

**15. ECONOMIC AND  
FINANCIAL EVALUATION**

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### **15.1 Economic Evaluation**

The economic evaluation method applied in this study is based on the principal known as "with and without". This means to analyze and examine differences of assumed economic effectivity in the execution of projects between "changes of national economy when the project is executed (with)" and "national economy assumed when the project is not executed (without)" so as to judge appropriateness of the project by net effects being induced by the execution of the project.

To do this correctly, cost - benefit analysis is conducted by using the discounted cash - flow method on measurable effects in monetary terms (direct benefit) to obtain the internal rate of return (IRR), net present value (NPV) as well as the cost benefit ratio (B/C) to evaluate the appropriateness of the project. As for a net effect assumed which is difficult to measure, the indirect benefit is analyzed by a qualitative method to supplement evaluation of appropriateness of the project.

Cost - benefit analysis on the subject project in this study is conducted on various alternatives delineated in Scenarios 1 - 4 that are mentioned in Chapter 8. Transferable benefit items such as tax, interest, subsidies, etc., and price escalation (rate of inflation) were excluded from the calculation of costs (out-flow) and benefits (in-flow) to prepare projected cash flow. The project term applied for the above mentioned evaluation was set as 30 years from the date of commencement. The salvage value of assets is assumed to be remain for 30 years within the project term and is calculated as in-flow thereafter.

#### **(1) Direct Economic Benefit**

##### **a. Traveling Cost Saving Benefit**

The cost of navigation in the case of project execution (with case) and that of land transport by vehicles in the case of no execution (without case) are compared and the difference is adopted for economic evaluation as Traveling Cost Saving Benefit.

As transporting costs for river navigation per ton per km unit differs by scenario, the costs obtained through the analysis in Chapter 7 is used for further studies. The on-land travelling costs of vehicles determined from "INDICADORE" issued by Brazil Truck Association was used for the evaluation of the unit cost benefit for river navigation. The traveling cost saving benefit was obtained by calculating the difference of traveling costs between the case of "with" and of "without", based on the above unit cost benefit and on the predetermined transport volume by the scenarios in Chapter 8. The results are summarized in Table 15.1.1.

**Table 15.1.1 Competing Traveling Costs and Traveling Cost Saving Benefits**

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Transport Cost of Ships per ton km	US\$ 0.0281	US\$ 0.0249	US\$ 0.0168	US\$ 0.0182
Transport Cost of Trucks per ton km	US\$ 0.067 - 0.081	US\$ 0.067 - 0.081	US\$ 0.067 - 0.081	US\$ 0.067 - 0.081
Traveling Cost Saving Benefit in 2010	US\$ 22,442,395	US\$ 21,870,714	US\$ 20,511,393	US\$ 23,085,300

Note : See Table 15.1.2 for the transport cost of truck per ton-km.  
 : See Tables A7.1.1 to A7.4.3 in Appendix 7 for the traveling cost saving benefit in 2010.  
 : See table 9.3.2 for the transport cost of ships per ton-km

**Table 15.1.2 Transport Costs of Trucks per ton-km**

	Paved Road		Gravel Road	
	Truck 1 (Less 10 t)	Truck 2 (10 t)	Truck 1 (Less 10 t)	Truck 2 (10 t)
Fixed Cost per km	443.4	477.0	443.4	477.0
Running Cost per km	309.0	353.0	464.0	530.0
Total (Cr\$/km)	752.4	830.0	907.4	1,007.0
Average Load (ton)	5	8	5	8
Traveling Cost per ton km	150.5	103.8	181.1	126.0
Average Cost (Cr\$/ton km)	127.2		154.0	
Average Cost (US\$/ton km)	0.067		0.081	

Source : INDICADORE DO TRANSPORTE, May 1994 for Fixed and Running Cost

### b. Benefit of Agricultural Production

According to production forecasting by the regional agriculture bureau, there will be considerably higher growth rate in the upper stream region comparing with the present condition. In particular, the growth rate of rice and soybean production is prominent. If this forecast is achieved, land transport alone will not be able to handle the required transport demand not only in the subject region but also in other regions and also the demand of soybean exports from the ports. In addition, the development and promotion of river navigation will contribute to the increase in agricultural productivity.

