

Significance of a Small Dam Project in the Sustainable Environmental Management of the Sorau Cross Border Community of Adamawa State of Nigeria

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ABSTRACT

Sorau is a cross border community of Adamawa State of Nigeria with residential structures in Nigeria and some farm lands across the Mayo (River) Jilayel – a tributary of Mayo Tiel, into the Republic of Cameroon. Situated at the foothills of the Adamawa highlands adjoining the Cameroon highlands, the surroundings are characterized by poorly weathered shallow soils with predominant rocky outcrops of quartz and other rock minerals dotting the landscape. The close proximity to the Cameroon Mountain makes the rainfall pattern orographic in nature, for a greater part of the year. South of the town and along the valley of the river, are some relatively deep weathered soils used for arable crop production in addition to the extensive livestock management in the area. Limited infiltration along the rocky slopes with shallow soils nearby, result in extensive sediment load in the surface runoff and the streams and river flow into the Mayo Jilayel and other rivers including Mayo Tiel, such that flooding, deep gullies that erode roads, bridges and human settlements are common place. The Sorau small dam across the Mayo Jilayel, regulates flow into the lower Mayo Tiel basin such that flow velocity is reduced through the erected embankment, reduces flooding, topsoil erosion and sediment load and even cause sediment deposit upstream to reclaim eroded stream and river channels, as well as dissipate the erosive energy that threatens the human settlement structures downstream. The reservoir water provides raw water for the supply of potable wholesome water to the community all year round and some for irrigated agriculture that not only boost the local economy and reduces poverty but also support a viable livestock management. In view of the cross border nature of the community, the dam project not only enhances sustainable environmental management among the indigenes of the Sorau Community in Nigeria but also their kits and kin separated by the international political boundary thus further cementing international peace and harmony.

Key Words: Cross border community, small dam project, Mayo (River) Jilayel, environmental management

1 INTRODUCTION

1.1 Preamble

Dams are man made water resources developments of various magnitudes that result in harnessing water for man's vital physiological (biological), economic and industrial needs. Their development, at least in the recent times, has been found to involve wide scale ecological transformations. Throughout civilization, man has been known to be so dependent on water that right from the early man, his growth and development from early civilizations have revolved around water bodies like the Nile to the Egyptian as the Euphrates and Tigris to the Mesopotamian civilizations. Even till today there is hardly any human settlement that is not within serviceable boundaries to a water source. It is in this regard that dams as anthropogenic interventions are still being vigorously pursued to supplement natural water bodies in the support and sustainability of human civilizations. This is in terms of harnessing water to supply drinking water for

human consumption and development, provide water for irrigation, hydroelectricity, industrial processes and ensure flood water control. It has been estimated that over 40,000 large dams and 800,000 small dams have been built, while 272 million hectares have been put to irrigation worldwide (Keiser *et al*, 2005). This magnitude of developments has individually and collectively been reported to result in numerous ecological modifications, most of which have negative impacts on the environment and ultimately the state of well being of the human populace. Notable among these is the prevalence of water borne and water related vector borne diseases such as malaria, schistosomiasis, and onchocerciasis among others. Most large dams and sometimes their attendant irrigation schemes also involve displacement of persons causing a disruption in the socio-cultural heritage and orientation of the resident populace. Also the management of these large dams and their irrigation schemes has not been host community friendly such that while they generate little economic benefits to the local and further communities they result in enormous failures (adverse impacts) most especially on the host communities, resulting in deprivation, poverty and disease. It is in this regards that recent opinions have favoured small dams and irrigation schemes which can be more efficiently managed to drastically reduce these adverse effects of large dams and irrigation schemes.

