

ECONOMIC AND FINANCIAL ANALYSIS

A. Economic Analysis

1. Introduction

1. This summary contains an analysis of the economic costs and benefits of the North Central Province Canal Project (NCPCP).¹ The first phase of the NCPCP comprises the Minipe Left Bank Canal Rehabilitation Project, the North Western Province Canal Project, and the Upper Elahera Canal Project. These investments will be cofinanced by the proposed Asian Development Bank (ADB) multitranches financing facility (MFF). Construction of the Upper Elahera Canal Project, which accounts for about two-thirds of the total cost of Phase 1, is needed to implement Phase 2 of the NCPCP. This second phase mainly consists of construction of the Kalinganuwara Pumping Station, the Lower Uma Oya Reservoir, the Randenigala–Kalu Ganga Transfer Canal, and the North Central Province Canal. Since the infrastructure to be financed by the MFF is needed to realize economic benefits that will accrue upon completion of the Phase 2 investments, the economic analysis covers the entire NCPCP instead of the part to be cofinanced by the MFF.

2. Macroeconomic Assessment

2. Since the end of the civil war in 2009, Sri Lanka has had rapid economic growth. From 2010 to 2013, gross domestic product (GDP) increased by over 7% per annum in real terms. The poverty head count dropped from 15.2% in 2007 to 6.5% in 2012. From 2009 to 2013, the share of the agriculture subsector dropped from 12.0% to 10.8% of real GDP. Nonetheless, this subsector continues to employ over 30% of the nation's labor force, a percentage that has remained stable since 2000. The subsector is therefore important to Sri Lanka's economy, both in terms of economic outputs and employment. It is especially important in the NCPCP area, where it accounts for 20%–25% of regional GDP and employs over 50% of the labor force.²

3. Demand Analysis

3. Over 50% of the population in the NCPCP's beneficiary area depends on irrigated agriculture. Cropping intensities in cultivated areas are suppressed, mainly because of persistent water shortages. This has caused strong demand by farmers for additional irrigation water to increase agriculture production, which mostly consists of paddy, and to allow the cultivation of higher value-added crops. The project would also help improve food security in the area, which is lower than in most other parts of Sri Lanka. Given the limited agriculture production and food insecurity status of the project area, strong local demand exists for the additional agriculture production to be generated by the project.

4. Rationale

4. The NCPCP will improve deliveries of irrigation water, and provide raw water to water utilities and hydropower plants. These are private goods that can, in principle, be delivered to individual customers. However, since farmers are exempt from irrigation water charges, the private sector cannot undertake the project on a financially profitable basis. Without some form of public intervention, the market will construct no (or less) irrigation water infrastructure than is

¹ Economic Assessment (accessible from the list of linked documents in Appendix 2)

² Central Bank of Sri Lanka. 2014. *Economic and Social Statistics of Sri Lanka 2014*. Colombo.

optimal. To address this market failure, government intervention is proposed in the form of capital grants and—to the extent required—operation and maintenance (O&M) subsidies.

5. Project Alternatives

5. The NCPCP is the least-cost option identified to achieve the objective of providing water to the project area while minimizing adverse impacts on the existing system and the environment. A large number of studies and simulations were undertaken to select the infrastructure that would best achieve this objective. The main reasons for choosing the selected option are that it:³ (i) has the shortest transfer route length compared with alternative options studied; (ii) has the least environmental damage compared with alternative options studied; (iii) allows optimization of infrastructure to be developed under Moragahakanda and Kalu Ganga reservoir projects, which are under construction; and (iv) enhances flexibility with regard to regulation of flows.

6. Methodology and Data

6. **Overview.** The economic analysis was prepared for the NCPCP in accordance with ADB's *Guidelines for the Economic Analysis of Projects*.⁴ The guidelines describe four basic steps to analyzing the economic viability of a project: (i) identify economic costs and benefits, (ii) quantify economic costs and benefits (comparing with- and without-project situations for each alternative), (iii) value economic costs and benefits, and (iv) compare benefits and costs.

