A SOCIO-BIOLOGICAL STUDY OF THE AQUATIC RESOURCES AND THEIR UTILIZATION IN AN UNDERDEVELOPED RURAL REGION, THE MUTSHINDUDI RIVER CATCHMENT

EXECUTIVE SUMMARY

REPORT TO THE WATER RESEARCH COMMISSION

by

J.J. Dederen, P.S.O. Fouche, I.G. Gaigher (editor), M.J. Gaigher, R.P. John, M. Ligavha, E. Mashau, P.F. Menne, L.O. Nethononda, A Szubarga, C. Todd, B.C.W. van der Waal, T. van Ree, C. Venter, C Wood and P. Weisser (in alphabetical order)

UNIVERSITY OF VENDA FOR SCIENCE AND TECHNOLOGY
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1. INTRODUCTION

1.1. Background

The underdeveloped rural regions of the Northern Province (mostly former homeland regions) are subject to severe environmental degradation. Serious socio-economic water related problems also exist in these regions because the specific problems and needs of these regions have in the past been largely ignored in water management policies. Lack of local expertise on water and ignorance of long term negative effects of human induced changes on water as a resource further exacerbates the situation. Standard management models for developed regions are unsuitable for underdeveloped rural regions due to a general lack of infrastructure, the traditional land tenure system and difficulty of enforcing legislation. These regions are also unique in various aspects such as the cultural importance of aquatic sites, the preference to use unpurified surface water for domestic purposes and dependence on natural riparian plants for energy, food, medicinal purposes, shelter, etc.

A need therefore exists for appropriate water management policies for these regions and also for local expertise to assist in implementing these policies.

The Mutshindudi River catchment was selected for the study because it is relatively small but includes a diversity of climatic and socio-economic conditions and problems typical of underdeveloped rural regions and because it is closely situated to the University of Venda. The Mutshindudi River originates in the Entabeni region of the eastern Soutpansberg mountains east of Thohoyandou. It drains part of the former Venda homeland and joins the Levubu River just below the Thohoyandou to Punda Maria road crossing.

The report is divided into two volumes. Volume 1 includes an introduction, a general description of the catchment, a socio-economic study of the inhabitants, a sociological survey of the needs and problems of the existing water reticulation network, the utilization of riparian plants, the importance of fish as a resource, agricultural water demand, the cultural importance of water, the importance of multidisciplinary research in programmes of this nature and a general discussion and recommendations. Chapter 2 includes a chemical profile of the river, an investigation into pathogenic microbial contamination, the structure and

composition of plant communities in the catchment, fish as indicators of water quality and the avifauna as indicator species for ecological integrity.

1.2. Aims of the project

To contribute towards a scientific basis for implementation of the Reconstruction and Development Programme on Water in underdeveloped rural regions of the Northern Province

To promote the conservation and sustainable utilization of water and associated organisms in these regions through community participation

To develop a centre of expertise on water utilization in the Northern Province

1.3. Approach and problems

Due to the complex nature of water related problems in these regions, it was necessary to involve a multidisciplinary team of investigators. All disciplines at the University of Venda were invited to participate, but only the Departments of Agriculture, Anthropology, Botany, Biology, Chemistry, Statistics, Sociology and Zoology could participate. The Department of Geography participated in the planning but withdrew due to the resignation of a staff member. A consultant was later appointed to survey small vertebrates as indicator species. The project lacks information on hydrology, on aquatic invertebrates and on the role of informal business.

Eleven independent but interrelated subprojects, seven of which were of a biological nature, were conducted. Each subproject is reported in a separate chapter. The findings of the different projects are combined in a general discussion chapter, together with proposals for the development and implementation of a rational management strategy for sustainable water resource utilization in underdeveloped regions of the Northern Province.