In this context, the implicit benefit of river navigation contributing to agricultural productivity can be considered in the case of "with" for the study. Unfortunately, a quantitative analysis for confirming such benefits can hardly be achieved from the available data so far collected. Under such circumstances, soybeans were focused, among the agricultural products, for they have been a typical product creating exporting revenues. Fifty percent of national net income (farm gate price - production cost) is deemed as an agricultural production benefit and accounted as a benefit (in-flow).

Tables 15.1.3 and 15.1.4 show the estimated agricultural production benefit and net profit of soybeans per ton, respectively.

**Table 15.1.3 Agricultural Production Benefit**

Unit : 1000 US\$

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Transport Section	To Parnaíba	To Teresina	To Floriano	To Teresina (Rainy season)
Agricultural Production Benefits (until year 2003)	1,477	1,477	-	1,477
Agricultural Production Benefit (until year 2010)	4,350	4,350	-	4,350

Source : JICA Study Team

**Table 15.1.4 Net Profit of Soybeans per ton**

Output per ha	Farm-gate Price per ha	Rough Profit per ha	Production Cost per ha	Net Profit per ton (R\$/ton)
2.7 ton	168.20	454.14	390.16	24

Source : Regional Agricultural Bureau

As described above, the benefits of traveling cost saving and of agricultural production are calculated as in-flow items for cost benefit analysis on an annual basis from the year 2003 when river navigation is expected to commence.

## (2) Project Cost and Cost for Maintenance, Management and Shipping Operation

The Project cost (initial investment cost) is composed of that for the resumption of Boa Esperança Lock, construction of river ports, installation of navigation aids and ship building as well as for maintenance, management and shipping operations associated with these major items as estimated in Chapter 14.

However, it is to be noted that the relevant costs in Chapter 14 are based on the present market price. These figures were used for the financial evaluation in this study, but the economic price, which was converted from these figures by the application of shadow rates taking into account the present national economic situation of Brazil and the socio-economic environment of Piauí region, was used for the economic evaluation.

Conversion parameters applied to this study were pre-determined by sectors as follows :

Accounting Rate of Interest	: 0.10 (see note 1, below)
Conversion Rate by Sectors	
Direct Construction Cost	: 0.80
Cost of Material and Equipment	: 1.00
Cost of Ship building	: 0.75
Engineering Cost	: 0.90
Labor Cost in Ship Operation	: 0.80
Office Administration Cost	: 0.80

The annual project costs and operation and maintenance, abbreviated as O&M hereafter, cost converted by the above mentioned rates, are used to prepare a projected cash flow for the cost benefit analysis based on the proposed construction schedule and navigation

operation plan. Table 15.1.5 shows the results of the project costs and O&M costs for the economic analysis (see Tables A7.5.1 to A7.5.4 in Appendix 7 for details of the projected economic cost).

Note 1 : In Brazil, an accounting rate of interest (ARI) used as a national parameter is normally 0.12. However 0.10 is adopted here, considering the present social and economic condition of Piauí region.

**Table 15.1.5 Economical Project Cost and O/&M Cost in 2010**

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Economical Project Cost	US\$ 119,700,000	US\$ 102,500,000	US\$ 77,400,000	US\$ 96,700,000
O&M Costs in 2010	US\$ 20,714,960	US\$ 15,419,000	US\$ 10,609,700	US\$ 12,034,600

### (3) Cost Benefit Analysis

The economic internal rate of return (EIRR) in each scenario was estimated based on the cash-flow of benefit and cost stream. Table 15.3.6 shows the results of the estimation (see Tables A7.6.1 to A7.6.4 in Appendix 7 for the projected cash-flow in each scenario).