7. **Economic surplus.** An economic surplus model was used to measure the agriculture benefits of the project. As a result of a project intervention, changes in the quantity of a commodity (e.g., wheat, rice) can result in product price changes, which together leads to changes in economic welfare. Economic surplus comprises two elements—consumers' surplus and producers' surplus. Consumers' surplus is defined as the extra amount a consumer would have been prepared to pay, and is measured as the area below the demand curve and above the price line. The basic premise of consumers' surplus is that at a certain market price some consumers would be willing to pay a higher price to obtain the same quantity, and that their welfare is increased by obtaining the product at a lower price. The traditional measure of producers' surplus is the difference between what a producer actually receives for a sale and the minimum amount he would have been prepared to accept.

8. The standard economic surplus model was used to measure the impact of a rightward shift in commodity supply functions resulting from increased agriculture production from additional irrigation water supplied by the project. This will have consumer and producer effects both within the project area and the rest of Sri Lanka. In the project area, there will be a direct effect on producers through the increase in supply of a commodity. Assuming competitive conditions prevail, this will also have broader implications on the rest of the country through the reduced market price as a result of increased supply. This will impact on consumers (who gain) and producers (who lose) from the reduced market price.

9. **Identification and quantification of economic costs and benefits.** The project's incremental economic costs and benefits were identified and (to the extent possible) quantified for 2015–2060 (30-year implementation period from completion of the NCPCP). All costs and

³ Mahaweli Consultancy Bureau Limited. 2012. *Pre-Feasibility Study for the Implementation of North Central Province Canal Program*. Colombo.

⁴ ADB. 1997. *Guidelines for the Economic Analysis of Projects*. Manila.

benefits were expressed in mid-2014 economic prices including physical contingencies, but excluding transfer payments. The economic cost–benefit analysis was conducted at the domestic price level (domestic price numeraire). For internationally traded inputs and outputs, economic prices (at farm gate) were derived from international border prices and adjusted for the cost of transportation, handling, processing, and packing. For non-traded inputs and outputs, financial prices were obtained from local markets and converted into economic prices using the standard conversion factor estimated at 0.91. The economic price of farm labor was estimated by applying a shadow wage rate factor of 0.7 to the financial price of this input.

10. **Valuation of economic costs.** The incremental economic costs of the proposed NCPCP comprise the project’s incremental investment and O&M costs during the project’s economic lifetime. The total economic investment cost of the NCPCP was estimated at SLRs 202 billion. To reflect the benefits that may accrue after the end of the project’s economic lifetime in 2060, the residual value of the project was set at 20% of the economic investment cost. The incremental economic O&M cost mainly consists of pumping costs, and the cost of cleaning and minor repairs of project assets, and was estimated at 1.5% per year of the economic investment cost. In 2050, it is assumed the hydraulic steel structures and mechanical equipment will be replaced at a cost estimated at 10% of the economic investment cost.

11. **Valuation of economic benefits.** The NCPCP will finance investments in infrastructure that will enable the government to divert water from the Mahaweli River to water-scarce areas in the northern dry zone region. Upon completion of the proposed investments, the available supply of water is expected to increase by over 1,200 million cubic meters per year.⁵ The increase in available water will have quantifiable economic benefits for (i) increased agricultural production; (ii) increased provision of raw water for domestic, municipal, and industrial (DMI) uses; and (iii) increased hydropower generation. In addition, the following benefits were assessed qualitatively—increased food security and increased internal security.

12. **Valuation of economic benefits from increased agricultural production.** The primary economic benefit of the NCPCP is increased agricultural production through improved deliveries of irrigation water which is expected to result in (i) an increase in cropping intensities on existing cultivated areas; (ii) an increase in paddy yields owing to the secured supply of water; and (iii) an increase in the production of high-value crops (such as fruit and vegetables).

