5. ENVIRONMENTAL IMPACTS

5.1 This chapter reviews the environmental impacts of TREFIP with respect to lacustrine and terrestrial ecological processes and human welfare concerns. Each Programme output is considered in terms of its probable or possible effects on (A) Ecology and Fish, (B) Forestry, and Land Use, (C) Hydrology, Water Quality, and Soils, (D) Landscape and Visual Features and (E) Communities.

5.2 A summary of the activities associated with each output is first provided for reference, in order to avoid repeated description of these components when reviewing the various dimensions of their projected impacts.

Output 1 Activities -- Implementation of co-management mechanisms

5.3 Activities foreseen in support of Output 1 include: a) establishment and operation of Community Management Zones (CFMZs and Local Fisheries Councils (LFCs); b) establishment and operation of a micro-credit scheme; and c) introduction of appropriate gear and fleet restructuring.

5.4 ***Establishment of CFMZs and LFCs.*** Under a plan that will eventually cover 200 pilot fishing villages, these partnership/co-management arrangements will involve several interrelated components.

5.5 In addition to facilitating the community education and outreach activities needed to build levels of environmental consciousness and receptivity to measures for the regulation of resource access and exploitation, the Programme will also facilitate direct partnership actions in support of responsible fishing practices and improvement of local welfare. These will include, *inter alia*, formulation of appropriate measures to control access within community-based fishing zones, and of the compliance mechanisms needed to ensure the effectiveness of these measures.

5.6 ***Micro-credit.*** New forms of license and fish levy revenue allocation to both LFCs and official fisheries agencies will be used in combination with the LFC Micro-Credit Scheme to mobilise and disburse locally needed development and operational funds.

5.7 ***Introduction of appropriate gear and fleet restructuring.*** The provision of loan assistance through the LFC Micro-Credit Scheme will in turn be used in combination with credit facilities to large commercial firms (linked with Output 2), environmental education (linked with Output 3), and new techniques of fresh fish collection and preservation to encourage:

- replacement and retirement of destructive gear and fishing methods;
- the use of improved fish handling and processing methods to ensure better fish quality and hence the possibility of obtaining higher market values for fresh and cured products; and
- redeployment of some industrial fishing units to serve as collection vessels in order to reduce fishing pressure in southern waters.

Output 2 Activities -- Improved Infrastructure and Services

5.8 Activities foreseen in support of Output 2 include: a) technical support for improved local post-harvest practices; b) provision of social facilities and services in pilot villages; and c) installation of strategic marketing centre infrastructure and services.

5.9 ***Improved local post-harvest practices.*** Training and extension services will be provided under the regional programme to encourage the wider use of cleaner processing techniques for small pelagic clupeids ('sardines'), and to build consumer preference for the improved products they yield.

5.10 Sun-drying on sand or gravel beds is the most common form of processing sardines, and this practice results in a product loaded with grit and other contaminants. The use of drying tables or concrete slabs, sometimes in conjunction with light brining and/or smoking, produces a cleaner, grit-free product sometimes known as 'dagaa safi' (Kiswahili for 'clean sardines'). Brining and table drying of *L. stappersii* is also carried out in some localities. The resulting product is particularly popular in the DRC (Photos 33 –34).

5.11 Salting, with or without smoking, has the effects of: a) reducing drying time; b) increasing shelf life; c) cutting loss from product breakage and fragmentation (fish stays firmer); and d) creating a brighter, more appealing product appearance.

5.12 By EOP, it is expected that the quantity of Lake Tanganyika 'dagaa safi' being sold at the major retailing outlets of Uvira, Bujumbura, Kigoma, Dar es Salaam, the Copperbelt, Lubumbashi, and Mbujimayi will have increased by a substantial margin – up from the current (estimated) <1 percent of total market share to somewhere in the 10 to 20 percent range.

5.13 ***Facilities and services in pilot villages.*** TREFIP proposes to provide grants-in-aid, subject to local co-payment or contribution in kind, for the construction or rehabilitation/upgrading of pilot village facilities e.g. schools, health centres/dispensaries, domestic water supplies and distribution networks, and latrines.

5.14 ***Strategic marketing centre infrastructure and services.*** TREFIP proposes to improve links between important fisheries production centres and market places and to upgrade marketing facilities at key trading centres around the lake. Undertakings will include the construction or upgrading of selected roads, jetties, central markets, and electricity services. Provision is also made for a credit facility to fund establishment of fresh fish collection, handling, and marketing systems in certain areas.

5.15 The Programme workplan calls for upgrade of an estimated of 70 kms of Lake Tanganyika ***feeder roads*** in the four countries, according to the breakdowns given in the following table.

Table 5. Proposed road improvement programme

Country	Road link	Kms	Tot. kms
Burundi	To be determined	10	10
DRC	To be determined	20	20
Tanzania	Kigoma-Katunga	4.0	
	Kipili-Kirando junction	6.5	
	To be determined	9.5	20
Zambia	Mpulungu town	1.0	
	To be determined	19	20

5.16 TREFIP proposes to construct or rehabilitate ***jetty facilities*** at selected sites, as noted in the table below.

Table 6. Proposed jetty construction programme

Country	Jetty location	Remarks

Burundi	To be determined.	Provision for 2 jetties
DRC	To be determined.	Provision for 4 jetties
Tanzania	Kipili	Rehabilitation of old jetty.
	Buhingu (Lagosa)	New jetty.
	Kibwesa	New jetty.
Zambia	Nsumbu	Rehabilitation of old jetty.

5.17 TREFIP will undertake construction of new ***marketing facilities*** and upgrading of existing facilities at the following key centres around the lakeshore.

Table 7. Proposed key marketing facilities improvement programme

Country	Marketing facility location	Remarks
Burundi	Bujumbura Central Mkt.	Rehabilitation
DRC	Uvira	Rehabilitation 2 markets
	Baraka	Rehabilitation 1 market
	Kalemie	Rehabilitation 2 markets
	Moba	Rehabilitation 2 markets
Tanzania	Kigoma Central Mkt.	Construction of new facility
	Kigoma Mwanga Mkt.	Rehabilitation
Zambia	Mpulungu	Construction of new facility
	Mpulungu Central Mkt.	Rehabilitation

5.18 TREFIP will install or upgrade ***electricity supply services*** according to the programme proposed in the following table.

Table 8. Proposed electricity supply installation/upgrade programme

Country	Supply site	Remarks
Burundi	To be determined.	Auxiliary generators for ice plants.
DRC	To be determined.	Auxiliary generators for ice plants.
Tanzania	To be determined.	Auxiliary generators for ice plants.
Zambia	Nsumbu	Installation of generator and distribution lines for township

5.19 Credit facilities are proposed under TREFIP to encourage larger commercial firms to establish improved ***fresh fish collection, handling, and marketing systems***.

5.20 In Zambia, where marked overcapacity has developed in the industrial fishing sector, it is envisioned that this credit facility will be used to establish fresh fish collection operations using re-fitted purse seiners as transport vessels in combination with ice production units, chilled storage facilities, and new product evacuation channels.

5.21 In the other countries, development of fresh fish collection and marketing systems will be fostered through construction of small flake ice plants and chilled storage units.

Output 3 Activities -- Protection of stocks and biodiversity

5.22 Activities associated with this output include improvement of fisheries monitoring procedures, establishment of lacustrine protected areas (PAs), and environmental education.

5.23 ***Fisheries monitoring.*** This activity component is also associated with Output 5 (see below).

5.24 ***Lacustrine PAs***. In the context of extensive consultation with stakeholder communities and agencies, potential sites for lacustrine PAs will be identified on the basis of a number of criteria. These include: a) existing status (already within national park/ reserve boundaries); b) importance as breeding and stock recruitment zones, and as aquatic habitat/bottom type sites supporting fish and invertebrate fauna with an exceptionally high degree of endemism; c) accessibility; d) scenic setting, and e) the general likelihood of offering significant attraction as ecotourism destinations.

5.25 Eight provisional candidate PA sites have been identified in the neighbourhood of certain national parks in four riparian countries, as listed in the following table.

Table 9. Provisional candidate PA sites

Country	PA site	Remarks
Burundi	Ruzizi River Delta area.	Strengthen existing protected status and expand reserve boundaries.
	To be determined.	
DRC	To be determined.	3 sites to be identified
Tanzania	Mahale National Park	Gazette aquatic protected area offshore of national park.
	Malagarasi River Delta area.	Gazette aquatic protected area.
	Gombe Stream National Park.	Gazette aquatic protected area offshore of national park.
Zambia	Kalambo River Delta.	Gazette aquatic protected area offshore of national park.
	Nsumbu National Park.	Gazette aquatic protected area offshore of national park.

5.26 ***Environmental education (EE).*** This component activity will be developed as an outreach programme through collaboration with LFCs, national fisheries researchers and managers, and NGO agencies involved with natural resource conservation and community welfare projects around the Lake Tanganyika littoral.

5.27 Relying heavily on video presentations as well as posters, pamphlets, community workshops and other conventional formats for community outreach and awareness building, the programme will highlight the following topics.

