Payment For Environmental Hydrological Services For Pangani River Basin – Tanzania.

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1. Introduction

1.1 Preamble

The study on Payment for Environmental Services (PES) is part of the IUCN's Water and Nature initiative (WANI) programme which aims to demonstrate ecosystem management in river and lake basins, empower people to plan for and manage their environment, promote wise governance of environmental resources, develop and apply economic tools and incentives for environmental conservation among others. This study is thus part of the ongoing implementation efforts of the WANI worldwide. Due to the fact that the flow of water is inextricably connected to the health of the catchment environment, the IUCN in collaboration with Pangani Basin Water Office, came up with the idea that, in order to ensure continuous and sustainable flow of water from the catchment areas to the streams and eventually to the Pangani River, the integrity of the environment in the basin catchment areas has to be conserved. Hence a feasibility of using economic instruments and incentives for this purpose was considered and has culminated into this study.

1.2 Rationale for the study

The rationale for this study is based on the recognition that natural ecosystems provide hydrological services in that they help to secure the quantity and quality of downstream water flow. Given the present declining water flow situation amidst increasing demand and ensuing water conflicts in the basin, this has been regarded as crucial at this moment. Protection of catchment areas and the environment around water sources is justified considering that there are no readily available alternative sources of water in Pangani basin making the opportunity cost for water availability very prohibitively high indeed. The PES proposition is that the conservation of forests by land/forest owners would be efficiently done if the owners were compensated for the services they provide. Private decisions to convert forests fail to account for the value of the services that those forests provide to others. Because those external benefits do not enter the land/forest owner's cost-benefit calculations, the social costs of cutting down trees exceeds the private gain and therefore too much forest is converted or degraded from a social viewpoint. Furthermore, the PES is also based on the recognition that prices and markets do not currently reflect or capture these values and hence cannot effectively reward efforts by the upstream custodians of the catchment and sources of water.

This means that the downstream beneficiaries of ecosystem-hydrological services do not pay for the benefits they enjoy, while upstream land managers do not get the full benefit of their contribution to conservation of the environment and management of water resources, nor do they have any incentives to protect the catchment area or riverbanks near where they live.

Because upstream landholders do not gain full benefits or reward from conserving ecosystems, and in fact can usually generate far higher financial gains and economic returns from destructive or unsustainable land uses, ecosystems get degraded, and downstream water quality and supply suffers.

PES aim to create markets for ecosystem hydrological services, so that the beneficiaries pay for the service they receive. They thereby aim to provide financial and economic compensation or

support for upstream landholders to manage ecosystems sustainably, so as to provide hydrological services.

1.3 Experiences of PES from the rest of the world

PES is a relatively new approach aimed at facilitating the conservation of the environment not only in Africa but also all over the world. However, there are already few cases where we may draw lessons and experiences of this approach for our study. Examples of payment for environmental services schemes, which have already been instituted in other countries include:

1.3.1 United States - New York City Pays Upstream Farmers for Protecting its Drinking Water

The Catskills project is among the first and famous cases for payment for environmental services in order to ensure good water quality and sustainable water supplies for various uses. New York City (NYC) obtains 90% of its drinking water from the mostly rural Catskill / Delaware watersheds which are located about 200 km from the city. There are 77,000 people living in the area and some 350 mostly dairy farms are operating. Farmers using fertilizers in their farms resulted in pollution of the water used by the city and overgrazing resulted in increased run-off and erosion. The solution was either to convince farmers not to use fertilisers, which obviously would mean a decline in productivity by compensating them, or to let them continue polluting the water and rely on treating the water. In 1989, a new law came into force, according to which drinking water had either to be filtered or a watershed control program had to be established to minimise microbial contamination. A new filtration plant would have cost the city $US 7-9 billion including operation costs for 10 years.

In order to avoid the costs for the new filtration plant, in 1992 NYC entered into a voluntary agreement with the watershed's farmers, forestry landowners, and timber companies. A year later these partners created the non-profit Watershed Agricultural Council (WAC), which was to provide leadership for the improvement of land use practices and to foster local economic development. Apart from the partners, the NYC Department of Environmental Protection and other local leaders are represented. The Watershed agricultural programme (WAP) is managed through the local WAC and fully financed by NYC to the tune of US$ 1-1.5 billion over 10 years. These funds are obtained through a 9% tax increase on NYC residents' water bills over a five-year period[1]. The funds are used for implementation of best management practices such as compensating dairy farmers and foresters who adopted best management practices to cover their all their additional costs. Foresters who improved their management practices (such as low impact logging) received additional logging permits for new areas, and forest landowners owning 50 acres or more and agreeing to commit to a ten-year forest management plan are entitled for an 80% reduction in local property tax. NYC also paid $US 472 million to improve and rehabilitate city-owned sewage treatment plants, water supply facilities, and dams (Koch-Weser & Kahlenborn, 2002)

1.3.2 Costa Rica.

Has been the pioneer to achieve environmental goals by creating markets for the environmental benefits of forests. In March 2000, adjustments to the water tariff were introduced in Heredia urban water bills by the local public utilities company ESPH, in order to ensure that all categories of water users contribute financially to the protection and maintenance of adequate forest cover

[1] The funds for these payments also come from various other sources. Supplemental funds also are provided by federal, state and local governments Taxes, NYC Bonds, Trust Funds; subsidies; logging permits; differential land use taxation; property transfer: development rights and conservation easements, development of markets for non timber products and certified wood.

in strategic areas that enable water catchment, infiltration and recharge. These revenues provide direct monetary compensation to the Braulio Carrillo National Park and private landowners for their investments in forest protection and restoration in key points of the watershed. An additional fee of US $0.05/m^3 of water consumed is charged on the monthly water bill, and participating landowners receive US$ 70/hectare/year for protecting ESPH water resources. The amount represents opportunity costs of land use in the upper watershed[2].

1.3.3 Ecuador.

In Pimampiro Village, the local law was changed to create a fund for catchment forest management for water, paying local people to do work in the forest. In the capital city Quito, a fund was established (FONAG) to administer catchment conservation fees, which are included in urban water bills. In Cuenca, a portion of urban water revenues goes into the management of a catchment-protected area, as well as in Loja a southern city of Ecuador.

1.3.4 Lao PDR.

Phou Khao Khouay Protected Area currently receives 1% of the gross revenues of power exports from a downstream hydropower dam, and the proposed Nam Theun 2 hydropower project will provide over $1 million a year for the management of the Nakai-Nam Theun Protected Area

Perrot-Maitre and P. Davis[3] lists some features of innovative cases of watershed management from around the world as follows;

1.3.5 France: Perrier Vittel's payments for water quality

Perrier-Vittel, a large water bottling company, has undertaken two schemes. Vittel subsidise the adoption of best management practices for cattle ranching and forest management among landholders who live around the springs that the water bottling plant depends on. Perrier also subsidises an organic vineyard to protect springs.

1.3.6 Colombia: Self-Organised Private Deals Cauca River: Associations of Irrigators' Payments

Here private irrigators organised themselves and make voluntary payments to government agencies and the agencies in turn make payments to private upstream landowners. For reforestation, erosion control, spring and waterway protection and development of watershed communities activities. The expected outcome from these payments is improved base flows and reduction of sedimentation in irrigation canals.

1.4 Problem statement and aim of the mechanism in the Pangani river basin

The PES scheme for Pangani aims to address the following problems:

[2] Economic-Ecological valuation of water Resource in Costa Rica, http://guide.conservationfinance.org/... see also Chomitz,K.M., Esteban Brenes, Luis Constantino (1998).