13. The project will increase water deliveries to 232,500 hectares (ha) of irrigable land in Sri Lanka’s dry zone (the agricultural benefit area). About 214,500 ha is already used to grow crops, mostly paddy, and the remaining 18,000 ha will be cultivated upon completion of Phase 1. According to a recent analysis, air temperatures in the project area will be 1.3°C to 1.7°C higher in 2050 than during 1961–1990.⁶ Another study estimates that paddy yields in South Asia will, on average, decrease by 4.0% per 1°C temperature increase.⁷ These parameters were used to estimate the decrease in agricultural production in the without-project scenario. Agricultural production is not expected to decrease as a result of climate change in the with-project scenario, as the newly built irrigation infrastructure will mitigate the adverse climate change impacts by securing the availability of water for agriculture.

⁵ Mahaweli Consultancy Bureau Limited. 2012. *Water Balance Study of NCP Canal Project*. Colombo.

⁶ C.S. De Silva. 2013. Impact of Climate Change on Water Resources and Agriculture in Sri Lanka. *Proceedings of the International Conference on Climate Change Impacts and Adaptations*. Colombo.

⁷ D.B. Lobell et al. 2008. Prioritizing Climate Change Adaptation Needs for Food Security in 2030. *Science*. 319. pp. 607–610.

14. Cropping intensities in existing cultivated areas are suppressed, mainly because of persistent shortages of irrigation water. Records of the Mahaweli Authority of Sri Lanka (MASL) indicate that cropping intensities are about 50% lower in *Yala* cultivation season (May to August) than in *Maha* cultivation season (September to March). At present, the average cropping intensity of the agricultural benefit area is 1.42 with about 331,000 ha harvested on an annual basis. Upon completion of the NCPDP in 2030, the cropping intensity will increase to 1.86. As a result, the harvested area will be about 107,000 ha larger and the annual agricultural production over 1.2 million tons higher than the without-project scenario (Table 1).

15. MASL manages a series of major irrigation schemes located in or near the agricultural benefit area, which already enjoy an adequate supply of irrigation water, notably Systems B, C, and H. Actual cropping patterns in these systems were analyzed to define cropping patterns in newly harvested areas in the benefit area. Based on the analysis, the following allocation rules were formulated:

- (i) **Maha: 100% paddy.** It is unusual for farmers in the agricultural benefit area to grow crops other than paddy in *Maha*, even in well-irrigated areas.
- (ii) **Yala: 25% paddy, 75% other field crops.** Based on current cropping patterns in Systems B, C, and H.⁸ About half of the increase in the harvested area for other field crops will be used for banana and maize (24% each), and the remainder for vegetables (14%), green gram (14%), dry chilies (11%), groundnut (11%), and big onions (2%).

In addition, about 6,600 ha in the Kantale area (which are currently fallow) will be allocated to sugarcane to help reduce Sri Lanka's considerable sugar imports. Upon completion of the NCPDP, over 60% of the expected increase in the harvested area will be absorbed by paddy, 6% is allocated to sugarcane, and the remaining 32% to other field crops.

Table 1: Harvested Area and Agricultural Production, 2030

Crop	Harvested Area ('000 hectares)			Agricultural Production ('000 tons)		
	Without Project	With Project	Increase in Area	Without Project	With Project	Increase in Production
Paddy, <i>Maha</i>	196	226	30	1,162	1,328	167
Paddy, <i>Yala</i>	96	135	38	493	687	194
Other field crops	33	66	33	231	462	231
Sugarcane	0	7	7	0	643	643
Total^a	325	433	107	1,885	3,120	1,234

^a Numbers may not sum precisely because of rounding.

Sources: Asian Development Bank (assumed allocation); Mahaweli Authority of Sri Lanka (other).

16. The economic value of final outputs and agricultural inputs was estimated by converting financial prices into mid-2014 economic prices using conversion factors (para 9). Paddy yields were assumed to increase by 0.1 ton/ha per year in *Maha* until the end of Phase I and remain stable thereafter. Assumed paddy yields in *Yala* and other field crop yields are the actual yields realized in Systems B, C, and H during 2008-2012. The present value of the economic benefits from increased agricultural production are estimated at SLRs104.9 billion (Table 2), or about 90% of the total present value of the project's quantifiable benefits. This comprises SLRs41.3 billion from paddy, SLRs24.0 billion from sugarcane, and SLRs39.5 billion from other field crops. In terms of welfare effects, consumers in the project area gain SLRs40.9 billion and consumers

⁸ Mahaweli Consultancy Bureau Limited. 2012. *Economic Analysis in Financial and Economic Terms of the North Central Province Canal Project of Mahaweli Development Program*. Colombo.

in the rest of the country gain SLRs74.6 billion; producers in the project area gain SLRs61.4 billion, but in the rest of country lose SLRs72.0 billion owing to lower market prices.

