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WATER RESOURCES OF THE CHAD BASIN REGION

by
Franklyn R. Kaloko *

ABSTRACT

River basin development is seen as a very effective means of improving agricultural productivity. In the Chad Basin area of the Sahelian Zone of the West African Sub-Region, the water resources have been harnessed to ensure viable agricultural programmes for Nigeria. However, the resultant successes have met by many problems that range from physical to socio-economic and of which water losses have been the most threatening. The study has called for the use of Hexadeconal ($C_{16}OH$) film on the water surface of the Chad as a means of reducing evaporation.

INTRODUCTION

A theory of river basin development involves a set of rules in the form of programme that takes special account of a particular region and itemizes aims and objectives for improving the levels of living of the people in that area. Olayide (1980) attempted to enumerate those aspects of river basin theory which in view of a programme for national, economic and social development, strive at a close integration with the structures, features and variables of the development process in Nigeria. These include: (i) ".... the regional population in relation to the area of land available and land water relationship; (ii) the demographic situation in relation to water demand and job opportunities as well as the growth of Franklyn R.Kaloko,Ph.D. is Senior Lecture in Geography at the Departement of Geography, Fourah Bay College, University of Sierra Leone Freetown, Sierra Leone-West Africa. Productive enterprises now and in the future; (iii) the structure of government in relation to the administrative and political processes in the region. This is more relevant in a federalised political system that is backed up by growing administrative decentralization; (iv) the structure of the agrarian and industrial enterprise in growth terms and patterns of spatial distribution ...." (Faniran, 1972: 131).

* Franklyn R. Kaloko, Ph.D. is Senior Lecture in Geography at the Department of Geography, Fourah Bay College, University of Sierra Leone Freetown, Sierra Leone-West Africa.

The theory therefore indicates the importance of the rational use of soil and water resources to improve the farming system through power generation, reclamation of swamps and their effective cropping. Water courses are used as a means of transportation as well as for domestic purposes.

AIMS OF THE STUDY

It is the aim of this study to show that the efficient management of water in a predominantly Sahelian Zone has resulted in the development of a viable agricultural programme (Chad Basin Development Authority,1982). The study looks at the water resources potential of the South Chad area of the Chad Basin. It also attempts to assess its viability and future development especially in the emergence of renewed interest in agricultural development in Nigeria.

THE STUDY AREA

The South Chad Irrigation Project (SCIP) (Figure 1) is essentially confined within the Chad Basin Formation and is one of several schemes undertaken by the Chad Basin Development Authority. The others are:(i) Baga Polder, (ii) Gamboru Ngala Pilot Project, (iii) Lake Alau, (iv) Gongolon Rice Project.

The raison d'etre for establishing this project is essentially to tap not only underground water, but also surface water so as to make it available for agricultural purpose. The available water is also designed for domestic and industrial purpose. The physical landscape of the area is uderlain by the Chad Formation which was deposited during pleistocene time. It is composed essentially of lacustrine sediment that consists of beds of sand, silt and sandy clay, the lithology varying greatly both laterally and in depth. The sediments which are unfolded, dip gently towards Lake Chad (Udo, 1970: 181-89). However, the whole formation (Figure 2) is underlain by sandy drifts which are 100 m thick especially in Central Borno. The dark nature of the clay results from the accumulation of the organic matter.

The mean elevation of the area is about 287 m above sea level with the main lake having an altitude of 282 m. The slopes are generally uniform with an average slope angle of 1.04 to 2.70. Surface drainage ways are few and that feature coupled with the flatness of the terrain present flooding problems during the rainy season and more espically in those areas with low water infiltration rates. The rivers are fed by this flood water which rarely reaches Lake Chad.

The soil is characteristically alkaline.Ferruginous tropical and undifferentiated semiarid brown soils predominate in the study area. In other areas, there are azonal vertisols, regosols and alluvials-vertisols mixtures (Figure 3). The potentiality of the soils is medium to high (see Figure 3) and this assures a great pos-sibility for agricultural development in the study area.

