainfall Before and After construction of the Project.

VILLAGE/TOWN	RESPONDENTS		%	
	BEFORE		AFTER	
BIRNIN KEBBI	3	8.57	32	91.42
ZAURO	2	5.71	33	94.28
ARGUNGU	-	-	35	100
KALGO	1	424	12	96

Table 4.5.1 shows that most of the farmers over 98% responded that rainfall is higher after the construction of the project, this is due to the addition of water vapour in the air has produced clouds formation and consequently increase precipitation effectiveness of the study area.

4.5.2 TEMPERATURE (MEAN MONTHLY MAXIMUM TEMPERATURE)

Temperature is the degree of hotness or coldness of a place or a substance. The mean monthly maximum temperature is obtained from the average of the total temperature recorded in a month. There is no significant difference between the temperature at pre-project period and post-project period (Table 4.5.2).

4.5.3 RAINFALL (MEAN MONTHLY RAINFALL)

Rainfall includes other forms of precipitation such as (snow, sleet and hail) is always measured by a rain gauge.

The mean monthly rainfall is obtained from the averages of the total rainfall in a month. From the records obtained between 1975-1991 it was found that rainfall amounts recorded happened to be high in the pre-project period as against post-project period (Table 4.5.3).

MEAN MONTHLY MAXIMUM TEMPERATURE IN ^{0}C PRE-PROJECT PERIOD

TABLE 4.5.2 a

Month / Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	32.5	36.2	37.8	36.6	33.7	32.6	29.9	29.0	29.8	32.5	35.3	33.8
1976	33.6	365	37.8	36.1	33.4	31.3	29.8	29.7	30.9	31.1	34.5	35.5
1977	35.3	36.4	37.5	38.9	34.9	32.2	31.8	29.3	30.9	32.9	36.6	34.8
1978	35.7	38.5	37.3	35.3	33.5	32.5	30.5	303.4	30.6	33.1	33.9	35.7
1979	36.4	37.4	38.4	37.7	34.4	31.7	30.7	30.5	30.8	33.4	36.0	34.3

DEPT. OF METEOROGICAL SERVICES, YELWA-YAURI

MEAN MONTHLY MAXIMUM TEMPERATURE IN ^{0}C POST-PROJECT PERIOD

TABLE 4.5.2 b

Month / Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1980	36.0	37.1	38.6	38.6	33.4	32.8	30.8	30.5	32.1	33.7	36.5	33.9
1981	33.1	37.6	38.8	38.4	34.3	33.5	30.3	308	31.4	34.6	36.0	36.0
1982	34.2	35.4	37.7	37.3	34.9	32.5	31.0	29.7	31.2	32.5	35.2	35.3
1983	31.1	38.0	38.3	39.1	36.1	33.1	31.7	30.5	31.9	36.3	37.7	35.9
1984	34.5	37.1	39.1	37.7	33.7	32.4	31.3	32.1	30.9	33.9	37.0	34.1
1985	36.6	36.4	38.9	38.6	36.7	33.1	30.7	30.7	31.3	34.7	37.5	33.7
1986	34.7	38.9	38.4	38.5	37.1	33.7	30.5	31.0	30.7	33.5	34.9	33.5
1987	36.0	38.3	38.9	40.7	38.6	33.6	32.4	31.0	32.3	34.3	37.7	36.0
1988	34.2	38.0	40.4	38.0	37.4	32.7	31.0	29.9	31.1	35.7	37.3	33.0
1991	35.3	38.0	38.9	37.6	32.9	31.4	30.0	29.7	31.7	32.9	35.8	33.9

DEPT. OF METEOROGICAL SERVICES, YELWA-YAURI

MEAN MONTHLY RAINFALL IN mm PRE-PROJECT PERIOD

TABLE 4.5.3 a

Month / Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975					31.0	294.0	389.1	475.5	510.0	447.0		
1976					258.2	336.5	389.9	543.7	428.1	363.8		
1977					213.9	282.0	386.6	487.4	550.9	393.3		
1978					334.3	334.6	389.9	452.6	400.5	398.7		
1979					280.5	304.2	387.0	545.2	516.3	395.0		

