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Performing a Cost-Benefit Analysis: With A Case of the Shiwha Coastal Development Project in Korea

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Abstract

This paper deals with a case study on the Shiwha Coastal Development Project in terms of cost-benefit analysis. The project had carried out for 20 years (1987-2006) in attempting to reclaim the Shiwha wetland area surrounded by shallow sea waters. Many economists and environmentalists argued that this huge project would result in marine environmental damage serious enough to offset the targeted economic benefit. Consequently, there have been many attempts to evaluate this project economically. In this study, the major costs include construction costs and loss of living marine products while the major benefits come from the reclaimed land for the purposes of agriculture, industrial complex, and residence. Since the technological progress over time is assumed to reduce the costs associated with this project, some what-if analyses were performed in terms of different development time and purpose. The primary conclusions resulting from this cost-benefit analysis on the Shiwha Coastal Development Project are two important elements. 1: It is not so good idea to launch the huge coastal development project like the case of Shiwha area without considering the irreparable damage of living marine resources. As a result, the investor is required to take into account the marine environmental protection technologies that allow reducing the relevant costs as well as increasing the economic benefits. 2: In performing the huge coastal development project, the investor also needs to make proper decision on the development scale and purposes. This case analysis reveals that multi-purpose development approach is better than single-purpose one economically. Finally the factor of scale merit should be taken into consideration in carrying out the gigantic coastal development project in view of demand for and supply of the reclaimed land.

Key Words: *Cost-Benefit Analysis, Coastal Development, Technological Progress, Environmental Protection, Development Scale and Purposes.*

Introduction

The coastal zone development in Korea has been characterized by a principle of balancing among the marine economic activities as fisheries culture, ports, shallow seawater reclamation for agricultural and industrial purposes, marine resorts, etc. Since these marine economic activities are subject to exclusive uses, some managerial decisions for their development priorities are required to optimize the total net benefit summing up each coastal economic activity aforementioned. There were strong arguments that the coastal zone development in Korea has been dominated by the shallow seawater reclamation, and thereby sacrificing the substantial benefits from the fisheries activities.

As a result, this paper mainly deals with a long-term cost-benefit analysis with the case of Shiwha Reclamation Project, carried out for 1987-2006, in order to evaluate if the planned purposes for the reclaimed land of Shiwha coastal area can be economically justified. The following sections briefly review such relevant theories as economies of scale, land pricing, marginal analysis, and technological change over time. Section III covers the economic results of analyzing the case study concerned. In the final section, we conclude the paper with some key implications, suggestions, limitations, and extensions.

Relevant Theories Associated with Coastal Reclamation

1) Land Pricing

As is the normal case of other economic goods, the market theory of demand and supply is applicable to explaining the equilibrium price of land reclaimed. Assuming that the demand for reclaimed land in time 't' equal to 'Q_{rd}',

$Q_{rd} = F(P, A, S, N)$ ------ (1)

P: Price of Reclaimed Land A: Level of Land User's Financial Ability
S: Price of Substitute Land N: Number of Users in the Market
Let the quantity supplied of reclaimed land in a span of time equal to 'Q_{rs}',

$Q_{rs} = F(P, M, V)$ ----- (2)

P: Price of the Reclaimed Land M: Level of Input Prices
V: Level of Technology Applied

Fig. 1 depicts a normal set of demand and supply curves reflecting an add of reclaimed land. In this figure, we observe that the supply curve tends to be inelastic to price because such natural resource as land or coastal area is limited. Consequently if the demand curve shifts from D1 to D2 widely, which results in increasing the price from P1 to P2 sharply, the supply of reclaimed land slightly increased by B'.

