KLANG RIVER BASIN ENVIRONMENTAL IMPROVEMENT AND FLOOD MITIGATION PROJECT

I. Background of the Project

Malaysia, one of the most rapidly urbanizing countries in Asia, faces major environmental challenges. Rapid industrialization, although relatively well planned and regulated, has generated increased pressure on urban areas especially in the Klang River Basin, the most densely populated area of the country. With an estimated population of over 3.6 million (about 21 percent of the national population), and growing at almost 5 percent per year, the Basin has experienced the highest economic growth in the country.

The Klang River has a total length of about 120 km. The Basin is 1,290 km^2, about 35 percent of which is developed for residential, commercial, industrial, and institutional use. The upper catchment of the Klang River and its tributaries the Gombak and Batu Rivers are covered with well-maintained forests. However, the lower reaches of the Basin, with extensive urban land development activities, are major contributors of sediment load and flood peaks. Since 1985, urban development has increased by about 4 percent per annum. Rapid economic growth has attracted a strong inflow of settlers from other parts of the country and overseas, which has resulted in squatter settlements along the river reserve area.

The fundamental problem of river basin management in the Klang River Basin is soil erosion and sedimentation. Soil erosion in the catchment is estimated at 18 metric tons per hectare (t/ha) per year, which is equivalent to approximately 2.3 million t of annual soil loss from the entire Basin. The major source of erosion is from urbanizing areas (about 660,000 t per year). Much of this occurs on construction sites where large areas of earth are exposed. On some steep lands, with over a 10 percent grade, soil losses are often in excess of 400 t/ha per year.

Although much of the soil erosion evident in the Klang River Basin is thought to be caused by inappropriate land uses (given the terrain), a major contributing factor is the inadequate erosion-control measures, particularly for areas affected by urban land development. A number of laws exist to ensure that effective erosion-control measures are undertaken particularly for urban developments. However, such measures are not enforced largely because of a lack of trained local enforcement officers.

The management of solid waste in the Basin is another major environmental issue. Buildup of solid waste in rivers particularly in urban areas impedes flows and thereby causes serious environmental problems, as well as compounding flooding. Unsafe solid waste landfills and illegal dumping of waste remain a problem, as enforcement is hampered by the lack of capacity and legal power of local authorities. About 150,000 t of solid waste were not collected in 1995. It is estimated that about 507,000 people, primarily squatters whose numbers are expected to grow despite resettlement programs, were not served by solid waste collection in 1995. In addition, because such areas are poorly served, the settlers generally dispose of their solid waste into the rivers, which not only reduces river conveyance capacities, but also leads to deterioration in water quality.

Another important dimension of integrated river basin management (IRBM) is water quality control. Of 119 major rivers monitored in Malaysia, 14 including the Klang River were found to be highly polluted. The disposal of untreated sewage from treatment plants and livestock farms contributes to the further deterioration of the Klang River's water quality, adding to its solid waste and suspended-sediment loading. The very low quality of river water in turn contributes to poor hygiene along the river corridors, degradation of vegetation, and loss of biodiversity in the river itself. In an effort to accelerate the provision of sewerage services, and to arrest the problems of domestic and animal waste pollution, the sewerage system in Malaysia was privatized in 1993. By the end of 1995, a single company was managing sewerage systems in 82 of the 143 local authorities in the country, including major urban centers.

The annual flooding causes extensive damage, and extreme flood events, such as those that occurred most recently in 1988 and 1993 as well as the highest flood on record in 1971, have a much higher economic cost,

in the absence of adequate flood protection. The flood problem is further aggravated by clogging of the river channels caused by deposition of sediment and solid waste. The flood damage potential of the Klang River is high because of its limited channel capacity and its route through the center of the Federal Territory and other urban and industrialized areas. About 17,000 ha (13 percent) of the Klang River Basin is flood-prone, with an average of three flood events per year. The flood-prone area is inhabited by about 500,000 people, of which 190,000 (38 percent) are squatters. The most flood-prone area consists of about 5,000 ha, with about 17,700 dwellings and 100,000 residents, as well as 1,410 farms, 42 km of roads, 1,260 commercial and industrial establishments, four schools, and five sewage treatment plants. About 5,000 people residing in low-lying areas are typically evacuated three times a year. The average annual flood damage in this area is estimated to be approximately $1.5 million.