WATER BOARD HEAD QUARTERS BIRNIN KEBBI

MEAN MONTHLY RAINFALL IN mm POST-PROJECT PERIOD

TABLE 4.5.3 b

Month / Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1980					52.4	91.5	123.7	144.2	147.0	99.2		
1981					71.3	68.3	110.9	144.6	136.3	91.9		
1982					67.6	77.8	91.6	118.5	132.7	91.4		
1983					82.2	114.6	138.8	168.1	157.7	123.7		
1984					96.3	102.0	107.7	95.8	93.3	113.2		
1985					113.9	93.9	128.8	155.3	163.9			
1986					96.1	70.7	140.9	178.6	143.3			
1987					129.0	129.8	110.5	181.0	184.8			
1988					89.9	103.8	155.5	188.5	157.2			
1991					164.3	174.0	189.1	204.6	204.0			

WATER BOARD HEAD QUARTERS BIRNIN KEBBI

4.5.4 Vegetation within the project Before and After Construction

Table 4.5.4 vegetation within the project Before and After Construction.

VILLAGE/TOWN	RESPONDENTS		%	
	BEFORE		AFTER	
BIRNIN KEBBI	1	2.85	34	97.14
ZAURO	6	17.14	29	82.85
ARGUNGU	-	-	35	100
KALGO	2	8	23	92

Table 4.5.2 shows that most farmers over 98% responded that there is more vegetation within the project area after the construction of the project. This attributed to the availability of River water throughout the project area.

4.5.5 Farmers' View/Perception on the Project

Table 4.5.5 farmers' perception on the project

VILLAGE/TOWN	**B/Kebbi**		**Zauro**		**Argungu**		
Kalgo							
WELL DESIGNED	15	42.86	20	57.14	23	65.71	60
QUITE SATISFACTRORY	20	57.14	12	34.29	12	34.29	40
AVERAGE	-	-	3	8.57	-	-	-

POOR	-	-	-	-	-	-	
TOTAL	35	100	35	100	35	100	100

Information were solicited on the impact of the design on the environment since this is an important component of the project. 42.86% to 65.71% respondents rate the design of the project well designed while 34.29% to 57.14% rate it as good and satisfactory respectively, only 8.57% in zauro respondents reported the design of the project as average.

4.6.0 HEALTH HAZARD

These study considered health impact of the population living on the project area who are mostly farmers (through direct observation and oral interview).

Malaria, yellow fever, diarrhaea/dysentery, cholera and Trypanosomiasis are the principal health concerned with the area.

Mosquitoes occur as a result of water logging and cropping all the year round, which provides breeding site for the mosquitoes.

Diarrhoea, Cholera is common within the area and this is due to drinking polluted water from the upstream.

Trypanasomiasis occurs in the project area due to flies breeding near water sources under the bushes. The above mention diseases usually transmission took place indoors or out-doors.

4.7.0 WILD LIFE

These study considered the effect of the project as it affect the wild life of the area, through direct observation and oral interview.

4.7.1 WILD LIFE SPECIES

At present no known game reserves within the project. Statements by farmers, hunters and forest officers in the project, indicate little or no wild life in the project area. There are diversity of rodents, birds, Alligators and grass cutters. These animals and birds can be found every where along the project area. Water in the river offered luxurious sanctuaries for wild life, the different species of wild life as indicated by the inhabitants of the project area are shown in table 4.7.1.

Table 4.7.1 list of common wild life species in the present area.

Giant rate

Rabbits

Crocodile

Grass cutters

Birds.

4.8 IRRIGATION WATER QUALITY

The suitability of water for irrigation purposes is judged on the basis of its content of total dissolve solid (TDS), Electrical conductivity (EC) sodium absorption Ratio (SAR). The data on these quality indicators for water from main canal, tertiary canal and main drain in the scheme are given in table 1.

According to U. S salinity laboratory staff (1954), irrigation water can be placed in the following four classes on the basis of EC value with corresponding TDS values as given by London (1991).

C1 - Low salinity water: EC < 250, TDS <200

C2 - Medium salinity water: EC250 – 750, TDS 200 – 500

C3 - High salinity water: EC 750 – 2250; TDS > 500 – 1500

C4 - Very high salinity water: EC<2250, TDS>1500

The SAR based classes are:

S1 - Low sodium water: SAR<10

S2 - Medium sodium water: SAR 10 –18

S3 - High sodium water: SAR 18 – 26 and

S4 - Very high sodium water: SAR > 26.