The South Chad Irrigation Project area lies within latitudes 12^0 - 13^0 North and bisected by longitude 14^0 East. It falls within a restricted climatic band between the Sahara Desert and the region of tropical wet savanna, which spans across the

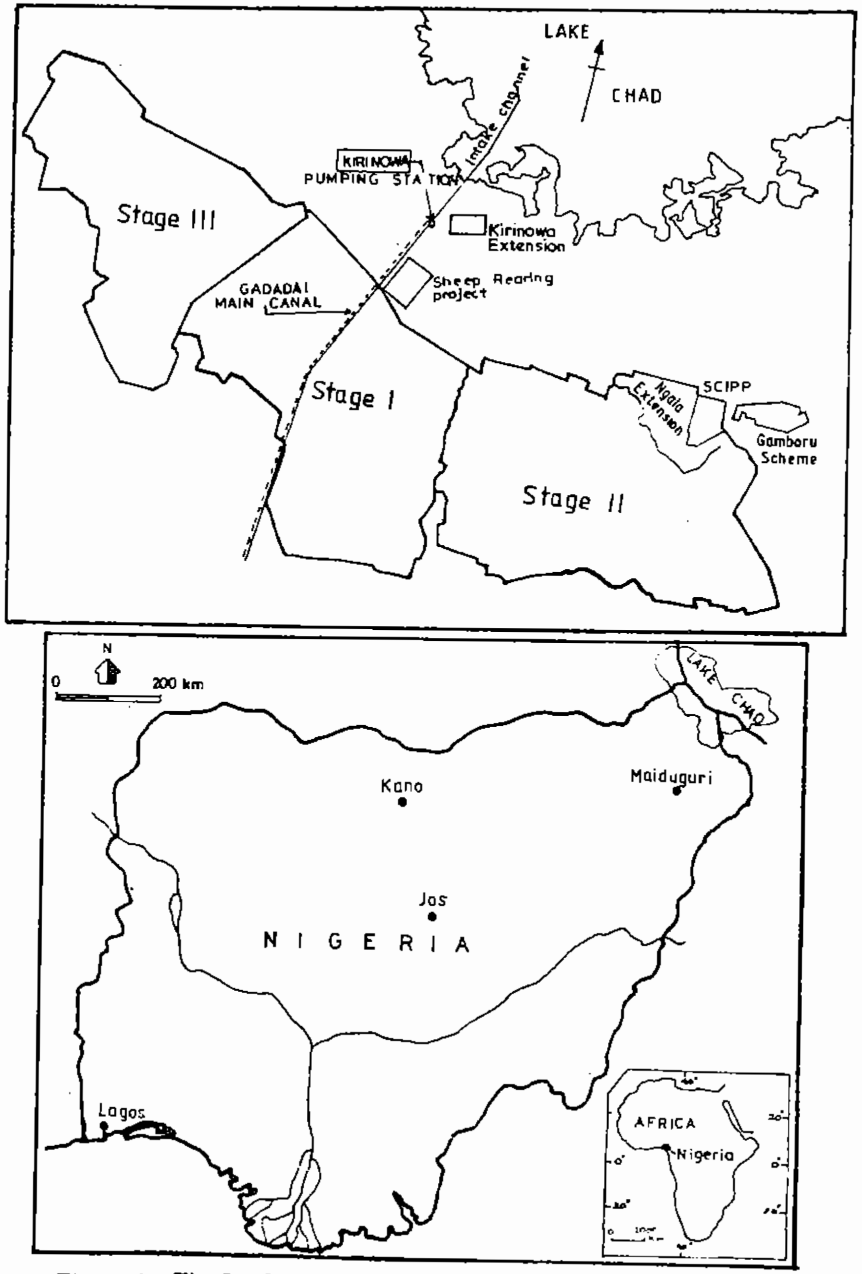

Figure 1. The Study Area : The South Chad Irrigation Project (SCIP)

