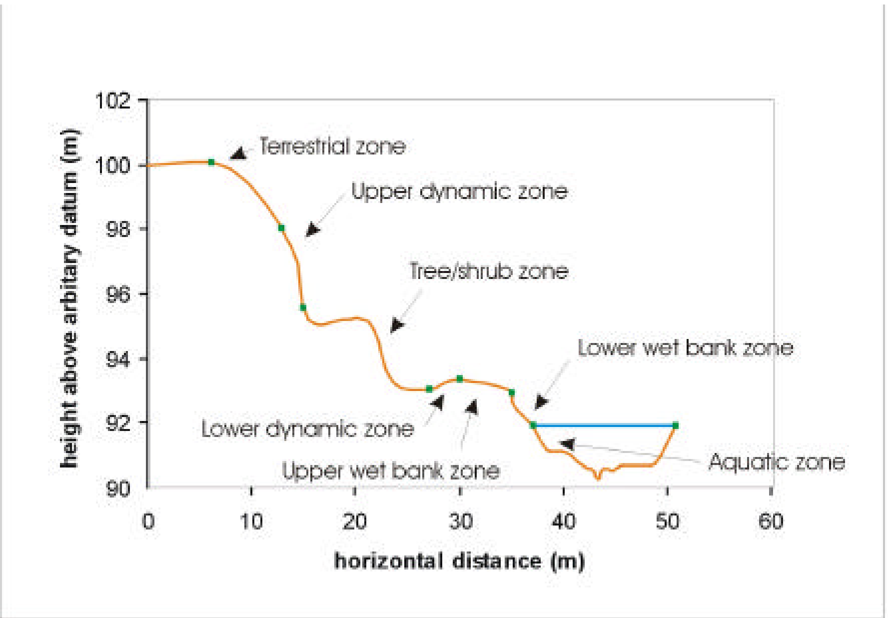
# *BUILDING CAPACITY TO IMPLEMENT AN ENVIRONMENTAL FLOW PROGRAMME IN TANZANIA*

**Report of a training workshop in Tanzania**
**13-21 September 2003**




**November 2003**

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Ministry of Water and Livestock Development

World Bank Netherlands Water Partnership Program - Environmental Flow Allocation Window

IUCN-The World Conservation Union - Water and Nature Initiative

Centre for Ecology and Hydrology, Wallingford, UK

Southern Waters, Cape Town, South Africa

University of Cape Town, South Africa

## Executive summary

1. A 4-day training course on environmental flows was held in Mbeya, Tanzania in September 2003. It was organised by the Ministry of Water and Livestock Development and supported by the World Bank, through its Lower Kihansi Environmental Management Project and River Basin Management Project, (with sponsorship from the Bank Netherlands Water Partnership Program) and by IUCN, through its Water and Nature Initiative. The course was designed, prepared and presented by the international EF Team: Dr Mike Acreman (Centre for Ecology and Hydrology, UK), Dr Jackie King (Southern Waters/University of Cape Town, South Africa) and Dr Cate Brown (Southern Waters, South Africa).

2. The course was attended by 26 participants from a range of technical backgrounds, including hydrology, hydrogeology, water chemistry, forestry, engineering and water management. They came from various organisations including governmental departments (such as Ministries of Water and Livestock Development and Natural Resources and Tourism) and agencies (River Basin authorities), universities (Dar Es Salaam and Sokoine University of Agriculture), non-governmental organisations (IUCN) and the private sector (TANESCO).

3. The course content included concepts in environmental flows, details of various environmental flow assessment methods, fieldwork in the Usangu/Ruaha basin, analysis and presentation of field data, stakeholder participation, assessing the implications of method outputs and planning an environmental flow assessment.

4. Overall, the course was extremely well received. In the course evaluation by participants, the main comment was that the course should have been longer (10 days). Some participants had envisaged that an actual environmental flow assessment would be undertaken, but this was not possible within 4 days. Emphasis was on principles and practices that would be employed over possibly several years to produce an assessment for any Tanzanian river basin.

5. The course included many interactive sessions in which participants suggested why environmental flow assessment was need in Tanzania, which stakeholders should be involved, which technical specialists should undertake the work and what should be done next on environmental flows in Tanzania.

6. The term “environmental flows“ was felt to portray saving endangered plants and animals for their own sake. To explain that environmental flows meant conserving natural resources for people, it was suggested that the term “flows for people and the environment” would be more appropriate.

7. Institutional analysis should be undertaken by the World Bank projects LKEMP and RBMSIIP to identify a lead organisation in Tanzania for Environmental Flows.

8. Consideration should then be given to two new appointments; a National Manager and a Process Manager. The National Manager could determine how different government departments and agencies and other stakeholders could interact with respect to environmental flows. This could include a review of how other countries are organised and an analysis of the regulatory framework within Tanzania. It could also include a review of academic institutions that could undertake the capacity building activities of the 10-point plan presented by the EF Team in December 2002.

9. The Process Manager could observe the environmental flow process in South Africa beginning in November 2003, then start to ensure consistency in the application of environmental flow methods within the basin specific projects. This Manager could be mentored by international experts.

10. Participants felt that there was an urgent need to practice what had been learnt on the training course and to begin environmental flow assessments (EFAs) in the various river basins of Tanzania, including the upper Rufiji (Usangu/Ruaha), Kihansi and Pangani. Work could also start on prioritising the need for EFAs in other basins within Tanzania.

11. The international EF Team could support universities to develop a capacity building programme.

12. A one-day awareness building seminar could be run by the EF Team for high level decision-makers and politicians including NEMC, Department of Environment, Vice Presidents Office, Basin Water Boards, senior administrative staff in Ministries and Universities, and the Commission for Science and Technology (COSTECH).

13. A national level awareness-raising meeting could also be held for the wide range of scientists (including physical, biological, social and economic scientists) that need to be involved in environmental flow assessment. Particular focus could be on how they need to re-orientate their expertise to EF issues.

14. The EF Team could provide advice in the Pangani basin on site selection and establishment of expert teams.

15. A compact disc was prepared at the end of the training course containing all course materials, lecture slides and other useful resource information. Copies can be obtained from LKEMP, RBMSIIP or IUCN.

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# PART A POLICY AND INSTITIONAL STRENGTHENING

## Introduction

### 1.1 Context

Conservation of nature and natural resources, including appropriate allocation of water to maintain aquatic ecosystems, is seen as a crucial element for sustainable development in Tanzania. The Tanzanian cabinet has approved a new National Water Policy, which covers strategic assessment of water resources. This Water Policy states that "water for the environment to protect ecosystems that underpin our water resources, now and in the future will attain second priority and will be reserved" (the first priority is for basic human needs). This policy follows others developed recently in South Africa and Zimbabwe and builds on several decades of environmental flow setting as a key aspect of water management in Europe, North America and Australia. However, the capacity of Tanzania in the environmental field remains weak and institutional strengthening is required to ensure that the Water Policy is implemented effectively.

This report is part of a programme to build capacity within Tanzania to implement an Environmental Flow programme as part of the National Water Policy. The programme is supported by the World Bank, with sponsorship from the World Bank Netherlands Partnership Program (WBNPP), and by IUCN-The World Conservation through its Water and Nature Initiative. An Environmental Flow (EF) is:

> ***water that is purposefully left in or released into an aquatic ecosystem to maintain it in a condition that will support direct and indirect use values.***

### 1.2 Background

The first mission of the international Environmental Flow Team to Tanzania took place in December 2002[1]. The objective of that mission was to address the need for capacity building for EFA in Tanzania to support the implementation of the Water Policy and to guide the assessment of environmental flows for the Great Ruaha and Kihansi river basins. The Team held discussions with a wide range of individuals and organisations with interests in environmental flow assessment both in Dar Es Salaam and during field visits to the two river basins. The mission resulted in a 10-point plan that was proposed for development of an EF programme in Tanzania, with specific actions for the EF Team. These are:

1. To devise and run a training course on EF in Tanzania.
2. To facilitate and make presentations at the workshop to define an assessment framework.
3. To prepare and help run an EF test application on a river basin in Tanzania.
4. To liaise with responsible institutions and personnel from foreign EF case studies to arrange visits for Tanzanian.
5. To help run EF workshops and symposia.
6. To review technical EF documents in collaboration with Tanzanian specialists.
7. To help assemble a national EF library and database.
8. To help establish a network of specialist in Tanzania to support EF assessments.

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[1] Acreman, M.C., King, J. 2003 Building capacity to implement an environmental flow programme in Tanzania. Report of mission to Tanzania 3-13 December 2002 Report to World Bank. Centre for Ecology and Hydrology, Wallingford, UK

9. To work with the organisations dealing with research development, to devise an EF research programmes
10. To support production of a communications strategy for EF.

The plan was presented to a stakeholder meeting on 12 December 2002; attended by 15 different organisations including governmental departments and agencies, universities, non-governmental organisations and the private sector. Participants endorsed the plan and discussed which agency or department should lead the proposed programme.

The World Bank agreed that the BNWPP should support a training course on environmental flows during 2003 to initiate implementation of the plan. As part of its Water and Nature Initiative, which includes a major focus on environmental flows, IUCN-The World Conservation Union agreed to co-sponsor the training course.

In Tanzania, the lead was taken by the Ministry of Water and Livestock Development.

## 1.3 Preparation

Dr Acreman from the Centre for Ecology and Hydrology (UK), Dr King from the University of Cape Town (RSA) and Dr Brown from Southern Waters (RSA) prepared the course materials and planned the programme of presentations, practical exercises, fieldwork and interactive sessions that would constitute the course. Much of material for the course was based on a book "Flow – the essentials of Environmental Flows" (Dyson *et al,* 2003) produced by the IUCN Water and Nature Initiative, particularly the chapter on defining water requirements (Acreman and King, 2003). Logistical support to the Ministry of Water and Livestock Development in Tanzania for organising the course was provided by Rufiji Basin Water Office (led by Mr Willy Mwaruvanda) and two World Bank projects; the Lower Kihansi Environmental Management Project (Dr Wilfred Sarunday) and the River Basin Management Project (Mr Washington Mutayoba). Interaction between the EF Team members and between them and Tanzania was undertaken by E-mail and telephone.

