

Intensification of Agriculture as the Driving Force in the Degradation of Nzoia River Basin: the Challenges of Watershed Management

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Abstract

The Lake Victoria riparian countries suffer from devastating effects of floods and droughts occasioned by severe weather related natural phenomena. The floods often follow prolonged droughts that have become a mark of despair for the communities living in the region. Climate change and anthropogenic factors causing land degradation such as deforestation of catchment areas, poor agricultural practices, inappropriate livelihood systems and changing land use systems are established to be the contributing factors. The physical setting of the flood impacted areas also play a major role. Whenever the floods and the droughts occur they are accompanied with serious human distress, suffering and fatalities with disruption of human settlements, damage to infrastructure, crop failure, disease outbreaks and disruption of the ecological environment. Two case studies illustrating the effects of intensified agriculture and the changing livelihood systems at the upper part of Middle Nzoia Catchment at Nzoia sugarcane growing area and the flood plain area of Nzoia River at Budalangi are presented to show the potential of geoinformation technology in assessing and monitoring land use changes and the impacts therein. SPOT image data show intensification of sugarcane growing with every inch of land under crop. All the wetlands along Nzoia river have been drained up to the riverbank. Although the problem is aggravated by rapid population increase the land use policy has disregarded the land potential, its carrying capacity, and limitations of the land resources as well as their diversity and distribution. The conversion of the land cover into a mono-crop agricultural cultivation is evident from the time series Landsat image interpretation for the area.

Introduction

The Lake Victoria riparian countries of Uganda, Kenya, and Tanzania view the lake as a critical resource that requires rational management to protect it from pollution and degradation (<http://www.aaas.org/international/africa/ewmi/bugenyi.htm>; Klohn and Andjelic, 2001). Recent strategies and priorities on the socio-economic development by the Eastern Africa countries have reflected a shift towards a focus on poverty eradication. This shift is reflected in policy documents such as the National Poverty Eradication Plans; Poverty Reduction Strategy Papers; and the Economic Recovery Strategy for Wealth and Employment Creation. In the Lake Victoria drainage basin the social inequalities have led to the formation of institutions and research

programmes such as the Lake Victoria Environmental Management Programme (LVEMP), the Lake Victoria Research Initiatives (VICRES) and the Nile Basin Initiative (NBI) to assess the resources and the problems of the lake, to develop management tools and establish adequate institutions and capacity to manage the problem. With growing population, the multiple activities in the lake basin have rendered it environmentally unstable. The overall goal of the on-going researches are to advocate for democratic community participation in the design and implementation of sustainable and environmentally sound land use and cultural practices that control soil erosion, reduce water pollution, maximize biological diversity, sustain stream-flow as well as promote community livelihoods.

The East African region largely depends on its natural resource-base for economic development, and therefore comprehensive information on its resources dynamics is key to implementing poverty alleviation strategies, improving human condition and preserving the biological systems. The need for up-to-date and timely information on the Lake Victoria watershed is crucial for its sustainable development and planning. The concerns on land use and settlement trends affecting the riparian communities in the watersheds of the lake reflect high levels of degradation. The economic potential and human settlement patterns are closely linked to the agro-climatic characteristics of the basin. The Nzoia river basin for example is considered of high to medium potential agriculture. It supports a large population which has led to immense land use competition and conflicts. The land use pattern has often disregarded the land potential, its carrying capacity, and limitations of land resources as well as their diversity and distribution. The problem is compounded further by rapid population increase, increased poverty levels and limited institutional capacity to deal with land use challenges.

The region's national policies, some of which are driven by the international discourse have not had a profound effect in tackling rural poverty. This is mainly because of the governments' failure to translate the policies to action. To reduce the vulnerability of the people to disaster and other challenges, social and technology systems must adapt to changing physical and social environment. The Research forums provide a forum for addressing challenges facing communities such as those living in Nzoia River Drainage Basin.

Materials and methods

Study sites

Lake Victoria Drainage Basin (LVDB) (Figure 1) covers 184,000 km² (Kohl and Andlejić, 2001). This study focused on two sites within the Nzoia River Basin in Kenya at Nzoia Sugarcane growing area (934 Km²) in Bungoma District and at the Budalangi floodplain area (610 Km²) in Busia District. The Nzoia River drainage basin traverses a vast area from Cherangani Hills; Mt Elgon; and Nandi Escarpment with its adjoining Trans Nzoia Plateau all considered the water towers of Lake Victoria North Catchment. The research site in Bungoma district extends between longitudes 34°34'00" to 34°51'30"E and latitudes 0°23'00" to 0°37'30"N. Bungoma District covers 2068.5 Km², which is about 25% of the total area of Western Province of Kenya. Nzoia river drains south westerly through the District and is fed by many tributaries among them Kuywa River whose wetlands have completely been drained for sugar cultivation. Among the main features in the area are the Nzoia Sugar Company plantations, Kalelwa and Mlaba Forests, the Nandi Escarpment, and the Pan Paper Milling Factory at Webuye. The