Table 2: Results of Discounted Economic Surplus Analysis
(SLRs billion)

Item	Paddy	Sugarcane	Other Field Crops	Total
Project area				
Consumer surplus	15.1	10.0	15.8	40.9
Producer surplus	25.7	13.5	22.3	61.4
Total surplus	40.8	23.4	38.0	102.3
Rest of country				
Consumer surplus	25.5	5.7	43.5	74.6
Producer surplus	(25.0)	(5.1)	(42.0)	(72.0)
Total surplus	0.6	0.6	1.5	2.6
Total				
Consumer surplus	40.6	15.6	59.2	115.5
Producer surplus	0.7	8.4	(19.7)	(10.6)
Total surplus	41.3	24.0	39.5	104.9

() = negative.

Source: Asian Development Bank estimates.

17. **Valuation of economic benefits from increased provision of raw water for domestic, municipal, and industrial uses.** An important secondary economic benefit of the NCPCP is improved provision of raw water for DMI uses. By 2030, the project will provide 162 million cubic meters of raw water per year to five districts (the DMI benefit area), which will provide piped water to about 830,000 persons. The quantifiable economic benefits of the NCPCP with respect to raw water comprise:

- (i) **Economic benefits from improved sources of non-piped drinking water supply.** The proposed irrigation canals will provide additional and secure supplies of raw water to areas that are water-scarce. This will provide substantial benefits to persons living in the DMI benefit area (including those without access to piped water), mainly by lowering the cost of obtaining water for domestic use (easier access to water sources, no need to pay water vendors) and by lowering health costs (better quality water, more reliable supply of water). This is especially relevant given the high incidence of chronic kidney disease in the DMI benefit area, which is widely believed to be associated with the absence of safe and clean drinking water supply.
- (ii) **Economic benefits from improved sources of piped drinking water supply.** The project will enable water utilities in the DMI benefit area to provide piped water at a lower cost than without the project, mainly because of substantial cost savings on transmission mains, source works, and groundwater development. This would lower the cost of providing water and enable the government to achieve its coverage targets for the project area earlier than without the project.

18. The net present value (NPV) of the quantifiable benefits from improved sources of piped and non-piped sources of drinking water supply (including health benefits from reduced chronic kidney disease mortality) is about SLRs10.1 billion (9%) of the total NPV of the project benefits.

19. **Valuation of economic benefits from increased hydropower generation.** From mid-2018 to 2029, the project will result in an increase in hydropower generation of 18 gigawatt-hours (GWh) per year, and the economic benefits of the increase were estimated at SLRs382 million per year. From 2030 until the end of the project's lifetime in 2060, the

economic benefit is –SLRs892 million per year because hydropower generation will drop by 42 GWh per year after commissioning of the NCPCP. The NPV of the hydropower generation is estimated at SLRs200 million, or about 0.2% of the total NPV of the project's benefits.

20. **Economic benefits from increased food security (not quantified).** The economy of the agricultural benefit area is heavily dependent on irrigated agriculture, so droughts adversely affect food security in the area. According to a recent World Food Programme survey, the 2014 *Maha* drought doubled food insecurity in 15 of Sri Lanka's 26 districts (including all four districts in the agricultural benefit area), and increased the share of households with inadequate diets by 6%–18%.⁹ The NCPCP would improve food security in the agricultural benefit area and thereby potentially protect at least 70,000 households from malnutrition during a drought event.