1.2 Location of the Project:

The dam project is located on Mayo Jilayel at Sorau Town in Maiha Local Government Area of Adamawa State of Nigeria that is about 103 kilometers to Mubi on the Yola - Mubi road through Jabi Lamba and Bitu Malabu. Sorau is a boundary town on the Nigerian side of Nigeria and Cameroon border and lies relatively on a lower terrain of about 409.7 MSL (1352 feet above sea level). It is surrounded by the Madama Range and the Bonja Hills to the south west and the Bomin, Larci, Magirdaki and Milbem Hills to the North. Northwards to Mubi through Maiha Town (the administrative capital of the Local Government Area), the topography is mainly rolling with ranging inselbergs and hills of basement complexes with predominant crystalline composition of the granitic and quartzite fractions. Weathering is of low to medium, forming concretionary shallow soils on hilly slopes which are sometimes underlain by bed rock that obstructs intra profile drainage and enhances extensive sheet erosion at the upper slopes of the surrounding hilly terrain because of the high velocities of runoff. However, there are some reasonably weathered soils south of the town and towards Wuro Alhamdu and along the road towards Belel town.

1.3 Climatic Conditions of the Sorau District:

There is no meteorological station at Sorau town or any part of the District, but estimates were made from readings from the nearest stations at Jabi Lamba and from the Yola Airport. These showed that the hottest months are between March and May of each year with daily temperatures exceeding 38⁰C and peaking at 42⁰C in most years over a 20 year data review while November to February were recorded as the months with the minimal temperatures which range from 16.4 to 19.5⁰C. Within the 20 year period, monthly averages of temperatures ranged between 35.7 and 39.4⁰C with annual averages of between 28 and 32.7⁰C.

Wind speeds are generally high for a greater part of the year with figures in excess of 70km/hr. Annual average sunshine hours are in excess of 150 hours with the months August, November and December recording the lowest figures due to cloud cover and harmattan haze during these months. Information on relative humidity values indicates a range of 21% in the month of February to 80% in the months of August and September. During the 20 year review period, open pan Class A evaporation readings for the area show lowest figures for August with 184mm and highest figures in March with 405mm.

The rainfall in the area is typically orographic, in view of the close proximity of the area to the Cameroon Highlands and the being within the Adamawa hills region. Rainfall in the area starts as early as April and end in October. From the collected climatic readings annual range of rainfall were observed to be between 1,720.5mm and 2,013.0mm.

1.4 The Vegetation of the Area

The vegetation is predominantly savanna, with a good herbage reservoir that supports extensive livestock management. There are visible presence of tall and thick grass elements which consist of *Andropogon spp.*, *Hyparrhemia spp.*, *Pennisetum pedicellatum*, *Schizachyrium sanguineum*, *Imperata cylindrical* and

Londetta arundinacca among others. Thickets of shrubs which consist of notable species like *Anonas senegalis*, *Poliostigma thinningii*, *Terminalia spp.* and *Uapaca togoensis* are also present among the vegetation. There are some woody species among which *Detarium microcarpum* is dominating. As part of the Middle Belt Region (MBR), include the riparian species like *Eleis guinensis*, *Azelia Africana*, *Albizia zygia* and *Terminalia laxifolia*. There are also scattered trees which include *Butyrospermum spp.*, *Daniella oliveri* and *Parkia clappertoniana*

1.5 Hydrology of the Sorau Area

The Sorau area is part of the Upper Benue River Basin. Because of the terrain, surface runoff in form of flood water is the principal source of recharging the surface water bodies and the upper aquifers. The assessment of the contribution of this runoff especially along the side slopes of the surrounding hills to the town shows a very significant contribution equivalent to about 38% of the total runoff from the catchment. The usually swift flowing floodwater is highly loaded with sediments and flows into the nearby water bodies like the Mayo Jilayel, Mayo Wanna and Mayo Pandi which are tributaries of Mayo Kurndul. The enlarged Mayo Kurndul further receives drainage waters from Mayo Baddi, Mayo Dishi, Mayo Pete, Walewol wojin and Mayo Garebiyel. This in turns meets the Mayo Pandi at Dundee and drains southwards to link up with the Mayo Tiel from the Cameroon Republic. Sometimes water from the lakes Girin, and Chafon Njarandi join the rivers to form the enlarged Mayo Tiel finally drains into the River Benue. Estimate of annual runoff within the catchment is about 8.67 million cubic meters of which 38% (2.8 million cubic meters) will drain into the reservoir. From this, it is deduced that the reservoir will be adequately replenished with water annually from surface flows. Since the swiftness of the surface runoff determines the rate of sediment transport (Richards, 1982) the water flow from the hillside slopes becomes sediment-starved (hungry water) and significantly erode the channel bed and banks, producing river channel incision (down cutting), eroding roads, bridges and housing structures in Sorau and other settlements near the river channels (Kondolf, 1997). These sediment loads are later deposited along the natural drainage channels downstream to create flooding conditions that further aggravates the erosion of adjoining lands when flood water recedes. Sorau had witnessed flooding spells in 1992, 1996 and 1998. The flood water during the rains is immediately lost beyond these sloping areas immediately after the rains creating near drought conditions during the dry seasons because of the heavy sediment load in the flood water.