VOLUME 1

2. A SOCIO-ECONOMIC STUDY OF THE INHABITANTS OF THE MUTSHINDUDI RIVER CATCHMENT

The inhabitants of the Mutshindudi River catchment area portray the following profile:

The community is poor with most households surviving on an income of less than R500 per month, half of which is provided through a state pension. The educational level is very low with the result that those who can obtain a job, hold one that is on the lowest salary scale. Infra-structure is underdeveloped with roads in an unrepaired state, electricity and telephone services in short supply, children have to walk long distances to the nearest school and health care facilities are understaffed, undersupplied and provide a poor service to an already suffering community.

Although most of the inhabitants have access to public taps, the reliability of water provision is particularly problematic. Women have to spend long hours waiting for, and carrying water to their houses. Often water from the river is used for drinking purposes without any treatment to purify it. In addition, most of the inhabitants wash or do their laundry in the river, mainly because there is no other sources of water available, but also because it is a cultural activity.

Despite this pattern of unsafe use of water, the incidence of water-borne diseases is relatively low. The exception is schistosomiasis [bilharzia] which has a high incidence. It seems, therefore, that the Mutshindudi River is still relatively unpolluted in terms of those harmful pathogens that cause most waterborne diseases.

In addition to the poor water supply, community health is also suffering as there is no proper sanitation system, no refuse removal system or a functional recycling process.

As can be expected in communities who live under circumstances of chronic poverty, the Mutshindudi community, and in particular the women, have a very low self-esteem with almost no decision-making skills and a total lack of genuine community involvement in the making of their own destiny. In such a situation, income-generating activities and community development in general, becomes a government incentive within an unproductive top-down approach.

It is of particular importance that institutions like the University of Venda, that is situated inside communities with a very low socio-economic profile, should see it as part of their responsibility to alleviate some of these problems. The involvement of students from the community, doing research with the community is one way of establishing a community-based link between academic research and community needs.

3. THE NEEDS AND PROBLEMS OF THE EXISTING WATER RETICULATION NETWORK

Water is one of the most important resources in developing communities and the availability of water is seen as one of the basic requirements for a better quality of life. In the former Venda Homeland, the provision of water was used as a political tool and the establishment of the existing reticulation infrastructure was largely dictated by political demands and power balances between areas. Water delivery appears to have been seen as a favour and not as a basic need as defined by consumers. The understanding of the end users was not as important as the agenda of the provider. For this reason, the investigation was driven by the need to understand the forces at play in the past and the direction the new government is taking to redress these imbalances.

In order to have a sound water delivery network and effective water service, broad participation and broad educational campaign processes must be allowed to play an effective role in the management process. The reticulation systems must be well understood by those benefiting from it. The system must be aimed at service rendering and production of intellectuals with the relevant attitude, skills and knowledge that will be required for proper management.

The study showed that almost all the villages in the catchment area experience problems regarding the existing water reticulation system, for example:

Some villages obtain water from unreliable and polluted sources.

Fair and equitable sharing of the available water in the catchment area is complicated by the planned, engineered and systematic discrepancies in the reticulation systems installed.

The existing reticulation network has not provided for the increase in demand that has come along with poverty and self-development by members of the various communities. It has also not provided for expansion of the villages. It does not meet the RDP requirements of a 200m radius from the supply point.

Several development options are available, some of which have already been introduced during the course of the study.

The following can be done to improve the situation:

Greater participation by community structures in order to promote satisfaction, effective decision making and personal development. This will serve to improve the acceptance of the network with its inherent deficiencies and immediately trigger a need to seek solutions based on and in response to the limited available resources, and thus minimise deficiencies. Feelings of alienation will be reduced when communities gain control of their immediate environment and may also strengthen their loyalty and ownership of the service provided.

An effective education campaign in water management and water service is necessary to reveal the mutual effect of the government/Transitional Local Council's problems while creating an awareness of and common approach to solve problems. The education campaign should aim to change the attitudes of communities to water use and water service. Indigenous knowledge needs to be integrated with scientific and formal wisdom in order to minimise inconsistencies in the objectives of the two types of wisdom

Recommendations proposed by consulting engineers need to be implemented to improve water provision, i.e. with regard to the positioning of a number of reservoirs in the network.

