Sri Lanka

Upper Watershed Management Project

I. Background of the Project

Sri Lanka's watersheds provide essential services to several key sectors in the economy principally through irrigation and hydropower generation. Increased population pressure has led to the degradation of watersheds through the clearance of land for cultivation, excessive grazing, and exploitative logging. This pressure continues to increase, with a consequent impact on water delivery potential of the watersheds.

An immediate and significant result of the continuing degradation of the nation's watersheds is the reduction in the capacity of the country's electricity generation (80 percent of installed capacity depends on hydropower). Following a severe drought in 1995, the rate of GDP growth in 1996 was reduced by 1.5 percent—largely as a result of the shortage in electricity supply. If the degradation is unabated, the capacity of reservoirs will rapidly be reduced due to excessive siltation, and this will bring about further reductions in hydropower generation. The degradation of watersheds and the siltation it causes also reduces the capacity of irrigation canals and the availability of water.

The major constraints in ensuring the adoption of appropriate watershed management practices have their origin in social factors, institutional inadequacies, and an inappropriate policy environment. Most farm lots in steep upland areas are less than 0.25 ha in size. Because of erosion-prone farming practices, the topsoil has been eroded, resulting in the depletion of soil fertility and declining crop yields. Farmers offset the resulting low income by growing more erosive but highly profitable crops such as potatoes. Thus, the farmers in these areas are largely responsible for the severe degradation of the environment, especially in terms of soil erosion through unsound land management.

Through an amendment of the National Environmental Act of 1980, efforts to control the degradation of watersheds through soil conservation were strengthened by the Government in 1988. Furthermore, the revision of the National Environmental Plan in 1994 recognized the importance of effective conservation and management of sensitive watershed areas. In 1996, the Government approved an amendment to the Soil Conservation Act of 1951 to give the Soil Conservation Board the responsibility to ensure interagency coordination to implement soil conservation programs. The Act discourages the cultivation of agricultural crops in all areas above 1,500 meters elevation. To further protect the forests, a nationwide logging ban was imposed in 1990 and the Government approved the Forestry Sector Master Plan (FSMP) in 1995. The FSMP is currently being implemented to emphasize: (i) adoption of integrated watershed management and planning based on an assessment of land capability, (ii) empowering people and the rural communities to manage and protect forests for multiple uses for their own benefit, (iii) developing home gardens and other agroforestry systems, (iv) developing and strengthening forest-based institutions and building partnerships through community-based organizations (CBOs) representing rural societies and groups, and (v) promoting forestry as a means of soil and water conservation. ADB's assistance in this area has been through funding forestry projects[8] and supporting integrated rural development projects.

II. Project Details

The Project includes the improvement of four upper watersheds (Uma Oya, Walawe Ganga, Kirindi Oya and Kalu Ganga) which are severely degraded by widespread deforestation and intensive cultivation of vegetables and potatoes (see Map). These watersheds play an important role in providing water for irrigation and hydropower generation in downstream areas.

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[8] *Loan No. 568-SRI: Community Forestry Project, for $10 million, approved on 25 March 1982 and Loan No. 1183-SRI: Participatory Forestry Project, for $10 million, approved on 5 November 1992.*

Map
Sri Lanka Upper Wateshed Management Project

The objectives of the Project are to: (i) rehabilitate, sustainably manage, and protect critical watersheds; (ii) improve the incomes of project beneficiaries; and (iii) strengthen the capacity of agencies in charge of watershed management. The Project will also facilitate the establishment of a national watershed management policy. The target groups include small landholders and marginal farmers, landless laborers, women, and unemployed youth. The Project area covers 13,000 ha with 270,000 beneficiaries.

The Project will address forest destruction, land degradation, and poverty by: (i) increasing forest cover in the critical areas of watersheds through integrated and participatory approaches (buffer zone planting - 4,000 ha, small timber farming - 3,000 ha, home gardens - 1,500 ha, conservation-oriented farming - 4,000 ha); (ii) increasing crop productivity and the incomes of small farmers on existing cultivated land through the promotion of conservation-oriented farming systems; and (iii) strengthening the capacity of, and coordination between, the agencies in charge of watershed management.