- fishing and fish biology (lacustrine ecology and production system dynamics (e.g. -- importance of species diversity and protected areas, impacts of different gear types and methods, fishing effort, fish biology and stock recruitment patterns, optimal harvest size of target species);
- post-harvest practices and the environment (impacts of fish smoking, reforestation needs);
- agricultural practices and water quality (soil erosion and sedimentation causes and effects, preventive measures);
- sanitation and health practices (causes and prevention of water borne related diseases, family and reproductive health.

Output 4 Activities -- Improved fisheries legal regimes and MCS capabilities

5.28 TREFIP will facilitate harmonisation of fisheries legislative frameworks and elaboration of specific regulatory measures for Lake Tanganyika, and the upgrading of MCS competencies along mutually agreed lines, through provision of technical assistance at both national and regional levels.

5.29 Particular attention will be given to provisions within a unitary legal framework that will enable:

- co-management arrangements (Community Fishery Management Zones and Local Fisheries Councils) that would secure the participation of stakeholders in management decision-making functions (consultations to identify planning and development priorities and problem areas, establish regulations, etc.), including
- new property rights regimes that would allocate control of access to the community level, in order to counter the 'race to fish' tendency that free access regimes entail; and
- the establishment and operation of enforcement and compliance assurance mechanisms under local responsibility.

Output 5 Activities: More effective use of scientific advice for management

5.30 Since planning and management processes for Lake Tanganyika fisheries will be impossible to pursue in future unless a regular lakewide monitoring programme is kept in place, TREFIP intends, through provision of technical assistance, training, and facility upgrades, a) to build on the monitoring activities initiated under LTR and LTBP by b) further strengthening statistical capabilities within the respective national fisheries agencies responsible for Lake Tanganyika, and c) consolidating an institutionalised basis for co-operation between the respective agencies.

5.31 ***Expanded LTFMP.*** The existing LTFMP developed for national execution in the final phase of the LTR Project will provide the core elements of the revised monitoring system, but provision will also be made to cover catch assessment and socio-economic parameters in data collection routines to be used within newly established pilot CFMZs, in partnership with members of LFCs. Further provision will be made to cover biodiversity parameters according to techniques developed by the LTBP Biodiversity Special Study team for recording data on habitat characteristics as well as fish and mollusc communities at designated sites.

5.32 ***Statistical capabilities.*** A programme of in-service skill development for national staff and upgrading of office equipment and premises will be initiated in order to ensure proper implementation of the expanded LTFMP.

5.33 ***Regional co-operation.*** Members of each country sub-office team, having become fully versed through in-service training in the use of the computer applications and procedures developed for the monitoring programme, will prepare and transmit quarterly data reports to the PIU.

5.34 PIU personnel will be responsible for the assembly of quarterly reports detailing LTFMP results, and for providing preliminary assessment of patterns of continuity and change under the parameters being monitored.

Output 6 Activities: Establishment of a regional fisheries management entity

5.35 In accordance with FFMP recommendations TREFIP will seek to establish a 'Lake Tanganyika Fisheries Centre'. The Centre will be constituted with a remit to:

- serve as a secretariat/executive arm for a Lake Tanganyika Regional Fisheries Council;
- facilitate technical investigations and discussions for all fisheries-related matters, including coastal zone management, and environment and water quality;
- promote exchange and dissemination of fisheries information, including operation of a Regional Fisheries Documentation Centre (ex-LTR Documentation Centre);
- develop, recommend, and facilitate implementation of conservation and management measures;
- in consultation with fisheries stakeholder groups, facilitate periodic review and revision as appropriate of the FFMP, taking into account the experiences and recommendations of TREFIP; and
- facilitate continued harmonisation of national policies and policy instruments pertaining to the sustainable utilisation of the living resources of the lake, in accordance with the CCRF principals endorsed by the FFMP.

A. ECOLOGY AND FISH

Impacts of Output 1 -- Implementation of co-management mechanisms

5.36 ***Establishment of CFMZs and LFCs.*** As distinct from the 'top-down' orientation of conventional fisheries management regimes, where a high degree of state intervention and control is involved, approaches that emphasise 'management in partnership' or 'participatory management' are more likely to increase the efficiency and implementability of management measures because local interested parties have had a hand in crafting them.

5.37 Co-management mechanisms should yield substantial positive impacts. They will provide a means through which local resource stakeholder groups can develop a sense of direct interest in, and exercise responsibility for, management decision-making and compliance.

5.38 A significant advantage conferred by partnership approaches is that MCS and enforcement tasks can be accomplished with far less administrative costs and with far greater effectiveness than present arrangements involving government agencies. In the Lake Tanganyika situation as elsewhere in the region, these agencies are chronically under-funded and poorly equipped and staffed.

5.39 The EIA Team is of the view that such partnership arrangements are a necessary condition for the long-term sustainability of the Lake Tanganyika fisheries.

5.40 ***Micro-credit, introduction of appropriate gear, and fleet restructuring.*** Substantial benefits are likely to accrue as a result of these activities. They should contribute towards the reversal of trends towards over-exploitation and, insofar as the retirement of beach seine units is concerned, improve the survival of juvenile stages of *L. miodon* and reduce damage to cichlid breeding and brooding areas along sandy littoral substrates.

5.41 There is some risk, however, that credit for input acquisitions will in localised instances draw new entrants into the fishery or attract former operators back into the fishery, thus countering efforts to reduce fishing pressure on overexploited stocks.

5.42 A related risk pertains to credits directed towards improvements in post-harvest handling and processing methods, and industrial fleet restructuring to facilitate more efficient fish collection from local landing sites. Significant rises in the price of fish and fish products could have the effect of increasing demand for raw product as well as attracting new entrants into the fish processing and trading business.

Impacts of Output 2 -- Improved infrastructure within pilot villages and strategic marketing centres

5.43 ***Local post-harvest practices.*** Improved methods of processing the small pelagic clupeids *L. miodon* and *S. tanganicae* to yield more 'dagaa safi' will result in a significant reduction of product loss from spoilage and breakage. This will in effect increase the yield of the fisheries without concomitant increase in fishing effort – a beneficial outcome in terms of commercial fish stock impacts.

5.44 ***Facilities and services in pilot villages.*** The EIA Team does not anticipate adverse impacts on the lacustrine environment resulting from such facility and service improvements.

5.45 ***Strategic marketing centre infrastructure and services.*** TREFIP will facilitate improvements or new construction for selected roads, jetties, central markets, and electricity services, as well as credits to fund establishment of fresh fish collection, handling, and marketing systems in certain areas.

5.46 ***Feeder road*** construction impacts on the lacustrine environment would be minimal. All of the route segments so far identified are existing roads, so that no new cuttings or other excavations will be required in the course of work.

5.47 Some gully and sheet erosion may occur in areas cleared for construction camps and equipment and materials storage. However, the net effect should be an amelioration of current soil erosion and sedimentation problems in affected areas since upgrading will involve the provision of proper road cambering and drainage management systems.

5.48 The operational impacts of rehabilitated roads on the lacustrine environment may be rather more serious in terms of adverse effects. In some cases, easier access to landing sites might encourage unsustainable increases in fishing and fish trading activities. Established operators would find it more convenient to evacuate fish and fish products, and new entrants might be attracted into the sector. Such developments could lead to increased harvest activities, more demand for raw product, and/or greater frequency of marketing trips.

5.49 ***Jetty*** construction impacts on the lacustrine environment would be quite marked, but very highly localised. Construction at each installation would involve pile driving to support the steel rail framework of a rock crib of some 20-30 m in length by some 10 m in width, the filling of the crib with heavy rock ballast, and the capping of the ballast with a concrete slab. An alternative approach could be to use old 40 foot cargo containers sunk into the bed of the lake and filled with ballast capped with concrete. Either approach would involve disruption of the substrate and any benthic or rock-dwelling aquatic organisms inhabiting the immediate area.

5.50 As with roads, the operational impacts of jetty installations on the lacustrine environment would be more serious and long lasting in terms of adverse effects. Loading of fish products onto passing steamers and 'water taxis' would be considerably easier, and again (like better roads) could encourage unsustainable increases in fishing and fish trading activities.

5.51 Localised pollution from fuel spillage, engine oil, bilge and other vessel wastes would probably not increase above current levels at the selected landings, but would be spread closer to the shoreline. This would result from vessels berthing alongside the new jetties rather than, as is now the case, standing off some distance whilst smaller boats ferry goods and passengers to and from the shore.

5.52 Neither construction nor operation of new or upgraded ***marketing facilities*** is expected to generate significant adverse effects on the lacustrine environment. In the case of Mpulungu in Zambia, the new facility to be created will replace an existing informal lakeshore market area that generates appreciable amounts of human and other waste runoff into waters close to the harbour area. For the other markets, waste flows into watercourses that eventually empty into the lake will also be controlled (Photos 35- 36).

5.53 Significant negative impacts from construction of the proposed ***electricity services*** are not anticipated.

5.54 There is the risk however that the generators could have quite adverse effects within their immediate areas of operation. Experience with the power station in Kigoma provides a case in point. Although the situation has recently been rectified, for years the station compound polluted the waters and beaches of a nearby bay with runoff of waste cooling water heavily contaminated with oil and fuel residue. It is probably also the case that the Kigoma station compound feeds a large subterranean plume of fuel-contaminated soil extending towards the lake.