The groundwater yield of the area is very high. This is probably not unconnected to the very porous nature of the soil profile despite the location being of the basement complexes. It is presently the source of domestic water supply through hand pumps which number about six within the town. Like the surface waters, the quality of the ground water resources is well within internationally acceptable limits for drinking and agricultural uses.

1.6 Socio-Economy of the Sorau Community

Sorau town is a relatively large nucleated settlement. It is a District capital in Maiha Local Government Area in Adamawa State. It is home to many tribes like Fulani, Hausa, Kanuri, Holma, Kilba, and Kurdu among a list of 15 tribes. The Maiha Local Government Area Office of the National Population Commission had a population estimate of 7,410 (3,090 males and 4,320 females) by 2000. The people are mainly farmers, growing arable crops, vegetables and tree crops. Among arable crops grown are millet, tamarind, maize, cowpea, thinya, soya beans, date palm, cotton, fruit trees and groundnuts. Vegetables include peppers, tomatoes, and sweet potatoes. Despite the shallowness of the soils and low fertility status, agricultural activity is very high with extensive use of farm yard manure (from household and farmstead wastes). Chemical fertilizers are in use but application is subject to availability and resources to procure them. Farmlands are individually owned. Within the Sorau District women can own farms, plant and derive revenue from farming activities and also from their husbands' and relatives' farms. Despite this the official land use decree is very well respected. However, land within the residential area, around the town and even across the river (Mayo Kurndul) is communally owned and shared among families and households. The vast lands outside the normal residential and farming activities are regarded as government land (especially within the Nigerian side of the river). There is some agricultural assistance to farmers from the Upper Benue River Basin Development and Rural Authority and the State Ministry of Agriculture.

Tractor hiring services in the district had collapsed due to dwindling economy from the era of Structural Adjustment Programme (SAP) in 1986.

Livestock is a very important economic and agricultural asset. This includes cattle, goats, sheep, poultry, guinea fowl and ducks. These, especially are managed extensively over the range while the birds are managed at homestead levels by free ranging. Farmers' – Pastoralists' conflicts are rife and these are managed adequately at local administrative levels and at Local Government levels. The machinery of settlement is extensive and broad based with representatives of the pastoralists, farmers, law enforcement agents, traditional administration ensuring adequate compensations for damage to any party even migrant pastoralists. Agreements are enforceable and have always resolved the conflict situations. Sorau District has a livestock population of 7,878 out of 23,528 heads of cattle in the Local Government Area (Maiha Local Government Agricultural Department, 2001)

The disease pattern as reported by the Health Department of the Maiha Local Government showed that malaria, dysentery with and without blood, pneumonia and sexually transmitted diseases are the most prominent reported diseases in the area. Reported cases are 2,001 and 1,227 for malaria (in 2001 and second quarter of 2002), 4,178 and 637 for dysentery without blood, 2,788 and 402 for dysentery with blood, 2,850 and 476 for pneumonia and 770 and 138 for sexually transmitted diseases.

Infrastructural development of the area is relatively very low. There is a very poor road network in the town to the local government headquarter and to Mubi, the provincial capital of the area. Water supply by hand pumps are courtesy of the erstwhile now defunct Department of Foods Roads and Rural Infrastructure (DFRRI) of the 1980s. Electricity supply to the town had not been functioning as the transmission lines were seriously damaged by rainstorm before commissioning. This had to be rewarded later to connect the area to the national grid. Telephone services are not in existence although some of the indigenes are engaging the GSM operators to link the area up in their network services. In view the lack of infrastructural services there is absence of many industrial establishments except agriculture and livestock management.

