ECONOMIC ANALYSIS

A. Introduction

1. Tamil Nadu recorded impressive annual economic growth that averaged 6.4% during 2013–2019.[1] The largest share of this growth was contributed by the service sector, which is mostly concentrated in urban areas. The state ranks first in India in terms of urbanization (48.4%) and third in urban population size.[2] The Vision Tamil Nadu 2023 established by the Government of Tamil Nadu underlines the need for urban infrastructure improvement to manage accelerated urbanization.[3] The proposed project aims to develop integrated flood management in the Chennai–Kosasthalaiyar basin.

B. Rationale

2. The rationale for the involvement of the governments of India and Tamil Nadu is sound, as the project will focus on providing basic urban services and improving climate resilience, where a natural monopoly exists, and the services are public goods managed by the government. As a nonrevenue-earning project with large up-front capital investment costs, it is not viable for private sector's investment, which justifies the state government's involvement in the project.

C. Demand Analysis

3. Inadequate and ineffective drainage network assets and management in the Kosasthalaiyar Basin in Chennai lead to more frequent, intense, hazardous, and destructive flooding, which is exacerbated by the effects of climate change. About 0.4 million people living within 15.85 square kilometers (km^2) (12.4% of the total project area) experience recurrent flooding. Regular flooding, along with frequent severe cyclonic activities in the project area, are attributable to the failure of the Kosasthalaiyar River and other drainage systems, with an average of 6 flooding days per year in the project area.[4] Less catastrophic flooding occurs regularly in low-lying areas of the project area because of the inadequacy or nonfunctioning of the local drainage infrastructure, causing extensive damage to structures. Damage to public properties in low-lying areas, economic loss through decreased working days, the closure of commercial units during floods, and additional health expenditures for households are regular flood-related problems in the project area.[5] These problems, along with the increasing urban population, lead to strong demand for the proposed project. Proposed integrated flood management under the "with project" scenario will address these flood-related problems, benefiting the project area population.

4. Uncertainty about the spread of coronavirus disease (COVID-19), including the duration of the ongoing second wave and the trajectory, continue to affect national and state economic growth. In early 2021, the Reserve Bank of India forecast economic activity to normalize gradually in fiscal year (FY) 2022 (ended March 2022) and stabilize from FY2023.[6] However, the economic

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1 Reserve Bank of India. 2019. *Handbook of Statistics on the Indian Economy, 2018–19*. Mumbai.
2 Government of India. 2011. *Census of India 2011*. Delhi.
3 Government of Tamil Nadu. 2012. *Vision Tamil Nadu 2023: Strategic Plan for Infrastructure Development in Tamil Nadu*. Chennai.
4 Discussion with Storm Water Department officials of the Greater Chennai Corporation (GCC) in October 2020.
5 Includes partial or full damage to houses, commercial and industrial units, roads, bridges, public buildings, trees, and public utilities. The average flood damage cost in the severely affected low-lying areas is estimated at ₹50 million/km^2. 59% of households are in the flood affected area and the remaining 41% of households lack the adequate drainage system.
6 Reserve Bank of India, 2020. *Monetary Policy Report, April 2021*. Mumbai.

fallout of the ongoing second wave of COVID-19 is likely to postpone the expected stabilization of the economy by a few more quarters in 2022.

D. Alternative Analysis

5. Alternative designs were assessed for life cycle cost analysis in the detailed project report (DPR) for the stormwater drainage component.[7] Delineations of 11 watershed drainage zones based on the existing drainage system, appropriate engineering solutions with the support of multidisciplinary data for rainfall and flood levels, the use of geographic information system tools, and Bentley Storm computer-aided design V8i software have been used to determine the optimum flood management solution. The selection of types of conduits and channel materials—including rectangular reinforced cast concrete and removable precast slabs for roadside stormwater drains, and reinforced cast concrete open channels for the larger discharges to suit the natural drains—was detailed in the DPR after considering alternatives and available design specifications. The above options were selected, taking into account economic, environment, and social safeguard issues; the availability of materials; and ruling specifications during the project design.[8] Following the comparison study, the proposed project was found to be the most economically viable option for meeting demand in terms of scale, technology, and timing.

E. Cost–Benefit Analysis

6. The economic analysis assessed the project's economic viability by estimating its economic internal rates of return (EIRRs) and net present value in accordance with Asian Development Bank guidelines, through a flood simulation model using the probability distribution function based on the different flood return periods.