5.55 ***Fresh fish collection, handling, and marketing systems.*** For the southern waters of the lake, this component activity is expected to yield positive effects for the environment insofar as it contributes to the reduction of industrial fishing pressure.

5.56 On the other hand, for all sites where new systems are to be developed there are risks similar to those cited for road rehabilitation and jetty construction – i.e., they could encourage unsustainable increases in fishing and fish trading activities.

Impacts of Output 3 -- Protection of stocks and biodiversity

5.57 Adequate ***fisheries monitoring*** is fundamental to the protection of commercial stocks and lacustrine biodiversity, as events of stability and change will otherwise be impossible to track on a regular basis.

5.58 This activity component is thus seen as playing a supportive role for efforts to maintain lacustrine ecosystem integrity and sustainable exploitation of fish stocks. No significant adverse impacts are foreseen with respect to the establishment and operation of an improved fisheries monitoring system.

5.59 ***Lacustrine PAs***. A large literature exists on protected or 'no take' areas and their role in serving conservation needs, particularly in regard to coral reefs (e.g. Allison *et al.*, 1998; Murray *et al.*, 1999). Observers have also commented on reserve areas with respect to

the diverse zoo- benthic and fish communities (e.g. cichlids) in Lake Tanganyika (Lowe-McConnell, 1987; Cohen, 1991, Martens, *et al.* 1994).

5.60 LTBP has conducted baseline studies on biodiversity and the human-borne factors (e.g. water pollution, eutrophication, destructive fishing, species introduction, siltation) that threaten its status within the Tanganyika basin (MRAG, 1996). The Project's Strategic Action Programme proposes a series of measures to control pollution and maintain the lacustrine and littoral environment. A variety of actions are suggested for the conservation of sensitive coastal habitats and support of parks management (LTBP, 2000). In weighing PA possibilities, TREFIP will benefit from the site analyses conducted by LTBP.

5.61 The effectiveness of even the best-designed networks of PAs will depend on conservation and fishery management efforts undertaken outside reserve boundaries (Murray *et al.*, 1999). Individual reserves or reserve networks cannot alone produce desired fishery and conservation outcomes (Roberts, 1998). To become viable in practical management terms they require multi-level actions (Fogarty 1999, Murray *et al.*, 1999). In the context of the Lake Tanganyika region, this will include managerial actions taken simultaneously with respect to habitat protection, land based operations, and monitoring and control of tourism and fishing activities.

5.62 Main production of the three commercially important pelagic species takes place in open waters. Of the clupeids, however, *L. miodon* spawns and hatches on sandy substrates in waters less than 130 m deep (Matthes, 1967), and produces large schools of juveniles (15-40 mm long) that spend their first two months inshore (Pearce, 1985; Mannini 1998).

5.63 The role of PAs in maintaining the commercial fish stocks whose life-history is only partly comprised of benthic- or littoral-dwelling stages will therefore be modest – particularly in the absence of measures to discourage the use of highly destructive beach seine gear.

5.64 Sanyanga *et al.* (1995) similarly concluded that PAs have a fairly minor positive impact on local recruitment and population structure of *L. miodon* stocks in Lake Kariba. It was nevertheless observed that PAs might contribute towards bigger fish size and non-skewed size distribution in comparison with fished areas of Lake Kariba. The non-fished areas provided bigger mean lengths but smaller CPUEs of *L. miodon*, the only clupeid present.

5.65 Based on calculations of Lauck *et al.* (1998), the required size of Marine PAs to sustain expected sustainable yield of demersal fish becomes unrealistic large in case when the catch statistics and harvest rates contain even a moderate degree of uncertainty (cf. Hall, 1998). It can be therefore be assumed that, given the highly dynamic and uncertain nature of the commercial fishery of Lake Tanganyika, pelagic ecosystem benefits accruing from PAs will be difficult to ascertain.

5.66 Benefits will probably be more apparent in the form of sustained biodiversity of littoral dwelling cichlids. This is no small consideration, however, as the health of inshore and pelagic fisheries are closely interdependent. A collapse of the latter would precipitate significantly greater fishing pressure on the former. And marked depletion caused by overfishing and habitat destruction within the littoral zone could easily lead to a transfer of fishing effort to the pelagic sector, already subject to over-exploitation risks of its own.

5.67 Also, to the extent that PAs will encourage the growth of ecotourism and thus economic diversification within the Tanganyika basin, they will benefit fisheries

sustainability. The existence of employment alternatives to fishing would tend to diffuse the growth of exploitation pressure on commercial fish stocks.

5.68 A further point to be borne in mind is that PA's, besides directly benefiting exploited stocks, may provide an ecosystem-based management tool that focuses on processes and functioning, and extends fishery and conservation benefits beyond individual target populations (Roberts, 1998).

5.69 Adverse effects for the lacustrine environment attendant upon the establishment and operation of PAs can be expected to be negligible for the foreseeable future. The development of ecotourism, should it prove successful, is not anticipated to be of such a scale as to cause major negative impacts to aquatic habitats and fish. There is some risk that no benefits will be forthcoming at all from PAs, however, in the event that continued scarcity of alternative income-generating opportunities, and/or increases in the number of fishers, and/or lack of environmental awareness amongst local resource users would lead to violations of reserve boundaries and regulations.

5.70 ***Environmental education*** is integral to the process of building fisheries management partnerships with and for local communities. If successfully implemented, it would provide an immensely useful foundation for responsible fisheries and the protection of lacustrine ecosystem integrity.

Impacts of Output 4 -- Improved fisheries legal regimes and MCS capabilities

5.71 The lake's ecosystem, including its pelagic stocks, exists and must be understood and managed as a unitary whole: it makes little sense to devise management approaches purely on a piecemeal, national jurisdiction-by-jurisdiction basis. Imposition of mesh size restrictions or the banning of beach seining, for example, will be of limited utility both in biological and social equity terms if the fishers or gear suppliers of an adjacent country are not subject to the same regulations.

5.72 Enforcement and compliance assurance are other major areas of legal deficiency. Even with substantially enhanced numbers of such agents, policing of the fisheries cannot be effective unless local stakeholders are inherently willing to co-operate. Genuine resolution of the enforcement and compliance problem, therefore, calls for full participation of local stakeholders in management decision-making and in MCS follow-up actions to ensure regulatory compliance.

5.73 Measures to harmonise fisheries legislative frameworks and upgrade MCS competencies are deemed essential to long term sustainability of the lacustrine ecosystem and its fisheries, and are thus inherently beneficial.

Impacts of Output 5: More effective use of scientific advice for management

5.74 TREFIP proposes to expand the LTFMP, strengthen statistical capabilities within national fisheries research agencies, and promote closer regional co-operation in the dissemination and use of monitoring information.

5.75 These component activities again are essential instruments for the task of building towards long term sustainability of the lake and its resources, and are again deemed inherently beneficial.

Impacts of Output 6: Establishment of a regional fisheries management entity

5.76 The Tanganyika Fisheries Centre and the Regional Fisheries Council are viewed by the EIA Team as crucial enabling mechanisms for the kind of lakewide planning, co-

ordination, and information processing services needed for maintaining ecosystem sustainability. As such, their establishment is inherently beneficial.

Key Issues and Conclusions

5.77 Table 10 at the end of this chapter summarises major environmental considerations in terms of TREFIP's impact on lacustrine ecology and fish. Considerations of particular note are highlighted below.

Beneficial impacts

5.78 Substantial positive impacts may be realised through the LFMZ and LFC arrangements. Such partnership arrangements are a necessary condition for the long-term sustainability of the Lake Tanganyika fisheries.

5.79 Component activities in the area of micro-credit and introduction of appropriate gear should help to counter trends of over-exploitation and the use of destructive fishing practices (beach seining).

5.80 Improved product shelf life resulting from upgraded artisanal post-harvest practices would increase fish supplies without concomitant increases in fishing effort.

5.81 Establishment of PAs will likely contribute towards sustained biodiversity especially amongst littoral dwelling cichlids, and, though the effects will be difficult to measure, a reduction of fishing pressure on juvenile *L. miodon* stocks.

5.82 Protection of sustainability within the inshore fisheries has direct consequences for the pelagic sector; depletion of the former could lead to a transfer of fishing effort to the latter, which is already subject to over-exploitation risks.

5.83 Furthermore, PAs may encourage the growth of ecotourism and thus economic diversification within the Tanganyika basin. This is another benefit for fisheries sustainability.

5.84 EE outreach activities developed in partnership with local stakeholders are essential building blocks for responsible fisheries and the protection of lacustrine ecosystem integrity.

5.85 Likewise, TREFIP outputs that would provide improved and harmonised regional fisheries legal regimes and MCS capabilities, more effective use of scientific advice for management, and a Tanganyika Fisheries Centre and secretariat for a Regional Fisheries Council are deemed inherently beneficial. All contribute essential tools for realising lacustrine ecosystem and fisheries sustainability in the long-term.