**Table 15.1.6 Estimated EIRR in Each Scenario**

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
EIRR (%)	Minus	6.56	8.54	11.02

Source : JICA Study Team

Judging from the above mentioned results, only Scenario 4 is considered to be feasible assuming a parameter on opportunity cost of initial investment as 0.10.

The net present value (NPV) for Scenario 4 is estimated as US\$ 7,807,152 and the cost benefit ratio (B/C) is calculated as 1.05. The NPV is thought to be low in comparison with the amount of the initial investment and it can be judged that the superiority of this project scenario is not identified among the others.

However, it is difficult to clearly define a distinct difference between the case of project execution, "with", and of no execution, "without", concerning the explicit benefit to agricultural production only from the prescribed examination. The increased soybeans' production could be transported on-land through the railway system, via Imperatriz or Teresina. As a consequence, the benefit will not be counted as concerned to the project, but the traveling cost saving benefit alone will be in the analysis. In this case the benefit is deemed to be an item for the project evaluation. The results of the analysis are given below. As shown, its EIRR does not reach to the national parameter of 0.10.

The EIRR, without including agricultural benefits into the evaluation, is 7.86 %.

#### (4) Sensitivity Analysis

Since the EIRR of Scenario 4 shows 11.02 %, the sensitive analysis is conducted only for the out-flow (cost) of Scenario 4.

As for analysis of the cost aspect, sensitivity analysis is conducted, assuming a 5 % reduction in the construction and associated costs with invariable costs of maintenance, management and operation.

The results of this analysis are tabulated in Table 15.1.7. As shown therein, a considerable increase in feasibility is hardly recognized.

**Table 15.1.7 EIRR, NPV, and B/C in Scenario 4**

	Original Case in Scenario 4	5 % Reduction in Construction cost of Scenario 4
EIRR	11.02%	11.59%
NPV	US\$ 7,807,152	US\$ 11,725,641
B/C Ratio	1.05	1.08

Note : See Table A7.6.5 in Appendix 7 for the projected cash flow

#### (5) Indirect Benefit

The following positive effects associated with the project can be expected from the foreseeable indirect benefits through the execution of the development plan in the Parnaíba river.

##### a. Regional Development Effect

The urbanization phenomena will appear especially near the river ports in the coastal zone of the Parnaíba river in the south-western area. This will benefit the distribution of the population and settlement of inhabitants, which will alleviate the regional economic imbalance.

##### b. Increased Employment Opportunities

Not only during the construction period, but also in the successive period of urbanization in the cities, the creation of additional commercial businesses along the river ports will be achieved through such regional development. These effects are expected to increase the opportunities of employment. Needless to say, settlements of workers in the ports can also be expected.

##### c. Consolidation of Administrative Functions

The new transport system opening up the upper stream region of the Parnaíba river by the resumption of the Boa Esperança Locks will contribute not only to increased cargo transport but to close and frequent interchanges of personnel that may lead to an appropriate consolidation of administrative functions on the local governments concerned.

## **15.2 Financial Evaluation**

In the actual implementation of the project, it is quite important to examine whether the project is manageable or not, in both terms of regional and national financial management.

Scenario 4, which is previously considered economically feasible, will have further detailed evaluations carried out.

Tariffs of transport for river navigation expressed in a unit of per ton-km are estimated in comparison with the present transporting costs of competing systems, such as by vehicles, or by trucks, based on the transporting costs in Scenario 4 including its capital investment. Having obtained the corresponding annual income by multiplying these charges by the estimated cargo volume, it is checked whether this would cover the project cost including maintenance and management by discounted cash-flow method. If the financial internal rate of return (FIRR) delineated from such process exceeds the national parameter (NP), it can be referred to as long term banking interest prevailing in Brazil. In such case, the project can be considered financially feasible.