Budalangi Floodplain area extends between longitudes 33°56'30" to 34°10'30"E and latitudes 0°30"S to 0°11'30"N and covers part of Siaya District and Busia District. Busia District covers 1262 Km² with 137 Km² of its land under permanent wetland conditions. A large part of the Budalangi area has poor communication network and is annually prone to flooding from the Nzoia River. The two study sites exhibit land use practices that threaten sustainability of the LVDB wetlands. The riparian communities engages in sugarcane agriculture, rice cultivation, fishing and livestock keeping along with subsistence farming of maize, beans, sweet potatoes and cassava.

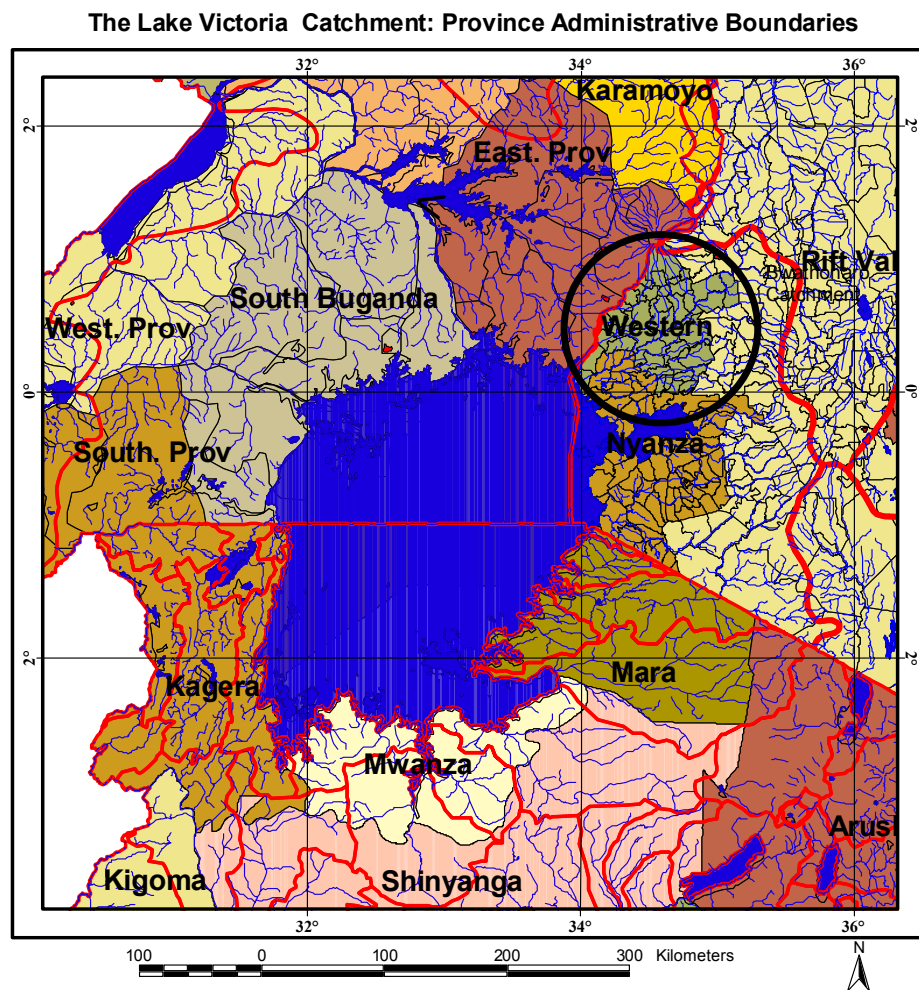


Figure 1: The Lake Victoria Drainage basin. The Location of Nzoia Basin is circled

Data Collection and Analysis

Image interpretation

Landsat MSS series of 1970s, TM of 1980s and ETM of 2000s imagery were evaluated for land cover and cover change at a temporal scale of a 10-year interval (1973, 1985, 1995, and 2005). SPOT image SCENE 5 133-349 of 30th November 2005 10 m resolution was also used to evaluate the farming activities at the household level. The remote sensing data were applied in assessing the land use/cover changes. Image interpretation was made based on land cover types and visual interpretation of the tonal, textural and structural characteristics rendered on the

images that helped in delineation of the land cover classes digitized for the various image dates. The size of the farms and the vegetation cover changes were mapped based on the pixel size of the satellite data types. The interpreted data informed on landscape qualities, land cover changes and land use patterns over the study area.

