

# **ASIAN DEVELOPMENT BANK**

SUMMARY INITIAL ENVIRONMENTAL EXAMINATION

FOR

SUNDARBANS BIODIVERSITY CONSERVATION PROJECT

IN

BANGLADESH

May 1998

## CURRENCY EQUIVALENTS

(as of 5 May 1998)

Currency Unit	—	Bangladesh Taka (Tk)
Tk1.00	=	\$0.02152
\$1.00	=	Tk46.46

## ABBREVIATIONS

EMP	-	Environmental Management Plan
FD	-	Forest Department
FRMP	-	Forest Resources Management Project
GDP	-	Gross Domestic Product
NGO	-	Nongovernment Organization
NWFP	-	Nonwood Forest Products
SAC	-	Stakeholder Advisory Council
SIEE	-	Summary Initial Environmental Examination
SMA	-	Sundarbans Management Agency
SRF	-	Sundarbans Reserved Forest
SSC	-	Sundarbans Stewardship Commission
TAG	-	Technical Advisory Group

## GLOSSARY

<i>Bowali</i>	Wood cutter or collector.
<i>Gewa (Excoecaria agallocha)</i>	Mangrove species—primary use is for newsprint pulp by the Khulna Newsprint Mill, preferred species for matchmaking, also used as low-value firewood and for other general purposes.
<i>Golpatta (Nypa fruticans)</i>	Stemless palm, the fronds of which are used for roof thatching.
<i>Goran (Ceriops decandra)</i>	Mangrove species which grows as a small tree or shrub—highly valued for firewood.
<i>Hantal (Phoenix paludosa)</i>	A slender, straight, small palm used for rafters, fences, and house posts.
Impact Zone	The 17 <i>thanas</i> immediately adjacent and most dependent on the Sundarbans Reserved Forest (SRF).
<i>Mowali</i>	Honey collector.
Poldering	Reclaiming land from the water's edge by building embankments around the perimeter to prevent the entry of water, in this case, typically the tidal waters.
<i>Shingra (Cynometra ramiflora)</i>	Used as firewood.
<i>Sundri (Heriteria fomes)</i>	Mangrove species, the most valuable timber resource in the SRF—large stems used as electricity power poles; sawn timber used for structural purposes; poles used for housing, bridges, jetties, and brushwood sold to the Khulna Hardboard Mill and used as firewood.
<i>Thana</i>	Bangladesh local administrative unit.
Top-dying	The gradual dieback of the topmost part of the <i>Sundri</i> tree, or early senescence as a result of disease, pests, or changing edaphic conditions

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## I. INTRODUCTION

1. The proposed Sundarbans Biodiversity Conservation Project in Bangladesh (the Project) has been designated Category B. Accordingly, an initial environmental examination was conducted in accordance with the Bank's environmental guidelines.

2. This summary initial environmental examination (SIEE) provides a report on initial screening of the activities identified for the Project. The report describes the scope of the anticipated beneficial and adverse impacts due to the Project, identifying appropriate measures for mitigation of potential adverse impacts and institutional linkages.

3. The SIEE is based on field surveys in the Sundarbans Reserved Forest (SRF, including two sanctuaries, a production zone, and a marine zone); field studies in local villages in the impact zone; several site inspections in four *thanas*<sup>1</sup> in the immediate vicinity of the SRF; and discussions with stakeholders including concerned officials of the Forest Department (FD), the Ministry of Environment and Forests (MOEF), various experts on silviculture, wildlife, hydrology and hydraulic engineering, and representatives from communities, the Association of Development Agencies in Bangladesh, and nongovernment organizations (NGOs) operating in the vicinity of SRF in various fields of rural development.

## II. DESCRIPTION OF THE PROJECT

4. The Sundarbans<sup>2</sup> offers coastal protection to southwest Bangladesh, including regional cities and towns. A globally significant ecosystem, SRF features habitats for fish, shrimp, birds, and wildlife, including the Bengal tiger (*Panthera tigris tigris*). While there has been little permanent settlement inside SRF, a large number of persons spend significant time inside the forest in boats, or in semi-permanent habitations along the border. The SRF is increasingly used by rural communities located within a 20 kilometer (km)-wide zone outside the forest boundary—referred to as the impact zone—by commercial wood product manufacturers, artisanal fisherfolk, and by fishing vessels from the Bay of Bengal. Under increasing pressure from these users, biological resources are being rapidly depleted. The FD is responsible for management of the SRF; however, it is inadequately staffed, and has insufficient budget allocations and equipment, such as watercraft, to perform the task effectively. The FD urgently needs to change from a single-sector institution to one capable of managing a multidimensional resource. Stopping and reversing the current deforestation and loss of biodiversity will require additional financial resources, a significant improvement in institutional capacity, and a changed management approach.

5. The Project will focus on conservation and natural resource management in the SRF, the country's largest tract of reserved forest (44 percent of the country's reserved forest area). The goal is to secure the integrity of the environment and the biodiversity of the SRF through an integrated conservation and development approach that links appropriate management and conservation measures with promotion of alternative income-generating activities and social forestry in the impact zone, and that supports nonconsumptive uses such as ecotourism.

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<sup>1</sup> A *thana* is a local administrative area; there are 460 *thanas* in Bangladesh.

<sup>2</sup> The Sundarbans refers to the entire Project area, which comprises both the SRF and the impact zone.

6. The objectives of the Project are to develop a sustainable management and biodiversity conservation system for all SRF resources, on the basis of rational plans and the participation of all key stakeholders.

7. The Project covers the SRF itself and 17 *thanas* located within the impact zone. The Project will establish a participatory system for the conservation and sustainable management of the SRF as a multidimensional resource area. An integrated approach will be employed to (i) conserve biodiversity and improve forest management; (ii) improve the FD's institutional capacity to manage the SRF; (iii) reduce poverty among the 3 million people living in the impact zone by expanding economic opportunities, improving social infrastructure, improving organization for resource users, and facilitating stakeholder participation in resource management; and (iv) adopt a supportive set of policies, especially charging market-based prices for licenses and permits to gain access to SRF resources. The Project area will be divided into four zones: (i) a production zone for sustainable production of terrestrial and aquatic species;<sup>1</sup> (ii) a sanctuary zone covering three existing wildlife sanctuaries, where only nonconsumptive use (such as ecotourism) will be allowed; (iii) an impact zone surrounding the SRF in Khulna, Satkhira, Bagerhat, Pirojpur, and Borguna districts, where economic activities will be promoted as an alternative to resource exploitation in the SRF; and (iv) a marine zone, consisting of an offshore area extending 20 km into the Bay of Bengal, which currently supports fisheries but also includes protected marine and terrestrial biodiversity, and where new islands often appear as a result of the massive sedimentation flows in the area.

8. The Project will introduce appropriate management systems to prevent further depletion and facilitate regeneration of the ecosystem (including wood products, fisheries and aquatic resources, wildlife and birds, and other nonwood forest products [NWFP]) of SRF. To that end, the Project proposes to establish a Project management organization to oversee an integrated multisectoral approach for the long-term conservation of this ecosystem, with full participation of beneficiaries and NGOs.

9. The Project consists of five components.

- (i) Establishment of a Sundarbans Management Agency (SMA), a Sundarbans Stewardship Commission (SSC), a Stakeholder Advisory Council (SAC), and upgraded infrastructure.
- (ii) Biodiversity conservation and sustainable resources management through improved FD capacity to plan and undertake operations in support of forest, aquatic, and wildlife resources, including the three existing wildlife sanctuaries.
- (iii) Socioeconomic development of the impact zone through (a) NGO operations for social mobilization and organization of user groups to exploit SRF resources on a sustainable basis; and (b) planned social investments and alternative livelihood activities, including microfinance services to reduce both the incidence of poverty and level of dependency on the SRF.
- (iv) Ecotourism development and marketing, involving (a) construction of basic public infrastructure; (b) training of related personnel to provide services acceptable to international and domestic tourists; (c) development of community awareness of ecotourism opportunities and their potential impacts; and (d) development of a regulatory

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<sup>1</sup> With appropriate controls for protected species.

framework and marketing strategy within the Government and private sector to promote Sundarbans as an ecotourist destination.

- (v) Technical advisory group (TAG), monitoring and studies, comprising (a) a TAG to provide scientific and resource management support and to train personnel; (b) environmental and resource monitoring by a specialist international NGO; (c) independent inspection services; and (d) related studies for improved ecosystem management, pollution monitoring and control, and other priority topics.

10. The Project is expected to prevent further forest depletion and to preserve an ecosystem that provides a habitat for the world's largest population of the Bengal tiger, as well as for other endangered species. The Project will devise ways to support the natural regeneration of the mangrove ecosystem. The main benefits will include sustainable use of wood and NWFP, conserved habitats for fisheries, aquatic resources and wildlife, and improved ecotourism opportunities. In the impact zone, the Project will provide alternative income generating activities, as well as improved infrastructure and services. The principal beneficiaries of socioeconomic gains will be the poor and disadvantaged sections of the rural communities living in the impact zone.

### III. DESCRIPTION OF THE ENVIRONMENT

11. Straddling the border between India and southwestern Bangladesh, the Sundarbans extends over approximately 10,000 square km (km<sup>2</sup>), and is the world's largest contiguous mangrove ecosystem. The SRF comprises slightly over 60 percent of this area (6,017 km<sup>2</sup>) and sprawls across the ancient delta of the Ganges River in the southwest corner of Bangladesh. It lies within a zone of cyclonic storms and tidal bores that originate in the Bay of Bengal and periodically devastate coastal areas. The SRF provides a resilient buffer for the lives and assets of the 3 million people who live in the immediate vicinity, as well as offers protection to infrastructure and urban populations in major towns such as Khulna and the international shipping port of Mongla. The Sundarbans has been acknowledged for its high biodiversity value.<sup>1</sup> In Bangladesh, three wildlife sanctuaries totaling 324 km<sup>2</sup> were established along the southern edge of SRF in 1977. Since then, the sanctuaries have been expanded to include river channels, bringing the total current area to 1,397 km<sup>2</sup> or 23 percent of SRF. At the 21<sup>st</sup> session of the World Heritage Committee (1-6 December 1997), these sanctuaries together were declared a world heritage site as they constitute one of the largest mangrove areas in the world, supporting an exceptionally wide range of fauna (including the Bengal tiger) and providing a significant example of delta formation, tidal influences, and plant colonization.