Adverse impacts

5.86 Road rehabilitation, jetty construction, and activities aimed at improving fresh fish collection, handling, and marketing facilities and practices each carry the risk of indirectly promoting unsustainable increases in fishing and fish trading activities. The advantages they confer might attract new 'economic migrant' entrants to the fishery sector. Established operators would clearly find it more convenient to evacuate fish and fish products. End results might thus include increases in harvest activities, demand for raw product, and/or the frequency of marketing trips.

B. FORESTRY AND LAND USE

Impacts of Output 1 -- Implementation of co-management mechanisms

5.87 ***Establishment of CFMZs and LFCs.*** Management partnership arrangements will serve a positive role vis-à-vis forestry and land use as they will provide community-based institutional structures through which actions can be mounted to promote sustainable resource exploitation practices.

5.88 These latter include the use of micro-credit schemes operated in conjunction with LFCs to encourage improved fish handling and processing techniques, and a programme of EE for pilot CFMZ villages.

5.89 ***Micro-credit, introduction of appropriate gear, and fleet restructuring.*** New and/or improved fish processing relying on more efficient techniques of drying carry obvious benefits vis-à-vis forestry and land use (see link to Output 2 below).

Impacts of Output 2 -- Improved infrastructure within pilot villages and strategic marketing centres

5.90 Upgrading of ***local post-harvest practices*** through the use fish drying techniques involving drying tables or concrete slabs and the use of salt will reduce fuelwood demand for smoke curing fish. Deforestation of areas around major landing sites would be reduced accordingly.

5.91 ***Facilities and services in pilot villages.*** Rehabilitation and upgrading of village facilities will involve the assembly of building materials as part of the in-kind contributions to be provided by community residents.

5.92 Construction impacts resulting from tree felling for roofing timbers and clay mining and firing for building brick manufacture are expected to be very minor and localised.

5.93 ***Strategic marketing centre infrastructure and services.*** This activity includes components of road, jetty, and central market construction, installation of electricity supplies, and promotion of fresh fish collection, handling, and marketing systems. Their environmental impacts with respect to forestry and land use are likely to be both positive and negative in effect.

5.94 Construction work on ***feeder roads*** would have a negligible impact, as all of the route segments so far identified involve rehabilitation of existing roads without significant widening or other major interventions.

5.95 Some quarrying of murram material to surface re-graded roads would be required, at pits or deposits within a convenient operating radius of each of the rehabilitation projects. Also, staging areas would be required for construction camps and materials storage. Both of these activities would result in disturbance to ground and soil cover at the affected sites.

5.96 Potential operational impacts include increases in extractive activities as businesspeople and local inhabitants find it easier to transport timber and raw materials for building (sand, gravel, clay, etc.) from areas adjacent to the improved roads.

5.97 There is the further possibility that, as a result of increases in trading activities attendant upon improved access conditions, some landing sites would experience an influx of immigrants and short-term residents. Increased numbers of such ‘economic migrants’ would

put further pressures on land and forest resources as new arrivals seek plots to cultivate, building materials for shelter construction, and fuelwood and water supplies for their households and/or businesses.

5.98 On the other hand, better road access to major marketing points would promote a greater volume of fresh fish trading (Photos 37 – 38), meaning that local fisherfolk would not have to resort to smoking as a means of product preservation. This would in turn reduce pressures on local forest resources since demand for fuelwood would decline.

5.99 ***Jetty*** construction impacts on forestry and land uses would not be significant, although it would require the quarrying of large rocks at appropriate locations to provide fill material. This would involve disturbances to plant and soil cover in or around project areas.

5.100 The potential operational impacts of new jetties would be similar to those anticipated for road rehabilitation activities. More efficient access to cargo evacuation routes could result in increased volumes of trade in natural resource products and the influx of more people in search of economic opportunities. This would be associated with further clearing of indigenous forest and bush areas for timber and fuelwood supplies, further agriculture encroachment, and further erosion and land degradation.

5.101 At the same time, as in the case of improved road access, jetties might facilitate trade in more fresh fish product, particularly if a system of icing and insulated container transport were to develop as a result of TREFIP efforts in this direction (see below).

5.102 ***Marketing facilities.*** Neither construction nor operation of new or upgraded facilities, as thus far planned, is expected to generate significant adverse effects on existing forestry and land use systems. Building contractors will, however, require certain quantities of local supplies in the form of sand and rock ballast from quarries, as well as timber and poles for scaffolding, etc.

5.103 Direct negative impacts to forestry and land use from installation and operation of ***electricity services*** are not foreseen. Indirect adverse effects could be encountered in the future, however, if the services induce other development in the form of increased commerce, road building, and settlement.

5.104 However, beneficial effects will also be forthcoming to the extent that electricity will make it possible to increase the marketing of fresh fish. Reduction of fish smoking activities would translate into reduction of tree felling and land clearing for the sake of obtaining fuel supplies.

5.105 ***Fresh fish collection, handling, and marketing systems.*** This component activity potentially could have marked beneficial impacts on forestry and land use practices. Deforestation resulting from tree felling to supply fish smoking operations is a major environmental problem around nearly all major landing sites along the lakeshore. To the extent that improved collection, handling, and marketing systems will deliver fish fresh to wholesale and retail outlets, there will be no need to engage in such processing operations or to procure the wood supplies they consume.

5.106 At the same time, indirect adverse impacts could ensue in the same way noted for road, jetty, and electricity service provision. Efficiencies in the collection and evacuation of fresh fish presumably would be accompanied by more favourable ex-vessel prices at landing sites, which could in turn attract new recruits to the fishery sector. Increases in local populations would translate into increased pressure on forest and land resources adjacent to settlement areas.

Impacts of Output 3 -- Protection of stocks and biodiversity

5.107 ***Fisheries monitoring.*** Routinely collected information on the fisheries harvest and post-harvest sectors would indirectly reflect effects of industry practices and trends on patterns of land and forest resource use. An improved fisheries monitoring system would thus serve a supportive role for efforts to ensure sustainability within the wider basin environment as well.

5.108 ***Lacustrine PAs***. As with the case of the aquatic environment and fish stocks of the lake, the net effect of PA impacts on forestry and land resource use would be positive. Economic diversification attendant upon development of non-consumptive recreational and educational holiday venues in the region -- ecotourism – will not only be conducive for fisheries sustainability, but for sustainable resource use within the wider Tanganyika basin.

5.109 Significant adverse effects for forestry and land use practices are not anticipated. Of the candidate PA sites proposed in the TREFIP feasibility study report, several already have tourist lodging facilities operating within the vicinity. New or upgraded facilities would probably be required in places like Ngombe Stream National Park[9] and Mahale Mountains National Park in Tanzania, but these would be of a modest scale, like the lodges operating in the Zambian sector. Future tourist traffic would not approach the very high volume streams found in popular destinations like the Serengeti in Tanzania or Victoria Falls in Zambia.

5.110 ***Environmental education*** topics to be emphasised through the use of such formats as video presentations, pamphlets, graphic displays, and discussion groups will include environmental effects of population growth, poor agricultural practices, fish smoking, and deforestation.

5.111 Greater awareness of environmental problems and ecosystem-based management approaches, to the degree that they can be fostered by educational partnerships between local community residents and TREFIP government and NGO agency associates, would potentially have far-reaching positive effects in promoting sustainable forestry and land use practices.

Impacts of Output 4 Activities -- Improved fisheries legal regimes and MCS capabilities

5.112 Improved legal regimes and MCS competencies would entail the reallocation of fishery resource property rights and control of their use to the community level.

5.113 Whilst access restriction is a necessary condition for fisheries sustainability, there is some risk that, in the absence of viable local or regional employment alternatives, those unable to join the fisheries would seek livelihood opportunities in such areas as woodcutting, charcoal production, brick-making, and cultivation. All such activities would put further pressure on forestry and land resources, and contribute to problems of erosion and other forms of land degradation.

5.114 On the other hand, there are indirect positive benefits in that overhauled fisheries legal frameworks would provide a basis for creation of local community institutions through which issues of forest and land resource misuse could be addressed.

[9] Subject to limitations due to the Park's status as a chimpanzee research reserve.

Impacts of Output 5: More effective use of scientific advice for management

5.115 The expanded LTFMP will generate more detailed information than available heretofore on continuities and changes in the harvest and post-harvest sectors, including fluctuations in fishing, processing, and trading activities. Number and type of harvest and post-harvest operations and volume of trade by product will be amongst the parameters measured.

5.116 This activity component will, therefore, indirectly provide data on the extent to which fisheries-related activities are affecting patterns of forest and land resource use. Such information is essential to planning and management for sustainability in the wider Tanganyika basin environment.

Impacts of Output 6: Establishment of a regional fisheries management entity

5.117 The Tanganyika Regional Fisheries Council and its secretariat, the Tanganyika Fisheries Centre, will monitor the adverse effects on forestry and land use caused by fisheries-related activities around the lake. Technical measures designed to mitigate such effects will be co-ordinated and promoted by the Regional Council, to the benefit of both the lacustrine and terrestrial dimensions of the Tanganyika basin environment.