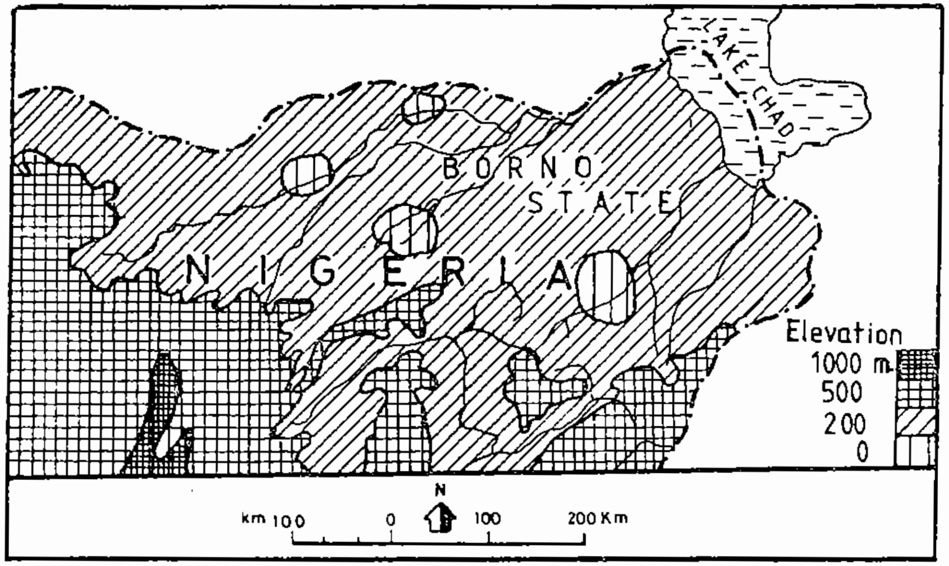

Figure 2. Study Area - Borno State Major Drainage System Topography

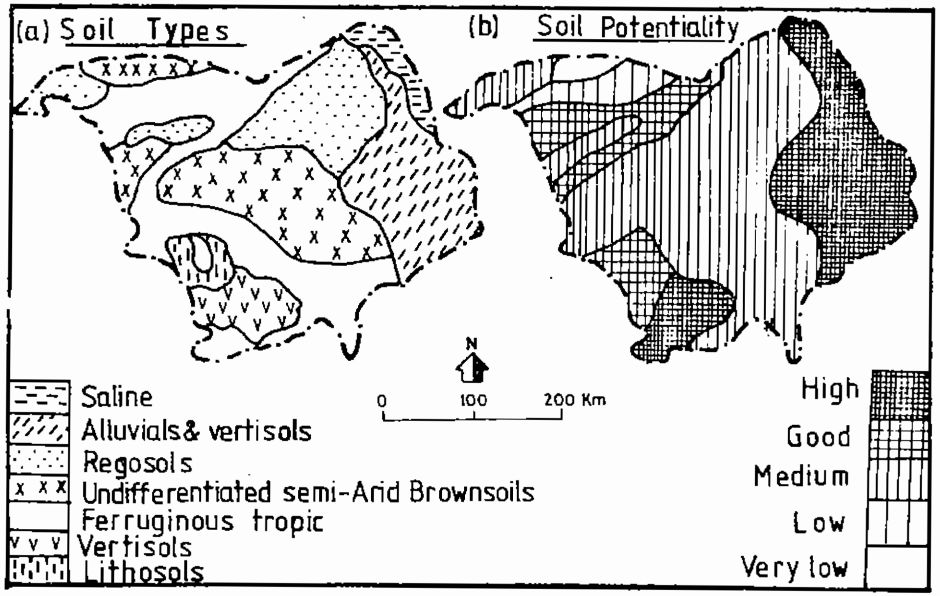

Figure 3. Study Area - Borno State, Soils

continent of Africa from the Atlantic to the Indian Ocean. Within this narrow band there is a significant change in climate characterized by a rapid decrease in rainfall (Table 1; Figure 4). The resulting vegetation is predominantly Sub-Sahelian type.