Urban and rural areas must be treated equally in terms of proclamations that include all villages in Thohoyandou as part of the town.

4. THE UTILIZATION OF RIPARIAN PLANTS IN THE MUTSHINDUDI RIVER CATCHMENT

Unstructured interviews revealed that at least 31 species of riparian plants in the catchment are commonly utilized, mainly for firewood, fence construction, furniture, medicinal purposes and food.

Juveniles had little or no knowledge about indigenous plants, those from 25 to 49 years old were more knowledgeable and the most knowledgeable were those in the age group 50 plus.

This resource is generally severely over-utilized or removed for crop production. Community members expressed concern about the over-utilization and they are also aware of the fact that this causes a deterioration of the water quality. This is encouraging and shows that the population will be receptive for environmental conservation programmes.

A solution to the problem should be sought in environmental education programmes, encouragement of negotiation and consensus between villagers and authorities, alleviation of poverty and the provision of alternative sources of energy.

5. THE IMPORTANCE OF FISH AS A RESOURCE IN THE MUTSHINDUDI RIVER CATCHMENT

Fish is generally not considered to be an important resource in small rivers and the possible benefits are consequently ignored in planning and management. This study investigated the use and sustainability of fishing in this river. The study was divided into three parts that will be discussed separately.

The attitude towards fishing and fish consumption was determined by means of a personal questionnaire survey in 23 villages in the catchment involving 542 households. Eighty five per cent of the respondents eat fresh water fish but prefer tinned pilchards. Fish is eaten in 80% of the homes at least once a week. Only 26% of the respondents eat fresh water fish.

At least 57% of the households carry out fishing activities on a regular basis. The motivation presented why fishing is undertaken included the collection of food (53%) and recreation (8%). There are some risks attached to the use of the river for fishing, including crocodile attacks and drowning. During the study period, one case of each was actually recorded.

In order to gather more detailed information on fishing methods, 403 persons involved in fishing were interviewed. Fishing takes place during summer, autumn and early winter. The fishers of the Mutshindudi catchment are mainly young school going persons with a mean age of 22y. Only 6.3% were female. Older fishers were often unemployed. The reasons offered for fishing were mainly for eating (74%) with recreation accounting for only 6%. About half of the fishers were satisfied with their catches.

Eighteen fish species were caught by fishers, using nine different fishing methods, of which fishing with a line and hook, was the most important (80%), followed by small gill nets of not more than 2,5m length, seine nets and traps. The most important fish species caught are banded tilapia, (*Tilapia sparrmanii)*, Mozambique tilapia *(Oreochromis mossambicus) and* redbreast tilapia (*T. rendalli*) and three species of small barbs (*Barbus paludinosus, B. unitaeniatus, B. trimaculatus*). In terms of weight however, the tilapia species are followed by the sharptooth catfish (*Clarias gariepinus*) and carp (*Cyprinus carpio*). The length distribution histograms of the catches indicate healthy fish populations with no indication of overexploitation as evidenced in a decrease of larger specimens in catches. The catch per unit effort is however lower (55g per hour per fisher) than reported for other (albeit larger and less heavily exploited) systems. As can be expected, the average size is also small, only 26g. This seems however to be quite acceptable as all fish caught are consumed.

The gill nets were selective for larger specimens of large scale yellowfish (*Barbus marequensis*) and labeo (*Labeo molybdimus* and *L. cylindricus).* Small mesh seine nets selected many small tilapia and barbs.

The mean investment of R1-50 in fish hooks and fishing line was repaid by the value of fish caught in two fishing trips. Only 6% of the fishers indicated that they regularly sell fish. So the fishery on the Mutshindudi can be characterised as a subsistence fishery.

The fish population of two pools was caught to depletion using a set of graded gill nets over a 24h period. Not all fish could be removed, however, and therefore the biomass could not be estimated. A comparison of the relative densities of catches by fishers and gill net catches indicated that angling is selective for tilapia and catfish. Fish species that were clearly not fishing target species, were quite common in the pools: Bulldog (*Marcusenius macrolepidotus,*) Churchill (*Petrocephalus catostoma*) and labeo (*Labeo molybdimus* and *L. cylindricus*).