Environmental assessment shows that the Project will improve the environmental quality of the watershed and the welfare of the people living in the area. Among the Project's positive contributions to the environment are the introduction of conservation-oriented farming systems utilizing less inorganic fertilizers and pesticides, increased soil conservation, reduced sedimentation of reservoirs, increased conservation of natural forests and wildlife sanctuaries, increased fuelwood production, better land-use planning, and more efficient tenure rights. The promotion of Integrated Pest Management will also enhance water quality and improve the health of farmers and consumers.

The Project was estimated to cost $23.7 million equivalent, including $4.9 million in foreign exchange. Of the total cost, $16.6 million was financed by ADB with an amortization period of 40 years, including a grace period of 10 years.

III. Analytical Methods

The economic analysis for the Project focused on the three major areas of quantifiable benefits. These were: (i) incremental production from

4,500 ha of vegetable and potato land; (ii) incremental forestry production from 4,000 ha of buffer area planting, 3,000 ha of timber farms and 1,500 ha from home gardens; and (iii) environmental benefits due to savings from reduction of hydroelectric power generation losses caused by decreased reservoir sedimentation, and to carbon sequestration from additional forest cover.

The economic evaluation was based on a 7-year project implementation period, and the following assumptions: (i) with proper operation and maintenance the tree plantations and vegetative contour systems constructed will have an economic life of 30 years; (ii) the financial benefits and costs are in 1997 constant terms; (iii) the wage rate for peak agricultural period work is SLRs125 per day. During non-peak times, the off-season wage rate for construction work is SLRs104 per day. In economic prices, the shadow wage rate is 0.9 times the financial rates, or SLRs113 per day for peak season wages and SLRs94 per day during the off-season. The unemployment rate in the country is about 15 percent while the underemployment rate is about 30 percent. Therefore, it is reasonable to assume that sufficient labor can be obtained for project activities without jeopardizing the regular economic activities in the project area; (iv) most of the quantified economic benefits are derived using salable incremental outputs such as vegetables, timber and fruits. The upper watershed area is the main exotic vegetable-producing region in the country and most of these vegetables are sold in urban centers either for local consumption or export. The country has a timber shortage and the project area is faced with a fuelwood shortage because all land is currently used for agricultural activities. Therefore, it is reasonable to assume that incremental output is salable; (v) the import parity prices of important traded outputs and inputs are separately calculated. These goods include mixed species logs, high quality timber logs, urea, and triple super-phosphate fertilizers. Shadow prices for these items are adjusted for various transport and transformation charges; (vi) the prices of outputs not internationally traded are based on field observations and interviews with producers in the upper watersheds of the project area; and (vii) a conversion factor of 0.90 is used to convert prices of non-traded inputs and other financial costs into economic costs.

IV. Economic Valuation of Environmental Impacts

A. Reduction in Power Generation Losses

Soil erosion into reservoirs and dams results in sedimentation that reduces the power generated by hydroelectric plants. At present, it is estimated that the Uma Oya vegetable/potato area is eroding between 100 and 280 tons of soil per ha per year. Much of this soil ends up as sediment in the downstream Rantembe reservoir. Assuming, as above, that three quarters of the 4,500 ha upstream Project area will come under effective soil conservation measures, the Project is expected to reduce total soil erosion by 470,000 m^3 in the catchment area. This will result in about 180,000 m^3 less silt flowing into the reservoir each year. The Project, then, will save 180,000 m^3 each year (after full development). The electricity generated from one drawdown of 180,000 m^3 is valued at $972. The Rantembe reservoir, unlike most hydropower facilities, is a daily regulator, i.e., it is drawn down and refilled each day. The annual value of electricity generated from 180,000 m^3 is therefore $355,000 (in economic prices). Given the cumulative nature of the Project-induced decreased sedimentation, the economic valuation of electricity capacity saved in the second year will be $710,000, and in the tenth year it will be $3.55 million (Table 1 shows the values in rupees).

B. Carbon Sequestration

Studies have shown that one hectare of forest cover is able to sequester between 6 and 16 tons of carbon annually. Carbon sequestration gives rise to important environmental benefits because carbon emissions result in climate change and its associated damages. The value for the damages used in this study is based on IPCC values. To be conservative the lower bound of carbon sequestration figures is used (i.e., 6 t/ha per year). These estimates were then applied to the 7,000 ha of forest buffer and timber farms forming part of the Project. The adjustments made were as follows: (i) midrange estimates from IPCC were used and converted into rupees; (ii) only 50 percent of the midrange estimates were applied to account for existing forest cover before the Project; and (iii) the benefits were scaled according to the forest production values cited in project documents, i.e.,

no benefits in the first five years, increasing until full benefits are achieved in the 25th year.