Key Issues and Conclusions

5.118 Table 11 at the end of this chapter summarises major environmental considerations in terms of TREFIP's impact on forestry and land use. Considerations of particular note are highlighted below.

Beneficial impacts

5.119 Establishment of the LFMZ and LFC arrangements would have secondary positive effects for forestry and land use practices since they would serve as mechanisms for focusing community attention towards problems of environmental sustainability.

5.120 More direct benefits would be forthcoming from improved fish processing operations encouraged by the micro-credit scheme and provision of technical support. Reduced demand for fuelwood supplies would result from declining reliance on smoke curing of fish.

5.121 Improved roads, jetty construction, provision of electricity supplies, and more efficient fresh fish collection, handling, and marketing networks would all yield potentially favourable impacts in terms of reduced pressure on forest resources for the supply of wood to fuel fish smoking operations.

5.122 PAs could encourage the growth of ecotourism and thus economic diversification within the Tanganyika basin, possibly leading to reduction in activities like woodcutting, charcoal burning, and brick production that exploit large quantities of forest and land resources.

5.123 Greater awareness of environmental problems and ecosystem-based management approaches, nurtured through educational partnerships between local community residents and TREFIP government and NGO agency associates, would potentially have far-reaching positive effects in promoting sustainable forestry and land use practices.

5.124 Improved fisheries legal regimes and MCS capabilities, an expanded LTFMP, and a Tanganyika Fisheries Centre and Regional Fisheries Council would all be complementary to planning and management efforts in support of sustainable resource use within the wider Tanganyika basin environment.

Adverse impacts

5.125 Road rehabilitation, jetty construction, electrification, and improved trade in fresh fish, carry possible adverse effects for forest and land resources within and around target communities. These include increased commercial activity, influxes of immigrants in search of employment opportunities, and the opening of easier marketing routes for timber and other natural resources. Such developments would be associated with further clearing of indigenous forest and bush areas for timber and fuelwood supplies, further agriculture encroachment, and further erosion and land degradation.

C. HYDROLOGY, WATER QUALITY, AND SOILS

5.126 The intensification of smallholder cultivation within the Lake Tanganyika catchment in recent decades was the subject of detailed investigation under the LTBP, through its Special Study on Sediment Discharge and its Consequences (SedSS). This study concluded that a dramatic five- to tenfold increase in the input of suspended sediments has occurred from the pre-1960s period. Littoral sites within 10 km of the point of discharge of a medium-sized (40 – 50,000 km^2) catchment area appeared to be most threatened by erosion within that area (Patterson, 2000).

5.127 TREFIP outputs will have negligible direct impacts on lake hydrology, water quality or soil. Land-based Programme activities related to upgrading of post-harvest operations and improved infrastructure within pilot villages are expected to have indirect positive effects through altered patterns of land use and raised awareness for environmental problems and their remedies. In particular they should help to diminish the loss of forests and other protective vegetation, which in consequence will diminish water run-off, soil erosion, and sedimentation of adjacent rivers, streams, and the littoral zone.

5.128 Risks of indirect adverse effects are essentially those identified under the discussion of forestry and land use impacts in Section B above.

Key Issues and Conclusions

5.129 Table 12 at the end of this chapter summarises major environmental considerations in terms of TREFIP's impact on hydrology, water quality, and soils of the Tanganyika basin environment.

5.130 Since various Programme activity components are expected to ameliorate soil erosion, run off, and pollution discharge within selected localities, a slight positive impact on Tanganyika's water quality and nearshore benthic community are anticipated.

D. LANDSCAPE AND VISUAL IMPACTS

Impacts of Output 1 -- Implementation of co-management mechanisms

5.131 No significant landscape and visual impacts would be associated with Output 1 activities involving the establishment of CFMZs and LFCs, and implementation of the LFC Micro-Credit Scheme for gear upgrades and fleet restructuring.

Impacts of Output 2 -- Improved infrastructure within pilot villages and strategic marketing centres

5.132 ***Local post-harvest practices.*** Some beach areas at pilot LFC villages would host new drying facilities in the form of tables and concrete slabs. Their construction would not scar the landscape and visual effects, though noticeable, would be negligible.

5.133 ***Facilities and services in pilot villages.*** Rehabilitation and upgrading of village facilities will involve construction of some new buildings within selected villages. All structures will be modest in scale, in keeping with proportions of existing village commercial and domestic buildings. Landscape and visual impacts will therefore be minor.

5.134 Installation and operation of new or rehabilitated ***strategic marketing centre infrastructure*** (roads, jetties, central markets, electricity supplies, and fresh fish marketing systems) is bound to carry a certain degree of landscape and visual impact.

5.135 The impacts of new ***road work and road operations*** are expected to be relatively minor, as they involve existing routes. Some landscape and visual disruption will accompany the construction phase, but only temporarily.

5.136 ***Jetties, central market facilities, electricity supplies, and fresh fish marketing infrastructure*** will for the most part involve new installations, and will thus alter the landscape and visual experience of the environment during both construction and operation.

Impacts of Output 3 -- Protection of stocks and biodiversity

5.137 The three activity components of Output 3, ***fisheries monitoring, establishment of PAs, and environmental education***, are predicted to yield strong net positive effects on landscape and visual aspects of the basin environment.

5.138 All will play either a direct or supportive role in maintaining the integrity of the lacustrine and terrestrial ecosystems of the Tanganyika basin. The role of EE will be of particular importance in fostering community awareness for and commitment to the value of preserving the natural landscape.

5.139 Establishment of lacustrine PAs will entail some minor visual disruption of the lake's surface by artificial features in the form of boundary buoys.

Impacts of Output 4 -- Improved fisheries legal regimes and MCS capabilities

5.140 No significant adverse impacts on landscape or visual features of the environment are foreseen for the activities associated with Output 4.

Impacts of Output 5: More effective use of scientific advice for management

5.141 No significant adverse impacts on landscape or visual features of the environment are foreseen for the activities associated with Output 5.

Impacts of Output 6: Establishment of a regional fisheries management entity

5.142 No significant adverse impacts on landscape or visual features of the environment are foreseen for the activities associated with Output 6.

5.143 Construction and operation of the Tanganyika Fisheries Centre, which will serve as the headquarters and secretariat for the Regional Fisheries Council, would not involve major landscape or visual disruptions as the new facility will only amount to an expansion of the former LTR office block located on the compound of the Département des Eaux, Pêches et Pisciculture (DEPP) in Bujumbura (Burundi).

Key Issues and Conclusions

5.144 Table 13 at the end of this chapter summarises major environmental considerations in terms of TREFIP's impact on landscape and visual aspects of the Tanganyika basin environment. Considerations of particular note are highlighted below.

Beneficial impacts

5.145 Activity components of Output 3, fisheries monitoring, establishment of PAs, and EE, are likely to generate strong positive landscape and visual impact effects. Community awareness for and commitment to the value of preserving natural landscapes will be an especially useful contribution from EE activities.

Adverse impacts

5.146 No significant adverse landscape and visual impacts are anticipated for activities associated with Outputs 1, 3, 4, 5, or 6.

5.147 Under Output 2, adverse impacts are foreseen to varying degrees in relation to the installation and operation of new or rehabilitated strategic marketing centre infrastructure. Concerns are raised especially in the case of jetties, central markets, electricity supplies, and fresh fish marketing systems.

E. COMMUNITIES

Impacts of Output 1 -- Implementation of co-management mechanisms

5.148 Several definite positive impacts will result from the new co-management mechanisms, although there are risks of some negative effects as well.

5.149 ***Establishment of CFMZs and LFCs.*** LTR SEC investigations have confirmed that, although views differ to some extent around the shoreline, local fisherfolk generally welcome the prospect of sharing management responsibilities. Participation in the pilot

CFMZ/LFC programme will be voluntary, with residents of particular communities deciding amongst themselves whether they want to join in. It is anticipated that the programme will foster a strong sense of solidarity and civic purpose amongst those who elect to participate. Such qualities would be conducive to the development of community self-help initiatives in areas beyond the affairs of fishing.

5.150 Possible adverse effects include the selective empowerment of segments of the pilot village communities, to the detriment of others. Women, though very active in fisheries post-harvest activities, tend not to share the advantages of educational attainment and income earnings realised by their male fisher or processor/trader counterparts. Women's comparatively low profile in civic affairs is also disproportional to the socio-economic contribution they make as fish workers, businesspeople, farmers, and household providers.

5.151 Others involved in fisheries-related work, especially as crew and helpers for more affluent boat and gear owners, similarly are often subject to the disadvantages of subordinate social status and poor income levels.

5.152 If women and low-income members of pilot communities are excluded from meaningful representation in LFC structures, such patterns of marginalisation would simply be reinforced and the implementation of the co-management mechanisms proposed under TREFIP would thus tend to run counter to responsible fisheries goals of socio-economic equity.