The annual total harvest from the river is estimated at 2500kg. The three dams in the catchment are excluded but can produce a considerably larger harvest if managed and harvested properly.

The fish life of the river itself, is presently harvested optimally, with some signs of overexploitation.

6. AGRICULTURAL WATER USE IN THE MUTSHINDUDI RIVER CATCHMENT

Agriculture is the main economic activity in the Mutshindudi River catchment.The most common agricultural activities are traditional cattle farming, irrigated estates and schemes, rain-fed orchards and fields and irrigated informal gardens. Informal gardens are expanding due to unemployment in the region.

A participatory appraisal approach was used to acquire information on agricultural land use. This was substantiated by information obtained from the Department of Agriculture.

A total of 1090, 880 and 60 ha are irrigated from the Mutshindudi, Mbwedi and Tshinane Rivers respectively. Five hundred ha of this from the Mbwedi River is from the Damani Dam. A further 440 ha in the catchment is irrigated from the Tshirovha River (a tributary of the Mutale River) The total agricultural water demand from the Mutshindudi River system is calculated as 21.52×10^6 mil kl/annum.

It is calculated that the estimated 8593 small- and 3030 large stock in the catchment use 88960 kl of water per annum

New informal irrigation projects in the catchment demand proper planning and investigation to ensure equitable water distribution, the conservation of the river ecosystem and improved efficiency of water use.

7. THE CULTURAL IMPORTANCE OF WATER IN THE MUTSHINDUDI RIVER CATCHMENT

Due to various problems a formal study of cultural aspects could not be undertaken and the information provided is based on personal experience and a literature review.

Venda is an extremely rich area as far as the cultural use of water is concerned and these cultural data could be used in a contemporary context of rural development as educational data in programmes or campaigns aimed at raising awareness on the importance of water resources and related environmental issues.

The water oracle is essentially a sacred decorated wooden bowl that was filled by the practitioner with water and consulted with the aid of a divining dice, a flute and small kernels. Only half a dozen of these bowls have been documented. A related use of water is the tracing of the New Moon in a clay bowl filled with water among the Lemba, a minority group.

The practise of u phasa, spitting out of water on ancestral objects near graves occurs at times of domestic stress, death, illness or drought in order to cool off the anger of the ancestors.

Sprinkling of water, e.g. at funerals, is still commonly used as a method of ritual cleansing especially by the so-called Zionist or Separatist churches. Water from specific pools is apparently also used during the malombo (spirit posession cult) activities. After interviewing members of a specific family, it appeared that the fantastic stories and miraculous events associated with a particular pool were local myth rather than part of the consciousness of the malombo organisers.

Pools feature in indigenous creation mythology as sites of creation. Similarly there are permanent water sources such as the Phipidi Waterfall which are considered to be sacred. They are mostly associated with supernatural beings, e.g. snakes with human heads etc.

There are further symbolic references- at a more abstract level - to water (re)birth throughout the vast array of cultural and religious beliefs and practices in the region.

Although ceremonies and special objects, such as sacred drums and rain pots, related to the production of rain have basically disappeared, more popular forms of medicinal paraphernalia to ensure a normal rainy season are still widely produced and distributed.

8. MULTIDISCIPLINARY RESEARCH IN DEVELOPING COUNTRIES : THE MUTSHINDUDI RIVER CATCHMENT PROJECT

The sustainable utilisation of water resources in underdeveloped rural regions can only succeed if it is based on a knowledge of both environmental and human factors and if local communities are involved in decision making. This also requires local expertise on water and aquatic organisms as a resource.

In most developing countries modern scientific research is not well established and infrastructure is fragile. Resource constraints - inadequate facilities, lack of technicians and support staff, unreliable equipment and unstable budgetary support - compromise many aspects of research. In addition, access to existing information is limited and the concept of peer review and constructive criticism still has to be established. As a consequence potential scientists are discouraged and good research programmes rarely get off the ground.