Malaysia has made a strong commitment to protection of the environment and sustainable development. The government policy for the development and management of rivers has the objective of ensuring that rivers meet requirements for water supplies, energy production, navigation, recreation, ecological balance, and a diversity of riverine flora and fauna. The policy seeks to promote a holistic approach to river management that integrates water resources, flood control, and environment planning and management in recognition of the important multi-functional role of rivers in socioeconomic development. The strategy aims for cost-effective river environment improvement and flood mitigation, using an appropriate combination of structural and nonstructural measures. Emphasis is placed on monitoring and regulating all catchment activities that could lead to increases in flooding and pollution of rivers.

II. Project Details

The Project provides an opportunity for ADB to play a catalytic role in improving the current approach to environmental improvement in the dynamic and rapidly changing area of the Klang River Basin (see Map). To mitigate environmental and flood-prone problems in the Basin now and

Map
Malaysia Klang River Basin and Flood Mitigation Project

in the future, the Project will introduce an integrated approach involving the comprehensive and coordinated management of river systems and their basins to foster the maintenance of a sound environment, while also meeting socio-economic development objectives. The Project will integrate the three ongoing government projects[13] for cleaning up the Klang River. Central to these projects are flood mitigation, and several private sector initiatives to: (i) provide a stronger focus on environmental improvement of the Basin, (ii) minimize overlapping jurisdictions, (iii) provide more cost-effective and long-term flood protection measures, and (iv) improve administrative efficiency.

ADB's policy dialogue with the Government has led to policy changes that will enhance the sector's efficiency, including: (i) an integrated approach to environmental improvement and flood mitigation, (ii) resettlement of squatters, (iii) recovery of capital and O&M costs, and (iv) solid waste management.

The overall objectives of the Project are to: (i) improve environmental conditions, including those that worsen flooding, through an IRBM approach that addresses environmental and economic development needs; and (ii) minimize the adverse economic, social, and environmental impacts of flooding in the Klang River Basin. Specifically the Project will: (i) implement IRBM and solid waste management to improve water quality and enhance the Klang River Basin environment; and (ii) provide a high level of flood protection to tributary river and downstream communities through the provision of flood mitigation measures, and an improved flood-forecasting system. Project interventions will lead to less soil erosion, cleaner rivers that can be used for recreation purposes, and reduced damage and disruption from flooding in the Klang River Basin.

The Project comprises three components that directly address needs for environmental improvement: (i) IRBM, (ii) solid waste management, and (iii) sediment trapping. In addition, there are two flood-mitigation

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[13] *Three ongoing projects address the environmental issues in the Basin: the Klang River Cleanup Program implemented through a multiagency task force chaired by the Director General of the Federal Department of Irrigation and Drainage (DID); the Klang River Basin Flood Mitigation Project, implemented by the Federal DID; and the Federal Territory Drainage Project, implemented by the Federal DID and Selangor State DID.*

components: (i) tributary river corridor improvements, and (ii) improved flood forecasting and warning systems.

The total project cost was estimated at $101.8 million. Of this amount, 26 percent ($26.3 million) was financed by ADB with an amortization period of 15 years inclusive of a 6-year grace period.

III. Analytical Methods

The Project's incremental impact on the economy is assessed using two development scenarios—expected development pathways in the project area both with the Project and without the Project. In the without-Project option, it is assumed that present conditions and practices in the Klang River Basin will continue unabated. In the with-Project case, IRBM institutional arrangements will be studied, working committee will be established, and demonstration projects will be implemented with associated sub-catchment groups.

