GEO-INFORMATION FOR INTERVENTIONS IN TRADITIONAL IRRIGATION AND ENVIRONMENTAL IMPROVEMENT – A CASE OF NORTH PARE, TANZANIA

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Key words: Spatial Information, Traditional Irrigation, North Pare, TIP, Conservation.

ABSTRACT

Traditional Irrigation and Environmental Development Organisation (TIP) is an NGO in Tanzania, focusing on helping farmers improve traditional irrigation, soil and water conservation, and participatory landuse planning. Data on TIP activities had been collected for over a decade. In the year 2000, TIP embarked on developing a Geographic Information System (GIS) to help meet its objectives. This paper looks at the development of a Geographic Information System (GIS) for TIP, with a focus on its interventions in North Pare.

1. INTRODUCTION

Traditional Irrigation and Environmental Development Organization (TIP) was registered as a Non-Governmental Organisation (NGO) in August 1999 evolving from the Traditional Irrigation Improvement Program (TIP). The Program was under the Netherlands Development Organisation SNV and Tanzania government. The first phase of TIP started in 1988 with financial support from the Netherlands government. TIP operated through partnership with seven districts in North and Central Tanzania (Arumeru, Mwanga, Same, Lushoto, Iringa, Mpwapwa and Kilosa). The mission of TIP remains "to contribute to a durable and gender-balanced improvement of standard of living of the community in traditional irrigated areas in Tanzania through sustainable development of catchments with regard to irrigation, natural resources management, soil and water conservation, afforestation, landuse planning and organisational development" (Mgendi, 2001).
The target group of TIP is the small-scale farmer (female and male) living in the catchment areas of traditional irrigation systems in Tanzania. A characteristic of the traditional irrigation system is that they have been constructed by the farmers themselves, and are farmer-managed and operated. Water User Group (WUG) stays the main entry point for TIP's interventions.

The TIP Interventions

The TIP interventions to the target group to consist of four main components: Irrigation improvement, Soil and water conservation, Participatory Landuse Planning, and Organisational Development.

Improvements in traditional irrigation system are not limited to the improvement of structures and canal lining only. Male and female farmers are also trained in water management in order to make a more efficient use of water. The farmers are reached through existing Water User Groups.
The farmers have to conserve soils before any assistance is provided to improve their irrigation systems. Through trained female and male farmers in each village ("village technicians"), farmers are assisted in constructing terraces and improving water harvesting techniques and drainage. For the protection of the water resources, farmers are trained in the management of homestead tree nurseries and mobilised to plant trees within the catchment area.

As government policies in Tanzania are increasingly focussed on decentralisation and increased stakeholder involvement, TIP tries to improve the position of women in regard to the access and control over land and water. An example is the new guideline on participatory village Landuse planning published by the National Landuse Planning Commission in December 1998. At the same time, a new Village Land Act has been approved giving equal rights to men and women in owning land. TIP utilises the new guidelines and creates awareness on the new Land Act to the farming communities.

Data Management Problems

Despite its fine aims, there existed data management problems at TIP. Though data had been collected over the years, it was not easy to readily retrieve them. There was not yet a well-established computerised database system, or a single map to tell where TIP was working or where land had been conserved. Moreover, there were neither aerial photographs nor satellite images for the area TIP was having intervention programs. This situation prompted TIP to look on ways Geographic Information Systems (GIS) could assist the organisation to manage and analyse data in such a way that it can help to develop future plans and to get more insight in the present situation.

2. RESEARCH METHODS

As part of MSc Studies at the International Institute for Aerospace Surveys and Earth Sciences (ITC), the author researched on the development of a GIS with TIP.

With the problems as outlined above, the objectives of the research was to assess the available data that could help Participatory Catchment Management Planning with TIP; and to develop a prototype for TIP of a GIS for Participatory Catchment Management, and explore its applications.