A multidisciplinary approach involving members of local communities may provide a means of overcoming some of these problems. Research actions for sustainable development requires scientists as citizens who can perform a societal role beyond technology generation. It requires a research effort able to involve people, institutions and processes. Its pursuit depends on systematic analysis, creativity and exploration.

The aim of interdisciplinary research should be to present horizontal rather than vertical, individual pieces of information, thus presenting a more holistic view of the problem under investigation

Inter-disciplinary research may create interaction not only between disciplines which usually do not work in close liaison, but also between the university or research organisation, students and the local community. As objectives and findings can be presented in a more comprehensive manner, the recommendations can often be presented more effectively to potential users.

Environmental education is crucial to sustainable utilisation of water as a resource. However, in developing communities environmental education can only be relevant if it is presented as part and parcel of a broader development initiative. Such educational efforts require the

support of a multidisciplinary team of experts including both natural and social sciences. It must, however, also utilise inputs of indigenous knowledge if it is to be understood and implemented by the local community. The Mutshindudi River programme achieved these goals by involving a team of experts as well as students and other members of the local community.

Multidisciplinary teams provide an opportunity for skilled researchers to build capacity amongst inexperienced colleagues. It also helps to demystify or remove the "fearful" connotation of the research concept. Team members are more willing to share experiences and mistakes thus showing that research skills are obtained by trial and error.

It is impossible to address sustainability or development without delving into the essence of human existence. Omitting to take people's intentions into account explains the failure of many conservation and development efforts. Science and technology can contribute to the conservation of natural resources only if people themselves become full partners in the implementation process.

In order to generalise research findings we require better standards to facilitate comparison and also theoretical clarification of the interpretive knowledge on which comparisons are based. This will prevent over-generalisation or too restricted generalisation. These objectives are more readily met in genuine collaborative research.

A better understanding of the capacity to conduct research and an increasing number of good researchers are critical for successful multidisciplinary research. Supported by a properly funded and skilled institution, such research efforts can transform the attitudes of people about themselves and their environment. It can help to foster a scientific, problem-solving culture that is urgently needed in all developing countries.

VOLUME 2

9. A CHEMICAL PROFILE OF THE MUTSHINDUDI RIVER

Suspended solids, total dissolved solids, calcium concentration, magnesium concentration, zinc concentration, electrical conductivity and dissolved oxygen concentration were determined at eight sights in the Mutshindudi River during October 1995 and during March and May 1996.

The water of the Mutshindudi River is relatively soft with a low concentration of dissolved solids. Concentrations varied dependent on runoff, but apart from occasional high concentrations of zinc and suspended solids, the values were within acceptable levels (Department of Water Affairs). Very high concentrations of suspended solids were measured from the mouth of the Tshinane River downwards during May 1996. This was probably caused by inorganic suspensoids from surrounding over-utilised areas. Runoff from the densely populated Sibasa area clearly impacted on concentrations.

10. AN INVESTIGATION INTO THE PATHOGENIC MICROBIAL CONTAMINATION OF THE MUTSHINDUDI RIVER

Several types of pathogenic bacteria were isolated from the Mutshindudi River, indicating faecal pollution. Contamination increases after runoff. In terms of faecal contamination the water does not comply with standards of the World Health Organisation and is therefore not suitable for human consumption.

The high faecal loading can be ascribed to the fact that one quarter of the households lack access to proper sanitation.

11. THE STRUCTURE AND COMPOSITION OF PLANT COMMUNITIES IN THE MUTSHINDUDI RIVER CATCHMENT

The structure and composition of seven forest communities, two bushveld communities, two secondary thickets, three grassland communities, one fallow fields community and four aquatic communities are described based on the data obtained from eighty plots. A total of 645 species of 404 genera belonging to 112 plant families were recorded. It was found that most of the vegetation of the catchment is secondary and is highly disturbed by human

activities or is occupied by replacement communities such as afforestation, fields and orchards. Pristine vegetation occurs mainly in the upper catchment and in some bushveld areas of the mountain slopes of the lower catchment. The riverine vegetation is the least disturbed in the upper catchment and in the Phiphidi Nature Reserve. From the eastern limit of the Phiphidi Nature Reserve only a small band of remnant riverine forest is left, cultivation areas having been established in the floodplain in some areas. Noxious weeds such as *Caesalpinia decapetala, Vernonia colorata, Melia azedarach* and *Lantana camara* are spreading fast and control efforts should be made.