### 1.4 Course location and duration

The original intention had been to run a 5-day training course. Day 1 was to be aimed at senior decision-makers, providing an overview of the concepts, issues and practicalities of environmental flow assessment. Days 2-5 were oriented towards technical staff and focused on details of environmental flow techniques. The local coordinators decided to hold the training course in Mbeya, in the far west of Tanzania, to have close involvement with a high priority river basin (Usangu/Ruaha) within the upper Rufiji basin. Mbeya is 10 hours by road from Dar Es Salaam and therefore it was not logistically realistic to hold day 1 in the capital and days 2-5 in the target basin. Consequently the course was held over 4 days (Monday 15 – Thursday 18 September), focusing on days 2-5 of the original programme. The Team's diary is given as Annex 8.

## 1.5 Course programme

In outline, the final course programme was as follows.

Day 1 Opening ceremony and introduction of participants
Concepts in environmental flows

Day 2 Details of various environmental flow assessment methods
Preparation for fieldwork

Day 3 Fieldwork in the Usangu/Ruaha basin

Day 4 Analysis and presentation of field data
Stakeholder participation
Assessing the implications of method outputs
Planning an environmental flow assessment
Identifying next steps for environmental flows in Tanzania
Course evaluation
Closing ceremony

The full programme is given as Annex 1.

Details of the activities carried out on the course at described in Part B of this report.

# 2. ANALYSIS

## 2.1 Where are we now?

The training course held in Mbeya was point 1 of the 10-point plan (see Section 1.1). During the course, some discussions were held on other points of the plan including which institution should take the lead. Discussion highlighted the key roles of the Ministry of Water and Livestock Development that had the mandate for implementing the Water Policy and the National Environment Management Council (NEMC), within the Vice President's Office, that had responsibility for Environmental Impact Assessment (EIA), of which environmental flows is a part.

Two universities were represented on the course (University of Dar Es Salaam and the Sokoine University of Agricultural) and both expressed an interest in future training and research in environmental flows.

A vital next step should be to identify an appropriate institution to undertake an analysis of the regulatory framework, institutional structure and capacity of universities to undertake capacity building.

Tanzanians should learn more about how the environmental flow process operates in other countries. South Africa would seem the most logical country in which to start. Opportunities to be involved in EFAs of the Olifants/Doring River in the Western Cape, South Africa are presented in Annex 7. It should be noted this assessment starts in November 2003.

## 2.2 A framework for the process required in Tanzania

Figure 1 shows the possible framework for relationships between the various actors in the environmental flow assessment process in Tanzania (the numbers in the circles relate to items in the 10-point plan). Two key posts are:

- the **National Manager,** who would be responsible for coordinating the inputs of various government departments and Agencies, particularly with respect to decision-making frameworks (point 2 of plan). S/he would have oversight of the basin specific projects (such as the River Basin Management and Small Irrigation Improvement Project RBMSIIP and LKEMP – point 3 of plan) and capacity building activities (points 1, 4, 5, 8, 9 and 10 of the plan). In addition, the National Manager would be responsible for the national library (point 7). A decision would need to be made on the lead institution for EF in Tanzania, since the National Manager should be based within it;

- the **Environmental Flows Process Manager** would be responsible for ensuring consistency in the application of Environmental Flow methods within the basin specific projects (point 3 of plan) taking best science (point 9) and assembling appropriate teams from the network (point 8) for the different basins in specific areas (rivers, wetlands, estuaries) including physical and biological scientists, economists and experts in social studies and livelihoods. This Manager could be mentored by the EF Team.

It is envisaged that each river basin will have a Board or Steering Committee. This Board would oversee the project implementation by the local basin Water Officer and Technical Advisor (funded by a sponsoring agency, such as IUCN or World Bank). These technical staff would manage inputs from the various stakeholders and sectors (e.g. irrigation, hydropower, industry, public water supply, wildlife conservation, recreation). As indicated above the Environmental Flows Process Manager would help each basin with the Environment Flow assessment process, including choice of method and establishment of teams of experts. The resulting assessment (various scenarios) would be fed back to project Boards for deliberation.

Capacity building would be largely undertaken by Tanzanian universities and would include training for water managers and technical specialists (point 1 of plan) and awareness building of politicians and local communities (point 10). These universities would also undertake research on environmental flows (point 9) and hold databases (point 7).

The EF Team would provide technical support to the Water Officer and Technical Advisor and would mentor the EF Process Manager. The Team would also support the universities to develop training courses and would host visits from Tanzanian experts (point 4 of the plan).

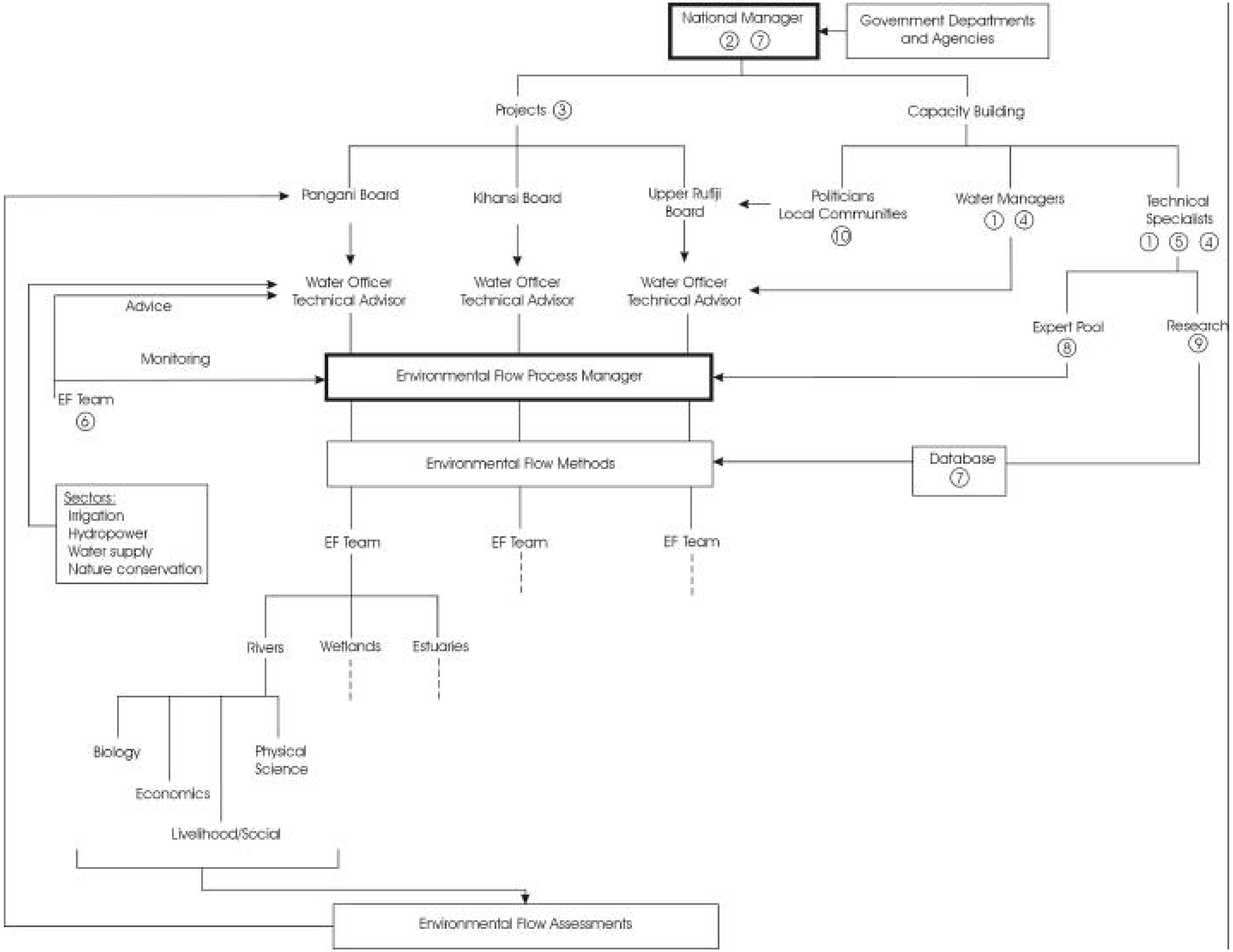



***Figure 1: Framework for the environmental flow assessment process in Tanzania***

# 3. RECOMMENDATIONS

## 3.1 General recommendations

1. There was a strongly held view amongst participants that the term “environmental flow“ would always be considered purely as flows to save endangered plants and animals for their own sake. It was difficult to convince people that environmental flows meant natural resources for people. As a solution, participants suggested that the term “flows for people and the environment” could be more appropriate.
2. Analysis of the institutions should be undertaken by the World Bank supported projects LKEMP and RBMSIIP to identify a lead institution with Tanzania for environmental flows could be identified.
3. A post of National Manager could be established within the lead institution. The post holder could determine how different government departments and agencies and other stakeholders should interact with respect to environmental flows. This could include a review of how other countries are organised and an analysis of the regulatory framework within Tanzania. The process could also include a review of academic institutions that could undertake the capacity building activities of the 10-point plan.
4. The immediate need for environmental flow assessments in the various river basins of Tanzania was identified by course participants, including the upper Rufiji (Usangu/Ruaha), Kihansi and Pangani. Work should begin immediately to prioritise the basins within Tanzania.
5. A Process Manager could be appointed. S/he could observe the EF process in South Africa beginning in November 2003, then start to ensuring consistency in the application of environmental flow methods within the basin specific projects (point 3 of plan) taking best science (point 9) and assembling appropriate teams from the network (point 8). This Manager could be mentored by the EF Team.

### 3.2 Recommendations for follow-up by international EF Team

1. The EF Team could assist if required with the process of identifying the National Manager and Process Manager, e.g. advise on Terms of Reference.

2. The EF Team could support selected universities to develop a capacity building programme, including training courses for technical staff, trainers, awareness, research programme and databases.

3. A one-day awareness building seminar could be run by the EF Team in early 2004 for high level decision-makers and politicians including NEMC, Department of Environment, Vice Presidents Office, Basin Water Boards, senior administrative staff in Ministries and Universities, and COSTEC.

4. A national level awareness-raising meeting could also be held for the wide range of scientists (including physical, biological, social and economic scientists) that need to be involved in environmental flow assessment. Particular focus could be on how they need to re-orientate their expertise to EF issues.