[3] See Perrot-Maitre, D and P. Davis (2001)

1.1 Water scarcity and quality in downstream areas due to deforestation and improper land management practices in the upper watershed.
1.2 Forest Department resource constraints for managing forests properly.
1.3 Landholders have insufficient income, and can earn more money from degrading the land than from conserving it for hydrological services because the risk of getting caught and punished is currently low!
1.4 Downstream water users have little awareness that upstream ecosystems matter for water.
1.5 The 2002 Water Policy provides for a catchment conservation fee, though does not elaborate the details or mechanism.

The aims of developing a PES scheme are to:

1.6 Improve water quantity and quality through better forest and upper catchment and stream and rivers buffer zone land management.
1.7 Improve funding for Forest Department management of catchment forests.
1.8 Generate financial and economic resources for landholders to benefit from managing land for hydrological services.
1.9 Improve downstream awareness that ecosystems matter for water.
1.10 Support the Ministry of Water & Livestock Development in developing a catchment conservation PES mechanism.

2.0 Situation Analysis of Water Use in Pangani Basin

2.1 Water flow and use

The Pangani basin draws its name from the river Pangani is a large river located in the northeastern part of Tanzania. The river has its sources at the rain catchment slopes of Mt. Kilimanjaro and Mt. Meru. In the east the Pare and Usambara mountains are found, while the dry Maasai Plain represents the southwestern parts of the catchment. Lake Jipe at the border of Tanzania and Kenya also supplies water to the Pangani through Nyumba ya Mungu dam. A small part of the catchment is located in Kenya, but the main part is in the Tanzanian regions of Kilimanjaro, Arusha and Tanga and it drains into the Indian Ocean. The total catchment's area of the basin is 56,300km^2 (URT 1995). The basin supports water demand for domestic and industrial use in three major urban centres and several small towns. Other major uses include hydropower generation The present hydropower generation capacity along the Pangani basin stands at more than 74MW. Irrigation agriculture is among the major consumptive uses of water in the basin. Today, approximately 310 square km of farmland are irrigated. Of this, about 60% is used to grow rice. Other crops include coffee, maize, beans, vegetables, and fruits. A study of the basin by the Norwegian Technical University and University of Dar es Salaam on the water management in the Pangani River basin[4], discovered that the irrigations systems were inefficient. In many cases, only 30% or less of the water being withdrawn for irrigation actually reached the fields. There is, however, a potential for making the irrigation channels more efficient. This presents a further challenge for the future.

Evidence shows that water flows in the Pangani River is declining and at the same time the quality of water is also declining[5]. The degradation of the catchment forests and pollution of river water by untreated industrial and domestic effluent and also agricultural run-off contribute to the pollution of the river.

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[4] See http://sv.ntnu.no/geo/Forskning/Pangani/

[5] Ngana (2002) asserts that ineffective enforcement of conservation laws, climate change, population growth, socio-economic and political changes and lack of an effective institutional framework contribute to the decrease in water in the basin.

2.2 Pressure on water resources

Increasing water demand also exacerbates the situation of water availability to human uses. During the past decade and half, population in the catchment area has grown by 32% to about 3.2million people from 2.4million people in 1988(census 1988 and 2002). Furthermore, increased irrigation activities in the areas of Arusha (flowers), Kilimanjaro (paddy and sugar cane) put pressure on available water resources. Although livestock numbers as well as wildlife numbers are not well established, also forests are known to place huge demand pressure on water resources making water availability even more bleak in the basin for the days to come due to the fact that these uses are on the rise.

Since the age of sisal plantations until 1960, the area at the foot of the Mount Kilimanjaro was sparsely populated with mainly immigrant labourers who worked on sisal farms (Yanda, 2002). The area is now densely populated due to increasing shortage of land, water and grazing land in the middle and upper sections of the mountain. The possibility for irrigating the land through water abstraction from rivers has given these dry areas an opportunity to be turned into agricultural land (cultivation of crops such as bananas) with the inevitable outcome of less water going downstream. Downstream Nyumba ya Mungu Reservoir land use has undergone tremendous change from pure pastoralism to pastoralism mixed with irrigation agriculture during the past four decades (Shishira 2002).

The Pangani basin offers many opportunities for tourism with the main attraction, naturally being Kilimanjaro and wildlife. Tourism affects water use in various ways. An increase in tourism will certainly increase the demand on water supply. With an increase in tourism, more people would move to the region to work in the tourist industry and thus also contributing to an increase in water demand. The number of tourists visiting the Pangani Basin's Arusha and Kilimanjaro national parks has consistently increasing over the years. The growth between 1977 and 2002 has been 645% from a total of 15,192 visitors in 1977 to 113,202 visitors in 2002[6]. This is even without considering conference tourism and United Nations' Rwanda Tribunal in Arusha town and other attractions. A further aspect to consider when looking at the relationship between tourism and use of water is that tourists who visit areas like this are interested in wildlife and the unspoiled nature. This means if water availability for environmental use declines, it may affect the natural beauty, which attracts tourists to these areas apart from affecting the sustenance of wildlife, which will be forced to out migrate to other areas in search of water and pasture. In order for the basin to benefit from tourism and alleviate the poverty of its inhabitants and that of the country as a whole, water availability for environmental use is of vital importance.

2.3 Number and type of water users and payment status

The Pangani Basin Water Office have been able to identify 3,450 water users in the basin of which only 438 paid their bills in 2003/04 representing about 13% of total users. The total number of water users in the basin has not fully been recorded. Respondents attested to this while the PBWO conceded by acknowledging that there is still much work to be done in terms of identifying all the water users and convincing them to get water rights in order to start paying for the water they use especially in the upper catchment areas. Water users in the basin are categorised as large and small-scale irrigators, domestic users, industrial and livestock use. In the large irrigators categories there are mainly commercial flowers growers (Dekker Tanzania-Arusha, Tanzania Flowers, Dekker Moshi etc) coffee (Tchibo estate, Kifufu etc) and sugarcane growers (TPC). The small-scale irrigators are usually found in water user associations or groups (Lekitatu, Tegemeo, Chawampu, Chawampyo, Shamima, Ambureni/Moivaro etc) farming mainly

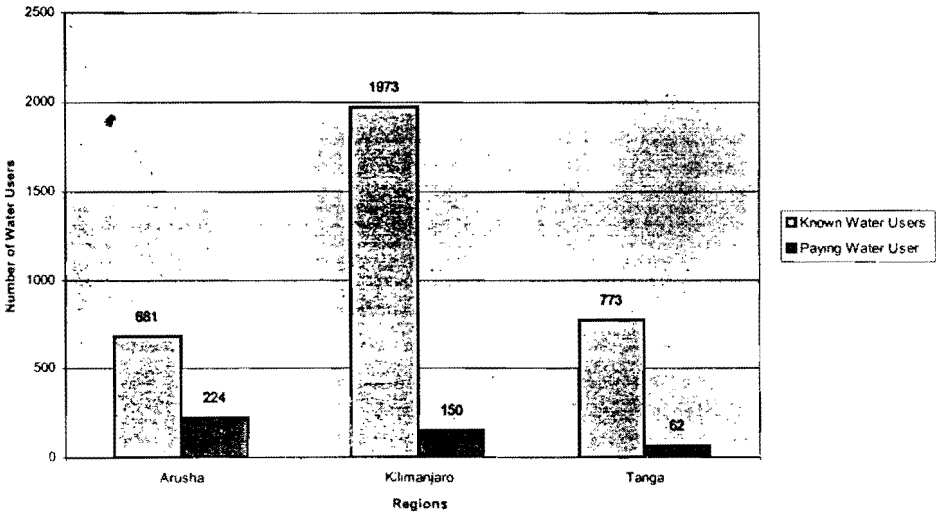
[6] Source Economic surveys various issues.

paddy, maize, vegetables and fruits. Domestic abstractors include AUWSA, MUWSA, Uroki-Bomang'ombe WUA, Mwanga Water Supply and Sewerage Authority, Losaa-Kia, Same Water Supply and Sewerage Authority, Korogwe Water Supply and Sewerage Authority etc). Industrial user include Tanzania Breweries Ltd, Bonite bottlers etc)

Kilimanjaro is the highest contributor to paying of the water user forces relative to Arusha and Tanga. This should not be construed to mean that they are more compliant compared to others; actually they are the less compliant together with Tanga region. Figure2 Exhibits only 7% of water users are paying for water they use! Kilimanjaro has the highest number of known users in the basin, (54.7% of total users).