21. **Economic benefits from increased internal security (not quantified).** The NCPCP is the capstone of the Mahaweli Development Program (MDP), which was formulated in 1968 to harness the hydropower and irrigation potential of the Mahaweli River. The civil war that ravaged Sri Lanka from 1983 to 2009 caused a major delay in implementation of the MDP, and impoverished most of the area that stands to benefit from the NCPCP. This applies especially to the districts of Anuradhapura and Vavuniya, which were located near the front line of the conflict, and where most of the project's beneficiaries live. Hence, the project will also serve the higher-level goals of restoring prosperity in a formerly conflict-affected area and help prevent the resumption of civil strife in that area.

7. Results

22. **Assessment of economic feasibility.** The economic net present value (discounted at the 12% assumed economic opportunity cost of capital) of the project is estimated at SLRs11.7 billion, indicating that the NCPCP is economically feasible. The same conclusion can be derived from the project's economic internal rate of return (EIRR), which is estimated at 13.1%. Increased agricultural production is the most important source of quantifiable economic benefits, accounting for over 90% of total benefits. Benefits from increased raw water provision account for most of the remainder. The project is also expected to generate significant nonquantifiable benefits, especially by accelerating the socioeconomic development of an area that was adversely affected by internal conflict since 1983.

23. **Sensitivity analysis.** Sensitivity tests were conducted by varying the project's investment cost, O&M cost, and benefits (Table 3). The results indicate the NCPCP's economic feasibility is sensitive to unfavorable changes to the investment cost and economic benefits. If the investment cost is 11.5% higher, or benefits are 11.2% lower, than in the base case, the EIRR will fall below 12%. The project's EIRR is relatively insensitive to changes in the O&M cost.

Table 3: Sensitivity of Project Economic Internal Rate of Return

Item	Change to Base Case	ENPV ^a (SLRs billion)	EIRR (%)	Switching Value (%)
Base case		11.7	13.1	
Investment cost	+10%	1.6	12.1	+11.5
O&M cost	+10%	10.7	13.0	+124.9
Benefits	–10%	1.2	12.1	–11.2

⁹ World Food Programme. 2014. *Sri Lanka - Rapid Drought Impact Assessment: Food Security and Livelihoods Affected by Erratic Weather, April 2014*. Rome.

ENPV = economic net present value, EIRR = economic internal rate of return, O&M = operation and maintenance.

^a Computed based on assumed economic opportunity cost of capital of 12%.

Source: Asian Development Bank estimates.

8. Distribution and Poverty Analysis

24. **Distribution of project benefits to stakeholder groups.** Three stakeholder groups were considered—government, agricultural producers, and consumers (agriculture and water). These groups were further disaggregated into the project region and the rest of the country. The government will finance the investment and O&M cost of the project. Because the project will not generate incremental revenue (with the exception of a small increase in revenue from hydropower), this stakeholder incurs a substantial net loss. Agricultural consumers and producers in the region will capture most of the net gains (Table 4). The poverty impact ratio of the NCPSP is estimated at 31.1%.

Table 4: Distribution of Project Benefits (SLRs billion)

Present Value of:	Government	Consumers		Producers		Total
		Project area	Rest of Sri Lanka	Project area	Rest of Sri Lanka	
Economic benefits						
Agricultural	0.0	40.9	74.6	61.4	(72.0)	104.9
Piped water	1.6	3.2	0.0	0.0	0.0	4.8
Non-piped water	0.0	5.3	0.0	0.0	0.0	5.3
Hydropower	0.2	0.0	0.0	0.0	0.0	0.2
Economic costs	(103.6)	0.0	0.0	0.0	0.0	(103.6)
Gains and losses	(101.7)	49.4	74.6	61.4	(72.0)	11.7
Benefits to poor	(6.9)	18.7	5.0	24.6	(5.5)	35.8
Poverty impact ratio^a						31.1%

() = negative.

^a Assumed poverty rates: national 6.9%, rural 7.6%, small farmers 40%.

Sources: Asian Development Bank, World Bank and International Fund for Agricultural Development estimates.