5. Work could begin on environmental flow assessments in priority basins immediately. The EF Team should provide advice in the Pangani basin on site selection and establishment of expert teams in early 2004.

# PART B ENVIRONMENTAL FLOW TRAINING COURSE

## 1. Opening ceremony and introduction of participants

The course was officially opened by Hon Bakari Mbonde, MP for Rufiji District and chairman of the Rufiji Basin Water Board. In his speech, he recognised that environmental flows is a new concept to Tanzania, essential for balancing water resources for human demands and ecosystem needs. He was impressed by the attendance on the course of participants from various professional disciplines and noted the need for training in environmental flows for a variety of professions.

The 26 participants introduced themselves to Mr Mbonde, indicating the organisations for which they worked and their specialist subject areas. Full details are given in Annex 2. Participants included hydrologists, hydrogeologists, water chemists, foresters, engineers and water managers. They came from various organisations including governmental departments (such as Ministries of Water and Livestock Development and Natural Resources and Tourism) and agencies (River Basin authorities), universities Dar Es Salaam and Morogorro), non-governmental organisations (IUCN) and the parastatal sector (TANESCO).

## 2 Why are environmental flows important in Tanzania?

Participants were invited to state why they thought environmental flows were important for Tanzania. A range of responses was given that focused on the importance of conflict resolution over water to achieve equitable sharing and allocation of natural resources. They felt that this was important to improve and sustain the overall economy of the country by harmonising energy and crop production whilst maintaining ecosystems. Participants recognised that the livelihoods of many (particular poor, rural) communities rely on activities such as fishing, fuel wood collection and livestock keeping that depend on ecosystems sustained by adequate river flows. They also felt a general need to take care of natural resources and ecosystem and to prevent natural resource degradation and environmental disasters. Full details are given in Annex 3.

## 3 Concepts in environmental flows

The basic concepts in environmental flows were explained to participants. An environmental flow (EF) is the water that is purposely left in, or released into, a freshwater or estuarine ecosystem to maintain it in a condition that will support its direct and indirect use values such as supply of good quality water, natural resources (e.g. fish, reeds, wild vegetables and medicines), recreation, aesthetic and cultural values and support of biodiversity. These aspects of ecosystems are of value to people for livelihoods, life support, quality of life or economic reasons. Many goods and services rely on the ecosystem functioning in a fairly natural manner. Manipulation of flow regime represents unnatural disturbances to aquatic ecosystems. To maintain a desired suite of goods and services, a corresponding level of ecosystem condition must be maintained. The ecosystem condition is determined by flow pattern, water quality and river structure.

Environment flow assessment (EFA) is concerned with balancing the use (or development) of water from aquatic ecosystems for various direct human needs, such as hydropower, industry, irrigation and public water, whilst protecting (or managing) the aquatic ecosystems so that they can continue to be used by present and future generations. Seven key concepts are important:

- complexity and variability are vital to ecosystem health;
- river systems can be maintained at different levels of health;
- different flows play different roles in maintaining river systems;
- ecological and social consequences of flow manipulations can be predicted;
- river condition is a societal choice;
- dams can be more river-friendly if designed and operated appropriately;
- uncertainty is a reality - adaptive management is crucial.

## 4. Methods

Key methods of environmental flow assessment were presented to participants with reference to specific models and illustrated by case studies. Emphasis was placed on four main types of methods.

- Hydrological methods that rely primarily on analysis of river flow data sometimes with interpretation by biologists of the ecological significance of different flows; whilst relatively simple, results from these methods have high levels of uncertainty (e.g. Tennant, 1976; Poff *et al*, 1997, Richter *et al,* 1996; 1997).
- Hydraulic rating methods that introduce aspects of the physical structure of river channel; these represent an improvement over hydrological methods but often lack ecological rigour (e.g. Gippel and Stewardson, 1998)
- Functional analysis methods that take a broad view and cover many aspects of the river ecosystem, use hydrological analysis, hydraulic rating information and biological data. (e.g. King *et al.* 2000; Arthington *et al* 1992).
- Habitat modelling methods that attempt to integrate the habitat requirements of different species with the river flow regime. These tend to be the mostly costly and data hungry methods, but give the most quantitative and replicable results (e.g. Bovee, 1982; Jowett, 1996; Jorde, 1989; Killingtviet and Harby 1994)

Details were also provided of methods that link functional analysis with decision-support, using the example of the DRIFT method (King *et al*, 2003) that combine the hydrological, hydraulic, ecological data to derive various flow scenarios and their implications for river ecosystem health.

## 5. Fieldwork

One day of field work was undertaken in the Mbarali River at Igawa near to the river flow gauging station (1KA11A). It was particularly useful to undertake the fieldwork in a catchment where there were on-going conflicts over water use. However, the field work demonstrate that it was not possible to collect sufficient data in one visit actually to complete an environmental flow assessment. The aim of the fieldwork programme was to enable participants to gain practical experience of field techniques needed to collect appropriate data.

Eight aspects of environmental flow field work were included:

- catchment setting (using long profile);
- hydrological regime context;
- present ecological status;
- habitat mapping;
- channel and valley cross-section;
- vegetation zonation;
- hydraulic charaterisation of habitat;
- spatial variations in habitat.

## 5.1 Catchment setting

Environmental flow assessments are usually site-based, that is, all data-gathering and analysis activities are centred on several sites along the river. These sites should be representative of different longitudinal zones along the system, and can act as future monitoring and flow management sites. An analysis of the nature of the catchment and the river system will guide selection of representative sites. Normally, a range of analyses would be done, to identify different river zones in terms of channel geomorphology, hydrology, water quality and river biota. These would be combined to produce one summary set of distinctly different zones along the river. In the Mbeya exercise, only geomorphological analysis was done. 1:50,000 topographical maps of the catchment were used to produce a graph of river-course length versus altitude (Figure 2). This showed where along the river the gradient changed. Valley width was also analysed on the maps, by measuring at each point where a contour crossed the river the width between the neighbouring contours on either side of the river. The combination of data on gradient and valley width revealed several geomorphological zones along the river, which we named high-gradient mountain torrent; high-gradient mountain stream; high-gradient gorge; medium-gradient foothill; low-gradient transitional zone with marshes, meanders and ox-bows; and a very low gradient zone with extensive swamps. Each, or some, of these zones might be represented by one site in an environmental flow assessment. In the field exercise of this course, one site in the medium-gradient foothill was visited. Although the analysis was not used to choose the site, it did help the Team to place the site in context in terms of its position and character.

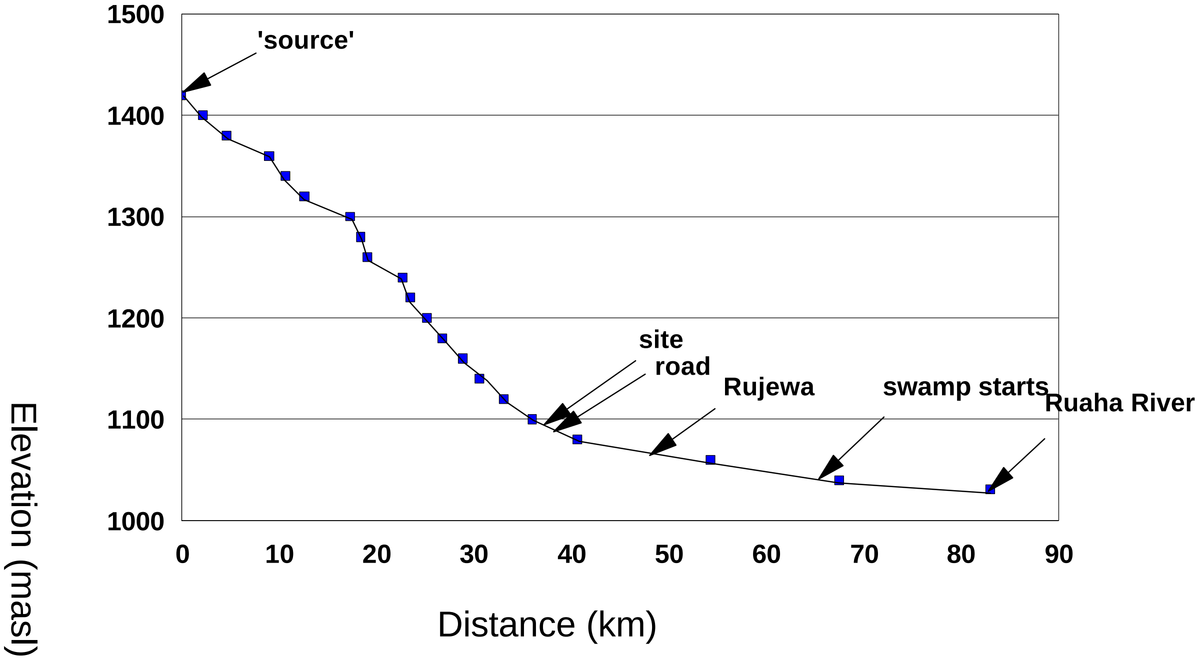



*Figure 2: Long profile of the Mbarali river from source to confluence with the Ruaha River.*

## 5.2 Hydrological regime context

Hydrological records form the basis of an environmental flow assessment. The division of the record is undertaken to assist the river specialists with their analysis of the response of the river to different types of flow events and in determining how the river ecosystem may change with changes in any of these events.

The flow record (1955-1994) for gauging station KA11A on the Mbarali River at Igawa was obtained from the Ministry of Water and Livestock Development. The first five years were reformatted for incorporation into the DRIFT software (Figure 3). The data were divided into the ten flow categories of interest in Environmental Flow assessments, *viz*.:

- Wet season low flows
- Dry season low flows
- Four size-classes of intra-annual floods
- Inter-annual floods with return periods of two, five, ten and twenty years.

Professor Simon Mkhandi assisted in the hydrological analyses by calculating the inter-annual floods.

To set the river flow on the day of field work into the context of the long term hydrological regime, the river discharge was measured. Staff from the Rufiji Basin Water Office assisted course participants in the use of current meters and cross-section survey techniques to estimate discharge at three points using the velocity-area method. One measurement set was derived at the Igawa gauging station, to provide the best estimate of discharge. Two other sets of measurements were taken at points further downstream; one in a rock section at the head of rapid and other in a deeper slower flowing reach. The best estimate of discharge was 3.17 $m^3s^{-1}$.