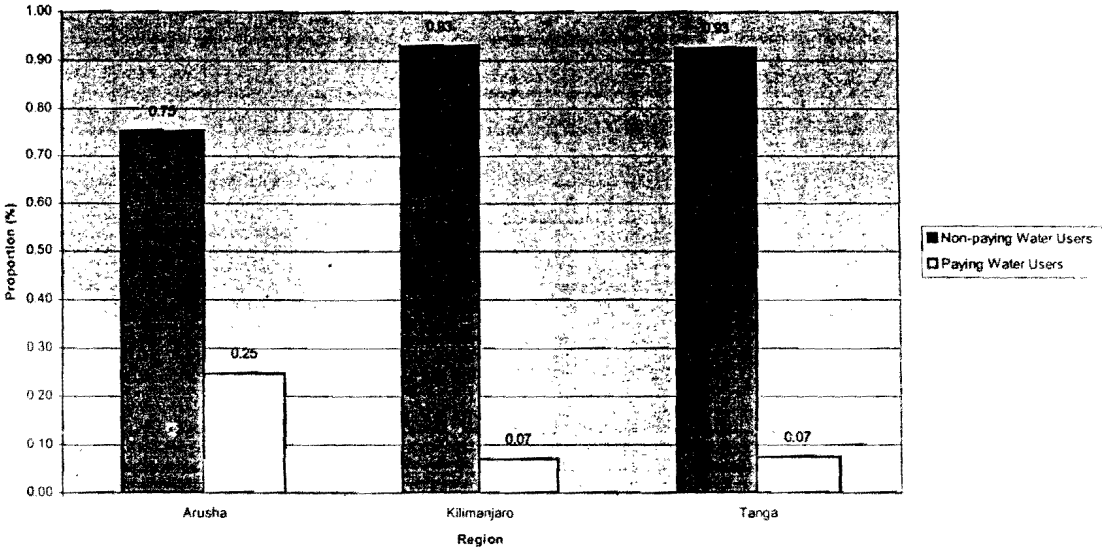
Pangani Basin Water Office is confronted with a number of problems. Turpie et al 2003 identified 7 problems emanating from inadequate funding being (i) water users abstracting more water than allocate in their water permits (ii) use of water without formal water permit especially traditional furrows (iii) inadequate monitoring of inefficient use of water by abstractors. (iv) inability to formulate integrated planning, development and management of water resources (v) inadequate human resources and (vii) inadequate enforcement mechanism of regulations and by-laws.

Fig. 1: Number of Paying and Non Paying Water Users in Pangani Basin (2003/04)



Apart from the identified set backs, one major setback is the non-payment of the water user fees in the basin. It is claimed that the concept of water as an 'economic good' has not completed been accepted by most users especially small-scale irrigators. They wonder why one should pay for water while this is 'a gift' from God! Others show their strong scepticism on paying water fees to PBWO as if PBWO has added value to the God given water!. The later sentiment cuts across all levels of users except commercial irrigators and domestic users who seem to appreciate the role of PBWO in facilitating their water use needs.

Fig. 2: Proportion of Paying and Non-Paying Water Users in the Pangani Basin (2003/04)

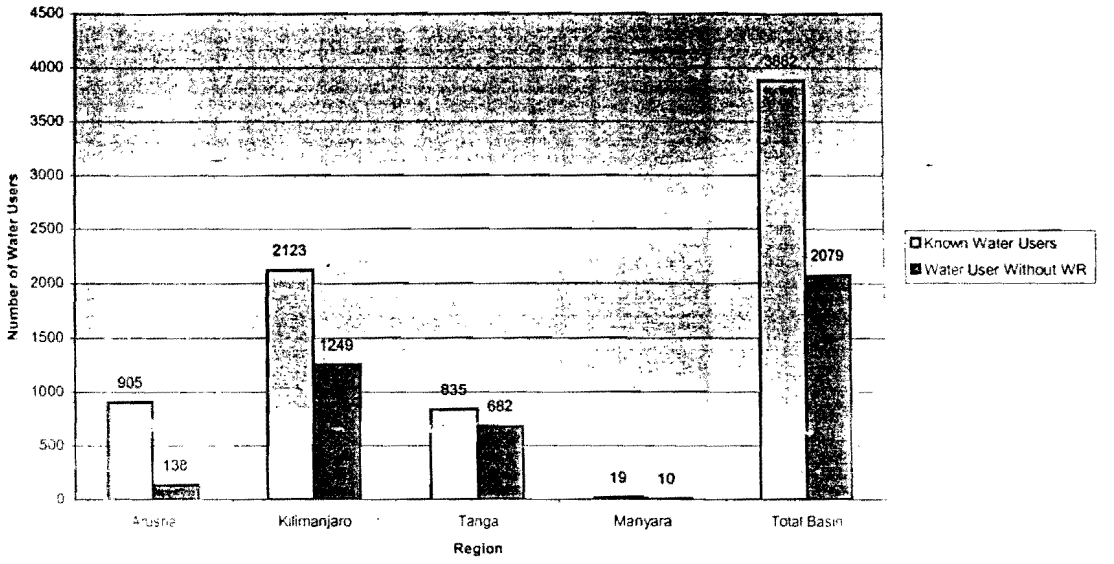


Yet other users pose quite a genuine case asserting that they never get the amount of water promised by their water rights. This has been the case in most of the areas we visited. Lekitatu is one of the cases where the amount of water paid for is not what they get. This is because water is Ngaresero River has declined. This claim was also attested to by the Tanzania Plantation Limited who shares the same river source. An even practical problem arises when one wants to know the amount of water users abstract! Most often water users do not have gauges or meters to measure the amount of water they extract in order to advance their claim! It is important therefore to look into the issue of measurement and monitoring of water use before considering charging in terms of amount used.

One case of charging water use per unit consumed without having to gauge, is the estimation of the water use intensity of different plant according to their known characteristics. For instance, eucalyptus trees[7] are know by many for their water intake and also paddy. Andre' de Moor and Calamai (1997) put into clear perspective the water intensity of paddy by asserting that the amount of water required each year for a hectare of irrigated rice land is enough to support 100 nomads with 450 head cattle for three years or 100 rural families for four years!

[7] It is said there are several species of eucalyptus some of which are not water guzzlers.

Fig.3: Number of water Users Without Water Rights (2004)



Although payment of water bills is improving every year, there is still a huge backlog of non-paying clients. The bulk of these are the traditional users for domestic and furrow irrigation. They contend that they have been using the water for centuries across generations. The present users inherited the canals, which had been a permanent feature of their landscape and very elaborate rules for the use of water from these canals were set and followed effectively over the years. Others even go to the extent of claiming that the water is theirs for deciding whether to give anybody else and how much and at what time because it is in the land they own and manage! Faced with such mindset, one can easily see the challenge the PWBO is facing and the more the support it needs to change this mindset for the benefit of all in the basin and the country as a whole. Luckily most of the upstream areas are faced with scarcity of land, this would have been even a greater problem for the downstream users.

