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Pangani Basin: A Situation Analysis (2nd Edition)



Pangani Basin:

A Situation Analysis (2nd Edition)

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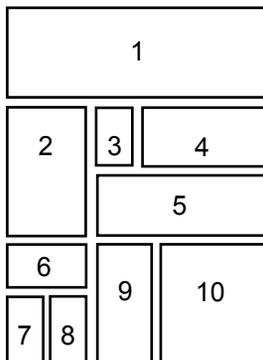


Photo 1: The summit of Mount Kilimanjaro; **Photo 2:** Forest stand at Shire Njoro; **Photo 3:** Gate controlling the release of water into irrigation furrows; **Photo 4:** Children swimming in an irrigation reservoir; **Photo 5:** Sisal plantations; **Photo 6:** Irrigated rice scheme; **Photo 7:** Water gauging station at Chemka Spring; **Photo 8:** Vandalized gate controlling the release of water into irrigation furrows; **Photo 9:** Dam wall at Nyumba ya Mungu Reservoir (color changes mark the declining water levels); **Photo 10:** A vendor sells water from a borehole.

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Abbreviations

ANR	Amani Nature Reserve
ASL	Above Sea Level
AUWSA	Arusha Urban Water and Sanitation Authority
BWB	Basin Water Board
BWO	Basin Water Office
CBNRM	Community-based Natural Resource Management
CCM	Chama Cha Mapinduzi
CDA	Coast Development Authority
CFP	Catchment Forest Project
CFR	Community Forest Reserves
CPRs	Common Property Resources
DFO	District Forestry Officer
DGIS.....	Dutch Ministry of Foreign Affairs
EACBP	East Africa Cross-border Biodiversity Project
EU-ACP	European Union - Africa, Caribbean and Pacific region
EU	European Union
FAO	Food and Agricultural Organization
FBD	Forestry and Beekeeping Division
GEF	Global Environment Facility
GIS	Geographical Information Systems
GoK	Government of Kenya
ha	Hectares
IRBM	Integrated River Basin Management
IBA	Important Bird Area
IDA	International Development Agency
IUCN	International Union for Conservation of Nature
JFM	Joint Forestry Management
kWh	Kilo Watts per hour
LGA.....	Local Government Authority
LMIS	Lower Moshi Irrigation Scheme
MAFS	Ministry of Agriculture and Food Security
MCM	Million Cubic Metres
MGR	Mkomazi Game Reserve
MMP	Mangrove Management Project
MOU	Memoranda of Understanding
MoWLD	Ministry of Water and Livestock Development
MW	Mega Watt
NAWAPO.....	National Water Policy

n.d.	No Date
NEMC	National Environmental Management Council
NGO	Non-governmental organisation
NPF	New Pangani Falls
NORAD	Norwegian Aid
NRM	Natural Resources Management
NWSDS	National Water Sector Development Strategy
NYM	Nyumba ya Mungu Dam
PA	Protected Areas
PBWB	Pangani Basin Water Board
PBWO	Pangani Basin Water Office
PRB	Pangani River Basin
PRBMP	Pangani River Basin Management Project
RBM	River Basin Management
RBMSIIP	River Basin Management and Small-scale Irrigation Improvement Project
RCE	Regional Centre of Endemism
RHO	Regional Hydrological Officer
RNRO	Regional Natural Resources Officer
SA	Situation Analysis
SNV	Netherlands Development Organization
TANAPA	Tanzania National Parks
TANESCO	Tanzania Electric Supply Company
TCMP	Tanzania Coastal Management Partnership
TCZCDP	Tanga Coastal Zone Conservation and Development Programme
TFAP	Tanzania Forestry Action Plan
TFCG	Tanzania Forest Conservation Group
TIP	Traditional Irrigation and Environmental Development Organisation
TPC	Tanzania Planting Company
UNICEF	United Nations International Children's Emergency Fund
UNDP	United Nations Development Program
USAID	United States Agency for International Development
VNRC	Village Natural Resource Committee
VWN	Vision for Water and Nature
WANI	Water and Nature Initiative
WDM	Water Demand Management
WHO	World Health Organization
WRMA	Water Resources Management Authority (Kenya)
WRM Act	Water Resources Management Act
WUA	Water Users' Association

Preface

The objectives of the first edition of the Pangani Situation Analysis included identifying the resources that occupy the Pangani River Basin (PRB) and the processes and events that affect them, and identifying a series of broad action areas wherein interventions may feasibly be delivered. The final objective was to identify other organisations, interests or institutions with which IUCN may develop partnerships as it seeks to develop the Water and Nature initiative (WANI) initiative in the PRB.

The IUCN Water and Nature Initiative (WANI) is an ongoing collaborative effort to address the world's water crisis. WANI builds on the Water and Nature Vision and Framework for Action and is a response to the call for action expressed before, during and after the 2nd World Water Forum in The Hague (March 2000). The goal of WANI is to mainstream the ecosystem approach into river basin policies, planning and management. In selected demonstration site basins around the world, WANI strives to: demonstrate ecosystem management, empower people to participate in sustainable water management, support wise governance of water resources and wetlands, develop and apply economic tools and incentives, improve knowledge to support decision making and learn lessons and raise awareness about wise water use.

Following consultations with stakeholders in the basin and culminating in a workshop hosted by Pangani Basin Water Office (PBWO) and IUCN – The International Union for Conservation of Nature in Moshi, Tanzania from 8-10 May 2002, the Pangani River Basin in Tanzania and Kenya was selected as a WANI demonstration site.

As part of its project development activities for the Pangani River Basin, IUCN commissioned a consultant, Dr. Kim Geheb, to develop a Situation Analysis of this basin. The fieldwork for the Situation Analysis was carried out in November 2002, and involved interviews with a wide variety of stakeholders within the basin. Additional sources of information included published sources and the proceedings of the above-mentioned workshop, entitled, 'The Pangani River Basin: Options for Integrated Management.'

A first draft of the Situation Analysis was completed in late 2002 and distributed to stakeholders for review and comment. At a workshop hosted by PBWO and IUCN in Moshi in March, 2003, stakeholders gathered to comment on the Situation Analysis and suggest amendments. Additional comments and contributions have subsequently been received from both the PBWO and the Coastal Development Authority (CDA - Kenya) at a meeting held in Nairobi in May 2003 between IUCN, PBWO and CDA. In 2009, a reprint of the Situation Analysis was needed so it was decided to take this opportunity to update some of the information in light of the operation of the Water Resource Management Act in July 2009. It should be noted that mainly information pertaining to the administrative structure, institutional arrangements, water law and policy has been addressed, as well as the impact of the Situation Analysis in developing the Pangani River Basin Management Project, but the remainder of the Situation Analysis has not been changed. Funding for the update and printing of this situation analysis comes from the Global Water Initiative which is supported by the Howard G. Buffett Foundation.

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Executive summary

The Pangani River Basin (PRB) covers an area of about 43,650 km², mostly in Tanzania with approximately 5% in Kenya. In Tanzania, the Basin is spread over four administrative regions: Kilimanjaro, Arusha, Manyara and Tanga. Most of the Kenyan portion of the Basin falls within the Taita – Taveta District. The Pangani River has two main tributaries, the Kikuletwa and the Ruvu, which join at Nyumba ya Mungu, a reservoir of some 140 km². The effluent of the reservoir is known as the Pangani River, which flows for 432 km before emptying into the Indian Ocean.

The Basin contains a wide array of resources. For its 3.7 million Tanzanian inhabitants, water and arable land are arguably the most important. The Basin's highlands receive substantially more rainfall than its lowlands. Nevertheless, highland farming intensities and the competition for land have meant that farmers have had to start irrigating their farms in order to maximise outputs. Those unable to obtain highland land have been forced to seek farmland in lowland areas, where rainfall is substantially less, and where irrigation is of paramount importance. This difficulty has been exacerbated by general rainfall declines within the Basin.

The competition for land has ensured that other land uses within the Basin, such as forestry, have come into direct competition with agriculture. In some cases, forests are protected by their national park status, such as that in the Mt. Kilimanjaro National Park, which falls under the purview of Tanzania National Parks (TANAPA). Other forests are ostensibly protected by the Kenyan and Tanzanian forestry departments. Through a combination of low staffing levels and difficult financial circumstances, however, these often do not enjoy the same standards of protection as those lying within TANAPA territory. The pressure on the PRB's coastal and Eastern Arc forests is of particular concern, given the high levels of biotic endemism within them.

Other resources within the Basin are its mineral deposits, which include tanzanite, tin and gemstones, its fisheries, wetlands and its numerous tourist attractions.

A host of different actors exploit these resources, and this Situation Analysis groups them as follows:

- Industrial interests, which include the Basin's important hydropower contributions to the national grid, mining and agro-industries such as sugar refineries and sisal processing plants.
- Farming interests: much traditional farming in the Basin is supported by irrigation. Traditional irrigation furrows are highly inefficient, and may lose as much as 85% of water between the point of abstraction and its destination. There are also several large-scale farming interests in the Basin, including sugar cane, sisal and flowers. Between 29,000 and 40,000 ha of the Tanzanian part of the PRB are irrigated, consuming between 400 and 480 million cubic metres of water annually.
- Pastoralist interests: present livestock population levels in the Basin are unknown. It is thought that, by 2015, pastoralism will consume 36,400 m³ of water a day.
- Urban interests: the Basin contains two major Tanzanian urban conurbations: Moshi and Arusha. As they grow, their demand for water has also escalated on two fronts: for industrial and domestic use, and as a means of disposing of waste. It is expected that, by 2015, urban water demand in the Basin will reach 163,600 m³/day.

There are, therefore, a diversity of interests in the Basin, and these are able to wield various degrees of power as they seek to lay claim to its resources. These differences in power underlie the many conflicts that characterise natural resource exploitation within the Basin. This Situation Analysis classifies these different types of conflict as follows:

- Conflicts of scale: the relationship between water users of different sizes and power in the PRB is often described in dichotomous terms. Hence, large-scale plantations using hundreds of litres of water a second and employing highly efficient irrigation systems, differ starkly from small-scale users using far less water and employing very inefficient irrigation systems. The extremes involved in these regards are fertile grounds for conflict. This Situation Analysis provides empirical examples of such scale conflicts between urban and rural users, and between large and small-scale mining interests.
- Conflicts of tenure: this document refers to tenure as the right to manage a resource. Throughout Tanzania, Community-based Natural Resources Management (CBNRM) has been seen as an attractive way of increasing the efficiency of the nation's Natural Resources Management (NRM) systems. This trend has been less marked in Kenya. The contention with these systems relates to the manner of their application and design. Here, communities may not be involved in the design of the management strategy, its implementation or even its justice systems. This may ensure that these institutions do not fulfil the management tasks that they were created to perform. Examples are provided of conflicts between community-level and government forestry management initiatives; between resource users of different kinds; and conflict over different management perspectives.
- Conflicts of location: users located in upstream areas are placed more favourably vis-à-vis water abstraction than are downstream users. At its most basic, these problems can be seen along irrigation furrows where users close to the water source are able to grow crops with high water demands (such as irrigated rice) and those located at the end of the furrow obliged to plant low water demand crops. The serious problems faced by downstream hydropower plants are another example. Examples of such conflicts are those between upstream and down-stream water users, and conflicts between hydropower interests and small-scale irrigators.

Conflict over resources is just one manifestation of the very high levels of competition that exist between the Basin's resource users. The impact of a growing population, the Basin's variable resource distribution and the finite nature of its resources mean that exploitation patterns are often deleterious. Examples of resource damage are as follows:

- The Basin's forests are threatened by logging, encroachment along their peripheries, demands for land, charcoal manufacture and fuelwood collection. Estimates suggest that up to 77% of the Eastern Arc Mountains' forest has been lost over the past 2,000 years due to human activities, while 41 km² of Kilimanjaro's natural forest was lost between 1952 and 1982.
- The Basin's water supplies are threatened by extremely high demands that have ensured that its water resources are considered 'stressed'. The main sources of demand are inefficient furrow-based irrigation systems. The Basin's swamps are threatened by the regulation of water by damming.
- The Basin's Protected Areas are threatened by poaching, and by threats similar to those faced by forest resources.
- Most of the Basin's biodiversity has been gained as a result of its unique array of forest habitat types. Threats to biodiversity, as a result, arise because of threats to habitat.
- The fisheries of the PRB are threatened by excessive fishing pressure, and weed growth occasioned by high nutrient loads. Indeed, 24 tonnes of soil per hectare of catchment flows into the Nyumba ya Mungu (NYM) reservoir every year. In 1970, 28,509 tonnes of fish were landed from the NYM reservoir. Catches have declined substantially since then, and in 1983, 2,430 tonnes of fish were landed.

A large number of governmental and non-governmental organisations exist within the Basin seeking to curb these trends and trying to improve the livelihoods of resource users. In recent years, perhaps the most important large-scale initiatives in the Basin are those of the World Bank-funded River Basin Management and Small-scale Irrigation Improvement Project (RBMSIIP), and the UNDP-GEF East Africa Cross-border Biodiversity Project (EACBP). The former project has been particularly important in strengthening the Pangani Basin Water Office (PBWO), as well as improving water-monitoring capabilities within the Basin.

NGO initiatives in the Basin include those concerned with the integrated management of Tanzania's coastline and its mangrove forests, and, in the north of the Basin, those concerned with the improvement of traditional irrigation practises, and facilitating lines of communication between local level resource users and the Basin's formal administration. Additional initiatives have concentrated on the conservation of the Basin's forests and wildlife resources.

The formal administration of the Basin is complex. In Tanzania, typically two sources of management occur for any one resource: that provided by central government, and that provided by regional government. At the same time, the Pangani Basin Water Board (PBWB) has been introduced to the Basin with a view to providing a Basin-wide approach to the management of its water resources. This means that, in many instances, the lines of authority between the management of a resource and management providers may be ambiguous and/or confused. This type of confusion is replicated at the local level. As mentioned earlier, Tanzania has turned increasingly to Community-based Natural Resources Management (CBNRM) as a way of improving its NRM. However, this has meant that committees or other community-level organisations have been created to deal with specific resources, and not natural resources generally. Hence, there are Village Natural Resource Committees (VNRCs), Water Users' Associations (WUAs), Village Governments and others, complicating the delivery of management and augmenting transaction costs considerably.

In Kenya, water resources have recently been placed under a Water Resources Management Authority (WRMA), which uses the river basin as its focus, and which is charged with the responsibility of integrating the management of such basins, and including stakeholder groups in the management structure. This is a relatively new initiative, and is likely to facing teething problems with respect to including stakeholders in the management structure, and difficulty integrating the various sectors of basins' administration.

Such a 'sectoral' approach to management is, therefore, present on both sides of the border, and refers to situations where departments are involved with the management of forests, water, irrigation, wildlife and other resources. This may ensure that management objectives and approaches run parallel to one another, and complicates the possibilities for integrated approaches to the Basin's management. The PBWB, however, has representation from the various departments to at least ensure that they communicate with one another, the Board is mandated by the new Water Resources Management Act (WRM Act) to formulate the Pangani Integrated Water resources Management plan by mobilizing all players all resources users and managers in the basin.

This Situation Analysis summarises the above problems and difficulties by identifying a series of issues that, it suggests, warrant significant managerial attention. Arguably, environmental problems are social ones. For convenience, and for the sake of highlighting the state of the PRB environment, these are divided between environmental and social issues as follows:

Environmental issues:

- Deforestation – causing water retention problems, increases runoff and hence promoting erosion, flooding and increased silt loads.
- Demands for land – many forests are located in prime agricultural areas that receive high levels of rainfall. This is a significant threat to the Basin's forest reserves
- Farming practises: many of the basin's farming techniques were developed at a time when populations were far smaller, and access to resources much better. As populations have increased, however, these same techniques may seriously threaten the Basin's environmental integrity. The systems are not water efficient, and repeated irrigation may prompt salinity and/or sodicity.

- Livestock increases: these are unknown, but are suspected to be considerable. With farming on the increase in the Basin's lowland areas, pastoralist land has been taken out of production, exacerbating the potential for over-stocking.
- Development: unmanaged development in the Basin is a concern given the potential for pollution and inadequate waste disposal that it represents.
- Water quality: this is threatened by pollution, but also damaged by localised geological characteristics that may give rise to fluoride contamination.
- Over-fishing: fishing pressures on the NYM appear to be excessive. Fishing is also threatened by the growth of waterweed on rivers and lakes, itself prompted by the increased nutrient loads of the Basin.
- Mining: uncontrolled mining activities in the Basin threaten its landscape and the future productivity of its land. It also has serious pollution potential. Sand mining along rivers undermines the stability of riverbanks.
- Lack of environmental awareness amongst the Basin's inhabitants.

Socio-economic and political issues

- Poverty: because secondary and tertiary forms of employment are typically unavailable in the Basin's commercial and industrial sectors, many of its inhabitants seek livelihoods in primary activities such as agriculture, the harvest of forest products, fishing etc.
- Conflict: because so many are involved in primary activities, the potential for conflict arises between small-scale users, and between small and large-scale users.
- Political expediency: politicians, eager to obtain votes from their constituents may sometimes encourage the wholesale exploitation of vulnerable resources.

Issues of management and administration

- Inadequate policies: policies that appear perfectly reasonable and carefully developed may be rendered impotent because their implementation cannot be monitored, and offenders are not sanctioned.
- Funding problems: these arise at virtually every point of the Basin's administration and range from difficulties in providing adequate remuneration to the purchase of technology to assist with Basin monitoring.
- Lack of management integration: the divisions between regional and national level administration coupled with 'sectoral' management approaches, ensures that much of the Natural Resources Management (NRM) in the Basin is not integrated, with one sector or level of administration pursuing objectives and management styles different to the other levels or sectors of the Basin. This difficulty also occurs across international frontiers: no mechanism exists for Kenya and Tanzania to co-ordinate their management of the Pangani River Basin.
- Problems with community administration: this relates, firstly, to the poor contributions communities make to the design, implementation and enforcement of the NRM systems that they are encumbered with. Second, many of these approaches, imposed from outside the community, seek the establishment of NRM committees of various types, resulting in a confusing plethora of local-level organisations and prompting the sectoral difficulties described above, conflicts of authority and limited managerial success.

On the basis of the issues defined above, the Situation Analysis identifies a series of priority areas for action. These are:

The development of integrated management strategies for the PRB along with attendant forums. There appears to be little doubt that the Pangani River Basin (PRB) urgently needs integrated management strategies that can cope with its diverse and complicated issues. Possible options that could be considered include the development of water demand strategies, assessing downstream water requirements for people and the environment, water incremental approaches to management, streamlining management and increasing the role played by communities in the design and implementation of integrated NRM.

The development of effective strategies to facilitate dialogue amongst and between resource users and managers of different types and involved in different sectors with a view to improving awareness at all levels of management. Mechanisms are needed to ensure that dialogue opportunities between and amongst stakeholders and managers are maximised, so as to ensure that two-way exchanges of information may occur, dissemination improved and the knowledge of how stakeholders all play a part in the well-being of the Basin delivered. It is necessary that awareness is created about all aspects of the condition and management of the Basin and its stakeholders at all levels of management and its co-ordination. Additional components of this priority area are the development of forums capable of assuming this task, as well as serving as a mechanism to remedy conflict, and to bridge gaps between different levels of administration

The identification and development of an adequate data collection and monitoring system. This action area is not restricted to the development of data collection systems for hydrological data. A satellite and GIS assessment of land use, exploitation rates and geographical change is a pre-requisite for the development of land-use planning and monitoring. The development of methodologies to assess and gauge the underlying social and economic causes of environmental degradation and resource over-exploitation also needs to be identified. Such systems should also be capable of identifying water demands within the Basin. The data and monitoring systems recommended must match local funding and maintenance capabilities.

A Introduction to the Pangani River Basin Situation Analysis

A.1 An overview of the Pangani River Basin

The Pangani basin is one of 9-river basins gazetted in Tanzania according to the Water Utilization (Control and Regulation) Act No. 42 as amended in 1981 (Amendment No. 10) (repealed by Water Resources Management Act 2009) to devolve the responsibility for water management to the basin level. The Pangani Basin covers an area of about 58,800 km^{2.1} administratively and includes the main Pangani River Basin and the smaller river basins of Umba, Msangazi, Zigi², and Coastal Rivers, including Mukulumuzi. This Situation Analysis concentrates on the main Pangani River Basin. However, details of the smaller river basins governed by Pangani Basin Water Office are provided in Annex 1.

The Pangani River Basin covers an area of 43,650 km^{2.1}, out of which 3,914 km^{2.1} lies in Kenya (Figure 1). In Tanzania, the Basin is distributed amongst the Kilimanjaro, Manyara, Arusha, and Tanga administrative regions of. The Kenyan portion of the Basin falls almost entirely within the district of Taita – Taveta.

The Pangani River itself has two main tributaries, both of which rise in the basin's northernmost portions. The first of these, the Kikuletwa, rises on the slopes of Mount Meru and the southern slopes of Mount Kilimanjaro, while the second, the Ruvu, rises on the eastern slopes of Mt. Kilimanjaro and Lake Jipe. These rivers join at Nyumba ya Mungu, a reservoir of some 140 km² (Røhr and Killingtveit, 2002). The Pangani River³ drains the reservoir, flowing for 432 km before emptying into the Indian Ocean.

Generally, the basin comprises a low elevation slope that drops gently south and southeastwards towards the Indian Ocean. On average, this landscape of 'Maasai steppe' lies at 800 m, and much of it receives little more than 500 mm of rain a year. In stark contrast, rising up out of the plain are a series of mountains whose altitude more than compensates for the difficult conditions of the plains. Up here, 2,000 mm of rain may fall per year. In effect, these mountains represent islands: while the plains around them display an unremarkable biodiversity and difficult livelihood conditions, the mountains are islands of spectacular biodiversity and biotic endemism. Humans have not failed to observe the qualities of these mountains, and even before the advent of Tanzania's colonial administration, the mountains of the Pangani River Basin (PRB) were the most densely populated areas on the plain.

As the Pangani River curves eastwards, and descends onto Tanzania's coastal plain, it yet again encounters enigmatic climatological and environmental conditions. Unlike the climates of the north, which have changed substantially over millennia from ice age to ice age, the climate generated out of the Indian Ocean has remained remarkably stable. The entire coastal plain of East Africa exhibits forest

¹ Many previous studies cite the catchment area of the administrative Pangani Basin in Tanzania as 56,300 km², and the area of the main Pangani River Basin in Tanzania and Kenya as 42,200 km² based on planimeter estimates made by S. Kamugisha (1992). Subsequently two different institutions (TANRIC at University of Dar es Salaam and the River Basin Management Project in the Ministry of Water & Livestock Development) have estimated these areas using GIS. These recent estimates are larger than the previous planimeter estimates. These discrepancies are probably a result of different interpretations of the basin boundaries, especially on the west side and differences between planimeter and GIS methods (Kamugisha & Mwakalinga pers. com., 2003).

² Some authors use 'Sigi' spelling, 'Zigi' is the preferred spelling of the catchment's residents (pers. comm., 2003)

³ Some maps and studies refer to the effluent of Nyumba ya Mungu reservoir as the Ruvu River until it joins with the Mkomazi River, at which point it becomes the Pangani River. This study will refer to the entire stretch, from Nyumba ya Mungu to the estuary, as the Pangani River.

patches of great antiquity, and its climate has ensured that these forests have been preserved in climatological stability. Climate change elsewhere on the African continent completely altered environmental conditions, forcing wholesale extinctions and the recommencement of evolutionary processes, so that Tanzania's coastal forests little resemble forest elsewhere on the continent. Like the mountains of the PRB, these forests display staggering biodiversity and endemism.

Today, there live an estimated 3.7 million people in the Tanzanian portion of the Basin, while in Kenya the Taita – Taveta's population is around 40,900. Settlement patterns within the Basin reflect the uneven environmental conditions of the Basin. In Tanzania, 90% of the Basin's population live in its highlands, and 80% of them depend, directly or indirectly, on agriculture for a livelihood (Mwamfupe, 2002).

This settlement concentration yields population densities of up to 300 people per km². In 1988, Tanzania's coastal regions had a population density of 28.4 people per km² (excluding Dar es Salaam), up from just 18 per km² in 1967. On the West Usambara Mountains, populations have grown 23-fold since 1900, while in the highland areas of Mt. Kilimanjaro, population densities are as high as 900 people per km² (Gillingham, 1999). In contrast, lowland areas exhibited substantially lower densities of around 65 people per km²

Historically, the Basin's occupants have practised economies that have reflected the divergent environmental conditions of the Basin. The lowlands supported pastoralists, while the highlands have supported agriculturalists. With the advent of European colonialists, great swathes of farming land were 'alienated' for plantation farming. In Kenya's Taita – Taveta District, virtually all land was set aside for sisal cultivation. This ensured that farming intensities magnified. Johnston (1946) claims that, in 1943, landholdings in the Kilimanjaro highlands were, on average, 1.2 ha apiece. In 1946, they were just 2.5 m².

Average holding sizes in the Kilimanjaro highlands have, apparently, grown since then, and Lein (2002) claims holding sizes to be an average of 0.6 ha per household. Lowland households farm an average area of 10.4 ha.

The latter average is likely to decline. As plot sizes in the highlands become smaller and smaller, plots less able to provide a livelihood, and soils exhausted from excessive cropping and irrigation, people have been forced to seek land in the lowland areas. Naturally, population has concentrated along the Pangani River Basin's (PRB's) rivers, and irrigation is extremely widespread. As a result, the biodiverse islands that pepper the Basin floor are under unrelenting pressure.



Figure 1: The Pangani River Basin, spanning Tanzania and Kenya

(Source: River Basin Management Project)

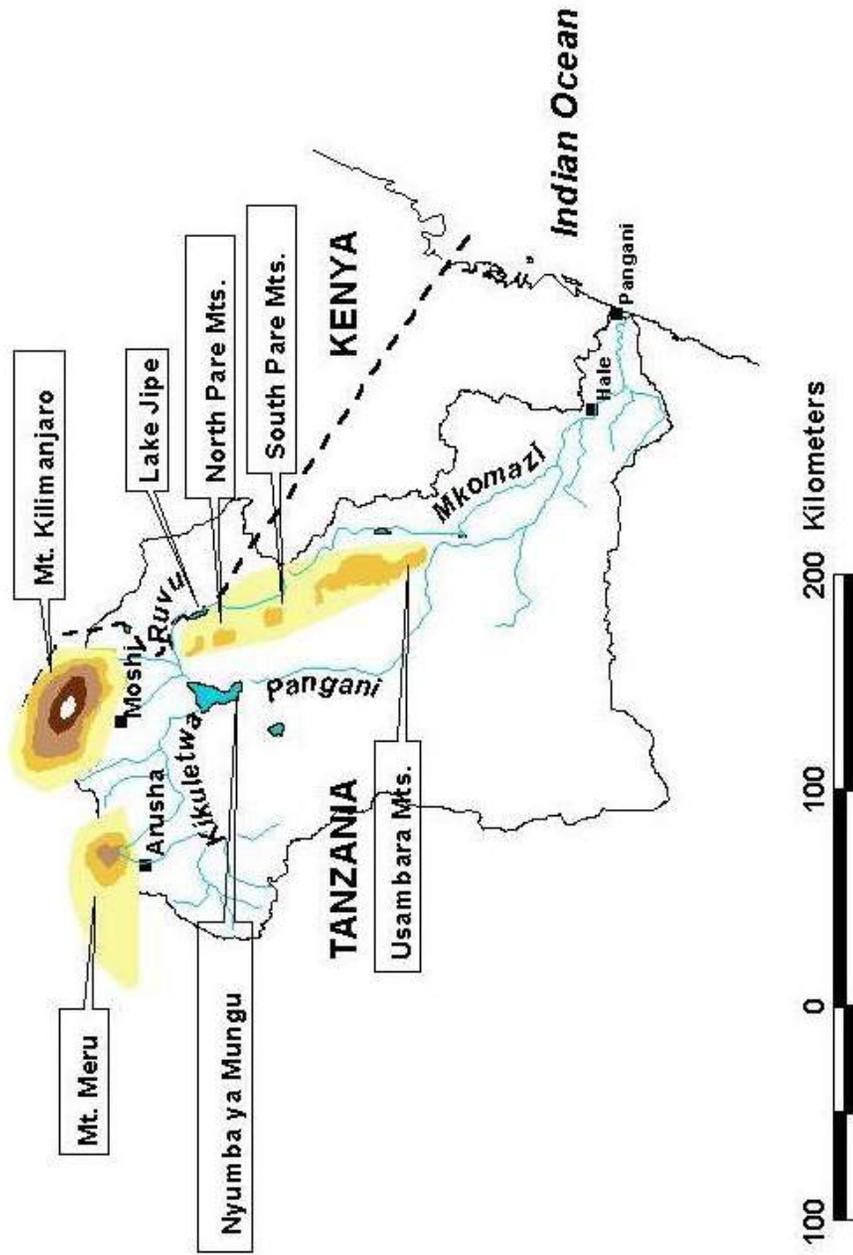


Figure 2: The Pangani River Basin
 see also Plate 1, page 43
 (Source: River Basin Management Project)

At its core, therefore, the problems of the PRB relate to population density and the two key farming and pastoralist ingredients: land and water. The interaction of these variables, and the claims that people make on the Basin's resources, has yielded a series of different conflict types:

Conflicts of scale

The relationship between water users of different sizes in the Pangani River Basin is often described in dichotomous terms. Hence, large-scale plantations using hundreds of litres of water a second and employing highly efficient irrigation systems differ starkly from small-scale users using far lower water volumes and employing very inefficient irrigation systems. These scale differences are not restricted to technologies, but to land. Large-scale users nearly always use more land than small-scale users. One important exception is hydropower interests along the river. The land actually occupied by these interests is (relatively) not that large, but their water demands are very high. This water, of course, is returned to the river, so that, arguably, power generation interests leave in as much water as they use. Their interests, however, are national in scope. The PRB generates up to 17% of Tanzania's electricity, and many of its hydropower units are designed with very specific water flows in mind. If water abstractions between the water source and the hydropower plant are excessive, the plants have to operate at less than optimal capacity. The conflict here brings to bear national interests against small-scale concerns.