5.153 ***Micro-credit, introduction of appropriate gear, and fleet restructuring.*** Substantial community benefits can be foreseen as a result of these component activities. Local fisherfolk face great obstacles in seeking loans from established commercial banks. Operation of the LFC Micro-credit Scheme will enable them to upgrade or modify their productive equipment and techniques in ways that not only will foster fisheries sustainability; it may lead to higher market values for fresh and processed fish as well, and thus to enhanced earning levels and living standards.

5.154 Risks include those already noted in Section 5A above – namely, the chance that credit for input acquisitions and fleet restructuring for more efficient fish collection might: a) attract new entrants into, or former operators back into, the fishery; or b) promote rises in the price of fish and fish products that would in turn increase demand for raw product. Such developments would run counter to aims of fishing pressure reduction on overexploited stocks.

5.155 A further possible adverse effect would arise in the event that women and low-income fish workers and processors/traders were to be excluded from or not adequately represented in the company of those receiving micro-credit assistance.

Impacts of Output 2 -- Improved infrastructure within pilot villages and strategic marketing centres

5.156 ***Improved local post-harvest practices.*** Very considerable positive effects will derive from this component activity. Local processors will benefit from reduced drying times in the treatment of small pelagics, and both processors and traders will benefit from extended product shelf life, and, probably, better product prices. Consumers, whether local or remote, will benefit from a cleaner and healthier product. Finally, local communities and fish consumers in urban centres and areas distant from Lake Tanganyika will benefit from a greater supply of fish because of reduced wastage from breakage, fragmentation, and spoiling of product as it passes through distribution and marketing channels.

5.157 Possible risks lie, once again, with the indirect effects that may arise from improved terms of trade. If a strong market develops for higher quality fish products, and local processors and traders benefit accordingly in terms of their earnings, it is likely that others would seek to enter the post-harvest business. In this event, demand for raw product could increase, with consequent increases in producer prices and fishing pressure.

5.158 Further self-recruitment of job seekers into fisheries-related activities could have additional negative repercussions on local terrestrial environments (pressure on forestry and land resources) and social infrastructure (strains on already poor amenities and services), leading to a net decline in levels of socio-economic welfare.

5.159 ***Social facilities and services in pilot villages.*** The EIA Team strongly endorses this activity component in that it ought to generate much-needed improvements to the weak and deteriorated infrastructure that seriously undermines the quality of life in most Lake Tanganyika fishing communities.

5.160 When respondents were asked to talk about their most pressing community development needs during the 1997 LTR survey interviews and the 1998 LTR Community Referenda exercise, schools, health centres, and potable water supply systems were most frequently cited.

5.161 The Programme through each of its national projects will, in partnership with pilot village residents, construct or rehabilitate the physical infrastructure needed for these and similar services, and/or augment the services themselves through provision of technical advice and supplies.

5.162 Residents of participating communities will benefit substantially from such partnership undertakings in the form of better educational opportunities, and reduced rates of illness and mortality because of better preventive, reproductive, and clinical health care, sanitation practices, and access to safe drinking water.

5.163 ***Strategic marketing centre infrastructure and services.*** This component activity will generate an array of community benefits but will also involve some costs in terms of negative impacts.

5.164 ***Feeder road*** rehabilitation works will yield immediate income benefit to communities along the route lines if the Programme contractors employ local labour.

5.165 In terms of operational impacts, better roads would have positive effects in providing easier access to marketing points for traders of fresh and processed fish, thus reducing product wastage. Lakeside villagers would also have easier access to trade items brought in from outside. Transport costs would be reduced, which might translate into somewhat lower consumer prices for outbound fish products and inbound agricultural and manufactured commodities. Access to community development and technical support agencies, including those providing education, health care, and agricultural extension services, would be improved.

5.166 Conditions of easier access to landing sites may also result in adverse community effects. Migration of aspiring job seekers and settlers could increase, placing greater pressure on the lacustrine ecosystem and forestry and land resources, as well as village infrastructure and social welfare facilities. In other words, further deterioration of general socio-economic conditions might ensue.

5.167 As in the case of roads, construction work related to ***jetties, central market facilities, and electricity supplies*** will all generate short-term income benefits for communities to the extent that Programme contractors employ local labour.

5.168 The operation of new jetties will provide a mix of potential benefits and costs in much the same way as for roads. Access to and from outside trading points will be improved, with attendant advantages for fish processors and traders, local residents, and remote consumers of fish products. On the other hand, in-migration of job seekers and settlers from other areas could diminish the ability of the natural environment and social infrastructure to sustain community welfare.

5.169 When new or rehabilitated central market facilities start to function, businesspeople and customers alike will benefit from much improved conditions of sanitation and fish product quality.

5.170 Electrification projects will do much to improve conditions for the fisheries sector, in that they will enable operation of ice machines, chill rooms, and freezing and cold storage facilities.

5.171 Benefits will not only accrue to local fishers (improved prices for catch), local traders (improved storage and handling facilities), and local and distant consumers of Lake Tanganyika fish (greater availability and improved quality of fresh product); they will also be felt in the wider community.

5.172 Reliable electricity supplies would serve domestic lighting and cooking needs, and considerably upgrade conditions at public facilities like clinics and schools. Electrification would in addition help to strengthen and diversify local employment and income opportunities in non-fisheries sectors, such as the food and beverage trade (supply of ice, availability of chilled storage, expanded business) and the tourist trade (improved and expanded lodge facilities, more clients).

5.173 Drawbacks are as cited for roads and jetty developments: influxes of 'economic migrants' might be encouraged, leading to further unsustainable pressure on the ecosystem and available social infrastructure.

5.174 ***Fresh fish collection, handling, and marketing systems.*** Improved marketing systems have the potential for boosting incomes and the general quality of life for local fisherfolk, and providing the wider public with greater quantities of fresh fish – a much-preferred alternative to processed products.

5.175 Possible costs in terms of adverse impacts are, again, linked with tendencies for unsustainable growth in pressure on lacustrine and terrestrial resources and social services that such development could induce.

Impacts of Output 3 -- Protection of stocks and biodiversity

5.176 ***Fisheries monitoring*** is also an activity associated with Output 4. Expected effects are discussed with reference to that output, in the following section.

5.177 ***Lacustrine PAs***. Establishment of protected areas will yield advantages to adjacent communities in the form of minor short-term employment opportunities during facility installation phases. Once operational, PAs will offer long-term employment opportunities in proportion to the amount of ecotourism traffic that is attracted. The expected economic return to benefit the local community will also depend on managerial organisation.

As learned from experiences with national parks and game reserves in other parts of Sub-Saharan Africa, community based management and local ownership of park areas and tourist facilities fosters strong employee commitment. Local worker-owners are eager to embrace proper management techniques and the better economic returns they yield, as opposed to employees of organisations controlled by remote parastatal administrations. The new LFCs could play an important role in developing management and services within PAs.

5.178 The TREFIP ***environmental education*** programme will use video presentations, pamphlets, graphic displays, and discussion groups to highlight such issues as the effects of population growth, invasive agricultural practices, and fish smoking and deforestation on lacustrine and terrestrial resource bases and human welfare.

5.179 Greater awareness of environmental problems and reproductive health and ecosystem-based management approaches to their resolution will strongly reinforce efforts to build towards balanced use of Tanganyika basin resources by its human residents, and away from current trends of resource over-exploitation and their inevitable outcomes of socio-economic marginalisation.

Impacts of Output 4 Activities -- Improved fisheries legal regimes and MCS capabilities

5.180 Improved legal regimes and MCS competencies would, amongst other things, empower local stakeholder groups, through CFMZs and LFCs, as direct participants in fisheries management decision-making and as principal responsible parties in enforcement and compliance assurance activities.

5.181 The EIA Team recognises that once LFCs are established as formal entities, they would serve a positive role as focal groups for the deliberation and amelioration of environmental problems with which Tanganyika fishing communities are often confronted. These problems, complex and interrelated consequences of expanding populations, unsustainable fishing and agricultural practices, and deforestation and land degradation, are ultimately best dealt with through concerted actions by members of the affected communities themselves.

5.182 This activity component essentially serves to provide the necessary instruments for community empowerment, and is regarded by the EIA Team as inherently beneficial.

5.183 As remarked when considering the forestry and land use impacts of Output 4 (section 5B), there is a risk that termination of open access conditions for the Tanganyika fisheries and allocation of access restriction responsibility to local stakeholder groups will be very problematical in the absence of viable local or regional employment alternatives for those who will no longer be able to recruit themselves to the fisheries.

Impacts of Output 5: More effective use of scientific advice for management

5.184 An expanded LTFMP would provide information on socio-economic parameters of the Tanganyika fishery, including changes in settlement population size and composition, infrastructure, and amenity features of lakeshore communities. Monitoring would thus serve as a tool for gauging the capacity of the natural environment and social infrastructure to cater for human welfare needs.

Impacts of Output 6: Establishment of a regional fisheries management entity

5.185 The Tanganyika Regional Fisheries Council and its secretariat, the Tanganyika Fisheries Centre, and will provide mechanisms for the compilation, analysis, and dissemination of fisheries information on a lakewide scale, and for the co-ordination of technical measures needed to ensure sustainable use of resources.