### **(1) Determination of River Transport Charge**

As discussed in Chapter 7, the transporting cost of river navigation including the capital costs applicable to Scenario 4 is 0.0272 US\$/ton/km.

On the other hand, the transporting charges by trucks in the Piauí region, which were studied through the cargo volume analysis in Chapter 4, ranges from 0.02 to 0.04 US\$/ton-km at present.

From the above, an advantage of river navigation compared with transport by trucks will possibly be lost, if the charge in the navigation is set more than 0,0272 US\$/ton-km. This limiting value is adopted for the project implementation without loss of its superiority over the on-land transport measures.

### **(2) Financial Evaluation**

The possibility of repayment is examined, based on the total estimated project cost and maintenance and management costs as well as applicable charges mentioned in the above, and the expected revenue from river navigation in Scenario 4. As FIRR shows a minus figure, the project is considered not feasible. Additional examination was conducted to find an applicable solution by setting the following 4 questions.

Case 1 : How high does the unit transport charge (per ton-km) have to be so as to repay the total project cost including its operation?

Case 2 : What will be the FIRR, if the transporting revenue from the competitive charges against by trucks can cover the cost of ship building and O&M?

Case 3 : How much is an appropriate charge just to cover the cost of ship building and associated O&M costs?

Case 4 : If the competitive charge against transport by trucks, i.e., 0.0272 US\$/ton-km, is applied, what subsidies for ship building would be needed?

Table 15.2.1 shows the results of the examination reflecting the above questions.

**Table 15.2.1 FIRR in Scenario 4 in Each Case**

Case	FIRR	Possible Solution
Original Case in Scenario 4	Minus	
Case 1	11.26 %	Charge per ton km is to be US\$ 0.0816
Case 2	2.91 %	Impossible to repay
Case 3	11.89 %	Charge per ton km is to be US\$ 0.0354
Case 4	11.78 %	50 % of the cost for ship building is to be subsidized

Note : see Tables A7.7.1 to A7.7.5 in Appendix 7 for the project cash-flow

In accordance with the above mentioned results, it shows that unless the cost by trucks is increased to 0.10 US\$/ton-km or more, the feasibility of the project cannot be achieved. Consequently, if it is decided to execute the project under the present conditions, all the costs for resumption of Boa Esperança Lock, construction of the river ports and cost for the installation of navigation aids are to be borne by public expenditure that does not require repayment. In addition, 50 % of the cost for ship building is to be provided as a subsidy of the government. Only such action can make this project viable.

### 15.3 Comprehensive Evaluation

A comprehensive examination on the preceding evaluations is summarized as follows :

The project may be considered as one of the national inputs for opportunity cost, although the results of the quantitative analysis on direct benefit of the project indicate relatively low EIRR values of 11.02 % or 7.86 %. Even if there is no sign of significant superiority in the project, it can be judged that the project is still feasible and economically viable when considering various positive effects counted as indirect benefits in the qualitative examination.

It should be considered that inherent difficulties of the project still exists in the financial and operative aspects. The substantial reason for this is a limitation imposed on the shape and type of vessels able to manoeuvre in the Parnaíba river because of its natural conditions. Resulting river navigation is obliged to transport limited cargoes and so reflects the incapability of offering a lower transporting cost.

To conclude the above, a policy formulation based on careful consideration of financial matters is imperative in determining whether to execute this project or not.



## **16. ENVIRONMENTAL STUDY**

## 16. ENVIRONMENTAL STUDY

Data collection, bibliographic research, study on the existing reports, and a field reconnaissance survey for the environmental survey were carried out from September to October, 1993 on a local contract basis in order to evaluate the possible impacts caused by the development of river transportation of the Parnaíba river basin, and to establish the countermeasures for future developments.

The impact analysis and evaluations are made by the "matrix-step" method ; a cause-effect relationship. The relationship between fifteen (15) relevant environmental attributes and seven (7) impact generating actions were utilized for the "matrix-step" method.