WATER RESOURCE AND USE

The principal source of water in the SCIP area is from surface water, reservoirs and marshes of which Lake Chad is the most important (Table 2). Other

TABLE 1. MEAN ANNUAL CLIMATIC FACTOR FOR MAIDUGURI AND NGALA IN THE STUDY AREA

Mean Annual Values	Maiduguri	Ngala
Temperatures (0C)	27.4	27.7
Rainfall (mm)	666	503
Penman E0 (mm)	2034	2722
Humidity (%)	48.9	46.4
Sunshine hours (Hrs./Day)	8.6	9.1
Wind speed (km/day)	112	230

sources include flood water, rainfall and underground water. Underground water can be extracted for domestic use presently, but its development in quantity for agricultural use cannot be ascertained. Besides low permeabilities, the water are of varied quality which precludes their general use in agriculture and occasionally for domestic purposes.

TABLE 2. MONTHLY LAKE LEVEL AND CHARI RIVER DISCHARGE FOR A LOW IN FLOW YEAR - 1968

Description	J	F	M	A	M	J	J	A	S	O	N	D	
Average lake level (M)	4.30	4.22	4.18	3.97	3.78	3.62	3.65	3.56	3.81	3.80	3.93	3.97	3.80
Mean Chari River Discharge (cu.m/sec.)	738	404	239	159	200	297	703	1500	2380	2690	2730	1050	10.0

Lake Chad is a vast area of shallow water with three fourth of its shores laying outside Nigeria in an area of 13,000 sq.km and 23,000 sq.km.(Chad Basin

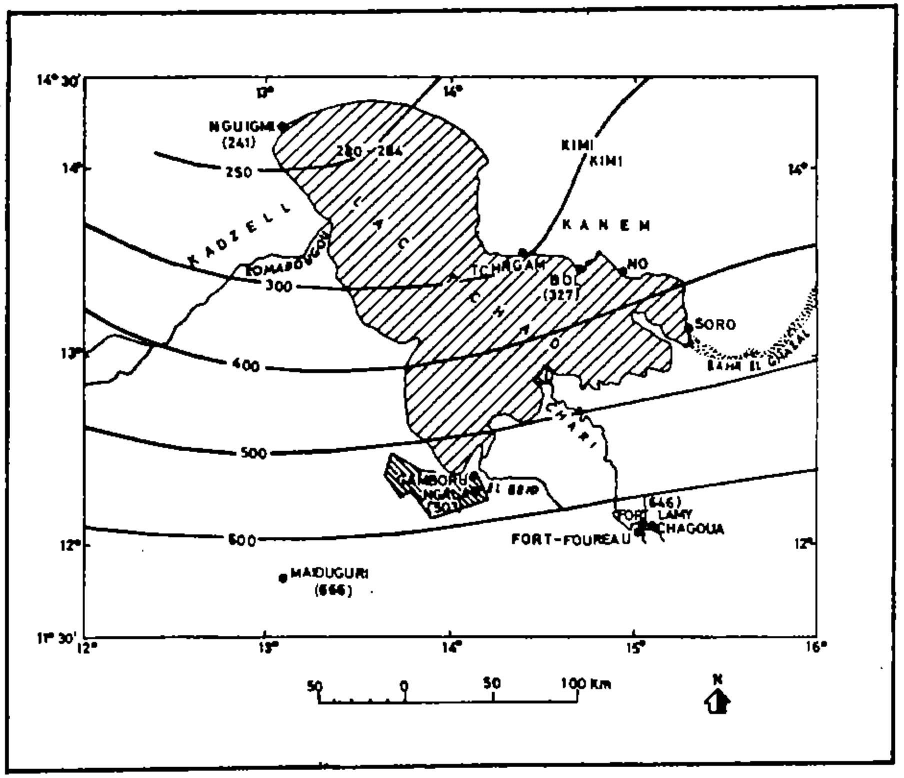

Figure 4. Mean Annual Isohyetal Map of Lake Chad Area

Development Authority,1982). The lake is an inland drainage lake, over 90 percent of the total inflow originates from the Chari which has a catchment area of 551,000 sq.km. The volume of water retained in the lake varies between 20 x 10^9 cu.m and 100 x 10^9 cu.m average depths varying between 1.5 and 5 meters. Interestingly, the average annual inflow into the lake via the Chari exceeds 66 percent of the average volume of water retained in the lake.