Field Survey

Field visits were made on 6th Feb - 18th Feb. 2005 (dry period), 25th- 5th May 2005 (wet period) and 8th Dec – 18th Dec 2006 (wet period) to map the land cover types and the land use characteristics prevalent in the two areas. This process was critical in assessing the land cover classes used to delineate land cover units. The field survey also helped the research team to use the Participatory Rural Appraisal (PRA) instrument and tested the potential of satellite imagery in land cover analysis. The field survey focused on land use and settlement trends, vulnerability of the communities to flood hazards at the base level of Nzoia River and sustainability of the livelihood systems based on land use policy and legislative framework governing the lives of the watershed and the riparian communities. The research team utilized existing data for planning sustainable management of the watershed resources in order to improve the livelihood of the local communities. The field survey also helped in setting up appropriate mechanisms to engage the communities in the identified sites in land resource management. Other tools employed in field data and information gathering included observation, focus group discussion, participatory observation and photo recording to capture observed information.

Review of Secondary data

The field session also served to gather all the secondary documentations from the District Offices. The study reviewed the progress made in crafting and implementing appropriate institutional arrangements; policy, legislations & organizational structures for addressing issues of poverty through wealth creation. Among the frameworks accessed were development plans, legislative acts and strategy documents.

During the field survey, water samples were also collected from selected sites along Nzoia River and along the Kuywa River to examine the impact of industrial and agricultural activities on the Nzoia River and therefore helped in determining the quality of the water.

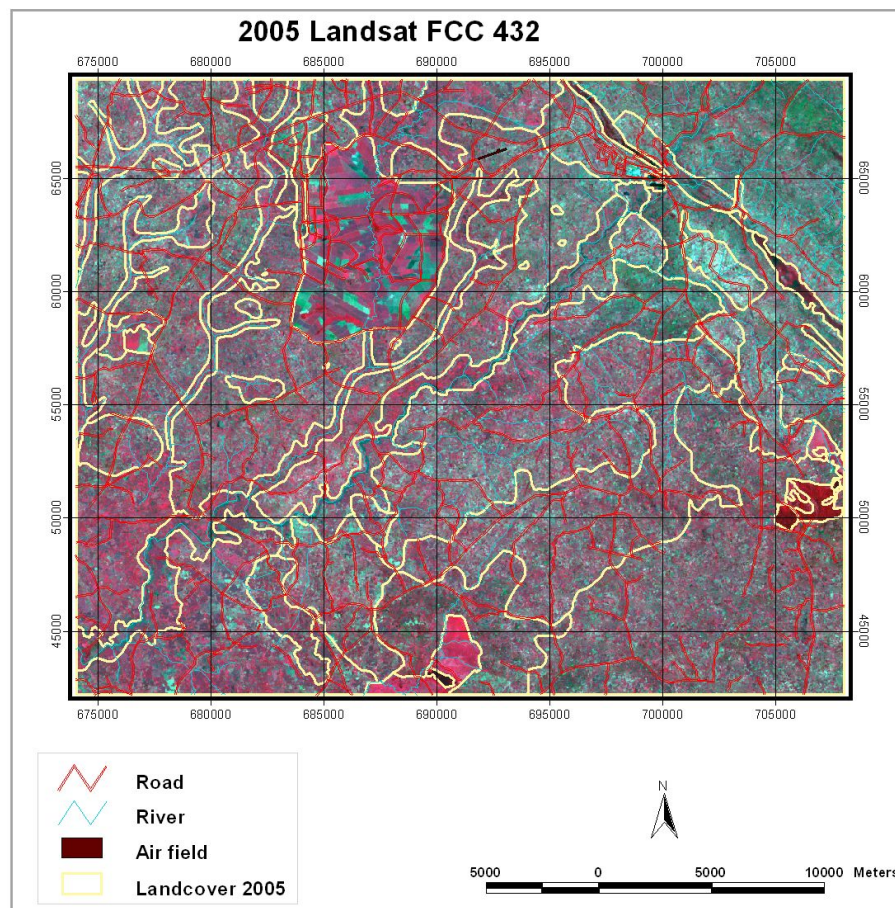
Results and Discussion

Nzoia Drainage Basin at Nzoia Sugarcane Growing area

Image analysis of Nzoia River utilized the existing image data to assess the land cover change and trends in land use (Figure 2). The used an integrated methodology of remote sensing data on a GIS platform to develop the land cover classes and used it to present the data as a basis for monitoring the land cover change. The results illustrate past and present processes impacting on growth, development and the livelihood systems of the communities in the Nzoia drainage basin. The following conclusions were drawn from the interpretations of the satellite imagery:

- The land use characteristics are dictated by the nature of the land, soils and moisture availability and content. Remote sensing data depicted pressure on the land resources that is seen from the status of land use and land cover change and intensification of sugarcane cultivation.