Conflicts of tenure

This document refers to tenure as the right to manage a resource. Like in most parts of the world, the notion of community-based management in Tanzania and Kenya is new. In countries where state-based management systems have, after more than half a century of operation, yielded lacklustre results, and the gravity of the countries' environmental problems increases, community-based natural resources management (CBNRM) can seem a remarkably attractive management option. Hence, in Tanzania, there are a plethora of such community-based management institutions. Community-based NRM remains very nascent in Kenya. The contention with these systems relates to the manner of their application and design. Here, communities may not be involved in the design of the management system, its implementation or even its justice systems.

Conflicts of location

The location of up-stream water users favours their resource exploitation over the location of downstream users. At its most basic, these problems can be seen along irrigation furrows where users close to the water source are able to grow crops with very high water demands (such as irrigated rice) and those located at the end of the furrow obliged to plant low water demand crops. The serious problems faced by downstream hydropower plants are another example.

Two main institutions administer the water resources of the Pangani River Basin. In Tanzania, it is the Pangani Basin Water Office (PBWO), while in Kenya it is the Water Resources Management Authority (WRMA). Under recent Tanzanian legislation, all of Tanzania's basins have (or will be) placed under similar offices. However, some Basins are too small to merit the creation of an independent office to manage them. Four such basins surround the PRB (the Uмба, the Zigi, the Msangazi and a collection of tiny catchments referred to as the 'Coastal River Catchment'). These fall within the administrative jurisdiction of the PBWO, and are not considered in the main body of this document. Summary information about these basins is, however, assigned to Appendix 1.

The PRB faces a number of serious management problems. In view of the extremely disparate natural resources of the Basin, along with its multitude of different interests and hopes, the need for an integrated approach to its management cannot be underestimated. In the past, the very 'sectoral' approach to the PRB's management meant that wildlife resources were managed in isolation of forestry concerns, in turn largely ignorant of water management priorities. The problem is also articulated in terms of priorities, with the water sector arguing that water is the strand that links all of the Basin's resources, but foresters complaining that most of the Basin's waters issue from forests in their jurisdiction.

A.2 Integrated River Basin Management (IRBM)

In many respects, river basins are extremely convenient Natural Resources Management (NRM) units. River basins comprise all the sources and processes that ultimately ensure that water is delivered to a river's terminus. Hence, a river basin will include a river's primary channel, secondary streams and its drainage basin. It will also include any delta associated with the river, and sub-surface water, wetlands and any impoundments.

The combination of processes that ensure that water is delivered from a river's source to its terminus is complicated and multidimensional. Additional resources, such as forests and wetlands, play integral roles in this process. The amount of water that ultimately emerges at a river's terminus will also depend on the number of abstractions that occur along its course, as well as evapotranspiration rates in wetlands and from aquatic and riparian vegetation. Finally, the quality of the water at a river's terminus will also reflect processes within the basin, such as farming techniques that increase or reduce erosion, industrial and urban development etc.

River Basin Management (RBM) recognises that a river's management cannot be implemented in isolation of the multifarious processes and conditions that impinge on the river's flow and the quality of its water. RBM considers the river basin as the management unit and involves consideration of the utilisation and conservation of (a) sub-ecosystems (sub-catchments, forests, wetlands, montane areas, drylands, etc.); and (b) human use systems within the watershed (agriculture, irrigation, fisheries, transport, mining, industry, etc.). RBM is usually based on the principle that water connects the ecosystems within the river basin (Howard, 2002).

Integrated River Basin Management (IRBM) attempts to balance the interests of all river basin users, while optimising the use of resources and promoting the sustainability of the water upon which the systems depend (Howard, 2002). It may be defined as follows:

"...a process that promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2002: 1).

IRBM deals with resources in the widest possible manner. It has to look at water resources in the context of the entire social, economic and ecological systems of a region or country. Operationally, this means that policies and programmes in other resource areas have to be carefully analysed to see how they influence the demands placed upon the water sector (GWP, 2002). IRBM regards environmental interests as equally important as peoples' needs for water resources. IRBM should work towards the objectives agreed upon by a majority of river basin stakeholders and include the principles of water resources management, ecosystem management, biodiversity conservation, sustainable natural resources management and ecosystem restoration (Howard, 2002).

An important part of integrated river basin management (IRBM) is land-use planning. Because so much of what happens to water concerns developments on land, it is important that land use is managed in such a way that water supply can be assured and that hydrological processes are not interrupted. Urban growth, for example, often has a serious impact on water resources through the massive increases in waste effluent that it represents. In the same way, forestry and agriculture can have repercussions for both the quantity and quality of water supplies.

Examples of land use management options include (a) zoning – here, specified areas are identified in which certain types of land use are prohibited. For example, drinking water zones, or areas where construction is banned because of flooding fears. (b) Soil protection and erosion control measures, such as ploughing parallel to contour lines, or the prescribed planting of trees. (c) Waste disposal regulations, such as where to locate waste disposal sites (Source: GWP, 2002).

Box 1: Water Demand Management

Water Demand Management (WDM) has developed from the recognition that (a) demand for water is increasing without any concomitant increase to water supplies; (b) as a result, the cost of increasing water supplies escalates as new sources become more difficult to abstract. Costs associated with the development of new abstraction technologies or methods may be prohibitive. WDM, then, seeks to save water abstracted from present water supplies, yielding both economic and environmental advantages. WDM may be defined as a strategy to improve the efficiency and sustainable use of water resources taking into account economic, social and environmental considerations (Wegelin-Schuringa, 1998). The main objective of WDM is to contribute to more efficient and equitable provision of water and sanitation services. IUCN believes that this may be attained via the application of selective, economic incentives, to promote efficient and equitable use of water as well as a number of water conservation measures aimed at raising awareness on the scarcity and finite nature of the resource. WDM embraces a wide range of measures leading to sustainable management. These include:

- the protection of water quality
- the reduction of wastage
- the improved allocation of water amongst competing users
- appropriate pricing mechanisms
- water conservation measures

A.3 The Water and Nature Initiative (WANI)

IUCN, the International Union for Conservation of Nature, helps the world find pragmatic solutions to our most pressing environment and development challenges. IUCN supports scientific research; manages field projects all over the world; and brings governments, non-government organizations, United Nations agencies, companies and local communities together to develop and implement policy, laws and best practice.

IUCN is the world's oldest and largest global environmental network. It is a democratic membership union with more than 1,000 government and Non Governmental Organisation (NGO) member organizations, and some 10,000 volunteer scientists in more than 160 countries. IUCN's work is supported by 1,100 professional staff in 62 offices and hundreds of partners in public, NGO and private sectors around the world. The headquarters are located in Gland, near Geneva, in Switzerland (IUCN, 2008).

IUCN launched the Water and Nature Initiative (WANI) in 2001. WANI is an action based programme that has worked with more than 80 partners in more than 30 countries to mainstream environmental and social issues into water resources planning and management. The initiative uses ecosystem management as a strategy for integrated management of land, water, biodiversity and communities. WANI helps to solve the dilemma between fulfilling development options and conserving aquatic resources by resolving water conflicts, reviving rivers and spurring local economic development.

WANI develops and demonstrates practical approaches to the implementation of IWRM. It supports and catalyses national water reforms and builds needed capacities in local communities. The first phase of WANI worked in 12 river basins and in over 30 countries worldwide from 2001 to 2008, with funding exceeding \$40m. Core funding was provided by the Dutch Ministry of Foreign Affairs (DGIS). WANI demonstration projects showed how to improve the well-being of both people and ecosystems using sustainable river basin management. WANI projects are partnerships of local communities, IUCN members, civil society and governments.

WANI helps to catalyse change, by integrating into practice development priorities, ecosystem services, good water governance, stakeholder participation, sustainable financing, learning and leadership.

The first edition of this situation analysis was conducted at the beginning of work in the Pangani and laid a foundation for subsequent projects. The first phase of WANI went on to work extensively in the Pangani River Basin and based on this work the PBWO secured significant co-funding from the European Commission through a grant from the EU-ACP (European Union - Water Facility, and the Global Environment Facility through UNDP to form the Pangani River Basin Management Project (PRBMP).

A.4 Situation Analysis: objectives and outputs

A Situation Analysis (SA) comprises an integral part of the IUCN's project cycle. It is 'an analysis of the status, conditions, trends and key issues affecting ecosystems, people and institutions in a given geographic context at any level (local, national, regional, international)' (IUCN, 1999: 1). The purpose of an SA is to provide an assessment sufficiently adequate for priority themes or areas for action to be developed.

Within this remit, this SA's objectives are as follows:

- To identify the resources that occupy the Pangani River Basin (PRB) and the processes and events that affect them. The SA will highlight those specific areas that require remedial interventions, based on evidence to suggest that the balance between obtaining adequate livelihoods for the Basin's inhabitants and the sustainability of the Basin's resources has been disrupted.
- To identify a series of broad action areas wherein interventions may feasibly be delivered. The SA recognises that many of these interventions may not be within the IUCN's expertise. It will therefore seek to identify other organisations, interests or institutions with which the IUCN may develop partnerships as it seeks to develop the WANI initiative in the PRB.

A.5. Data sources

This Situation Analysis (SA) is based on data derived from two main sources:

- Published information. Of particular importance are outputs from the research on Water Resources Management in the Pangani River Basin, a collaborative effort between the University of Dar es Salaam and the Norwegian University of Technology and Science. In addition, the SA also draws on the Report on a workshop called the 'The Pangani River Basin: Options for Integrated Management', and held at the Kilimanjaro Crane Hotel, Moshi, Tanzania, 8 – 10 May, 2002.
- Semi-structured interviews carried out by the author with PRB stakeholders. These included water administrators, forestry interests, farming communities, wildlife and conservation interests and private water users. Interviews were held in Arusha, Moshi, Hale, Tanga and Dar es Salaam between November 12 and 22, 2002. The interviews, respondents and their institutional affiliation are provided as part of this document's references.

This Situation Analysis has been reviewed by a large number of the Pangani River Basin's stakeholders. During a workshop held in Moshi, Tanzania, between the 10th and 12th March, 2003, the Situation Analysis was presented to stakeholders for review and comment. In May, 2003, additional comments were received from the Pangani Basin Water Office (PBWO) and the Coast Development Authority (CDA – Kenya). Suggested amendments have subsequently been noted and incorporated.

A.6 Situation Analysis Structure

This Situation Analysis commences with an overview of the Basin's resources and the difficulties facing them. It then considers the activities of the Basin's human resources, their economies, problems and resource access constraints. The SA then goes on to consider the problems and issues that various stakeholders perceive to exist in the Basin as a basis upon which to discuss the Natural Resource Management (NRM) structure of the Basin. In most chapters, the SA summarises relevant points that the reader should be aware of and which s/he should bear in mind as s/he proceeds to subsequent sections of the analysis. These summaries are brought together in the document's conclusion, where the discussion will return to its objectives, and consider how the problems that have been identified, the management initiatives that have been embarked upon and the options that have been considered in the text may all serve as a viable basis for WANI intervention and collaboration.

B The Pangani River Basin's natural resources

B.1 Introduction

The introduction to this Situation Analysis (SA) has already provided some insight into the diversity of resources contained within the Pangani River Basin (PRB). In this Chapter, we commence by taking a look at the PRB's forests, the role they play in the basin and the conservation threats that challenge them. Much the same format is then used to consider additional resources within the Basin, including water and wetlands, protected areas and biodiversity. The chapter concludes with a summary of important points. This chapter is concerned primarily with the Basin's water and biotic resources. Attention is not given to the PRB's mineral deposits for lack of data.

B.2 Basin forests

The distribution of forest, types and legal status in Tanzania is as follows:

Table 1: Tanzanian forest types, uses and legal status.

	1,000 ha	%
Forest type		
Forests (other than mangrove forests)	1,141	3.4
Mangrove forests	115	0.3
Woodlands	32,299	96.3
Total	33,555	100.0
Use of forest land		
Production forest area	23,810	71.0
Protection forest area (mostly catchment areas)	9,745	29.0
Total	33,555	100.0
Legal status		
Forest reserves	12,517	37.3
Forest/woodlands in national parks, etc.	2,000	6.0
Non-reserved forest land	19,038	56.7
Total	33,555	100

(Source: Lambrechts et al., 2002).

The forests of the Pangani River Basin (PRB) are represented by five broad types: (a) Afromontane forests (b) Mangrove forests (c) Coastal forests (d) Miombo woodland and (e) Riverine forest. The forests may be reserves, production forests or forests without any kind of designation. The Coastal and Afromontane forests, because of their unique biodiversity features, gain the most consideration here. International biodiversity interest in these forests also ensures that there tends to be more data on them than there are on other forest types. This is reflected in the text.

Box 2: Pangani River Basin forest basics

The Pangani River Basin's (PRB) forests are crucial to its hydrology because:

- they regulate run-off, prevent soil erosion, store water and improve water quality;
- they contribute to the maintenance and conservation of the gene pool;
- they yield timber and medicinal products to local communities.

There are five main types of forest within the basin:

- Mangrove forests: these play a crucial role in the protection of coastlines. They protect soft sediment shorelines from erosion, trap sediments and recycle nutrients. The trees themselves and the mud around their roots are important habitats to a variety of aquatic and avian life.
- East African coastal forests: these are unique to East Africa and contain remarkable biodiversity and endemism. They lie in the coastal plain between the mangrove forests and the Eastern Arc Mountains.
- Afromontane forests: those of the Eastern Arc Mountains share the same high levels of endemism and bio-diversity as coastal forests. On Mounts Kilimanjaro and Meru, the forests do not display similar diversity, but play vital hydrological functions.
- Riverine forests: these fortify riverbanks, and as the Pangani descends down through the semi-arid and arid lowlands, represent a unique oasis for both humans and wildlife.
- Miombo woodland: this comprises extensive stands of tall *Brachystegia*, *Isoberlinia* and *Julbernardia* trees. Unlike rainforest, Miombo woodland are not so densely packed together that they prevent light from reaching the forest floor. As a result, grass covers much of the forest floor, and, during the rainy season, this may grow to a metre in height.

A large part of the Pangani River Basin's (PRB) ability to deliver water has to do with its forests. On Mt. Kilimanjaro, for example, an estimated 96% of the water flowing from the mountain originates from the forest belt alone (Lambrechts et al., 1992), and Mount Kilimanjaro is estimated to provide 60% of the inflow to the Nyumba ya Mungu (NYM) Reservoir, and 55% of the PRB's surface water (Røhr and Killingtveit, 2002)

Catchment forests perform three important functions (Akitanda, 2002):

- Forests contribute to water conservation by regulating run-off, preventing soil erosion, storing water and improving water quality.
- Gene-pool conservation: forests, such as tropical moist forests, display very high levels of biodiversity, and contribute to the maintenance of the global gene pool.
- Forests yield products for local communities such as timber and medicinal plants.

Mangrove forests

Mangrove forests play a crucial role in the protection of coastlines. They protect soft sediment shorelines from erosion, trap sediments and recycle nutrients. The trees themselves and the mud around their roots are important habitats to a variety of aquatic and avian life. At high tide, hundreds of fish species move into the mangrove forests to feed or breed. Many fish and prawns rely on mangroves as nursery grounds for their young. Mangrove wood is very dense, and can therefore resist termites and fungi. They are used for a variety of purposes. The trunks of *Rhizophora*, *Ceriops* and *Bruguiera* are long and straight, and are therefore used almost exclusively as building poles, although they are also used as masts, in the construction of fish traps

and in furniture construction. In recent years, mangroves are also being used to make charcoal and collected as fuelwood. Mangrove forest close to urban areas is heavily exploited for these purposes. Mangroves can be coppiced to increase branch growth, and replanting is relatively straightforward. Neither activity is commonly practised along the Tanzanian coast, however (Richmond, 1997).

Virtually all of Tanzania's coastline is fringed by mangrove forest. In the PRB, they are restricted to the Tanga Region, where almost 11% of Tanzania's mangroves are to be found (Bwathondi and Mwamsojo, 1993). This includes the 753 ha of mangrove forest clustered around the mouth of the Pangani River (Kijazi, 2002).

East African Coastal Forests

East African coastal forests are found on the coastal plain between the Eastern Arc Mountains and the mangroves of the coast. The forests are extremely scattered, and forest patches are separated by stretches of semi-arid ecosystems. They range from between 500 and 1,000 m ASL. An important characteristic of coastal forest (which they share with the Eastern Arc Mountain forests) is their dependence on the Indian Ocean's climate and the historical stability this has provided. Restricted to the East African coastal plain, the forests' isolation from other African forest systems has resulted in high levels of species endemism (see below) (Burgess *et al.*, 1996). There are believed to be 76 coastal forests in Tanzania (Burgess *et al.*, 1996). They are very numerous in the swathe of coastal plain between the Pangani River's mouth and the foothills of the Usambara Mountains (see Baker and Baker, 2001).

Afromontane forests

The Eastern Arc Mountains range from Tanzania's border with Zambia through to the Taita- Hills in Kenya. They comprise ancient crystalline mountains located in eastern Tanzania and southeastern Kenya under the direct climatic influence of the Indian Ocean. Within the PRB, they comprise the North and South Pare Mountains, the East and West Usambara Mountains and the Taita Hills. The mountains are of great age, and the most recent period of tectonic uplift to affect them occurred 7 million years ago. In comparison, the oldest lavas on Mt. Kilimanjaro are just 1 million years old. (Burgess *et al.*, 1996).

The proximity of these mountains to the sea has also ensured that their climate has remained remarkably stable. During the last ice age, sea surface temperatures in the Indian Ocean did not change. Thus, while the ice age may have altered climate in other parts of Africa, it did not do so for the Eastern Arc Mountains. The mountains have, therefore, enjoyed very long periods of environmental stability, and have also been isolated from other forests and, indeed, from one another (Burgess *et al.*, 1996).

The result of this evolution is that the biotic characteristics of the mountains are remarkably diverse and characterised by high levels of endemism or near endemism (see below). It is probable that the somewhat lower level of species diversity and endemism on Mount Kilimanjaro is a result of its relative youth.

Box 3: The Taita Hills

The Taita Hills are the only Kenyan representatives of the Eastern Arc Mountains. The hills and their forests harbour over 2,000 species of flora and fauna, of which 13 taxa are known to be endemic. 67 known indigenous plants, including wild coffee (*Coffea fadenii*), grow on the hills. The Taita Hills are an Important Bird Area (IBA), and contain three endemic species: the Taita Apalis, the Taita Thrush and the Taita White-eye. The hills' forests are also rich in amphibian, insect and other life. Just 6 km² of forest remain in the Taita Hills, divided into 13 forest patches. Newmark (1998) estimates that this remnant forest represents just 2% of the forests' extent 2,000 years ago. The Taita Hills have lost more forest than any other Eastern Arc mountain.

Mt. Kilimanjaro's forest is classified into a series of vegetation types: the savannah zone, the densely populated agro-forest area, the forest belt, the sub-alpine and alpine vegetation zones. In terms of ecosystems and biodiversity, the forest belt is the most important on the mountain, and contains almost half of the mountains vegetation species (Lambrechts *et al.*, 2002).

Riverine forest

Riverine forest around the Kirua Swamp may be divided into seven groups as follows (IVO – NORPLAN, 1997):

- Riparian vegetation: this comprises vegetation extending to about 50 m to either side of the river channel. On the eastern side, dominant species comprise Cyperaceae (e.g. *Cyperus alticulatus*, *C. laevigatus*), Gramineae (e.g. *Phragmites mauritianus*, *Echinochloa colonum*) and Typhaceae (e.g. *Typha domingensis*). Where the riverbank is deep, *Ficus sur* and *Acacia zanzibarica* are common. The western bank is dominated by *Ficus sur*, *Trichilia emitica*, *Elaeis guineense*, *Albizia graberrima*, *Antidesma venosum* and *A. zanzibarica*. The riparian shrub layer is dominated by species such as *Sesbania sesbans* and *Phyllanthus muellerianus*.
- Cyperus and Sesbania marshland: in areas that are permanently waterlogged, species such as *Cyperus axaltatus* and *Typha domingensis* predominate. In those areas that are seasonally flooded, *Sesbania sesbands*, *Cyperus laevigatus* and *Acacia xanthophloea* are the only tree species associated with this type of vegetation. This is the most common vegetation category within the Kirua Swamps, although it is more common on the eastern bank of the river than on the western. On the eastern side, it may extend up to 3 km away from the river, while at its widest point it is just 700 m from the river on the western side of the river.
- *Sporobolus pyramidalis* and *Cynodon dactylon* grassland: Poaceae family members dominate here, with a few scattered trees and shrubs. In the Kirua Swamps, this vegetation type covers the largest area. It may occur in patches or continuous swaths.
- *Acacia xanthophloea* woodland: this vegetation type sees these Acacia species dominating, rising up to 18 m, and with a canopy cover of over 20% of the ground area. This vegetation type has high social and economic values to the wetland's human inhabitants.
- Desert with clumps of *Suaeda monoica*: a self-explanatory vegetation type, typically found fairly far from the river beyond the grassland vegetation sections.
- *Commiphora africana* bushland: an extended zone of bushland dominated by *C. africana* that is found at the foot of the Martin Escarpment. Typically, individual bushes are less than 6 m in height, and their canopy will cover more than 20% of ground area.
- Cultivated land: in 1997, cultivation within the Kirua Swamps was restricted to a fairly small area, and dominated by crops with high water demand such as bananas and sugar cane, but also maize.

Miombo woodland

Miombo woodland covers some 50 per cent of Tanzania and is East Africa's largest single vegetation type. East Africa's miombo woodlands are an impoverished form of the more extensive and species rich miombo woodlands of Central Africa (Rogers, 1996). They may be described as follows: 'A deciduous unarmed (having few tree species with spines or thorns) woodland occurring in the unimodal rainfall areas on geologically old, acid, sandy soils. It is characterized by trees in the sub-family *Caesalpinioideae*, especially species in the genera *Brachystegia* and *Julbenardia*. The shrub layer is variable in density, percent cover and species composition. It is often dominated by *Diplorhynchus* and *Combretum* spp. The ground cover varies from a dense coarse grass growth to a sparse cover of herbs and small grasses. The structure and species composition is largely maintained by periodic season fires' (Rogers, 1996: 301). Some 3 million km² of Africa are covered in miombo woodland. In the Pangani River Basin (PRB) it is confined mainly to coastal areas, both to the immediate north and south of the Pangani River's mouth.

Conservation threats and status

On Mt. Kilimanjaro, the forest is increasingly threatened by encroaching agriculture, itself arising from increasing population densities. Additional threats are timber extraction, the development of softwood plantations, fire, illegal and excessive timber harvesting, poaching and illegal honey harvesting (Yanda and Shishira, 2001). On all but its northern slopes, 'heavy' illegal logging occurs in forest areas below 2,500 m, concentrating on camphor, cedar and other indigenous trees (Lambrechts *et al.*, 2002). Additional threats comprise the establishment of 'forest villages' (of which there are 18 covering some 215 ha) within the forest reserve. 'Shamba' farms are also increasingly common within the reserve. In August 2001, there were 125 charcoal kilns observed on the mountains southeastern slopes (Lambrechts *et al.*, 2002). Grazing occurs up to 8 km into the forest, and in August 2001, 814 livestock animals were counted, concentrated on the mountains northern slopes (Lambrechts *et al.*, 2002).

Between 1952 and 1982, Kilimanjaro's natural forest area declined by 41 km². The areas where natural forest once stood have been replaced by cultivation or degraded vegetation. Worst affected are the edges of the forest reserve (Yanda and Shishira, 2001), particularly in the so-called 'half mile strip'. In 1941, the Tanzanian colonial government designated an area of Kilimanjaro's forest reserve as an agroforestry area. The strip stretches between the Kikuletwa and Sanya Rivers, and for half a mile uphill from the edge of the reserve. The 'half mile strip' was intended for the cultivation of fast growing trees for use by the Chagga communities below the reserve, where land scarcity precluded the planting of forests (Baldwin, 1946). Today, about 66% of areas allocated to forest plantation are under agriculture or have been cleared (Lambrechts *et al.*, 2002).

In the PRB, the Eastern Arc Mountains occupy some of the most densely populated areas of the Basin. On the West Usambara Mountains, for example, populations have grown 23-fold since 1900 (Newmark, 1998). In a social environment characterised by poverty, the importance of land to farm is disproportionately high. The pressure that this represents on the Basin's remaining forest reserves is formidable. If it is assumed that the Eastern Arc Mountains were, prehistorically, more or less continuously covered by forest, 77% of this has been lost to human disturbance and/or fire over the past 2,000 years (Newmark, 1998). An additional concern is that many of these processes have created forest patches, and animal species are often unwilling to cross over forest gaps. This means that in individual patches, the gene pool shrinks and species survival is threatened by in-breeding. In the Pangani River Basin, this loss is as presented in Table 2.

Table 2: Eastern Arc Mountain forest cover loss in the Pangani River Basin

Forest	Natural forest (km ²)	No. forest patches	Closed forest (km ²)	Loss of original forest cover (%)
North Pare	151	2	28	50
South Pare	333	5	120	73
West Usambara	328	17	245	84
East Usambara	413	8	221	57
Taita	6	13	4	98

Source: Newmark, 1998:4)

The designation of a forest as a 'forest reserve' appears not to have had much impact on levels of deforestation. In the Nilo Forest Reserve (5,872.1 ha) in the Usambara Mountains, there are 33.8 ha of 'cultivation under forest', 372.3 ha of 'peasant cultivation', 37.2 ha of barren land and 1.9 ha of human settlement (Cordeiro, 1998). The Tongwe-Muheza Coastal Forests used to cover 1,202 ha, but just 300 ha of forest cover remain, while Gombero Forest Reserve has been completely cleared for agriculture (Baker and Baker, 2002).

On Mt. Meru, the problems facing the forests are similar to those threatening Mt. Kilimanjaro, and are as follows (Bwoyo, pers. comm.):

- Illegal cutting – the mountain's forests are usually exploited for commercially attractive juniper and *Olea capensis* trees.
- Grazing – in the dry season, adjacent communities graze their livestock inside the forest.
- Land scarcity – on the eastern side of the mountain, encroachment is an increasingly serious problem.
- Lack of support – in some villages, the Catchment Forest Project (CFP – described below) gets little support from village leaders, some of whom are personally involved in harvesting the forest.
- Fire – this was a particularly serious problem between 1998 and 1999.
- Funding – the CFP obtains virtually no money for its operational activities from the government. Bwoyo (pers. comm.) argues that because of the vital role played by forests in the PRB, funds should be invested in the CFP by power generating interests or the Pangani Basin Water Office (PBWO) (see also Evans, 1997).