Environmental survey and assessment shows that no serious damage will be imposed to fauna or flora representatives, and that there are no endangered species subject to the direct consequences of the Navigation Plan. Besides these aspects, it was noted that the fisheries of the basin will not be affected by navigation activities due to the present low significance of fishing activities. The following is a summary of the studies.

### 16.1 Environmental Problems

The environmental study pointed out several problems correlated to bad land and soil usage and agricultural and livestock practices, which could impose future problems for the region, even if they are not directly linked to the navigation development, but could be worsened as a consequence of disorganized development.

In view of the navigation development plan for the Parnaíba river basin, the impact survey clearly showed that the impacts and problems that will arise directly from the waterway implementation and eventually its operation, will be — *in general* — temporary, of small magnitude and spatially very small in coverage, mainly those resulting from specific construction actions since large scale dredging works on the channel is not planned.

From the discussions and analyses for the study, a general scenario can be outlined for the Parnaíba river basin, as stated below:

- The biggest effects of waterway operation, especially those that will result from the probable intensification of economic exploitation of extensive areas along the main riverbanks, will be of great magnitude and coverage, basically due to the extremely out of date socioeconomic, political and cultural patterns that still predominant all the region.
- The navigation development will be able to extend human occupation along the marginal areas of Parnaíba and Balsas River valleys, as well as in the plateaus of Southwest Piauí and Southeast Maranhão, with acceleration and amplification of the deforestation processes and consequent deterioration and environmental weakening of marginal areas along river valleys, borders and steep areas.
- Construction of new roads for production flow may affect hydraulic conditions of minor drainage systems due to obstructions, landslides along river banks, etc., with increasing erosion processes, which will be intensified by burning practices, thus

affecting greater areas than at present. As a consequence, obstruction of river beds will be intensified, thus bringing problems for the future waterway traffic.

## **16.2 Matrix Examination and General Consideration**

From the matrix examination, it may be observed that most impacts will affect surface water quality, but in general temporary effects, which will last as long as the causing actions last. However, other environmental factors are also important, as the matrix shows, which are likely to be changed and cannot be disregarded.

On the other hand, the study also points out the presence of significant impacts over socioeconomic factors. This shows that the navigation plan could originate important changes to the region in general, not only affecting the natural resources. Moreover, the study also shows that the future consequences of the Navigation Development Plan will be closely related to the type of occupation and economic activities that may be developed in the region, which in turn could be conditioned to a higher or lower degree by the development of navigation.

The present practices of intensive agriculture become highly questionable, considering that:

- a. The bad use of soil making them prone to intensive erosive processes;
- b. An increase of water pollution is observed, due to excessive use of pesticides and fertilizers;
- c. The incorrect use of irrigation in the plateau area together with swamp drainage, associated to the destruction of riparian forests can, in the long run, jeopardize the regional water balance;
- d. The uncontrolled deforestation, linked to the excessive use of pesticides and monoculture implantation provokes ecological imbalances, with consequent increase of plague incidence;
- e. The intensification of burning frequency, mainly at the end of drought periods, leads to loss of soil protection, which is highly susceptible to erosion, thus diminishing its potential for production.

Consequently, it is important to consider that new management practices in the savanna areas should be established, but, prior to this, it is necessary to know in detail the peculiarities of the environment so that it can be provided to the society, without destroying its natural inheritance.

## **16.3. Conclusion and Recommendations**

Thus, the analysis of the environmental study, in the present stage of knowledge and information about the waterway shows that certain precautions are necessary as regards a region *with a high degree of environmental fragility*.

Also, the development actions which will bring new inhabitants and new economic activities to Piauí, could be responsible for making worse the present conditions of environmental deterioration, which may jeopardize the integrity of the waterway itself.

However, these considerations have in mind a longer period than a more immediate planning view, being only a warning for the future. The study does not reveal more serious problems other than the ones that can be predicted in the light of current socio-environmental conditions of Piauí today.