- Trans-Nzoia Plateau north of the Nandi escarpment is heavily cultivated showing a dominance of red iron-rich soils
- Existing forest cover has remained more or less the same in the period of image data (1985-2005). The forest however is still under threat as seen from clear cut into Kalelwa and Mlaba forest zones shown in Figure 2.
- The extent of the sugarcane area, which is a mono-crop cultivation activity, has threatened subsistence farming. Sugarcane cultivation requires heavy application of fertilizer and pesticides to fight sugarcane bores and this is a major source of water pollution, land and wetland degradation in the area. This is seen in the high turbidity of the water that indicates high levels of siltation from erosion.
- Although plantation agriculture has lead to commercial farming and lead to industrial growth, it is also major source of discharge from industry.



2001 landcover Types For Nzoia Areas

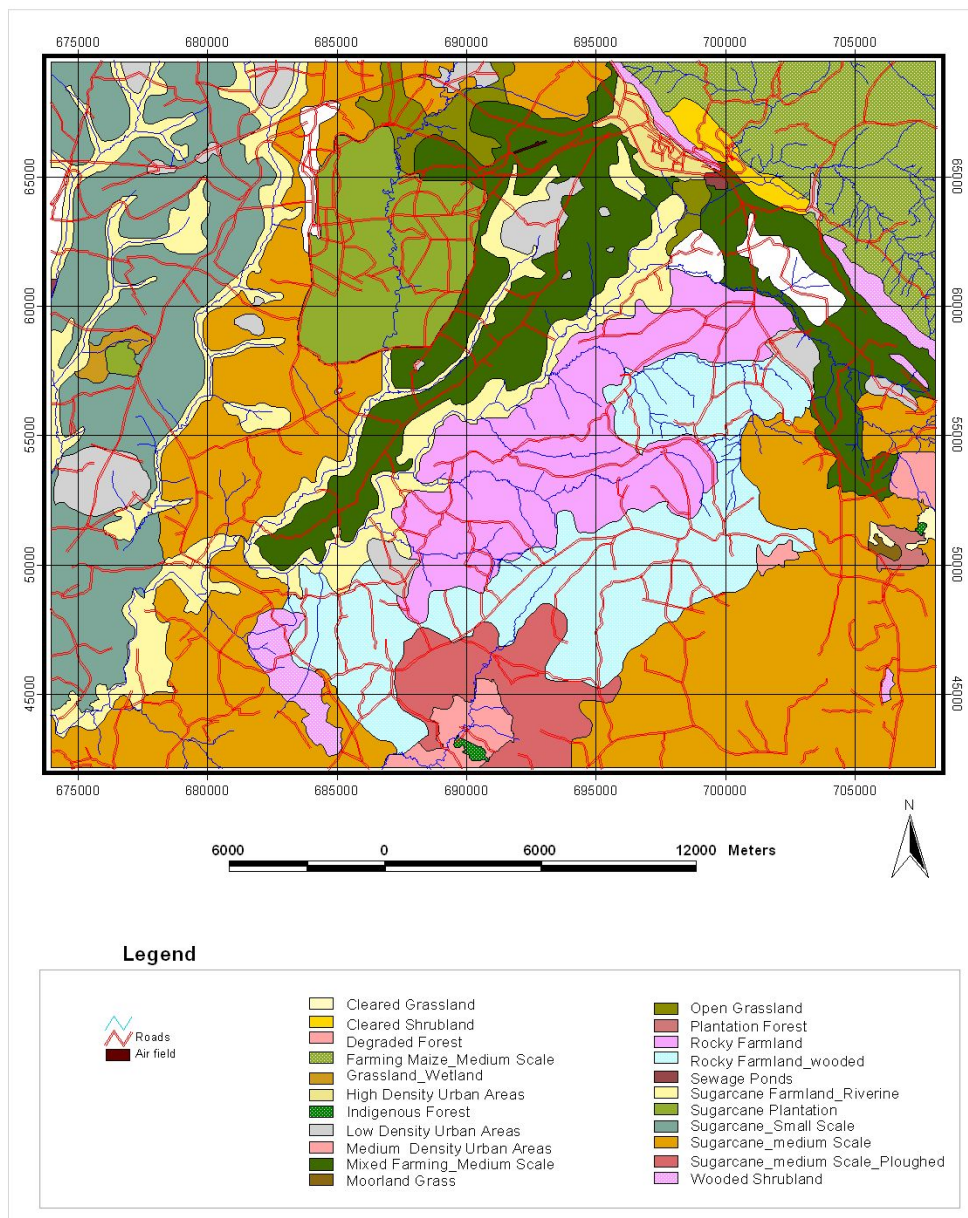


Figure 2 a & b: The Nzoia River at Nzoia-Webuye area with the delineated land covers boundaries overlain. The river runs from northeast to southwest through the middle of the photograph. The characteristics of the land cover, the exposed nature of the riverine and the intensity of land use and its are shown in the land cover classes map