Effort a using the lake Chad water for irrigation started far back as the colonial period with the production of irrigated whear. This cultimated in the systematic survey of the Chad Basin between 1951 - 1954. Thereafter a series of project-based programmes in 1959, at Yobe River and Gamboru in 1962 with a total of 16,000 and 800 hectares of land were carried out respectively. By 1968, large scale irrigation was conceived with the assistance of the Food and Agricultural Organization (FAO) studies with research work on the heavy clay soils of Ngala giving indications of promising yield of wheat, rice and cotton. By 1969, therefore,

the Northeastern State Government through the United Nations Development Programme (UNDP) undertook a feasibility study of the South Chad Irrigation Project. Out of a total of 1000,000 hectares envisaged 16,000 hectares would be for immediate development. Other feasibility studies were carried out in 1971 with a pilot project initiated at Ngala.

Lake Chad is known to provide the principal source of water for the project area. The water from the lake reaches the project area by artificial canals comprising the intake channel that stretches about 19 km and 6 m deep in Lake Chad and 7 m from the mouth of the Kirinowa pump station (Figure 1). The main canal is 22 km long with both embankments and bed clay lined at a minimum of 1 meter thick and with Kirinowa and Cadadai pump station lifting water for 8.5 m and 5.0 m respectively.

For effective management of both surface and underground water, the Chad Basin Development Authority has devised many techniques. The distributions basin was designed in order to make water available for sometime when the inflow is low or temporarily halted. Small ridges were built in order to prevent inundation of crops in the farms and simultaneously to 'inhibit' water legging in the farming. Metal storage reservoirs thanks were built at strategic locations in the project area with the view to maintaining a a constant supply of domestic water from boreholes since the canal water is insafe for human consumption due to the vulnerability of bilharzia disease carried by snails.

CONSTRAINTS ON WATER RESOURCE DEVELOPMENT AND MANAGEMENT

Despite the technological ingenuity to harness the water resources if this area, there are general difficulties for the effective development which range from physical to socio- economic problems. This study will examine some of these problems and try to offer some initial suggestions to their solutions.

The project experiences lots of difficulties under components of water resources vis-a-vis rainfall and drought, flood , aridity, evaporation, water in unsaturated zone groundwater and surface water. Others include water quantity as well as demand and supply (Olayide *et.al*, 1980: 44-47).

Rainfall and Drought

Since the project area receives rainfall of less than 5000 mm, this poses a great problem in water development and management. Rainfall fluctuates sporadically and therefore could lead to acute drought, aridity and evaporation and consequently this limits the amount of flood water storage that feeds the River Chari. This may indirectly affect the level of Lake Chad. In such a situation there is mass recession of the lake water and an increase in saline content. The fluctuating water table also cause water logging. This is usually common where gravity irrigation is practised extensively deep percolation of irrigation water takes place at the upper reaches of gravity irrigation runs. In raises the water table to levels within the root zone. Water extraction, from the elevated water table occurs on evapotranspiration between successive irrigations and the water table recedes leaving its load of salts behind in the root zone.The decrease in rainfall will lead to an increase in drought, aridity and evaporation and consequently a decrease in flood water that feeds the lake.

Irrigation

Irrigation is an intensive farming operation both in terms of capital and labour. In order to ensure a reasonable profit on this capital mainly invested in equipment, it must not be allowed to sit idle. In the case of the study area with its distinctive harsh climate. a minimum of two irrigated crops has been propounded. This intensive cropping means a heavy draft on the soil's fertility bank. To circumvent soil exhaustion and sustain the productivity of the land, a large annual input fertilizers and manures have been used.