Box 4: Threats to the PRB's forests

- Demand for land: as population densities rise and rural economies remain poor, the demand for agricultural land increases and, hence, forests are felled to make way for these.
- Demand for timber: many of the remaining forests within the PRB contain economically valuable timber species, which, as they become scarcer, attract higher prices. Timber is also felled for firewood and for charcoal manufacture.
- Demand for pasture: livestock populations within the Basin appear to be on the increase. As agricultural land increases in area, grazing land decreases, and herders mount forest incursions to seek pasture.
- Forest settlement: as communities seek to extend their agricultural and grazing land, so too they settle within forest boundaries.
- Weak regulation: despite the reserve status of many of the Basins forests, the authorities cannot implement the restrictions that this implies because of low staffing levels, poor pay and corruption. In addition, the Forestry and Bee Keeping Division's Catchment Forest Project is funded almost entirely by donors, giving rise to questions about its sustainability. Finally, community involvement in the management of the basin's forests is nascent and, at present, largely ineffective.
- Forestry development: the development of plantation forest at the expense of indigenous forest gives rise to conservation concerns.
- Forest fragmentation: as pressure mounts on the Basin's forests they often become fragmented. Many forest species are unwilling to cross over forest gaps, giving rise to biodiversity conservation concerns.
- Fire: typically started by humans either deliberately (so as to destroy forest regarded as unfairly protected and closed to human exploitation) or, more typically, accidentally (from, for example, accidents during charcoal burning or 'smoking-out' bees from hives).

B.3 Water and wetlands

The Pangani River has two main tributaries: the Ruvu, which rises on the eastern slopes of Mt. Kilimanjaro; and the Kikuletwa, which rises on Mt. Meru and the southern slopes of Mt. Kilimanjaro. At the confluence of the Ruvu and Kikuletwa Rivers lies the Nyumba ya Mungu Dam, whose reservoir covers some 140 km² (Røhr and Killingtveit, 2002). The flow into the reservoir is thought to be 43.37 m³/s (TANESCO, 1994). As the river leaves the reservoir, it becomes the Pangani, and thereafter flows for 432 km before emptying into the Indian Ocean, where it discharges some 0.85 km² of water annually (Vanden Bossche and Beracsek, 1990).

Within the Pangani River Basin (PRB), Mt. Kilimanjaro is the single most important hydrological feature (Lambrechts et al., 2002). As mentioned earlier, rainfall on the mountain is estimated to provide 60% of the inflow to the Nyumba ya Mungu (NYM) Reservoir, and 55% of the PRB's surface water (Røhr and Killingtveit, 2002).

The PRB's water supply is mainly derived from rainfall, which is very unevenly distributed within the Basin. On average, the Basin receives 34,773.4 m³ annually, and its average yearly potential evapotranspiration is 1,410 mm. Based on rainfall differences within the Basin, the PRB may be divided into two hydrological regimes.

The highland area is considered to be that land lying ca. 900 m, such as the slopes of Mounts Meru and Kilimanjaro, as well as areas in the Usambara and Pare Mountains, which receive between 1,200 and 2,000 mm of rainfall annually. Rainfall is bi-modal in these areas, peaking between March and May, with a smaller peak between October and November. Rainfall in the former season may exceed 600 mm a month, and 300 mm in the latter. Above the Nymuba ya Mungu (NYM) Dam, rainfall has generally declined since record taking began in the early 1930s. Present rainfall patterns typically vary around 10% from the mean (Mkhandi and Ngana, 2001).

Land below 900 m receives the least rainfall in the Basin, declining to as little as 500 mm a year (Mkhandi and Ngana, 2001). Indeed, 50% of the PRB is considered arid or semi-arid (Røhr and Killingtveit, 2002).

An additional source of water in the Basin are springs. Some of the Basin's larger springs contribute as much as 20 m³/s to the NYM's inflow, a proportion that becomes vital during the dry season when rainfall contributions diminish (Røhr *et al.* n.d.). A major part of the Basin's spring yield is concentrated in three areas of Kilimanjaro Region: Kambi ya Choka, Rundugai and Chemka (Røhr *et al.*, 2002). The origin of the waters in the latter spring are unknown, and water output remains remarkably constant

Box 5: Pangani River Basin water and wetland basics

- The highland areas of the Pangani River Basin (PRB) receive markedly more rainfall than do the lowlands. Hence, agriculture is concentrated in the highlands, while the lowlands are better suited for pastoralism.
- Most of the Pangani River's water is derived from rainfall and glacial melt.
- Most of the water to flow into the Nyumba ya Mungu (NYM) reservoir is derived from Mt. Kilimanjaro. Virtually all of the rest is derived from Mt. Meru and the North Pare Mountains.
- The greatest use of water in the Basin is for irrigation. Electricity generation and fishing are important additional uses, as are urban and industrial demands.
- The PRB has large wetland resources, including Lakes Jipe and Chala and the NYM reservoir. All of these support fisheries. The Basin contains considerable swamp resources, although little is known about their biodiversity or their hydrological contributions

throughout the year - rainfall patterns on Mt. Kilimanjaro, which lies immediately to the north of the spring, appear to have no bearing on its output (Røhr *et al.*, 2002). In Kenya, the Lumi River drains the southern slopes of Mt. Kilimanjaro, and is the main source of water to Lake Jipe. Almost all of the river's discharge into the lake is derived from springs (Musyoki, 2003).

About 5% of all the water used in the PRB is derived from groundwater sources. Boreholes yielding more than 100 cubic metres per hour have been drilled in the Kahe Plains while boreholes yielding between 10 to 50 m³/h have been sunk in the Sanya plains and Karoo Rocks of Tanga. Groundwater recharge is mainly from rainfall and rivers (Makule, n.d.).

As the Pangani leaves the Nyumba ya Mungu Reservoir, the following demands are placed upon it (Mujwahuzi, 2001):

Firm flow for power production	24 m ³ /s
Irrigation.....	7m ³ /s
Domestic uses	1–2 m ³ /s
Total.....	32–33 m ³ /s

Sarmett (pers. comm.) states, however, that the NYM is rarely able to release more than 22 m³/s.

The NYM Reservoir is the largest water body in the Basin. There are three others: Lake Ambussel, and, lying on Tanzania's border with Kenya, Lakes Chala and Jipe. These lakes feature prominently in the irrigation and hydrological planning of Kenya's Taita-Taveta District, in which they lie. Lake Jipe's water level and surface area vary substantially with rainfall. Thus, its surface area varies from 18 km² (1954) to 28 km² (1947), while the amount of water contained within it varies from 20 to 60 MCM (Musyoki and Mwandotto, 1999). Within the Kenyan portion of Lake Jipe's catchment lies part of Tsavo West National Park, 48.5 km² of swamp, 435 km² of sisal estates and 196.5 km² of what is described as 'public land' set aside for the Lake Jipe Settlement Scheme (Musyoki and Mwandotto, 1999). An estimated 300,000 tonnes of silt are washed into the lake annually (Musyoki, 2003).

Lake Chala lies in a small volcanic crater on Mt. Kilimanjaro's southern slopes. It is between 85 and 90 m. deep, and covers a surface area of about 3.15 km². It contains between 300 - 350 MCM of water (Musyoki and Mwandotto, 1999). Its water quality is very good, and for this reason is being considered a source for Kenya's growing coastal urban areas. Projected future abstraction rates are for 7 MCM annually (Musyoki, 2003). Its elevated situation means that water may be conveyed by gravity to its destination.

Box 6: Threats to the PRB's water and wetland resources

- By 2015, water demand within the Basin is expected to double, while, at the same time, evidence of water stress has been present since the 1940s.
- Principal areas for concern are increasing irrigation and urban demands. In the case of irrigation, water losses can be as high as 85%.
- As the number of water users increase, along with the competition between them, the likelihood of conflict between water users will also augment.
- The fisheries of the Nyumba ya Mungu (NYM) Reservoir are said to be under considerable stress due to over-fishing.
- Large portions of the largest wetland in the Basin – the Kirua Swamp – have dried up as a result of the regulation of water flows issuing from the NYM dam.
- Large nutrient inflows into Lake Jipe have encouraged excessive papyrus and *Typha* growth that threatens to overwhelm to lake.

The PRB is thought to have about 90,000 ha of swamp, most of which comprises the Kirua Swamps, lying to the south of the Nyumba ya Mungu (NYM) Dam. These have already been severely affected by the Dam's control of the river's flow, and large areas of the swamp have dried up. Nevertheless, they are still thought to retain large amounts of the Pangani River's water. If the river were 'trained' and a canal built through the swamp, an additional 42.4 million m³ would reach downstream dams annually (IVO – NORPLAN, 1997). The vegetation of these swamplands is described above as examples of riverine forest.

Other swamplands are the Ruvu Swamp (approx. 35 km²) that lies at the point where the Ruvu River exits from Lake Jipe, and a swamp lying in the confluence of the Ruvu and Kikuletwa Rivers where they join the NYM. The latter swamp area is said to cover some 40 km² (Baker and Baker, 2001).

Conservation threats and status

In the Tanzanian portion of the Basin, estimated and anticipated water demand in 1995 and 2015 are presented in Table 3. In the Taita-Taveta District, lying in the Kenyan part of the Basin, water demand was calculated to be 5,625 m³ per day. By 2005, this is projected to increase to 8,844 m³ per day, and to 12,521 m³ a day by 2015 (Taita – Taveta District Water Plan 1995, cited in Musyoki, 2003). With water demand set to double by 2015, the pressure on the PRB's water resources may be considered to be very high. The Basin is already considered to be facing water stress, and in the absence of any emphatic regulation to date, it seems unlikely that this threat will dissipate.

Table 3: Estimated water demand in 1995 and anticipated water demand in 2015

Use	Water demand (m ³ /day)	
	1995	2015
Urban	71,200	163,600
Rural	52,000	83,500
Livestock	30,500	36,400
Sisal	1,300	1,300
Total	155,000	284,700

(Source: IVO- NORPLAN, 1997)

Evidence of water stress is ample. Mujwahuzi (2001) reveals that at station 1DC1 on the Ruvu River, mean monthly flows have declined from 14.2 m³/s between 1958 – 65 to 11.45 m³/s between 1987 – 97. Many of the streams in the highland areas of the Basin no longer flow during the dry season (September to February) because of the intensity of irrigation abstractions. After abstractions for irrigation, the Rau River runs completely dry (Mujwahuzi, 2001). Water demand from the Kikafu and Weru Rivers ranges from 90 – 125%, substantially exceeding the rivers' 80% assured discharge (Mwamfupe, 2002). As water is released from the NYM Reservoir, a series of abstractions occur before it reaches Pangani Falls. Often – and especially during the dry season – the water arriving is inadequate to run the turbines of the hydropower station based there (Lugeiyamu, pers. comm.). Perhaps the most compelling evidence of water stress are the escalating numbers of water-related conflicts in the Basin. These are considered fully below.

Between 1912 and 1989, the area of Kilimanjaro's ice cap reduced by 75%, from 12.5 km² to 2.6 km². Between 1989 and 2000, nearly a quarter of the remaining ice was lost. The cause of this sudden and rapid change has been blamed on human influences, although this is by no means clear (Hastenrath and Greischar, 1997). If this decline is maintained, the Pangani River Basin's (PRB's) will soon receive no more water from glacial melt.

Lake Jipe's *Typha* growth is said to be sufficiently out of control that the water weed almost completely covers the lake. This trend has apparently arisen as a result of nutrients and silt washed down off Mt. Kilimanjaro and the North Pare Mountains. Silt has decreased the lake's depth, and occasioned a small water level rise. Nutrient inflows to the lake are thought to have prompted rises in alkalinity and/or sodicity, causing its lilies to disappear. Silting also affects the NYM reservoir, but this is apparently not yet a problem given the reservoir's very large 'dead storage' area.

As discussed earlier, the regulation of the Pangani River has reduced flooding in the Kirua Swamps, and hence large areas of the swamp have dried out. At a water release rate of 25 m³/s from NYM, the swamp floods, but farmers encroaching upon it then voice serious complaint (Ngula, pers. comm.).

The NYM reservoir supports a substantial fishery that is heavily exploited, as will be discussed further below.

B.4 Protected areas

In Tanzania, the Pangani River Basin (PRB) contains one wildlife reserve (Mkomazi - 3,276 km²), while parts of the Kilimanjaro (756 km²) and Arusha (137 km²) National Parks also lie within the Basin. Part of Kenya's Tsavo West National Park (9,065 km²) also falls within the Basin, and is contiguous with the Mkomazi Game Reserve. The Sadani National Park partially falls within the Basin, but will not be dealt with here. Arguably, forest reserves are also protected areas, but these are not dealt with here (see above). All of these make valuable contributions to Tanzania's economy by attracting tourists. Kilimanjaro in particular draws some 67,000 visitors annually (WCMC, 1987).

Mt. Kilimanjaro is the world's highest freestanding mountain and Africa's tallest. It rises 5,000 metres above an open undulating plain that averages 800 m ASL (Lambrechts *et al.*, 2002). The park is the oldest protected area in Africa, having gained this status in the early part of the 20th Century. In 1921, the park was gazetted as a forest reserve, and then, in 1973, the area above the 2,700 metre contour was reclassified as a national park. At present, the park covers 75,353 ha and is surrounded by a 107,828 ha forest reserve (Lambrechts *et al.*, 2002). In 1987, the Kilimanjaro National Park was inscribed on the World Heritage Site list, the seventh Tanzanian World Heritage Site (Lambrechts *et al.*, 2002).

The Mkomazi Wildlife Reserve is an extension of Kenya's Tsavo West National Park. Like Tsavo and Arusha National Parks, Mkomazi lies within the Somali – Maasai Regional Centre of Endemism (RCE). It stretches from the Tanzania – Kenya border to the foothills of the Pare and the West Usambaras. The reserve is characterised by savannah woodland, and, until 1988, pastoralists of various ethnic origins were allowed to exploit its pasture. Homewood and Brockington (1999) argue that although the reserve has some biodiversity interest to Tanzania, it is far over-shadowed by other regional centres of considerable biodiversity interest, not least the Pare and Usambara Mountains. Keith Eltringham *et al.*, (1999) identified 102 mammal species as present within Mkomazi, including the recently re-introduced Black rhino.

The Arusha National Park lies in the foothills of Mt. Meru (4,565 m.), and was established in 1967. The park contains a very wide array of environments, including fine examples of montane forest on Mt. Meru, the Momel Crater Lakes and lowland savannah and miombo woodland. The park's bird list comprises some 400 species, and it is one of the few Tanzanian parks where black and white colobus monkeys are commonly seen. Contiguous to the park is the 300 km² Mt Meru Game Reserve. Arusha National Park is said to contain the highest giraffe densities in the world.

The Nairobi - Mombasa Highway, separates Tsavo West National Park from Tsavo East. Together, these parks, created in 1948, form Kenya's largest national park, and one of the world's largest protected areas. In 1983, Tsavo West's northwestern boundary was extended to include the Chyulu Hills, the main source of water to the park's famous Mzima Springs. 225 million litres of water emerge from these springs daily, which supply Mombasa, Kenya's second largest city. In excess of 150,000 people visit Tsavo West annually. The park's rugged scenery has been shaped by ancient volcanic activities, leaving in its

wake lava flows, cinder fields and small volcanic cones. The park contains Kenya's largest population of elephants. The park area of Ngulia has become one of Kenya's most important rhino sanctuaries. The cliffs at Ngulia are an important stop-off point for migratory birds from the Northern Hemisphere, many of which are very rare.

Conservation threats and status

In the late 1980s, the Tanzanian Wildlife Division judged the Mkomazi to be in a florally and faunally degraded state. Amongst the problems facing the park was the extinction of its rhinos. In the mid-1960s, there were at least 150 rhinoceros in the reserve, but the species was extirpated, mainly through poaching. In 1997, rhinos were re-introduced to the reserve (Keith Eltringham *et al.*, 1999), along with wild dogs. The reserve's close proximity to the Kenyan border poses a poaching threat.

Kilimanjaro does not appear to face any similar poaching threat. Here, threats appear to be restricted mainly to the park and the forest reserve's edges, where logging, farming, fuelwood collection and charcoal burning are concentrated. An additional problem in this national park is its high number of visitors, who leave behind them large amounts of waste that cannot decompose in the mountain's freezing and rarefied air.

The areas surrounding Arusha National Park are heavily populated, and the park is said to be threatened by encroachment and widespread poaching (WCMC, 1985).

Tsavo West National Park faces significant poaching difficulties. The slaughter of the park's elephants in the past has often been dramatically portrayed in the media. In addition, the park lies in a climatic zone prone to drought and variable climate, leaving it vulnerable to bush fires. Fires are also a problem on Mt. Kilimanjaro, as discussed above.

Other wildlife resources also occur throughout the Basin, including much of the wildlife to be found in the Eastern Arc and Coastal forests. The threats to the latter are very serious (see below). In the Maasai steppe of the lowlands of the Basin, ungulates are common, while the river and other wetlands also harbour wildlife.

B.5 Biodiversity and conservation

The biodiversity resources of Kenya and Tanzania are substantial. In terms of number of species per unit of area, Kenya has the third highest mammalian diversity in Africa, the second highest bird diversity and the third highest reptile diversity.

Tanzania has the second highest reptile, amphibian and plant biodiversity on the African continent (Rodgers *et al.*, 2001). The Eastern Arc and Coastal Forests are one of just 25 global biodiversity 'hotspots'. The biodiversity and associated species endemism in the mountains is virtually unparalleled in the world. As much as 30% of the 2,000 or so plant species and more than 80% of their spider and millipede groups are endemic to the mountains. Famed African *Saintpaulia* violets are only found naturally in the Eastern Arc and Coastal forests. At least four mammal species, five bird species, four amphibian species, twenty

Box 7: Pangani River Basin Protected Area threats

- Most of the parks within the Pangani River Basin are threatened by poaching.
- The threats confronting Kilimanjaro National Park relate more to encroachment on its forest reserves and the exploitation of their timber.
- Large tourist numbers on Mt. Kilimanjaro cause serious waste disposal problems, in large measure because waste freezes and does not decompose.

seven reptiles, forty butterflies, twenty millipedes, four hundred plants and an unknown number of flies, beetles and other invertebrates are endemic to East African coastal forests (Burgess *et al.*, 1996). This level of endemism has arisen because of the forests' isolation from other African forests, their old age and the fact that the Indian Ocean's climate has remained more or less stable over very long periods of time.

As a result, the threats that many of these species face relate to the preservation of their environment. Because so much of the Eastern Arc and Coastal Forest is threatened, many of their animal species are considered endangered (see box 9).

On Mt. Kilimanjaro, 2,500 species of plants have been recorded, including 130 tree species from 100 genera and 50 families. 170 shrub species have been identified from the mountain's forests, and these belong to over 100 genera and 40 families (Lambrechts *et al.* 2002). Some 140 mammal species are recorded from the mountain, including the world's largest known population of Abbot's duiker, a globally threatened species (Lambrechts *et al.*, 2002). The park contains an endemic shrew, four endemic species and subspecies of butterfly, six endemic plants, twelve endemic mosses and liverworts (Baker and Baker, 2001).

A rare and endangered bull shark (*Carcharrhinus leucas*) occasionally swims up the Pangani River from its delta, and has been seen as far up its course as Jambe (TANESCO, 1994). Besides the shark, however, none of the river's 41 species of fish are thought to be endangered. It does contain several endemics, comprising two cyprinids (*Barbus paegnstecheri* and *Labeo coubie*), one characin (*Rhabdalestes leleupi*) and three cichlids (*Ctenochromis pectoralis*, *Oreochromis korogwe* and *O. pangani*) (TANESCO, 1994).

The tilapia genus, *Oreochromis*, derives its name from the Latin for 'mountain chromis', which Gunther gave it in 1889 after discovering *Oreochromis hunterti* in Lake Chala, on the slopes of Mt. Kilimanjaro (Dadzie *et al.*, 1988). In Lake Jipe, an additional two endemic tilapia are to be found: *Tilapia jipe* and *T. girigan*. *Oreochromis esculentus*, a Lake Victoria endemic⁴, has been introduced to the basin and comprises a substantial part of the catch in Nyumba ya Mungu Reservoir. An additional exotic, *T. rendalii*, has been collected from Lake Chala.

Box 8: Biodiversity hotspots

Biodiversity hotspots are designated by the American conservation organisation, Conservation International. They are regions of the globe that harbour a great diversity of species but which, at the same time, have been significantly impacted and altered by human activities. Plant diversity is the basis for hotspot designation, because plants are the foundation for diversity in other taxonomic groups. In order to qualify, a site must contain at least 1,500 endemic plant species, fully 0.5% of the global total of known plants. In addition, 70% or more of the site's original habitat must have been destroyed or altered.

Between them, the world's 25 biodiversity hotspots cover just 1.4% of the globe's area, but contain 44% of the world's known plants, and 35% of all known terrestrial vertebrates.

Such hotspots are often 'islands' of biodiversity surrounded by areas of relatively poor biodiversity. As is the case with the Eastern Arc Mountains, these areas have typically obtained their biodiversity as a result of environmental conditions that have not changed over great lengths of time.

Besides the Eastern Arc and Coastal Forests Biodiversity Hotspots, there are four other hotspots in Africa: the Madagascar and the Indian Ocean Islands, the Guinean Forests of West Africa, the Cape Floristic Region and the Succulent Karoo along Africa's south-western coast.

Source: www.biodiversityhotspots.org.

⁴ n a curious twist of fate, this species is now extinct from Lake Victoria.

Box 9: Category 1 Globally threatened bird species of the Usambara Mountains

Critically endangered

- Long-billed Tailorbird (*Orthotomus moreau*): not described until 1931 and still a little known species.

Vulnerable

- Sokoke Scops Owl (*Otus irenae*): only discovered in 1965 in Kenya's coastal Arabuko-Sokoke forest, where it was considered an endemic species until another population was discovered in the Usambaras in 1995.
- Usambara Eagle Owl (*Bubo vosseleri*): discovered amongst the Usambara's lowland forests in 1992, after having been thought of as a low density high-altitude bird previously.
- Swynnerton's Robin (*Swynnertonia swynnertoni*): only discovered in the Usambaras in 1990.
- East Coast Akalat (*Shepperdia gunningi*): discovered in the Usambaras in 1992.
- Dappled Mountain Robin (*Modulatrix orostruthus*): rarity in the East Usambaras probably as a result of forest fragmentation.
- Amani Sunbird (*Hedydipna pallidigaster*): first described by Sclater and famed ornithologist, Moreau, in 1935, this tiny sunbird is known from just three localities in East Africa. In the Usambaras, just 320 km² of suitable habitat remain (Cheke *et al.*, 2001).
- Banded Sunbird (*Anthreptes rubritorques*): known from only four localities in Tanzania. Its largest habitat area is the Udzungwa Mountains.
- Usambara Weaver (*Ploceus nicolli*): weaver endemic to the Usambaras where, Zimmerman *et al.* (1996) estimate, less than 100 remain.

Near-threatened

- Southern-banded Snake Eagle (*Circaetus fasciolatus*): previously thought a fairly common resident of coastal forests stretching from northeastern Kenya to northeastern South Africa. Now considered threatened by human population density and excessive exploitation of forests, its main habitat. An estimated one pair per 100 km² remain within its range (Ferguson-Lees and Christie, 2001).
- Fischer's Turaco (*Tauraco fischeri*): locally common throughout the forest. Threatened by the international trade in wild birds.
- Plain-backed Sunbird (*Anthreptes reichenowi*): the race *reichenowi* an Eastern Arc endemic. Threatened by deforestation.

Conservation threats and status

The primary threats facing the biodiversity of the Pangani River Basin (PRB) relate to habitat destruction. The very high levels of endemism typically equate with the high levels of unique and diverse habitat types in the Basin, particularly its Afromontane and coastal forests. For example, virtually all of the Basin's endemic bird species are also considered restricted range species, making them extremely vulnerable to habitat destruction and fragmentation.

Fears for the destruction of these valuable forest habitats have ensured that Tanzania's coastal forests and Eastern Arc Mountains have received international attention. Virtually all of them hold Important Bird Area (IBA) status (Baker and Baker, 2001), serving to focus international conservation attention on these delicate and very vulnerable ecosystems. Nevertheless, very few of the PRB's Eastern Arc or Coastal forests are anything but forest reserves.

B. 6 Fisheries

Fisheries are often a vital source of animal protein to rural African communities. In 1970, the NYM fishery supported 3,161 fishers, who landed 28,509 tonnes of fish between them. By 1983, there were 1,342 fishers, who managed to land just 2,430 tonnes of fish (Vanden Bossche and Bernacsek, 1999).

Typha and papyrus cover almost half of Lake Jipe's surface, and has almost halted fishing activities on the Tanzanian side of the lake (Sarmett and Kamugisha, 2002). On the Kenyan side of Lake Jipe, some 200 villagers in three villages are said to rely on the lake's fisheries. Besides problems associated with water weed, the siltation of the lake is also a threat to the fishery (Musyoki, 2003).

Villagers around the Kirua Swamp downstream of the NYM dam complain of fish declines due to the regulation of water flow from the dam (Sarmett and Kamugisha, 2002).

B.7 Soils

Most of the Pangani River Basin comprises a crystalline and limestone geological series, along with patches of lacustrine deposits. Closer to the coast, the geology is one of fluvial and estuarine deposits. Areas close to Mt. Meru and Mt. Kilimanjaro are typically highly fertile alkaline volcanics (Geological Survey, 1960). This combination of soils of lacustrine and volcanic origin, as well as areas of high average annual rainfall mean that parts of the Pangani River Basin have come to be seen as the 'breadbasket' of Tanzania.

The principal concerns regarding the soils of the Pangani River Basin (PRB) are reduction to soil fertility, and soil loss to erosion. Stoorvogel and Smaling (1990) estimated that arable Tanzania soils lost 27 kg of N, 9 kg of P₂O₅ and 21 kg of K₂O per hectare per annum in 1983. They predicted that, by 2000, these rates of loss would increase to 32 kg of N, 12 kg of P₂O₅ and 25 kg of K₂O per hectare per annum if the nutrient losses observed in 1983 were not reversed. For nitrogen and phosphorous, these rates of loss are equivalent to 251,448 tonnes and 115,112 tonnes per annum respectively. Losses, Stoorvogel and Smaling claimed, were due to three factors: first, the normal harvest of the crop, through which most nutrients are lost. Second, through the removal of crop residues. For example, when beans are harvested in Arumeru District in the Arusha region, the whole plant is removed from the ground. Third, through erosion, particularly as a result of cultivation of steep slopes (Kaihura *et al.*, 2001). It should be noted that not all agriculture within the Pangani River Basin is deleterious (Kaihura *et al.*, 2001).

B.8 Summary of points

The resources of the Pangani River Basin (PRB) are all heavily exploited. In this section, we first briefly summarise the important contributions that these resources make to the PRB and, in the second part, summarise the threats to them.

PRB resources

- Forests play a crucial role in the PRB's hydrology, serving to regulate water run off, minimise erosion, store and purify water. In the PRB, they also make a vital contribution to global biodiversity. In the PRB's forests some of the world's highest levels of species endemism and biodiversity are to be found.
- Water in the PRB is integral to the Basin's agricultural economy, its power generation, its urban, industrial and domestic demands and to livestock. Swamps are also common in the Basin and play a vital role in water retention and regulation.
- The Basin contains four Protected Areas (PAs). Kilimanjaro, in particular, plays an important role in the nation's tourism economy, and also harbours a wide array of plant and animal species.

- The Basin's biodiversity is almost unparalleled globally, and the centre of a great deal of international interest and conservation concerns.
- The PRB's fisheries make important nutritional and economic contributions to the Basin's rural communities.
- Soils are at the heart of the Basin's agricultural economy. The area's history of volcanic activity and patches of fertile lacustrine deposits, contribute to the Pangani River Basin's reputation of being the breadbasket of Tanzania.

Threats to the PRB's resources

- The Basin's forests are threatened by logging, encroachment along their peripheries, demands for land, charcoal manufacture and fuelwood collection.
- The Basin's water supplies are threatened by extremely high demands that have ensured that its water resources are considered 'stressed'. The main sources of demand are inefficient furrow-based irrigation systems. The Basin's swamps are threatened by the regulation of water by damming.
- The Basin's PAs are threatened, on the one hand, by poaching, and, on the other hand, by threats similar to those faced by forest resources.
- Most of the Basin's biodiversity has been gained as a result of its unique array of forest habitat types. Threats to biodiversity, as a result, arise because of threats to habitat.
- The fisheries of the PRB are threatened by excessive fishing pressure, and weed growth occasioned by high nutrient loads.
- Low levels of nutrient return and inputs, as well as high rates of erosion, threaten the Basin's soils.