To meet the objectives, the research was expected to face questions such as what information was required to help TIP support traditional irrigation; data collection needed to provide such information; and, what do the existing data tell, and how could GIS be useful to the Participatory Traditional Irrigation with TIP?

As TIP had provided indicative list of data it required, research did not venture into a 'full-blown' system analysis and design. It however, developed a prototype based on the preliminary information from TIP, and tested it during the fieldwork to TIP. Therewith, further improvement of the prototype, and analyses of data collected would be done.

Geo-Information System Development Approach

There exist different approaches to system development. The approaches have varying advantages and disadvantages. One adopted was the “evolutionary” method of "Rapid Application Development" or in short, RAD. This method improves speed of system creation and achievement of cost reduction and quality improvement of the development by means of user participation and step-wise approach. Its main characteristics include cyclic / iterative development (small steps with deliverables, prototyping for evaluation of specifications, iterations); step-wise development (successive versions developed, each development terminates with a new version of the system); User involvement (Paresi, 1999). This is shown in Figure 1.

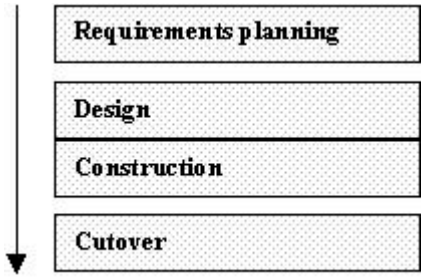

Figure 1: Phases followed in the Rapid Application Development of the TIP GIS prototype. (*Adopted from* Paresi, 1999)

Prototyping

Prototyping is primarily an experimental method. The main role of prototyping in information systems design is to improve requirement definition by involving potential system users. A rough system is built, and users can experiment with it and make comments. Their reactions are obtained and used to define requirements in an iterative way. (Hawyryszkiewycz,1998).

A decision to use prototyping is usually made in the feasibility phase. Prototyping is used to gain a better understanding of possible solutions. Prototyping is often used in system development to clarify user requirements in imprecise systems.

Imprecise systems occur when it is not possible to develop a precise system specification. This often occurs in organisations that are just starting to use computers. It is more

appropriate to develop the system gradually; learning about system capabilities as one goes along.

Requirement planning involved designation of key functionality and system requirements. Design and construction were not really separated. They went hand in hand. Cutover involved the testing, installing and further improvements.

Voluminous tasks that are required to achieve 'full-blown' Information System are trimmed down under this procedure. Usually, to arrive at what data / entities are to be included in the database is a long process in itself. It involves systematic analysis, dataflow and entity-relationship diagramming, as well as the system design, prior to implementation. The method depicted above, "jump-starts" the procedure by going directly to the implementation of a prototype of only a part of the full system (modular approach).

A draft Database Prototype was done in MS Access97 format. This was meant to guide discussions and testing in the field. For a couple of weeks, office work at TIP Moshi headquarters and further work in Mwanga District Highlands (North Pare Mountains) was done. Together with the first draft of the database, GIS software (ILWIS version 2.2). and Landsat7 179-63 satellite image scene of 25 October, 1999 were provided. The image covers substantial part of Kilimanjaro region, small parts of Tanga and Arusha regions, and parts of Republic of Kenya. The image was both in digital and paper formats. This satellite image was classified into landcover map.

3. SAMPLE APPLICATIONS OF THE GIS

The Geographic Information System thus developed had two main components. First is an MS Access database (or just "the database") and Remote Sensing and Mapping component in ILWIS environment (or simply "the GIS"). Various applications that could be achieved from the GIS were demonstrated. The applications include analysing distribution of TIP involvement in the catchments, membership distribution by gender within the Water User Groups in various districts, outlining areas susceptible to erosion and computing for areas in the catchments that require more TIP attentions. These example applications are in no way exhaustive of what the system could offer.

North Pare Situation

Water User Group usually owns a furrow, though there could be isolated cases of some WUGs with more than one. At the beginning of these furrows is an intake or a *Ndiva*, a reservoir. These furrows and *Ndiva*s have been there for decades, predating colonial era in some instances.