During the Third national Development Plan of the Federation it was emphasized that there should be large quantities of fertilizers available to the farmers so that they apply as much as 18.18 kg per cropped hectare. On the other hand, this is much too low for the irrigated farms of the project area. Therefore as much as 40 kg of fertilizers has been applied per hectare per year in order to make the project viable. However, not all the fertilizer is consumptively utilized by the crops. A portion of it is lost, normally by irrigation runoffs slushing the surface whilst another parts is lost as solution in delp percolating water during and following irrigations and rains. Both portions eventually find their ways into the drainage system of the immediate or distant watershed. Most of the phosphorus may be fixed on to the soil surfaces but the nitrates remain soluble throughout. The nitrate-charged irrigation return flow pollutes the drainage system in a variety of ways. Consequently, there is the prolific growth of algae in the streams and in the long run nitrate in livestock and humans a serious aftermath.

Similarly, the management of annual wastes which are likely to accompany the intensive operations in and around irrigation projects have their related problems. Studies have shown that a cattle generates 16.4 times as much waste as a person, a horse 11.3 times, as sheep 2.45, a pig 1.9 and a chicken 0.14 times. Adeniji (1975) confirms that unprocessed blood of slaughtered animals constitutes potent high protein waste in terms of its biological oxygen demanded for decomposition.

Nitrate pollution, likely spread of gastrointestinal diseases among humans and animals, increased biological oxygen demand. Load in streams, anaerobic decays in streams and desecration of the environment are a few of the likely consequences.

Impacts of Fertilizers on the Environment

In the way that fertilizers could create an environment problem, aerosols such as herbicides and pesticides may create an air polution problem. With higher intensity of cropping in the project area, a heavier annual application of these chemicals would be called for than that needed under dryland farming. While small dosages of farm chemicals may not be toxic to humans, a large accumulation of pesticides and insecticides is undesirable for human health and certainly fatal to lower order animals and birds. The usual mistake is to ignore this type of problem because its effect is generally slow and imperceptible for many years until it has

Canal Degradation

Seasonal flooding has been discerned to engender acute degradation of the canal banks and aggradation of canal beds which calls for constant dreging, thus increasing the operational cost of the project. On the other hand, poor water quality may limit the effective utilization of the water resource.

The construction of the Tigga Dam and manipulation of the head stream of the river has seriously limited the water of the River. Yobe and consequently affected the full utilization of Project, it portrays how uncoordinated planning can place a limit to water development.

Seasonal Inundation

It is also pertinent to say that due to the physiography of the terrain, the area may face a problem of seasonal inundation of the basin especially the irrigated fields. Oguntoyinbo (1978, pp 35-37) and Faniran (1977, p 202) observed that crops may be lost through flash floods which may drain or sweep the crops away. Added to this, such a project according to Faniran et al (1977,p 131) may initiate alternate run off and soil erosion vis-a-vis sheet, rill and gully erosion which bay have severe damaging effect on the crops perhaps due to indiscriminate deforestation, over farming and grazing. Many gullies have an average depth of 1.04 m and an average of 2.7 m with a mean slope angle of 10^0.

Water borne diseases may also restrict the usefulness of the water resources of the project especially for domestic uses. There is a very strong feeling though not yet substantiated in the canal water. This is seen to pose health problems to the inhabitants of the area.

Socio-Economic Problems

Apart from the environmental problems, socio-economic problems also limit the water resource development. These problems include lack of adequate effective institutions, financial and management resource coupled with international politics. Administration is very important in planning and realization of development and operation management. If the administration has no efficient staff, it might jeopardise the execution of water resource development.

A corollary of this is the issue of infrastructural institutions which may also pose a serious challenge to the project, such as electricity, adequate water supply, (and improvement), migration and land fragmentation. These will facilitate effective functioning of the project.