C The socio-economy of the Pangani River Basin

C.1 Overview

There are an estimated 3.7 million people in the PRB, 80% of whom rely, either directly or indirectly, on agriculture for their livelihoods. 90% of the Basin's population live in its upper parts. This settlement concentration yields population densities of up to 300 people per km². In the highland areas of Kilimanjaro there are some 900 people per km² with average farm holdings of just 0.2 ha per household. In lowland areas at the same time, there were only 65 people per km², and each household farmed an average area of 10.4 ha. (Lein, 2002).

The Basin's urban and industrial economies are not sufficiently large to absorb this labour force. As a result, its burgeoning population seeks livelihoods in agriculture, a large part of which is irrigated. As the number of claims on water increase, so too do the number of conflicts. Demands for access to water are symptomatic of wider demands for access to a whole variety of resources, including land, forest products, pasture, mineral deposits and, ultimately, livelihoods. A livelihood may be described as follows:

“...a means of securing a living...Encompassed in a livelihood is the totality of resources, activities and products which go to securing a living. It relies on ownership of, or access to products or income-generating activities. A livelihood is measurable in terms of both stocks – that is the reserves and assets – and the flows of food and cash” (Conway and Barbier, 1990: 117).

The notion of access to resources is the most important factor in determining whether or not the pursuit of a livelihood is successful (cf. Ellis, 2000). It follows, then, that where a resource on which a community relies becomes scarce, then access to it is curtailed. As resources become ever more scarce, then the measures that people will adopt to try and procure resources may become increasingly more desperate, and more difficult for the resource concerned to sustain. This trend may then reach a point where the pursuit of livelihoods actually starts to undermine the ability of a resource to regenerate itself.

A factor that serves to amplify the problems associated with livelihood claims is if the resources involved are Common Property Resources (CPRs). These are resources that share two fundamental characteristics: (a) they are 'subtractable'. The subtraction of a unit of water upstream yields a unit less of water downstream. Equally, a fisherman landing 100 kg of fish ensures that there is 100 kg less fish for others to catch. (b) It is difficult or impossible to 'fence off' CPRs. 'Fencing off' metaphorically refers to the serious problems of policing CPRs. Due to their nature, CPRs (such as oceans, the atmosphere or river courses) cannot be fenced off. They are also remarkably difficult to monitor and police. CPRs, therefore, are best managed in common, with inputs by all users. If such a communal style of management is absent, CPRs are very vulnerable to becoming 'open-access', in which patterns of exploitation are characterised as 'free-for-all', with resources users taking more than is necessary today for fear that they may gain nothing tomorrow. Such patterns of exploitation are characterised with very high levels of competition between users, and any intrinsic worth associated with resource conservation is typically disregarded. When resources are exploited in such a fashion, the 'tragedy of the commons' is often said to have occurred, and the demise of the resource is fairly certain.

To varying degrees, and depending on resource type, many of the PRB's resources display open-access traits and serious livelihood difficulties. The relationships that characterise the exploitation of the Basin's resources are often characterised as conflicting. To simplify and clarify these difficulties, this chapter considers the interests of the Basin's various economic interests, starting with its industrial interests that include electricity generation, and then going on to consider the largest part of the Basin's economy, its agriculture. Other interests are also considered in turn, and the Chapter culminates with an assessment of the conflicts that characterise exploitation in this Basin.

*Table 4: Tanzanian and Kenyan socio-economic basics
2001 unless otherwise indicated*

	Kenya	Tanzania
Population	29m	32m
Population annual growth rate in 2000	2.6	2.8
Infant mortality rate/1000 live births	75.0	91.0
Under-5 mortality rate/1000 live births	117.0	142.0
Probability of dying, male < 5 yrs (per 1000)	100.0	157.0
Probability of dying, female < 5 yrs (per 1000)	99.0	48.0
Life expectancy at birth (males)	47.3	44.4
Life expectancy at birth (females)	48.1	45.6
% access to safe drinking water	44.0	66.0
% access to adequate sanitation	85.0	86.0
% infants with low birth weight ¹	16.0	14.0
% stunted children (moderate and severe) ²	33.0	42.0
% wasted children (moderate and severe) ³	6.0	6.0
Average per capita daily calorie intake (1999) ⁴	1,886.0	1,940.0
GNP (US\$) per capita	340.0	210.0

Notes

- ¹ Low birth weight is often an indication of maternal stress while the foetus is carried, such as illhealth (including malnutrition).
- ² Stunting is a chronic form of malnutrition derived from not obtaining sufficient, quality, nutrients over the long term.
- ³ Wasting is a dangerous, acute, form of malnutrition derived from not obtaining sufficient, quality, nutrients in the short term.
- ⁴ The FAO sets the minimum daily energy requirement for humans at 2,600 kilocalories (kcal) a day.

Sources: UNICEF, 2001; FAO, 2001; WHO, 2001

C.2 Industrial interests

Probably the largest industrial interest in the Pangani River Basin (PRB) is power generation. The main supplier in this regard is the state-owned Tanzania Electric Supply Co. [*sic.*] (TANESCO), which owns four hydropower facilities on the Pangani River. These are Nyumba ya Mungu (NYM) (with an 8 MW capacity), Hale (21 MW), and New Pangani Falls (68 MW). All the power plants are connected to the national grid and they contribute about 17% to the total hydropower production of the country (Ngula, 2002). The firm discharge through the power plants is about 24 m³/s, whereas the maximum designed discharge is 45 m³/s. Old Pangani (17.5 MW) operates only occasionally, crippled by lack of adequate water (Lugeiyamu, pers. comm.).

In the dry season, water shortages may cause power generation within the basin to drop to as low as 32 MW (Sarmett and Kamugisha, 2002).

There are extensive mining interests in the Pangani River Basin. These include tin mining in Korogwe, tanzanite and phosphate mines in the Arusha Region, and limestone mines in the Tanga Region (Mkuula, 1993). Gemstones are also an important quest, and 80% of the world's known tanzanite reserves are to be found at Merelani, 100 km northeast of Arusha. Sand mining for building purposes is common along riverbanks, and in Kenyan parts of the Basin, ruby mining is carried out.

Other industry within the basin is that associated with farming, such as sugar refineries and sisal processing plants. In Kenya's Taita – Taveta District, sisal production is the main agricultural activity.

C. 3 Farming interests

The Chagga peoples have lived on Mt. Kilimanjaro's slopes for between 300 – 450 years. Their farmland is divided into two types of tenure. The first is '*shamba*', and is typically restricted to the lower slopes of the mountain where rainfall is much less reliable, and irrigation commensurately more important. The use of *shamba* land was overseen by Chagga chiefs, who would allocate parcels of land to farmers on a seasonal basis. While a farmer might exploit the land for a long period of time, it was never his to own (Johnston, 1946). The second type of Chagga land tenure is the '*kihamba*', which was set aside for the private use of Chagga denizens. *Kihamba* was – and still is – farmed with remarkable intensity. Even in the 1940s, at the time of Johnston's (1942) writing, there was very little *kihamba* land left that could be used as pasture, and most livestock was stall-fed. In those areas where farming intensities became too high, and no additional *kihamba* land was available, Chagga chiefs were obliged to convert *shamba* land to *kihamba*. In effect, this gesture served to siphon off excess farming from the upper slopes to the lower slopes of the mountain. The Chagga could not expand up the mountain because this was already set aside as forest reserve, and they could not expand into the middle slope areas because this was 'alienated' land for European settlers (Lein, 2002).

Against this background of high farming intensity, the Chagga devised furrow systems to deliver water from natural watercourses to their crops. This system is said to be one of the oldest (thought to have started in the 18th Century (Gillingham, 1999)) and most extensive furrowbased irrigation systems in Africa (Røhr *et al.* n.d.). To obtain such furrow water, a Chagga had to be a member of a furrow board, which was governed by furrow elders whose instructions farmers had to follow on pain of fines or prohibition from using furrow water (Johnston, 1946). Furrow board members were also expected to play a part in the maintenance of the furrows. Furrow members who abstracted water from furrows owned by individuals or claims had to pay fees to do so.

Despite the apparent farming intensity and population pressure on *kihamba* land, traditional institutions of governance and conflict prevention appear to have been effective. Johnston (1942) commented that "...it is remarkable that, with a big and complicated furrow system in the *kihamba* land, so well are matters run by the furrow elders, that the number of cases arising out of disputes over water rights are relatively few" (p. 4).

Further to the south, farming intensities in the Usambaras were also proving problematic to colonial observers. "The necessity for the natives to cultivate perpetually on hillsides makes soil erosion an acute problem, and large tracts of land...are badly eroded" (Dobson, 1940: 3). The Sambaa faced similar problems to the Chagga. The middle-slope areas of the mountains possessed a climate pleasing to early German farmers, who alienated large tracts of land for sisal farming.

Water amongst the Sambaa was considered communal property, and a person who had a natural water source upon his land could not prevent outsiders from using it. Landowners could impose fines if livestock damaged their crops, or if the water was fouled.

Water from furrows, which were in common usage in the early 1940s, belonged to those who had constructed the furrow (Dobson, 1940). "When the furrow is dug the shamba owners decide amongst themselves who shall have the water and on which days" (p. 22). Again, despite apparently heavy farming intensities and population density, water use right disputes appeared to be minimal. "There appear to be surprisingly few disputes", wrote Dobson (1940), "...but in the case of very long furrows, the elders generally put in a reliable man to supervise and see that everyone gets their fair share of water and that none is wasted..." (p. 22).

Unlike the Chagga, the Sambaa were very reluctant to descend down the mountain slopes to find alternative sources of farmland. The absence of water user rights disputes and the fact that moving into lowland areas was still a matter of choice, suggests that farming intensities were not, in 1940, anywhere near as pronounced as they are today.

The Pangani River Basin (PRB) was, during Tanzania's colonial period, a core development area, with large-scale coffee, sisal, wheat and sugar interests becoming established within the Basin. The demand for labour therefore grew, attracting migrants from all over the country and even as far afield as Rwanda, Burundi and Mozambique (Mbonile, 2002).

It is not clear how much of the Pangani River Basin (PRB) is irrigated today. In the part of the Basin that lies in Tanzania, Mujwahuzi (2001) estimates that 40,000 ha of land are under irrigation, Røhr *et al.* (n.d.) claim that 29,000 ha are effectively irrigated, while Ngula (2002) estimates that 31,075 ha of the PRB are irrigated (Ngula, 2002).

In the Kenyan portion of the PRB, the single biggest demand on Lake Jipe's waters is irrigation. Within the lake's Kenyan watershed, there are 10 irrigation schemes covering a combined area of 1,717 ha. This area is expected to increase. The Lake Jipe Irrigation Scheme will lie along the lake's shoreline, and will cover 77.2 ha. and will require 308 m³ of water per hour (Musyoki and Mwandotto, 1999). At present, most water is abstracted from that portion of the Lumi River that flows through Kenya, along which there are 21 water supply schemes. Total abstraction within the Kenyan portion of the lake's basin is 77,274 m³ per day. An additional 54,681 m³ are abstracted during flood periods (Musyoki and Mwandotto, 1999).

Box 10: Traditional furrow design flaws

According to Mwamfupe (2001), the problems with traditional furrow design in the PRB are as follows:

- much water is lost at the point of abstraction because of the materials (banana logs) used to divert water into the irrigation furrows;
- the design of plots is poor – they are not typically levelled, causing water to pool, prompting salinisation and low crop yields;
- furrows are poorly constructed with weak banks, causing water to break out.

Additional problems are that farmers often relate their abstraction size to the amount of land that they have to irrigate, and not to the amount of water that is available. Water abstracted is retained, and in many cases allowed to pool. It is not typical for farmers to construct return furrows to the water source. "Tanzanian irrigation systems are just a waste of water" (Nasari, pers. comm.).

According to Ngula (2002) current water demand within the Tanzanian part of the Basin is 807.99 million m³ for 20% irrigation efficiency. Irrigation in the PRB uses between 400 and 480 Million Cubic Metres (MCM) of water annually (Mujwahuzi, 2001). Distribution of this usage appears to be uneven – with half of the Basin's water consumption concentrated around Mt. Kilimanjaro. Here, 500 traditional irrigation furrows, that, combined, stretch for 1,800 km, draw an estimated 200 MCM annually from the mountain's rivers (Gillingham, 1999). Røhr *et al.* (n.d.) refer to work that indicates that, between 1997 and 2007, for every 1.5% increment to the Basin's population, low season river flow is reduced by 8 m³/s. In the Kilimanjaro Region, 80% of water abstraction is for irrigation (Ngana, 2001). Areas of Hai and Moshi Rural Districts (around Mt. Kilimanjaro) display the highest traditional furrow densities in Africa (Tagseth, 2002). As a result, erosion rates from Mt. Kilimanjaro are high (Mtalo and Ndomba, 2002). 24 tonnes of soil per hectare of catchment flows into the Nyumba ya Mungu reservoir every year (Mtalo and Ndomba, 2002).

All of this irrigation is assured by the PRB's 2,000 traditional furrows (Mujwahuzi, 2001), which corresponds, Mwamfupe (2001) says, to 80% of the Basin's irrigated area. This may not be an indication of farming intensity, however. Tagseth (2002), drawing on data for his study area comprising three locations in southern Moshi Rural District, argues that the amount of water abstracted actually *declined* between 1940 and 1993, as did the number of furrows.

The reasons for irrigation are twofold. In the highland areas, average plot sizes are between 0.1 and 0.2 ha. Up here, population densities are in the region of 700 – 1,000 people per km² (Mwamfupe, 2001). To compensate for small farm sizes and ensure that such land as is available will be as productive as possible, irrigation is practised. Lower down in the basin, in the traditional '*shamba*' areas, plot sizes tend to be larger (0.8 – 1.5 ha), and farming less intense (Mwamfupe, 2001). Down here, however, rainfall patterns tend to be irregular, and irrigation is practised to mitigate climatic vagaries.

It is clear that with such levels of irrigation, upstream water users are more favourably placed than are downstream users. Water shortages are very common within the basin. Mwamfupe's (2001) study is drawn from two locations: Makuyuni, on Kilimanjaro's slopes, and Kahe, lower down in the mountain's foothills. His respondents said that they did not receive enough water for irrigation. The largest proportion of respondents – most of whom were from Kahe – blamed this on prolonged drought; followed by those – mainly from Makuyuni – who blamed increased water uses and demand. Just 7.3% blamed their water supply problems on inefficient furrow design.

It is important to recognise that a large part of the reason why these traditional irrigation systems have not changed, despite their inefficiencies, is because of the costs involved in obtaining efficient, low-maintenance and durable irrigation alternatives. It is also important to note that furrow design may yield social and economic benefits that outweigh the losses incurred from inefficient water conveyance.

The amount of vegetation cover in the Basin has declined, contributing towards reduced dry season discharges, and threatening livelihoods. Farmers have responded to water shortages in a number of ways. They have reduced the amount of cotton that they grow, preferring to cultivate tomatoes, which have a short growing period and a good market. Mwamfupe (2001) also claims that coffee is being abandoned because of fluctuating prices⁵. Farming households have also, increasingly, sought to diversify their livelihood bases by seeking off-farm incomes. Interestingly, the type of alternative income pursued appears to vary on the farming area from which the farmer comes. Alternatives obtained by highland households included tailoring, radio and TV repair, watch repair and shoe-making. In the lowlands, alternatives included selling cattle fodder, stone-crushing, charcoal-making and casual labour. Mwamfupe (2002) suggests that this is because the highland zone is better developed and contains more urban areas than lowland areas, so opportunities to enter the service sector are better.

⁵ It should be noted that fluctuations in the global coffee market, as well as markets for other agricultural goods, and variable trends in Tanzania's tourist economy, all contribute towards altering the stability of the Basin's own economy and influence the ability of its inhabitants to secure adequate livelihoods.

Box 11: Sodicty and salinity

Sodicty is the presence of excess 'exchangeable sodium' (sodium salts capable of alkaline hydrolysis) and results in poor soil permeability and tilth. Salinity is common in arid/semi-arid areas because there is not enough water to flush accumulated salts from the crop root zone. Salinisation may occur when the supply of salts exceeds their removal by flooding or leaching. Amongst many problems associated with salinisation is its impact on soil absorption and moisture retention. The breakdown of the soil's physical properties causes its top layer to compact, ensuring that water infiltration from the surface layers to the root zone is restricted. In the Pangani River Basin, the problem of salinity has been reported in some irrigation schemes, including Musa Mwijanga, Kikafu Chini (both in Hai District) and Mawala (Moshi Rural District) (Misana and Makoi, 2001), as well as on some of the Basin's large private irrigation schemes (Sahib, 2002).

Amongst the difficulties arising from high levels of irrigation intensity are sodicty and salinity. At Misana and Makoi's (2001) three survey sites (all in Moshi Rural District), irrigation water has not been the cause of salinity, although there has been a 'slight to severe' restriction in infiltration rate in the topsoil at all study sites. At two sites, irrigation did contribute to sodicty. 'Good quality' water, they say, is needed to address this problem. Irrigation was not found to have negatively affected the fertility of the soil except at one site. Misana and Makoi (2001) recommend the use of low levels of various fertilisers to address problems of less than satisfactory soil fertility. They suggest that salts may well be leached by irrigation, but where the water stands, then the problem is not solved because it causes structural change to topsoil layers, affecting water transfer from top soil to the crop root zone.

The largest farms in the Basin are the Tanzania Planting Company (TPC) (17,000 ha), the Kilimanjaro Agricultural Development Programme (KADP – 6,320 ha), and the Burka Coffee Estate in Arusha.

TPC lies just south of Moshi, and was first established by Danish investors in the early 1930's. It was nationalized in 1980, and re-privatised in 2000 through Mauritian (Deep River Bean Champ Sugar Estate, Mauritius) and French investors (Group Quartier Francais Reunion Island). The estate covers some 17,000 ha of which some 5,750 ha are presently under sugar cane. It is planned to increase this to some 7,500 ha in the near future (Sahib, 2002).

Benefiting from only some 450mm rainfall a year, irrigation is a pre-requisite for sugar cane cultivation. The effective crop water deficit has been estimated at a minimum of 1,200 mm/year thus requiring irrigation applications varying between 1,500–1,900 mm per year depending on the irrigation system and methodology. Roughly half the estate is overhead irrigated, while the remainder is surface furrow irrigated. Rivers lying on the western boundary of the estate provide part of the irrigation water, the rest being pumped from an underlying aquifer through high delivery flow boreholes (500 m³/hr) (Sahib, 2002).

In Tanzania, water may only be legally abstracted if users are in possession of a water right, which, for Pangani Basin, is issued by the Pangani Basin Water Board (PBWB), and priced depending on the use to which the water is to be put. The PBWB has encountered serious problems implementing the water rights system because most small-scale users believe that water is a 'gift from God'. While they wish to abstract water legally, they typically do not believe that they should have to pay to do so. Most large-scale users do, however, pay for water rights (Sarmett, pers. comm.).

C. 4 Pastoralist interests

Between 1994 and 1995, livestock contributed some 30% to Tanzania's GDP. The country has an estimated 60 million hectares of land suitable for livestock grazing, and believes it can support some 20 million livestock units. The country has an estimated 16 million livestock units at present.

There are few data on the pastoralists of the Pangani River Basin. In 1995, livestock within the Basin was estimated to need 30,500 m³ of water a day, while they are expected to require 36,400 m³/day in 2015 (IVO – NORPLAN, 1997). Current livestock numbers in the Basin are not known. The most recent figures available to this survey come from 2002, and are derived from scattered districts and municipalities throughout the Basin (Table 4).

Table 5: Livestock population in selected areas of the Pangani River Basin (2002)

Region	Cattle	Shoats*	Donkeys
Simanjiro District, Manyara Region	305,075	133,000	11,000
Arusha Municipality & Arumeru District, Arusha Region.	470,000	461,450	21,991
Kilimanjaro Region	568,689	534,420	12,380
Tanga Region	421,261	378,442	Not counted
Taita – Taveta District (Kenya)	37,800	40,277	Not counted
Total	1,765,025	902,972	

Source: Various sources. **Shoats' are goats and sheep combined.

C. 5 Urban interests

The Pangani River Basin (PRB) contains two main urban areas. In the north, and located relatively close to one another, are Moshi and Arusha. In 1995, urban water use from the Basin was estimated to be 71,200 m³/day, and was expected to grow to 163,600 m³/day in 2015 (IVO – NORPLAN, 1997). The volumes of water used at present, Sarmett and Kamugisha (2002) estimate are low, and no more than 1.1 m³/s.

Arusha municipality has a population of between 250,000 and 350,000 (depending on authority). Although most of the water coming off Mt. Meru is used for irrigation and domestic purposes, the biggest commercial water user is the Arusha Urban Water and Sanitation Authority (AUWSA). It has 15 boreholes and an average annual capacity of 7.4 million m³ (Schechambo, 2002). The Authority also taps water from two springs with an average combined annual yield of almost 6.4 million m³ (Schechambo, 2002).

The rivers are also used to dispose of urban waste. Moshi Municipality, Ngana (2001) says disposes sewerage directly into rivers, while Mkuula (1993) claims that the rivers Themis (near Arusha), Karanga, Njoro and Rau (near Moshi) are all polluted by urban-based industrial waste.

C.6 Interventions by NGOs and international organisations in the PRB

There are large numbers of NGOs operating in the Pangani River Basin (PRB), and far fewer international organisations. In this section, it is understood that these interests do not typically make demands upon the PRB's natural resources, but that their interests are often focussed upon Natural Resource Management (NRM), conservation and the development and sustenance of livelihoods. There are far more NGO and international donor interventions than those considered. Those discussed below may form the basis for collaborative integrated management activities in the Basin, as will be discussed in the conclusion.

Non-governmental organisations

PAMOJA is a Tanzanian-based NGO that believes that dialogue is necessary in a conflict situation. It argues that 'if the voices of the unofficial and marginalised community groups are heard and listened to by policy and decision makers, local actors can effectively contribute to the protection and rehabilitation of water catchments, while also increasing the efficiency of economic production and use of water' (PAMOJA, 2002: 3). Mutual agreement, they say, works better than law. Of late, PAMOJA has increasingly come under the scrutiny of the Pangani Basin Water Office (PBWO) as a possible route through which dialogue and mutual understanding between the PBWO and the Basin's water users can be developed.

Launched in 1992, the *Tanzania Forestry Action Plan* (TFAP) Project in the North Pare Mountains was concerned with a number of serious problems, including high population density, small plot sizes, exhausted soils and alarming levels of forest encroachment. Using an approach that sought to draw up site-specific management plans in collaboration with the project area's communities, it was able to improve soil fertility, reduce surface run-off and stabilise river banks. TFAP also sought to utilise irrigation systems developed by the Wapare and used by them for centuries. Plot sizes, however, remain small, and the only cash crop cultivated in the area was coffee, leading Mndeme (n.d.) to suggest that the development of off-farm income-making opportunities and the diversification of the cash crop base would be necessary for the future success of the project (source: Mndeme, n.d.).

The *Traditional Irrigation and Environmental Development Organisation* (TIP) has been registered in Tanzania since 1999. The organisation inherited the assets and took over the functions of a former 13-year old donor-funded project called the Traditional Irrigation Programme. As it was with the latter programme, the main focus of TIP is to assist in poverty alleviation and sustaining food security for the small-scale traditional irrigation community in selected areas of Tanzania by improving traditional irrigation practices. TIP emphasises land use planning as a basis for basin management, and argues that, as an initial starting point, the Basin should be divided into sub-catchments. In each of these, there should be a sub-catchment board comprising representatives sent by each village within the sub-catchment. Each sub-catchment board will send representatives to a Basin water board (Mjata, pers. comm.).

TIP works through Memoranda of Understanding (MOUs) with four Tanzanian districts: Same and Mwanja in Kilimanjaro Region, Lushoto in Tanga Region and Arumeru in Arusha Region. It reaches other clients and/or interested partners elsewhere through contracts and assignments upon request (Mjata, 2002).

The *Tanga Coastal Zone Conservation and Development Programme* (TCZCDP) has partnerships with the District Councils of Pangani and Muheza, the Tanga Municipal Council, the Tanga Regional Authority, Irish Aid (donors), and the IUCN (The World Conservation Union) for technical and managerial advice. The overall objective of the TCZCDP is the sustainable use of coastal resources. The programme aims to enhance the well-being of coastal communities in the region by improving the health of the environment that they depend upon and diversifying the options for using the coastal environment. The TCZCDP started its work in 1987 and its activities are ongoing (Mgongo, 2002).

The *Tanzania Coastal Management Partnership* (TCMP) is a joint initiative between the National Environmental Management Council (NEMC), the Coastal Resources Center/University of Rhode Island and USAID. The partnership was initiated in 1997 to develop and apply a national coastal management framework. This latter framework is based on a series of strategies that aim to develop an integrated management plan for Tanzania's coastline and to develop sustainable and environmentally friendly economic activities in the area (Luhikula, 2002).

The *Tanzania Forest Conservation Group* (TFCG) was established in 1985, and promotes the conservation of forests with high biodiversity in Tanzania. The group counts amongst its successes lobbying for the creation of the Udzungwa National Park, Tanzania's first rainforest park; the purchase of the Mazumbai Forest in the West Usambaras for research purposes by the University of Dar es Salaam; and lobbying for the EU – IUCN/Ministry of Livestock and Agriculture funded East Usambara Conservation and

Development Project. Amongst its present activities within the PRB is the development of a Joint Forest Management (JFM) framework for the Ambangulu Forest (West Usambaras) between local communities, local government and a nearby tea estate. Through its work with communities adjacent to the Kambai Forest (West Usambaras), the TFCG has managed to have 600,000 trees planted. At Ngulwi (West Usambaras), the TFCG is trying to afforest denuded slopes and establish an ecotourism programme.

International interventions

Probably the largest intervention in the Pangani River Basin (PRB) has been the *River Basin Management and Smallholder Irrigation Improvement Project* (RBMSIIP). This is a twocomponent project being implemented by the Ministry of Water and Livestock Development (MoWLD) through its Water Resources Department; and the Ministry of Agriculture and Food Security (MAFS) through its Irrigation Department. RBMSIIP was originally designed as a six year programme (1996/97-2001/02) funded with IDA credit and government counterpart funding. Following a mid-term review in 2001, the project's new completion date was extended by a year to June 2003 to finalise planned activities.

The primary objectives of the project are to strengthen the government's capacity to manage its water resources in an integrated and comprehensive manner that ensures the equitable, efficient and sustainable development of the resource and to address water-related environmental concerns at the national level and in the Rufiji and Pangani River Basins; and, to improve irrigation efficiencies of selected smallholder traditional irrigation schemes in the two target basins. Its major achievement to date has been a review of the national water policy and the drafting of a new water policy. The latter was approved by the Tanzanian Parliament in July 2002.

The UNDP-GEF *East Africa Cross-border Biodiversity Project* (EACBP) is a regional project funded by the Global Environment Facility (GEF) through the UNDP, and, in Tanzania, is implemented by the National Environmental Management Council (NEMC). The project works through existing administrative structures in the region, with a strong community involvement as a backbone. The project's major objective is to reduce the rate of biodiversity loss at selected cross-border sites in East Africa. It has two immediate objectives. The first is to create an enabling environment in which government agencies and communities can jointly regulate resource use; the second is to balance the supply and demand factors that impact upon biodiversity conservation and wise use. In the Basin area, the EACBP has been working in the Shegena Forest Reserve, the largest forest block in the North Pare Mountains, where it has sought to establish a JFM framework with local communities.

The Pangani River Basin Management Project (PRBMP) is generating technical information and developing participatory forums to strengthen Integrated Water Resources Management in the Pangani Basin, including mainstreaming climate change, to support the equitable provision and wise governance of freshwater for livelihoods and environment for current and future generations. The Pangani Basin Water Office is implementing the project with technical assistance from IUCN (International Union for Conservation of Nature), the Netherlands Development Organization (SNV) and the local NGO PAMOJA. The project is financially supported by the IUCN Water & Nature Initiative, the Government of Tanzania, the European Commission through a grant from the EU-ACP Water Facility, and the Global Environment Facility through UNDP.