Studies show that there are no animal or plant endangered species that *could* be affected by the necessary actions for implementation of the plan. Thus, one can conclude that the plan will not jeopardize the natural environment. However, the proponent must be acquainted of the fact that, at least for the regional vegetation, it is not secure to make any conclusions about rare or endangered species due to the small amount of available studies and information.

As for legal aspects, attention must be given to Brazilian laws concerning the environment, in order that any project or action that may affect the environment must be submitted for the scrutiny of the State authorities as for licensing purposes, as well as to some other institutions in specific cases, such as wood procurement, hunting, fishing, etc.

#### **16.4 Study Team's Comments**

The Study Team makes the same judgment. The project is basically planned to maintain the natural conditions. No conspicuous alteration of the environment, like dredging work on a large scale, is incorporated therein. The environmental status of the Parnaíba river will be preserved without any damage to its present character. Besides, the Study Team is fairly certain of the possible positive effect on the socio-economy in the State, which will lead to the promotion of employment opportunities and for development of the upstream region. These inherent potentials may be a significant point in the project.

**17. CONCLUSION AND  
RECOMMENDATIONS**

## 17. CONCLUSIONS AND RECOMMENDATIONS

### 17.1 Conclusions

Throughout the course of the studies so far conducted, the applicability, the feasibility and the possibility of river navigation on the Parnaíba river have been investigated as a transporting method for agricultural products promoting the sectorial development in the South-west region of the State. The main conclusions derived from the study are summarized below.

- 1 River navigation along the whole of the Parnaíba river is at present very difficult because of the following reasons:
  - The cargo volume transported downstream of Teresina will decrease greatly during the dry season, because only smaller vessels of 0.9 m or less in draft can safely manoeuvre in the channel. The outcomes of such a limitation are lower efficiency in the transport and the resulting higher transporting cost expressed in a unit per ton-km. The possible solution would be regular dredging work or construction of effective groins to provide sufficient water depth in the channel, though the required investment would be great, and thus it could no longer be payable only from the transporting revenues.
  - The particulars of vessels traveling in the channel will be affected by the existing locks at Boa Esperança, particularly in their size. In terms of safe maneuvering, self-propelled vessels shall be assigned rather than barges without propellers. Subsequent transporting cost per ton-km for such vessels will be comparatively higher and less competitive than for transport by barges, typically practised in the river Tiete.
2. The development of a port at Luiz Correia located at the mouth of the Igaráçu river has a potential prospects for its future, though the necessity of its urgent implementation has not been yet confirmed for the project period until 2010. For the time being, the ports of Fortaleza and Itaquí will preferably be utilized as a substitution.
3. A feasible scenario can possibly be proposed in view of the socio-economic situation around the Parnaíba river, where the river navigation is limited to the upstream region of Floriano in dry season and to that of Teresina in the dry season. Despite such conditions, the project still requires a great deal of investment. The feasibility from a financial aspect for a prolonged period will still be discouraging.
4. The essential implications stated above serve as a significant warning about the project implementation. Deliberate and obstinate determination shall be required in the implementation program covering aspects on the possible funding resources, the commencement schedules, etc.

## **17.2 Recommendations**

To extend the above conclusions, some recommendations shall be stressed as below:

1. As a life-line of transporting agricultural products from the south-west region of the State, a state-wide study on the facilities supporting the State infrastructure will be a possible room for the development plan. It is worth studying overall transport activities, perhaps constituting a linking network in the state.
2. Despite relatively low feasibility for the river navigation, any countermeasures shall be adopted sooner or later in order to offer an effective transport service for the future demand of agricultural products, because no such transporting system is currently available in the southwest region of the State. If the program is implemented, backed up by an adequate financial policy, a pilot program on a smaller scale, using much smaller vessels, shall firstly be planned and examined. Based on such trials, the actual project will be continued by solving the problems experienced in the prototype.