5.186 Such measures would be informed of the actions and recommendations of LFCs, and of the routine socio-economic monitoring work conducted as part of the LTFMP. Community interests would therefore be strongly represented in efforts to further responsible fisheries management processes on a regional basis.

Key Issues and Conclusions

5.187 Table 14 summarises major environmental considerations in terms of TREFIP's impact on communities. Considerations of particular note are highlighted below.

Beneficial impacts

5.188 Participation in the pilot CFMZ/LFC programme will foster a strong sense of solidarity and civic purpose amongst those who elect to participate. Such qualities would be conducive to the development of community self-help initiatives in areas beyond the affairs of fishing.

5.189 Operation of the LFC Micro-credit Scheme will enable local fisherfolk to upgrade or modify their productive equipment and techniques in ways that will foster fisheries sustainability, and may result in higher market values for fresh and processed fish as well.

5.190 Activities directed towards improving local post-harvest practices would benefit fish processors and traders by extending product shelf life. Wholesale and retail product prices are also likely to improve. Fish consumers will benefit from availability of cleaner and healthier dried clupeid products, and from a greater supply of fish because of reduced wastage.

5.191 Construction or rehabilitation of social facilities and services in pilot villages will yield substantial benefits in the form of better educational opportunities, and reduced rates of illness and mortality because of better preventive, reproductive, and clinical health care, sanitation practices, and access to safe drinking water.

5.192 Construction or rehabilitation of roads, jetties, central market facilities, and electricity supplies will all generate short-term income benefits to project communities to the extent that Programme contractors employ local labour.

5.193 Possible benefits from improved marketing systems include increased incomes for local fisherfolk and the availability of greater quantities of fresh fish to national populations.

5.194 Development of ecotourism in association with lacustrine PAs would stimulate much-needed economic diversification along the Tanganyika shoreline, creating jobs and raising income for adjacent communities.

5.195 Environmental education will build local awareness of the problems brought on by over-population and over-exploitation of the natural environment, and possibilities for their amelioration through reproductive health and ecosystem-based management measures.

5.196 Activities aimed at the improvement of regional fisheries legal regimes, use of scientific advice for management, and lakewide management co-ordination through creation

of a permanent regional fisheries entity are inherently beneficial. They would all establish instruments through which community interests can be represented, understood, and meaningfully incorporated within a responsible fisheries management process.

Adverse impacts

5.197 Possible adverse effects of the CFMZ/LFC programme include the exclusion of women and low-income fish workers such as crew and helpers of boat and gear owners from full participation. Implementation of the co-management mechanisms proposed under TREFIP would in this eventuality run counter to responsible fisheries goals of socio-economic equity.

5.198 Input acquisitions and fleet restructuring for more efficient fish collection financed through micro-credit facilities might have the effect of raising fishing pressure on stocks that in some sectors of the lake are already overexploited.

5.199 A further possible adverse effect would arise in the event that women and low-income fish workers and processors/traders were to be excluded or not adequately represented amongst groups of micro-credit assistance recipients.

5.200 Road, jetty, and electrification projects, as well as improvements to fresh fish marketing systems, all carry the potential for creating conditions that would draw 'economic migrants' into target localities, leading to further unsustainable pressure on the ecosystem and available social infrastructure.

Table 10. Summary of projected beneficial and adverse impacts of TREFIP outputs on lacustrine ecology and fish stocks.

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
1. Implementation of co-management.			
1.1 Establish CFMZs and LFCs	Substantial in terms of regulation fishing mortality, control resource access. LFMZ and LFC partnership arrangements seen as necessary condition for long-term sustainability of fisheries.	None foreseen.	
1.2 Micro credit scheme.	See below.	See below.	Linked to Activity 1.3 & Outputs 2 & 3.
1.3 Introduction of appropriate gear.	Likely to contribute towards reversal of trends towards overexploitation. Retirement of beach seine units should improve survival juvenile stages *L. miodon*, reduce damage to cichlid breeding and brooding areas.	Some risk of input acquisitions attracting new entrants into fishery/ former operators back in. For credits directed towards post-harvest, significant rises in price fish could increase demand for raw product/ attract new entrants into fish business.	
2. Improved infrastructure/services.			
2.1 Local post-harvest practices	Reduction of post-harvest losses in effect increases yield without increase in fishing effort.	None foreseen.	
2.2 Village facilities/services.		None foreseen.	
2.3 Strategic marketing channels.			
2.3a Roads	Amelioration of soil erosion and sedimentation: upgrading will involve proper road cambering and drainage management.	Some gully and sheet erosion associated with construction staging. New entrants could be attracted into the sector in some localities; possible increased demand for raw product.	
2.3b Jetties		Disruption of substrate and benthic/ rock-dwelling aquatic organisms in immediate area of construction. Could encourage unsustainable increases in fishing and fish trading activities in some localities.	No net increase in localised pollution from fuel spillage, engine oil, bilge and other vessel wastes anticipated.

Table 10 (Cont.)

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
2.3c Central markets	Reduction of waste runoff into lake	None foreseen.	Possible waste disposal problems due to concentrations of traders and market users.
2.3d Electricity services		Runoff of waste cooling water contaminated with oil and fuel residue from generator station compounds.	
2.4 Fresh fish marketing systems	Could contribute to the reduction of industrial fishing pressure in southern waters.	As with roads and jetties, new entrants could be attracted into the sector in some localities; possible increased demand for raw product.	
3. Protection of biodiversity/lacustrine system productivity.			
3.1 Fisheries monitoring.	Support service for efforts to maintain lacustrine ecosystem, sustainable fisheries.	None foreseen.	Linked to Output 5 activities.
3.2 Lacustrine protected areas.	Probable benefits in terms of biodiversity protection & stock sustainability, though difficult to measure. Existence of employment alternatives to fishing (ecotourism) could temper exploitation pressure on commercial fish stocks.	Negligible.	
3.3 Environmental education (village workshops, media, videos).	Potentially immense. Contributes towards foundations for responsible fisheries and protection of lacustrine ecosystem integrity.	None foreseen.	
4. Improved legal regime/MSC capabilities.	Essential to long term sustainability of lacustrine ecosystem and fisheries; inherently beneficial.	None foreseen.	
5. Facilitate use of scientific advice for management.	Technical support to efforts towards long term sustainability of lacustrine ecosystem and fisheries; inherently beneficial.	None foreseen.	
6. Establish a regional management entity.	Co-ordinating body and information services agency essential to long term sustainability of lacustrine ecosystem and fisheries; inherently beneficial.	None foreseen.	

Table 11. Summary of projected beneficial and adverse impacts of TREFIP outputs on forestry and land use

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
Implementation of co-management.			
1.1 Establish CFMZs and LFCs	Will provide structures through which community actions for long-term resource sustainability can be directed.	None foreseen.	
1.2 Micro credit scheme.	See 2.1 below.	None foreseen.	Linked to Activity 1.3 & Outputs 2 & 3.
1.3 Introduction of appropriate gear.		Some risk of input acquisitions attracting new entrants into fishery, leading to greater pressures on forest and land resources.	
Improved infrastructure/services.			
2.1 Local post-harvest practices	Improved processing techniques → reduced fuelwood demand for fish smoking operations → less deforestation.		
2.2 Village facilities/services		Localised minor impacts associated with acquisition of construction materials.	
2.3 Strategic marketing channels.			
2.3a Roads	Better access could lead to greater trade in fresh fish, which would reduce fuelwood demand for fish smoking.	**Construction:** Localised minor impacts associated with murram quarries and staging areas. **Operational:** Increases in extractive activities (timber, charcoal, brick making, quarrying). Attraction of 'economic migrants' = greater pressure on forest and land resources.	
2.3b Jetties	Better access & co., as above.	**Construction:** Localised impacts associated with fill rock quarries. **Operational:** Increases in extractive activities (timber, charcoal). Attraction of 'economic migrants' → greater pressure on forest and land resources.	No net increase in localised pollution from fuel spillage, engine oil, bilge and other vessel wastes anticipated.

Table 11 (Cont.)

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
2.3c Central markets		Localised minor impacts associated with acquisition of construction materials.	
2.3d Electricity services	Could lead to increased marketing of fresh fish, attendant reduction of fish smoking activities.	Induces developments that could attract 'economic migrants' → increased settlement, pressure on natural resources.	
2.4 Fresh fish marketing systems	Reduced fuelwood demand for fish smoking operations; less deforestation.	Induces developments that could attract 'economic migrants' → increased settlement, pressure on natural resources.	
Protection of biodiversity/lacustrine system productivity.			
3.1 Fisheries monitoring.	Supportive of efforts to ensure sustainability within wider basin environment	None foreseen.	Linked to Output 5 activities.
3.2 Lacustrine protected areas.	Existence of local employment alternatives (ecotourism) could temper exploitation pressure on forest and land resources.	Negligible.	
3.3 Environmental education (village workshops, media, videos).	Builds environmental consciousness, with possible far-reaching effects in promoting sustainable forestry and land use practices.	None foreseen.	
Improved legal regime/MSC capabilities.	Enabling benefits: provides basis for local community institutions through which forest and land resource misuse issues could be addressed.	Limitation of access could divert would-be fishers to seek livelihoods in such areas as woodcutting, charcoal production, brick making, and cultivation; consequent problems of erosion, other forms of land degradation.	
Facilitate use of scientific advice for management.	Will provide indications of impacts of fisheries sector activities on forestry and land use situation.	None foreseen.	
Establish a regional management entity.	Co-ordination, promotion of technical measures to benefit of both the lacustrine and terrestrial basin environments.	None foreseen.	