C.7 Conflict

As mentioned above, water users are legally obliged to hold water rights issued by the Pangani Basin Water Office. The cost of a water right depends on the end to which the water is to be put. Small-scale users are often reluctant to apply and pay for water rights, arguing that water is a 'gift from God'. According to Mujwahuzi (2001) there are 1,028 water rights in the Basin with a capacity to abstract 30.7 m³/s. There are, however, an additional 2,094 abstractions with a capacity to abstract about 40 m³/s. "The present and potential water use conflicts [in the Basin] are the result of past uncoordinated and increased development of the water resources of the Pangani especially above Nyumba ya Mungu Dam" (Mujwahuzi, 2001: 131).

Conflict within the Pangani River Basin (PRB) is not, however, restricted to water users alone. In the examples provided below, it will become clear that many of the conflicts facing the water sector are replicated in other resource use sectors, and between different types and claims over resource use. The types of conflict identified here are a simplification of the highly complex and contentious nature of conflict development. This Situation Analysis groups conflict into three broad categories designed to provide an overview of the various types and scales of conflict present within the PRB. The categories are not mutually exclusive, given that it is in the nature of natural resources conflict and livelihood claims that the problems that affect resource access overlap, and often feed off one another. Hence, conflicts of scale may exacerbate conflicts of tenure and vice versa. The categories are: conflicts of scale, conflicts of tenure and conflicts of location.

Conflicts of scale

The relationship between water users of different sizes and power in the Pangani River Basin is often described in dichotomous terms. Hence, large-scale plantations using hundreds of litres of water a second and employing highly efficient irrigation systems, differ starkly from small-scale users using far less water and employing very inefficient irrigation systems. It should be noted that similar conflicts may also occur within communities, between vested power interests (such as village governments) and other community members. The extremes involved in these regards are fertile grounds for conflict to erupt. Examples of these kinds of conflict are as follows:

The Shiri – Njoro Village and the Moshi Municipal Water and Sewage Authority

Shiri – Njoro lies along the Moshi – Arusha Road, close to Moshi Town. Moshi is a rapidly growing urban area supported, in the main, by agriculture. As the town grows, so too has its demand for water. In 2000, engineers from the municipal water authority arrived in Shiri – Njoro and capped the community's main spring. The spring yields 218 L/s, and the Moshi Municipal Water and Sewage Company (MMWSA) obtained a water right to abstract 116 L/s. The village had three furrows originating from the spring that abstracted about 30 L/s each. Urban Water abstraction, therefore, should have left the community with sufficient water to fill its furrows.

The MMWSA, however, abstracts around 24 L/s more than it is entitled to. The Shiri – Njoro Village Council claims that it can no longer operate the three furrows from the spring, and that their community – and its agricultural economy - has been hit very hard. It is their intention to take the MMWSA to court and 'we will sell our goats and dogs to raise the money' to do so (Source: pers comm., Shiri – Njoro Village Council).

Afgem and the small-scale miners of Merelani

Tanzanite is a semiprecious bluish-purple gemstone found only in Tanzania. Tanzanite-bearing soils are said to cover an area of just 20 km² at Merelani. The area is divided into a series of blocks, A, B, C and D. The 8 km² Block C is said to contain the richest deposit, an estimated 2.2 million tonnes of tanzanite. Tanzanite was discovered in the area in 1967, and Merelani town now has 75,000 inhabitants (Majtenyi and Muindi, 2001). It is 'a boisterous, lawless settlement reminiscent of a California gold rush town' (Lovgren, 2001: 1).

In 1999, a South African multinational, African Gem Resources Ltd (Afgem), sought, and obtained, a 13-year mining concession for Block C. By 2001, Afgem had invested US\$ 8 million in the concession, and another \$12 million will follow once the company starts full-scale operations (Majtenyi and Muindi, 2001).

Afgem, however, are not the only miners in Merelani. In fact, the industry is dominated by 10,000 small-scale miners, who oppose Afgem's activities for the following reasons (Majtenyi and Muindi, 2001):

- They accuse Afgem of trying to monopolise tanzanite mining in the area, and of attempting to drive small-scale miners away. Afgem retorts that 70 percent of its concession is mined illegally. In the second of the mine's two shafts, workers discovered a tunnel that lead all the way to the small-scale mining plots in Block B (Lovgren, 2001).

- Soon after obtaining its concession, Afgem started fencing off Block C. Local miners claim, however, the boundaries between the blocks are indistinct and that Afgem has no right to fence off the area.
- It is claimed that Afgem has sought to laser-brand its gems as a mark of quality and authenticity. Local miners argue that this is, in fact, a ruse to ensure that their own gems are perceived as fake, forcing them to sell their gems only to Afgem's agents.

In 2000, soon after Afgem sought to fence off its concession, local miners invaded. Afgem's security guards opened fire, killing seven and injuring many more. In April, 2001, another invasion was mounted, and a teenager killed. The following May, dozens of miners were injured when 400 of them invaded Block C, demanding Afgem's expulsion (Majtenyi and Muindi, 2001).

The miners have since sued the company, alleging that Afgem's security guards tortured six of them. In the court papers, they also claim that Afgem's mining licence is invalid, that company officials conduct illegal searches on pedestrians and have buried 30 small-scale miners in an abandoned mine. Against this backdrop of violence, the Tanzanian Minister for Energy and Mines, declared Merelani a controlled area, and police patrol the roadblock linking the town to the main road at the Kilimanjaro International Airport, 14 km away. The government has also formed two committees to probe the clashes (Majtenyi and Muindi, 2001).

Afgem is supported by the Tanzanian Government, which argues that expelling the company would run contrary to the policy supporting the 1998 Mining Act. The Regional Commissioner, furthermore, argues that Afgem's expulsion would be tantamount to giving in to lawlessness (Majtenyi and Muindi, 2001).

Conflicts of tenure

This document defines tenure as the right to manage a resource. Throughout Tanzania (and rather less so in Kenya), Community-based Natural Resources Management (CBNRM) has been seen as an attractive option with which to increase the efficiency of the nation's Natural Resources Management (NRM) systems. Hence, Beach Management Units in fisheries, Village Natural Resource Committees in forests and Water Users Associations along river courses have all been created. The contention with these systems relates to the manner of their application and design. Here, communities may not be involved in the design of the management system, its implementation or even its justice systems. This may ensure that these institutions do not fulfil the management tasks that they were created to perform. In addition, such styles of implementation may ensure that newly formed local resource management institutions may come into conflict with pre-existing community institutions. What will also be clear from the examples provided below is that tenure relates to the right of choosing the use to which a resource is put, and the power to prevent others from putting it to different uses. Hence, conflicts of tenure will also include conflicts between different types of resource users.

The Duru – Haitemba Forest management conflict

The Duru – Haitemba Forest is a miombo woodland covering 40,000 ha. Along the forest's edge lie eight, long-established villages, whose inhabitants had maintained control over the forest – albeit loosely. Charcoal-burning, in-forest cultivation and habitation, and the setting of fires, were all strictly prohibited. In 1983, reacting to a government policy directive, these villages had started the process of applying for ownership of village lands, including adjacent forested ridges. In 1985, however, the Duru – Haitemba Forest was ear-marked for reservation so as to guarantee its future productivity, assure its conservation and, novelly (at the time) to make the forest pay for its own management via, for example, the imposition of exploitation permits or fines. The mainstay of the forest's protection was to be delivered via large numbers of forest guards. Village representatives clearly indicated to government foresters that while they supported the conservation of the forest, they resented the need for them to lose their forest in order for this to be achieved. Once the Forest Guards were established, all semblance of community concern for the forest was discarded. Fields were cleared well into the forest, charcoal burning commenced,

felling started and outsiders, perceiving that government control of the forest equated with a free-for-all, started bring their cattle into the forest to graze. "By eliminating the local sense of proprietorship, no matter how weakly local rights were backed up in statutory law or implemented on the ground, the government also eliminated local guardianship, or recognition in the wider community that the forests were not public property..." (Wiley, 1999: 53 – 54). (Source: Wiley, 1999).

Conflicts between resource users of different types

As land becomes increasingly scarce in upstream areas of the PRB, farmers seek additional land and irrigation opportunities downstream. As early as 1946, Johnston noted that "...as the Chagga extend their *kihamba* land lower down the slopes of Kilimanjaro, they will begin to resent the aliens there whom chiefs in the past allowed to settle" (p. 4). This friction between people of different ethnic origins is accentuated when the demands of both are for land and water. Different resource demands, however, may not necessarily cancel out a basis for conflict. Much of the land in the lowland areas of the Basin has traditionally been utilised by pastoralist Maasai. The Maasai consider migration into their traditional lands as an invasion of their territory, and the transformation of productive pastoral land into other uses.

Simanjiro District lies to the south of Arusha town, and contains within it the mining town of Merelani. In 1995, 85% of its 65,000 inhabitants were Maasai pastoralists. Pastoralism is often considered the most appropriate form of land use in Africa's arid and semi-arid lands (cf. Warren, 1995). These systems, however, assume a certain degree of resource permanence. Pastoralist resource management institutions, associated lifestyles and social patterns are often built upon the premise that the area covered by their pasture will not be altered. This has not been the case in Simanjiro.

The traditional pastureland of the Simanjiro Maasai has been threatened from three directions:

- Commercial farming: by 1994, 50,000 hectares of Simanjiro land had been set aside for use by large-scale farms of between 90 and 13,000 ha size. The farms produced mainly seed beans for export to Holland. 'To discourage and prevent pastoralists from grazing their cattle on these farms, all biomass residues are burnt immediately after harvest' (ole Sikar, 1996: 1). Land owners also confiscated cattle, fined trespassers and, ole Sikar claims, shot livestock and their herders.
- Mining activities - of both small and large-scale varieties, have assumed control over large tracts of Simanjiro land that are then either so badly damaged that they yield no useful grazing product, or else are closed to grazing completely.
- Tourism: As has been the case for pastoralists in and around Mkomazi Game Reserve, land in Simanjiro has been alienated for the purposes of protecting wildlife. The district's Maasai argue that this is unnecessary, given that they have co-existed with wildlife for centuries. 'Households have been forced to stop grazing their animals in these areas. At the same time the wild animals have been allowed to graze with domestic animals in traditional grazing areas such as the Simanjiro Plains' (ole Sikar, 1996: 2). In addition, the Maasai complain, wildlife transmits disease to Maasai livestock. The Simanjiro Maasai have been compensated neither for lost pasture nor for livestock lost to wildlife diseases.

These trends have occurred against a background of official government policy seeking, in particular, large-scale farming and industrial investment aimed at satisfying national needs over and above localised pastoralist interests. Hence, strategies aimed at meeting national goals may result in difficult-to-solve local management problems, and intractable resource exploitation difficulties giving rise to over-exploitation and localised conflict. In this sense, the conflicts of the Simanjiro and other Maasai are also conflicts of scale, and provide a graphic example of how scale conflicts may also be tenurial conflicts at the same time.

Kenya's Taita – Taveta District is not immune from these conflicts. Two thirds of the district's land is owned by just two land owners and the county council. As a result, many of Taita–Taveta's indigenous population are squatters. As a result, serious conflict exists between the landless and land-owners. Such conflict complicates the management of the district's natural resources considerably, a problem

that extends into the water sector. Squatters seeking to till the land in this semi-arid area are wholly dependent on irrigation (Musyoki, pers. comm.). They do not, however, possess water rights, as they are obliged to do, and much of the water is in any case abstracted upstream by the district's large-scale sisal interests. Partly in an effort to address the conflict in the area, the government has purchased some 9,700 ha in an effort to find land on which to settle small-scale farming interests.

Conflicts between differing water management perspectives: an example from Mt. Kilimanjaro

Tagseth (2002) argues that the failure of formal administrative systems within the Basin to recognise customary rights to water and its administration has been a cause of conflict between such customary interests and the formal administration of the Pangani River Basin (PRB). One method employed by formal administrative sources within the Basin has been the use of water control gates. It is said that because small-scale irrigating communities were not consulted first, they viewed the control gates as a gross violation of their right to water. In many cases, the gates have been vandalised or completely destroyed (Figure 4). In other areas, villagers have simply cut new inflow points in the riverbank, by-passing control gates (Shishira, 2002).

PAMOJA (2002) argues that communities within the PRB perceive access to water as being one of their basic rights, and take a dim view of government attempts to impose tariffs on water use and rules on its exploitation. Part of communities' reluctance with the PRB's administration stems from their perception that large-scale commercial interests are favoured over their own, smaller claims for water. The 'top-down' approaches so far adopted by the government, PAMOJA argues, are characterised by an absence of dialogue, and yields difficult-to-solve conflicts. Dialogue-based approaches, they feel, are more likely to 'forge a way forward that meets the needs and interests of policy makers, legislators and communities alike' (PAMOJA, 2002: 2).

On Mt. Kilimanjaro, a furrow committee chairman has traditionally managed irrigation furrows. Chairmen are always male, and are drawn from the lineage of the person who originally dug the furrow. The furrow passes through or along the land of various potential water users, many of whom wish to use the water for irrigation purposes. To qualify for an allocation, users must contribute towards maintenance crews who regularly patrol the furrow looking for damage. Various additional rules regulate water use, such as times between which abstraction may occur, how water use is to be rotated amongst users and so on. These rules are not set in stone. This is useful, because some people alongside furrows may need less water than others, while some need considerably more. Gillingham (1999) describes five ways in which people who need more water than their allocation permits may obtain additional water: the first is to 'borrow' water – someone who needs more water than their allocation will borrow water from someone they know who needs less. This is the most common method of obtaining water additional to a person's allocation. The second is to obtain additional water from another nearby furrow. The third is to buy water – here, someone who has used less water than he needs offers to sell the remainder of his allocation to someone he knows who needs more than his allocation. Because water is considered a 'gift from God', then it is illegal to buy it directly. Sellers get around this by selling their labour to the buyer, and then, if questioned, saying that the buyer is borrowing the remainder of their water allocation. The fourth way of obtaining water is to irrigate at night when there are no water allocations. Finally, the fifth way of gaining additional water is to steal it by, for example, irrigating while it is someone else's allocation day, although this is very unusual (Gillingham, 1999).

This flexibility in the rules, Gillingham (1999) argues, '...is crucial to the allocative efficiency and sustainability of the irrigation system...If all furrow users were restricted to the use of their formal allocation only, the furrow irrigation system would meet the irrigation water needs of only a few furrow users'. Gillingham argues that this system is reliable, because stealing is permitted neither under the formal allocation system nor under the working rules – if the system were unreliable, people would not contribute to the furrow's maintenance. This complementary relationship between formal and working rules takes a great deal of time to develop – the first furrows on Mt. Kilimanjaro were dug in the 18th century. In the lowland areas, where settlement is more recent, the climate drier, the population more scattered and social diversity much higher, then the cohesion between formal and working rules is not so great.

These rules emphasise social equity and conflict minimisation. They sit uneasily alongside new, externally imposed, rules that demand efficient water use. In addition, these new rules seek the establishment of Water Users' Associations (WUAs), which are not the same as Furrow Committees. WUAs are expected to collect fees from water users that then contribute towards the payment of a water right, obtainable from the Pangani Basin Water Office. In a culture where water is perceived to be a 'gift from God', the notion that it must be paid for is simply illogical. In addition, Gillingham worries, externally imposed sets of rules are far less likely to succeed than internally generated ones that have been altered and moulded to local cultural and environmental peculiarities over long periods of time. Gillingham believes that the mismatch between the management process at the local level and that at the external level may endanger the success of externally sourced management initiatives.

Conflicts of location

Users located in upstream areas are placed more favourably vis-à-vis water abstraction than are downstream users. At its most basic, these problems can be seen along irrigation furrows where users close to the water source are able to grow crops with very high water demands. Irrigated rice, for example, requires 3,000 litres of water to produce a kilo of harvest. Users located at the end of a furrow, however, are obliged to plant low water demand crops. The serious problems faced by downstream hydropower plants are another example.

The Lower Moshi Irrigation Scheme

Before the Lower Moshi Irrigation Scheme (LMIS) was developed in 1987, there was very little irrigated rice paddy in the area, and farmers could expect to harvest about 2 tonnes of rice per hectare. Following completion of the scheme, yields increased to 8 tonnes per hectare, prompting farmers outside the project to try to replicate the Scheme's farming techniques. As a result, water demands increased substantially, causing a constant water shortage supply problem downstream of the project. The Scheme itself has suffered from water shortages on account of intense abstractions upstream, and has been forced to reduce the hectareage under irrigation from 2,300 to 647 in 1994. Farmers involved in the Scheme were very unhappy. They explained that their water allocations followed a well-planned programme. Upstream users had no such programme, so causing the water scarcity at the Scheme. In addition, farmers claimed, upstream users had influence within the government and Chama Cha Mapinduzi (CCM) (Tanzania's ruling party) circles, so they could not be challenged (Mujwahuzi, 2001: 134 and 136).

The case of small-scale irrigators and the Tanzania Electric Supply Co.

TANESCO claims that it needs at least 40 m³/s to run the New Pangani Falls (NPF) Hydropower facility. After the Nyumba ya Mungu Dam (NYM) has released water into the Pangani, additional water joins it via a few tributaries. By the time the water arrives at NPF, however, it is often insufficient to drive the turbines. "Sometimes we have so little water that we have to close down the station and allow the water to pool overnight, so that we can open again in the morning" (Lugeiyamu pers. comm.).

As land becomes more and more scarce upstream of the NYM, farming downstream of the dam has also increased. Because conditions down here are much warmer and rainfall much lower, the need to irrigate is commensurately greater. The NPF's manager, therefore, blames unregulated water abstractions for the inadequate amounts of water that he receives. He points out that while water to his plant has declined, the area under irrigation has not. "Small-scale irrigators do not use electricity, so they do not understand these problems" (Lugeiyama, pers. comm.).

At the same time, control over abstractions has declined. When the NPF facility was constructed, money was also available to construct water control gates along the river's main abstraction points, and to monitor these. As funding has declined, monitoring has become more infrequent, the control gates have been destroyed and/or new abstraction points cut into the riverbank.

As a result, electricity generation has declined. In April 1999, the NPF facility generated 45 million kWh. In April, 2002, it generated 25 million kWh. This, of course, has a direct impact on the investment attractiveness of the plant. TANESCO is, at present, seeking to privatise itself. "If the NYM power plant has an 8 MW capacity and we can deliver only 3, who will invest in us?" (Lugeiyamu, pers. comm.)

C.8 Summary of points

At its core, the problems that face resource use in the Pangani River Basin (PRB) relate to an increasing population against a background of high levels of poverty. Poverty and environmental degradation are often perceived to be interlinked (cf. WCED, 1987). The problems of managing Common Property Resources (CPRs) are often thought to increase when there are large numbers of people involved, particularly when their cultural homogeneity may be weak (cf. Ostrom, 1990). The structure and function of rural livelihoods may become imperilled when the ability of rural people to control and secure adequate sources of livelihood are threatened.

This chapter has reviewed these difficulties by first identifying a series of major 'interests' within the Basin. It has then gone on to consider the various conflicts that exist between them. The main points to be derived from this discussion are as follows:

- The major interests within the Basin comprise industrial interests (electricity, mining and farming), farming (large and small scale farming, both associated with a considerable reliance on irrigation), pastoralist interests (particularly in lowland areas), and growing urban interests. This chapter has focussed primarily on the water usage of these interests. Operating between these diverse interests and the multiplicity of natural resources within the Basin are NGOs and international donor agencies. The mandate of these is primarily conservation and/or the development and enhancement of rural livelihoods.
- It is important to note that the population of the Basin is high, that for many of them, livelihoods are derived from farming, and that there is much to suggest that they are economically vulnerable. In addition, the diversity and richness of the Basin's resources mean that large(er)-scale interests are attracted to the Basin, and substantial investments have been made. There exists, between these large-scale interests and small-scale livelihood security, room for conflict.
- This Chapter divided conflicts into three broad, inter-related, categories. The first related to conflicts of scale, in which it was argued that small-scale users often had to compete against much larger claims for the same resource. The second conflict area related to conflicts of tenure. 'Tenure' here refers to the right to manage one's resources, and conflict arises between different management sources and priorities. The third class of conflict is related to location. Here, the way in which the location of a group of resource users can bring them into conflict with users elsewhere, was considered. The classic example of such 'location' conflict arising between upstream and downstream users was provided.
- It is clear, therefore, that the diversity of resources in the Pangani River Basin (PRB) brings with it an equal diversity of conflict types. What concerns the PRB is the extent to which management is able to deal with conflict of all degrees of intensity and the natural resource allocation problems that underlie them.

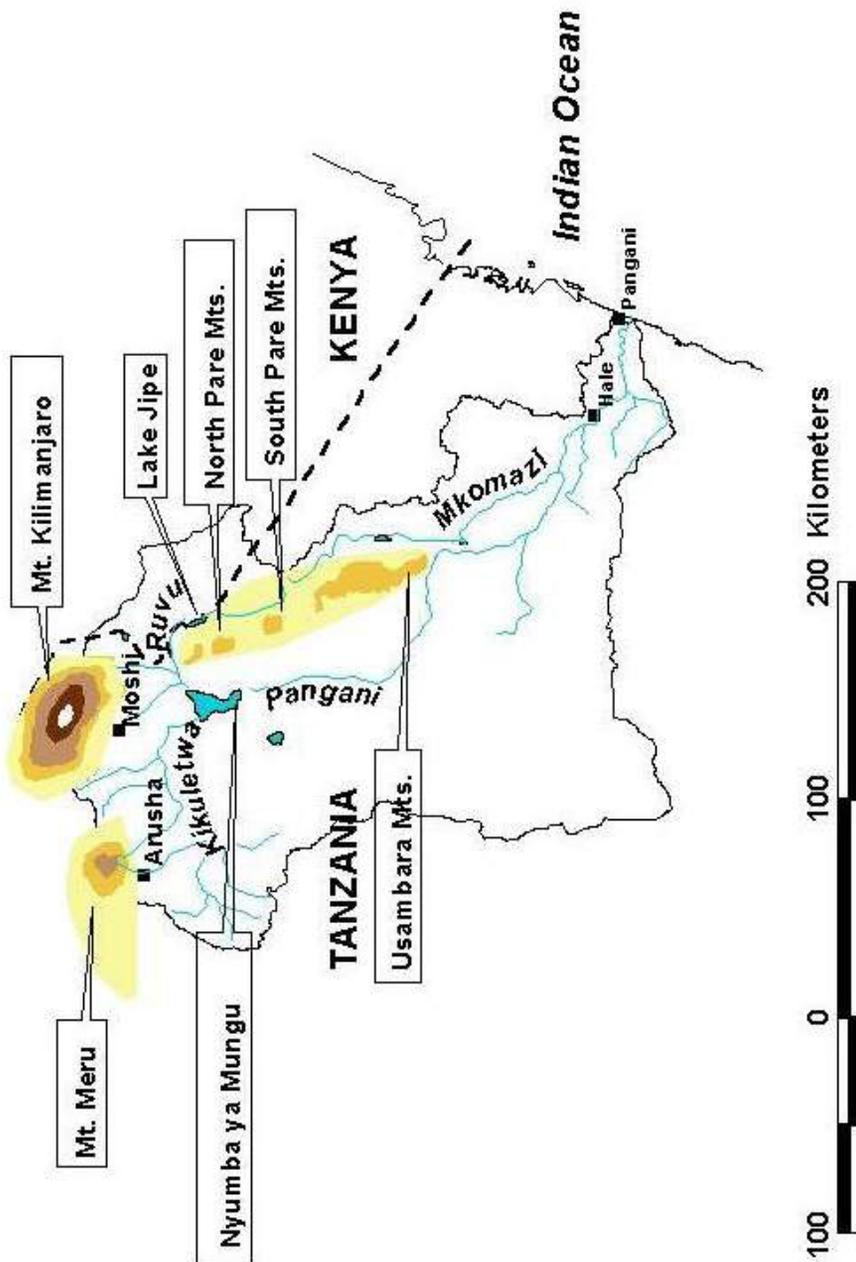


Plate 1: The Pangani River Basin
 (Source: River Basin Management Project)

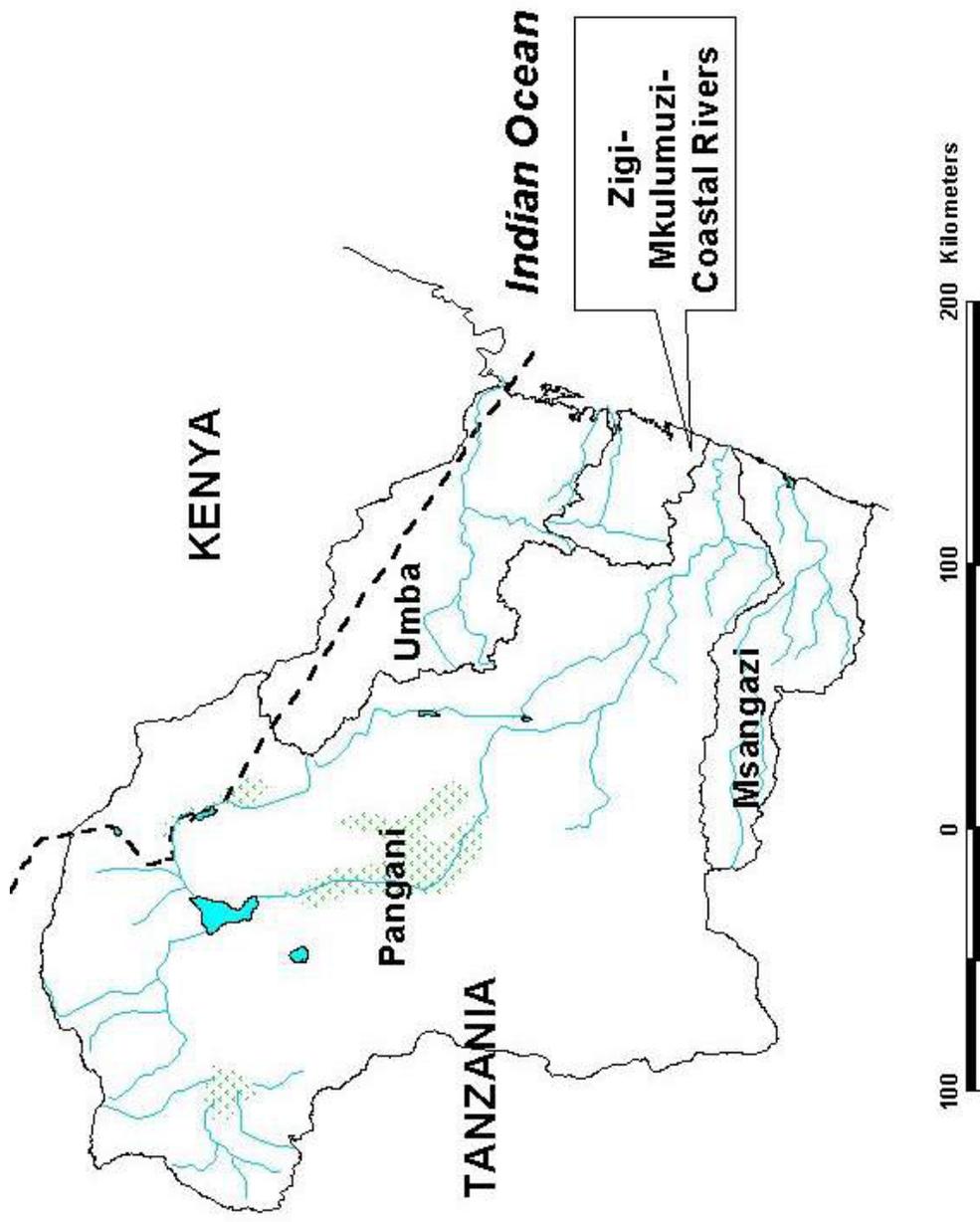


Plate 2: The Administrative Pangani Basin
 (Source: River Basin Management Project)



*Plate 3: Kilimanjaro's famous snowcap in 1993 (at the top) and in 2000
(Source: Bergkamp et al. 2003)*



Plate 4: The River Karanga at Moshi (Kim Geheb, 2002).