2.4 Competition and conflicts for water resources

Conflict between upstream and downstream water users and also between the use of water for agricultural purposes as opposed to other activities such a hydropower generation do exist in the Pangani River basin. In the Pangani river basin both the highland dwellers and the people of the lowland channel water for agricultural purposes. However, whereas the inhabitants of the upper parts of the basin have always had enough water, the people lower down have had to struggle for an adequate water supply. In Pangani basin, conflicts between groups of farmers using water for irrigation have intensified of late. Following the construction of the first phase of the 2,300-hectare Lower Moshi irrigation scheme, farmers upstream on the Rau River began expanding rice irrigation (to over 3,000 ha) without proper water rights.

Research conducted jointly by the University of Dar es Salaam and Norwegian University of Technology and Science found a new conflict arising in the basin as a result of the increasingly modernized and organized character of the agriculture further down which is demanding greater amounts of water. In the upper reaches of the basin, on the slopes of Kilimanjaro, some 2000 water-extractions can be found, most of them serving only a few farms. The larger farms lower down have gained more influence and are now increasingly voicing their demand for better water

management in the river basin at large[8]. With a combination of access to water and rich volcanic soils, the Pangani River basin has among the richest strips of land in the country. There is an even greater potential for farming this land, but an increase in agriculture may lead to further water conflicts unless a suitable solution for fair water distribution is provided. This problem is further poised to escalate as water scarcity due to weather changes intensifies in the future.

The Tanzania Electric Supply Company (TANESCO) is at loggerheads with farmers for increased water abstraction for irrigation upstream the NYM. Farmers on the other hand perceive basin management as a ploy to deprive them of their historical customary right to use water for irrigation.

Inundation of small area within existing river banks, Resettlement of people pollution from explosives, trucks, oil spills, human litter during construction fish migration to be affected (as there will be no fish ladders) disappearance of Pangani Falls, a loss to landscape scenery a small stretch of riverine forest deprived of water.

Table 2.1: Water use conflicts in Pangani Basin dealt with by PBWO (Jan. 2003 – Sept. 2004)

Number of Conflicts	Type of Conflicts	Resolution	Period (quarterly)
4	2 - Large vs Small scale irrigators 2- Government Institutions and water users	All Conflicts were resolved	January - March 2003
1	Water users sharing same irrigation canal	Resolved	April – June 2003
5	2- Water users and District Councils 2-Upstream vs downstream users 1- Village government vs water users association	All conflicts resolved	July – Sept 203
6	2 – Decrease of water from source 1- Nduruma WUA v/s AUWSA	All conflicts resolved	Oct - Dec. 2003
5	1- Customary water rights 1 Water users Association vs Village government 2. Conflicts between institutions and communities for piped water	All conflicts resolved	January – March 2004
7	7 Decrease of water from source	6 Conflicts still being solved 1 already resolved	April June 2004
16	11 Decrease of water from source 1 Conflict between small-scale miners	6 Have been resolved 5 Conflict resolution efforts continuing	July – Sept2004

[8] See http://sv.ntnu.no/geo/Forskning Pangani/

	1 Conflict between livestock keepers and farmers 1 Water users from same canal	One conflict still being resolved Conflict already resolved	
	2 Water users from same source	Efforts to solve the conflict continuing	

Source: Pangani Basin Water Office December 2004

Most of the conflicts, which occurred, have been due to the declining water flows thus decreasing water availability in the streams and rivers in the basin. There exists many users with varied needs hence putting pressure on the dwindling resource and inevitably with everyone defending/ protecting their interests, conflicts ensue. In terms of managing the water resources, increased water use conflicts are positively correlated to increased conflict resolution costs on the part of the PBWO.

3 Catchment environmental health status

The forest health in the Pangani basin is shown to be unsatisfactory. Research shows that between 1952 and 1982, Kilimanjaro's natural forest area has been shown to decline tremendously. The natural forest areas had declined by 21%, riverine forest declined by 12%, plantation woodland by 47% and closed woodland by 81% (Yanda, 1999). Newmark (1998) shows significant forest cover loss have taken place in the Eastern Arc Mountain amounting to 1231 km^2 of natural forest and 618 km^2 of closed forest from North Pare, South Pare, West Usambara, East Usambara and Taita with South Pare, East and West Usambara having lost a larger portion. According to Cordeiro, (1998), In the Nilo Forest Reserve in the Usambara mountains, which has 5,872.1 hectares or 58.721 km^2 there are 33.8ha of 'cultivation under forest', 372.3 ha of 'peasant cultivation' as he terms it. This goes on to show how classification of forests alone cannot work to preserve our forests without investing in monitoring and working with the people for conservation. Baker and Baker (2002) further show that in Tongwe-Muheza Coastal forests used to cover 1,202 ha, but remain with only 300 ha of forest cover, while Gombero forest Reserve has been completely cleared for farming. On the downside, loss of forest cover does result into soil erosion and the sedimentation of streams and rivers and reduction in water quality and damage fisheries. Siltation, which is the result of erosion upstream, reduces the capacity of hydropower reservoirs and may cause damage to hydropower turbines and above all deforestation reduces dry season flows.

Water pollution is another aspect of the declining environmental integrity in the basin. The PBWO monitors a total of 14 industries, sisal estates and institutions for water pollution. All of these have been found to be lacking in effluent treatment and are required to either improve their treatment or install treatment facilities. Seven of these have inadequate treatment facilities or processes, while the reminder do not have treatment facilities. Most of the water returned into streams and rivers do contain low Dissolved Oxygen (DO) and, high BOD and phosphates, elevated zinc, ammonia values.

4 Cost of Catchment Conservation

Funding for forestry and catchment conservation is done at two main levels namely; the central government through the Division of Forestry and Beekeeping in the Ministry of Natural Resources and Tourism and the second level through the District Natural Resources Officer's budget to the President's Office Regional Administration and Local Government (PO-RALG). In most cases PO-RALG does provide funds for Personnel Emoluments (P.E) but does not provide funds for operations. This is no wonder because in the Appendices to the volume III on

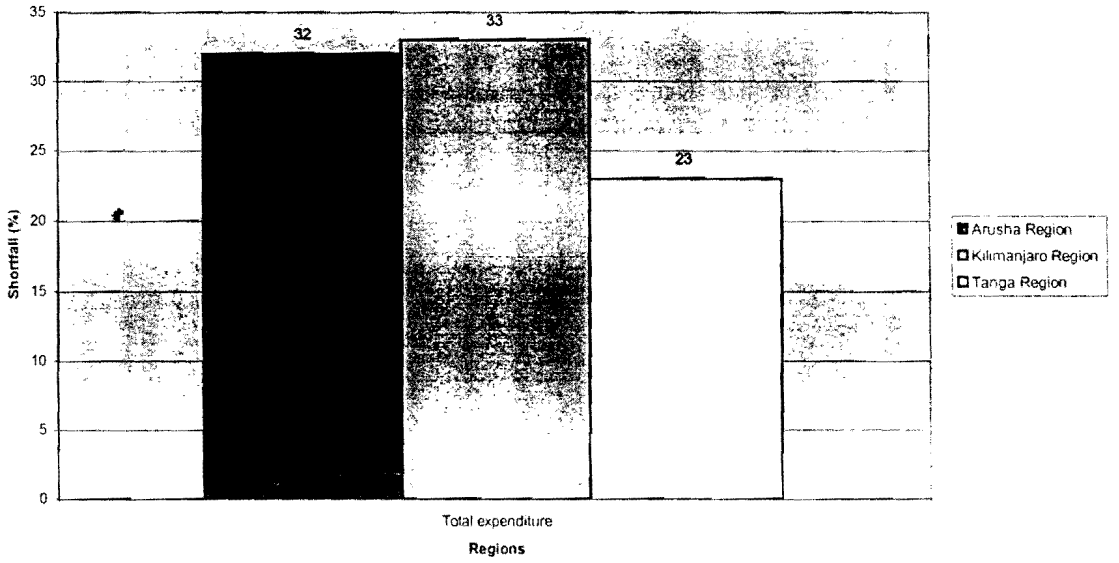
Estimates of Public Expenditure Supply Votes (Regional) Details on Urban and District Councils Grants and Subventions, the natural resources sectors are not represented.
The gap between the amounts approved by the budgeting process and those disbursed is quite significant. Overall the money is inadequate given the state of the catchment and their importance to water availability.