Table 12. Summary of projected beneficial and adverse impacts of TREFIP outputs on hydrology, water quality, and soils

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
Implementation of co-management.			
1.1 Establish CFMZs and LFCs	Will provide structures through which community actions for long-term resource sustainability can be directed.	None foreseen.	
1.2 Micro credit scheme.	See 2.1 below.	None foreseen.	Linked to Activity 1.3 & Outputs 2 & 3.
1.3 Introduction of appropriate gear.		Some risk of input acquisitions attracting new entrants into fishery → greater pressures on forest and land resources → erosion, sedimentation.	
Improved infrastructure/services.			
2.1 Local post-harvest practices	Improved processing techniques → reduced fuelwood demand for fish smoking operations → less deforestation.		
2.2 Village facilities/services		Localised minor impacts associated with acquisition of construction materials → erosion, sedimentation.	
2.3 Strategic marketing channels.			
2.3a Roads	Better access could lead to greater trade in fresh fish, which would reduce fuelwood demand for fish smoking.	**Construction:** Localised minor impacts associated with murram quarries and staging areas → erosion, sedimentation. **Operational:** Increases in extractive activities (timber, charcoal, brick making, quarrying) → erosion, sedimentation. Attraction of 'economic migrants' = greater pressure on forest and land resources → erosion, sedimentation.	

Table 12 (Cont.)

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
2.3b Jetties	Better access & co., as above.	**Construction:** Localised impacts associated with fill rock quarries → erosion, sedimentation. **Operational:** Increases in extractive activities (timber, charcoal) → erosion, sedimentation. Attraction of 'economic migrants' → greater pressure on forest and land resources → erosion, sedimentation.	
2.3c Central markets		Localised minor impacts associated with acquisition of construction materials → erosion, sedimentation.	
2.3d Electricity services	Could lead to increased marketing of fresh fish, attendant reduction of fish smoking activities.	Induces developments that could attract 'economic migrants' → increased settlement, pressure on natural resources → erosion, sedimentation.	
2.4 Fresh fish marketing systems	Reduced fuelwood demand for fish smoking operations; less deforestation.	Induces developments that could attract 'economic migrants' → increased settlement, pressure on natural resources → erosion, sedimentation.	
Protection of biodiversity/lacustrine system productivity.			
3.1 Fisheries monitoring.	Supportive of efforts to ensure sustainability within wider basin environment	None foreseen.	Linked to Output 5 activities.
3.2 Lacustrine protected areas.	Existence of local employment alternatives (ecotourism) could temper exploitation pressure on forest and land resources.	Negligible.	
3.3 Environmental education (village workshops, media, videos).	Builds environmental consciousness, with possible far-reaching effects in promoting sustainable forestry and land use practices.	None foreseen.	

Table 12 (Cont.)

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
Improved legal regime/MSC capabilities.	Enabling benefits: provides basis for local community institutions through which forest and land resource misuse issues could be addressed.	Limitation of access could divert would-be fishers to seek livelihoods in such areas as woodcutting, charcoal production, brick making, and cultivation; consequent problems of erosion, other forms of land degradation.	
Facilitate use of scientific advice for management.	Will provide indications of impacts of fisheries sector activities on forestry and land use situation.	None foreseen.	
Establish a regional management entity.	Co-ordination, promotion of technical measures to benefit of both the lacustrine and terrestrial basin environments.	None foreseen.	

Table 13. Summary of projected beneficial and adverse impacts of TREFIP outputs on landscape and visual features

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
Implementation of co-management.			
1.1 Establish CFMZs and LFCs		None foreseen.	
1.2 Micro credit scheme.		None foreseen.	Linked to Activity 1.3 & Outputs 2 & 3.
1.3 Introduction of appropriate gear.		None foreseen	
Improved infrastructure/services.			
2.1 Local post-harvest practices		Negligible visual effects from introduction of new fish drying tables and concrete slabs on at some landing sites.	
2.2 Village facilities/services		Localised minor landscape and visual impacts.	
2.3 Strategic marketing channels.			
2.3a Roads		Relatively minor impacts as involves existing routes.	
2.3b Jetties		Some alteration of landscape and visual experience at project sites.	
2.3c Central markets		As above.	
2.3d Electricity services		As above.	
2.4 Fresh fish marketing systems	Reduced fuelwood demand for fish smoking operations; less deforestation.	Induces developments that could attract 'economic migrants' → increased settlement, pressure on natural resources.	
Protection of biodiversity/lacustrine system productivity.			
3.1 Fisheries monitoring.	Supportive of efforts to minimise adverse fisheries-related impacts on natural landscape and visual features of environment.	None foreseen.	Linked to Output 5 activities.

Table 13 (Cont.)

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
3.2 Lacustrine protected areas.	Indirect effects of demonstrating value of preserving natural landscapes, scenery.	Minor impacts from boundary buoys.	
3.3 Environmental education (village workshops, media, videos).	Builds community awareness for and commitment to the value of preserving the natural landscape.	None foreseen.	
Improved legal regime/MSC capabilities.		None foreseen.	
Facilitate use of scientific advice for management.		None foreseen.	
Establish a regional management entity.	Co-ordination, promotion of technical measures to benefit of both the lacustrine and terrestrial basin environments.	None foreseen.	New office facility will be expansion of existing structure.

Table 14. Summary of projected beneficial and adverse impacts of TREFIP outputs on communities.

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
1. Implementation of co-management.			
1.1 Establish CFMZs and LFCs	Fostering of solidarity and civic purpose within participating communities; conducive to development of self-help initiatives generally.	Possible risks in event that less empowered community members excluded from full participation, including women and low-income fish workers.	
1.2 Micro credit scheme.	Fisherfolk able to upgrade/modify productive equipment/techniques in ways conducive to fisheries sustainability, and higher market values fish.	Possible risks include elevated fishing pressure on stocks, and exclusion of less empowered community members from adequate participation.	Linked to Activity 1.3 & Outputs 2 & 3.
1.3 Introduction of appropriate gear.		Some risk of input acquisitions attracting new entrants into fishery, leading to greater pressures on forest and land resources and strains on social facilities and services to provide adequate coverage.	
2. Improved infrastructure/services.			
2.1 Local post-harvest practices	Wholesale and retail product prices are likely to improve for traders; availability of cleaner and healthier dried clupeid products in greater supply for consumers because of reduced wastage.		
2.2 Village facilities/services	Improved quality of life. (E.g. better educational opportunities; reduced rates of illness, mortality because of better preventive, reproductive, and clinical health care, sanitation practices, and access to safe drinking water.)	Localised minor impacts associated with acquisition of construction materials.	

Table 14 (Cont.)

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
2.3 Strategic marketing channels.			
2.3a Roads	Short-term benefits to project communities through local employment during construction; improved communications, access to markets, agricultural commodities, essential services over long term.	Possible effect of drawing 'economic migrants' into target localities → further unsustainable pressure on ecosystem and social infrastructure.	
2.3b Jetties	Short-term benefits to project communities through local employment during construction; improved communications, access to markets, agricultural commodities, essential services over long term.	As above. Increase in localised pollution from fuel spillage, other vessel wastes?	Pollution from vessels may shift closer to shoreline.
2.3c Central markets	Short-term income benefits & co., as above. Also, availability of fresher, higher quality fish products and hygienic market conditions.	As above.	
2.3d Electricity services	Short-term income benefits & co., as above.	As above.	
2.4 Fresh fish marketing systems	Increased incomes for fisherfolk; availability of greater quantities of fresh fish to national populations.	As above.	
3. Protection of biodiversity/lacustrine system productivity.			
3.1 Fisheries monitoring.	Supportive of efforts to ensure sustainability within wider basin environment	None foreseen.	Linked to Output 5 activities.
3.2 Lacustrine protected areas.	'Ecotourism' would stimulate economic diversification → job creation, increased income for adjacent communities.	Negligible.	

Table 14 (Cont.)

0. Outputs/ 0.0 Activities	**Beneficial Impacts**	**Adverse Impacts**	**Remarks**
3.3 Environmental education (village workshops, media, videos).	Raised local awareness of problems of over-population, over-exploitation of natural environment, possibilities for amelioration (reproductive health and ecosystem-based management measures).	None foreseen.	
4. Improved legal regime/MSC capabilities.	Enabling benefits: provides basis for local community institutions through which social and environmental issues could be addressed.	Could raise social tensions, foster resentment amongst those denied access to fishery resource exploitation.	
5. Facilitate use of scientific advice for management.	Provides tool for gauging capacity of natural environment and social infrastructure to cater for human welfare needs.	None foreseen.	
6. Establish a regional management entity.	Supports representation of community interests and their incorporation into responsible fisheries management process.	None foreseen.	