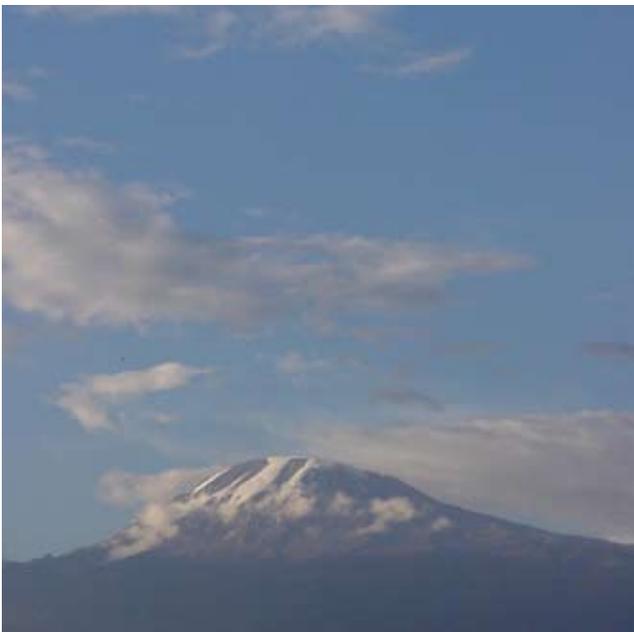


Plate 5: Mount Kilimanjaro (Kim Geheb, 2002).



Plate 6: An irrigation furrow in Moshi Rural District. The upper image shows it close to its source, while the lower near its terminus. (Kim Geheb, 2002).





Plate 7: The capped spring at Shiri – Njoro. The spillway in the foreground directs water into the village's furrows, while the control gate mounted on a concrete structure in the background directs water to Moshi.
(Kim Geheb, 2002).



Plate 8: Forested slopes on Mt. Meru
(Kim Geheb, 2002).

D Natural Resource Management in the Pangani River Basin

D.1 Introduction

This Chapter considers the Natural Resources Management (NRM) of the Pangani River Basin (PRB). In the first section, the 'formal' administration of the Basin is considered. Many arms of government administer the basin. This is, in and of itself, problematic because it can mean that the initiative of one branch may undermine the activities of others. For example, water conservation initiatives may be undermined by irrigation development activities. In addition, it may also mean that Central Government may seek to implement *national* policies within the Basin without reference to local conditions, demands and resource difficulties. Finally, it also means that a highly 'sectoral' approach to management occurs, with forestry departments unaware of, for example, wildlife development initiatives. While the latter initiatives may not directly concern forests, they do concern the overall management of the Basin, of which both sectors are an integral part. The first section of this Chapter considers the activities of two important sectors within the Basin: water and forestry, and assesses these in the light of management delivery.

The second section assesses the activities of management at the community level, while the third considers cross-border management of the Basin. The fourth section addresses the difficulties of monitoring and data collection in the Basin. The final section will summarise the findings of this Chapter.

D. 2 Government management, Legislation and policy

Water administration, legislation and policy

The principal legislation governing water resources in Tanzania is the Water Resources Management Act 2009 (WRM Act) that provides for implementation of the National Water Policy 2002. The WRM Act repeals the Water Utilization Act No. 42 of 1974 and its Amendment Act No.10 of 1981; and Written Laws (Miscellaneous) Act No.17 of 1989 and General (Regulations) Amendment. Particularly Act No. 10 of 1981 introduced the concept of allocating water based on hydrological boundaries. Accordingly nine river/lake basins were gazetted, although it was not until 10-years later that administrative authorities (Basin Water Offices) to manage water resources started to be established. The Pangani River Basin was firstly appointed in 1991 followed by the Rufiji Basin in (1993), by 2004 all 9-Basin Water Offices were established. The establishment of PBWO in 1991 was a product of donor concerns that there would be inadequate water to run the New Pangani Falls Hydroelectric Plant, at the same time serious water use conflicts were emerging and escalating in both the Pangani and Rufiji basins.

The WRM Act provides for the legal and institutional framework for river basin management as envisaged by the policy and provides for three levels of basin management: national, basin, and catchment. Local government authorities and community based organizations or water associations are key players in some of these institutions and the minister may delegate some functions to these entities. All water is public water and is vested in the President as the trustee for the benefit of the citizens; thus at the national level the Minister responsible for water resources is in-charge of all water resources affairs and is the appellate authority. The Minister is responsible for National Policy and strategy formulation, appoints members of the National Water Board, the Director for water resources, Basin Water Officers of the Basin Water Boards (BWB). The Minister establishes BWBs and catchment or sub-catchment committees and facilitates sectoral coordination and planning. The Minister is assisted by the Director of Water Resources, and advised by the National Water Board on matters related to multi-sectoral coordination in integrated water resources planning and management. The Director is the chief advisor to the Government on all matters of water resources, supervises and coordinates activities of the Basin Water Boards, prepares

the National Water Resources Plan an implementation strategy, coordinates preparation of basin plans and generally ensures coordinated water resources development, management and protection.

The new BWBs are fully responsible for all matters related to allocation, management and protection of water resources and formulation of policies and programmes aiming at management and development of water resources and control of water pollution. The BWBs have legal powers and functions to prepare basin water resources management plans in which sectoral and district plans are integrated. They coordinate inter-sectoral water management and serve as a channel of communication for the sectors at the basin level. They approve issuance of water permits and effluent discharge permits, monitor, evaluate and approve construction of hydraulic structures, and generally monitor the health of rivers, aquifers, lakes, wetlands and enforce the law. The new Basin Water Board advises the Director and coordinates activities of the catchment committees. The Basin Water Officer is the principal officer of the BWB responsible for the management of the affairs of the Board and serves as the ex-officio Secretary. The Pangani Water Board is expected to function in accordance with the institutional set-up prescribed by the WRM Act

The PBWO encourages the formation of Water User's Associations (WUAs) and, typically small scale farmers using one source and the same water infrastructure are formed into a WUA which applies for a water permit on behalf of its members. It is said that the WUAs make administration easier, because then the PBWO deals with the WUA alone and not multiple individuals. WUAs are also supposed to collect fees from water users that will ultimately be used to pay for their water permit.

In the early 1990s, water rights in the PRB consumed a total of 33.4 m³/s, but an inspection carried out by the PBWO in 1992/93 suggested that actual abstraction came to 48 m³/s (Mujwahuzi, 2002). There are 567 approved water rights in the four Tanzanian Regions sharing the Pangani River Basin, while an additional 300 have provisionally been granted. There are, however, almost twice as many abstractions carried out without any water right (Table 5). About 46% of final and provisional water right grants come from the Kilimanjaro Region. Almost 66% of the Basin's illegal abstractions occur in this Region.

Clearly, therefore, there exist serious difficulties in monitoring abstractions and in implementing the tenets of Tanzania's water legislation. Amongst the problems confronting the PBWO are the following;

- Although there are many monitoring stations throughout the PRB, their operation is erratic, and data series often interrupted because the stations fail. Manual monitoring can also be carried out, but data collectors are often insufficiently enumerated and may lack any incentive to collect these. As a result, water rights are issued without really knowing how much water can, in fact, be allocated. Additional important data, such as environmental flow data, is unavailable, and the PBWO does not know how much water must be retained within the basin to supply its ecosystems (Sarmett, pers. comm.).
- Because so many abstractions are illegal, it is not possible for the PBWO to know how much water is being abstracted.
- The PRB and all other basins in the country are not institutionally and financially strong enough to manage and monitor and control all water use in the basin. Thus control gates built at the junctions of furrows and rivers by PBWO in 1994 have largely been destroyed by communities unable to see their utility and reluctant to pay water users' fees. There is no way that this could have been prevented unless the affected saw the need and value of the gates, and unless the local authorities were involved in their planning in the first place.
- The PBWO is supposed to be administratively and financially independent. However, many water users believe that water is a 'gift from God', and refuse to pay for their water rights, even though the rates are very low. The PBWO therefore faces serious funding difficulties. The law is silent on how to deal with debtors. As a result, almost 60% of annual water rights bills fail to be settled (Sarmett and Kamugisha, 2002).

Table 6: Water rights (WR) in the Pangani River Basin (Tanzania), May, 2003

Region	Final Grant	Provisional Grant	Application WR.	Without WR.	Dormant WR.	Total
Arusha	184	135	57	141	144	661
Manyara	3	3	2	10	0	18
Kilimanjaro	264	138	118	1224	203	1947
Tanga	116	24	25	488	118	771
Total	567	300	202	1863	465	3397

Notes

Final grant: a water right granted and operational.

Provisional grant: a water right granted, but for which the applicant has yet to complete the construction of water conveyance systems to the satisfaction of the PBWO. Normally, s/he has a year to do so, after which an extension must be sought.

Application WR: water rights applied for. The PBWO processes such applications following existing procedures before submission to the PBWB meeting for approval and issuing the right.

Without WR: these refer to illegal abstractions (i.e. abstractions without a water right). Half of these are thought to abstract around 10 litres per second; this estimate needs to be verified.

Dormant WR: these are water rights granted, but whose owners are currently not utilising them. If the right is not used for three years, the permit will be withdrawn. A water right and water use survey is needed to verify the number of dormant rights in the Basin, and to determine whether or not any should be withdrawn.

Source: Pangani Basin Water Office.

- The WRM Act does not provide a direct link between the PBWB and Local Government Authorities (LGAs) or other lower levels of administration save for representations in the basin board and catchment committees. However the Minister may delegate the performance of any function stipulated in the act to a local government authority. The BWOs are not part of the LGAs and do not have the same responsibilities in the basin, but necessarily must work together under the principles of common but differentiated responsibilities. Working with the LGAs and a multitude of other stakeholders and sectoral interests is a challenge for the basin water officers who must be resourceful in this matter. The BWB are required, by the WRM Act to integrate District plans into the basin water resources management plan which will be legally binding to every player in the basin.
- The administrative jurisdiction of the PBWO is the PRB, which does not follow formal administrative boundaries. In the PRB, the PBWO must work with a multitude of local government authorities.
- River basins comprise large numbers of resources that are inter-connected with one another and changes to one resource may have repercussions for the other basin resources. In the PRB, planning is fragmented, sectoral and regionally or district oriented. The WRM Act mandates BWBs to prepare Integrated Water Resources Management Plans in their respective basins that will be legally binding to all water developments, management and protection.

Water administration in Kenya is governed by the Water Act of 2002 (RoK, 2002). Insofar as basin-wide management is concerned (provision for which is contained within the Water Act), the National Water Resources Management Strategy (RoK, 2003) is highly relevant. The Water Act established a Water Resources Management Authority (WRMA) charged with the management and administration of most aspects of Kenya's water resources. There are numerous organisations arranged beneath the WRMA, which are described in the Box to the right. Here, the incorporation of stakeholders into the management and administration of the Act is considered.

Box 12: Kenyan Water Administration

- The Minister for Water: exercises control over all water resources in accordance with the 2002 Water Act.
- Director of Water: assists the Minister with the discharge of his/her duties.
- Water Resources Management Authority (WRMA): undertakes water resources management functions.
- Catchment Area Advisory Committee (CAAC): advises officers of the WRMA on matters of water management relevant to the catchment area under its jurisdiction.
- National Water Conservation and Pipeline Corporation (NWC&PC); on behalf of the Minister, carries out the development of state schemes that provide bulk water for use by licensees and other water services providers.
- Water Appeal Board (WAB): hears and determines any suit of any person having a right or proprietary interest which is directly affected by the decision of order of the Authority.
- Water resources users associations: assist the authority in water resources protection at the grassroots level.

The management unit that the WRMA is expected focus upon is water catchment areas, which it is charged with defining. Each catchment is supposed to have a Catchment Area Advisory Committee (CAAC) of 15 members, appointed by the WRMA, and comprising representatives from a wide array of private and public stakeholder sectors. Under the Water Act, the CAAC is charged to 'advise officers of the Authority [WRMA] at the appropriate regional office concerning:

- (a) water resources conservation, use and apportionment;
- (b) the grant, adjustment, cancellation or variation of any [water] permit; and
- (c) any other matters pertinent to the proper management of water resources' (RoK, 2000: 953).

Actual power for the administration of the Water Act (including powers of arrest, prosecution and issuing water permits) rests with the WRMA. The latter is also charged with the development of a national water strategy, which was published in 2003 (RoK, 2003). The Strategy explains stakeholder involvement in Kenya's water management and administration as follows: 'The National Water Policy (NWP) foresees a situation whereby NGOs and communities will play a greater role in the water sector including water resources management. This would require that the new actors undergo capacity building...' (RoK, 2003: 73).

The Strategy emphasises environmental protection in whole catchments, and provides the following policy guideline:

'To ensure environmentally sustainable development, geared towards the integrating and strengthening of environmental values and considerations into water resources planning, management and development and increasing awareness on [*sic.*] their impact on human health, development and other natural resources. Focus will primarily be concentrated on clarifying, improving and streamlining the institutions and processes responsible for the integration of environmental aspects in overall water resources management' (RoK, 2003: 23).

In addition, the Strategy places considerable emphasis on catchment protection, particularly on the conservation of Kenya's rapidly declining forest reserves:

'Water catchment areas need...to be identified and delineated and water catchment preservation and protection programmes instituted with the relevant ministry in-charge of forestry. In addition, groundwater conservation zones need to be identified to avoid depletion of this resource to promote integrated catchment management. All stakeholders will be encouraged to pool their resources to protect the country's catchments' (RoK, 2003: 33).

In this respect, Kenya's Water Policy provides a basis upon which the trans-boundary management of the Pangani River Basin's resources may be managed, given that it is deforestation on Mt. Kilimanjaro's slopes (in Tanzania) that directly affect Lake Jipe's water level and quality (in Kenya).

Forestry administration, legislation and policy

The management of Tanzania's forests is divided between two main authorities. The main custodian of the nation's forests is the Forestry and Beekeeping Division (FBD), which falls under the Ministry of Natural Resources and Tourism. The President's Office is also a managerial player in Tanzania's forests through roles played by regional governments and local government. A third managerial interest is Tanzania National Parks (TANAPA), which administers those forests that fall within national park boundaries (Lambrechts *et al.*, 2002).

Like the present water administration, the forestry administration is also dualist. At the regional level, a Regional Natural Resources Officer (RNRO) sits on the Regional Secretariat, representing forestry. Reporting to the RNRO are District Executive Officers, below whom are District Natural Resources Officers.

The regional administration does not have jurisdiction over Catchment Forests. The Catchment Forestry Project (CFP) was launched in 1976 by the Forest and Beekeeping Division (FBD). In the Arusha Region, 118,921 ha of forest are covered by the project. In Kilimanjaro Region, it is 138,785, while in Tanga it is 107,499 (Kijazi, 2002). Catchment forests are considered 'core protected areas', and are administered from the CFP office in the FBD Headquarters, which reports to central government. Reporting to the CFP office are Regional Catchment Forest Managers – one in each region. Reporting to these are District Catchment Forest Managers. These managers receive funds straight from the CFP office, and must have a management plan for each of the forests within their jurisdiction. These two separate hierarchies are presented in Figure 3. At the district level, District Forestry Officers (DFOs) implement FBD activities, including revenue collection. Most of the time, local and production forests fall under the district administration, but catchment forests may also fall within their remit. Because DFOs collect revenues on behalf of the FBD, then all of those holding a diploma or better are paid by the FBD (Kijazi and Nashanda, pers. comm.).

The 1998 Forest Policy encourages community participation in the management of natural resources and this includes those communities adjacent to mangrove forest reserves. The Management Strategy requires that efforts be made to include local communities in different activities, from planning to implementation. Such activities include control of harvesting, planting mangroves in depleted areas, protection activities like patrols, and awareness creation (Kijazi, 2002).

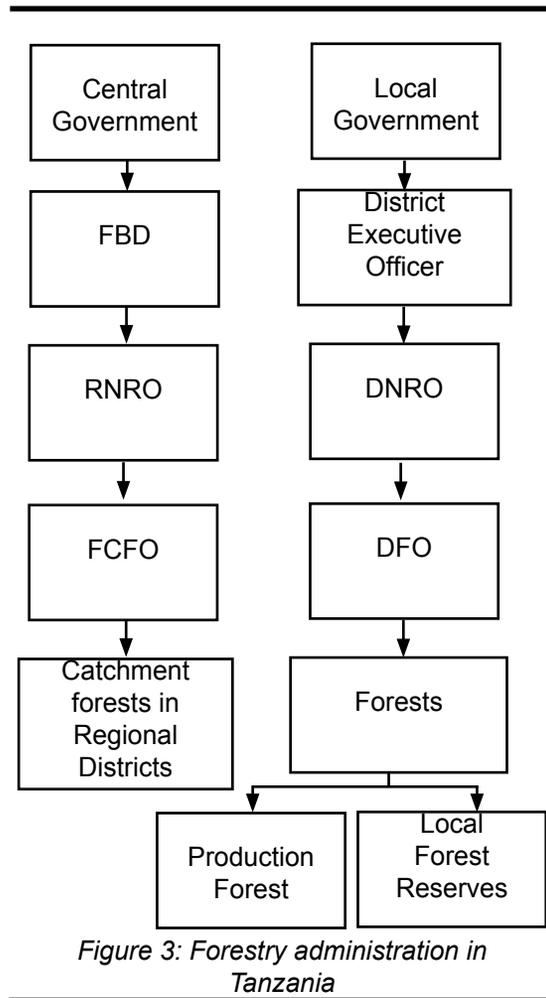


Figure 3: Forestry administration in Tanzania

In Kenya, forests are remarkably under-regulated, a fact borne out by the crippling rates of deforestation that have ensured that just 2–3% of the country is covered by forest. Urgent remedial measures carried out by the government, including significant reform of the Forestry Department and the introduction of a new Forestry Bill, have yet to bear fruit. Within Kenya's portion of the PRB, very few forest reserves remain, except for small patches of forest in the Taita Hills, Kenya's only representative of the Eastern Arc Mountains. Most of the difficulties associated with deforestation arising in Kenya relate to tree cutting across the border in Tanzania, providing an excellent example of the need for an adequate cross-border management strategy for the Basin.

D.3 Community-level administration

Ideas concerning the joint management of resources have, of late, become a much-vaunted option in the management of natural resources. Typically (but not always) the 'stakeholders' involved in the management scheme are the state and resource using communities. At this broad level of discussion, the concept of joint management is extremely ambiguous, in part, because of the need to develop Natural Resources Management (NRM) systems that are site and society-specific.

Typically, at these levels of managerial intervention, management seeks institutions as their building blocks. Institutions are "...the rules of the game in a society or, more formally...the humanly devised constraints that shape human interaction" (North, 1993: 3). In this sense, institutions form the limits within which daily lives are conducted. Care should be taken to understand that institutions are not static end products, but dynamic processes that alter to respond to external pressures, internal changes and conflict and other pressures. A society's institutions may play an important role in shaping how it develops its economies and, indeed, how it responds to external economies. Institutions are not organisations, the success and operation of which will often depend on institutions.

In much of the literature on common property resource management, it is traditional institutions that are recommended as the basis for co-managerial development (see examples in Berkes, 1989 and MacKay and Acheson, 1983). Typically, these are heralded as evidence that communities are capable of managing

Box 13: The development of community-based forestry management in the Duru – Haitemba Forest, Arusha Region

Above, the conflict that erupted between community members living alongside the Duru–Haitemba Forest and the Tanzanian government when the forest was turned into a reserve was described. Once it was clear that the forest was not benefiting from state management, and given that local government had few remaining resources with which to support forestry staff, it was decided to give the forest communities the opportunity to run the forest for themselves. The only condition stipulated was success: that the Duru – Haitemba became and remained uninhabited, that its degraded condition be reversed and that its products be exploited sustainably.

Early steps taken by the communities commenced with the demarcation of the forest into zones for which each peripheral community would assume responsibility. A very simple management plan was then produced for each zone. These plans stipulated (a) who could or could not use the forest (b) the forest uses that the communities allowed themselves to undertake (c) what uses could be effected only on a village-managed quota and permit system; and (d) what forest uses were wholly forbidden. Encroachers were promptly evicted, charcoal burning, ring-barking and forest clearing were banned, and non-local loggers 'encouraged' to leave. Damaged areas were closed off to community exploitation, while an increasingly nuanced range of regulations served to ensure that what exploitation did occur was sustainable. Sophisticated 'closed' and 'open' seasons were developed, allowing certain types of exploitation to occur in certain places at certain times of the year (such as grazing). Finally, young men from the communities were taken on to patrol the forest, and rewarded with a share of the fines they managed to collect (Source: Wily, 1997).

their resources. However, institutions are contextual and temporal, and are developed in response to particular social and economic needs set within particular times and places (North, 1993; Ostrom, 1990; Crean and Geheb, 2001). Hence, traditional institutions designed to manage forests may have worked well under conditions where user rights were in place, markets were restricted and populations low. Under opposite conditions, these institutions may have little managerial value. Nevertheless, they retain attractions because they may be socially and culturally more attractive than novel, externally-derived institutions.

A second batch of institutions of potential managerial value are government implemented structures and organisations that have been in place for a sufficiently long time that communities view them as 'normal' within the remit of their daily lives. In this sense, such structures have become institutionalised to a host society.

As discussed earlier, Tanzania has been keen to establish Community-based Natural Resource Management (CBNRM) institutions in virtually all of its resource areas. In the Pangani River Basin (PRB), amongst the most important are Water Users Associations (WUAs) and Village Natural Resources Committees (VNRCs). Attention is given to both of these in this section.

Tagseth (2002) identified two types of village-level furrow organisation. The first of these is centred on unnamed and informal groups of users described above, lead by a chairman who organises users into work groups to maintain the furrow in return for an allocation of water. Chairmen have typically owned their furrows for generations. This historical claim of the organisation over the furrow and its water means that the organisation perceives seeking permission to use the furrow's water from, for example, the PBWO, as completely alien.

The second type of furrow organisation identified by Tagseth (2002) is much more formal. Its leader is either elected or appointed. There are more rules governing, for example, contributions towards the scheme and water allocation. Access to water is regulated with the use of membership fees, fines for violations and possibly bribery.

It is clear that the first of these two types of institutions is the least formal, which may render it unappealing to government administrative systems keen to develop bureaucratic structures and clarity. It is, however, also based on traditional social structures and ideologies which probably mean that (a) it is better able to deal with very localised difficulties and conflicts; and (b) it is more compatible with local perceptions and ways of thinking. In this sense, the first, informal, institution is better able to deal with the high levels of social, resource and cultural heterogeneity present in the PRB, while the second may not be able to deal with these kinds of vagaries.

Earlier, thoughts criticising the establishment and implementation of WUAs were discussed. It was claimed that irrespective of the community emphasis contained in this approach, WUAs still represented impositions on communities which they had little respect for (PAMOJA, 2002). It should be stressed, however, that such institutions, despite being imposed upon communities, may still become 'socialised', in the sense that they may be warped to meet communities' needs and so as not to endanger community livelihood claims. This may not mean that the institution then delivers a desired managerial outcome, however. In order for this to occur, management objectives must also, in some way, curb communities' fears and, to some extent, ensure that it contributes to meeting their aspirations. In order for this to occur, communities must play an important role in the design and implementation of management systems, in particular associated sanctioning (punishment) systems.

The Catchment Forestry Project (CFP) in Tanzania manages forests jointly with local communities adjacent to 23 catchment forests on a pilot basis. 36.5% of the forest in the three Tanzanian regions sharing the Pangani River Basin (PRB) is under Joint Forest Management (JFM: Table 6). The main community component of this initiative are the Village Natural Resource Committees (VNRC). Each VNRC has between 8 to 15 members who are democratically elected. At least two members must be female. About 129 (70%) of the VNRCs participate in planning and decision-making, as well as sensitising and mobilising villagers in JFM. Draft management plans for nine priority Community Forest Reserves (CFRs) have been produced, including Mt. Kilimanjaro, Chome and Kindoroko CFRs in Kilimanjaro region and Kwani/Tongwe and Mafi Hill forest reserves in Tanga region.

The Tanzanian Forestry and Beekeeping Division has also implemented the Mangrove Management Project (MMP), which it launched in 1988. This started with the preparation of a management plan for the mangrove ecosystems of Tanzania's mainland. The management strategy devised required that efforts were made to include local communities in different activities, from planning to implementation. Such activities included control of harvesting, planting mangroves in depleted areas, protection activities like patrols, and awareness creation.

The MMP has involved 100 out of 130 villages adjacent to the mangrove forests in their management. Furthermore, the project has been improving the mangrove stock through climber cutting in 430 ha, and promoting alternative income-generating activities for local communities, such as seaweed farming and beekeeping activities (Kijazi, 2002).

The MMP has rehabilitated 1,300 ha of mangrove forest out of a planned 2000 ha, of which 100 ha were rehabilitated voluntarily by villagers and environmental NGOs. The performance of newly planted stock varies from 80% to 40%. It is especially poor in areas where paddy farming is practiced, such as the Rufiji Delta, due to the reluctance of some plot owners to allow mangrove regeneration.

VNRCs co-operate with project management by observing harvesting procedures. Through this supervision, revenue realised by Central Government has increased from Tshs. 12 million in 1999/2000 to 17 million in 2001 from pole sales and management fees from salt pans (Kijazi, 2002).

Insofar as creating alternative income-generating activities, the MMP has introduced 830 traditional and 28 transitional beehives to the mangrove forests in 2001. In addition, seaweed farming is practised along the coast.

Table 7: Forest area under Joint Forest Management by region

Region	Area (ha)	# villages involved
Arusha*	7,0248	70
Kilimanjaro	122,996	63
Morogoro	58,579	33
Tanga	15,233	19
Total	267,056	185

(Source: Kijazi, 2002). *includes Manyara Region.

In the process of awareness creation, a mangrove ecology teaching programme was held in 47 primary schools in the Northern and Southern Zones. Village meetings, radio programmes and interactive video shows were also employed.

Box 14: An example of a Water Users' Association

Tegemeo WUA, Kawaya Village, Hai District

Tegemeo was formed in 1999 by the PBWO to solve the problems of water distribution in five villages in Hai District. 5,000 people use the water that Tegemeo abstracts, but only 300 are registered with the WUA. People, it says, need to be educated about the benefits of membership. These are (a) that they will learn about water policy and law (b) that they can get water rights more easily (c) that they can attract donor and NGO interest (d) they can rehabilitate their water infrastructure more easily as a group; and (e) they can try to solve their problems as a group. Their main water sources are a series of springs. The water is fed into traditional furrows, often named after the people who initially dug them. Some are very long – the longest is 14 km. Tegemeo presently has three water rights totalling 720 L/s, and has applied for additions. The WUA collects users' fees from the plots that line the channels, and every user will have to pay irrespective of whether or not they are members of the Association.

Users at the beginning of the furrow tend to benefit far more than those at the end of it. The Association has byelaws limiting the amount of water that users at the source end of the furrow can take, but people cheat. Another problem that they face is that it is very flat in the area. In the absence of a gradient, their water often pools and does not flow. Additional problems that they faced are, amongst others:

- Conflict between upstream and downstream water users.
- Cultivation in water source areas and tree felling.
- Paddy farmers often do not release unused water back into the furrows.
- Salinity.
- Pastoralists bring their livestock to water off the furrows and damage their banks.
- The WUA's jurisdiction is very large and it is often difficult for WUA members to get to problem spots.
- Their water is not clean. During the rains, the water table rises, flooding latrines. Some people do not boil the water that they collect and so get sick.
- Irrigation for long periods of time reduces soil fertility.

Source: Tegemeo Water Users' Association and Kawaya Village Government

D.4 Transboundary basin management

Facilities to manage the resources of the Pangani River Basin (PRB) between its benefactor states of Kenya and Tanzania are limited. Efforts to remedy this difficulty have largely been based around IUCN - EARO initiatives to conserve Lake Jipe. In Kenya, the Coast Development Authority (CDA) has the mandate to co-ordinate and plan developments in the Kenyan portion of the PRB. In 1993, it was determined that the CDA should work towards a comprehensive management and development plan for those parts of the Basin located in Kenya, as well as looking into ways of dealing with the specific problems of Lake Jipe. The CDA felt that they should co-operate with similarly mandated counterparts in Tanzania (Howard, 1999).

In 1994, the CDA and the Pangani Basin Water Office (PBWO) met in Mombasa, Kenya to discuss common interests and possible ways of working together to develop a coordinated management system for the Basin, wetlands and the open waters of Lake Jipe. In 1996, the PBWO and the CDA finalised their assessments of the needs of the Lake Jipe catchment and its wetlands. In 1999, the CDA, PBWB and other stakeholders participated in a workshop to develop mechanisms to manage Lake Jipe (Howard, 1999).