This value is a very low flow even for September (Figure 3). This is probably lower than the natural flow would be due to the irrigation off-take upstream of the gauging station.

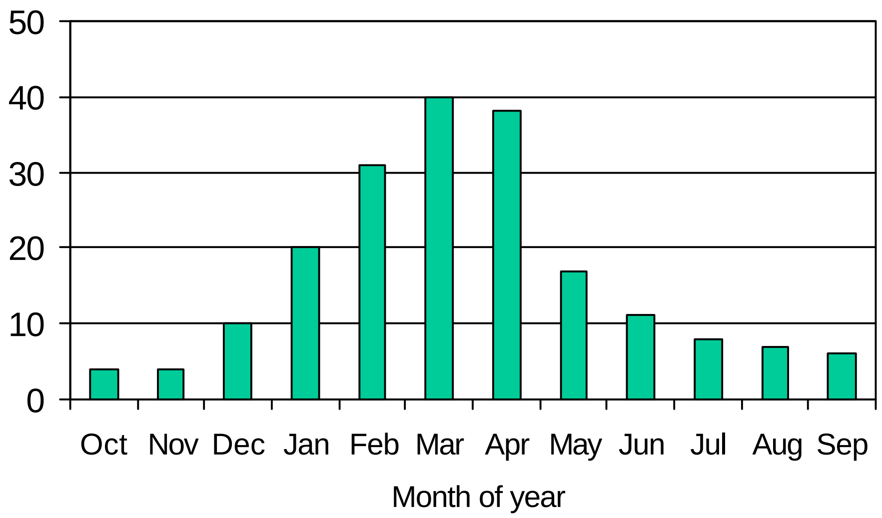



***Figure 3: Monthly mean flows ($m^3s^{-1}$) for Mbarali at Igawa.***

## 5.3 Present ecological status

Present ecological status assessment is a summary of the overall condition or health of a river and is used to establish a baseline from which changes in river health that result from flow changes can be described. Future changes can also be summarised for easy dissemination by expressing the sum total of the expected changes in terms of their effect on the overall health of the river system.

More detail on present ecological status assessments is provided in DWAF (1999).

Two groups of participants undertook a preliminary assessment of the present ecological status of the Mbarali River, using the Habitat Assessment methodology. The method is based on the qualitative assessment of a number of pre-weighted criteria (Table 1) that indicate the condition of the instream and riparian habitats available for use by riverine biota. The assessment is based on the professional judgement and experience using a 0-25 point rating, with 0 = no impact and 25 = critically severe impact.

*Table 1: Criteria and weights used for the assessment (from Kleynhans et al. 1998).*

| INSTREAM CRITERIA | WEIGHT | RIPARIAN ZONE CRITERIA | WEIGHT |
|---|---|---|---|
| Water abstraction | 14 | Indigenous vegetation removal | 13 |
| Flow modification | 13 | Exotic vegetation encroachment | 12 |
| Bed modification | 13 | Bank erosion | 14 |
| Channel modification | 13 | Channel modification | 12 |
| Water quality | 14 | Water abstraction | 13 |
| Inundation | 10 | Inundation | 11 |
| Exotic macrophytes | 9 | Flow modification | 12 |
| Exotic fauna | 8 | Water quality | 13 |
| Solid waste disposal | 6 | | |
| TOTAL | 100 | TOTAL | 100 |

The results of the participants' assessments are given in Table 2. The two assessments were remarkably similar, differing only in their assessment of water quality. The water quality impacts are difficult to assess without either analysing water quality samples or undertaking some assessment of the biota, and score assigned to water quality impacts at a site (Table 2) was informed by undertaking a rapid bioassessment (see South African Scoring System [SASS]), whereafter the water quality ratings provided in Table 2 were revised.

*Table 2: Ratings provided by the participants for each of the criteria.*

| INSTREAM CRITERIA | TEAM 1 | TEAM 2 | RIPARIAN ZONE CRITERIA | TEAM 1 | TEAM 2 |
|---|---|---|---|---|---|
| Water abstraction | 5 | 6 | Indigenous vegetation removal | 8 | 5 |
| Flow modification | 1 | 1 | Exotic vegetation encroachment | 0 | 0 |
| Bed modification | 0 | 0 | Bank erosion | 1 | 1 |
| Channel modification | 1 | 0 | Channel modification | 1 | 0 |
| Water quality | 5 | 1 | Water abstraction | 5 | 6 |
| Inundation | 0 | 0 | Inundation | 0 | 0 |
| Exotic macrophytes | 5 | 5 | Flow modification | 1 | 1 |
| Exotic fauna | 0 | 0 | Water quality | 5 | 1 |
| Solid waste disposal | 0 | 0 | | | |
| TOTAL | 92% (A) | 94% (A) | TOTAL | 90% (A) | 93% (A) |

The initial ratings by the participants put the Mbarali River in an A Category, where:

A = 90-100% of potential value. A natural river, with no modifications.
B = 70-89% of potential value. A largely natural river with few modification, where a small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C = 60-79% of potential value. A moderately modified river, where change of natural habitat and biota has occurred, but the basic ecosystem functions are predominantly unchanged.
D = 40-59% of potential value. A largely modified river, where large changes in natural habitat, biota and basic ecosystem functions have occurred.
E = 20-39% of potential value. A seriously modified river, where the loss of natural habitat, biota and basic ecosystem functions is extensive.

On the basis of the SASS results, the water quality rating for both groups was increased to 10, i.e., moderately modified, which resulted in the overall assessment for the river being a Category B. This is probably consistent with the diversion of flow upstream of the site for irrigation. It should be noted that during the training course more consideration was given to instream analysis. In an EF assessment, equal effort would be given to marginal and out of channel vegetation.

**South African Scoring System (SASS)**

The bio assessments were undertaken using SASS5 (the South Africa Scoring System, version 5), a field-based, rapid assessment of water quality, designed for use in South African rivers (Chutter 1998). SASS makes use of the principle that the composition of macro-invertebrate communities within a river reflect the immediate history of the physical and chemical conditions in the water at that point, and serves to integrate the effects of multiple pollutants or types of impacts, thereby providing an overall assessment of water quality. Thus, it can be used to assist in evaluating the water quality for the present ecological status of the riverine ecosystem.

In SASS, different macro-invertebrate families have been allocated a score based on their known sensitivity to pollution. These scores range from 1-15, with higher scores being awarded to the more sensitive taxa.

In the case of the Mbarali River, the participants collected macro-invertebrates from two different locations in the river, and identified the invertebrates in the field to the taxonomic level of family, using field guides designed for South African rivers. These families were then recorded, and the animals were returned to the stream.

The following day, participants calculated the overall SASS score for the Mbarali River at the study site (Table 3).

SASS4 yields three values, namely:

| | |
|---|---|
| Total SASS score: | A summation of the sensitivity scores assigned to each family at each site |
| Number of Taxa: | Total number of families in a sample. |
| Average Score per Taxon (ASPT). | SASS4 score divided by the number of taxa at that site. |

*Table 3: SASS score for the Mbarali River at the study site.*

| Sampling location | Number of taxa | Total SASS Score | ASPT |
|---|---|---|---|
| Marginal vegetation | 5 | 34 | |
| Fast flowing | 13 | 73 | |
| TOTAL | 18 | 104 | 5.94 |

These results were assessed against guidelines for the categorisation of SASS scores into water quality groups devised for the foothill rivers in the Western Cape South Africa (Table 4). On the basis of the categorisation in Table 4, participants concluded that the water quality rating of the present ecological status should be ‘moderate’, and they agreed on a rating of 10 (see Present ecological status).

*Table 4: Categorisation of SASS scores into water quality groups devised for the foothill rivers in the Western Cape South Africa.*

| | | | |
|---|---|---|---|
| A | Largely unimpacted | >110 | >7 |
| B | Moderately impacted | 70-110 | 5-7 |
| C | Severely impacted | <70 | <5 |

## 5.4 Habitat mapping

Habitat mapping is used as an inexpensive tool that can be used to provide a "bird's-eye view" of a study site at a spatial resolution relevant to biological studies. Normally, both subtrata and flow types are measured and mapped at different discharges in order to provide an indication of how the proportions of available habitat change with changing discharge.

For the Mbarali River, because of time constraints, the participants only coarsely mapped the emergent substrata and the flow types (Figure 4). The categories of flow types are provided in Table 5.

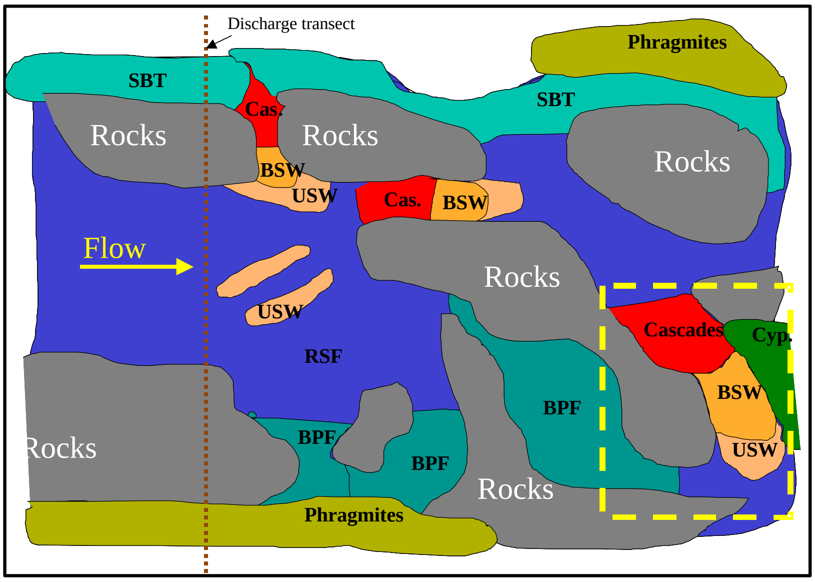



***Figure 4: A section of the habitat map created by the participants for Mbarali River (Section 2). The yellow square denotes the location from which invertebrate samples were collected (fast flow).***