The economic costs of the Project include all capital costs, including resettlement costs and recurrent costs, and are based on average 1996 market prices. The financial (local market) costs of Project inputs and benefits are converted to economic values using conversion factors (construction = 0.96; petroleum products = 0.94; nonelectric machinery = 0.98; electric machinery = 0.81; motor vehicles = 0.78; real estate and dwellings = 0.89; and other services = 0.86). The economic life of the Project is assumed to be 30 years, as its impacts are long-term in nature.

The economic benefits of the Project consist of directly quantifiable benefits, indirect benefits (indirect use values), and nonuse values. The major benefits are summarized in Table 1, including quantified and nonquantified environmental benefits. The quantifiable benefits of project interventions are summarized in Table 2 where it is shown that the net present value of the Project's environmental benefit stream as a percentage of net present value of all project benefits is about 60 percent.

Table 1: Estimated Project Benefits

Benefit	On-site Benefit	Off-site Benefit	Total Estimated Value in 2003 ($ million)
Integrated River Basin Management			
• *Soil erosion reduced* • *Aesthetic values* • *Improved river quality*	• *1,290 km² assuming $130/ha incremental value for 30 percent of the land* • *Sediment reduced from 2.3 million tons to 1.5 million tons* • *Aesthetic value*	• *Clean water (water pollution reduced by 50 percent by 2003)* • *Reduction in sediment removal costs*	• *1.0 million*
Solid Waste Management			
• *Reduced cost of rubbish collection* • *Improved health* • *Civic values*	• *Improved health* • *Uncollected solid waste reduced by 30 percent* • *Aesthetic values* • *Civic values*	• *Clean air* • *Clean water* • *Reduced cost of collecting rubbish from the rivers*	• *1.2 million due to reduced costs and 1.2 million from indirect benefits*
Sediment Trapping			
• *Sand sales* • *Cost savings from avoided dredging* • *Improved river quality*	• *Sand sales: $0.2 million/yr (130,000 m³ per year)*	• *Cost savings: $0.6 million/yr* • *Clean water*	• *0.2 million* • *0.6 million*
Tributary River Corridor Improvement			
• *Land value improvement* • *Aesthetic values* • *Avoided damages and distruption* • *Recreational values* • *Reduction in riverbank erosion*	• *2,500 ha assuming $130/ha incremental land value* • *Aesthetic values* • *Recreational values*	• *Avoided damages about $6 million in 2003* • *Clean water*	• *0.7 million land value* • *3.6 million land value*
Flood Forecasting and Warning System			
• *Avoided damages and disruption*	• *Avoided damages*	• *Avoided damages*	• *2.6 million*

Benefit	On-site Benefit	Off-site Benefit	Total Estimated Value in 2003 ($ million)
Rasau Swamp Protection (1,800 ha)			
• *Flood retardation* • *Carbon sequestration* • *Tourism* • *Biodiversity*	• *Carbon sequestration assuming 11 mt/ha-yr for 1,800 ha at $12.76/mt initially* • *Tourism: 15,000 persons/yr each spending $10* • *Biodiversity: $15/ha-yr*	• *Flood retardation $0.3 million/yr* • *Carbon sequestration*	• *0.3 million flood retardation* • *0.25 million carbon sequestration* • *0.16 million tourism* • *0.03 million biodiversity*
Soil Erosion Demonstration Projects			
• *Land value improvement of the demonstration areas*	• *Land value improvement*	• *Diffusion effect*	• *Value is minimal due to smallness of areas involved*
Education/Public Participation			
• *Solid waste reduced* • *Health benefits* • *Aesthetic values* • *Soil erosion reduced* • *Water pollution reduced*	• *Solid waste reduced* • *Health benefits* • *Aesthetic values* • *Soil erosion reduced*	• *Solid waste reduced* • *Health benefits* • *Aesthetic values* • *Soil erosion reduced* • *Clean water*	• *Value quantified in above categories*
Improvement of Health			
• *Increased productivity*		• *Improved human welfare*	• *Value not quantified*
Beautification			
• *Land value improvement* • *Increased tourism*		• *Land value improvement* • *Increased tourism*	• *Value not quantified*
Increased Fish Production			
• *River and wetland* • *Offshore*		• *River and wetland fish life increased by 20 percent by 2003* • *Offshore*	• *Value not quantified*