The PBWO has now taken the matter of waterweed on Lake Jipe to the legislative assembly of the East African Community for Action. Since then, the momentum has slowed, and the need to develop some mechanism by which to co-ordinate management between the two countries remains as important as ever. This is particularly true in the light of recent Kenyan developments that have seen the creation of Water Resources Management authorities. What their creation means for the Pangani River Basin and how they will liaise with their Tanzanian counterparts is still not known.

D.5 Data collection and monitoring

A persistently raised cause for concern amongst the professionals interviewed for this Situation Analysis and in the literature on the Pangani River Basin (PRB) relates to the absence of adequate data on the Basin. Typically, these concerns focus on the absence of hydrological data, and the worry is that a regulatory system based on the issuance of water rights must be able to know the size of the water stock. There exist, on the PRB's rivers, many hydrological stations. For a variety of reasons – such as poor maintenance and batteries running out – many of these have not operated for a statistically adequate length of time. In some cases, stations have stopped running after just two years of operation, and nothing has been done to return them to service.

It is possible to carry out manual measurements, but the incentive for the technician to do so had, informants claimed, to be balanced against his/her inadequate remuneration. Respondents typically seemed preoccupied with the development of an automated hydrological network against which manual measurements could be compared, and which could serve as the backbone of a substantial monitoring system.

Monitoring, of course, does not only comprise the collection of data. The translation of such data into a regulatory system is worthwhile only insofar as some sort of regulatory back-up is available to ensure that these data play a managerially significant task. Hence, knowing how much fish is available to the Nyumba ya Mungu Dam has no relevance if that information cannot translate into a managerial output. In much the same way, the development of an automated hydrological data collection system makes no sense if illegal water abstractions cannot be prevented.

It is also important to emphasise that data on the technical dimensions of resource change (such as reduced flows, or variations in forest area) only yield information on the outcomes of trends and processes occurring elsewhere, typically in social and economic arenas (although not always e.g. climate change). If the causes of environmental and natural resource change have social and economic origins, it is necessary to develop dynamic systems of monitoring socio-economic variation, the underlying causes of these and the development of conflict. Such systems should also be capable of determining water demand within the Basin.

D.6 Summary of points

The administration of the Pangani River Basin's (PRB) natural resources is sectoral. The activities of forestry departments are not necessarily synchronised to some wider and over-riding PRB management plan, but the outcome of forestry policies, in much the same way that the activities of institutions responsible for water management react to the nation's water policy. This sectoralism permeates down into local-level administrative strategies. Hence, Village Natural Resources Committees utilised in Joint Forestry Management are not the same as Water Users' Associations. Communities located close to fisheries and protected areas, may also be obliged to create Beach Management Units and wildlife protection committees as per the policies of the Wildlife Division and the Fisheries Division. The plethora of village-based organisations in Tanzania overlay previously created ones like Village Governments. In many respects, the tasks that each group is charged with are not dissimilar to the tasks other groups are charged with. Ultimately, all of these organisations have to deal with the fair division of resources within a community, their sustainable exploitation and their conservation.

From the above discussion, the following points are emphasised:

- The WRM Act gives executive powers to the Pangani Basin Water Board to prepare basin water management plans and upon which to base water allocations. The new water legislation has put in place a streamlined administrative hierarchy and a clear institutional set-up with the necessary powers to implement the policy and legislation. Kenya's water resources are distributed over six catchment areas of five drainage basins namely the Lake Victoria which comprises a North catchment and a South catchment; Rift Valley; Athi; Tana; and Ewaso Ng'iro. The portion of the Pangani Basin that lies in Kenya is within the Athi Catchment. The 2002 Water Act shaped a new institutional framework for the management and protection of Kenya's water resources at national, catchment and sub-catchment levels.
- The Forestry and Beekeeping Division appears not to have any similar plans for restructuring, and forestry administration within the Basin remains dualised between national and regional level administrations, and between the two countries that share the PRB.
- Both the water and forestry policies in the Basin increasingly emphasise the use of community-based organisations in their implementation. Concerns have been raised as to the extent to which these organisations have been imposed upon communities. If communities have not been involved in the design and implementation of these organisations, there may be negative repercussions on management outputs. An understanding of this problem may yield important lessons for Kenya as it seeks to include users in the management of the nation's resources.
- The transboundary management of the Basin is nascent. There exist, however, authorities with a mandate to manage and develop it on both sides of the Tanzania-Kenya border, and discussions geared towards identifying management solutions to the Basin's problems have commenced.
- The data collection and monitoring network within the Basin appears to be poor, irrespective of the resource sector. This Chapter has cautioned that emphasising data collection as integral to a management system makes no sense if the data cannot generate a managerial follow-through. It also emphasises the need to develop methods of monitoring social and economic change, and of establishing what the Basin's water demands are, in addition to the technical parameters of resource change.

The next Chapter sets out to summarise the 'issues' that confront the Pangani River Basin. It commences with a summary of the issues gained from the proceedings of a recent Pangani River Basin workshop, along with those raised during interviews conducted for this Situation Analysis. The Chapter evaluates these issues as a basis for establishing priority areas for action, and suggestions in this respect are provided in its final section.

E Pangani River Basin problems and issues

E.1 Introduction

This Chapter is based on two sources of information. The first is the proceedings of a workshop on the Pangani River Basin, held in May 2002 in Moshi. The second is the interviews conducted for the purposes of this Situation Analysis. This Chapter is an attempt to assemble the perspectives of various stakeholders on the Pangani River Basin (PRB) as a potential basis upon which to identify priority areas for future action. The PRB's issues are divided between environmental issues, socio-economic and political issues, issues of management and administration, areas for research and, finally, the thoughts of respondents on what the management priorities of the Basin should be. On the basis of these issues, the concluding section lays out a number of priority areas for action.

In almost every case, the issues considered below occur against a background of rapid and high population growth and attendant increasing population densities. The finite nature of the Basin's resources ensures that population increases and slow developmental growth within the PRB may create the problems and issues considered here, or else exacerbate them.

E.2 Problems and issues of the PRB

Environmental issues

Amongst the Basin's most serious difficulties is deforestation, which directly affects its water retention capabilities, increases runoff and hence causes erosion within the Basin. Downstream, such processes ensure that flooding may occur and that the silt load of the Basin's watercourses is considerable.

In some measure, deforestation has been wrought by high demands for forest products. Many of the Basin's remaining forests contain highly valuable timber, which, in the absence of any effective monitoring and sanctioning system, is logged fairly easily. Forests are also exploited for charcoal production, as well as for fuelwood to meet domestic demand. In addition, the Basin's forests often occupy prime agricultural areas. The Eastern Arc forests, for example, are located in high altitude areas where rainfall is good. As populations within the Basin increase, the amount of human settlement along forest edges has grown, escalating the risk of forest fires. Fire is also used to clear land for agriculture.

In many cases, the farming practises employed have been developed at times when resources were considerably more abundant than they are now, and may not be compatible with conditions of resource scarcity. Hence, much of the traditional irrigation within the Basin is highly inefficient and was developed against a background of ample per capita water supplies. As water abstractions have increased with population densities, these farming systems can have serious impacts on the Basin's environment. These pressures have prompted farming along riverbanks, in stream-valley bottoms and spring sources. Increased siltation has repercussions for the river course (it may prompt meandering), as well as for down-stream industry, particularly hydropower water retention facilities.

The high farming intensities in the Basin have ensured that soils are increasingly exhausted as crop rotation systems are replaced by perennial agriculture. Because land is now rarely fallow, it has to be irrigated to maintain outputs. The Basin's traditional water abstraction systems are very inefficient and the amount of water reaching crops may be up to 85% less than at the point of abstraction. Repetitive irrigation increases the likelihood of soil salinisation and/or sodicity. The very large number of abstractions in the Basin, furthermore, have reduced water flows, presumably including the amount of water available for environmental maintenance.

In the Basin's lowland areas, it would appear that livestock numbers have increased considerably, while the amount of pasture has declined as a result of agricultural development. This has prompted concerns for livestock over-stocking and consequent degradation of pastoralist lands.

As development within the Basin increases without any concomitant waste disposal systems, so too the likelihood of pollution at both local and Basin-wide levels has increased. Water quality concerns also arise in a different form – locally high levels of fluoride content can have serious consequences for riparian populations.

Like elsewhere in Tanzania, overfishing within the Basin is a problem, with its coastal and Nyumba ya Mungu (NYM) dam fisheries being of particular concern. In Lake Jipe, the growth of waterweed has been so substantial that fishing is impeded. The latter has itself been prompted by increased nutrient inflows coming down from agricultural areas on Mt. Kilimanjaro and the North Pare Mountains. Elsewhere in the Basin, water hyacinth is a problem.

The problems facing the Basin's swampland are contrary. On the one hand, the drainage of swamp has serious repercussions for the regulation of river flow, as well as the biodiversity supported by such wetlands. On the other hand, the training of watercourses (including those that pass through swampland) can increase the amount of water available downstream, particularly for hydropower production. It is not only the water retained by such swamps that reduce river flows, but also the increased evapotranspiration rates that they imply.

Uncontrolled mining can adversely affect landscapes and may even have pollution implications if the extraction of minerals from ore requires the use of chemical processes. Sand mining in river courses can undermine the stability of riverbanks.

Many of the above trends occur against a background of considerable environmental ignorance. On the one hand, these relate to the absence of data concerning the Basin's flows and the water needed to meet environmental demands. On the other hand, many of the Basin's population are unaware of the environmental consequences of their economic activities.

The high intensity of resource exploitation, development, manipulation and change within the Basin has very serious consequences for the Basin's biodiversity. The PRB contains some of the globe's most outstanding biodiversity resources with high levels of associated endemism and many restricted range species. Much of this (but by no means all) is forest-based. With so many of the Basin's resource bases threatened in the ways described above, these biodiversity resources face very real and serious threats.

Socio-economic and political issues

Like many of Tanzania's other populations, most of the Pangani River Basin's (PRB) inhabitants are not wealthy. Although the Basin contains substantial urban conglomerations, these are not sufficiently large to absorb much of surplus labour contained within its rural areas. Many (if not most) of the Basin's inhabitants are under-educated and/or under-skilled. In any case, even if skills were available, it is doubtful that the labour market is sufficiently developed to absorb them. Development within the Basin - as elsewhere in Tanzania - has failed to yield alternative income-generating opportunities that match the technical and skills levels of the Basin's inhabitants.

As a result, the only source of livelihood available to many in the Basin is primary i.e. a livelihood based on the direct exploitation of the Basin's natural resources, be it forests, fisheries, wildlife resources or, most importantly, agriculture. For many, the success of these small-scale ventures is directly related to land and water availability. As populations increase, however, so too does conflict between various types and scales of users. As a result, this Situation Analysis has presented examples of the conflict that occurs between upstream and downstream users, as well as that between large-scale and small-scale ones.

Of course, conflict is but one manifestation of competition for resources. As this intensifies in upstream areas of the Basin, agriculturalists are forced to travel downstream to attempt agriculture in less than adequate farming conditions. As discussed earlier, this takes land out of pastoralist production, bringing agriculturalists into conflict with livestock herders.

As described above, much of the land use within the Basin can have very serious environmental repercussions. Indeed, the nature of these consequences may directly impinge upon the ability of the land to support the economic uses to which it is put. In some cases, the political support to alter or stop these trends is absent or even contrary, with politicians encouraging people to over-exploit resources in order to garner votes.

A final political problem voiced by respondents was that the Central Government of Tanzania, in its efforts to implement policy, may make management and resource-related decisions without reference to administrators and resource managers within the Basin. Of particular concern were large-scale developments (such as irrigation schemes and mining concessions) that were perceived to provoke additional, localised, conflict or to seriously impact the condition of the resource.

Issues of management and administration

The Basin's natural resource management legislation and policy is, in many cases, adequate, but is only potent insofar as it is supported by effective monitoring and law enforcement. Monitoring entails not only the ability to observe illegal resource use, but also the ability to gauge resource production and change. For example, the absence of an adequate water flow monitoring network means that the water authorities do not know how much water travels through the Basin, and cannot therefore allocate water rights on this basis. Similarly, there exists no methodology for monitoring and gauging the social and economic causes that underlie much environmental degradation and resource over-exploitation.

Monitors assigned by the state to keep an eye on resource trends and exploitation may be disinclined to monitor the resource if they are not adequately remunerated to do so. Poor remuneration may also be the basis upon which officials are bribed to turn a blind eye on illegal resource use. Low levels of expertise, or the absence of adequate technology, may also compound resource monitoring difficulties.

Funding problems may affect other aspects of the management system. In the absence of adequate finances, for example, it is difficult to see how an adequate monitoring system may be implemented within the Basin, regardless of the resource involved. Lack of funding may also ensure that such data as can be collected may not be analysed or findings correctly interpreted. Finally, funding difficulties may also impede the development of managerial capacity and efficiency.

In addition, management may be undermined by the manner in which it is arranged. In the Pangani River Basin (PRB), this problem appears to occur on two levels. On the one hand, management is not integrated, so that management activities in one sector – such as the development of irrigation – may have serious repercussions in other sectors – such as water conservation. On the other hand, the lines of authority often appear confused, with overlapping administrative jurisdictions or, indeed, inadequate jurisdictions. Hence, the Tanzanian system of central and regional government ensures that there are potentially two administrative actors involved in the management of any one resource. In Kenya, the developmental mandate of the Coast Development Authority appears to overlap with that of the newly created Water Resources Management Authority.

Communities of resource users can solve many of the problems of administrative confusion and inadequate monitoring via different degrees of participation. In the PRB, the implementation of this process has faced a number of problems. First, many of the structures by which it is intended that communities should be involved in management have been imposed upon them, with no community participation in administrative design, in the implementation of management strategies or the sanctioning of offenders. Second, because communities may not have much input in management design and implementation,

these types of systems may actually undermine the ability of communities to meet livelihood needs or their ability to compete effectively against other resource users. Thirdly, a plethora of various resource 'committee' types have been created throughout the Basin, instead of simply increasing the mandate of pre-existing village governments. Hence, village-level administration has been complicated and many Natural Resource Management (NRM) committees have overlapping or contrary jurisdictions. Finally, the lines of communication between central NRM authorities and communities may be inadequately developed. As a result, community demands and views may be overlooked or unrecognised. In the same way, the resource management or conservation goals of centralised NRM authorities may not be understood – or even wholly misunderstood – by communities.

The administrative and bureaucratic process may hamper or undermine well-intentioned management gestures. For example, communities of resource users are empowered to create bye-laws which have the recognition of central government, regional and district authorities. However, the process of endorsing these may take so long that a community's initiative and managerial momentum is undermined and authorities perceived not to be supporting them.

The Pangani River Basin (PRB) is a cross-border resource. The mechanisms needed to ensure that management in both Kenya and Tanzania is harmonised do not exist.

Areas for research

The above difficulties are, in many respects, exacerbated by the absence of clear and adequate data on the trends and processes that shape the Pangani River Basin (PRB), and affect its management. There is no clear understanding of how the Basin's increasing population will affect its resources in the future. Nor is there a good understanding of what kinds of Natural Resource Management (NRM) techniques can be employed that are able to operate under such population densities.

Many of the research demands in the Basin concern its water and hydrology. Thus, while the total number of licensed abstractions are known, accumulated illegal abstractions are unknown. In addition, the amount of water required to maintain the Basin's environmental systems is also unknown. The implications for the Pangani River of its training through the Kirua Swamps requires additional research (although see IVO – NORPLAN, 1997). The contribution of Kilimanjaro's snowcap to the Basin's water flows is unknown, as are the implications of the cap's reduction.

Finally, little research has been carried out to identify effective management practises that will be able to cope with the Basin's particular characteristics and problems. There is no understanding of how water may be adequately and fairly distributed between up-stream and downstream users. There is no knowledge of how a management system can be efficiently monitored and implemented in an environment characterised by inadequate and intermittent funding, limited technical inputs, low skill levels and poorly developed community involvement. Importantly, the development of management systems capable of surviving under such constraints into the future has not occurred. Finally, an effective institutional basis upon which the integrated management of the Basin's resources has not yet been developed.

The management of the PRB

Discussions that occurred during the May 2002 Workshop on the Pangani River Basin, as well as interviews carried out in support of this Situation Analysis, suggested a number of options that management of the Basin may wish to consider. Amongst these was the argument that the Basin's inhabitants need to be aware of the PRB and the functions that it plays. Complaints have been raised that the river basin is not adequately recognised as an administrative unit, and that vested administrative and bureaucratic interests do vie to maintain the country's regional and national administrative emphasis. Funding, respondents said, needs to be adequate, and associated remitting mechanisms need to be efficient.

The management of the Basin will need to ensure that government departments are coordinated with other managerial institutions. Good quality data needs to be collected to inform management, and management should be integrated. Finally, amongst a number of macrolevel planning suggestions put forward was that the management of the PRB be linked to population growth control strategies.

Given that many of the Workshop's participants and the individuals interviewed for this Situation Analysis came from the water sector, many of the management suggestions obtained were concerned directly with water use and its regulation. Hence, it was suggested that management will need to follow clear work plans, which should contain measures to deal with water loss and inefficient water use. Management will need to be able to cater for the fair and adequate allocation of water, and illegal or inappropriate water use must be monitored and sanctioned. Water abstractions should be licensed so that abstractions can be monitored. The management of the Basin, respondents argued, would also need to be able to reverse the degradation of water sources, and the PBWO should have an improved fee-collection structure.

Some Workshop participants felt that water shortages were not adequately recognised in Tanzania's policies and that this needed to be remedied. In order to ensure that stakeholders' views are adequately represented in the Basin's water management, calls were made for better stakeholder representation on the PRB Water Board. Finally, an adequate strategy is needed to oversee the implementation of Tanzania's new Water Policy.

Following the National Water Policy 2002 (NAWAPO) as approved by the Cabinet on July 21, 2002, the National Water Sector Development Strategy (NWSDS) was prepared. The NWSDS sets out how NAWAPO, will be implemented and describes the institutional and legislative changes necessary so that the specified actions contained in the NWSDS can be implemented. On Institutional frameworks for water resources management the NWSDS say: "Water is a national and international resource, which cuts across villages, districts, regions, national and international administrative boundaries and can only be effectively managed on the basis of water basins through Basin Boards and Catchment Committees. Representation from district councils and lower local government authorities to these Boards and Committees is arranged so as to ensure the presence of the elected voice of the people during core decision making regarding water resources conservation, management, allocation, development and utilisation." The NWSDS further states: "The NWSDS support re-alignment of the water related aspects of other key sectoral policies with the National Water Policy, and to provide a focus on specific roles of the various actors through clearly defined roles and responsibilities and hence the removal of duplications and omissions." In order to provide the enabling legislative framework for water resources management a Water Resources Management Bill and enacted into law by parliament in April 2009.

E. 3 Priority areas for Action

On the Basis of the above discussion, three priority areas for action are identified:

1. *The development of integrated management strategies for the PRB along with attendant forums.* There appears to be little doubt that the Pangani River Basin (PRB) urgently needs integrated management strategies that can cope with the diverse and complicated issues that have been described in this Situation Analysis. As such, it is proposed that the first priority area that needs to be considered is the development of such strategies. Within this remit, attention is drawn to the following constituent parts of any such strategy:
 - Integration is necessary in the environmental perceptions of planners and administrators to ensure that management adopts holistic, basin-wide planning strategies capable of dealing with the diversity of resources and problems confronting the PRB.
 - It is important that the river basin should be seen as an administrative unit around which management integration can occur and resource conflicts can be resolved. It is also important that the use of the river basin as an administrative unit need not be contrary to the fulfilment of national and regional administrative and policy objectives.

- An additional administrative device that could be considered is the adoption of Water Demand Management (WDM) (see A.2 above). Given that such evidence as is available suggests that the Basin's water supply is stressed, and that present demand outstrips supply, the implementation of mechanisms that serve to conserve water and encourage its efficient use would be valuable within the context of the Basin's integrated management.
 - There is some sense in constructing strategies that can, in their early stages, be implemented incrementally as logistics and funding permits. In the absence of adequate logistical and financial support, strategies that can only work via an immediate, blanket, application are likely to fail. One possibility is to focus planning on the sub-basin.
 - The multitude of community-based institutions dealing with all sectors of natural resources exploitation is confusing and administratively inefficient. Hence, it makes sense to consider ways in which broad-spectrum local institutions can be developed with the capability and power to tackle all natural resource management difficulties within their jurisdiction. Each institution will require state support, particularly in the form of endorsing community byelaws, and supporting community management initiatives.
 - Land use planning should be considered an integral planning strategy from the outset.
 - Planning strategies should be matched against an understanding of capabilities and funding in the long run. It makes little sense to develop planning strategies dependent on funding, data and logistical support that will either disappear once donor funding is withdrawn or which do not match the underlying institutional make-up of the Basin.
2. *The development of effective strategies to facilitate dialogue amongst and between resource users and managers of different types and involved in different sectors with a view to improving awareness at all levels of management.* Mechanisms are needed to ensure that opportunities for dialogue opportunities between and amongst stakeholders and managers are maximised, so as to ensure that two-way exchanges of information may occur, dissemination improved and the knowledge of how stakeholders all play a part within the well-being of the Basin delivered. It is necessary that awareness is created about all aspects of the condition and management of the Basin and its stakeholders at all levels of management and its co-ordination. It is suggested that forums be developed for this purpose, the mandate of which will extend to the resolution of conflict.

In addition, such forums could have administrative and executive powers, in which all sectors of the Basin's administration are represented. An important component of this process is ensuring that adequate lines of communication and dialogue are established between the upper echelons of administration with the lowest, community-levels.

The possibility of using radio and other forms of mass media must be considered as possible avenues for the development of dialogue and effective, two-way, information dissemination. Care should be taken to ensure that all stakeholders and managers are aware of new policy developments and changes to resource administration and regulation. The role of forums developed for the purposes of integration should be expanded to include dialogue responsibilities and information exchange. These initiatives could be backed up with extension initiatives, which could also be used to obtain an impression of local concerns and grievances.

3. The identification and development of an adequate data collection and monitoring system. This action area is not restricted to the development of data collection systems for hydrological data. Satellite and GIS assessments of land use, exploitation rates and geographical change are pre-requisites for the development of land-use planning and monitoring. In addition, methodologies designed to monitor and gauge social and economic change and the development of conflict need to be identified and implemented. The data and monitoring systems recommended must match local funding and maintenance capabilities. Finally, the use of community-based natural resource management organisation as a way of monitoring resource use should also be explored.

F Conclusions

F.1 Synthesis of findings

It will be recalled that the first objective of the Situation analysis was *to identify the resources that occupy the Pangani River Basin (PRB) and the processes and events that affect them.*

The Pangani River Basin has a very wide diversity of resources. Some of these, and the important role they play in the Basin, are as follows::

- Forests play a crucial role in the PRB's hydrology, serving to regulate water run off, minimise erosion, store and purify water. In the PRB, they also make a vital contribution to global biodiversity.
- Water in the PRB is integral to the Basin's agricultural economy, its power generation, its urban, industrial and domestic demands and to livestock. It sustains all life in the Basin.
- The Basin contains four protected areas (PAs). Kilimanjaro, in particular, plays an important role in the nation's tourism economy, and also harbours a wide array of plant and animal species. The Mkomazi Game Reserve and Tsavo West National Park are examples of the Maasai – Somali Regional Centre of Endemism (RCE).
- The Basin's biodiversity is almost unparalleled globally, and the centre of a great deal of international interest and conservation concerns.
- The PRB's fisheries make important nutritional and economic contributions to the Basin's rural communities.
- The fertile volcanic soils of the Pangani River Basin are the basis of its agricultural economy, and turned it into the 'breadbasket of Tanzania'.
- Mining plays an important role in the nation's economy and in the generation of employment. Its benefits must be considered against its negative impacts, including pollution of the environment and the destabilisation of riverbanks.

The threats faced by the Basin's resources are almost all related to over-exploitation. At their core, these threats relate to an increasing population against a background of high levels of poverty. Poverty and environmental degradation are often perceived to be interlinked (cf. WCED, 1987). The problems of managing Common Property Resources (CPRs) are often thought to increase when there are large numbers of people involved, particularly when their cultural homogeneity may be weak (cf. Ostrom, 1990). The structure and function of rural livelihoods may become imperilled when the ability of rural people to control and secure adequate sources of livelihood is threatened.

Above, the stakeholders of the Basin and their interests were described as follows:

- The major interests within the Basin comprise industrial interests (electricity, mining and farming), farming (large and small scale farming, both associated with a considerable reliance on irrigation), pastoralist interests (particularly in lowland areas), and growing urban interests. Operating between these diverse interests and the multiplicity of natural resources within the Basin are NGOs and international donor agencies. The mandate of these is primarily conservation and/or the development and enhancement of rural livelihoods.
- It is important to note that the population of the Basin is high. For a large proportion of this population, livelihoods are derived from farming, and there is much to suggest that they are economically vulnerable. In addition, the diversity and richness of the Basin's resources mean

that large(er)-scale interests are attracted to the Basin, and substantial investments have been made. There exists, between these large-scale interests and small-scale livelihood security, room for conflict.

- This Situation Analysis has divided the PRB's conflicts into three broad categories. The first relates to conflicts of scale, in which it was argued that small-scale users often have to compete against much larger and more powerful claims for the same resource. The second conflict area identified related to conflicts of tenure. 'Tenure' here relates to the right to manage one's resources. It was pointed out that it is increasingly popular in Tanzania to assign communities of resource users with various types of associations and/or committees with which to manage their resources. The hope is that the creation of such institutions will yield better management outcomes. It was argued, however, that the way in which these institutions were often imposed upon communities, who then had no input into their design, goals or regulations, could potentially undermine the quality of their outputs. The third class of conflict related to location. Here, the way in which the location of a group of resource users can bring them into conflict with users elsewhere, was considered. The classic example of such 'location' conflict arising between upstream and downstream users was provided. Here, downstream users suffer from the excesses of upstream users.

Chapter D argued that the administration of the Pangani River Basin's (PRB) natural resources is sectoral. The activities of the Forestry and Beekeeping Division is not necessarily synchronised to some wider and over-riding set of PRB management strategies, but the outcome of forestry and beekeeping policies, in much the same way that the activities of the Pangani Basin Water Office (PBWO) reacts to the nation's water policy.

This sectoralism permeates down into local-level administrative strategies. Thus, in Tanzania's Village Natural Resources Committees utilised in Joint Forestry Management are not the same as Water Users' Associations. Communities located close to fisheries and protected areas, may also be obliged to create Beach Management Units and wildlife protection committees as per the policies of the Wildlife Division and the Fisheries Division. The plethora of village-based organisations in Tanzania overlay previously created ones like Village Governments. In many respects, the tasks that each group is charged with are not dissimilar to the tasks other groups are charged with. Ultimately, all of these organisations have to deal with the fair division of resources within a community, their sustainable exploitation and their protection from outsiders.

In Kenya, conversely, very few such groups exist, although new natural resource policies increasingly seek to incorporate users into their management structures.

Chapter D emphasised the following points:

- The WRM Act gives executive powers to the Pangani Basin Water Board to prepare basin water management plans and upon which to base water allocations. The new water legislation has put in place a streamlined administrative hierarchy and a clear institutional set-up with the necessary powers to implement the policy and legislation.. In Kenya, the New Water Policy sees the creation of a Water Resources Management Authority and the inclusion of stakeholders in catchment management.
- The Forestry and Beekeeping Division appears not to have any similar plans for restructuring, and forestry administration within the Basin remains dualised between national and regional level administrations. In Kenya, the restructuring of the Forestry Department has yet to yield dividends. This may be of little consequence to the well-being of the Kenyan part of the basin, which suffers mainly from the consequences of deforestation in Tanzania.

- Both the water and forestry policies in the Basin increasingly emphasise the use of community-based organisations in their implementation. As far as Tanzania is concerned, there are worries over the extent to which these organisations have been imposed upon communities. If communities have not been involved in their design and implementation, management outputs may be less than satisfactory. The lessons that the Tanzanians learn from these experiences may be valuable in the design and implementation of similar systems in Kenya.
- The data collection and monitoring network within the Basin appears to be poor, irrespective of the resource sector. This Chapter has cautioned that emphasising data collection as integral to a management system makes no sense if the data cannot generate a managerial follow-through.