In assessing the ecological status of the Nzoia river drainage basins at Nzoia sugarcane growing area, six issues emerged:

- 1 Planning and management of the basin from the policy perspective is based on intensification of sugarcane growing encouraged through the extension services provided by Nzoia Sugar Company
- 2 Farming activities have taken up all the available land including the wetlands leading to land degradation (erosion, wash off, riverbank destruction and flooding)
- 3 The Lake Victoria North Water Resources Management Authority is concerned about the level of impacts on the water resources and is therefore taking a leading role in accordance with the Water Act 2002.

- 4 Data records from the area on geology, land, forest, water, meteorology are location specific and are scattered in public institutions, based on the different specializations and sectoral policies
- 5 Data storage systems amongst the public institutions differ and are often neither accessible nor disseminated to the public.
- 6 Resource management questions relate to planning and management of space. Resources use problems have therefore to be geographically linked for accuracy and consistency and the spatial information about environmental impacts have to be provided to the public
- 7 Resource poverty alleviation would require integrating approaches and rationalization of land use practices that avoids costly experiments, develops effective cost cutting strategies and takes care of the environment

There are other environmental challenges occasioned by pollution of River Nzoia waters by discharge of poorly treated effluent from sugarcane, pulping, coffee processing factories and the agricultural chemical run-offs. Effluents from the major industries in the basin but from outside the district namely paper mills, tobacco leaf factories and cotton ginnery have degraded the environment of the basin due to improper management of industrial waste. The waste is discharged into the river and the atmosphere. The pollutants have profound impacts on the fishing industry, killing fish in Nzoia River with the water unusable for any purpose for at least 20km from Webuye. There have been records of death fish at the mouth of the river.

Flooding challenge in the Budalangi Flood plain of Nzoia River

A number of regions in Kenya suffer from devastating effects of disasters from weather related natural phenomena such as floods, droughts, landslides and lightning and from disaster occasioned by anthropogenic factors causing land degradation such as deforestation of catchment areas, poor agricultural practices, inappropriate land use systems, changing living conditions, among others. The physical setting of the impacted areas and the agro-climatic zones play a major role. Flood and draught related disasters often lead to displacements of people, loss of lives and properties, and crops damage. The disruption of economic activities of the people living within the impacted areas has lead to heavy expenditure by the government and non-governmental organizations in relief operations and rehabilitation process. The areas affected most area known: the flood plains of Tana, Nzoia, Sondu and Nyando rivers within the Lake Victoria drainage basin. Floods and draught related disasters in these areas occur periodically and usually disrupt the socio-economic lifestyles, ecological systems and general development of the areas. The use of geoinformation tools such as remote sensing data in assessing the flood impacts in Budalangi provide a clear evidence on the need for integrated efforts in research in the region.

The Government of Kenya coordinates the disaster related activities through the Office of the President which has formulated a National Policy on Disaster Management. This policy aims at addressing the increasing incidences and emergence of both slow and rapid on-set disasters and provides the management option. The Disaster Management Policy (RoK, 2002) in Kenya is linked to a number of other Acts including the Environmental Management and Coordination Act (EMCA) (RoK, 1999), which have a provision for hazards prevention. The Water Act, 2002 (Cap 372) empowers the Minister for Water Resources Management and Development

(MWRMD) to declare an emergency where there is exceptional deficiency of water for domestic use. The act is biased to clean water provision without consideration to disasters arising from excess water in inhabited areas including floodplains. The Sessional Paper of 1999 on National Policy on Water Resources Management and Development is also silent on flood management issues although the Kenya Meteorological Department's Information Policy has a provision for availing forecasts in general terms.

The failure of the Busia District Development Plan to propose any programmes for flood management signifies major weak linkages between National Planning and District Planning that is reflected in the Budalangi flooding problem. Despite the government's extensive grassroots based development and administrative network, which would effectively manage emergencies, and disasters such as famine and floods, there is no attempt to mainstream disaster management in the National Development Plans. Consequently, sectoral budgets on disaster management are lacking. This also reflects weaknesses in the economic system and class structure that allocates income and access to resources leading to impacts in terms of the people's ability to cope with flood hazards.