V. Notable Aspects

The hydropower component illustrates two interesting issues in project evaluation. First, improved management of the catchment area will extend the economic life of downstream hydropower facilities. Second, the annual production of electricity will be enhanced because of avoided sedimentation in streams and reservoirs. Since electricity is marketed, both of these effects can be valued using rather traditional cost-benefit methods.

One novel dimension of the Project is carbon sequestration. Most reforestation efforts generate benefits to those who extract products from the newly forested area. This could be commercial timber or it could be incidental forest products such as fodder, small poles, or minor fruits. It is also not uncommon for benefits of reforestation to occur because of reduced soil erosion. In those cases, the benefits are calculated as the downstream costs of erosion that are avoided because of the improved ground cover. In each of these instances the benefits are local in nature because the beneficiaries reside in the immediate vicinity. Here, however, we see benefits accruing to the larger "global" community in the form of sequestration of carbon. That is, greenhouse gases are a global problem and this Project will play a small role in reducing such gases.

It is not enough to plant trees—they must be sustained. Therefore, the economic life of carbon sequestration benefits will depend upon the ability of local individuals, and the Government, to maintain the plantation somewhat intact into the indefinite future. We also know that younger trees are capable of sequestering more carbon than are older trees. Therefore, the stream of benefits is critically dependent upon the long-run maintenance of a mixed-age stand of trees. This suggests that sustainable forestry must be a central part of the Project.

The base case economic internal rate of return (EIRR) without environmental impacts is 20.3 percent. The addition of the two quantified environmental benefits increases the EIRR to 22.3 percent. The Project's

Table 1: Integrated Economic and Environmental Analysis (Rs million)

Year	Economic Cost	Economic Benefit				Net Benefit
		Buffer Area Planting	Timber Farm	Home Garden	Increased Agricultural Productivity	
1998	*(158.2)*	*–*	*–*	*–*	*–*	*(158.2)*
1999	*(120.2)*	*–*	*–*	*–*	*–*	*(120.2)*
2000	*(154.7)*	*–*	*–*	*–*	*3.4*	*(151.3)*
2001	*(208.9)*	*–*	*–*	*–*	*13.1*	*(195.9)*
2002	*(221.9)*	*0.6*	*–*	*0.1*	*34.5*	*(186.7)*
2003	*(146.9)*	*2.1*	*–*	*0.3*	*74.9*	*(69.5)*
2004	*(112.5)*	*6.8*	*0.2*	*0.8*	*131.5*	*26.8*
2005		*9.6*	*0.5*	*1.5*	*200.0*	*211.6*
2006		*20.8*	*0.7*	*2.1*	*259.2*	*282.8*
2007		*31.0*	*1.1*	*3.0*	*298.0*	*333.1*
2008		*38.3*	*1.2*	*3.6*	*318.4*	*357.5*
2009		*32.2*	*0.6*	*4.1*	*316.4*	*353.3*
2010		*37.2*	*0.3*	*4.8*	*316.4*	*358.7*
2011		*44.7*	*–*	*5.6*	*316.4*	*366.7*
2012		*56.0*	*11.0*	*6.6*	*316.4*	*389.9*
2013		*72.2*	*27.4*	*7.6*	*316.4*	*423.5*
2014		*81.3*	*41.1*	*8.6*	*316.4*	*447.3*
2015		*74.3*	*65.8*	*9.3*	*316.4*	*465.8*
2016		*78.4*	*74.0*	*9.7*	*316.4*	*478.5*
2017		*82.8*	*35.6*	*9.6*	*316.4*	*444.4*
2018		*99.6*	*41.0*	*9.1*	*316.4*	*466.1*
2019		*117.3*	*54.5*	*8.3*	*316.4*	*496.5*
2020		*124.1*	*81.8*	*7.6*	*316.4*	*529.9*
2021		*125.8*	*130.9*	*6.8*	*316.4*	*579.9*
2022		*122.7*	*292.0*	*21.1*	*316.4*	*752.2*
2023		*120.2*	*432.8*	*42.4*	*316.4*	*911.8*
2024		*118.4*	*581.1*	*60.5*	*316.4*	*1,076.5*
2025		*117.2*	*868.7*	*93.0*	*316.4*	*1,395.2*
2026		*116.3*	*977.2*	*102.8*	*316.4*	*1,512.7*
2027		*116.0*	*470.5*	*49.3*	*316.4*	*952.2*
2028		*111.2*	*253.3*	*26.4*	*316.4*	*707.3*
2029		*99.6*	*–*	*–*	*316.4*	*416.0*
2030		*82.3*	*–*	*–*	*316.4*	*398.7*
2031		*54.4*	*–*	*–*	*316.4*	*370.8*
2032		*23.2*	*–*	*–*	*316.4*	*339.6*
2033		*8.1*	*–*	*–*	*316.4*	*324.5*
EIRR (%)						*20.3*