12. The Sundarbans has a humid maritime tropical climate with a marked seasonality shared between heavy monsoon rains and a dry, relatively cool winter. The monsoon coincides with the arrival of the moisture-laden southwest trade winds during May to October. This is a time when mean temperatures reach 35°C, with maxima of over 40°C, and high humidity peaking at around 95 percent. The monsoon declines with a change in wind direction to the northeast, ushering in cool dry winters that last until April.

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<sup>1</sup> The Bangladesh portion of the Sundarbans is included in the Ramsar List of Wetlands of International Importance.

## A. Physical and Ecological Resources

13. The biophysical properties of the SRF have been comprehensively studied and documented, e.g., by the World Conservation Union, Food and Agriculture Organization, United Nations Development Programme, and most recently, by the World Bank-supported Forest Resources Management Project (FRMP) initiatives. As the largest forest area in the country, and with extensive aquatic and marine components, the SRF represents a significant storehouse of biodiversity, which includes 245 genera and 334 species of plants. The SRF is the country's major habitat for wild shrimp breeding, and home to many species of fish, birds, dolphins, and other wildlife. It is also the most important contiguous habitat in the world for the highly endangered Bengal tiger.<sup>1</sup> It also offers tourism and recreation benefits, and is a major pathway for nutrient cycling and pollution abatement. Other significant faunal components include aquatic mammals, nesting marine turtles, saltwater crocodiles, and important colonies of resident and overwintering migrant birds. The vegetation cover includes a mosaic of soil/drainage-specific mangrove associations developed along east-west and north-south salinity gradients, and grassy meadows, dune, and beach vegetation along the coast. At its northern margin, the mature mangrove forest shows climax features, with gradual (natural) disappearance of halophytes and shifting to a nonmangrove ecosystem.

### 1. Biological Diversity

14. The Sundarbans has been classified as a moist tropical forest demonstrating a whole mosaic of seres, comprising primary colonization on new land which has appeared due to siltation, to more mature beach forest, often conspicuously dominated by *Keora* (*Sonneratia apetala*) and tidal forests.

15. As indicated in Appendix 1, the SRF supports a wide diversity of amphibians, reptiles, birds, and mammals. Of these, the tiger and dolphin are especially important in wildlife management planning and tourism development. They are both high-profile and vulnerable mammals, and their status is a strong indicator of the general condition of SRF wildlife and its management.

16. The mangrove vegetation of the SRF differs greatly from other nondeltaic coastal mangrove forest and upland forest associations. Unlike the former, the Rhizophoraceae is of minor importance, and the dominant species are *Sundri* (*Heritiera fomes*) and *Gewa* (*Excoecaria agallocha*). This difference has been explained in terms of freshwater and low salinity influences in the northeast and variations in drainage and siltation. Historically three principal vegetation types have been recognized in broad correlation with varying degrees of water salinity, freshwater flushing, and physiography, and which are represented in the wildlife sanctuaries, as described below.

- (i) In Sundarbans east, freshwater and *Sundri* mangrove varieties dominate, interspersed with *Gewa* and *Passur* (*Xylocarpus mekongensis*), with *Kankra* (*Bruguiera gymnorrhiza*) occurring in areas subject to more frequent flooding. Here, there is an understory of *Shingra* (*Cynometra ramiflora*) where soils are drier, *Amur* (*Amoora cucullata*) in wetter areas, and *Goran* (*Ceriops decandra*) in

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The Bengal tiger population in SRF was most recently estimated in excess of 350 individuals (Tamang 1994), or approximately 10 percent of the population worldwide.

more saline places. *Golpatta* (*Nypa fruticans*) palm is widespread along drainage lines.

- (ii) Sundarbans south has the greatest seasonal variation in salinity levels and possibly represents an area of relatively longer duration of moderate salinity where *Gewa* is the dominant woody species. It is often mixed with *Sundri*, which it is able to displace in circumstances such as artificially opened canopies where *Sundri* does not regenerate as effectively. Sundarbans south is also frequently associated with a dense understorey of *Goran* and sometimes *Passur*.
- (iii) Sundarbans west supports sparse *Gewa*, dense stands of *Goran*, and discontinuous patches of *Hantal* palm (*Phoenix paludosa*) on drier ground, river banks, and levees.

17. *Sundri* and *Gewa* occur prominently throughout the area with discontinuous distribution of *Dhundal* (*Xylocarpus granatum*) and *Kankra*. Among grasses and palms *Portresia coarctata*, *Myriostachya wightiana*, *Imperata cylindrica*, *Phragmites karka*, and *Nypa fruticans* are well distributed. *Keora* is an indicator species for newly accreted mudbanks and is an important species for wildlife, especially axis deer (*Axis axis*).

18. For production forestry, *Sundri* is by far the most important species followed by *Gewa* and *Goran*; nypa palm is the most valuable of the plant-based nonwood resources. The distribution and status of these species is therefore of paramount concern in determining management practices, silvicultural activities, and biodiversity management. The flora of the mangrove forest, however, have far-reaching appeal to many other sections of society including research scientists, students, pharmacologists, and ecotourists.

## 2. Threats to SRF and its Biodiversity

19. The proposed Project interventions are required to counter the threats to the ecosystem. The results of the forest inventory recently completed under the FRMP (January 1998) are of concern. All key forest species in the SRF are overexploited, and the rate of degradation is increasing. The number of *Sundri* trees, the most abundant timber species, has declined by 76 percent since 1959; top-dying disease and overharvesting are the leading causes. *Gewa*, key species for paper and hardboard manufacture by the State-owned Khulna Newsprint Mill, has declined by 88 percent over the same period. There are strong indications of widespread uncontrolled extraction practices for *Goran*, the prime source of fuelwood among mangroves. Nonwood forest products are equally recorded as being in decline, such as *Golpatta* used for thatch, mats, fishing poles, etc. The reported average extraction of honey from the SRF in 1991-1996 was 139 tons (t) annually, with the 1994-1996 annual average being 117 t. Beeswax averaged an annual output of 35 t over 1991-1996, but only 29 t annually in 1994-1996. Declining outputs of beeswax are attributed to extraction practices that occasionally cause forest fires.

20. Fisheries and aquatic resources are also overexploited at present. The single most detrimental impact on the entire aquatic ecology and food chain originates from excessive collection of shrimp fry. Destruction of aquatic resources is considerable due to harmful practices in the discard of bycatch. Quantitative (destructive) fishing of all aquatic life, through methods such as fencing tidal creeks is frequently seen all over the Sundarbans, and reports of fish poisoning are common. Large mangrove crab (*Scylla serrata*) fishing is also not regulated

within SRF; fishermen usually take undersized individuals and, whenever possible, mature egg-bearing females.

21. Wildlife resources have not been fully researched, although the protected axis deer population is believed to be so high that it causes considerable damage to the forest by inhibiting natural regeneration. According to FD sources, poaching is currently not a problem. The Bengal tiger population of the SRF seems to be fairly stable. Calculations about the prey/predator relationship between tiger and ungulates suggest that only 13 percent of the deer biomass is consumed. The records of the Sundarbans Forest Division Office in Khulna reveal that 429 people were killed by tigers between 1976 and 1992, an average of 25 per year.

22. Pests and diseases are common in many mangrove species. Woodborers, moths, and a number of fungi contribute to the physiological stress on mangrove vegetation. In recent decades, the most significant and widespread damage to the Sundarbans mangroves is attributed to the "top-dying disease" in *Sundri*. Presently, some 215,000 cubic meters (m<sup>3</sup>) are affected by this disease.<sup>1</sup> Underlying causes include salinity encroachment, entomological attacks, gall cankers, nutrient imbalance and physiological stress due to sedimentation, extended waterlogging, and sediment-laden tidal surges. A combination of several factors and the rapid deposition of sediment burying the respiratory root organs of the tree seem to be the most plausible explanation. This process might be inseparable from the natural maturity of the delta, bringing about irreversible vegetation changes in the floral composition of the entire Sundarbans region.

23. The Sundarbans is regularly affected by cyclones arising in the Bay of Bengal. The continued integrity of the forest ecosystem of the SRF will mitigate the impact of these storms. While natural recovery in the aftermath of wind breaks and tidal surges is relatively fast (2-4 years, depending on the genetic disposition of pioneer species), the economic impact can be considerable.

24. The northern zones of the SRF are presently undergoing fundamental, long-term ecological changes due to progressing sedimentation, siltation, subsiding tectonic movements, and possibly sea level changes. The cumulative effect of these parameters, compounded by temporary acute water shortage caused by excessive off-take in the hinterland irrigation and aquaculture schemes, is causing gradual ecological changes, and is evident in several different mangrove species. The successive occupation of the same site by different plant communities is regulated by external factors, such as deposit and accretion of alluvial material, freshwater discharge and salt accumulation in the soil, nutrient content in the soil, and interspecies competition. In the northern (landward) fringe of SRF, where sufficient alluvial material accumulates to raise river terraces above the level of daily tidal flooding, a directional change of vegetation type is observed. It is expressed as the gradual transgression from a wetland/mangrove ecosystem, that was fully influenced by the regular flushing of tidal (brackish) and freshwaters to a terrestrial nonmangrove vegetation system. Depending on the different degrees of saltwater intrusion, different plant species and associated fauna and flora dominate, all which have different implications for forestry management and conservation policies.

## **B. Human and Economic Development**

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<sup>1</sup> FRMP, 1998.