Finance is another that is important in water resource development. It can either accelerate or retard the process of water development and management. Although River Basin Development Authorities in the Federation were empowered (Federal Government decree 1976) to acquire land compulsorily, it also emphasised the need for adequate compensation and participation in the settlement of resettlement issues. Lack of finance invariably engenders non-payment of compensation on time, or compensation never being commensurate with the land value.

Lack of marketing facilities and incentives could ruin the whole scheme, because if the farmers could not dispose of their produce, the incentive to produce more will diminish.

Another important problem is the fact that Lake Chad transcends the Nigerian border. It is not uncommon for some of these countries to embark on a similar project which may leave little or no water in the lake. For instance, there has been reported cases of manipulation of the head streams that feed the Lake at the Cameroon side with consequent negative effect on the farmers using such rivers.

SOLUTIONS AND CONCLUSIONS

There is need to provide and conserve water in this agriculturally viable area. For lack of rainfall research needs to be intensified to understand the meteorological conditions of the study area and possibly to know the suitability of using the technique of cloud seeding to induce rain. These has been attempted with some measure of success in Southern Alberta, Western Australia and Israel. For this method to succeed, the moisture vapour content of the atmosphere in the study area must be rather high to allow the vapour to condense around the artificially introduced nuclei in order to fall down as rain. If on the other hand the vapour content is low, then whatever the amount of silver iodide that is sprayed, there will be resulting precipitation.

The study area depends to a very large extent on ground water resources for effective utilization of this, a conservation technique should be applied; for example boreholes should never be permitted to flow uncontrolled and the average rate of flow from boreholes generally should not exceed the limit of yield. To make sure that boreholes yield seasonal amount of water, the optimum spacing between boreholes be encouraged preferably 700 m and that abandoned and defective boreholes should be filled and plugged with drilling mud or concrete. However, this use of boreholes should not become a predominant feature despite the aridity of the study area and the dare need of water for agricultural success.

Adeniji (1977) worked out the cost benifit analysis of boreholes that make the reliance on them rather uneconomical. For example, he worked out that if a 150 mm diameter borehole were sunk in the first acquifer at 30 - 100 m depth and yielding 10 litres per second, this will cost about ₦ 109,000 to sink and for pumping and maintenance for ten years. For a 200 diameter borehole sunk in the third acquifer at 600 m depth and yielding 20 litres per second, this will cost about ₦ 700,000 per a period of 10 years.

There is therefore need to meet with the serious water problems of this area by direct attenuation of losses. These processes include seepage control in water courses and reservoir sites, reduction of open water evaporation as well as surface evaporation and evaportranspitration. In the study area, the intake channels of main canals were lined by clay to prevent water seepage and deep percolation because in the Lake Chad area, there is need to reduce this rate considerably. There are several open water surface evaporation control methods. Firstly, by reducing the ratio of the surfaces area to storage of reservoirs, the percentage of evaporation loss could be minimized. Sometimes the use of mechanical roofs, floating rafts and windbreaks will also hold back the evaporative effect in the area.

The use of Hexadeconal ($C_{16}OH$) film on water surfaces has been tested in some parts of the world and is here suggested for the reduction of evaporation in the study area. Several scientists, (Pockels, 1891; Robert, 1957; Raliegh, 1899; Rideal,1925) advocated the use of the chemical hexadeconal ($C_{16}OH$) spread periodically as a monomolecular layer on water surface can reduce evaporation by as much as 40 percent (Linsley et al., 1958). It is a white, waxy crystalline solid available in either flakes and derived from fallow or coconut ail and is tasteless and odourless and non toxic.

When spread as a monomolecular film, hydrophylic end is attracted to water while the hydrophobic end repels water molecules. Besides the film prevents the water molecules from escaping through the atmosphere above the water surface but it is pervious to both oxygen and carbon dioxide. It will not therefore hinder aquatic life of the lake.