*Table 5: Categories of flow types used in the mapping exercise.*
*After Rowntree et al. (1996), Padmore (1997), Newson et al. (1998).*

| FLOW TYPE | DEFINITION |
|---|---|
| Free falling (ff) | Water falls vertically without obstruction |
| Cascade (cas) | Water tumbling down a stepped series of boulders, large cobble or bedrock |
| Boil (boil) | Water forming bubbles, as in rapidly boiling water; usually below a waterfall or strong chute |
| Chute (ch) | Water forced between two rocks, usually large cobble or boulders; flowing fast with the fall too low to be considered free falling. |
| Stream (str) | Water flowing rapidly in a smooth sheet of water; similar to a chute but not forced between two bed elements |
| Broken standing waves (bsw) | Standing waves present which break at the crest (white water) |
| Undular standing waves (usw) | Standing waves form at the surface but there is no broken water |
| Fast riffle flow (frf) | Very shallow, fast, flickering flow, still covering most of the substrata |
| Rippled surface flow (rsf) | The water surface has regular smooth disturbances which form low transverse ripples across the direction of flow |
| Slow riffle flow (srf) | Very shallow, slower, flickering flow, still covering most of the substrata |
| Smooth boundary turbulent (sbt) | The water surface remains smooth; medium to slow streaming flow takes place throughout the water profile; turbulence can be seen as the upward movement of fine suspended particles |
| Trickle (tr) | Small, slow, shallow flow; when occurring with small or large cobbles, flow is between bed elements with few if any submerged |
| Barely perceptible flow (bpf) | Smooth surface flow; only perceptible through the movement of floating objects |
| No flow (nf) | No water movement |

## 5.5 Channel and valley cross-section

A cross-section of the river valley and channel is useful for several purposes. The physical structure of the terrain is valuable for classifying the type of river channel with regard to its geomorphology, hydraulics and ecology. More specifically hydraulic modellers require the cross-section to be quantified to allow them to calculate the water depth and velocity of given river discharge. By combining this with calculation of the frequency with which different flows occur (from analysis of the river flow regime – see above), the frequency of inundation of zones in the river corridor can be estimate. Frequency of inundation will influence the type of vegetation that will grow in different vegetation zones up the channel and valley side.

Participants learnt how to use a surveyor's level and staff to determine the cross-section of the Mbarali River. This included both the mechanics of reading the instruments, structured recording of data and the practicalities of how to negotiate and survey in steep terrain and thick vegetation. The resulting cross-section presented as Figure 5.

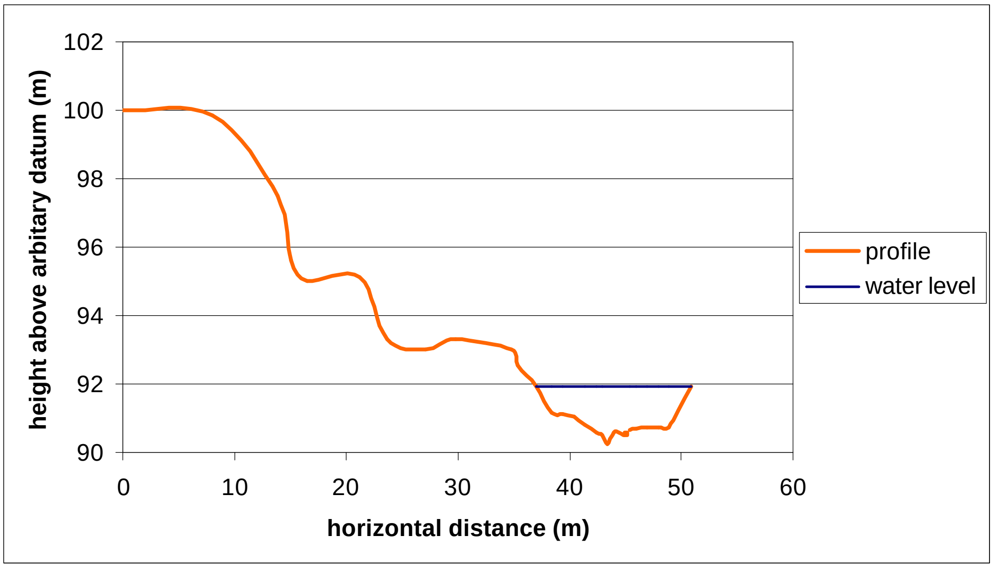



***Figure 5: Cross-section of the right side Mbarali river valley.***

## 5.6 Vegetation zones

The vegetation along river banks is different to that in the rest of the catchment. The longitudinal strip of vegetation stretching along both banks may consist of trees, shrubs, herbaceous perennials, grasses, reeds and so on, that depend on the river for survival. Botanists recognise distinctly different groups of plants within the riparian area. These groups occur at different heights above water level, and correlate with how often they are inundated by water. The lowest zone (*Aquatic zone)* consists of those plants that are usually under water all the time. The zone above that is sometimes called the *Lower Wet Bank*, and the one above that the *Upper Wet Bank.* At increasing heights above water, the other zones may be called the *Lower Dynamic, Tree and Shrub*, and *Upper Dynamic* zones; each is inundated less frequently than the one below it. Above the *Upper Dynamic* zone, the riparian zone stops and the species of vegetation change to ones common over the dry parts of the catchment. The riparian vegetation is important as a buffer zone between landscape activities and the river, as a bank stabiliser, as a producer of many natural resources such as wood and medicines, and as a refuge for animals. Knowing the links between the vegetation and different magnitudes of flows, botanists can predict how the different zones could be impacted by flow changes. In this training course, the objective was to recognise different zones of vegetation down the riverbank and mark these onto the surveyed cross-sections. In an environmental flow assessment, this would be taken further by hydrological and hydraulic modelling together describing how far any magnitude flow reached up the bank and how often it occurred. The link between position on bank and frequency of inundation would then allow prediction about how the vegetation zones could change with flow change. The zones are shown on the cross-section in Figure 6.

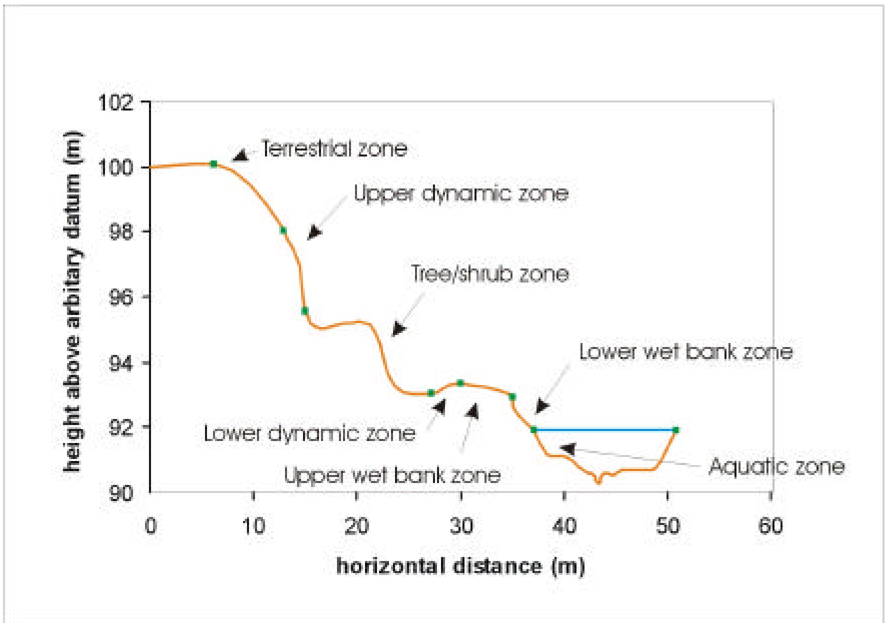


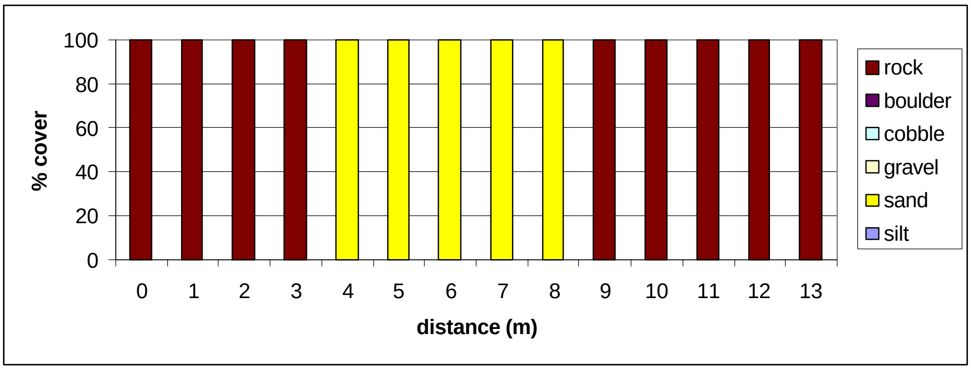

***Figure 6: Valley cross-sections and vegetation zones.***

## 5.7 Hydraulic characterisation of habitat

Within the water, different species of fish, aquatic invertebrates and water plants occur in areas of different conditions. For example, some occur in rocky areas, and some in sandy areas, some in fast water and some in slow areas. These species are important to people, because they provide food, construction and craft materials, and some are disease-bearing organisms. When aquatic species are collected it is possible to characterise the conditions they were living in by measuring water depth, water velocity and substrate size in a grid of readings around the point of collection. Once the preferred conditions of each species are know, it is possible to predict which species will become more or less abundant as flow changes. In this training course, the participants identified two different kinds of aquatic habitat: slow-flowing areas of marginal vegetation (reeds) and a boulder rapid with fast, turbulent flow. The aquatic invertebrates were collected from each area, and then repeated readings of area, depth, velocity and substrate were taken in the same areas. These would normally be used to characterise the hydraulic habitat of those areas, allowing prediction of invertebrate habitat under possible future flow changes. Unfortunately, the flow meter was malfunctioning, and so the results are not presented.

## 5.8 Spatial variations in habitat

Two addition channel surveys were undertaken using the flow meter; a rocky site near to the top of a rapid and a site upstream of the rocks with slower, more even flow. Neither site was particularly suitable for estimating total discharge. The discharge estimate at the upstream sites was 2.34 $m^3s^{-1}$, whilst downstream at the head of the rapid it was estimated at 1.95 $m^3s^{-1}$, i.e. both lower than at the gauging station. However, the data were collected to show the variations in velocity and depth across the cross-section. River bed material was also recorded, since along with depth and velocity, it determines the main characteristics of physical habitat for species such as fish, invertebrates and aquatic plants. The resulting data for the latter site are shown in Figure 7.