Table 4.8

QUALITY OF WATER SASMPLE TAKEN FROM DIFFERENT LOCATION IN PROJECT AREA

WATER SAMPLES

PROPERTIES	AW1	AW2	AW3	MEAN
TDS Mg/L	114	96	119	110
EC Umhos/CM	100	90	90	93
Ph	7.5	7.7	7.7	7.6
Ca^+ Mg/l	18	16	14	16
Mg^+ Mg/l	22	18	21	20
Na^+ Mg/l	42	40	42	41
K^+ Mg/l	13	13	12	13
SAR	9.39	9.70	10.03	9.7

Quality Class C_1 S_1

REMARKS GOOD FOR IRRIGATION

Accordingly, the water from various canals in the scheme with means TDS 110mg/l, EC 100 umhos/CM, SAR 9.7 and ph 7.6 (table 1) can be placed C_1 S_1 – low salinity, low sodium water category. They appeared free from salinity, socidity problems and save for irrigation purposes.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

Survey showed that water logging, erosion and drainage problems appeared in the project area.

The commonest diseases in the project are malaria, yellow fever, Diahoea/dysentery and Trypanosomiasis. Rodents and birds usually eat crops causing reduction in yield. The irrigation water can be placed in C_1 S_1 – low salinity low sodicity category. They appear free from salinity/sodicity problem and are save for irrigation purposes.

To improve the condition in the zauro polder project irrigation scheme, the following recommendation should be adopted:-

(1) Regular addition of plant residues and organic manure to the soils in order to check soil erosion and improve soil physical condition as well as fertility.

(2) Careful land leveling in the project area to improve the poor drainage

(3) There should be adequate monitoring of the lateral canals in order to forestall illegal activities of the farm.

(4) The drainage and canals should be regarded so that smooth inflow and outflow can be attained.

(5) To prevent vectors of the diseases, control measures may be practised which includes irrigation maintenance, avoidance of over irrigation, use protective devices by the communities in the vicinity and occasional spray with biodegradable insecticides. Improvement of the sanitation in the living areas will be very useful

(6) Regular monitoring of the canals, farms and area for preventing their breeding or controlling them.

(7) A good scheme of health education should be incorporated to the extension workers who may educate the farmers on the environmental and public health issue.

(8) A continuous periodic monitoring of water is essential so as to embark on appropriate measure as and when necessary.

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APPENDIX

NVIRONMENTAL IMPACT ASSESSMENT OF IRRIGATION PROJECTS
CASE STUDY OF ZAURO POLDER PROJECT PILOT IRRIGATION SCHEME BIRNIN KEBBI

This questionnaire is designed to find out informations on the environmental impact Assessment of irrigation such as erosion, flooding, cropping, fishing, Domestic, animal Wild-life, Acidity, Alkalinity, Salinity and Climate (Rain & Temperature) water logging before and after construction of the pilot irrigation scheme.

(A) FARMERS CHARACTERISTICS:

1. Name of Farmer: ----------
2. Fadama Site: ----------
3. Age of Farmer: ----------
   - (a) Below 30 years ----------
   - (b) 31 – 40 years: ----------
   - (c) 41 – 50 years: ----------
   - (d) 51 – 60 years: ----------
   - (e) above 60 years: ----------
4. Village of farmer: ----------
5. Educational status: ----------
   - (a) Primary: ----------
   - (b) Secondary: ----------
   - (c) Post Secondary: ----------
   - (d) Adult Classes: ----------
   - (e) Others (specify): ----------
6. Marital Status: ----------
   - (a) Single: ----------
   - (b) Married: ----------
7. What is your primary occupation?
   - (a) Cropping ----------
   - (b) Livestock: ----------
   - (c) Fishing: ----------
   - (d) Hunting: ----------
   - (e) Civil Servant: ----------

. . . . /2

8. For how long have you been farming?: ----------

(B) FADAMA FARMING ACTIVITIES:

9. Which year is the pillot Irrigation Scheme constructed?

---

10. Which year is the Dyke constructed?:----------

11. Do you have any problem with the pilot Irrigation Scheme?: Yes or No: ----------

12. If yes above what is the nature of the problem?:

---

13. How many site do you have before construction of the Pilot Irrigation Scheme nand after the construction?:

---

14 What is the size of your farm before and after construction of Pilot Irrigation Scheme?: ----------

15. List major crop cultivated before adoption of Fadama Farming:

(a) ----------

(b) ----------

(c) ----------

(d) ----------

16. Please list new crop introduced on your farm under irrigated farming:

(a) ----------

(b) ----------

(c) ----------

(d) ----------

17. Please give account of your fadama crops output both before and after construction.

	CROP OUTPUT BEFORE	CROP OUTPUT AFTER
(a)	Tomatoes	Tomatoes
(b)	Onion	Onion
(c)	Pepper	Pepper
(d)	Rice	Rice
(e)	Wheat	Wheat
(f)	Garlic	Garlic
(g)	Maize	Maize
(h)	Others(specify)	Others (specify)

(i) Please specify the Unit(e.g. Mudu, Basket, Bags, e t.c.).

18. Did you change your planting period for any crop after the construction?:(Yes or No) _____

19. If yes give reason for your action(tick as applicable):
   (a) Better yield
   (b) Better price output
   (c) Subsistence requirement
   (d) Other specify

20. Do you practice animal traction?:(Yes or No) _____

21. If yes which year did you start?: _____

22. What is the benefit of the ~~Dam~~ project to you as a animal rearer?:

_____

23. How many times do you cultivate your Fadama land in a year?:

_____

	Before	After
(a)	Once	Once
(b)	Twice	Twice
(c)	More than twice	More that twice

24. What are the main problems of Fadama in your area?:

_____

25. Did you have any problem with the water supply for your farming activities before and after construction? (Yes or No): _____

26. If yes thick below:

	Before	After
(a)	Low	Low
(b)	Moderate	Moderate
(c)	High	High
(d)	Others(specify)	Others(specify)

27. Is there any water logging before and after the construction of the scheme? (Yes or No): _____

28. If yes to what extent is the water logging

	Before	After
(a)	Low	Low
(b)	Moderate	Moderate
(c)	High	High
(d)	Others(specify)	Others(Specify)

29. Is there any erosion problems before and after the construction of the scheme? (Yes or No): _____

30. If yes, how did the erosion damage the land?

	Before	After
(a)	Slightly	Slightly
(b)	Moderately	Moderately
(c)	Worstly	Worstly
(d)	Others(specify)	Others(specify)

31. How did the erosion afftected the production of the farm activities?:

	Before	After
(a)	Good production	Good production
(b)	Better production	Better production
(c)	Bad production	Bad production

32. Have you ever experience flooding before and after construction of the scheme? (Yes or No) ----------

33. If yes to what extent is the damage by flooding?:

	Before	After
(a)	Low	Low
(b)	Moderate	Moderate
(c)	High	High
(d)	Others(specify)	Others(specify)

34. Is there any changes in the Annual Mean Temperature before and after construction of the scheme? (Yes or No)

35. If eyes what is the different?:

(a) Low
(b) Higher

36 How does the change in temperature affect the farmers and the crop yield.

(a) Good
(b) Better
(c) Worst

37. Is there any changes in the Annual Mean Rainfall before and and after the construction of the scheme? (Yes or No)

38. If yes, what is the different?:

(a) Lower
(b) Higher

..../5

39. How does the change in the Annual Mean Rain Fall affected the farmer and the crop yield?:

(a) High
(b) Moderate
(c) Low

40. Please assess the plant and vegetation within and around the scheme after construction.

(a) More
(b) Less.

41. Please assess the plant and vegetation within and around the scheme before cinstruction.

(a) More
(b) Less

42. Please assess the production of fish before the construction

(a) More fish
(b) Less fish

43. Please assess the production of fish after the construction.

(a) More fish
(b) Less fish

44. Partaining to your general farming activities did you prefer the local way i.e. before construction of the scheme?

(Yes or No): _____

45. Partaining to your general farming activities did you prefer the construction of the scheme? (Yes or No)

_____

46. How will you rate the design of the Fadama programme as Development project.

(a) Well design
(b) Quite satisfactory
(c) Average
(d) Poor.