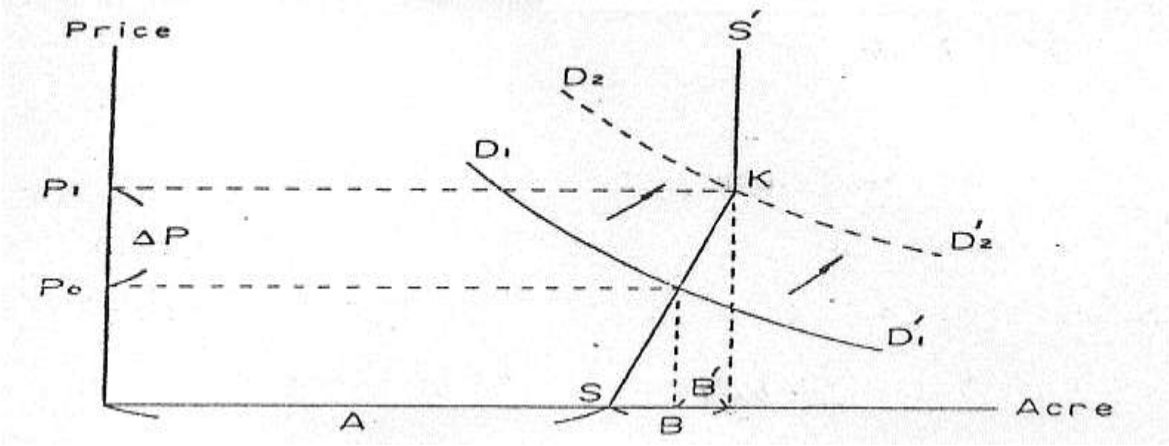

Fig. 1: Theory of Land Pricing

2) Scale of Coastal Development for Land

Fig. 2 illustrates the economies and diseconomies of scale in developing coastal zone for land. In this figure, we observe that a typical relationship between returns to scale and long-run average cost curve exists in developing coastal zone for reclaiming the land.

In case of LRAC1, the development scale is not so large enough to achieve economies of scale effect. On the other hand, in case of LRAC2, an effect of economies of scale is significant enough to justify the coastal development project, where the price of reclaimed land 'P' is lower than 'P1'. As a result, relatively small sized coastal development for land is suitable for urban planning and industrial complex, whereas larger scale coastal development is for agriculture or multi-purpose utilization.

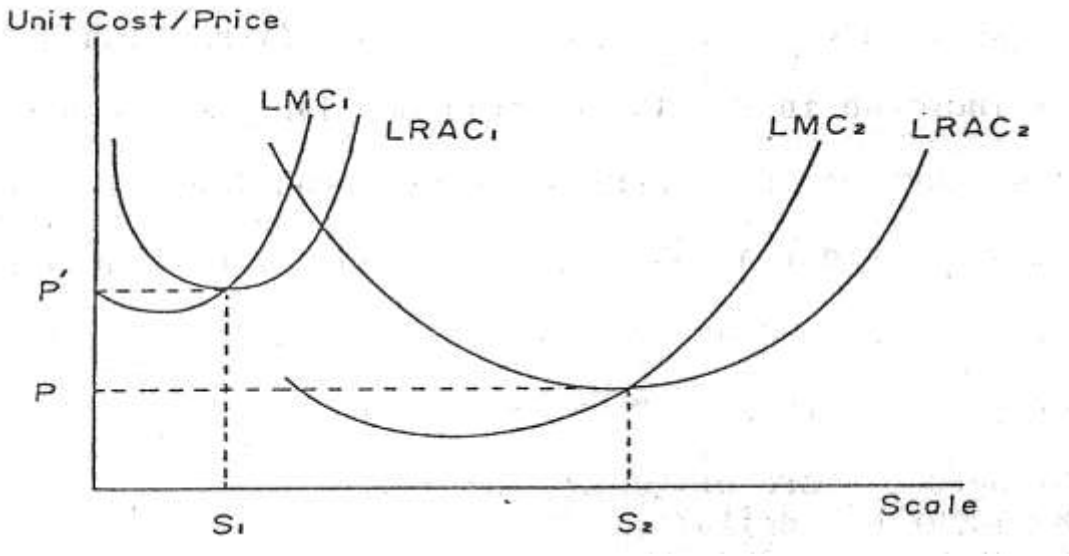

Fig. 2: Economies of Scale

3) Technological Change

Another major factor contributing to economies of scale is the technological advance. As a result, it is worthwhile to review some previous works for the effect of technological change.