25. The SRF is an important source of annual revenue to the Government from the sale of licenses for access to resources (currently, approximately \$4.4 million) and of income and employment to people in the surrounding area. In addition to timber, the SRF is an important source of NWFP and fisheries resources. It is estimated that the Sundarbans contributes over Tk4.0 billion (\$86 million) to annual Gross Domestic Product including ecotourism and wildlife (without valuing fuelwood). Most of this value currently comes from non-terrestrial sources, especially from the extensive shrimp breeding and nursery grounds, which underpin the \$400 million shrimp export industry. The majority (75 percent) of people exploiting SRF resources are shrimp fry collectors, some 20,000 are woodcutters, and 13,500 are NWFP collectors. The southern coastal margins of SRF are temporarily inhabited by some 55,000 seasonal (migrant) fishermen.

26. There are no industrial developments in SRF. Approximately 600 ocean-going ships annually pass along the Passur River between the Bay of Bengal and Mongla Port immediately to the north of SRF. Other important industrial centers are located in Khulna. The Khulna Newsprint Mill, formerly the major user of mangroves wood from SRF, is presently working at a marginal scale due to a variety of technical, managerial, and market constraints. There are new investment plans to revive the mill's performance which will partially replace Gewa with alternative products (e.g. jute).

27. There is a likelihood that in the near future Mongla's port facilities may need to be shifted further south because of increased, possibly irreversible, siltation caused by upstream flood protection works and river barrages. Continued development of poldering, embankments, and interventions that alter the natural flow of fresh and tidal waters, even well beyond the boundaries of SRF itself, could inadvertently have a serious impact on the ecosystem. Siltation of navigational channels will become more pronounced in many parts of the SRF and in the impact zone. East-west waterway communication between major rivers is already impeded in several locations at the northern boundary of SRF. Countermeasures to reduce siltation and/or to reexcavate blocked boat thoroughfares might become difficult, if not prohibitive, both technically and economically.

28. Risks from contamination from industrial sources or oilspills due to marine shipping in the nearby rivers will be addressed through the Project. However, the reversibility of the impacts of pollution—from urban sewage, industrial effluents, or agricultural development—may be hard to assess. This difficulty notwithstanding, the Project will analyze and monitor existing and potential water pollution, which may have both immediate and long-term adverse effects on SRF resources and on the people dependent on them. The Project will also support development of an oilspill contingency plan.

29. Other concerns relating to offshore and possible onshore (including within SRF itself) exploration for oil and gas will need to be carefully regulated and scrutinized for possible environmental impacts. The present weak capabilities for environmental oversight of development and industrial projects in Bangladesh could expose SRF to environmental risks of this type.

### **C. Quality of Life**

30. At least a third of the population in the impact zone lives in poverty (approximately 1 million people). Dependency on SRF is high, with nearly half (46 percent) of

all household income of communities living within 10 km of the forest boundary being derived from SRF resources. In total, an estimated 300,000 people derive all or part of their income by collecting products from SRF. The average household size in the impact zone is 6.3 persons, higher than the national average. The female/male sex ratio (100:117) shows temporary male migration for work into the area.

31. According to the joint Government and World Food Programme food insecurity analysis, five *thanas* have very high poverty indices. Six more *thanas* have high indices, three moderate, and three low. Food insecurity, expressed as significant proportions of grain deficit, landless people, and unemployment, is high due to the large-scale conversion of agricultural land to shrimp farms.

32. The literacy rate (73.5 percent) among respondents in the impact zone is slightly higher than the national average. This is attributable to a relatively large number of NGOs operating in both the formal and informal education sectors. While access to primary schooling facilities may exist in rural areas, effective access is lacking due to poverty as well as the presence of employment opportunities for children in the SRF. Boys of poor households are sent to the forest to work for several months of the year as helpers and apprentices in fishing and fish processing, as well as in the collection of other NWFPs. Girls from the age of five work along with their mothers to meet the ever-increasing demand by the local aquaculture industry for wild shrimp fry.

33. The impact zone districts have very high levels of skin diseases and diarrhea among both children and adults. Immunization rates have improved but vary between districts. Effective access to health services at the village level is impeded both by poor communications and by poverty.

34. Access to safe drinking water is a major problem in the area: it is notably lower than the national level, and there are local problems with arsenic contamination. More than a quarter of the population in Khulna, Bagerhat, and Pirojpur districts, 19 percent of the people in Satkhira, and 7 percent in the Borguna district still drink water from marshes and ponds. This contrasts strongly with only 2.5 percent of the population using such sources for drinking water at the national level.

35. Domestic fuel consists of wood extracted from the nearby SRF, such as *Goran*, *Shingra*, and various species of grasses and vines. Cow dung, a common source of cooking fuel in Bangladesh, is notably less in use due to the low incidence of livestock ownership, a consequence of the high proportion of land that has been converted into shrimp ponds.

36. Field observations confirmed that the most frequently expressed problems among villagers were lack of personal security, grievance with FD malpractices regarding unofficial levies, and income inadequacy. A high proportion of women expressed particular hardship relating to drinking water quality, lack of medical and education facilities, marriage, and harassment problems.

37. The Sundarbans is believed to have significant tourism potential for both domestic and international tourists, featuring a quiet, semiwilderness character, the world's largest mangrove forest, beaches, diverse flora and fauna, traditional fishing activities, e.g., using domesticated otters, and the annual fisherfolk festival at Dubla Island. At present, tourism

facilities are very limited,<sup>1</sup> and access for visitors to SRF from Dhaka is somewhat limited. Boat excursions starting in Mongla ranging from two to four days are operated by private entrepreneurs.

#### **IV. SCREENING OF POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES**

38. Screening of potential environmental impacts and identification of mitigation measures were carried out in accordance with the Bank's environmental guidelines, which require consideration of all of a Project's possible environmental impacts, both positive and adverse. The adverse impacts were rated as insignificant, small, moderate, or significant depending on the probability of occurrence and magnitude of impacts.

39. Any adverse impacts accruing from the proposed Project will be incremental to those that have already occurred as a result of prior or ongoing land use activities within and upstream of SRF. However, as none of the impacts identified are expected to remain significant after mitigation, the Project's contribution to cumulative effects is expected to be negligible.

40. Activities to be generated by the Project components and subcomponents were systematically assessed against the lists of actions affecting environmental resources and values in the relevant phases. The potential beneficial and adverse impacts were identified for each Project component with regard to whether the impacts were due to location and siting, design and planning, construction,<sup>2</sup> operation, or socioeconomic factors .

41. The following sections summarize environmental impacts anticipated due to design, construction, and operation of the Project. A summary of anticipated beneficial impacts is presented in Appendix 2, and a summary of adverse impacts and mitigation measures is presented in Appendix 3.

##### **A. Project Organization and Management**

42. The activities proposed under this component of the Project include establishment of an effective organization to manage the SRF (para. 9), and they are strictly institutional in nature. The only exception is construction of a Project office and upgrading of a small dockyard in Khulna which will cause no significant environmental impact. All of the other subcomponents will have overall beneficial impacts and therefore need no mitigation.

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<sup>1</sup> Some of the outposts for the staff of the FD within SRF provide basic tourist accommodations.

<sup>2</sup> Construction included forest planting interventions in the widest sense.

## **B. Biodiversity Conservation and Sustainable Resources Management**

43. Activities under this component will be accomplished through improved FD capacity to plan and properly undertake operations to manage forest, aquatic, and wildlife resources, including the three existing wildlife sanctuaries. Specific activities include (i) forest inventories, (ii) studies of conservation and management of forest resources, (iii) boundary demarcation and silviculture in silted boundary canals, (iv) reforestation and enrichment planting, (v) wildlife management in the protected areas, (vi) hydrology and pollution monitoring, and (vii) fisheries and aquatic resources management.

44. All activities pertaining to inventories, research, and studies are beneficial as they do not physically affect the environment, and are excellent planning tools for large-scale forestry management activities and policymaking. Disturbance during ground truthing surveys will be minimized by keeping the study teams small and well trained. Entering sensitive habitats will be avoided at certain times, e.g., during mating and breeding seasons of vulnerable wildlife, including bird colonies.

45. The delineation of the SRF border by establishing a natural barrier of vegetation against intrusion to the forest reserve will have a general beneficial impact. Ideally, clearly defining the limits of SRF to the surrounding community should reduce the continual pressure on SRF resources, and give the boundary villagers and their livestock additional protection against tiger attacks. Ultimately, the reduction of casualties from tiger encounters will also reduce intentional killing of tigers by desperate villagers. The proposed measures need to be well explained to the villagers; a public awareness campaign will address in particular the potential benefits with respect to protection against tiger attacks. Regular patrolling and broad-scale provision of alternative income opportunities (social forestry) will further contribute to the success of boundary demarcation and public acceptance of SRF access regulations.

46. Silviculture of silted-up canal areas focusing on the northern SRF boundaries through NGO mobilization and participatory plantation of multipurpose species to act as a live fence will contribute significantly to soil conservation and accrual of socioeconomic benefits (employment, fuel and construction timber, medicine, fruits, recreation, flood/storm protection). Other long-term benefits include reforestation of currently degraded forest—e.g., areas affected by forest fires—adding to the conservation value of SRF, enhanced habitats attracting birds and other species and thus increased biodiversity and NWFP use, and reduction in demand for construction timber from SRF through planting of bamboo as an alternative.

47. Potential adverse impacts associated with this intervention are minor, but may include (i) withdrawal conflicts associated with definition of the boundary canal area; (ii) possible permanent alteration of floristic components in adjacent SRF zones; (iii) possible permanent conversion of former ecosystem properties; (iv) reduction in usufruct of local people due to high-quality timber plantations and introduction of plant diseases due to monoculture plantations; (v) alteration of soil characteristics (exposure of acidic sulfate soils) and drainage patterns; (vi) potential impacts associated with current livestock keeping; (vii) illegal exploitation of newly established plantations; (viii) incremental risk of forest fires in the impact zone and the adjacent dry forests; and (ix) fear of villagers that this activity will create tiger hide-outs in their immediate vicinity.