The second Objective of the Situation Analysis was to *identify a series of broad action areas wherein interventions may feasibly be delivered.*

Chapter E drew of the proceedings of a workshop on the Pangani River Basin and a series of interviews with Basin stakeholders to list the problems and issues of the Basin. Based on this, three areas for priority action were identified. These were:

- *The development of integrated management strategies for the PRB along with attendant forums.* There appears to be little doubt that the Pangani River Basin (PRB) urgently needs integrated management strategies capable of coping with the diverse and complicated issues that have been described in this situation analysis.
- *The development of effective strategies to facilitate dialogue amongst and between resource users and managers of different types and involved in different sectors with a view to improving awareness at all levels of management.* Mechanisms are needed to ensure that dialogue opportunities between and amongst stakeholders and managers are maximised, so as to ensure that two-way exchanges of information may occur, dissemination improved and the knowledge of how stakeholders all play a part within the well-being of the Basin delivered. It is necessary that awareness is created about all aspects of the condition and management of the Basin and its stakeholders at all levels of management and its coordination. Additional components of this priority area are the development of forums capable of assuming this task, as well as serving as a mechanism to remedy conflict, and to bridge gaps between different levels of administration.
- *The identification and development of an adequate data collection and monitoring system.* This action area is not restricted to the development of data collection systems for hydrological data. A satellite and GIS assessment of land use, exploitation rates and geographical change is a pre-requisite for the development of land-use planning and monitoring. The development of methodologies to assess and gauge the underlying social and economic causes of environmental degradation and resource over-exploitation also needs to be identified. Such systems should also be capable of identifying water demands within the Basin. The data and monitoring systems recommended must match local funding and maintenance capabilities.

The third objective of the first edition of the SA was to identify other organisations, interests or institutions with which the IUCN was to develop partnerships as developed the WANI initiative in the PRB.

In section C6, a number of interventions by NGOs and international organisations were considered and assessed in terms of their potential contribution to the development and implementation of integrated management strategies for the PRB. Here, we develop that analysis further, and suggest ways in which these organisations may contribute towards the integrated management of the PRB:.

- *PAMOJA's* expertise lies in the area of developing dialogue, particularly between government and community interests. This expertise could play a crucial role in the integration of government planning and administration with local level community resource management. At the same time, it is crucial that community concerns and ideas are adequately reflected in government decision-making and actions. PAMOJA can potentially ensure that this can occur.
- The *Traditional Irrigation and Environmental Development Organisation (TIP)* has experience similar to that of PAMOJA, and could enhance its application. Of greater interest, however, are the technical inputs that TIP can supply in the form of furrow design and development that can improve water conveyance systems and their administration.
- The *Tanzania Forestry Action Plan's (TFAP)* experience in the development of local level, integrated, resource problem solutions appear particularly pertinent to the Pangani River Basin. The development of such systems for communities living alongside the Basin's forests would be a welcome component to any effective management planning within the Basin. If coupled with the activities of the Tanzania Forest Conservation Group (TFCG), the coverage of these initiatives could be increased, the two organisations could mutually benefit from their shared experiences and knowledge, and an effective strategy for dealing with forest loss and degradation developed.
- *Tanga Coastal Zone Conservation and Development Programme (TCZCDP)* possesses important practical experience in the development of an integrated natural resource management strategy, from which the PRB could learn and potentially build upon, expanding these lessons upwards and away from the TCZCDP's jurisdictional area. The jurisdiction of the Tanzania Coastal Management Partnership (TCMP) is considerably larger, and for that reason, the latter NGO could possess valuable experience on the integrated management of large areas containing a very wide variety of natural resources.
- The *River Basin Management and Smallholder Irrigation Improvement Project (RBMSIIP)* is the only project to have attempted a Basin-wide approach to solving the PRB's problems. In addition, it has also sought to integrate water conservation issues with water development initiatives. The knowledge possessed by the Project in these areas is extremely important for the development of management strategies for the Basin. In addition, the experience of the Project in the development of a hydrological data collection network for the Basin is also pertinent for the PRB.
- The *UNDP-GEF East Africa Cross-border Biodiversity Project (EACBP)* experience with cross-border resource management is important for the PRB. In addition, the EACBPs experiences with the development and implementation of community-based joint forestry management could be useful for the integrated management of the Basin.

The PBWO has engaged with some of these organisations and this still can be a useful list for reference.

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H. Appendix 1: Smaller basins included in the administrative Pangani Basin⁶

H.1 Introduction

The Pangani River Basin (PRB) covers an area of 43,650 km². The Basin is surrounded by a series of small, independent, basins, which while not strictly part of the Pangani River Basin hydrologically, they are administered by the Pangani Basin Water Office (PBWO) because they are too small to merit their own Basin office. The area administered by Pangani Basin Water Office includes the main Pangani, Umba, Msangazi, Zigi⁷, Coastal Rivers and Mkulumuzi Catchments, together totalling 58,510 km². In this Appendix, information about these additional basins is summarised as a basis upon which future project activities within the PRB may expand to include these additional basins. The basins concerned are as follows:

- The Umba River Catchment (8,070 km²)
- The Msangazi River Catchment (5,030 km²)
- The Zigi River Catchment (see Coastal Rivers)
- The Coastal Rivers Catchments (2,080 km² including Zigi and Mkulumuzi). Besides the Mkulumuzi, most of the Coastal Catchment's rivers are seasonal.

Each of these catchments is discussed in turn.

H.2 The Umba River Catchment

The Umba River Catchment covers a total area of 8,070 km² (of which about 2,560 km² lies in Kenya), where the Umba's mouth lies at Vanga on the Kenya coast. The river has a dense network of tributaries most of which drain the north-western slopes of the Usambara Mountains. These enter the Umba from the south. The river receives very few tributaries from the north. The catchment receives an annual average of 600 mm of rainfall.

The Umba Game Reserve, formerly part of the Mkomazi Game Reserve, lies within the Basin. Vegetation typical of this park covers much of the catchment: sparse, dry, savannah-type bush and low trees. Mountainous slopes in the Basin are covered by afro-montane forest. The Umba River Catchment is sparsely populated. The main land use in its northern part is wildlife conservation, while cattle grazing is the main land use in the south.

Agriculture and irrigation

Rainfed agriculture is considerably more common than irrigated agriculture. Nevertheless, besides the Mkomazi and Luengera valleys, which lie in the main Pangani River Catchment, most of the present or proposed small irrigation schemes in the Tanga Region are situated along the Umba River and its tributaries. These schemes include Mnazi, Kitivo, Kivingo Mnazi village and Mwakijembe Irrigation schemes. The main irrigated crop is rice, followed by maize. In the upper parts of the catchment; vegetables and Irish potatoes are also under irrigation. The total area under irrigation is estimated at 1,475 ha, consuming an estimated 25.2 m³ x 10⁶ annually.

⁶ This Appendix has been prepared by the Pangani Basin Water Office.

⁷ Some authors use the 'Sigi' spelling, 'Zigi' is the preferred spelling of the catchment's residents (pers. comm., 2003)

Natural Resources

Protected Areas

The Uмба Game Reserve contains an area of some 450 km² contiguous to Kenya's Tsavo National Park. The reserve's wildlife comprises, amongst others, buffaloes, elephants, lions and various buck and antelope. The main threat facing this wildlife is poaching by locals, and people entering the area from Kenya.

Forests

The Uмба catchment was once rich in forests that included tree species such as *Brachylaena hulensis* ('*Mkarambati*') and *Albizia vesicular* ('*Mkingu*'). *Brachylaena hulensis* is used mainly for making carvings, building poles and furniture. It is heavily harvested and is considered an endangered species. Illegal forest harvesting for charcoal manufacture also occurs.

To address the problem of illegal forest harvesting, community-based forest management approaches have been developed with villagers, such as those in Mwakijembe, Mwanyumba, Mavovo and Daluni villages.

Minerals

The Uмба River Catchment is rich in mineral deposits, particularly gemstones. Around the Mghwashi and Kararani areas, blue sapphire is to be found, along with green tourmaline and the rose garnet. Mining is presently carried out by small-scale miners who lack internal markets, forcing them to sell their gems on the black market in Kenya (Kisheru, pers. comm.).

Water use conflict

Conflict exists between water users due to insufficient supply, especially in those areas where irrigation is practiced.

Data collection network

- Uмба River at Mlalo (1B1): a secondary station, with range of staff gauges (0 - 3m.); the station is operational with a rating curve, but needs updating.
- Uмба River at Mwakijembe (1B4A): a primary station, with staff gauges (0 - 4m); it is installed with a, 'Orpheus' type data logger. The station is operational, although it requires updating.
- Mbalamo River at Kivingo (1B1A): a secondary station with staff gauges (0 – 2m). Requires rehabilitation.
- Bombo River at Kwamkole (1B5): an operational secondary station with staff gauges (0 - 3m).
- Mlalo rainfall station (9438068): operational and in good condition.
- Mnazi meteorological station (9438075): well-functioning, with both auto-met and manual stations.

H. 3 The Msangazi River Catchment

The Msangazi River Catchments covers an area of 5030 km² and is considered to include a series of narrow catchments extending from west to east over almost the entire width of the Tanga Region. The catchments border the Pangani River Basin to the South. Most of the rivers only flow during exceptionally wet rainy seasons in their upper reaches. Downstream of Handeni Township, however, the Msangazi River flows regularly during the rainy season.

The entire catchment has uniform geographical features and can be classified as hilly, although the lower reaches, where sisal and coconut plantations are cultivated, are flat. The vegetation cover is comprised of bush and low tree savannah. Besides scattered agriculture, most of the land is unused economically. Average annual rainfall is about 900mm.

Population

The Msangazi sub-catchments cover three districts in the Tanga Region: Kilindi, Handeni and Pangani. The total population within the catchments in the Kilindi District was 31,177 in 2002, and 141,263 in the Handeni District. This represents about 44% of the population of the two districts. The population of the Msangazi Catchments within Pangani district is 10,298 people.

Land use

- Agriculture: mainly subsistence farming. Crops grown include maize, cassava, beans, banana, sugar cane and various vegetables. A newly introduced crop, *Moringa oleifera* ('*Mirongeronge*') is used in the manufacture of cooking oil and in water purification.
- Livestock: small quantities of cattle, goats and sheep are kept in the catchments.

Natural resources

Water

The main town in the catchment is the Handeni Township (population 7,700). The town's main water supply is derived from water pumped from the Pangani River. In addition, the town derives water from two boreholes: Nderema (9 m³/hr) and Mnazini (12m³/hr). These serve 35% of township's population. The town's final water source is derived from one of the Msangazi River's tributaries, which has been ponded nearby. The pond's capacity 22,500 m³, and about 12m³/hr is abstracted from it.

Forests

The Bondo and Kwamsisi forests both lie within these catchments. Available species of trees are *Juberialia gloriflora* ('*mtondoro*'), *Dalbergia Melanoxylon* ('*mpingu*'), *Pterocaptus angolensis* ('*mninga*') and '*mkomba*'.

Wildlife

Spartan wildlife reserves occur in the upper reaches of the catchments, and include wild pigs, monkeys/baboons and reedbuck. In the lower parts of the catchments (in Pangani District) lies the Sadani National Park, within which elephants, giraffes, antelopes, sable antelope and reedbuck.

Minerals

The catchments have no known mineral potential.

Problems and potential conflicts

- Encroachment and cultivation around water sources, including riverbanks.
- Bush fires: these are a serious problem, and are set to clear bush for agricultural use.
- Illegal tree harvesting: for timber, building poles and charcoal. The most sought after timber trees are *Pterocaptus angolensis* ('*mninga*'), *Dalbergia melanocylon* ('*mpingu*'), and *Julberialia gloriflora* ('*mtondoro*') and *Mkomba*
- There is an emerging conflict between livestock keepers and farmers over watering points.

Disease

The most common diseases in the catchment area are malaria and typhoid. Cholera and other diseases that cause diarrhoea occur occasionally.

Data collection network

- Msangazi River at Kideleko (1E3): an operational secondary station with a number of gauges (0 - 1m ranges).
- Msangazi River at Kwedilomba (1E1): an operational station (0 - 2m ranges), installed with a 'Thalamides' type data logger.
- Handeni Meteorological Station (9538079): operational, with an auto-met station.
- Rainfall station at Kwedilomba: operational.

Governmental and non-governmental organisations operating in the catchment

- World Vision (NGO)
- HADEA - (Handeni Development Association)
- HIAP - Handeni Integrated Agro-forest Project (Phased out 2000.)
- Ded - GTZ –Technical and advisory support in the district (water)

H.4 The Zigi River Catchment

The perennial Zigi River drains the eastern slopes of the Usambara Mountains, and has two main tributaries flowing from north and south (Muzi and Kihuhwi). After their confluence, the Zigi drains eastwards into the Indian Ocean via the Mabayani Dam, a source for the Tanga Municipal Water Supply.

The upper reaches of the catchment are mountainous, consisting mainly of dense forest interspersed with tea plantations. Its lower parts are hilly, comprising dry savannah-type bushes and low trees, as well as sisal estates. Along the coast, coconut and palm trees are common. As such, the entire catchment is fairly well vegetated, and the risk of erosion minimal.

Rainfall in the Zigi catchment is bi-modal. However, its distribution varies from 1,000 to 2,000 mm. Yearly average rainfall is estimated at 1200 to 1400 mm.

Natural resources

Forests

There are 30,000 ha of forest in the Zigi Catchment, which include the East Usambara Catchment Forest, part of the Eastern Arc Mountain forests. The importance of the catchment's forests includes:

- provision of timber and medicinal plants to local communities;
- forests are the source of the Zigi River, which provides domestic water for Tanga Municipality;
- conserving water by regulating run-off, preventing soil erosion, improving infiltration to groundwater aquifers and water quality;
- habitat for very high levels of biodiversity, and contributing to the maintenance of the global gene pool;
- the escarpment forests of the East Usambara Mountains prevent erosion and landslides.

Biodiversity and protected areas

Amani Nature Reserve (ANR) was established in 1997 and has a total area of 8,380 ha. The Reserve is located in the East Usambara Catchment Forest. The East Usambara Mountains are the largest mountain block in the Eastern Arc Mountain chain. The ANR consists of tall luxurious montane forest and deciduous lowland forest with an average altitude boundary of 850m.

Biologically, the ANR has a very rich species composition. The East Usambara Mountains are regarded as a global centre of plant diversity. Amongst the reserve's and forests' endemic plant genera and species are *Saintpaulia* (9 species), *Cynometra* (4 species), *Streptocarpus* (2 species), *Impatiens katae*, *Vernonia amaniensis*, *Dolichometra leucantha* and *Cordia peter*.

In addition, the East Usambara Mountains are recognised as having the second most diverse fauna in Africa. Some of the ANR's mammals are classified as globally threatened, such as the East African Collared Fruit Bat (*Myonycteris relicta*), the Black and Rufous Elephant Shrew (*Rhynchocyon petersi*), the Bushy-tailed Mongoose (*Bdeogade crassicauda omnivore*) and Abbot's Duiker (*Cephalophus spadix*).

The International Council for Bird Preservation (ICBP) has classified both the montane and lowland forests of the East Usambara as an Endemic Bird Area (EBA). Thirteen globally endangered species of birds, such as the Usambara Eagle Owl (*Bubo vosseleri*), the Usambara Mountain Weaver (*Ploceus nicolli*), the Amani Sunbird (*Antheptes pallidigaster*), and the Long-Billed Apalis (*Apalismsoreaui moreau*), are known to live in ANR.

Amongst the Reserve's and forests' amphibians, reptiles and invertebrate species, biodiversity and endemism are also very high. Many amphibians breed and find habitat in and along the Zigi River, which also provides habitat to numerous reptile and insect species.

Water and soils

The Amani Nature Reserve is one of the most important water catchments areas in the East Usambara Mountains. The montane rain forest that covers the larger part of the Reserve plays a significant role in the hydrological cycle of the Tanga Region. The Zigi River provides domestic water to Tanga Municipality (population 300,000), associated industries, estates and adjacent local communities.

The Mabayani dam lies on the Zigi River, water from which supplies Tanga Municipality. Its reservoir is approximately 3,500m long with an average width of 400m. Initially (in 1978), the reservoir had a nominal storage capacity of 7.7 million m³, but this has gradually decreased due to siltation caused by erosion and landslides. Additional deposits are derived from plants uprooted by floodwaters, effluent from the decortication of sisal leaves and matter synthesised in the reservoir itself by phyto- and zooplankton communities, fish and other invertebrate animals.

The decay of organic matter requires oxygen, resulting in the de-oxygenation of surrounding waters. The presence of such organic nutrients also stimulates the production of more plant material, causing the production of more organic matter and subsequent oxygen depletion at the bottom of the dam. Combined, these processes of nutrient inflows and subsequent deoxygenation may cause eutrophication, although no evidence of this has yet been obtained from the dam. The concern that this may occur nevertheless exists, and the following are recommended as possible mitigating measures:

- to monitor the accumulation of sediment /organic matter in the dam;
- to frequently remove aquatic weeds (e.g. water hyacinth or the Nile cabbage) from the surface of the dam manually, biologically or mechanically;
- to control the quality and volume of effluent from upstream sisal factories;
- to identify the proportion of aquatic macrophytes that are swept over the dam spillway. If the proportion is small, methods for increasing it should be undertaken.

Fisheries

Fishing is carried out mainly along the coast of Indian Ocean, where the Zigi River's mouth is to be found. Minor fisheries exist along its course, targeting fish such as *Clarias* spp. (a cat fish, 'kambare'), *Tilapia* spp. ('perege'), *Labeo* ('ningu'), *Synodontis* ('ngogogo'), *Barbus* ('kuyu') and others. Fishing on the Mabayani reservoir is forbidden because its water is intended as a source of domestic water for the Tanga Municipality.

Land

The main land use in the catchment is agriculture, practised mainly on a small-scale level. Crops such as maize, cassava, banana and fruit are cultivated, while cash crops such as sisal, tea and forest (like the Longuza Teak Plantation project). To a minor extent, cattle grazing is also practiced.

Problems

- Deforestation: this occurs mainly as a result of illegal tree harvesting for timber, firewood, building poles, clearing for agriculture etc., and serves to increase surface runoff, while decreasing groundwater recharge.
- Effluent discharge: the discharge of raw or partially treated effluent from sisal decortications causes the de-oxygenation of the water into which it is deposited, and works as a nutrient, so assisting eutrophication.
- Agrochemical application: although there is no available data on the effect of agrochemicals on water sources in the catchment, it is likely that agrochemical residues/spills reach water bodies via storm water. Depending on agrochemical type and concentration, human health and the aquatic life can be affected by such residue. In the Zigi River Catchment, agrochemicals, including pesticides, herbicides and fertilisers are mainly used in Amani tea estates and tree nurseries (Materu, pers. comm.).
- Human settlement close to water sources: this causes land degradation and increased sediment concentrations in water; the pollution of water by faecal seepage from toilets or the direct disposal of faeces, as well as physically and chemically by solid waste disposal to water bodies
- Aquatic weed: several species of aquatic weed occur in the Zigi River and Mabayani dam, e.g. Water hyacinth (*Eichhornia crassipes*), Nile cabbage (*Pistia stratiotes*) and the water ivy (*Lpomoea aquatica*). The water hyacinth is capable of blanketing the water surface such that it affects water quality. This may also affect human health by improving the conditions needed for the reproduction of various vectors important in the life cycle of various human pathogens, such as mosquitoes (malaria), and snails (bilharzia).
- Poor farming methods: the use of fire to clear vegetation, the cultivation of mountain slopes, tree felling and other human activities in water catchments may serve to increase water turbidity, colour and sediment load, especially during the rainy season. These causes have been attributed to the December 1999 increase in water turbidity on the Mabayani Dam from 20-30 NTU to 1,400 NTU (Materu, pers. comm.).
- Disease: river blindness occurs in the Muheza District of the Zigi Catchment. This is caused by a worm (filaria) called *Onchocerca volvulus*. The parasite is transmitted to humans through the bite of a small black fly. Besides blindness, the disease also causes severe skin problems. The flies breed in well oxygenated fast moving water. Other diseases in the Zigi Catchment related to water are cholera, typhoid and malaria (Maggid, pers. comm.)

Existing and potential conflict

- Conflict is expected between water users in the Tanga Municipality and Muheza town. The latter's water supply is presently inadequate, and a proposal exists to tap water from the Zigi River on which the whole population of the Tanga Municipality presently depends on.
- Conflict between domestic water use and environmental requirements: the minimum water flow required to sustain the ecosystem below the Mabayani Dam is unknown.
- Conflict between polluters and water managers: for example, conflict between water management and agricultural interests as the former seeks to control water pollution, for example, organic pollution from sisal estates (Mjesani, Kibaranga, Lanconi and Bamba), and agro-chemical pollution from tea estates.

Data collection network.

- Zigi River at Lancon (1C1): an operational primary station with staff gauges (0 - 10m); installed with an 'Orpheus' type data logger.
- Zigi River at Miembeni (1C2): an operational secondary station with staff gauges (0 - 4m); the rating curve needs updating.
- Zigi River at Kisiwani (1C4): a secondary station with staff gauges (0 - 3m) for catchment forestry use. Rating curve needs updating. 0 - 1m gauge has been washed away by floods.
- Muzi River at Msakazi (1CA1): operational, but rating curve needs updating.
- Zigi-Lancon Rainfall Station: operational.
- Mabayani dam, water level and rainfall stations: operational.
- There are additional rainfall stations in the catchment operated by various institutions, such as Longuza Forest, East Usambara Catchment Forest etc.

H.5 The Coastal River Catchment (Mkulumuzi)

The coastal rivers originate in the escarpment that runs parallel to the coast at a distance of 20 to 30 km. Average rainfall within the catchments is 1,100 mm. Their ecology is fairly uniform. Slopes at the headwaters are generally hilly, and gradually flatten as they enter the coastal plain. Coconut, palm and cashew nut trees dominate vegetation. Sisal is also grown on a large scale. Erosion problems have not been observed in these catchments.

Most coastal rivers only flow during short periods in the rainy season and are dry for the rest of the year. The only exception is the perennial Mkulumuzi River. This river's catchment covers 337 km², and is situated directly to the south of the Zigi River catchment. Its source lies in the Magoroto Forest.

Natural resources

Water supply

The Mkulumuzi River supplies water to Muheza town, with a population of about 25,700 people.

Agriculture

Agriculture in the area is mainly practised at a subsistence level, with an exception of sisal, which is grown at commercial scales. Subsistence crops grown include maize, banana, cassava, rice and sweet potatoes. Fruit (particularly oranges), coconuts, cashew nuts and spices are cultivated as cash crops.

Livestock

Livestock keeping in the catchments is fairly insignificant. Small numbers of dairy cattle, goats and pigs are kept.

Fisheries

Although fishing is a common activity along the coast, no significant fishing activity occurs in the coastal river catchments.

Existing and potential conflicts

- Settlement: serious demands for settlement land occur after sisal plantations have collapsed, and staff evicted.
- Insufficient water for Muheza Township.

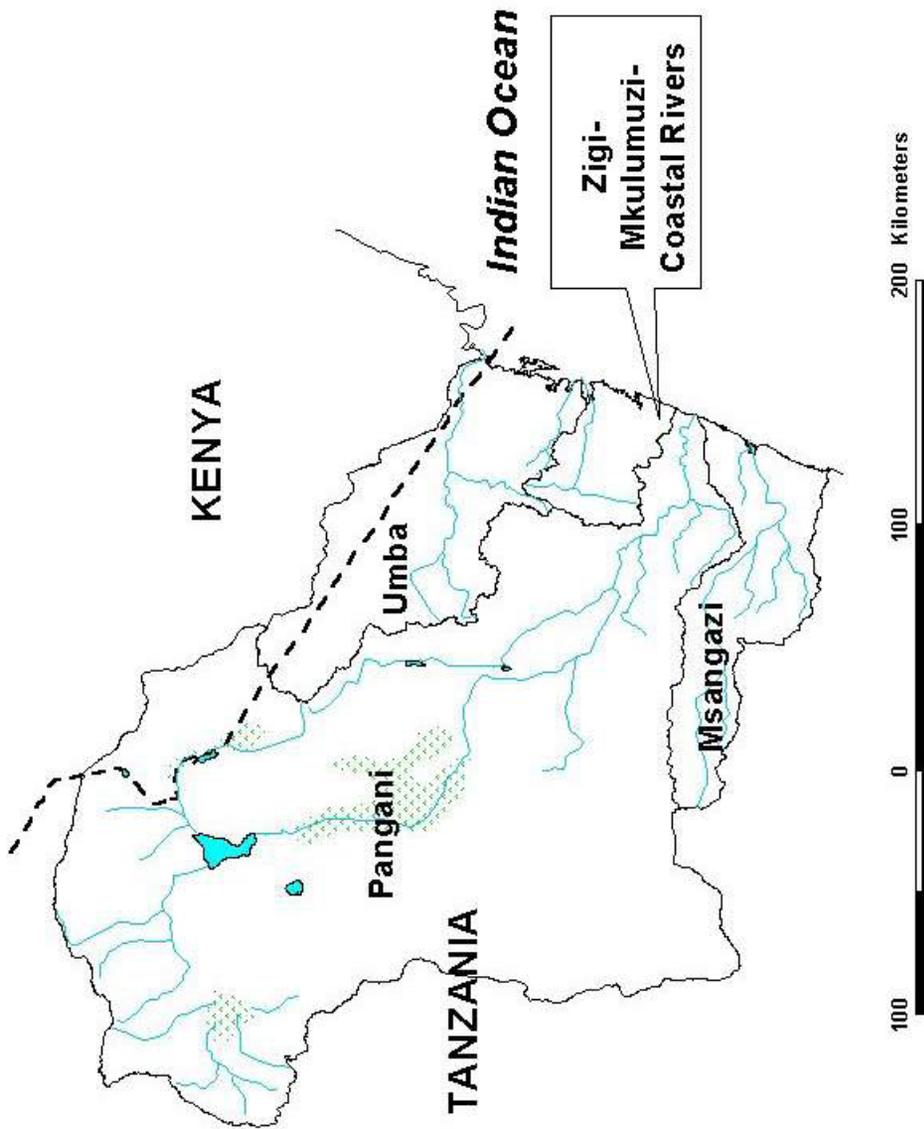


Figure 4: The Administrative Pangani Basin
 see also Plate 2, page 44
 (Source: River Basin Management Project)

The data collection network

- Mkulumuzi at Upare (unregistered): a new river gauging station equipped with a 'Thalimedes' type data logger.
- Msimbazi River at Lugongo: a new river gauging station equipped with staff gauges (ranging from 0 - 2m)
- Mlingano Meteorological Station (under the Ministry of Agriculture): operational.

Supporting organisations

- Irish Aid: supports integrated planned programmes in the area.
- TASAF
- NORAD: Village Transport and Travel Programme (VTTP)
- IUCN: Coastal environmental conservation, in collaboration with Ireland Aid.
- AXIOS International: assists orphans and vulnerable children
- GTZ: assists health infrastructure, support of basic drug distribution to the health centres.
- APOC/CDTI: Onchocerciasis control



Water and Nature Initiative



Coast Development Authority



The Global Water Initiative
A Partnership Funded by the Howard G. Buffett Foundation

IUCN–International Union for Conservation of Nature

IUCN, International Union for Conservation of Nature, helps the world find pragmatic solutions to our most pressing environment and development challenges.

IUCN works on biodiversity, climate change, energy, human livelihoods and greening the world economy by supporting scientific research, managing field projects all over the world, and bringing governments, NGOs, the UN and companies together to develop policy, laws and best practice.

IUCN is the world's oldest and largest global environmental organization, with more than 1,000 government and NGO members and almost 11,000 volunteer experts in some 160 countries. IUCN's work is supported by over 1,000 staff in 60 offices and hundreds of partners in public, NGO and private sectors around the world.

IUCN Water and Nature Initiative

The IUCN Water and Nature Initiative is a 5 year action programme to demonstrate that ecosystem-based management and stakeholder participation will help to solve the water dilemma today - bringing rivers back to life and maintaining the resources for many.

Pangani Basin Water Office

Amendments to Tanzania's Water Utilization Act (Act No. 10 of 1981) introduced the concept of managing and allocating water based hydrological boundaries. The Pangani Basin Water Office was subsequently established in 1991. Its main duties are to control and regulate the uses of water in Pangani Basin both in terms of quality and quantity.

Coast Development Authority

CDA is a Regional Development Authority established to provide integrated development planning, facilitation, initiation, coordination and implementation for projects and programmes within its area of jurisdiction, namely the whole of Coast Province and Ijara District and the Kenya Exclusive Economic Zone (EEZ).

Global water Initiative

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