7. **Economic costs**. The following assumptions were made for the economic analysis: (i) all costs were expressed in 2020 constant prices and converted at $1.00 = ₹74.80; (ii) projections covered 2021–2050, including 7 years of construction (2021–2027); (iii) all costs, including capital, capital replacement, and operation and maintenance (O&M) expenditure, were valued using the domestic price numeraire; (iv) tradable inputs and unskilled labor costs were further adjusted by a shadow exchange rate factor of 1.04 and a shadow wage rate factor of 0.85;[9] and (v) the economic opportunity cost of capital was assumed to be 6% in real terms.[10]

8. By adding all the economic costs by component, estimated separately (foreign, unskilled labor, and remaining local costs), the economic cost was derived, translating into 79.9% of the project cost (Table 1).

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[7] GCC. 2020. *Detailed Report for Providing Integrated Storm Water Drains for Kosasthalaiyar Basin in Greater Chennai.* Chennai.

[8] It follows Central Public Health & Environment Engineering Organisation specifications for storm water drain project designs.

[9] The shadow exchange rate factor is calculated as follows: 1+ $26.30 billion (average customs duties during 2015–2019)/[$290.2 billion (average exports during 2015–2019) + $429.1 billion (average imports during 2015–2019)] = 1.04. Source: Government of India, Ministry of Finance. 2019. *Receipt Budget 2016–2017 to 2018–2019*. Delhi. The shadow wage factor of 0.85 was estimated by dividing $4.1 per day (unskilled labor cost, using the practiced labor wage rate paid by contractors to unskilled laborers) into $4.8 per day (minimum wage for unskilled labor in Chennai District from July 2020).

[10] Given the project's intended beneficiaries, the economic opportunity cost of capital rate used is 6%, as suggested for social sector projects by Asian Development Bank. 2017. *Guidelines for the Economic Analysis of Projects*. Manila.

Table 1: Details of Project Costs

Subproject	Capital Costs ($ million)		O&M Costs[a] ($ million)		Implementation	O&M
	Financial Costs	Economic Cost[b]	Financial Costs	Economic Cost[b]		
Integrated flood management	470.5	375.9	72.6	58.0	2021–2027	2028–2050

O&M = operation and maintenance, : $1.00 = ₹74.80
[a] An annual O&M cost increase of 0.5% was considered for additional maintenance requirements.
[b] Excludes taxes and duties, price contingencies, and financing charges.
Source: Asian Development Bank estimates.

9. **Economic benefits**. On completion of the construction of 588 kilometers (km) of new stormwater drains, and the rehabilitation of 175 km of stormwater drains, the project will address the recurrent flood and drain related issues in the Chennai–Kosasthalaiyar basin, benefiting 4.7 million people in 2028. Of the total population of 4.7 million (2028) living in the project area of 127.76 km^2, 40.3% or 1.9 million people (equivalent to 470,000 households) will live in flood-prone areas (80 km^2). The project area population is expected to grow at 2.9% annually.[11]

10. Flood areas with flood levels greater than 0.5 meter under different return periods are prone to damage to assets including houses, public buildings, roads, bridges, trees, and utilities; and considered for direct flood damage impact. The flood damage cost was estimated based on damage during the 2005 rainfall, which is the recent maximum rainfall (2,431.5 millimeters). The estimated average flood damage cost per km^2 was ₹53.4 million in 2020 prices.[12] This damage cost is estimated for different return periods and has been adjusted for exceedance probabilities to derive the total expected damage cost. With the project, the cost of flood damage would be substantially avoided up to a 2-year return period and partially avoided for a higher return period.

11. In addition to flood damage costs to assets and physical infrastructure, other benefits considered include (i) savings in the residential flood maintenance cost, (ii) savings in road maintenance, (iii) income loss to residents during flooding days, and (iv) income loss to commercial units. These other benefits for different return periods are also included in the probability model, along with the direct flood damage benefits. The overall net benefits for different return periods, along with the exceedance probability, are shown in Tables 2 and 3 for the current period (2020).