48. These effects can all be mitigated through simple measures that include (i) public awareness campaigns and employment of participatory approaches; (ii) preference to

landless poor for involvement in Project activities; (iii) use only of species that have proven compatibility with existing vegetation at the boundary zone, appreciation of natural succession occurring in the northern boundary zone, provision for intercropping fruit and medicinal plants and bamboo, and selection of suitable species to avoid conversion or degradation of mangrove-specific forest to species-poor or monoculture forest; (iv) use of planting methods that minimize exposure of sulfate acidic/peaty soils; (v) provision of control structures to minimize salinity intrusion; (vi) formation of beneficiary groups who will maintain and guard their source of livelihood against illicit exploitation; and (vi) tiger behavior monitoring.

49. Wildlife management in the protected areas will involve multidisciplinary coordination. By nature, the operational context of these activities will have significant beneficial impact. Wildlife research is essentially a set of activities designed to produce the information base on which sound management of the resource can be established. The potential environmental impacts of these activities are considered to be insignificant, and will be mitigated through careful and timely publicity to explain the purpose of the management prescriptions. Wildlife disturbance and stress impacts will be reduced by minimizing time spent in sensitive areas, and by ensuring that activities are carried out by well-trained personnel who are cognizant of wildlife behavior and handling.

50. Instituting scientific fisheries and aquatic resources management will yield socioeconomic benefits by reducing dependency of fisherfolk on the SRF and by increasing their catch per effort rates. Significant improvement of livelihood for the fisherfolk can be expected when the widespread problem of bandit interference can be overcome. Ecologically this program is expected to have long term beneficial impacts by abolishing destructive fishing practices and reducing the waste of bycatch, which is mostly biota that are essential in the aquatic trophic chain.

51. All activities associated with the hydrology and pollution monitoring are beneficial as they do not physically affect the environment. Water quality monitoring will have a long-term positive impact by providing basic data to enhance the understanding of hydraulic and geomorphological changes in Sundarbans. Pollution control and oilspill contingency planning will provide significant benefits by ensuring long-term protection for both the natural and human assets in the Sundarbans.

### **C. Socioeconomic Development of the Impact Zone**

52. This component includes roadside and embankment forest planting, social forestry in homesteads, and charcoal making on a pilot basis. Roadside and embankment forest planting and social forestry in homestead areas have proven successful in Bangladesh. These activities will be introduced into the impact zone through the Project.

53. Charcoal making on a pilot scale is designed to reduce the pressure on *Goran* extraction from the SRF if properly managed and supervised during implementation in close consultation with potential beneficiaries. As a potentially viable alternative to the current uncontrolled *Goran* extraction, charcoal making is expected to enhance economic benefits through income for those holding a license and for those involved in marketing. Public awareness campaigns, participatory approaches, and close monitoring will address the risks of uncontrolled development once entrepreneurs realize profit opportunities and will attempt to channel socioeconomic development in the desired direction. Licensees will be required to follow prescribed quota and harvest modes for *Goran* extraction. Emphasis will be on linking

raw material supply from intensive *Goran* plantations (silviculture) to charcoal marketing. Proper site selection will avoid or minimize local air pollution that may result from charcoal kilns. The charcoal kilns will be designed and constructed to minimize the exposure of workers to smoke during production. Training of operators will also help to avoid environmental and health hazards.

54. This component also includes provision of drinking water facilities, rural sanitation, health services, and development and marketing of NWFP. While all these interventions are expected to have significant positive impacts on the socioeconomic well being of the beneficiaries, certain environmental problems at planning, design, and operational stages may occur in activities dealing with the provision of drinking water facilities and rural sanitation. These problems may include (i) unsuitable drinking water quality, e.g., arsenic contamination or brackish; (ii) social conflicts on account of unequal water use rights; and (iii) undesired aquatic organisms such as excessive algae in reservoirs causing quality deterioration.

55. These potential effects will be mitigated by a participatory and community based approach including the following: (i) planning for fair and equal appointment of water use rights; (ii) training of communities, particularly women, to look after communal water and sanitation infrastructure and service; (iii) introduction and enforcement of pumping regulations based on local investigations and monitoring of the groundwater level and its seasonal fluctuations; (iv) prior laboratory water quality tests; (v) ensuring that water quality is acceptable to the public; (vi) additional security measures against surface contamination, for example concrete lining and a lockable lid for the storage ponds; (vii) supervision and compliance monitoring of contractors to avoid disturbing the local community; (viii) adequate treatment measures; and (ix) strict control against fish culture in drinking water ponds.

#### **D. Ecotourism Development and Marketing**

56. The SRF has significant qualities which are attractive to ecotourism. However, due to its isolation, poor basic infrastructure, and lack of communications, only approximately 350 foreign tourists and 15,000 domestic tourists visited the SRF in 1997. Ecotourism growth is projected to be slow, but steadily increasing. Under the Project this component will involve (i) construction of basic public infrastructure, (ii) training of personnel to provide services acceptable to international and domestic tourists, (iii) development of community awareness of ecotourism opportunities and the potential impacts, and (iv) developing a regulatory framework and marketing strategy within Government and the private sector to promote Sundarbans as an ecotourist destination. Among these activities, potential adverse impacts may be associated with the construction of basic public infrastructure and with the private sector operation of tourism-related facilities. These will be mitigated by proper site selection of the infrastructure and other facilities, adoption of accepted architectural standards for designing facilities in natural settings (including the design of unobtrusive buildings), the use of natural colors and materials to blend in with the landscape, traditional local design features, nonlinear layouts, and the use of indigenous species for relandscaping and site restoration. This will be accompanied by appropriate disposal and treatment of waste, and adequate construction supervision. The Project will adopt a conservative approach to ecotourism, to preserve the semiwilderness characteristics of the area.

57. Provision of auxiliary facilities for the coastal tourism in the SRF (including sanctuaries) includes the construction of jetties, catwalks, observation towers, fences, and buoys. The establishment of these facilities will be done in coordination with other ongoing

support initiatives. The establishment of these structures may result in (i) encroachment into precious ecological areas and change of land use; (ii) possible blockage of wildlife movements; (iii) impacts during construction (wildlife disturbance and temporary or permanent displacement, sanitation, poaching, security, use and disposal of construction material); (iv) waste disposal and sanitation problems during construction; (v) river bank erosion by increased boat traffic, unintentional wildlife and habitat disturbance, disturbance to nesting sites of colonial birds, turtle nesting beaches and crocodile nesting sites; (vi) encounters between tourists and tigers involving risk of injuries or fatalities to both tigers and people; (vii) risk such as poisoning through change in the natural feeding habits of wildlife; and (viii) sanitation problems during operation, and problems associated with littering, pollution, and disposal of liquid and solid waste material.

58. Mitigation measures for impacts associated with the construction will be the same as outlined in para. 56. For other impacts, the mitigation measures will include (i) careful site design to avoid encroachment into sensitive wildlife areas; (ii) avoidance of fragile coastal sand dunes; (iii) avoidance of developments that affect turtle nesting beaches; (iv) site selection that avoids sensitive habitats based on investigation of major wildlife migration passages; and (v) fencing of construction sites and restriction of access for laborers. Wildlife displacement can be mitigated by (i) carrying out the construction quickly, (ii) suspending construction activities between dusk and dawn, (iii) avoiding excessive noise, (iv) specifying allowable types of boats and engines, and (v) imposing limits on speed and trip frequencies as appropriate. In addition, part of the training program for both tour operators and FD staff will pay attention to the safe handling of fuels and lubricants to avoid contamination of waterways. Employment of permanent water patrols will be done to check boat operators' compliance.

59. Development of tourism facilities within the SRF will inevitably bring people into contact with coastal beaches, estuarine areas, and mangroves, which all harbor wildlife. Noise originating from visitors will inevitably have its bearing on wildlife. Fencing of access areas, regular patrols, and enforcement are the means of choice to offset or minimize disturbances. To minimize the risk of tiger/tourist encounter all jetties, catwalks, and access areas to the observation towers and other facilities will be enclosed by a tiger-proof fence from the point of entry on the river bank. Feeding of wildlife, and close approaches for photography or other purposes, will be strictly prohibited and enforced in all areas used by tourists. Unauthorized entry to the SRF will be controlled. Improved security for visitors and other users will be achieved through increased patrolling by the FD. For botanists, birdwatchers, scientists, etc., special arrangements will be made, including the obligatory company of trained guides. The number and timing of such specific expeditions, together with the corresponding fees, will be subject to operational and conservation considerations developed by the wildlife management experts. In addition, sanitation systems will be restricted to water-borne facilities: toilets and sewerage removal systems will be installed, and suitable waste management systems as part of infrastructure facilities planning and design will be introduced.

## **E. Technical Advisory Group, Monitoring, and Studies**

60. A TAG will (i) establish baseline information and criteria for sustainable practices, draft integrated conservation and management plans, and assist in developing a self-sustaining management system; (ii) assist the FD to retrain staff and help focus its activities to more effectively conserve the SRF, and to serve the needs of its primary stakeholders; and (iii) train resource users and community representatives to engage in ecotourism related activities.

61. To maintain a high level of both national and international credibility regarding the quality of the environment and the sustainability of use of the SRF, external monitoring will be undertaken. An internationally respected environmental NGO will be engaged to submit an independent annual report on the status of the conservation and management of the SRF and its biodiversity. A second form of checks and balances will be provided through an independent certification and investigation role. A suitably qualified firm offering inspection services to an international standard will be retained.