Table 2: Incremental Benefit and Cost Streams *(1996 RM million)*

Item	1	2	3	4	5
Project benefit					
IRBM: Land value increase	–	–	–	–	–
Solid waste: Collection cost savings	–	1.8	2.5	2.6	2.7
Solid waste: Indirect benefit	–	1.8	2.5	2.6	2.7
Sediment trapping: Cost savings	–	–	0.5	1.1	1.6
Sediment trapping: Sand sales	–	–	0.2	0.4	0.6
Tributary rivers: Damage avoided	–	–	4.2	5.9	8.4
Tributary rivers: Land value increase	–	–	–	–	0.2
Flood forecasting: Damage avoided	–	–	4.2	5.7	6
MWSS: Tourism	–	–	–	–	0.4
MWSS: Biodiversity	–	–	–	–	0.1
MWSS: Carbon sequestration	–	0.1	0.2	0.3	0.4
Total		3.7	14.3	18.6	23.1
Project cost					
Integrated river basin management	5.8	6.7	6.2	4.7	3.6
Solid waste management	2.7	6.5	5.2	2.4	2.4
Sediment trapping	0.3	1.1	3.9	2.9	–
Tributary river channel improvement	6.5	32.0	42.7	34.6	19.2
Flood forecasting and warning system	2.6	1.3	0.2	–	–
Operation and maintenance	–	–	–	–	–
Total	17.9	47.6	58.2	44.6	25.2
Net benefit	-17.9	-43.9	-43.9	-26.0	-2.1

RM = Malaysian Ringgit
Economic internal rate of return (EIRR) in % 14.9
Net present value (NPV) 65.7
NPV of environmental benefits as percent of total 60

EIRR decreases by less than one percent if computed global benefits such as biodiversity and carbon sequestration are removed.

IV. Economic Valuation of Environmental Impacts

A. Direct Benefits

The direct economic benefits from the solid waste component are assumed to consist of annual savings of $1.2 million in 2003 from the reduced cost of clearing solid waste from trash screens and rubbish booms. It is assumed that as a result of project interventions, the amount of un-

Year										
6	7	8	9	10	11	12	13	14	15	30
2.5	2.5	2.5	2.5	2.5	–	–	–	–	–	–
2.8	2.9	3	3.2	3.3	3.4	3.6	3.7	3.8	4.0	7.2
2.8	2.9	3	3.2	3.3	3.4	3.6	3.7	3.8	4.0	7.2
1.6	1.6	1.6	1.6	1.5	1.5	1.4	1.3	1.3	1.2	0.6
0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.2
8.8	9.1	9.5	9.9	10.3	10.7	11.0	11.3	11.7	12.0	17.1
0.2	0.2	0.2	0.2	–	–	–	–	–	–	–
6.2	6.4	6.7	7.0	7.3	7.5	7.8	8.0	8.2	8.5	12.1
0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.8
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.5	0.8	0.8	0.8	0.6	0.6	0.6	0.6	0.6	0.7	0.7
26.5	27.5	28.4	29.5	29.9	28.2	29.1	29.7	30.4	31.4	46.0
3.2	–	–	–	–	–	–	–	–	–	–
0.6	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–
5.4	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–
–	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
9.2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
17.3	27.0	27.9	29.0	29.4	27.7	28.6	29.2	29.9	30.9	45.5

collected solid waste in project areas will be reduced by 30 percent to 105,000 t by 2003.

Direct benefits from sediment trapping are valued at $0.6 million per year and the sale of sand removed from traps is assumed to be $0.2 million yearly; both are assumed to gradually decrease over the life of the Project on the assumption that soil erosion and sediment in the river systems will decrease over time. Furthermore, about 17 million worth of expected annual losses due to floods will be avoided from the year 2003 onward, and expected losses of $6.2 million will be directly avoided by the Project.