Table 2: Details of Cost Computation for Different Return Periods

Return Period (year)	Flood-Affected Households, 2020 (direct)[a]	Direct Flood Damage Cost		Other Flood Impact Costs (₹ million)				Total Costs (without project)
		Area affected (km^2)[b]	Amount (₹ million)[c]	Residential Flood Maint.[d]	Road Maint.[e]	Income Loss to Residents[f]	Income Loss to Commercial[g]	
1	69,735	7.93	423.0	200	73	585	188	1,470
2	73,780	15.85	846.0	424	155	1,238	1,238	3,901
5	80,294	21.14	1,128.4	615	226	1,797	1,797	5,563
10	92,451	34.98	1,867.2	1,172	430	3,423	3,423	10,316
25	122,568	51.01	2,722.8	2,267	831	6,619	6,619	19,057
50	285,610	62.26	3,323.3	6,447	2,362	18,824	18,824	49,781
100	1,169,769	68.38	3,650.0	28,999	10,627	84,676	84,676	212,628

km = kilometer, km^2 = square kilometer, Maint. = maintenance, ₹ = Indian rupee
[a] Severe and moderate flood-affected categories are considered for the direct flood-affected category.

[11] The projected population during the analysis period is adopted from GCC. 2020. *Detailed Report for Providing Integrated Storm Water Drains for Kosasthalaiyar Basin in Greater Chennai.* Chennai.
[12] The average flood damage cost of₹40 million/km^2 was estimated on the basis of: (i) DPR prepared for stormwater drain for Adyar and Cooum Basin for the GCC in 2015 under World Bank Assistance, and (ii) discussion with GCC officials. With 5.9% inflation, the 2015 priced damage cost per km^2 was escalated to 2020 at ₹53.4 million/km.^{2}

[b] Estimated from the data available in the detailed project report (2020).
[c] An estimated direct flood damage cost of ₹53.4 million/km^2, adopted from the detailed project report (2020), is used.
[d] Savings in the annual household flood maintenance cost = ₹2,000/household/year ($26.7/household/year). Source: focus group discussions (2020) carried out in the project area.
[e] Some 50% of the annual road maintenance cost of ₹0.19 million/km^2 for 313.5 km of flood damaged roads and 25% of the maintenance cost of ₹0.19 million/km^2 for 891.5 km of drainage-affected roads is saved because of project intervention (sources: discussion with Greater Chennai Corporation officials; and detailed project report [2020]).
[f] ₹1,080 (average daily household income) x 5 days (annual working days lost during flooding) = ₹5,401/household/year ($72.2/household/year), benefiting 108,310 flood-affected households (source: focus group discussions [2020] carried out in the project area).
[g] Income loss to commercials units = 18,810 (number of units available in the 313.5 km length of flood-affected roads) x ₹4,000 (average daily earning per unit) x 5 flood days in a year based on the outcome of focus group discussions and discussion with Greater Chennai Corporation officials x 50% of earnings affected during flood days = ₹188.1 million/year ($2.5 million/year) (source: detailed project report [2020]).

Source: (i) University of Madras, 2017. 'CDRP – Climate Disaster Recovery Process in Chennai: Final Summary Report,' Chennai; (ii) discussions with Greater Chennai Corporation officials; (iii) Focus Group Discussions carried (FGDs) out in 2020 with project beneficiaries; (iv) Updated detailed project report (DPR) (2020); (v) Storm Water Department, Greater Chennai Corporation, 2020; and (vi) ADB TNUFIP, Baseline Survey June–July 2017 and its projection.

Table 3: Details of Overall Benefit Computation with Exceedance Probabilities

Return Period (Year) (i)	**Frequency (Year) (ii)** (ii)=(i)/100	**Per Year (iii)** (iii) = (ii)/100	**Probability (iv)** (iv) = value in each column (iii)/total in (iii)	**Exceedance (v)** (v) = difference between each occurrence in (iii)	**Average Annual Benefits** (₹ million)[a] **(vi)** (vi) average of net benefits of each occurrence, calculated from benefits table	**Expected Annual Benefits with Project** (₹ million) **(vii)** (vii) = (v) * (vi)
1	100	1.00	0.53	0.00	1,470	-
2	50	0.50	0.27	0.50	2,686	1,343
5	20	0.20	0.11	0.30	4,709	1,413
10	10	0.10	0.05	0.10	7,222	722
25	4	0.04	0.02	0.06	10,878	653
50	2	0.02	0.01	0.02	19,028	381
100	1	0.01	0.01	0.01	46,557	466
	187	**1.87**	**1.00**	**0.98**		**4,977**

$1.00 = ₹74.80
[a] Net benefit after considering both "without project" and "with project" scenarios.
Source: Asian Development Bank estimates.

12. **Results of cost–benefit analysis.** The results of the cost–benefit analysis show that the project is economically viable, with an EIRR of 13.5%, higher than the minimum required economic opportunity cost of capital of 6.0% (Table 4).