62. Studies by the TAG and contracted agencies in Bangladesh will be undertaken into topics which are critical to the development of sustainable management strategies and operations in the SRF. These will include, among others, (i) hydrological aspects of the SRF and its upstream catchments for pollution monitoring and control; (ii) the feasibility of alternative sources of supply for paper manufacture other than *Gewa* from the SRF; (iii) forestry research into *Sundri* top-dying disease to assist in understanding and possibly counteracting the widespread natural degeneration, as well as research into mangrove regeneration, habitat adaptability and regeneration of *Goran* and *Golpatta*; (iv) aquatic resource assessments and analysis of existing exploitation levels, and better understanding of the habitats of endangered species (e.g., marine turtles and saltwater crocodiles), as inputs for developing fisheries plans; (v) wildlife-related studies of tiger ecology, marine turtles, otters, etc., as inputs for wildlife planning; and (vi) ecotourism-related studies of visitors.

## V. BENEFIT-COST ANALYSIS

63. The main benefits of the Project are (i) sustainable use of wood and nonwood products. Improved management of the SRF will enable sustainable harvests for roundwood, pulpwood, fuel wood and NWFP, and reduced illegal offtake; (ii) NWFP production. Healthy mangrove areas contribute to enhanced NWFP production by providing a sustainable habitat; (iii) marine resources and fisheries. Healthy mangrove areas also contribute to enhanced marine fishery production by providing a nursery habitat, e.g., shrimp fry; and (iv) ecotourism, including provision for basic public infrastructure to support private ecotourism. In the impact zone, benefits include social and economic gains from sustainable resource use and alternative income earning activities. These alternatives include forestry from homestead and roadside plantations, poultry products, aquaculture, and ecotourism.

64. Without the Project, the SRF may gradually be destroyed. If this occurs, it would lead to loss of existing or potential (i) coastal protection; (ii) Bangladesh's single major domestic source of wood; (iii) ecotourism; (iv) supply of over 95 percent of the inputs (shrimp fry) to the \$400 million annual shrimp and fish export industry; (v) food supplies and employment for the local population; (vi) wildlife habitats, including the Bengal tiger; and (vii) revenues to the Government (currently approximately \$4.4 million) from fees and permits charged for the use of the SRF. These losses, if they cannot be prevented, will have highly adverse local, regional, and global ramifications.

65. The total cost of the Project is estimated at \$81 million. The portion of the total Project cost that can be attributed to environmental protection and enhancement is approximately \$32 million. These measures include forestry inventory using remote sensing techniques, hydrological investigations using remote sensing techniques, hydrology and pollution monitoring, and oilspill contingency planning. The Project has an economic internal rate of return of 14 percent.

## **VI. INSTITUTIONAL REQUIREMENTS AND ENVIRONMENTAL MONITORING PROGRAM**

### **A. Environmental Management Plan**

66. The mitigation plan is determined by the nature, scope, and timing of each measure that has been identified for the corresponding Project activity having the potential for adverse environmental impact. The outlined protection measures are site specific and will be undertaken during planning, design, construction, and operational stages as applicable.

67. The environmental management plan (EMP) emphasizes the linkages between the environmental and economic significance of the SRF. Accordingly, the studies, monitoring, and supervision activities devised will enable the FD and others concerned with protection and conservation of the SRF to better participate in discussions/actions related to the consequences of onsite and offsite developments and their potential environmental impact.

### **B. Implementation Arrangements**

68. The proposed mitigation measures will be implemented by the SMA. The SMA will be established within the FD to manage the overall coordination and supervision of the implementation activities. Microcredit will be implemented through Palli Karma-Sahayak Foundation,<sup>1</sup> and all lending activities as well as liaison, education, and training for beneficiary group members will be carried out by partner NGOs. With support from the TAG, the personnel entrusted with environmental monitoring within the SMA will include professional staff with skills in remote sensing, forestry, fisheries, wildlife, communication, education, sociology, and tourism staff who will be responsible for overseeing the implementation of appropriate mitigation measures for all Project activities having potential environmental impacts.

69. The SMA will coordinate the proposed research programs, compilation of data and results, and the decision on use of the results. The SMA will be assisted by various internal and external specialists, who will work in close consultation with the SSC, SAC, and TAG. Technical consultants recruited for the specific Project components will provide expert advice, as required, for the further development, implementation, and monitoring of mitigation measures and environmental impacts as part of their responsibility for ensuring protection and/or sustainable use of SRF resources.

70. The EMP also covers important external impacts on the SRF. Above all, this includes the investigation and monitoring of industrial and oil pollution in the upstream industrial areas of Khulna and Mongla, and an oilspill contingency planning for Mongla Port. In addition, the EMP addresses ongoing urban and industrial development, including a study on the future economic and environmental viability of the Khulna Newsprint Mill, which currently is subject to reinvestment and restructuring initiatives. Finally, the contingency plan will carry out environmental assessments of planned poldering and similar water impoundment activities within watersheds affecting the SRF.

71. Implementation arrangements for the programs foreseen in the impact zone will principally be carried out by participating NGOs, who will be responsible for community

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<sup>1</sup> The Palli Karma-Sahayak Foundation (the Poverty Foundation) is a specialist microfinance apex institution with considerable expertise in working with the NGO community in Bangladesh.

organization. The Khulna chapter of the Association of Development Agencies in Bangladesh will coordinate the consensus-building process among local NGOs. A coordination committee will be set up in Khulna to coordinate the respective Project activities.

72. An internationally respected NGO without direct participation in Project execution will be chosen to carry out an independent international environmental audit. The NGO will be recruited by the SMA but will report annually to the SSC. A team of two international and three local experts will spend one-month each year over the seven years of the Project conducting an environmental audit. The team will assess the status and use for all major resources of the SRF, the suitability and sustainability of resource extraction methods, the integrity of managers of the resource and the degree of participation of the resource users in resource management decisions.

### **C. Community Participation and NGO Involvement**

73. During Project preparation, detailed consultations have been held with the community in the impact zone. A multilevel participatory social assessment approach was followed in 16 sample villages in Khulna, Bagherhat, and Satkira districts. A total of 174 semistructured interviews with male and female stakeholders, as well as 14 focus group discussions were conducted, NGO members of the Association of Development Agencies in Bangladesh's Khulna chapter were fully involved in fieldwork and consultations throughout the process. The Minister of Environment and Forest opened a major workshop in Khulna in July 1997, which brought together over 200 stakeholder representatives, NGOs, and the FD to ensure all views were expressed. In addition, the Bank engaged a staff consultant to undertake further fieldwork in February-March 1998, as part of the preparation of the impact zone strategy. At this time two days of workshops were held with 29 Khulna-based NGOs, and rapid social assessments and individual interviews were conducted in five villages in the impact zone.

74. It was found that in the villages that depend on the SRF for their subsistence, there is a high level of awareness of the long-term problems that result from overexploitation of the SRF. Unsustainable practices are due to commercial contracts for the use of *Gewa*, and uncontrolled harvesting of forest, aquatic and wildlife resources by users from the impact zone. There is a very strong interest among villages in the impact zone in conserving resources, in stopping unsustainable practices, and in pursuing alternative income-earning opportunities.

75. The Project will increase support in the impact zone for biodiversity conservation and sustainable resource use. Participatory approaches will be adopted to organize the resource user/extractors into groups, as well as to improve their access to productive resources, social services, and infrastructure. The impact zone strategy focuses on empowering resource user/extractor groups under the Project, so they can participate meaningfully in resource conservation and management of the SRF through collective self-regulation. Strengthening the capacity of NGOs to effectively manage programs relating to social forestry, income opportunities, community mobilization and group formation, improved access to alternative sources of finance, social services, and infrastructure, and a public awareness program focusing both on conservation issues for the SRF and on the objectives of the proposed community work and social investments, will also be supported by the Project. Formation of local community organizations is part of this strategy, recognizing that the SRF cannot be managed sustainably and its resources protected for future generations until those who depend upon SRF for their survival are able to meet their basic needs without recourse to unsustainable resource use.

## VII. FINDINGS AND RECOMMENDATIONS

76. Project-related impacts are predominantly positive with no major adverse effects. Successful Project implementation will result in the conservation of biodiversity and establishment of a sustainable resource management system. The SIEE indicates that only a small number of proposed activities can have potentially adverse environmental impacts, and that they can be effectively mitigated by known methods and available technologies. Another finding is that net benefits will outweigh any minor residual adverse impacts remaining after mitigation. None of the activities proposed under the Project are expected to result in disruptive social impacts such as resettlement, impacts on water supply, loss of income, increased traffic, increased health hazards, or unacceptable noise or water pollution.

77. SRF includes a number of environmentally sensitive areas. Impacts on these areas will be avoided when planning detailed location and design of Project activities and during subsequent construction and operational phases.

78. The effect of deer on mangrove forest regeneration needs to be duly addressed. There are indications that controlling the deer population is a necessary forest management action.

79. The natural sequence of mangrove plant communities, i.e., the transgressional substitution of mangrove species by either other halophytes or nonhalophytes, needs to be taken into account when developing forestry management options. It is necessary to acknowledge the time implications and the economic consequences while appreciating that the two most important commercial timber species (*Sundri* and *Gewa*) will gradually be replaced by others that have less suitable properties.

80. Appropriate management options for *Goran* are considered to play a key role in the near future of Sundarbans forestry. This species, particularly its predominating shrubby form, can be used for fuelwood, if properly managed. The proposed trials for developing rural charcoal industries based on controlled silviculture schemes, together with tannin production and promotion of energy-saving cooking stoves is considered one feasible step to both resource conservation and sustainable utilization.

81. Wildlife research, particularly on the Bengal tiger, will be performed with utmost care in order to avoid injuries to either the study personnel or the tigers. Results on tiger territorial behavior and site preference studies will be treated as restricted information to avoid unintentional supply of information to poachers and wildlife traders.

82. The Project will build capacity for integrated, ecosystem-oriented resources management planning and implementation. This approach will also include capabilities for monitoring the impacts of external threats, particularly changes in the hydrological regime upstream and water pollution, on the sustainability of the SRF ecosystem. The Project will also prepare an oilspill contingency plan in the Khulna/Mongla Port region.