A major reason why a WUG would go to TIP for help, is the improvement of the furrows and intakes or *Ndiva*s. The furrows are not big. A cross-section of about 25 x 30 cm is not uncommon (Mgendi, 2001). But the furrows can be a kilometre or more long. Greater

percentage of lengths of these furrows is unlined. There is much loss of water in conveyance. Also, traditional intake structures and *Ndiva*s are not efficient. With the help from TIP, the WUGs can improve the irrigation structures.

However, improving water conveyance may bring more problems downstream, in terms of conservation. When farmers have more water for their farms, without applying conservation measures, even more degradation is happening, especially in sloping areas. So TIP set conservation as one of preconditions of assistance: a Water User Group would be required to use soil-conserving methods prior to getting assistance.

Soil conservation in areas with steep slopes like North Pare mountains in Mwanga District, involves the arduous terracing. Terracing need to be done professionally, because if poorly done, it results into even bigger damage. So TIP trains selected farmers in a WUG, and would like to keep record of them. They are also trained in other courses like bookkeeping, leadership, gender-awareness and environment. TIP would like to keep track of the impact of training and other assistance to WUGs, and quantify it where possible.

The WUGs are also encouraged to plant trees. Agroforestry is intended to also provide firewood, the main source of fuel in TIP areas of intervention. Thus the location of the tree nurseries, type of trees grown, owner and year established and other data would matter to TIP if were recorded.

Water Users in the Districts

By September 2000, there were four districts partner to TIP. These were Mwanga and *Same* districts in Kilimanjaro Region, Arumeru in Arusha and Lushoto in Tanga Region. TIP records shows a total of 181 Traditional Irrigation Water User Groups distributed in the four districts. Arumeru had a low 9.4% of these, whereas Lushoto had a high of 45.3%. Mwanga district hosts 13.3% of the TIP-supported WUGs, whereas the remainder 32.0% are in *Same* District as the following table depicts.

District	Water User Groups	Total Male Members	Total Female Members	Average male members	Average female members	Total Irrigated Area (ha)	Average Irrigated Area (ha)
Arumeru	17	3654	929	215	55	2555	150.3
Lushoto	82	3833	3540	49	45	2180	26.6
Mwanga	24	646	1102	27	46	1498	62.4
Same	58	4963	4399	86	76	6655	114.7

Table 1: Water User Groups in the four TIP intervention districts. (Mgendi, 2001)

It is estimated that the ratio of males to females in the agricultural sector in Tanzania is 2:3 (The United Republic of Tanzania, 1997a). However, this is not reflected on the composition of the Water User Groups.

In total, there were 23,066 farmers who were members of the water user groups, nearly a half of whom (43.2%) being female. However, distribution among districts is not uniform as the following figure illustrates.