B. Indirect Benefits

Of the many indirect benefits from the Project, four are amenable to quantification. Indirect benefits from the IRBM component, made possible by higher land values as a result of reduced soil erosion and runoff control, are estimated for 30 percent (the critical erosion-prone lands) of the total basin area at a value of $130 per ha. These benefits are assumed gradually to accrue to 20 percent of the critical lands per year, beginning in year 5 of the Project, and continuing a further four years.

Intangible benefits are attributed to the solid waste management component in terms of improved community health as a result of solid waste removal, primarily in squatter areas, a strong improvement in aesthetic values, and increased civic pride. These significant indirect benefits are valued at 50 percent of the value of the estimated direct benefits of the solid waste component.

Indirect benefits from the preservation of the Malaysian Wetland Sanctuary, Selangor (MWSS) are estimated for its tourism and recreational value, and from carbon sequestration. Although the tourism value of the MWSS is yet to be realized, given its proximity to the capital city and major urban centers, it is assumed that 15,000 tourists per year, or about 40 persons per day, will visit the site starting in 2001. It is estimated that these visitors will spend $10 that is directly attributable to the tourism and recreational value of the MWSS. These benefits are assumed to grow by 4 percent annually until 10 years after the commencement of the Project. The annual growth rate is assumed to decrease to 3 percent for a further 10 years, and to 2 percent for the final ten years of the Project. It is assumed that without the Project, 300 ha of the MWSS will disappear yearly starting in 1997. It is further assumed that 11 tons per ha of carbon is sequestered annually, with a value of $12.76 per t from 1991 to 2000, $14.04 per t from 2001 to 2010 and $14.47 per t thereafter (these are median IPCC figures, in contrast to low-high ranges), leading to benefits of $0.25 million in 2003.

C. Nonuse Values

The MWSS and its associated forest reserve also have significant ecological value, especially since they represent the last remnants of lowland swamp forest in western Peninsular Malaysia. The open grassland and weed area provides a valuable adjunct and buffer for the maintenance of the existing hydrological balance of the MWSS. The rapid land development in the Klang River Basin, and in the area of the MWSS itself, especially land filling, threatens the ecological integrity of the area. The IRBM component will ensure that the MWSS area is protected from such developments and the irreversible loss of the MWSS. Recent studies in Malaysia have quantified the use and nonuse values of wetlands, including functions such as a carbon sink, and for flood retardation, their use as habitat for fish and wildlife, and their biodiversity attributes. It is difficult to calculate the value of retaining options to future uncertain alternative uses of the MWSS. Moreover, given data limitations, this option value, although likely substantial, has been conservatively estimated at $15/ha per year.

V. Notable Aspects

The novel aspect of this Project is that approximately two-thirds of the benefits are attributable to environmental components. Uncontrolled urbanization and squatter settlements, increased flooding and soil erosion, and general destruction of the Klang River Basin provide the context for this Project. The Government seeks to implement an integrated catchment area management scheme and the ADB will participate in this effort.

Benefits arise from a reduction in necessary outlays for cleaning solid wastes from the waterways in the project area, and from reduced flood losses. Indirect benefits arise from higher land values and improved community health associated with improvements in the basin. Increased tourism will also account for some indirect benefits of the Project. Nonuse values arise because of components that will protect the Basin's ecological integrity.

A substantial portion of project benefits have not been valued, therefore the economic internal rate of return (EIRR) calculation underestimates the

benefits of the Project and should be considered as a conservative estimate of the rate of return. The project EIRR is estimated at about 14.9 percent.

The use of environmental economics permits the classification of almost two-thirds of project benefits as environmental benefits. This has been used to justify the primary environmental strategic objective accorded to the Project. Appendix 1 contains a discussion of ADB's classification system based on objectives. Although costs are conventionally used for project classification, environmental investments were only 40 percent of total project costs. However, because of the large amount of quantified benefits, this Project has been recognized as primarily environmental in nature. In addition, the Project has other significant benefits that were not quantified. These include beautification and improvement of amenities of the rivers and river corridors, catchment improvement due to water pollution control, fish life rehabilitation, public education programs and the diffusion effect of the soil conservation demonstration plots, and child safety and improved health conditions as a result of reduction in waterborne diseases.