The surface area of Lake Chad ranges from 10,000 to 25,000 sq. km the annual evaporation is about 2 m, a 40 percent reduction in evaporation would make available for beneficial uses of an additional annual minimum of 8000 million cubic meters and as much as 20,000 million cubic meters of water. If 1.5 meters of irrigation is supplied per year, these savings from evaporation will irrigate additional 523,330 and 1,333,330 hectares of land respectively.

The use of this method to control evaporation is best ettempted in plot projects to ascertain its feasibility on a bigger scale that covers the whole study area. This is more as because hexadeconal has been known to be harmful to human, or any organic life, besides it is aesthetically, religiously and culturally acceptable. This author contends that the control of evaporation is a let cheaper than that to provide alternative water especially in the circumstance of the prevailing climate of the study area. Problems in the realization of the water conservation method arise but for large scale projects like the South Chad area, but for large scale project like The South Chad area it is necessary to try this out.

The management should discourage further deforestation in this area and at the same time encourage afforestation programmes. It has been observed that the rate of aggradation is correlated to the rate of degradation which is the function of negative clearance. It is shown that increase in vegetation leads to decrease in degradation and aggradation respectively and vice- versa.

Faniran (1972 : 131) contends that forest or vegetation clearing and indiscriminate farming in the water shed have implications for flow regime and the sedimentation load carried down stream, excessive silting on the canal as a result of erosion could engender flood during the storm of high itensity and short duration characterised of this area. The effect of the farm is better imagined than described. It is therefore strongly recommended that channel improvement, proper management of the soil, vegetation resource of the cathment areas and construction of ice levels, spillways and flood ways are obvious.

Similarly, afforestation simultaneously will help to increase infiltration rate which may be necessary for recharging of underground water reservoir. For steady improvement of water quantity efforts should be itensified to reduce much contamination of water by environmental pollutions especially through solid wastes disposal etc.

The role of water as an important element of the natural environment cannot be overemphasized and therefore should be regarded as a free gift from nature. It calls for adequate harnessing and management. There should be a lot of conservation considering the enormous amount of water lost through evaporation and other areas.

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POPULATION MOBILITY AND THE LINKS BETWEEN MIGRANTS AND THE FAMILY BACK HOME IN NGAWIS VILLAGE, GUNUNG KIDUL REGENCY, YOGYAKARTA SPECIAL REGION *

by
Ida Bagus Mantra**

ABSTRACT

The total population of Yogyakarta Special Region was 2,966,549 persons in 1985, while the population density was 931 persons/sq.km. The Yogyakarta Special Region is one of the poor areas of Java in an economic sense.

The annual rate of its population growth is much lower than those of other provinces in Java. The region experienced a net loss of population through migration. The losses were greater in the poor areas of Gunung Kidul, one of its regencies.

This study aims at developing the knowledge on the nature and incidence of population mobility from the rural to the urban areas, and investigating the extent and nature of the links established and maintained between the area of origin and the area of destination, by temporarily returning migrants in Ngawis Village of Gunung Kidul.

The main reason for migrating out of the village is an economic one. Although the greater part of returning migrants stated that their economic conditions improved after moving out, the income they receive monthly is still low. The link between migrants and their relatives back home is very intensive. They maintain contact by visiting, sending letters, money and goods, and exchange views and ideas on developmental issues.

INTRODUCTION

The heavy stream of traffic moving into Yogyakarta City in the morning is a familiar phenomenon, as is the reverse movement away from the city in the afternoon. This phenomenon can be attributed to the fact that many people live in the rural areas around Yogyakarta and work in the city.

* A part of this paper was taken from a paper entitled "*Population Mobility and Links between Migrants and Family Back Home: A Case Study of Two Villages in Yogyakarta Special Region, Indonesia,*" by Ida Bagus Mantra and Sho Kasai (1987).

** Dr. Ida Bagus Mantra is Senior Lecturer in Population Geography at the Faculty of Geography and Research Associate in Population Studies Center, Gadjah Mada University, Yogyakarta, Indonesia.