The project offered an opportunity for student and staff training in plant collecting and identification, field vegetation study methods and ecological interpretation of data of plant communities. One honours project was completed. The floristic and vegetation data of this project will be used in lecturing and in further research on the key plant communities of the Mutshindudi River Catchment.

12. FISH DISTRIBUTION IN THE MUTSHINDUDI RIVER SYSTEM

Twenty seven of the fifty four species of Limpopo River system fishes were collected from the Mutshindudi River system. None of the species are endemic. Two species, namely *Chiloglanis pretoriae* and *C. paratus* are endemic to the Limpopo, Incomati and Phongolo river systems. Only one species, *Opsaridium peringueyi* is listed in the South African Red Data Book on fishes, but fourty two percent are considered to be sensitive.

Natural distribution in the Mutshindudi River system is mainly affected by temperature, geomorphology and habitat preferences. Human induced changes has obviously affected distribution. Only four species were recorded above the Phipidi Waterfall and two of these might have been introduced here by man. Species richness increases with a decrease in altitude with the highest number of 15 species recorded near the confluence with the Levubu River.

13. NICHE DIFFERENTIATION IN RHEOPHILIC FISHES OF THE MUTSHINDUDI RIVER SYSTEM

The food habits, external morphological adaptations and the morphology and histology of the digestive tract of eight species of fish collected from rheophilic biotopes were compared.

Although all the fish in the study were found to be monogastric, two distinct stomach types, namely U-shaped and straight-tubed, were identified. Based on the thickness of the stomach wall these stomach types could in turn also be categorized as thin, thick or intermediate.

Based on gut length expressed as a percentage of body length, the fish can be divided into three distinct groups with an indication that a finer subdivision may exist. Relatively short gut lengths can be associated with carnivory, and long guts with detritivory and herbivory. Stomach type, wall thickness and relative gut length, although diet related, are independent of one another which in effect implies that carnivores, for example, could have a tube shaped or U-shaped stomach that is thin or thick walled, combined with a relative short gut. This indicates varying diets amongst carnivores. Eye and mouth size and placement, which varied between species, could be also linked to the diet and food habits such as the ventro-terminal mouth typical of epibenthic microphagous feeders. Histological examination of the stomach wall showed typical vertebrate cellular layering and also indicate that the extent of muscular development as well as the shape and height of the rugae could be related to the diet.

The food habits of some species overlapped to a large extent indicating interspecific competition. Calculated indices of food similarity, supported by data concerning the time of food ingestion, however show that this is not the case and points towards possible niche differentiation.

14. AN INDEX OF BIOTIC INTEGRITY BASED ON RHEOPHILIC FISH SPECIES

A biotic index based on the presence and abundance of eleven rheophilic fish species is proposed. The index compares the presence and abundance of the species at the site under investigation with their presence and abundance in a pristine environment. The index differs from published indices in that each species is scored separately in terms of presence and abundance. The assumption being that, because the niches of the species are segregated, they will respond differently to negative influences. The sum of the responses should thus give an indication of the severity of degradation (not at all assuming that the relationship is linear).

Application of the biotic index to the Mutshindudi River indicated that the river is severely degraded mainly due to siltation, increased turbidity and destruction of habitats as a result of overgrazing, cultivation, removal of riparian vegetation and disturbance of river banks. The results coincide roughly with a superficial evaluation of environmental degradation. However, the method will have to be evaluated in a variety of different streams with known environmental disturbances to assess its applicability.