Table4.1: Actual Capital and Recurrent Expenditures for Catchment Forests (2001-2002)

Item	Arusha Region 2001	Arusha Region 2002	Kilimanjaro Region 2001	Kilimanjaro Region 2002	Tanga Region 2001	Tanga Region 2002
Capital expenditure	7,231,450	27,793,200	5,022,000	14,100,000	30,252,000	25,558,000
Recurrent expenditure	74,582,138	55,520,656	80,631,000	77,294,921	69,826,988	61,392,004
Total expenditure	81,813,588	83,313,856	85,653,000	91,394,921	100,078,988	86,950,004

Source: Forestry and Beekeeping Division, MNRT December 2004

Fig.4: Expenditure Gaps Between Approved and Actual Expenditure (2002)



In the Districts containing catchment forests, the forestry office does Conservation in collaboration with the Zonal forest catchment project activities by involving the community in JFM making it a participatory activity. Education for awareness creation to conserve the forestry by not cutting trees and replanting in the watershed areas. DWE contributes by sensitising communities on conservation through "water week", distributing brochures and national water policy. However this is done without a budget and therefore the exercise is done occasionally.
The Forestry District office (DFO) has no funds to carry out its functions properly. When there is a project, that is when they become active using the project to carry out some of their normal responsibilities by providing expert services (e.g. Eastern arc conservation project). The financial resources they get are mostly for Personnel emolument and OC.

Other managers include UWSSAs, which as a rule conserve their water intake areas. MUWSA for example, has a conservation programme whereby it provides source conservation budget for

activities like tree planting, fencing etc. For the year 2004/ 05 the budget is Tshs 2.68million for water source protection and wetland.

5 Opportunity costs of water availability

The loss of surface flows of freshwater from rivers and streams in the Pangani Basin from the catchment areas is manifest in a wide range of economic benefits foregone. These include economic costs related to shortage of drinking water supply with its concomitant time use implications in fetching water for domestic use and increased health risks. Other costs are related to reduction in agricultural land use opportunities and loss of low cost hydropower generation opportunities.

TANESCO

Power production by TANESCO relies mainly on two sources namely; hydro generation and thermal generation using fuel-oil/diesel, coal and recently natural gas. Hydro-generation is by far the major contributor to Tanzania electric power supply. The high reliance on hydropower makes it mandatory for Tanzania to place due emphasis on maintaining the integrity of the water catchment areas so as to ensure that the economy does not suffer due to disruption of hydropower production caused by declining water flow from the catchments.[9]

Hydropower is the cheapest source of electric power generation in Tanzania compared to the other available sources of coal and diesel generation. Natural gas generation has a lower cost compared to diesel/fuel oil and coal but has just been introduced. Pangani's contribution to the hydropower equation of Tanzania is shown to be significant at 12% and 12.76% in 2002 and 2003 respectively. If one removes this amount of power from the National Power Grid surely power shortage is bound to occur and affect production and other social and economic activities in the country as a whole.

In the event that electric power was to be generated using thermal (diesel or fuel oil) the production cost per unit of electricity that TANESCO will have to maintain electric power supply at the current level unless other hydro sources are found to substitute the Pangani Hydro System in the National Electric power Grid. The incremental cost in order to obtain the same unit of electric power would be for this illustrative case Tshs 159.88 for the low cost scenario and Tshs 186.95 per unit for the high cost scenario, instead of Tshs 6.24 and Tshs 2.56 for high and low cost scenarios respectively.

Urban Water Supplies

Water drawn from surface gravity flows is charged a flat rate of Tshs 1,000/- per month while that drawn from boreholes costs Tshs 3,000/- per month per household which is estimated to consume 8m^3/month (equivalent to 8,000 litres per month) in Mwanga. This difference is brought about due to the high cost of construction of a borehole (Tshs 34million on average) with the cost of its pump. Furthermore, running cost especially for buying fuel makes it a difficult option compared to gravity surface flows[10].

The cost of supplying water from boreholes is higher than that from gravity surface flows sources. Furthermore both in Mwanga and Same, the water is in most cases saline when the

[9] It is noted that climate variability plays a part in the weather fluctuations as well, however, catchment environmental integrity is what we can directly control and manage.

[10] See also Shechambo, F (2002: 161)

water levels recede, hence making the utilisation of this water unsuitable for some uses. This could be the case for the other areas when surface flows diminish to the minimum. So the opportunity cost of declining flows in the streams and rivers of the basin is the second best available option for water supply, which is mainly underground water through boreholes. This will cause higher prices for domestic water users as compared to the existing prices paid for water drawn from surface flows. For irrigators, the majority of small-scale irrigators will be left without a feasible option while the large-scale irrigators will have to use boreholes to obtain the precious liquid at a higher cost effectively cutting their profit margins. These include flower and coffee growers. However, this is not an automatic solution, it depends on whether the area contains ample supplies of ground water.

Water for Irrigation

Losing the surface flows of the streams and rivers in the basin will thus mean dependency on rain fed agriculture which will exclude some of the currently irrigation dependent crops like paddy, flowers and sugarcane, and reduce the yield of others which also need supplementary irrigation as mentioned above with the undesirable outcomes of food insecurity, increased unemployment and falling regional and National GDP[11]. The option of transferring water from another basin is not there because there is no other basin nearby. Groundwater source is a short-term option because it also depends on recharge from rainfall and the integrity of the catchment forest environment for efficient percolation (i.e. to reduce run-off and evaporation).

In Pangani, the effects of low water flows in the Pangani River have started to be seen. Coconut palms alongside the river are drying up/ rotting and dying due to infiltration of salt water upstream. The coconut crop is lost, farmland is also lost and people are abandoning their farms for other areas[12].

6 Willingness to Pay for Environmental Services

The main question asked here is whether water users for domestic and irrigation exploiting water resources from a given watershed, contribute to the sustainable management of the catchment? Specifically we asked the rural and urban households in the Pangani basin whether they are willing to pay for improvements in the quantity, quality and reliability of water supplies in the face of dwindling water flows in the streams? We seek to determine what local people are willing to pay for improved supply of water for domestic use and irrigation particularly in the case of improved performance that would results from catchment conservation.

In the present study, domestic water users, irrigators and power generators were covered. A total of 6 water users associations for small-scale irrigation were surveyed, while 8 private large-scale irrigators were also covered. Seven (7) urban water supply and sanitation authorities were also consulted [13]. Domestic consumers in 5 district centres as shown in the table below were surveyed.

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[11] The total average GDP for the three regions for the years 1998 and 2002 was around 16%. PO-RALG (2004), The Socio-Economic Profile and Investment Potentials in Mtwara Region. Report Prepared by the Economic Research Bureau, University of Dar es Salaam for the Regional Commissioner, Mtwara. Note also more than 60% of the region's GDP depends on agriculture URT (1998) Kilimanjaro Region Socio-Economic Profile.

[12] Source: DALDO Pangani at the consultative meeting at the Pangani District Executive Director's Office, November 2004.