B. Financial Analysis

25. **Introduction.** The Upper Elahera Canal Project will be operated and maintained by MASL and the Minipe Left Bank Canal Rehabilitation Project and North Western Province Canal Project will be operated and maintained by the Department of Irrigation (DOI). These projects will not (and were not designed to) generate direct financial revenue that could be used to cover incremental O&M costs. Instead, the government will finance these costs from its own sources. This section presents estimates of the expected O&M costs of the investment program. It then presents estimates of the past and projected budgets of MASL and DOI, and concludes that they are likely to have sufficient financial resources to cover the expected O&M costs.

26. **Incremental operation and maintenance costs.** The cost of routine O&M mainly comprises pumping costs, cleaning costs, and minor repairs of project assets; and is estimated at 1.5% per year of the investment cost. In 2050, hydraulic steel structures and mechanical equipment may need to be replaced. The one-time replacement cost of the items is estimated at 10% of the investment cost. From 2015 until 2024, incremental O&M costs are about SLRs200 million per year. Upon completion of the MFF, these costs will increase substantially to about SLRs1.2 billion (all prices are expressed in mid-2014 financial prices). Table 5 shows incremental O&M cost estimates for selected years.

Table 5: Financial Cost of Incremental Operation and Maintenance
(SLRs billion, mid-2014 prices)

Item	2015	2020	2025	2030	2040	2050	2060
Routine O&M cost	0.2	0.2	1.2	1.2	1.2	1.2	1.2
Replacement cost	0.0	0.0	0.0	0.0	0.0	7.6	0.0
Total	0.2	0.2	1.2	1.2	1.2	8.8	1.2

O&M = operation and maintenance.

Source: Asian Development Bank estimates

27. **Government budgets.** The combined budget for the Ministry of Mahaweli Development and Environment (MMDE) and DOI almost doubled when expressed in mid-2014 financial prices, from about SLRs25.8 billion in 2011 to SLRs50.5 billion in 2014 (Table 6). The rise was mainly caused by a very substantial increase in capital expenditure, especially for the Uma Oya Diversion Project and the Moragahakanda and Kalu Ganga reservoir projects. It was conservatively assumed that budgets will continue to increase with general price inflation. Hence, in mid-2014 prices, the total budget will remain SLRs50.7 billion per year.

Table 6: Financial Cost of the Investment Program's Incremental Operation and Maintenance (SLRs billion, mid-2014 prices)

Item	2011A	2012B	2013E	2014MP	2015MP	2016AP
Recurrent expenditure	3.9	3.9	3.8	3.8	3.7	3.7
Capital expenditure	21.9	35.4	39.4	46.7	46.9	46.9
Total	25.8	39.3	43.3	50.5	50.7	50.7

Notes:

1. A = actual, B = revised budget, E = estimate, MP = Ministry of Mahaweli Development and Environment projection, AP = Asian Development Bank projection.

2. Numbers may not sum precisely because of rounding.

Source: Asian Development Bank and Ministry of Mahaweli Development and Environment estimates.

28. **Incremental Operation and Maintenance cost as a percentage of the Ministry of Mahaweli Development and Environment and Department of Irrigation budget.** ADB does not have a formalized method to assess the financial capacity of an executing or implementing agency to provide the minimum required subsidies for a project. For previously ADB-financed projects, it was assumed that an agency is financially capable to provide the required subsidies if these do not exceed a significant portion of the agency's total budget. Throughout the implementation and operation period of the investment program (2015–2060), the incremental O&M cost of the project will not exceed 2.3% of MMDE's and DOI's total budget (Table 7), except in 2050 (when hydraulic steel structures and mechanical equipment would need to be replaced). Both MMDE and DOI are therefore deemed to have sufficient financial capacity to cover the investment program's incremental O&M cost in all years except 2050 (when it may require additional financial support from the government to cover the project's one-time replacement costs).

Table 7: Financial Cost of Incremental Operation and Maintenance of the Investment Program (%)

Item	2015	2020	2025	2030	2040	2050	2060
Incremental O&M as % of existing budgets	0.4	0.5	2.3	2.3	2.3	17.3	2.3

O&M = operation and maintenance.

Source: Asian Development Bank estimates.