83. Construction supervisory staff and site operations staff will be provided training in sound environmental practices. Environmental protection measures will be incorporated in all construction and operational contract documents. Casual hunting by workers and other construction-related environmental damage will be prevented by supervisory personnel through

Careful monitoring.

84. Waste management and disposal plans will be formulated and implemented in all construction and operations areas. These plans will be formulated, reviewed, and approved by the SMA prior to the onset of construction or other activities.

85. Development of tourism infrastructure will be done through very careful planning and operations to avoid damage to environmentally sensitive areas, displacement/mortality of wildlife, other impacts on plant and animal communities, and visual and aesthetic impacts on the natural setting of the SRF. Appropriate environmental protection measures will be fully implemented under the ecotourism component to ensure that impacts are avoided to the maximum extent possible, and that environmental carrying capacities are not exceeded. The development of ecotourism will also require development and delivery of a comprehensive training guide and a visitors education and awareness program to prevent impacts on wildlife and other resources. The preparation of a popular scientific guidebook on SRF is recommended to satisfy the information needs of a wide clientele.

86. The institutional framework proposed for the Project is sufficient for overseeing mitigation efforts and for effective environmental monitoring.

## **VIII. CONCLUSIONS**

87. The majority of the Project's impacts are environmentally beneficial, many of which have a large beneficial impact in securing the long-term sustainability of the SRF. Some minor adverse impacts are associated with the Project, mainly related to short-term construction activities, all of which can be mitigated by appropriate measures. It is therefore concluded that no Environmental Impact Assessment is required.

88. Implementation of the Project as planned will result in significant beneficial impacts with regard to the conservation of SRF's biodiversity and establishment of a sustainable resource management system. This includes major improvements in the existing facilities and management of the area, greater involvement by stakeholders and the community, together with direct involvement in wildlife and forestry enhancement programs. All of these beneficial impacts will assist in achieving the Project's long-term aims of preserving SRF as a valuable area of biodiversity.

**Table 1: Diversity of Mammals, Birds, Reptiles, Amphibians, and Fish in the Sundarbans Reserved Forest in Comparison with Bangladesh as a Whole**

Group	Total Families in Bangladesh	Total Families in Sundarbans	% of Families in Sundarbans	Total Species in Bangladesh	Total Species in Sundarbans	% of Species in Sundarbans
Mammals	35	14	40	119	42	35
Birds	64	39	61	660	315	48
Reptiles	20	16	80	124	59	48
Amphibians	4	4	10	19	8	42
Fish	133	39	35	474	120	25

**Table 2: Vertebrate Faunal Species in Sundarbans Reserved Forest of Special Significance to Conservation**

Common Name	Scientific Name
Greater False Vampire Bat	Megaderma lyra
Flying Fox	Pteropus giganteus
Rhesus Macaque	Macaca mulatta
Ganges River Dolphin	Platanista gangetica
Common Dolphin	Delphinus delphis
Irrawaddy Dolphin	Orcaella brevirostris
Indo-Pacific Humpbacked Dolphin	Sousa chinensis
Finless Porpoise	Neophocaena phocaenoides
Smooth-coated Otter	Lutrogale perspicillata
Oriental Small-clawed Otter	Amblonyx cinereus
Bengal Fox	Vulpes bengalensis
Golden Jackal	Canis aureus
Bengal Tiger	Panthera tigris tigris
Fishing Cat	Priailurus viverrinus
Leopard Cat	Priailurus bengalensis
Jungle Cat	Felis chaus
Wild Boar	Sus scrofa
Barking Deer	Muntiacus muntjak
Axis Deer	Axis axis
Swamp Deer	Cervus duvaucelii
Hog Deer	Axis porcinus
Water Buffalo	Bubalus bubalis
Javan Rhinoceros	Rhinoceros sondaicus
Great Indian One-horned Rhinoceros	Rhinoceros unicornis
Dugong	Dugong dugon
Marsh Crocodile	Crocodylus palustris
Saltwater Crocodile	C. porosus
Olive Ridley Turtle	Lepidochelys olivacea
Green Turtle	Chelonia mydas
Loggerhead Turtle	Caretta caretta
Hawksbill Turtle	Eretmochelys imbricata
Leatherback Turtle	Dermochelys coriacea
Estuarine Terrapin	Batagur baska <sup>a</sup>
Black Mud Turtle	Trionyx nigricans
Roof Turtle	Kachuga tecta
Rock Python	Python molurus
Monitor Lizard	Varanus salvator

<sup>a</sup> This is the only endemic species.

Source for Tables 1 and 2: United Nations Development Programme/Food and Agriculture Organization of the United Nations. 1998. "Integrated Resource Management Plan of the Sundarbans Reserved Forest," Final Report.

## Summary of Proposed Project Activities with Primarily Beneficial Environmental Impacts

Project Activities	Environmental and/or Social Benefits
<b>Component A: Effective Organization of the Sundarbans Reserved Forest (SRF)</b>	
<ul style="list-style-type: none"> <li>▪ Establishment of multisector and multidisciplinary Sundarbans Management Agency, Sundarbans Stewardship Commission, Stakeholder Advisory Council, and Technical Advisory Group</li> </ul>	<ul style="list-style-type: none"> <li>▪ Enhanced knowledge about resource, stakeholders interests, planning options, appropriate environmental monitoring, securing of international support and policy making, and securing participatory approach and long-term socioeconomic benefits while implementing the Project</li> </ul>
<b>Component B: Biodiversity Conservation and Sustainable Resources Management</b>	
<ul style="list-style-type: none"> <li>▪ Establishment of efficient patrol units</li> <li>▪ Wood and nonwood forest product (NWFP) resource extraction compliance monitoring</li> <li>▪ Mangrove silviculture experiments</li> <li>▪ Provision of gear and training for fisherfolk easing their financial dependency on money lenders</li> <li>▪ Gear and consultant expertise to reduce losses in shrimp fry bycatches</li> <li>▪ Training of fisherfolk in catch practices and handling, introduction/enforcement of fisheries management tools</li> <li>▪ Ensure fisherfolk's protection against external threats</li> <li>▪ Elaboration of a comprehensive fisheries management plan for Sundarbans, in cooperation with ongoing initiatives (Government of Bangladesh/Dept. of Environment, FD, World Bank, Food and Agriculture Organization/ United Nations Development Programme, academia)</li> <li>▪ Aquatic biota study and support for fisheries management plan, monitoring fish population dynamics, shellfish study and management options, fish catch trials in control areas with modified gear</li> <li>▪ Introduction/enforcement of wildlife management</li> <li>▪ Social forestry in silted up boundary canals</li> </ul>	<ul style="list-style-type: none"> <li>▪ Enhanced security for SRF users and visitors, reduced illegal activities</li> <li>▪ Reduced illegal extraction</li> <li>▪ Better understanding of mangrove productivity</li> <li>▪ Assistance in preparing and implementation of a fisheries management plan for Sundarbans</li> <li>▪ Reduced loss of bycatch, and reduced loss of species</li> <li>▪ Reduced damage to stocks and environment from unsustainable practices, reduced post harvest loss, and improved quality of marketed products</li> <li>▪ Improved SRF security through Forest Dept. (FD) patrols</li> <li>▪ Sustainable fisheries and aquatic resources management</li> <li>▪ Understanding population of aquatic biota in relation to hydrological parameters and to harvest practices</li> <li>▪ Sustainable wildlife management is practiced in the SRF, especially in 3 wildlife sanctuaries</li> <li>▪ Employment opportunities</li> </ul>
<b>Component C: Socioeconomic Development of the Impact Zone</b>	
<ul style="list-style-type: none"> <li>▪ Mobilization and group formation of SRF resource users through NGOs</li> <li>▪ Social forestry in the impact zone (homestead plantings, roadside plantations, nursery development)</li> <li>▪ Provision of drinking water facilities, sanitation facilities, and mobile medical service</li> <li>▪ NWFP use promotion programs</li> <li>▪ Support for poultry farmers, horticulture, apiculture, charcoal (pilot), stove making, and tannin production</li> <li>▪ Awareness campaigns (formal and nonformal education); action research</li> <li>▪ Introduction of suitable communication system and mobile medical boat service</li> <li>▪ Public education on minimizing pollution and energy conservation, e.g., fuelwood consumption</li> </ul>	<ul style="list-style-type: none"> <li>▪ Provision of broad scale socioeconomic benefits (employment, improved quality of life, health, drinking water fuel and construction wood, medicine, fruits, recreation) and creation of income-generating opportunities</li> <li>▪ Employment opportunities</li> <li>▪ Improved health for isolated communities</li> <li>▪ For sustainable conservation and management</li> <li>▪ Employment opportunities in isolated areas. NGO integrated poultry programs are suitable for women.</li> <li>▪ Increased awareness of value of SRF</li> <li>▪ Improved access to information, health, and emergency services</li> <li>▪ Improved knowledge of modern technology</li> </ul>

(Reference in text: page 9, para. 41)