15. THE AVIFAUNA OF THE MUTSHINDUDI RIVER CATCHMENT : INDICATOR SPECIES FOR ECOLOGICAL INTEGRITY

The Mutshindudi River is part of a river corridor that connects Mozambique to the Soutpansberg mountains. As such it provides a potential route for the migration of bird species and thus the potential for providing a high species diversity. The avifauna was surveyed separately in six habitats namely aquatic, forest, woodland, grassland, scrub and montane to rocky but only three were used in the final analysis namely forest, woodland and grassland. The Mutshindudi River was divided into six portions for the purposes of the survey. The data was analysed using a simplified version of the habitat annotation system. The sites were compared with the Upper catchment where the highest number of species were recorded and where the vegetation is the least disturbed.

A total of 125 species were recorded of which 110 can be tied to a specific habitat. The exotic plantation areas were virtually devoid of bird life. The highest species richness was found in the high catchment. This declined toward the middle river and increased again lower down. The degree of similarity with the high catchment showed the same trend. A low index of similarity between sites suggest that bird life associated with relics of riparian forests is highly mobile, moving between the "islands" of forest on the Mutshindudi corridor. Diversity along the whole river is thus considerably higher than that of any individual site. This likely high turnover of species between the different island patches of forest makes survey and predictive assumptions very difficult.

Significant differences were found between the occurrence of indicator species at different sites. The Longtail Wagtail is the most likely individual bird species to be of value as an indicator of the health of the river system. It is a bird of riverine forests and forages for insects and larvae of dragonflies and mosquitoes entirely within the watercourses. Its normal

distribution along rivers is about one pair per 0.5 km of pristine river and about 1 pair per 1 km of unclean river. Other species that are likely to prove useful are the Emerald Cuckoo, Dusky Flycatcher, Cape Batis and Olive Bush Shrike. However, the first three have only limited value as they all have the highest reporting rates for afro-montane forest. Their presence is likely to be more valuable as an indicator of the integrity of the High Catchment than the lower river. The situation along the river has deteriorated to the extent where no forest indicator species were recorded below the Phipidi Falls during the survey. And even at the Falls themselves, only the Longtail Wagtail was recorded as an indicator species, suggesting that the quality of the water is still relatively good at this site

If the remnant riparian vegetation can be saved and then gradually allowed to spread back along the river, the conditions for the terrestrial biota can still be improved. If the destruction continues it cannot be very long before the river deteriorates to the extent that only major and expensive interventions could turn the situation around.

The primary focus of the intervention should be to save what remnants are left of the original riparian vegetation. This cannot be enforced without the acceptance of, and support for, such measures as would be required by the communities living along the length of the river and members of the local government institutions in the area. It is proposed that a scheme that was successfully applied in a developing community in Belize be applied to preserve and extend the riparian forest in the Mutshindudi River catchment.

16. RECOMMENDATIONS FOR RATIONAL WATER RESOURCE MANAGEMENT IN UNDERDEVELOPED RURAL REGIONS OF THE NORTHERN PROVINCE

The study substantiated the general perception that aquatic systems in the Northern Province (former homeland regions) are rapidly deteriorating due to the pressures of a growing human population. High dependence on natural resources due to a very low per capita income, limited environmental awareness and a general lack of infrastructure and of rational planning for sustainable utilization worsen the situation.

We recommend that three basic aspects be addressed simultaneously namely environmental awareness, community empowerment and conservation of the environment. These should be applied within the framework of the National Water Act no 36 of 1998.

Environmental Awareness

Adult literacy classes aimed at creating a true community centered approach should be introduced to educate impoverished people and to improve the efficiency of environmental education programmes. Students at the University of the North and at the University of Venda for Science and Technology should be involved in such programmes.

Health education programmes should be enhanced to reduce the incidence of water-borne diseases, particularly bilharzia.

Water provision programmes should be socially sensitive, clear and open and should not be used as political tools to disempower certain villages. Emerging structures such as water committees, development forums and civics could be utilized to create awareness and to disseminate knowledge about reticulation networks.