The continuous progress in technology allows us to predict that future generation enjoys more economic benefits from new technological application in performing the large scale coastal development project like the case of Shiwha Area. Thus, we can assume that the national development project, like Shiwha, also experience, to some extent, a technological change in reducing the factor prices as well as in supply of reclaimed land itself.

Using Solow's work on the contribution of technological change to economic performance, we may consider a Cobb-Douglas production function for coastal development project with constant return to scale as below (Stoneman, 1987):

$Qt = A^{t}e\ K^{a}t\ L^{1-a}{}_{t}$ ---- (3)

Where Q: output (reclaimed land)

K: Input of Capital
L: Input of Labor
t: time
λ: a rate of growth of total factor productivity resulting from technological advance

Assuming capital and labor get paid their marginal products which enable measuring α, we can calculate the timing position in determining the output. Using the dot convention for a derivative with respect to time (t), we are able to estimate λ under the given data for Q, K, and L. For example, Solow estimated that λ is 1.5% per annum, which means the output might have grown at around 2% annually, resulting from technological advance, under the constant K and L(Stonman, 1987). This implies that the timing for the large coastal zone development project, like the case of Shi-Wha Coastal Development, is also important decision factor together with the economic benefit by scale merit and purposes for reclaimed land utilization.

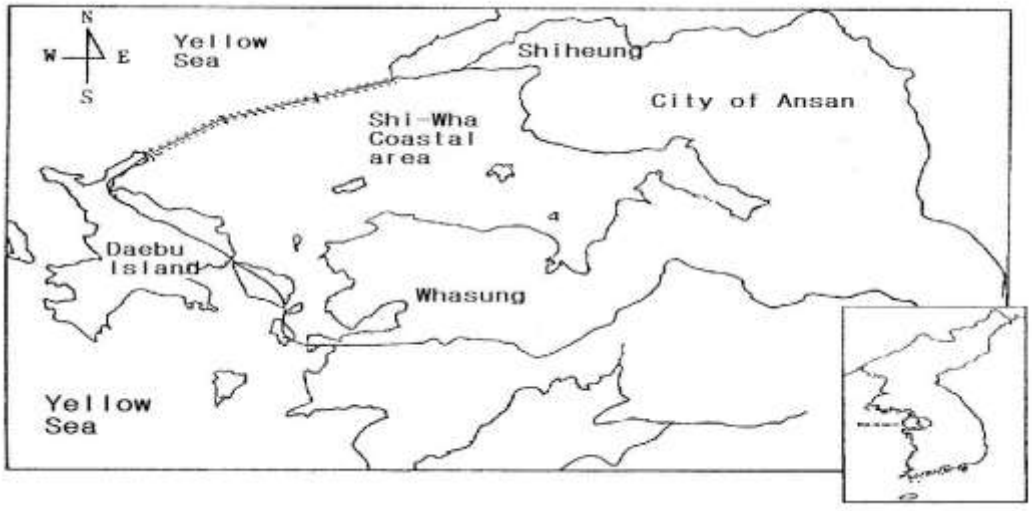

Fig. 3: Map of Shiwha Coastal Development Area

Case Analysis of Cost and Benefit for the Case of Shi-Wha

1) Overview of Shi-Wha Coastal Development Area

The development of Shiwha Coastal area for a reclaimed acre of 11,264 ha, composed of 2,2444ha for industrial site, 4,030ha for urban land, and 4,990ha for agriculture, has launched in 1987.

2) Benefits

The benefits generated from the development of Shiwha coastal zone include reclaimed land, production, and economic spillover effects. The total present value (TPV) can be estimated by summing up the discounted future land price multiplied by the acre of each sector, which is expressed by the following equation:

$$\sum_{i=1}^{n}\sum_{i=1}^{m} TPV = P_{ij}A_{ij}/(1+r)^n + E/(1+r)^n$$

Since the supply of land is very limited in Korea, the land price is expected to rise higher than average, particularly for the case of urban and industrial uses. There are some other external economic factors affecting the benefit from the Shiwha coastal development.