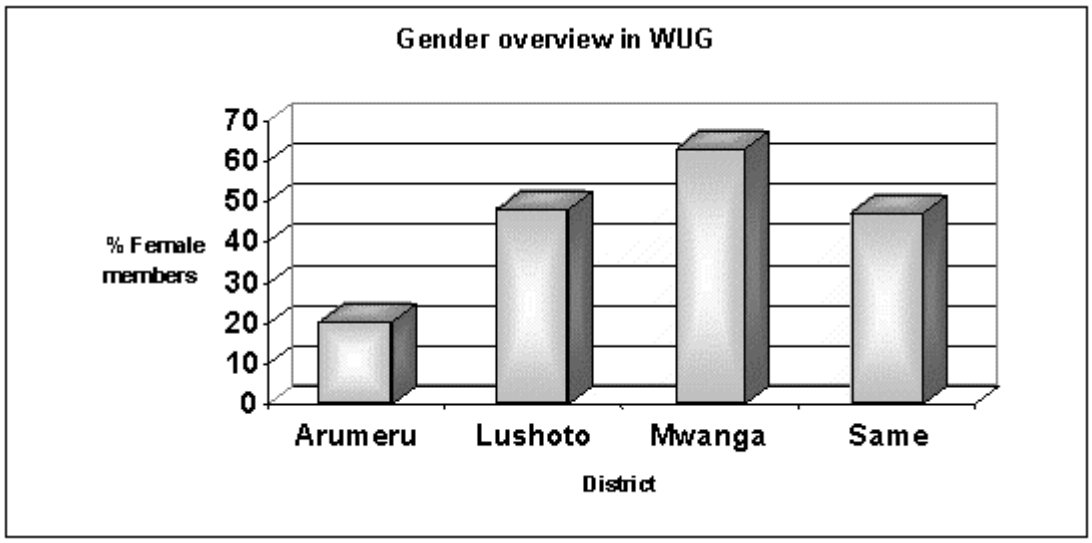

Figure 3: Female composition in WUGs. (Source: Mgendi, 2001)

It is can be seen that on average, gender imbalance exists in Arumeru, in composition of WUGs, with one female in every five male members (4:1 Male to female ratio). In Same and Lushoto districts membership is balanced, while in Mwanga the ratio approximates to the average national figure for female involvement in agriculture.

Irrigated area

The database table for general information about water user groups contains data on area reportedly irrigated by each WUG. These data were aggregated per district as shown in the following table. Then the irrigated area was divided to average number of members in a WUG. This gave area cultivated by each member in a WUG on average.

District	**Irrigated hectares per member**
Arumeru	0.6
Lushoto	0.3
Mwanga	0.9
Same	0.7

Table 2: Average Irrigated land per member of WUG varies significantly among the four districts. (Source: Mgendi, 2001)

It could be seen from the data that the average size of acreage per WUG member in the four districts varies considerably. A WUG member in Mwanga, for instance, irrigate three times bigger farm than a colleague in Arumeru. Although the database so far does not

include data on non-irrigated farms, the possible cause for such differences could be attributed to the availability of land, and economic strength to invest in Irrigation. In Mwanga District, for instance, land is scarce, and even more pronounced scarcity is on the highlands, where situation force people to maximize the output in their small farms

Priority Areas for TIP intervention

As the area TIP has involvement is vast; priority areas need to be highlighted. Knowing these areas would help in planning priorities on where to put emphasis, or which Water User Groups may first be included in the TIP programs. To arrive to the knowledge of these priority areas, maps of different criteria were overlaid. The criteria used included steepness of the slopes, population density, landcover and distance to local market.

The resultant maps had shown that TIP is already involved in the catchments that would require more attention for interventions.

The Author was expected to present research results to TIP in early September, 2001.

4. DISCUSSION

TIP expects to play "an important role in the supply of data towards the districts, as well as to the region and other NGOs and Donor organisations" (Mgendi, 2001). The Geographic Information System at TIP is destined to be at centre-stage of future TIP activities. And as the Tanzania government's policy on water resources management emphasises the need to establish a Management effective Information System (Water Resources Department, 1999), TIP efforts of utilising Geographic Information Systems as a tool to help reach informed decision-making is even more underlined.
Geo-Information Systems can successfully be used in interventions in traditional irrigation for sustainable development. The sample applications outlined in this paper serves as a highlight of what GIS offers to TIP and other organisations with similar intervention activities.

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BIOGRAPHICAL NOTES

In undergraduate studies, author studied Environmental Engineering at the University College of Lands and Architectural Studies (UCLAS, A Constituent College of the University of Dar es Salaam). In 1999 he went to the International Institute for Aerospace Survey and Earth Sciences (ITC) of Enschede, The Netherlands for MSc Studies where he followed the Water Resources and Environmental Management Program. In December 1999 he presented a paper in Cotonou, Benin, on the *Application of GIS in Environmental Impact Assessment in Africa: Challenges and Opportunities*. In February 2001, the author concluded his studies at ITC, and returned to Tanzania to continue working at UCLAS.

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