2 DAM PROJECT DETAILS

The dam project consists of a small earth dam, a water treatment plant for the supply of wholesome potable water to Sorau community and neighbouring settlements and an irrigation scheme to support the agricultural activities of the settlements. The details of these are provided below.

2.1 Dam Characteristics

The dam structure consists of an impoundment with a maximum elevation of 336.0 MSL. It is an earth dam with a concrete diaphragm constructed along the Mayo Jilayel. It was designed by Messer Ecosystem Consult Nig. Ltd., in 2002. Details of the dam specifications are presented below. The dam crest is constructed of compact fine clay core fill supported with fine and coarse transition material to the core. The upstream and downstream slopes are compacted shell filled and have a filter layer at the top slope, while the down stream consists of chimney filter and horizontal filter below the compacted coarse aggregate fill. The coarse transition fill material is an aggregate rock riprap of granite material on the top of the down stream and upstream slopes. The rip rap is used as reinforcement at the dam toe drain and to prevent erosion which could threaten the dam crest foundations.

Table 1: Detail of Dam Characteristics (source: Ecosystem Consult Nig. Ltd .August 2002)

Maximum height of Dam	8.00m
Length of Dam Crest	750.00m
Dam crest	338.00 MSL
Maximum Water Level	336.00 MSL
Spillway Crest Level	336.00 MSL
Elevation of River bottom	330.01 MSL
Type of Dam	Small Earth Dam with Concrete diaphragm wall
Top width of Dam Crest	5.50m
Down stream slope of embankment	1:2.5
Upstream slope of embankment	1:3.0
Reservoir Area	15 ha
Approximate catchment Area	13 km ²
Dead Storage Capacity	0.795 x 10 ⁶ m ³
Live Storage Capacity	2.8 x 10 ⁶ m ³
Gross Storage Capacity	3.595 x 10 ⁶ m ³
Type of Spillway	Baffled Chute plus auxiliary spillway
Spillway capacity	100 m ³ /sec
Stability factor against slipping of embankment	1.5 steady state seepage 1.25 Rapid draw down 1.00 For a combination of both

2.2 Irrigation Scheme

The Reservoir has an operational storage capacity of 2.8 x 10⁶ as it is designed. With this, the dam facility is supporting an irrigation scheme by supplying irrigation water to support supplementary and complete irrigation of suitable crops over 72 hectares of developed land. The developed field plots are rectangular in shape and are laid out in sizes of 1.6 net hectares and a gross area of 2.0 hectares including the field canals and drains. The layout of the developed irrigation scheme also include primary, secondary and tertiary (field) canals. Access roads in the form of secondary and tertiary roads are provided adjacent to the primary, secondary and field drains. The field structures are appropriately dimensioned to facilitate efficient water distribution to irrigate the fields. Operationally water is conveyed in closed pressurized AC pipes from the dam reservoir over a distance of 2.5km to a fore bay located at 330.40 MSL where water is distributed by gravity through the described field laterals and canals to irrigate the laid out field plots south of the dam axis near Wuro Alhamdu. Among the crops grown under irrigation in the floodplains component of the irrigation schemes are maize, swamp rice banana, and vegetable crops, while in the upland areas of the scheme, maize, upland rice, soya beans, fruit trees and sweet potatoes are cultivated. Most of the crops will be grown under supplementary irrigation while swamp rice, sweet potatoes and vegetables will be grown under complete irrigation. As recommended during the Environmental Impact Assessment the practice of fodder bank cultivation is not yet fully practiced but has scope as a panacea to the growing need for livestock feed especially during the dry seasons when transhumance is the only option to feeding the livestock population in the area. Therefore the introduction of a good herbage/forage legume mixture into the cropping pattern in the dry season will not only support the active livestock industry but also supplement the fertility of the soil.