[13] See also appendix 2

Table 6.1: Study Areas in the Pangani Basin

Region	Town	District	Division	Ward	Village	Number of respondents
Arusha	Usa River	Arumeru	Usa River	Poli	Usa River	64
Kilimanjaro	Hai	Hai	South Masama	Masama	Mungushi	64
	Same	Same	Same	Same	Same	64
Tanga	Korogwe	Korogwe	Korogwe	Old Korogwe	Old Korogwe	64
	Pangani	Pangani	Pangani	Pangani East	Pangani	64
Total Sample						**320**

The domestic water consumers are by far the majority of water users although domestic consumption accounts for less than 30% of total water supplies compared to irrigation uses. We focus on domestic users because they are better organised under their urban water authority and also because of their good record of payment and the potential for contribution to the ESF. A total of 320 households were interviewed in all the district centres surveyed.

Comparison with national estimated consumption provision of 30 lcd (i.e. 150 litres per household of 5 persons per day), Mungushi in Hai and Same are the only ones consuming below the national benchmark others surpass it. Further comparison shows that in the USA one person uses about 196.4 litres per day, which translates to 982 litres per household per day! (i.e. 6.5 times the water use of a Tanzanian household water consumer!). In Melbourne, Australia likewise water consumption stands around 164.25 lcd. (5.5 times a Tanzanian household Consumer)[14] However, in some cases consumption maybe understated due to the fact that other water uses are normally not counted because they are performed at water sources such as rivers, lakes, wells etc. Such activities include washing of clothes, domestic utensils and even bathing.

During the survey, the main question asked was whether the respondent was willing to pay twice or more the amount they were paying at present so as to accommodate PES[15]. Most of the respondents declined and went forth to suggest the amounts (post their votes), which they were willing to pay per month!

[14] See Abrashinsky,N (2004) Domestic Use of Water. http://www.uwec.edu grossmzc/ABRASHNM/
[15] See Appendix 4

Box 1: Aggregate Willingness to Pay Estimation

$$\text{Aggregate } WTP_a = \Sigma_i [(\square_i) \times (\square_j) \times (\square_{i\,wtp} \times WU_m)] \quad \text{——————} (1)$$

Where:

WTP_a = *Willingness to pay for environmental services (hydrology) per annum*

$\square_i$ = *group i's percentage of the sample and i = 1,2,…, 5 groups*

η_j = *total water utility clientele of the area j*

$\square_{i\,wtp}$ = *Amount of money group i is willing to pay for an extra litre on water as environmental services fee.*

WU_m = *Household's water use per annum.*

$$\text{Individual Household } WTP_a = \text{Aggregate } WTP_a / \square_j \quad \text{——————} \quad (2)$$

D = *Aggregate water utility clientele in 9 areas listed below*

The following results were obtained from employing the above equation on data from the five locations sampled plus 4 other localities of Arusha, Moshi, Mwanga and Tanga, which used weighted estimates from the 5 sampled areas.

Table 6.2: Willingness to Pay for Water for Domestic Use

Area	WTP Tshs/month	WTP Tshs/ltr	Water ltrs/month	Consumption	Water consumption (ltrs/day)
Usa River	1613	0.28	5,760		192
Hai/Mungushi	1226	0.28	4380		146
Same	1142	0.28	4080		136
Korogwe	1071	0.21	5100		170
Pangani	1173	0.23	5100		170
Basin Weighted Average(upper bound)	1056	0.22	4800		160
Basin Weighted Average	672	0.14	4800		160

Result from the WTP for environmental hydrological services by domestic water consumers indicate further that the total amount of expected collections under the upper bound values expected collections under the upper bound values scenario is Tshs.708. 9.million which is equivalent to US $ 708,897.23. The lower bound values scenario results into expected revenue collection of Tshs.444.8 million or the equivalent of US $ 444.843.45. Supposing that one desires a gradual increment in payment by consumers, than a Tshs.0.10/litre overall increment across the basin domestic water consumer will bring about Tshs 317.7 million per year equivalent to US $ 317,745.32. These amounts are estimated from paying urban water consumers in the basin. The total expected amount therefore will depend on the urban water supply authorities' collection efficiency. At the moment, collection efficiency of bills is satisfactorily high.

Expected amount from all water abstractors is estimated at Tshs.78.036 million or US$ 78,036.4 being half of the present collection amounts. The grand total of expected collection from WTP will therefore be Tshs.786.9 million per year for upper bound values, equivalent to US $ 786,933.6, Tshs. 522.88 million per year for lower bound values, equivalent to US 522,880 and Tshs.395.9 million per year for a gradual increment of Tshs 100/m^3 equivalent to US $ 395,782.

In the equation below, we ask a direct question; what are the key social and economic determinants of the domestic consumer's willingness? Demand theory dictates that ones ability and willingness to pay is influenced by several factors which include the consumer's level of income, price of the commodity, availability of substitutes and their prices, prices of complementary goods. In the case of one's willingness to pay, incomes is an important element in decision-making but also are other factors such as availability of substitutes, amount and the cost involved in acquisition of the good or service. In the case of water for domestic use, several factors were considered these were; income, level of education, size of the household, amount of water consumption and gender. All but 2 of the included factors were found to be insignificant. Statistical significance tests indicate that, the overall goodness of fit is 32% of variation in the sample, being a cross section data analysis this is a good enough explanation of the behaviour between WTP and the independent variables of income and the household water consumption.

Box 2: Empirical model specification:

$$WTP = a_0 + \beta_1 Y + \beta_2 W_C + \varepsilon \quad \text{----------} \quad (1)$$

Where:

WTP= Willingness to Pay for environmental services
Y = Level of income per annum
C = Amount of water use per month
α_0 *= constant coefficient*
$\beta_{1,2}$ *= Coefficients for income and water consumption respectively.*

Results:

$$WTP = 0.03\,Y + 0.012\,W_C \quad \text{----------} \quad (2)$$
$$(1.73)^{***} \qquad (2.88)^{**}$$

$$AdjR^2 = 0.32 \qquad F_{3,270} = 3.03$$

***95% level of significance*
****90% level of significance*

Note: Cross - section data has been used for the regression.

Results show that the amount of water consumption per household is very significant in explaining individual willingness to pay at 95% confidence as shown by the t-statistics above is > 2. Also Household total income per month is significance at 90% confidence. The dependent variable WTP for environment services fee. Income and amount of water consumption emerged

to be the most important factors, which influenced the Pangani basin domestic water users to be willing to pay for environmental services. These results are similar to those SANREM (2003) FOR Cotacachi, Ecuador, where they also found income and family size to be positively correlated and significant in explaining the willingness to pay of communities to obtain good quality water from conservation of the watershed.