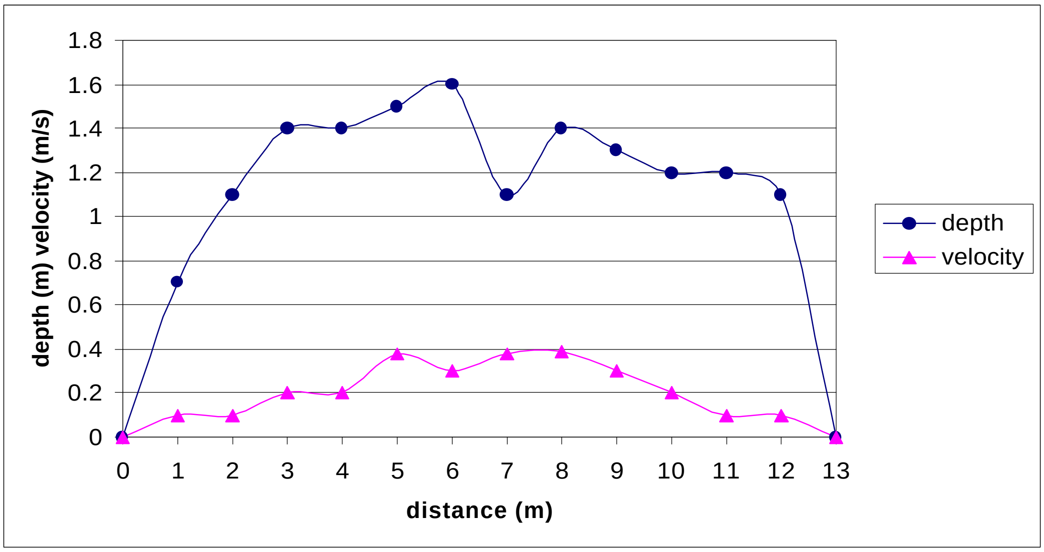




***Figure 7 :Variations in velocity, depth and substrate type across the River Mbarali.***

## 6. Habitat Suitability Indices

Habitat suitability indices (HSIs) are a way of representing the habitat conditions that particular target species or communities like or dislike. They are frequently used in habitat assessments as part of environmental flow setting around the world. Participants on the EF training course undertook an exercise to create habitat suitability curves. Few had much knowledge of river biology, so Tanzanian children were used as the target species, rather than fish, plants or invertebrates that might be used in an environmental flow study. Participants were told that children like to paddle in the river, but only up to knee height; they liked the river to flow so that they could race sticks; they preferred sand between their toes and disliked mud. Participants worked in pairs to produce HSIs for depth, velocity and substrate for the children on overhead projector films; they then laid the films on top of each other on the projector to identify similarities and differences. The height of knees of children and velocity suitable for racing sticks were not precisely defined; they were the subject of expert judgement and so varied between the graphs drawn. Figures 8, 9 and 10 show HSIs drawn by two groups.

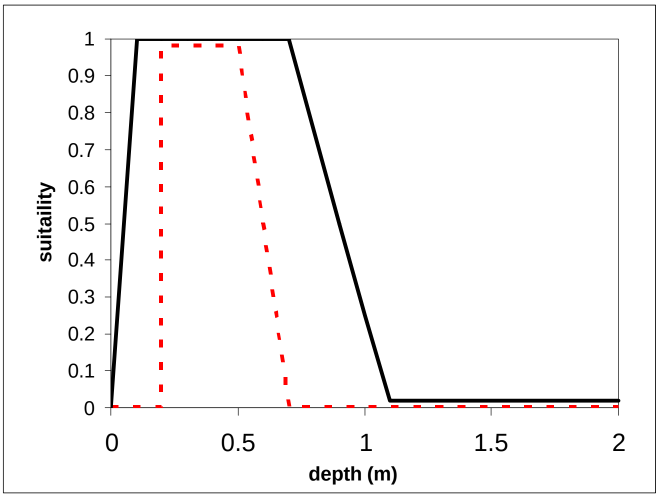



***Figure 8: Habitat suitability index (depth).***

In terms of depth (Figure 8), group A (solid line) suggested that any depth between 0.1 m and 0.8 m was optimal (suitable = 1) with depths 0 to 0.1 and 0.8 to 1.1 m being less suitable. Group B (dashed line) felt that any depth over 0.7 m would be above children's knees and so only depths between 0.2 and 0.7 m were suitable. The two groups discussed their differences and recognised reasons why the others had drawn alternative shaped curves. Through debate they were able to obtain broad agreement on a "best" HSI.

Similar discrepancies were found between the HSIs drawn by the two groups of participants for velocity (Figure 9) and substrate type (Figure 10).

This process mirrored closely an exercise carried out in the UK by CEH for development of environmental flow method, where a group of fish experts were brought together and asked to draw HSIs for a specific species. None had exact knowledge of the habitat requires of this fish, but each had some experience, either as researchers, fishermen or river wardens. At first their curves for depth, velocity and substrate varied considerably, but they were eventually able to reach agreement. Structured expert consensus building is often used in this way throughout the world (e.g. King et al, 2000; Arthington, 1998) to obtain best estimates of species behaviour where precise knowledge is lacking. In the USA this approach has been used to set flows from dams for white water rafting and canoeing, so the exercise using children playing in a river is not so abstract.

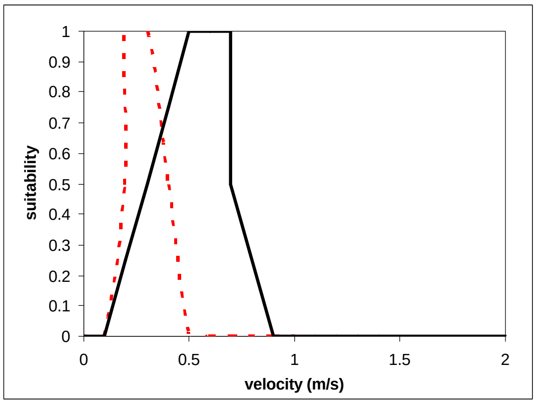



***Figure 9: Velocity HSIs.***

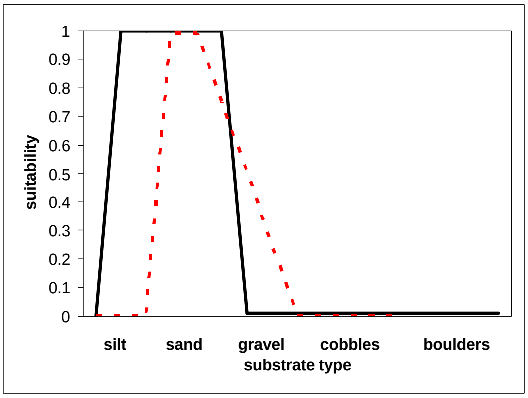



***Figure 10: Substrate HSIs.***

## 7. Teams

Environmental flow assessment is a multi-disciplinary activity that requires experts from a wide range of disciplines. The roles of different team members were discussed and the need for close collaboration, frequent meetings and strong leadership were emphasised. Course participants were invited to recommend which specialists should be included in an EF team for Tanzania. They proposed fish specialists, hydrologists, biologists, environmental experts, hydraulic engineers, agricultural officers, foresters, livestock experts, miners, dam control and operation experts, water resources managers, economists, hydrogeologist and water quality chemists. The full list is given as Annex 4.

## 8. Stakeholder participation

Involving interested groups is as important to environmental flow assessment as the technical studies. Methods of stakeholder participation were presented stressing the significant difference between consultation and true participation. Course participants were invited to recommend which stakeholders should be included in an EF assessment in Tanzania. They proposed water use organisations (large scale irrigators, and TANESCO), local water users (e.g. subsistence farmers, fishermen and livestock keepers), authorities (such as basin water offices, Regional and District Authorities and National Parks), government departments (e.g. Ministry of Water and Livestock Development, Ministry of Agriculture) and the financial community (including donors and investors). Full details are given in Annex 5.

## 9. Assessment of results for decision-making

Many water managers and decision-makers require straightforward results from an environmental flow assessment, such as the minimum flow that needs to be left in the river to sustain ecosystem health. Such simple thresholds are very elusive and some of the main concepts introduced within the course are that "river systems can be maintained at different levels of health", "the more the flow regime is changed from natural the more degraded the ecosystem will be" and "river condition is a societal choice". In recent years there has been a move towards the use of scenarios, where the costs and benefits, in economic, social and environmental terms are determined for different river alteration options.

Participants were invited to suggest the expectation of decision-makers from EFA. Some response were general, in terms of requiring the impact of different options of EFAs; others were more specific in suggesting the need for information on economic, ecological or social outcomes, such as food production, power production, livelihoods of local communities and river health. Full details are given in Annex 6.

## 10. Planning and environmental flow assessment

A step by step guide was presented to participants on planning and implementing an environmental flow assessment. These steps included identifying a team and producing terms of reference, health and safety issues of working in rivers, choosing an appropriate method, establishing stakeholder participation and preparing results. Reference sources, for details of existing procedures, were given such as the Building Block Method Manual from South Africa.

## 11. The way forward

It was stressed many times during the course that within a four-day training programme it was not possible to train fully any environmental flow experts or to make an environmental flow assessment for any river basin. The course did however provide a sound introduction to environmental flow methods, organising experts, presenting to decision-makers and involving stakeholders. Course participants were invited to recommend what Tanzania should do next on environmental flows.

A variety of recommendations were made including institutional arrangements (identifying champions and focal points/coordinators), defining regulatory a framework and decision-support system, building awareness amongst politicians and local communities, fund raising, prioritisation of catchments to Identify those with greatest problems, practical applications of ideas learnt on the course, further training (e.g. more on environmental flow assessment and on conducting awareness campaigns) and research (such as classification of rivers).

## 12. Evaluation

At the end of the course, participants were invited to complete a course evaluation form. The complete form is given as Annex 7. For each of 10 aspects of the course, they selected from excellent/good/average/below average/poor. Forms were completed anonymously, but job titles were provided to allow assessment of whether the course was more or less satisfactory for any particular group of specialists.