Communities should be persuaded to conserve and extend the natural vegetation, particularly in the riparian zones. This could be done by persuading communities and individuals that it is in their interest to do so. One way to achieve this is to form a conservancy along the length of the river in consultation with the TLC and tribal authorities. A certificate signed by the Premier of the province or the State President should be given to all those who agreed to join and abide by the recommended practices. An award could be presented for the most improved section of the river bank. The scheme should be run in conjunction with an environmental awareness programme that would be able to demonstrate the positive effects of conservation.

The cultural importance of water needs to be further investigated and be used in a contemporary context of rural development as educational data in programmes or campaigns aimed at raising the awareness of the importance of water resources and related environmental

issues. Such data could also feature in the national curriculum because of the latter's emphasis in the indigenization of the teaching content.

A community based action or participatory approach should be used in future research on water related problem in developing regions.

Existing or planned environmental education centres should be encouraged to include water awareness programmes in their curicula.

Community Empowerment

Income generating activities which are market oriented and sustainable should be stimulated as part of the local development objectives in these regions.

Infra-structure in these regions should be improved as part of the Reconstruction and Development Programme. Communities should be assisted to inform government of their needs and to participate in the whole process. Electrification should be speeded up to reduce the dependency on indigenous wood for energy.

More emphasis must be placed on genuine reforms and new approaches for community development in these regions. The apparent apathy of rural communities could be rectified if government agencies, local authorities and RDP officials based their actions and programmes on the premise that improvement in the quality of life is a precondition to productivity, and not a consequence. Only when people have the means to provide for their basic needs, will they have the energy and dedication to utilise their natural resources in a sustainable manner.

Broad participation and broad educational campaign processes must be part of the planning and implementation of any water delivery network in these regions. The reticulation systems must of necessity be well understood by those benefiting from it, and service rendering rather than political power struggle should be the main objective.

.As part of the RDP there should be a well planned government policy to address the imbalances between the urban and rural delivery modes.

Water delivery and service must be a win-win process between government/TLC and communities. Water suppliers and beneficiaries must share their responsibilities to ensure a better quality of life.

Water management plans should take cognizance of the importance of fish is a source of protein, even from relatively small streams. Existing legislation prohibiting the use of gill or seine nets in rivers should be enforced to prevent over-utilisation. Commercial utilisation of impoundments should be encouraged. Quotas for commercial netting should be allocated to rural communities living in the vicinity of impoundments. The feasibility of aquaculture as a source of protein and income should also be investigated. Staff and students of local universities should be involved in these developments>

A detailed investigation of all forms of water use needs to be done and regularly monitored to ensure equitable water distribution, conservation of the environment and improved efficiency of water use.

Water Committees, Catchment Management Authorities, and Water Users Associations should be encouraged to co-opt staff from local university departments with relevant expertise in water resource management.

Environmental Conservation

Local leaders as well as members of communities should be involved in all stages of environmental conservation programmes through participatory rural appraisal.

The ecological integrity of rivers in underdeveloped rural regions of the Northern province should be regularly monitored as part of the National Biomonitoring Programme. The numbers and distribution of Longtailed Wagtails and African Black Duck along rivers should be monitored as part of this programme. Students from local communities should become involved in these programmes.

The centre of expertise on water established through this project should be maintained and encouraged to remain actively involved in research on water.

More research should be done to determine the direct and indirect effects of man-induced changes on rivers and other aquatic ecosystems. This information should be used in environmental awareness programmes.

Legislation should be introduced to protect remaining indigenous forests along rivers. No removal of indigenous vegetation should be allowed within a predetermined distance from river banks.

As part of the Work for Water Programme, all exotic trees in the riparian zones should be killed by ring barking. The trees should not be felled as this will lead to erosion and disturbance of marginal habitats.

The occurrence and spread of exotic invaders should be monitored. Inhabitants should be made aware of the negative impacts of invaders and be encouraged to remove them.

17. CONFERENCE PAPERS OR PUBLICATIONS EMANATING FROM THIS RESEARCH

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