2.3 Domestic Water Supply Scheme

One of the primary reasons for the establishment of the project is to provide wholesome potable water to the Sorau and nearby settled communities. With a projected increase in population to 2010, it is estimated that domestic water demand in Sorau town will be about 6.6 x 10⁶ litres per day. This amount of water cannot be met by ground water abstraction alone as is presently the case by the use of hand pumps. This project therefore is a deliberate intervention to satisfy the immediate water needs of the community as it grows into the future. Therefore a suitably sized water treatment plant to deliver 12 litres per second of treated water is erected in the community to supply this treated water. It is hoped that this will significantly

minimize some of the water borne and water related diseases like dysentery with and without blood. The water treatment facility consists of a low lift facility to take in raw water into the treatment plant where the water is strained and passed to the coagulation chamber where it is thoroughly mixed with alum (aluminum sulphate) before being passed to the sedimentation chamber for filtration. Filtered water now free of suspended and some dissolved contaminants is subsequently passed to a disinfection chamber where it is mixed with chlorine gas or chlorine dioxide as the disinfectant in the clear water well. High lift pumps are used to lift the water to two elevated tanks located at the south and northern ends of the town. Some stand pipes are strategically located to support the supply of water to the various households even though majority of households are being served through individual connections which are duly charged.

2.4 Fish Ponds

This was one of the proposals for the completeness of the project to complement the arable crop production. However, it had not fully taken off as the members of the community had looked on the reservoir for their fishing activities which had to be restricted since the reservoir is primary providing the raw water for treatment and distribution for domestic uses. Being an agrarian community it is most probable that the awareness will gradually grow to include fish ponds within the flood plains of Mayo Jilayel immediately after the dam embankment. Also, more extension activities are still required to make the indigenes more aware of the fishing potentials and attendant advantages from fish ponds.

3 ENVIRONMENTAL SIGNIFICANCE OF THE DAM PROJECT

Before the commencement of the project there was an Environmental Impact Assessment of the project at the design stage to enhance its environmental sustainability and in fulfillment of the statutory required as demanded by Decree 86 schedule B section 13 and sub section 13(bi) and 19(a). An environmental audit of the project revealed that, most of the probable impacts identified in the EIA report of the project are already obtainable among these are:

3.1 Positive Impacts

3.1.1 Flood Water Control

The dam has significantly reduced flood water flow around the Sorau environment. This is because the collection of the hillside runoff in the impoundment greatly dissipates it of its erosive energy thereby rendering it less erosive and less degrading to the soil resources in the area. There has been a significant reduction in the devastation to household and structures due to the flooding incidences especially during the rainy seasons. Also the ever increasing fear of flooding and its devastations on the on set of the rainy seasons has seriously decreased as so is the risk of flooding.

3.1.2 Water Supply to the Community

Water Supply to the Community through the surface impoundment has provided a more reliable water availability all year round to the Sorau community. Even though the ground water supply through the use of hand pumps is relatively available, the problems of servicing the hand pumps rendered them inadequate when a break down occurs. The present water treatment system ensures a more wholesome (healthy) and dependable water to the community in the present and into the future. It will significantly reduce incidences of water borne diseases like dysentery with and dysentery without blood.

3.1.3 Improvement in the River Biology

The impoundment of the water in the reservoir has made water to be available all year round despite the level of sediment load. As a result there is a gradual generation of all year round aquatic ecosystem within the impoundment thereby encouraging the development of relevant benthic fauna and flora, both in quality and quantity in the reservoir and upstream, which could not have been possible without the reservoir due to the relative dryness of the river for parts of the year. Also perennial nature of the impoundment is encouraging the growth and development of a viable riparian ecosystem which will include micro- and

macro- organisms including fishes and their supporting invertebrates. Ultimately fish development will increase to support regulated fishing as long as it does not compromise the integrity of the reservoir water as a drinking water source.

3.1.4 Improvement of Agricultural Production

The development of irrigation activities on the 70 hectares down stream of the reservoir is enabling the cultivation of more crops and additional area of land to increase rain fed agricultural production. The increased production has contributed to increased revenue to the average farming family, enhance their purchasing power, their standard of living and in the long run ensure food security for the nation. Also available has resulted in more water available for the livestock industry. This is further enhancing agricultural productivity and an improvement in national food security.

Improved water availability is also an encouragement to the domiciled Fulanis to engage in dry season growing of rich fodder crops for their livestock to prevent the stressful nomadic life which not only stress the cattle and lower their animal quality but also exposes the human beings to undue health risks. Such sedentarized livestock owners will be saved the drudgery and risks to life attendant to nomadic life and provide livestock owners with a more satisfying employment of tending to their cattle and have more opportunities for other productive ventures like fodder crops cultivation to feed their animals and for sale to other migrant herdsmen to earn more revenue. This enhances their standard of living.