Weather related vagaries (alternating drought and flood periods) and other environmental challenges: plague/locusts of 1931 and 1933; army worms of 1931 and 1977; famine of 1942, 1968, 1979, 1984 and 1995; floods of 1975, 1976, 1985, 2001 and 2003 have impacted the area for a long time (RoK, 2002). While floods related disasters have been recorded in many parts of the country, the prevalence of floods in Budalangi has been unique in frequency and character. The Southern half of Budalangi Division is flood-prone lowland (see Figure 2) and is thus exposed to flooding nearly every year. Flooding in Budalangi has been noted even when there are no rains in the region raising concerns about the need to manage the entire Nzoia River drainage basin. Although in Budalangi floods are a perennial problem, the present arrangements for disseminating information are inadequate. Flood forecasts are not disseminated immediately they are received from the forecast formulation team at the Meteorological Department in Nairobi. For this to be effective, response teams need to be set up on the ground. The local communities have therefore no means of getting the forecast information and if any come it is often too late and it does not reach a wide audience. Sometimes unwarranted flood warnings are issued based on inadequate data leading to tension among the affected communities. Further, there is no proper co-ordination and control of activities based on information from hydrological monitoring stations along the river.

Despite the construction of dykes, the flood problem still persists. In 2003 for example, out of Budalangi's population of 53,000 nearly 25,000 were displaced by floods. Some 10,000 people were accommodated in the District officer's camp, necessitating health emergency measures to control possible outbreaks of malaria, bilharzias, cholera and other water borne diseases (Daily Nation, 24th September 2003). In December 2006 there was a repeat of the flooding situation witnessed during the field study period 8th Dec- 18th Dec. 2006. During flooding, roads are impassable, children are cut off from schools, food in farms is swept away and latrines and buildings collapse. The extent of the area impacted can be seen on the Landsat image, bands 453RGB captured on 18th May 2003.

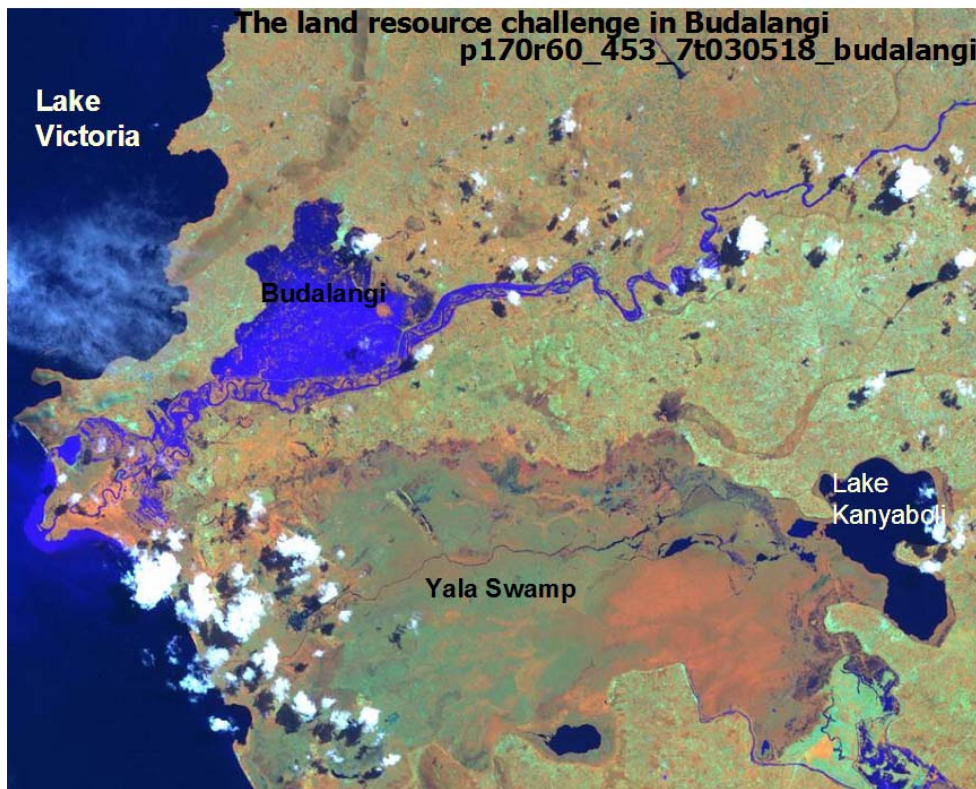


Figure 3: Landsat images p170r060 of 18th May 2003 bands 453 RGB showing Nzoia river and the flooded Budalangi Plain. The same extent of flooding was witnessed in Dec 2006

The general blue waters indicate the level of turbidity and siltation at the mouth of Nzoia river. While floods related disasters are recorded in many parts of the country, the prevalence of floods in Budalangi has been unique in frequency and character. The Southern half of Budalangi Division is flood-prone lowland and is thus exposed to flooding nearly every year. Flooding in Budalangi has been noted even when there are no rains in the region raising concerns about the need to manage the entire Nzoia river drainage basin as the flush waters from the catchment also lead to flooding.