Project Activities	Environmental and/or Social Benefits
<b>Component D: Ecotourism Development and Marketing</b>	
<ul style="list-style-type: none"> <li>▪ Group formation and training in marketing products, training of FD personnel</li> <li>▪ NWFP resource utilization programs, handicraft development</li> <li>▪ Public awareness campaigns and environmental education</li> <li>▪ Profile of Sundarbans visitors, detailing demographic features, aspirations, and budget availability</li>   <li>▪ Assessment of behavior patterns of both domestic and foreign SRF visitors, and marketing analysis</li>   <li>▪ Introduction of improved FD communications</li> <li>▪ Assessment of training needs and training of tourist guides and preparation of a popular/scientific field guide to Sundarbans</li> <li>▪ Establishment of educational center in Khulna, mangrove interpretation center in sanctuary zone</li> <li>▪ Establishment of a mangrove arboretum</li> <li>▪ Educational trails and observation towers and fenced areas</li> </ul>	<ul style="list-style-type: none"> <li>▪ Skills development and enhanced responsibility for conservation of SRF resources</li> <li>▪ Employment opportunities</li> <li>▪ Wider involvement/understanding of SRF value</li> <li>▪ Data on actual number and aspirations of domestic and foreign visitors (including proportion of expatriate community), serving as base for decision making</li> <li>▪ Knowledge on status of tourist behavior, and on "tourism ethics" among population; decision making for suitable marketing strategies</li> <li>▪ Improved visitor safety</li> <li>▪ Development of tourism sector by satisfying visitors' needs and concerns</li>   <li>▪ Public environmental education, particularly on mangrove ecology and biodiversity value of the Sundarbans</li> <li>▪ Serving scientific and public relations purposes</li> <li>▪ Channeling tourism to sites where impacts can be controlled</li> </ul>
<b>Component E: Technical Advisory Group, Monitoring, and Studies</b>	
<ul style="list-style-type: none"> <li>▪ Environmental monitoring through international nongovernment organization</li> <li>▪ Deer control/natural regeneration studies, <i>Sundri</i> top-dying disease research, mangrove silviculture experiments, enrichment planting</li> <li>▪ Remote sensing applications (hydrology, geomorphologic changes, water pollution, forest inventory, land-cover change detection); also related to change detection (land-use, forest types, geomorphologic changes, sedimentation, erosion, accretion, seasonal blooms)</li> <li>▪ Tiger and ungulate research, studies of otters, turtles (marine, freshwater), and insects</li> <li>▪ Re-introduction of extirpated mammals</li> <li>▪ Ornithological research</li> <li>▪ NWFP resources inventory and use potential</li>   <li>▪ Bioproductivity study in representative habitats; hunting and trade control</li> <li>▪ Hydrological monitoring and hydraulic modeling study, pollution analysis, monitoring and contingency planning</li> <li>▪ Adjust royalty fees for SRF products in accordance with market prices</li> <li>▪ Alternative uses of <i>Goran</i> as fuelwood</li> <li>▪ In-depth study of <i>Golpatta</i> growth, regeneration and management</li> <li>▪ Water quality monitoring</li>   <li>▪ Remote sensing applications relating to land-use cover, pollution detection, current pattern and long-term hydraulic regime changes</li> <li>▪ Development of thematic Geographic Information System maps relating to industrial land-uses and pollution risks</li> <li>▪ Oil spill contingency planning</li> </ul>	<ul style="list-style-type: none"> <li>▪ Annual environmental status assessments</li>   <li>▪ Support for natural regeneration of mangrove vegetation and identification of interventions for future research and management</li> <li>▪ Cost-effective large-scale and spatial inventories with option of modeling trends, serving as planning tool; improved monitoring of physical changes and pollution levels</li>   <li>▪ Wildlife/biodiversity conservation, and contribution to operational planning, especially for wildlife management</li> <li>▪ Improved biodiversity values</li> <li>▪ Basic understanding to preserve habitats</li> <li>▪ Improved understanding of options for commercial use in context of sustainable management</li> <li>▪ Conservation of wildlife</li>   <li>▪ Increased knowledge about the resource uses and changes, serving as base for policy making and operational planning</li> <li>▪ Increased Government revenues, leading to greater financial sustainability of conservation measures</li> <li>▪ Improved efficiency of use</li> <li>▪ Management on long-term sustainable basis</li>   <li>▪ Understand the present and potential risk for water pollution and its implications for the Sundarbans ecosystem</li> <li>▪ Facilitate industrial development planning in upstream region of SRF and define environmental standards for new industrial plants</li> <li>▪ Determination of pollution control capacities and possible strengthening measures</li> <li>▪ Identify policy, legislation, risk preparedness in case of emergency</li> </ul>

## Summary of Project Activities with Potential Adverse Impacts and Mitigation Measures

<b>Component B: Biodiversity Conservation and Sustainable Resources Management</b>		
<b>Reforestation within the Sundarbans Reserved Forest (SRF), Boundary Canal Areas, and Nonwood Forest Products (NWFP):</b> Social forestry (afforestation) of 30 kilometers boundary canal, enrichment planting (3,000 hectares), assisted natural regeneration (10,000 ha), timber stand improvement, and planting/enrichment of NWFP.		
<b>Potential Adverse Impacts</b>	<b>Significance of Impact</b>	<b>Mitigation</b>
<ul style="list-style-type: none"> <li>▪ Potential land use conflicts with current users of silted boundary canal areas</li> <li>▪ Reduced value for local people in impact zone plantations due to high-quality timber plantations</li> <li>▪ Reforestation within SRF and impact zone could possibly alter plant and animal composition in adjacent SRF zones; risk of introduction of plant diseases</li> <li>▪ Depletion of natural seed resources (uncontrolled wild seed collection)</li> <li>▪ Contribution to risk of forest fires in boundary plantation</li> <li>▪ Alteration of soil characteristics (exposure of acidic sulfate soils) and drainage pattern while executing plantation</li> <li>▪ Creation of tiger hide-outs with new intensive silviculture plots along former boundary canal</li> <li>▪ Illegal exploitation of newly established plantations</li> <li>▪ Interference with SRF resource users living in impact zone while executing boundary demarcation</li> <li>▪ Destruction/disturbance of critical wildlife habitats or other precious ecology due to plantation efforts</li> <li>▪ Poor growth of seedlings in enrichment plantations and timber stand improvement programs</li> </ul>	<p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p>	<ul style="list-style-type: none"> <li>▪ Landless poor currently using the land will be preferred candidates for social forestry beneficiary group</li> <li>▪ Intercropping, fruit, medicinal plants, and bamboo</li> <li>▪ Select suitable species and perform physiological pre-studies to identify physiological requirements of plants to avoid conversion or degradation of mangrove-specific forest to species-poor or monoculture forest</li> <li>▪ Training and supervision of laborers; only use planting material reared in newly established nurseries</li> <li>▪ Harvesting prescriptions/ control relating to slash removal</li> <li>▪ Use planting methods that minimize exposure of sulfate acidic/peaty soils, and provide control structures to minimize salinity intrusion</li> <li>▪ Public awareness campaign and tiger ethology monitoring; where necessary, introduction of tiger deterring devices</li> <li>▪ Formation of beneficiary groups that would act primarily as stewards</li> <li>▪ Public awareness campaign, patrolling and broad-scale provision of alternative income possibilities (e.g., social forestry)</li> <li>▪ Avoid environmentally sensitive areas; avoid entering those areas at certain periods; training and supervision of staff</li> <li>▪ Study causes of poor growth and counteract, e.g., appropriate fencing, good propagule selection, regular patrolling and re-planting</li> </ul>
<b>Component C: Socioeconomic Development of the Impact Zone</b>		
<b>1. Social Forestry in the Impact Zone:</b> Establishment of homestead woodlots, 650 km of road and embankment planting, 750 ha of block plantations		
<b>Potential Adverse Impacts</b>	<b>Significance of Impact</b>	<b>Mitigation</b>
<ul style="list-style-type: none"> <li>• Change in land use and/or change in land ownership</li> <li>▪ Potential uncontrolled extraction of <i>Goran</i> following charcoal making on pilot basis</li> <li>▪ Potential air pollution associated with pilot Charcoal Scheme</li> </ul>	<p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p>	<ul style="list-style-type: none"> <li>▪ Avoid conflicts with other dedicated land uses or existing subsistence uses</li> <li>▪ Securing approval of Government/Department of Environment to assist this activity on a trial basis; strict supervision of production line through the Sundarbans Management Agency (SMA) Inspection Forest patrols and enforcement; licensing of kiln operations</li> <li>▪ Proper kiln siting and design; training of operators, debarking <i>Goran</i> (to benefit tannin production)</li> </ul>

(Reference in text: page 9, para. 41)