3.1.5 Improvement in International Cooperation between Cameroon and Nigerian Communities

The good neighbourliness between Sorau and their counterparts in the Cameroon is further strengthened by the dam project as the Cameroonians have started sharing in the access to the reservoir water with their Nigerian counterparts for their livestock and in the participation in the irrigation activities during the dry season. This is cementing the cordial relationship between the peoples separated by these colonial boundaries and is fostering cooperation among the peoples.

3.1.6 Dividend of Democracy

The community is satisfied with this project as a dividend of democracy to them and the project is making the people to be politically and socio-economically satisfied to contribute to national development instead of feeling politically and economically marginalized. This will further enhance their chances of receiving further infrastructural development due to their full involvement in the political and economic activities of government.

3.1.7 Sustenance of Wild Life and Recharge of Groundwater

The presence of the body of water on a perennial basis will attract wild life to the area for their water need. With the wooded hills in close proximity, an appropriate sanctuary is being developed around the lake reservoir and thus enhancing the propagation of valuable species of wild life. It is also possible that different birds of different types and sizes will now be attracted to the area including migratory ones.

With the lake reservoir in place now, there will be a gradual recharge of the ground water resources through intra-profile seepage. There will be gradual upward rise of the water table for a greater part of the year

3.2 Adverse Impacts

3.2.1 Downstream Ecology

The operation of the dam has significantly reduced flow of water down stream especially after the cessation of the spillway, such that subsequently the habitats and riparian forests downstream may subsequently be affected. It is also possible that non riparian species may gradually be encroaching into the riparian domain down stream of the dam embankment.

Close examination has shown that because of the numerous tributaries to the Mayo Kurndul to which the Mayo Jilayel drains, the likelihood of this occurrence in the immediate future is not foreseen. This is because as the gradual starvation of the down stream sets in, tributary recharge will minimize the immediate shock of the reduced flow until seepage beneath the dam becomes a major portion of the stream flow. This will create an insignificant impact in the long run. Also, the planted riparian species of trees upstream of the reservoir as protector of the lake shoreline will compensate against any loss in biodiversity of the riparian species.

3.2.2 Close Proximity as Source of Danger and Risk of Drowning

The close proximity of the reservoir to the Sorau town is a potential source of risk to the community. This is because the inhabitants face the risk of drowning in the reservoir as living quarters are less than 1 kilometer from the reservoir periphery.

Now that the reservoir shore has been properly fenced, the risk to life posed by the reservoir will be minimal as some form of restriction has been put in place to restrain the populace from unguarded contact with the reservoir. Also, regular awareness and publicity should be regularly mounted to enlighten the community of the inherent danger of drowning and hence guard against carelessness within this restricting fence.

3.2.3 Increase in the Population of Mosquitoes and Black Flies

The body of water is an attractive breeding ground to mosquitoes with the attendant increase in incidence of malaria and yellow fever in the community. The introduction of malophagous species of fish species like *Clarias gariepinus* and *Synodontis species* and larvivorous species like *Gambusia affinis* and *Lebistes reticulates* in the reservoir will check snail and mosquito populations in the reservoir removing the threat of mosquitoes and black flies that could make the diseases of malaria and schistosomiasis endemic. Further more regular weed control at the reservoir edge will prevent the breeding of the mollusks and mosquitoes.

4 SUMMARY AND CONCLUSION

From the foregoing, the erection of the Sorau dam and its support projects of irrigation and domestic water treatment facilities have transformed the local Sorau environment such that the constant fear of flooding and its attendant devastation every rainy season is no longer a reality. The project has provided all year round reliable availability of water for domestic and agricultural use such that there is improvement in the health and wellbeing of the populace of this community, while also providing additional source of revenue to members of the community, thus enhancing their standard of living. The environmental benefits of this project to the Sorau community are numerous and widespread that their kits and kin in the Cameroon Republic will also benefit to the extent that this good neighbourliness will cement international cooperation among nations that some few years ago were so daggers drawn that had to resort to the International Court of Justice at the Hague for arbitration

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