Figure 4: Challenges faced the communities settled in the Budalangi flood plain. Photo 1 is courtesy of UNEP/GoK survey July 2003. Other photos are from field Dec 2006.

Within the Budalangi area, the nature of extreme events is seen from the time series image analysis. The extent of the 2003 flooding for example is seen in the 2003 imagery (Figure 3). Analysis of the 1997-2001 Busia Development Plans and Poverty Reduction Strategy Papers indicate that there was dismal implementation of the plans with high rate of failure of poverty reduction programmes. The plans showed that financial constraints led to only 30% of the plan being implemented. Other plans have failed before. For example, the revitalisation of the

agricultural sector through the Ministry of agriculture's National Irrigation Board established a rice irrigation scheme in the Budalangi area in the late 1970s/early 1980s. By 1986 the scheme showed a vibrant economy and a record of the status of the scheme is reflected in the Landsat image interpretation of 1986. Subsequent Landsat satellite image records show a depressed agricultural activity with complete abandonment of the scheme by 2001. The scheme has only been revived in the second year of the current government. Other challenges due to the failure of the government development plans are for example lack of implementation of the Sirisia and Mufula Youth Polytechnics project that was meant to utilise local raw materials to bring income to the local communities in the area. The project failed due to the collapse of the dairy, cotton and sunflower schemes and lack of financial support from institutions offering credit facilities.

Any members of the communities settled in the floodplain are often challenged and rendered vulnerable to flood disasters. Although scientific and engineering techniques have developed remarkably over the decades, success has not been achieved in preventing floods or in insulating humans from their effects. Humans can avoid residing in flood prone areas which experience periodical flooding but populations growth and pressure for land will continue to push people to flood prone areas. More people in Budalangi are therefore at risk of flood hazards since the households have put themselves at risk. Their plight is clearly evident from exacerbated poverty level in the area. An integrated sustainable flood management action plan for Budalangi Division that takes into account land reform, policy review, formulation and implementation would enhance socio-economic activities and if put into good use may contribute significantly towards disaster reduction and poverty alleviation. An integrated sustainable flood management action plan for Budalangi Division that takes into account land reform, policy review, formulation and implementation would enhance socio-economic activities and if put into good use may contribute significantly towards disaster reduction and poverty alleviation.

Socio-Economic Factors Impeding Poverty Reduction in Nzoia River Basin

The majority of the households in the Busia areas traversed by Nzoia River have between 5 to 10 members, most of whom (72.65%) live on less than 4 acres of land. 80.9% of the families are male headed households which reflect on imply a dominated land ownership. The basin has a rich paternalistic cultural traditions leading to cultural-based land inheritance by the male children. The women, apart from those windowed, have no right to any land and although very enterprising, cannot get access to credit where land can be used as collateral.

The first generation land title deed issued shortly after independence are the only legal evidence of land ownership. The title deed holders have been reluctant to subdivide their land among the older sons most of whom are married with their own families. This has slowed down the agrarian efforts of poverty reduction that could be spearheaded by the more educated and informed sons although in general 20.7% of the Budalangi population has not received any formal education. Those with formal tertiary education, which is responsible for imparting life and economic transformation skills, accounted for only 7.5 % of the population. This has serious implications on poverty reduction campaigns, especially absorption of new innovations and limits economic and social ideas that are necessary for change. Management skills of any enterprise ventures aiming at economic utilization of the wetland resources are grossly lacking. Numerous

interventionist efforts by a myriad of governmental and non-governmental organizations over the years have therefore failed to turn around the development fortunes of the area.

Within the Budalangi area 46.9 % of the population is engaged in farming of crops such as maize, sugarcane, cassava and beans and keeping of livestock. However, the population growth in the basin far outstrips economic growth leading to deprivation of many households especially during the time of distress such as during flooding and draught impacts. Problems bedevilling the agricultural sector in the area include donor dependence, high cost of farm inputs, lack of access to production assets and inhibitive cultural practices. The commercialisation of farming activities in the basin is also hampering local development especially where progressive farmers reside outside the basin (civil servants living in Nairobi, Kakamega, Bungoma among other towns). There is also the issue of unclear land ownership in the flood plain especially the land reclaimed from the wetlands.