7.0 Payment Mechanisms and Management of Environmental Services Funds

7.1 PES sources and use of funds

Environmental Services Fund Mechanism (ESFM) is defined here as an institutional arrangement that results in the transfer of new or increased financial resources from those willing to pay for sustainably produced goods and/or forest ecological services, otherwise known as Payment for Environmental Services (PES), to those willing to ensure these goods and services are available in turn. The overall goal of developing PES is to supplement efforts by forest managers through stakeholder participation of all those who use the ecological services of the forest and those who manage the forest catchment areas as well as the riverbanks and other water sources in ensuring a sustainable flow of hydrological services through adding financial value to their forests based on the benefits they generate. This mechanism therefore creates the necessary incentives to users and managers to conserve and restore forests as well as water source and riverbank areas. The main two objectives are; Firstly, PES can "capture" the non-market values of ecological services through economic transactions, thus creating new markets. On the other hand, the PES can charge on the non-marketed portion of people's willingness to pay for forest goods (hydrological services in this case), thereby increasing the market value of forest goods that are produced in a sustainable way. Under PES the following will be the sources of funds:

1) Charging domestic consumers (under urban and rural water supply authorities)
2) Charging large and small scale agricultural producers (irrigators)
3) Hydroelectric generation
4) Charging industrial producers including water bottlers
5) Charging defaulting effluent dischargers into water bodies
6) Donations and subventions from various donors and government

Uses Of Funds

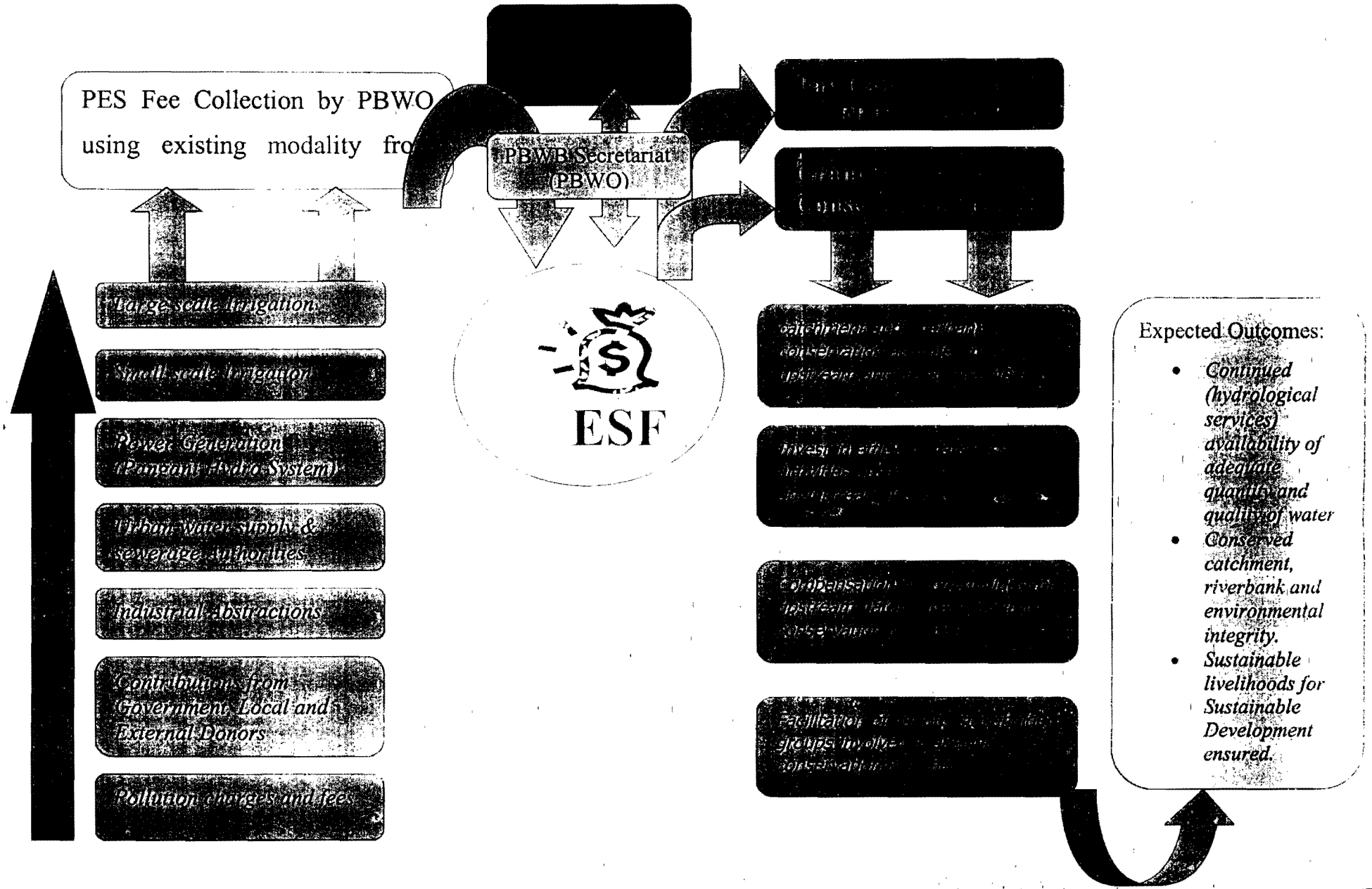
1) Pay catchment fees to Forestry and Beekeeping division of MNRT
2) Invest into catchment and riverbank conservation activities in upland and along the river areas
3) Invest in efficient water use activities upstream
4) Compensation of communities for upstream nature areas for strict conservation purposes.
5) Facilitation of various stakeholder groups involved in specific conservation activities

7.2 Environmental Services Fund Management Board

It is proposed here that the existing PBWO Board should be used after strengthening it and making it an *executive instead of advison Board* to manage the ESF. Its composition is proposed to be non political and to comprise the following members

1) Chairman: Appointed by the minister for MOWLD (From the stakeholder groups – non political)
2) Secretary: Water Officer, PBWO
3) 1 Representative from Large scale irrigators using basin water
4) 1 Representative from small - scale irrigators using basin water (WUGs)
5) 1 Representative from the domestic water providers (WUAs, UWSSAs)

6) 1 Representative from the Hydropower generators (TANESCO)
7) 1 Representative from Forest managers (FBD – Forester, Catchment Forests)
8) 1 Representative from Water managers (MOWLD – Hydrologist or legal expert)
9) 1 Representative from Environmental managers (NEMC)
10) 1 Representative from Agriculture Sector (MAFS- TIP Regional)
11) 1 Representative from Industrial Sector (MIT-Regional)
12) 1 Representative from TANAPA
13) 1 Representative from Ministry of Lands
14) 1 Representative from NGOs (PAMOJA)
15) 1 Representative from Local Government (Regional Level Administration matters)


PES Fee Collection by PBWO using existing modality fro
PBWB Secretariat (PBWO)
Large scale Irrigation
Small scale Irrigation
Power Generation (Pangani Hydro System)
Urban water supply & sewerage Authorities
Industrial Abstractions
Contributions from Government, Local and External Donors
Pollution charges and fees
ESF
Expected Outcomes:
Continued (hydrological services) availability of adequate quantity and quality of water
Conserved catchment, riverbank and environmental integrity.
Sustainable livelihoods for Sustainable Development ensured.

The PES and ESF mechanisms above depict the kind of relationship and responsibility various stakeholders will have in the whole aspect of environmental conservation in the Pangani Basin.

As the diagram shows, water users will be required to pay their user fees (and PES fees to the collector PBWO or its representative (sub-catchment officers) who will then present the collections to the PBWO who will go on to deposit the PES portion into the ESF account.

The distribution of these funds will be done according to set procedures, some of which will elaborated here. We propose a 50% of all collected PES funds be paid to FBD for catchment conservation in Pangani Basin. However, payment could also be made according to the base flows of adequate quantity and qualify from the catchment forests, but should not exceed 50% of the collections. The other half of collections should then be allocated to stakeholders based on priority issues of environmental degradation in efficient use of water, riverbank degradation and pollution in the whole basin and also on distributional equity.

We propose the distribution to be as follows:

Box 3: Proposed PES Distribution Mechanism

$PESF_a = 0.5\ CF_{fbd} + 0.3P - 0.2\ E_{sc}$

Where:

$PESF_a$ = *payment for environmental services fees allocation*

CF_{fbd} = *conservation fees paid to Forestry & Beekeeping department for Pangani basin forests.*

P_b = *Allocation to priority environmental and water conservation issues.*

E_{sc} = *Allocation to all sub-catchments on equity consideration aspects.*

Fifty percent of the collected amounts of PES fees should be set aside as catchment fees to be paid to the Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism for Pangani basin Catchment Forests Conservation through the JFM approach. Sixty percent (60%) of the remaining funds should be allocated objectively on prioritized issues of conservation to be found anywhere in the basin (not location specific), and the reminder 40% should be allocated proportionately to basin water users according to their contribution to PES fees payment. This is done deliberately to encourage stakeholders to influence the non-payers of fees to also pay.