EIRR = economic internal rate of return.

Environmental Benefit		
Avoided Power Loss	Carbon Sequestration	Total Net Benefit
–	–	*(158.2)*
–	–	*(120.2)*
–	–	*(151.3)*
–	–	*(195.9)*
–	*0.1*	*(186.7)*
1.0	*0.3*	*(68.2)*
2.7	*1.0*	*30.4*
5.7	*1.3*	*218.6*
10.6	*2.9*	*296.3*
15.5	*4.4*	*352.9*
19.9	*5.1*	*382.5*
39.7	*4.5*	*397.6*
59.6	*5.2*	*423.5*
79.5	*6.5*	*452.7*
99.3	*8.1*	*497.4*
125.8	*10.5*	*559.8*
145.7	*11.8*	*604.8*
165.6	*10.8*	*642.1*
185.4	*11.4*	*675.2*
205.3	*12.0*	*661.7*
225.2	*14.4*	*705.7*
245.0	*17.0*	*758.5*
264.9	*18.0*	*812.7*
284.8	*18.2*	*882.8*
304.6	*17.8*	*1,074.6*
324.5	*17.4*	*1,253.7*
344.3	*17.2*	*1,438.0*
364.2	*17.0*	*1,776.4*
384.1	*16.8*	*1,913.6*
403.9	*16.8*	*1,373.0*
423.8	*16.1*	*1,147.2*
443.7	*14.4*	*874.1*
463.5	*11.9*	*874.1*
483.4	*7.7*	*862.0*
503.3	*3.3*	*846.1*
523.1	*1.2*	*848.8*
		22.3

value cannot be considered as a complete assessment since other benefits were not quantified. These other beneficial effects are: (i) reduction in the loss of valuable land to spreading gullies due to erosion; (ii) improved water retention in the hills, which extends the growing season, assured drinking water supplies in village wells, and increased base flows in rivers during the dry season (thereby enhancing downstream irrigation); (iii) improved conservation and protection of biodiversity in a number of forest reserves and wildlife sanctuaries; and (iv) institutional development for conservation and protection of natural resources, by strengthening the ability of district and local government agencies to use participatory methods in working with villagers.

Standard travel cost method could have been used to estimate recreational benefits from forest reserves and wildlife sanctuaries. However, studies have estimated that a reliable study requires roughly $100,000 and 10-12 person-months. Under the time and resource constraints, such methodologies cannot be employed. Despite this, from the partial analysis of impacts, it is clear that the Project contributes to the sustainable improvement of the environment.

The results of the economic valuation of environmental impacts of the Project highlight the importance of protecting reservoirs for hydropower generation. This brought to focus the fact that soil erosion is not simply an issue of lost productivity of land. It has substantial effects on subsequent power generation. Thus, the Project was able to call the Government's attention, resulting in the proposed amendment of the Soil Conservation Act. The Project will require the Government of Sri Lanka to gazette a regulation that will prohibit any cultivation and agricultural activities that could have negative impacts on slopes with an incline of over 60 percent. It will also address land tenure policies of the country and develop a framework to address the problem of landlessness in agricultural areas.

The development of watershed policy will also have major environmental benefits for the country. This policy will address the issue of beneficial participation and proper compensation or financing mechanism to assure water use conflicts between upstream (hydropower) vs. downstream (irrigation). This recognition was clearly a result of the economic valuation of environmental impacts. The valuation showed that investment in conserving soils in upper watersheds bring benefits to the urban consumer and industries, via better electricity availability. The valuation was also used to show electricity benefits vs. irrigation benefits from upper watershed protection. Hence it was possible to establish the beneficiaries-pay approach for watershed management in Sri Lanka.