<b>2. Rural Development Programs in Impact Zone:</b> Provision of drinking water and sanitation facilities in 17 <i>thanas</i> , mobile medical boat service		
<b>Potential Adverse Impacts</b>	<b>Significance of Impact</b>	<b>Mitigation</b>
<ul style="list-style-type: none"> <li>▪ Lowering of groundwater table and equal share in drinking water resources</li> <li>▪ Unsuitable drinking water quality, e.g. arsenic contamination, brackish</li> <li>▪ Excessive algae and undesired aquatic organisms in reservoirs causing quality deterioration</li> <li>▪ Inadequate drinking water distribution system monitoring</li> <li>▪ Pollution of drinking water resources due to improper sanitation facilities and sludge removal</li> <li>▪ Increased treatment costs of sanitation</li> </ul>	<ul style="list-style-type: none"> <li>Minor</li> <li>Minor</li> <li>Minor</li> <li>Minor</li> <li>Minor</li> <li>Minor</li> </ul>	<ul style="list-style-type: none"> <li>▪ Fair appointment of water use rights, pumping regulations, and monitoring groundwater level fluctuations</li> <li>▪ Prior laboratory water quality tests; ensuring that water quality is acceptable to public; concrete lining of storage ponds</li> <li>▪ Concrete lining and lockable cover lid for storage ponds, adequate treatment measures; strict control against fish culture in drinking water ponds</li> <li>▪ Training of operators/supervisors to comply with intended objectives and enforcement of quality standards</li> <li>▪ Adequate site planning, development of proper sludge disposal system</li> <li>▪ Monitoring of effects, and study alternative use of sewerage as fertilizer or energy source</li> </ul>
<b>3. Microcredit for Alternative Income Generation:</b> Smallholder integrated poultry production systems through proven NGO approach in the impact zone outside of SRF, horticulture and nursery development, apiculture, tannin production, development of small handicraft industries using NWFP.		
<b>Potential Adverse Impact</b>	<b>Significance of Impact</b>	<b>Mitigation</b>
<ul style="list-style-type: none"> <li>▪ Pond water eutrophication and waste water problems associated with duck <i>cum</i> pond cultures</li> <li>▪ Risk of misuse of credits to establish undesired shrimp ponds</li> <li>▪ Residual pesticides in poultry products</li> <li>• Continuation of harmful honey and wax extraction practices, including increased risk of forest fire</li> <li>▪ Increased uncontrolled extraction of <i>Goran</i> from SRF if pilot project for charcoal and tannin production is successful</li> <li>▪ Insufficient linkage to SRF forestry component while promoting horticulture &amp; nursery and NWFP handicraft development programs</li> </ul>	<ul style="list-style-type: none"> <li>Minor</li> <li>Medium</li> <li>Minor</li> <li>Minor</li> <li>Minor</li> <li>Minor</li> </ul>	<ul style="list-style-type: none"> <li>▪ Adequate fisheries extension service focusing on pond water quality management; recycle manure through fish ponds and home gardens</li> <li>▪ Planning, avoidance of constructing new ponds; rehabilitation of unproductive ponds and borrow pits</li> <li>▪ Adequate extension service focusing on pond water quality management</li> <li>▪ Training of users becoming members of <i>mowali</i> groups formed under supervision of a contracted NGO</li> <li>▪ Strict supervision of production through SMA Inspection Unit</li> <li>▪ Monitoring and evaluation, modification of operational approach as necessary; establishment, control and enforcement of extraction quota for NWFP users in line with program</li> </ul>
<b>Component D: Ecotourism and Marketing</b>		
<b>1. Establishment of Basic Facilities:</b> Construction of educational center in Khulna, Mangrove Interpretation Center in one sanctuary, development of basic infrastructure for water-borne tourism (buoys, jetties, and trails at sites at or near the landward edge of the Sundarbans; mangrove arboretum; observation towers; drinking water storage tanks; communication system)		
<b>Potential Adverse Impacts</b>	<b>Significance of Impact</b>	<b>Mitigation</b>
<ul style="list-style-type: none"> <li>▪ With the proposed infrastructure, encroachment into precious ecological zones and habitat loss</li> <li>▪ Wildlife displacement (disturbance avoidance) during construction and subsequent operations, including offsite avoidance of increased boat traffic</li> </ul>	<ul style="list-style-type: none"> <li>Minor</li> <li>Minor</li> </ul>	<ul style="list-style-type: none"> <li>▪ Avoid facilities development in precious ecological zones and other environmentally sensitive areas; locate facilities in currently developed areas; minimize total site development area</li> <li>▪ Restrict access for public to adjacent areas; avoid environmentally sensitive areas, including all known wildlife (especially birds) reproductive habitat; avoid blockage of wildlife movement; strictly enforce provisions for guided accompaniment on all trails</li> </ul>

<ul style="list-style-type: none"> <li>Visual/aesthetic impacts by the new construction on natural settings</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Use only natural colors and materials and local design features in all structures; proper site rehabilitation after construction; incorporate environmental protection measures in construction contract documents</li> </ul>
<ul style="list-style-type: none"> <li>Various impacts during construction (sanitation, poaching, security, use and disposal of construction material)</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Supervision of construction through SMA, compliance monitoring with respect to environment-related clauses in contracts</li> </ul>
<ul style="list-style-type: none"> <li>Waste disposal, pollution and sanitation problems at visitors sites</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Restrict tourism to water-borne facilities; introduction of suitable waste management system (sealable waste containers, waste compaction and burning) and sanitation facilities; appropriate training for tourist guides and public awareness campaigns against littering and trespassing (signboards, brochures, movies)</li> </ul>
<ul style="list-style-type: none"> <li>Wildlife harvest by operational personnel</li> <li>Increased demand for animal and plant souvenirs</li> </ul>	Minor Minor	<ul style="list-style-type: none"> <li>Train site staff in prevention and enforcement</li> <li>Train tourist guides, boat operators and site staff in prevention of purchase or collection of animal and plant products by visitors; review, update and enforce legal provisions; implement an education and awareness program in all tourist areas</li> </ul>
<ul style="list-style-type: none"> <li>Interference with ecological balance while operating a mangrove arboretum</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Cultivate/display only mangrove species naturally occurring in geographical range</li> </ul>
<ul style="list-style-type: none"> <li>Habituation of other wildlife species, and management removals of nuisance animals</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Strictly prevent feeding of wildlife; train tourist guides and site staff in enforcement</li> </ul>
<ul style="list-style-type: none"> <li>Risk of tiger/tourist encounters, and killing or threatening of habituated animals</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Fencing of all tourist facilities and access areas to river point; implement a tiger safety and awareness program in all tourist areas, including provision for reporting of tiger sightings and encounters</li> </ul>
<ul style="list-style-type: none"> <li>River bank erosion due to increased boat traffic</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Regulating type of boat; access, frequency and navigation speed in small channels, train boat operators; patrolling and compliance monitoring</li> </ul>
<ul style="list-style-type: none"> <li>Misuse of drinking water tank, e.g., fish culture</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Supervision through SMA, and enforcement of prescribed use</li> </ul>

**2. Support to the Private Sector:** Impact study in relation to development of land-based tourism in SRF, income opportunities relating to tourism sector development

Potential Adverse Impacts	Significance of Impact	Mitigation
<ul style="list-style-type: none"> <li>Uncertainties as for ecological impacts, social conflicts, and other adverse effects when establishing land-based tourism facilities</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Sectoral examination to assess the ecological and economic viability of such a strategy, and to facilitate future decision making</li> </ul>
<ul style="list-style-type: none"> <li>Uncertainties as for ecological impacts and other adverse effects when implementing innovations within SRF</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Sectoral examination to assess the ecological and economic viability of such ventures.</li> </ul>

**Component E: Technical Advisory Group, Monitoring, and Studies**

**1. Wildlife:** Research on tiger and ungulate ecology, species status assessments, identification of wildlife concentration areas, hunting and trade control, monitoring of wildlife populations and habitat availability and condition, re-introduction of extirpated species

Potential Adverse Impacts	Significance of Impact	Mitigation
<ul style="list-style-type: none"> <li>Wildlife and habitat disturbance or displacement of wildlife during studies</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Avoid entering sensitive areas at certain periods, e.g. mating, breeding times; minimize close approaches and time spent in sensitive areas</li> </ul>
<ul style="list-style-type: none"> <li>Poaching by personnel involved in wildlife studies, or control personnel will become involved in illegal practices</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Training and adequate payment of wildlife officials, emphasizing improved enforcement and security standards</li> </ul>
<ul style="list-style-type: none"> <li>Exposure of tigers to poaching risks once territorial habits and sites are identified and mapped</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Screening of staff, restricted distribution of (coded) habitat/territory maps of tigers and other sensitive information</li> </ul>
<ul style="list-style-type: none"> <li>Conflicts with boundary communities who suffer from regular tiger attacks</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Awareness campaign; establishment of appropriate tiger deterring devices in areas known for frequent attacks</li> </ul>
<ul style="list-style-type: none"> <li>Poor understanding and participation of the communities in conservation efforts</li> </ul>	Minor	<ul style="list-style-type: none"> <li>Incorporation of wildlife conservation issues in formal and non-formal education, focusing on tiger protection</li> </ul>

<ul style="list-style-type: none"> <li>▪ Marine turtles and their litter might become more vulnerable to poaching once their habitat and ethology are better known</li> <li>▪ Injuries/deaths of animals during capture and handling</li> <li>▪ More wild otters might be domesticated for otter fishing</li> <li>▪ Change of ecological balance when re-introducing extirpated species</li>   <li>▪ Further depletion of vulnerable stocks where these re-introduced species still occur</li> </ul>	<p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p>	<ul style="list-style-type: none"> <li>▪ Timely publicity to explain the purpose of the measure; awareness campaign among fisherfolk and tourists</li> <li>▪ Ensure that capture and handling are carried out only by qualified personnel; minimize recaptures</li> <li>▪ Careful publication of otter study results; quota for applicants</li> <li>▪ Small-scale trial programs as a start, in confined areas, e.g., islands, and termination of experiments once detrimental effects become apparent</li> <li>▪ Select only zoo-bred specimens; careful introduction to the wild only after sufficient period of keeping the animals in game farms</li> </ul>
<p><b>2. Fisheries:</b> Stock assessments, investigation of biological parameters, and population dynamics of main finfish and crustacean species.</p>		
<p style="text-align: center;"><b>Potential Adverse Impacts</b></p> <ul style="list-style-type: none"> <li>▪ Further depletion of vulnerable fish stocks while conducting catch trials in control areas</li> <li>▪ Mortality caused during sampling</li> <li>▪ Continuation of depletion of vulnerable fish stocks while providing support to fisherfolk</li> </ul>	<p style="text-align: center;"><b>Significance of Impact</b></p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p> <p style="text-align: center;">Minor</p>	<p style="text-align: center;"><b>Mitigation</b></p> <ul style="list-style-type: none"> <li>▪ Local trials, monitoring and adjustment of experiments if necessary</li> <li>▪ Minimize destructive sampling; training of staff</li> <li>▪ Awareness building, monitoring, evaluation and modification of support as necessary; licensing to favor traditional (non-motorized) craft, small scale operations, and traditional fisherfolk; review of license/permit system to ensure charges are market based.</li> </ul>
<p><b>3. Hydrology and Pollution Monitoring:</b> Permanent water sampling, water pollution tests</p>		
<p style="text-align: center;"><b>Potential Adverse Impacts</b></p> <ul style="list-style-type: none"> <li>▪ Mortality caused to aquatic wildlife during large-scale sampling</li> </ul>	<p style="text-align: center;"><b>Significance of Impact</b></p> <p style="text-align: center;">Minor</p>	<p style="text-align: center;"><b>Mitigation</b></p> <ul style="list-style-type: none"> <li>▪ Minimize destructive sampling; training of staff</li> </ul>

Note: There are no major impact risks of the Project. The only medium impact risk may be the increased vulnerability of tigers to poaching due to detailed knowledge of habits and ranges, and from potential misuse of microcredit to expand shrimp culture. Both these potential risks have been adequately mitigated. All other impact risks are minor.