The lake has also had a big influence on the population in Budalangi with the predominantly able bodied men engaged in fishing activities. Fishing accounts for 34.4% of the livelihoods of the households. Most young women in the area are engaged in vending the fish catches leaving the aging population and the children to take care of the farm. Middlemen from outside the district exploit the fishermen by dictating the prices of the highly perishable fish. Fishing is therefore a high-risk business and is done as cultural activity rather than a serious economic activity. There are also constant incidence of conflicts in the basin caused by boundary disputes with neighbours, regional border disputes in Lake Victoria, immigrants from Uganda, land sharing within households, land scarcity, and livestock overgrazing.

Extension service, which is essential channel of propagating new technologies, is inadequately dispensed across the basin. 62.5% of the respondents indicated that extension service does not serve them. This is attributed to change of government policy from supply driven to demand driven extension initiated in 1988. Agricultural extension officers on the ground are also thinly spread due to employment freeze by the government since 1988. Common avenues of disseminating the scanty extension services information included seminars, workshops and public gatherings (barazas). Veterinary services that had largely been offered by the Government were privatised in 1998 hence throwing into jeopardy livestock improvements in the basin. In most cases the Government has not followed up on the limited advice given to the farmers. The lack of emphasis on the extension policy by the government has thus made its role in the basin inconsequential to farmers. In addition, the readily disposable income from fishing is fuelling the HIV/AIDS pandemic and heightening school drop-out rate as children are pulled out of school to engage in economic production. This implies that child labour is rampant in the basin making the eradication of poverty in the long term a mirage as the poverty cycle is perpetuated.

Conclusions and recommendations

In East African countries the economic potential and human settlement patterns are closely linked to the agro-climatic characteristics of the region. A small fraction of the area, much of it within the LVDB, is considered high to medium potential and supports a large population and contains the lake's catchments. This has led to immense land use competition and conflicts where land use has often disregarded land potential, carrying capacities, and limitations of land resources as well as their diversity and distribution. The problem is compounded further by rapid

population increase, increased poverty levels and limited institutional capacity to deal with the challenges.

Remote sensing application and spatial data storage in GIS makes it possible to relate information of areas to development and resource use. The approach to sustainable development in the LVDB should therefore be based on:

- The satisfaction of human needs and aspirations especially the basic needs of the poor for food, shelter, clothing and employment.
- The reorganization of existing technological and social limitations on the ability of the environment to meet present and future needs that recognises that environment and development are interrelated
- Emphasis on the ethical and ecological responsibilities of the present generation towards future generations.
- The watershed address, the sub-catchment, should be the basis for effective local watershed partnerships and can be used as a reference to improving the ecological environment and water quality in the LVDB. The strategies to be used should be specific to LVDB and have a framework that involves partnerships with all stakeholders.

Despite shift in government policies, strategies and priorities on socio-economic development towards a focus on poverty eradication, it has had dismal impact in the Budalangi area of Nzoia River Basin. Rural development is essential for the reduction of poverty and inequalities in rural areas especially vulnerability to famine, water-stress (floods and draughts) and land degradation. In the Lake Victoria drainage basin, the various challenges have led to the formation of institutions and research programmes such as the Lake Victoria Environmental Management Programme, the Lake Victoria Research Initiatives and the Nile Basin Initiative in order to come up with participatory, target specific, and home grown solutions to conservation and sustainable development for rural poverty reduction and inequalities in Lake Victoria basin. University faculties have found a leeway in the research and thus contributing in formulation of poverty reduction strategies.

The policy framework governing resource use across the basin should ideally be based on integrated management of water and resources. The aim of environment and natural resources sector is to achieve economically, socially and environmentally sustainable national development. The poverty levels and the land resource degradation in the basin is high and require integration of environmental concerns into the national planning and management processes. Provision of guidelines for development that is environmentally friendly is lacking with the current wetland management institutions failing to implement sustainable management practices and utilization of wetland resources.

Due to the prevailing food insecurity in the areas, there is the desire to open up and put the wetlands under food production. At the same time the wetland areas qualify to be put under conservation status for the above reasons. This leads to conflict of interest and dilemma as to what use wetlands should be put under. Wetlands in the two study sites have significant multiple uses of social and economic values to the riparian communities if measures are taken for their sustainable development. Indigenous and scientific knowledge and community participation in planning should be put in place to promote the application of appropriate technologies, communication and networking that would empower the local people to conserve and use the soil and wetland resources sustainable way

Acknowledgements

Acknowledgement is made to Sida/SAREC who through the Inter University Council for East Africa (IUCEA) funded this work under the VICRES programme. Thanks to the project participating Universities; Kyambogo University, Kenyatta University, Makerere University, Western University Collage of Moi University, and University of Dar es Salaam.

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