The allocation of the 60% (0.3P) and the 40% ($0.2E_{sc}$) will be done by way of application as elaborated below.

Stakeholders from different parts of the basin (paying ones of course!) will identify a problem related to conservation of either the environment degradation or water conservation (aspects of efficient use) like canal lining, canal clean up, or restoration of river bank buffer zone environmental integrity (planting of appropriate vegetation cover) or construction of cattle troughs for watering livestock to avoid riverbank and irrigation canals and channels' destruction

etc. These stakeholders may be comprised of a certain village community or water user group, working together with a forester, hydrologist, irrigation expert, PBWO officer etc. It should be a collective effort utilizing all the relevant expertise available on the ground. They should put down a technical project proposal as much as possible and submit it to the PBWB secretariat (which is the PBWO). Depending on collection modalities, the PBWB may meet once or twice a year to consider proposals sent from all over the basin. Those proposals qualifying for basin priority allocation will be identified and considered thus. The reminder should be considered in the Equity allocations category.

8.0 Monitoring Of PES And ESF Implementation

All stakeholders should do monitoring of PES collection and ESF Projects implementation collectively, each according to their capabilities and position. There should be monitoring for Economic, Social and Environmental aspects with respect to the monitoring of the quality and quantity of water in the basin. The proposed division of responsibilities is as follows below.

Table 8.1: Monitoring Of PES And ESF Projects Implementation

SN	Proposed Monitor/Stakeholder	Proposed activity to perform (which aspect, ecological, hydrological or social economic?	Reason/remarks
1.	PBWB	Overall overseer	It is composed of major stakeholders' representatives. Ultimate decision maker vested with the responsibility and powers to manage ESF
2.	PBWO	Supervision and management of catchment, provide hydrological expertise and monitoring	It is composed of major implementers with the mandate for the management of the basin waters.
3.	External Evaluation	Evaluation of performance, EIA monitoring, independent audits of ESF account,	Provide an objective assessment of ESF utilisation and activities' implementation.
4.	Forestry (Catchment and Regional and District Forest Officers)	Provide technical expertise and monitor vegetative cover rehabilitation and restoration activities.	It is composed of experts and experienced operational staff in forestry with further advantage of JFM approaches adopted
5.	Sub-Catchment officers	Catchment conservation fee collection and monitoring of water flow, use and users social and economic benefits. Co-ordinate and compile information from UWSSAs, WUGs, WUAs and Village communities.	Major responsibility at the sub-catchment level on behalf of the PBWO.
6.	UWSSAs, WUAs and WUGs	Catchment conservation, distribution of water, provision of education, fee collection and waste water treatment (ecological, hydrological and social economic aspect)	It's a major stakeholder, which consists of a full operating and management board.

7.	Large and Small-scale Irrigators (WUGs)	Catchment conservation fee collection and monitoring of water flow, use and users social and economic benefits	They leave near the catchment so it is easy to conserve and collect the fee. Provide rehabilitation and restoration information and statistical data.
8.	Village Communities	Village government through their Environmental Committees enforce by-laws	Protection, provide labour power for rehabilitation and restoration information and statistical data.

9.0 Legal and Institutional Issues for Water Resources Management

There are several regulations and legal provisions governing water resource management and utilisation in Tanzania. Regulations and legal provisions include: Water Utilisation (Control and Regulation) Act, 1974, Overall Control Over Water in Tanzania as a Management Tool, Declaration of Controlled Water as a Management Tool, Management of Water Resources through Power of Minister. Water Utilisation (Control and Regulation) Act, 1974 and Pollution of Water Sources, Environmental Standards For Receiving Waters, Effluent Standards to guide maximum direct effluents discharge into Receiving Waters.

Institutions Responsible for Water Management at National Level and in Pangani Basin

Ministry of Water and Development (MWLD), Central Water Board, Pangani Water Office, Regional Water Engineers, Pangani Basin Water Board, Holders of Water Rights and Other Institutions suggested by NAWAPO.

10.0 Locating the Mechanism for Payment for Environmental Services in Various National Policies

Several line ministries' policies; regulations and activities touch on the use or management of water and its catchment environment. These include; (i) Planning Commission,(ii) National Environmental Management Council (NEMC), (iii) National Agricultural and Livestock Policy, 1997 (iv)The National Forest Policy, March 1998 and Water Resources, (v)The Mineral Policy of Tanzania, October 1997 and water, (vi) The land policy and regulation of water, environmental, catchment, river banks, springs and streams. Coordination among the various stakeholder institutions for water management and utilization is of vital importance in order to facilitate successful implementation of various strategies and initiatives

11.0 Operationalisation Of Payment For Environmental Services

There are several legal aspects, which need to be taken care of before the PES and ESF can become legally operational. In order to charge extra levies on the existing water bills, subsidiary legislation made under Water Utilisation (Control and Regulation) Act, 1974 already prescribe fees to be paid to the Basin Water Boards for various activities related to water. Applicable regulations should be amended to build in Fees to be collected for the purposes of PES.

In addition, PBWB may recommend to the Minister to make further Regulations on the various issues including penalty against water right holders failing to pay, return flows back to streams or rivers, treat effluents discharged into streams or rivers and underground strata and those abstracting water without water rights.

12.0 Conclusions and Recommendations

The study on PES has found out a very challenging management situation indeed in the Pangani Basin. The decline in water flows in streams and rivers feeding into the Pangani River is real. Various studies have attested to the fact that environmental degradation has been

rampant in the catchment areas and buffer zones of river and stream bank also water sources in the catchment. Pollution of water in the basin is again real. As a result of the declining water situation amid increasing demand of water for competing and expanding uses, conflicts are inevitable and are actually happening. This points a very gloomy picture and it may not result into the sustainable development we aspire for. The lack of financial resources and inadequate involvement of water users in management of the water resources are some of the causes of the present situation. The survey done in the basin during the month of October and November 2004 has opened up the possibility of a way of tackling some of the problems leading to such state of affairs discussed above.

The PES and ESF are but mechanisms for financial mobilization, funds having been mobilized, the next important step is the use of the funds effectively and objectively to solve some of the problems related to catchment forests environmental degradation, inefficient use of water and pollution. The modality to do this is very important for success. We have adopted several approaches; one is to pay catchment fees, which will be spent on restoration and maintenance of the integrity of the forests. Secondly, we have opted for a stakeholder participatory approach in solving problems relate to environmental conservation inefficient use of water and pollution outside the catchment forests. Thirdly, we have also proposed the adjustment of the present PBWB to accommodate the new demands on managing the hydrological services of catchment forests. We have suggested a change from being an advisory to executive board manned by stakeholders from both the environment and natural resources (water) management and utilization side.

Together with the above proposals, several other things need to be considered. These include technological improvement in irrigation for efficient use of water, institutional, legal, awareness creation of the PES to communities and decision makers alike, financial and compensation of tree farm owners.

13.0 Further Work

In order to facilitate conservation, identification of people living in sensitive catchment areas for water sources should be done in order to estimate their land use benefits (opportunity costs) for future compensation in case of moving them.

Tradable Water Permits have great potential in re-allocation of water in the basin if the necessary conditions for their operation become available. The necessary conditions, which are non-existent at the moment, include: lack of proper monitoring of the amount of water one gets, water rights are at the time being not enforced, transferable, and exclusive. Monitoring indicators need to be developed in order to follow up performance and implementation of the PES and ESF activities.

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