The 24 completed forms received gave the following evaluation:

1. Technical content of course
    - 18 excellent 6 good.
2. Technical level at which course pitched
    - ??? excellent 11 good.
3. Work load for participants
    - ??? excellent 14 good 6 average (some commented that the course was too short).
4. Quality of presentations
    - 19 excellent 4 good 1 average.
5. Quality of audio-visual aids
    - ??? excellent 8 good 1 average.
6. Field work
    - 9 excellent 13 good 2 average (some felt that 2 days was needed).
7. Relevance to my job
    - ??? excellent 10 good (excellent grade came from hydrologists and water managers).
8. Opportunity to contribute
    - 11 excellent 11 good 2 average.
9. Length of course
    - ??? excellent 6 good 12 average 2 below average.
10. Overall assessment
    - ??? excellent 10 good 1 average.

11. If the course was run again it should do the following differently ……..

    10-day course, more time for field work, material should be provided before the course, DRIFT method should be described in more detail, more practical examples, more exercises.

12. Having completed the course I will need the following to implement what I have learnt (e.g. further training, case studies, text books, on-the-job training, technical support, practical experience).

    More practical experience needed for implementation, MSc in environmental flows, training to train others, text books, manuals, technical support, on-the-job training.

## 13. Closing ceremony

The guest of honour at the closing ceremony was Mr A N Luvanda, Acting Regional Administrative Secretary for Mbeya. He felt that Tanzania was moving toward a new phase in water resources management, resulting from the need to address emerging water management problems brought about by increasing demand for water and the need to protect and preserve the resource and its environment. He welcomed the course as part of the larger strategy for holistic water resources management and for capacity building to face boldly the challenges of the future. He recognised that it was not expected that participants would be "gurus" in EFA after a single short course, but this was an important opener and the beginning to implementing EFAs in Tanzania. Mr Luvanda anticipated that more capacity building may be needed in this area.

## 14. Training course information CD

A compact disc was prepared at the end of the training course containing all course materials, lecture slides and other useful resource information. Copies can be obtained from LKEMP, RBMSIIP or IUCN.

# Annex 1: Course programme

Day 1 Introduction
Opening ceremony and introduction of participants
Concepts in environmental flows
- Why environmental flows are important for Tanzania

Day 2 Details of various environmental flow assessment methods
- Rapid look-up methods
- Hydrological methods
- Physical habitat modelling (PHABSIM)
- Framework for scenario development (DRIFT)

Preparation for fieldwork

Day 3 Fieldwork in the Usangu/Ruaha basin
- Measuring discharge
- Measuring river hydraulics
- Physical surveying of river channel and valley
- Habitat mapping
- Characterising habitat hydraulics
- Vegetation surveying
- Sampling invertebrates
- River status assessment

Day 4 Rounding up
- Analysis and presentation of field data
- Stakeholder participation
- Concepts of participation and consultation
- Identifying stakeholders in the Usangu/Ruaha basin
- Assessing the implications of method outputs
- Planning an environmental flow assessment
- Identifying next steps
- Course evaluation
- Closing ceremony

## Annex 2: List of participants

**EFA TRAINING COURSE MBEYA – SEPTEMBER 14 – 20, 2003**

| S/N | NAME | INSTITUTION | MAILING ADDRESS | CONTACT TELEPHONE |
|---|---|---|---|---|
| 1 | Wilfred Sarunday | Lower Kihansi Environmental Management Project<br>Vice President's Office (VPO) | P.O. Box 40446,<br>Dar Es Salaam. | 022-2134434<br>0748-489403 |
| 2 | Igonya I. Nkuba | Pangani Basin Water Office (PBWO) | P.O. Box 33696,<br>Dar Es Salaam. | 0744-852425 / 0748-317566 |
| 3 | Kamugenyi Luteganya | TANESCO | P.O. Box 9024,<br>Dar Es Salaam. | 0748-302464 / 022-2451131-4 |
| 4 | Lusekelo Mwambuli | Lake Victoria Basin Water Office (LVBWO) | P.O. Box 1342,<br>Mwanza. | 028-2500557/ 0741-424636 |
| 5 | Immaculata Raphael | Hai District Council, Kilimanjaro Region | P.O. Box 27,<br>Hai,<br>Kilimanjaro | 027-2756134 / 027-2750993/ 0744-692536 |
| 6 | Raphael L. Daluti | Kilimanjaro Zonal Irrigation Unit | P.O. Box 1843,<br>Moshi. | 027-2750494 / 048-328319 |
| 7 | Jonas Buyeya | Rufiji Basin Water Office (RBWO) | C/O Gerase Kamugisha,<br>P.O. Box 11491,<br>Dar Es Salaam. | 022-2113086 / 0748-786188 |
| 8 | Mtoi Kanyawanah | Ministry of Water and Livestock Development (MWLD) | Water Department,<br>P.O. Box 324,<br>Moshi. | 027-2752219 / 0744-596122 |
| 9 | Kamukuru O. Maganya | Division of Environment,<br>Vice President's Office | P.O. Box 5380,<br>Dar Es Salaam. | 022-211393 / 0741-220315 |
| 10 | Aloyce Mwitagila | Lake Nyasa Basin Water Office (LNBWO) | P.O. Box 3852,<br>Mbeya. | 025-2502655 / 0744-814427 |
| 11 | Japhet J. Kashaigili | SWMRG-SUA (RIPARWIN PROJECT) | P.O. Box 3003,<br>Moroagoro. | 023-2601206 / 0744-645144 |
| 12 | Joseph S. N. Nasari | Regional Water Engineer's Office | P.O. Box 3020,<br>Arusha. | 0744-509043 / 027-2548103 |
| 13 | Danel G. Issara | Natural Resources Advisor – Regional Secretariat – Kilimanjaro | P.o. Box 1333,<br>Moshi. | 027-2755063 / 02752184 / 0744-3914408 |
| 14 | Washington Mutayoba | River Basin Management Project (RBM Project) | P.O. Box 35066,<br>Dar Es Salaam. | 022-2450792 / 022-2450909 |

| | | | | |
|---|---|---|---|---|
| 15 | Idris A. Msuya | Rufiji Basin Water Office (RBWO) | P.O. Box 134,<br>Rujewa, Mbeya. | 025-2590246 / 0744-028930 |
| 16 | Romuald A. L. Matteru | Ministry of Water & Livestock Development (Directorate of Water Laboratories) | P.O. Box 2705,<br>Mbeya. | 025-2502252 / 0744-695590 |
| 17 | Willie N. Mwaruvanda | Rufiji Basin Water Office | P.O. Box 1798,<br>Iringa,<br>Tanzania. | 026-2702434 / 0744-298260 |
| 18 | Sophiani Komesha | Ministry of Water & Livestock Development | P.O. Box 762,<br>Mbeya. | 125-250417 / 0744-695720 |
| 9 | Ipyana E. Mwakalinga | MOWLD, Division of Water Resources, RBM – Project | Maji-Ubungo,<br>P.O. Box 35066,<br>Dar Es Salaam. | 022-245792<br>0748-635918 |
| 20 | Simon Mkhandsi | Department of Water Resources Engineering,<br>University of Dar Es Salaam. | P.O. Box 3513,<br>Dar Es Salaam. | 022-2410029 / 0744-285069 |
| 21 | John E. Lazimah | Tanzania Electric Supply Company Limited (TANESCO), Directorate of Corporate Planning and Research | TANESCO, DCPR,<br>P.O. Box 9024,<br>Dar Es Salaam. | 022-2451131/8 Ext. 2926 |
| 22 | Isaria S. Masam | Regional Commission's Office,<br>Iringa. | P.O. Box 858,<br>Iringa | 026 – 2702715<br>0744-376448 |
| 23 | Sylvand M. Kamugisha | Wami Ruvu Basin Water Office,<br>Morogoro. | P.O. Box 826,<br>Morogoro | 023-3988 / 0744-844320 |
| 24 | Kelly West | IUCN Eastern Africa,<br>Nairobi – Kenya | P.O. Box 68200,<br>Nairobi 00200, Kenya | 00520-890605 or 0744-823328 (in Tz) |
| 25 | Julius D. Sarmett | Pangani Basin Water Office – Tanga | P.O. Box 5976, Tanga | 027-2640836, 0744-315275 |
| 26 | Arnold Mapinduzi | National Environment Management Council | P.O. Box 63154, Dar Es Salaam. | 0744-279542 / 022-2127817 / 2134603 |

# Annex 3: Why EFs are important to Tanzania

**<u>Response of participant to "why are environmental flows important in Tanzania?"</u>**

**Holistic ecosystem**

- Sustain the ecosystem on which life depends
- Life engine
- Protect the silent god-created system

**Water allocation and conflict resolution**

- Water is scarce, EF is a way of budgeting it
- Better use of limited water resources and food security
- Better water allocation and reduced conflicts
- Reduce conflict over water use and create peace
- Equitable use of natural resources
- Sharing of water resources amongst different users
- Rational and equitable use of water

**Development**

- Improve economy of country in terms of electricity and ecology
- Overall development of the country
- Harmonised development and maintenance of ecosystems
- Water resource development and conservation
- Management of river basins

**Sustainability**

- Enhance sustainability of water resources
- Provide proper guidance on sustainable development
- Use natural resources in a sustainable manner
- Sustainable freshwater development

**Livelihoods**

- Ensure livelihoods enhance for communities through fishing and livestock
- Conserve livelihoods dependent on the environment
- Ensure environmental sustainability and livelihoods of Tanzanians
- Balance between ecosystems and communities who derive their livelihoods from natural resources

**Conservation and ecosystem protection**

- Manage our environmental virtues better
- Protect downstream ecosystems
- Take care of natural resources and ecosystems
- Ensure valuable ecosystems are maintained at a reasonable level
- Keep rivers healthy
- Protect biodiversity
- Conserve wildlife

**Degradation, disasters and restoration**

- Control natural resource degradation
- Rivers are dying through lack of water
- Ensure ecosystem health and restoration of ecological functions
- Determine dilution flow for waste water
- Eliminate or reduce some environmental disasters
- Reviving floods in overused rivers

**Capacity building**

- Capacity building in environmental management

## Annex 4: Multi-disciplinary expertise required for EF

**<u>Response of participant to: "who should be in the technical team for an environmental flows assessment?"</u>**

- fish specialists
- botanists
- zoologist
- ecologists
- environmental expert
- agricultural officer
- livestock experts
- foresters
- miners
- hydrologists
- groundwater (hydrogeologist)
- water resources expert/manager
- hydraulic engineers
- dam control and operation experts
- water quality chemists
- business community (traders representatives)
- economists

## Annex 5: Stakeholders who should be involved

**Response of participant to: “which stakeholders should be involved in an environmental flows assessment?”**

**Organisations in water use**
- Large scale irrigators
- Power company (TANESCO)

**Local water users**
- Subsistence farmers
- Fishermen
- Farmers
- Livestock keepers
- Small-scale irrigation farmers

**Authorities**
- Rufiji basin water officer
- Upper Rufiji government officials, hydrologists
- Regional and District Authorities
- Ruaha National Park
- TANAPA, Ruaha National Park
- Usangu Game Reserve

**Government Departments**
- Ministry of Water
- Ministry of Agriculture

Decision-makers

**Financial community**
- Donors
- Investors

# Annex 6: EFA outputs and decision-making

**<u>Response of participant to: "what do decision-makers need from environmental flows assessment?"</u>**

**Expectation of decision-makers from EFA**
- Any decision-maker would like to get clear interpretation of the results and advice based on the results.
- What is the current situation and what is the effect of the respective options of EFAs presented?
- The advantage of implementing the EFA tool in environmental management.