Table 4: Summary of Cost and Benefit Streams
(₹ million)

Year	**Economic Capital Cost**			**Economic O&M Cost**		**Economic Benefits**		**Net Benefit**
	10-year life (30%)	**20-year life (40%)**	**40-year life (30%)**	**Total**	**O&M**	**Total**	**Total**	
2021	808.7	1,078.2	808.7	2,695.6	0.0	0.0	0.0	(2,656.6)
2023	1,943.6	2,591.5	1,943.6	6,478.6	0.0	0.0	0.0	(6,478.6)
2025	1,201.2	1,601.6	1,201.2	4,004.0	0.0	0.0	0.0	(4,004.0)
2027	149.7	199.6	149.7	499.1	0.0	0.0	0.0	(499.1)
2028	0.0	0.0	0.0	0.0	230.8	230.8	6,236.0	6,005.2
2036	556.6	0.0	0.0	555.6	249.9	249.9	7,814.1	7,008.6
2044	1,858.6	2,478.1	0.0	4,336.7	270.6	270.6	9,791.6	5,184.2
2050	0.0	(10,121.6)	(3,584.7)	(13,706.4)	287.3	287.3	11,596.6	25,015.7
Total	**25,304.1**	**12,370.9**	**4,849.9**	**42,524.9**	**5,935.3**	**5,935.3**	**199,030.2**	**150,570.0**

Year	Economic Capital Cost			Economic O&M Cost		Economic Benefits		Net Benefit
	10-year life (30%)	20-year life (40%)	40-year life (30%)	Total	O&M	Total	Total	
NPV	**12,283.7**	**10,493.2**	**4,446.3**	**28,088.6**	**1,943.9**	**1,942.9**	**62,206.5**	**32,175.0**
EIRR								**13.5%**

( ) = negative, EIRR = economic internal rate of return, NPV = net present value, O&M = operation and maintenance.
Note: The salvage value at the end of analysis period and the replacement cost during the analysis period are considered.
Source: Asian Development Bank estimates.

13. **Sensitivity analysis.** Sensitivity analysis for the project was conducted to assess the effect of adverse changes in key variables (Table 5). The analysis revealed that the results are satisfactory for all scenarios, with an EIRR greater than the minimum required (6%). The project's economic viability increases if unquantifiable benefits such as environmental improvements, industrial development, and savings in health expenditures are included in the analysis.

Table 5: Economic Internal Rate of Return and Sensitivity Analysis

Scenario	EIRR (%)	ENPV ($ million at 6%)	Switching Value (%)
(i) Base case	13.5	430.1	
(ii) Construction cost increase (20%)	11.6	355.0	115.0
(iii) O&M cost increase (20%)	13.4	425.0	1,656.0
(iv) Benefit decrease (–20%)	11.0	263.8	52.0
(v) Delay in operation by 1 year	13.2	375.2	
(vi) Combined worst case scenario ([ii] to [v])	8.5	127.8	
(vii) Decrease in population growth rate (–20%)	11.7	298.1	
(viii) Lower flood incidence area (–20%)	13.0	397.7	

EIRR = economic internal rate of return, ENPV = economic net present value, O&M = operation and maintenance.
Note: $1.00 = ₹74.80.
Source: Asian Development Bank estimates.

F. Distribution Analysis and Poverty Analysis

14. Distribution analysis was used to calculate the poverty impact ratio, i.e., the proportion of project net benefits accruing to the poor. To distribute the net economic benefits, the stakeholders are grouped into households, unskilled labor, urban local bodies, and the government. The analysis shows that the poverty impact ratio is 13.2%. Considering that the proportion of slum households living in Chennai City is 11.6%, the proposed project is expected to benefit the poor considerably.[13]

G. Sustainability Analysis

15. As this is a nonrevenue-generating project, no project-specific revenue stream would cover the O&M expenses, requiring historical and future cash flow analysis of the Greater Chennai Corporation (GCC), which is responsible for O&M. This analysis has revealed that (i) the GCC has high dependence on own source income, which is positive from a financial sustainability perspective; (ii) revenue grants and subsidies from the Government of Tamil Nadu is adequate to improve the GCC's operating revenues; (iii) the GCC has maintained an operating ratio of less than or equal to one from fiscal year FY2015–FY2019; and (iv) the GCC has the capacity to operate and maintain the project. The Output 3 of the proposed project will support for the GCC to ensure sustainable O&M of the assets.

[13] GCC. 2020. *Data Provided on the Slum Population in Chennai City in 2020.* Chennai.