**Economic optimisation of impacts.**
- Impact on economy, both local and national.
- EFA results: How will it affect the economy?
- Economics of the arrived at flow.
- Economic development of the country or region.
- Water for Poverty to ensure food security.

**Impact on Agricultural Production**
- Have you reserved enough water for irrigation and hydropower?
- How much discharge is for the development of people.
- Making of bye-laws regarding use of water resources.
- How do the EFA results involve different disciplines in implementation?

**Water Quality Status**
- How is the water quality known to the stakeholder?
- What benefits are expected from EFAs?

**Sociological Impacts**
- The impact on the social-economy.
- Economic and social costs/implications of various scenarios.
- Improvement of social economy.
- Who will be affected by a given abstraction from a given river?
- Social impacts of the arrived-at flow.

**Impact on Livelihoods**
- How environmental flow allocations will impact peoples' livelihoods.
- The relationship of environmental flows to the livelihoods of local communities.
- How can the environmental flow be reached without affecting the people?

**Range of desired flows that can be recommended.**
- What amount of minimum flow is required in the river?
- How much water is needed for the river to e healthy?
- How much water is required for the EF and how frequently will it be abstracted?
- The optimal use of EFs.
- Hoe to enhance EFs.

**Gains and Losses of leaving enough water for the environment.**
- Loss of not implementing the recommendation.
- Positive and negative impacts of EFA.
- Amount of water available for local communities.
- What amount of water is available for a particular point in the river?
- Quantity of water during the dry season low flow.
- Will this minimum environmental flow change with drought or season or remain the same?

# Annex 7: The way forward

**<u>Response of participant to: "what should Tanzania do next on environmental flows?"</u>**

**Institutional**

- Identify champions/institutions
- Establish focal point/coordinator

**Regulatory framework**

- Define an assessment framework
- Regulatory framework and decision-support system

**Awareness**

- Enlist political support
- Feedback on EFA to community around the river
- Invite more stakeholders to EF workshop
- Conduct public awareness campaigns to communities/water users along the river
- Awareness building for decision-makers
- Awareness campaign to MPs in Dadoma

**Fund raising**

- Find funding
- Realistic application of funds to Water Resources Dept to undertake EFAs
- Seek further financial support to continue training and applications of EFs
- Solicit funding for further studies (MScs, PhDs)
- Look for other IUCNs to support

**Catchment prioritisation**

- Identify rivers which are more problematic
- Prioritise catchments to importance/levels of conflict
- Basin authorities to start identifying problem rivers
- Undertake river classification

**Application of methods to river basins**

- Lets do it!
- Begin some EF assessments!
- Choose a river and conduct an assessment soon (Kihansi or Great Ruaha River?)
- Trail/practice what we have learnt
- Test application of EFs
- Start assessment in some reaches of Pangani

**Networking**

- Sharing experience
- Visit places where EFAs have been done and share experience

**Training**

- Establish an EFA centre of excellence in the UDSM
- Identify a leading research centre /experts
- Training of trainers and EFA process managers
- More practical training – ie application of EF knowledge
- More training on environmental flow assessment
- Training in conducting awareness campaigns
- Linking catchment/forest management with EFs

**Research**

- Improve our understanding
- Put more weight on chemical loading to rivers as a variable in river classification and EFA

## Annex 8: Observing the process elsewhere

**Participation in key activities in a Comprehensive (or Intermediate) Reserve Determination for an Observer.**

As discussed on Day 4 of the Training Workshop, an opportunity exists for **one** Observer from Tanzania to attend the full suite of team meetings undertaken during the Reserve determination for the Olifants/Doring River in the Western Cape, South Africa.

The person selected would have to comply with the same requisites for selection as an Observer as other local observers. The following requisites apply:

- Commitment to attend full suite of identified activities.
- Commitment to meet the pre-requisites for attendance of each meeting.

These requisites are particularly important as the identified activities together comprise a cohesive whole and provide a comprehensive overview of a Reserve determination, and by skipping some the Observer will 1) reduce the value of the experience and 2) loose track of the proceedings.

The key activities and team deliverables for the Olifants/Doring river Reserve determination recommended for inclusion in this exercise are presented in chronological order below:

**Overall Planning Meeting:**

**Timing:** November 2003.

**Duration:** 1 day.

**Attendees:** Whole Reserve team, Management PSP, Representative of RDM Office.

**Pre-requisites:** Familiarity with the contents of the *Olifants/Doring Reserve Determination Inception Report*, plus any additional background information provided to the specialist team.

**Purpose:** Introduce the team to one another. Explain the RDM procedures and areas to be covered by the study. Provide an overview of the Terms of Reference for the study, including components of aquatic ecosystem being addressed, number of sites to be used in river, and timing of key activities. Present and explain the methodology to be used in the study. Provide individual Terms of Reference of the specialists. Present and explain background data on the study area, including overviews, comprising a geomorphological reach analysis and Habitat Integrity assessments. Preliminary selection of study reaches and discussion on possible study sites, including identification of a short-list of possible site localities.

**Outcome:** General overview of the study structure, area and team. Scheduling of key activities.

**River site selection meeting:**

**Timing:** November 2003.

**Duration:** 3-5 days

**Attendees:** Usually: Hydraulician, botanist, macroinvertebrate specialist, fish biologist.

**Prerequisites:** Attend Planning Meeting.

**Purpose:** Visit key sites within the preliminary study reaches identified at the Planning Meeting. Allow specialists time to assess the site, and hold on-site discussions about the merits and disadvantages of each site visited. Hold on-site discussions with the team on positioning and number of cross-section, and identify key habitats of interest.

**Outcome:** Value gained from specialists' discussions re site and cross-section selection. First hand experience of the study area, slightly broader than just the study sites (where future data collection will be focused).

**Initial river data collection trip - OPTIONAL**

**Timing:** November 2003.

**Duration:** 5 day.

**Attendees:** All river specialists.

**Prerequisites:** Attend site selection meeting. Some familiarity with data collection techniques described for each biophysical component in the BBM Manual.

**Purpose:** Data collection for each of the specialities focussed on the cross-section selected at the site selection meeting. Other data collection will occur later but the initial data collection is usually the time when everyone works together. The trainees would gain from observing the different tasks, techniques, subtleties and difficulties associated with each specialists' data collection.

**Outcome:** First hand experience of the data collection procedures and difficulties.

**PES Workshop:**

**Timing:** *c.* November 2004.

**Attendees:** River team, Management PSP, Representative of RDM Office.

**Duration:** 1-2 days.

**Prerequisites:** Familiarity with contents of the specialists' *Reference Condition* and *PES Reports*. Attendance at Initial data collection.

**Purpose:** Present and discuss theoretical Reference Conditions for each study reach. Discuss anthropogenic impacts and their effect on river condition. Trajectories of change, separation of flow and non-flow related impacts.

**Outcome:** Observers will start to build up an understanding of the reference (or undisturbed) conditions for the river, and of the sorts of impacts on the river and the consequences they have had for river functioning and condition. They will also become more familiar with the process used to determine PES and the trajectories of changes, as well as the distinctions used in determining flow- and non-flow related impacts, and proximal and distal (origin) causes.

**EWR Workshop:**

**Timing:** *c.* November 2004, held concurrently with PES workshop.

**Attendees:** River team, Management PSP, Representative of RDM Office

**Prerequisites:** Familiarity with contents of the *Starter Document*. Attendance at PES Workshop.

**Duration:** 3-5 days.

**Purpose:** Implementation of the EWR methodology. Discussion of consequences of/motivations for flow change. Determination of the flow requirements for different scenarios. Determination of Ecospecs.

**Outcome:** First hand experience of the workshop process and implementation of the selected methodology. Additional benefit of informal discussion with specialists, facilitators, etc., during the evenings.

**Financial considerations**
Disbursement costs would need to be covered by the Observer or their employer.

**Other considerations**
This offer is subject to:

- Permission from the Client: Department of Water Affairs and Forestry.
- Approval by the Client of the Inception Report for the Olifants Doring Comprehensive Reserve Determination.

## Annex 9: Mission diary

| | |
|---|---|
| Friday 12 September evening | Dr King and Dr Brown arrive in Dar Es Salaam |
| Saturday 13 | Dr King and Dr Brown finalise course material meet with Dr Sardunday and Dr Mutayoba to finalise logistical arrangements |
| Sunday 14 September | Dr Acreman arrives in Dar Es Salaam<br>All trainers travel to Mbeya<br>Dr King and Dr Acreman finalise course presentation plans |
| Monday 15 September to Thursday 18 September | Course run in Mbeya with field work on Mbarali river |
| Friday 19 September | All trainers return to Dar Es Salaam<br>Dr King and Dr Acreman analyse training course and prepare recommendations |
| Saturday 20 September | Dr Acreman, Dr King and Dr Brown prepare report and recommendations and meet with Task Team Leader, Dr. Ladisy Chengula<br>Dr Brown prepares CD of course material for participants. |

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