Firstly the wet land reclamation provides water resource for the industrial use. Secondly, such huge national project as the Shiwha coastal development was able to contribute to improving employment and to utilizing the idle construction equipment.

secondly, investment on such social infrastructure as public transportation facilities, including roads and ports, irrigation system, marine resorts, energy generation using tidal power, etc., is expected to improve the economic benefit in this project. Additionally, these economic activities have allowed the local government to develop the relatively remote coast and islands near Shiwha area which is located not far from Seoul metropolitan area in view of logistical management. Besides, relevant technological advance effect can be achieved by the development of Shiwha coastal area. Since these economic benefits can't be easily estimated, we use some existing research results for quantifying them (Gold, 1977).

3) Costs

We also delineate the costs involved in carrying out the Shiwha coastal reclamation project. These costs mainly result from the construction works, compensation for foregone fisheries rights, and some negative economic externalities particularly associated with environmental damage.

Firstly, the construction works for developing Shiwha coastal area and basic survey for environmental damage claimed 15 million dollars in 1987 and so on as shown in table 1. We also consider an actual capital cost at rate of 8% for 1987-1996 and 6% for 1997- 2006. Secondly, the compensation for the foregone economic rights including boat fishing, sea-farming, salt production, quarrying, cropping etc., which have existed in this coastal area. The actual compensation for various property rights turned out more than 250 million US$ since 1986.

As we considered some positive externalities caused by the coastal zone development for reclamation, we also checked out some negative externalities resulting from the Shiwha coastal development project. The primary negative aspect of the massive reclamation project is a matter of environment deterioration caused by industrialization and overpopulation (Forsund, 1988).

Table 1: Investment Flow of the Shiwha Coastal Development Project for 1987-2006

Unit: million US$

item/year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	2000	2003	2006
Outerbank	2.5	10.2	34.2	57.1	86.3	27.4	14.5	5.3	2.1	*	*	*	*
Watergate	*	*	98.5	50	22.4	12.2	*	*	*	*	*	*	*
Interbank	*	*	0.8	0.9	1.1	0.6	3.2	4.8	4.6	0.5	*	*	*
Irrigation	*	*	*	*	*	*	*	4.9	5.5	6.3	2.1	1.3	0.5
Farming Arr.	5.4	43.8	31.4	71.4	42.2	23.5	15.6	10.8	5.6	2.5	0.8	0.5	0.5
Reclamation	6.5	45.6	32.7	75.6	53.7	12.5	8.9	22.9	68.6	48.5	12.1	10.5	5.5
Water used	*	14.6	30.3	39.3	45.5	21.4	17.9	8.5	6.8	4.3	1.5	1.5	1.5
Sewage	*	*	18.9	39.3	45.5	59.3	42.9	48.8	14.5	10.2	5.5	2.5	2.5
Road Wroks	*	11.2	13.6	21.4	22.6	59.4	59.5	44.8	29.8	23.6	20.7	10.3	5.6
Electricities	*	1.8	2.3	2.9	4.6	6.4	5.4	3.6	2.6	2.6	1.5	1.5	1.5
Landscaping	*	*	1.2	1.8	1.8	2.4	3.2	3.5	4.5	2.5	2.5	2.5	2.5
Antipollution	*	*	2.5	3.8	5.6	6.7	7.2	9.5	10.8	12.6	10.5	5.5	5.5
Setup&Finish	1.5	3.5	22.7	21.4	28.6	50.1	30.5	18.6	10.8	6.5	5.5	4.5	3.5
Monitoring	2.5	9.6	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	5.5	5.5	5.5
Total const.	18.4	140.3	297.6	393.4	368.4	290.4	217.3	194.5	174.7	128.6	68.2	46.1	34.6
Financing cost	1.8	14.0	29.8	39.3	36.8	29.0	21.7	19.5	17.5	12.9	6.8	4.6	3.5
Total Investment	20.2	154.3	327.4	432.7	405.2	319.4	239.0	214.0	192.2	141.5	75.0	50.7	38.1

Source: Korea Water Resource Development Corporation

Results of Cost-Benefit Analysis

Using the relevant data and the results of previous analyses associated with Shiwha coastal development project, we performed a cost-benefit analysis in order to figure out some implications in conjunction with this project. Fig. 4 exhibits a trend of net present value (NPV) of the Shiwha project for the cases of multi-purposed development and single-purposed one respectively. Obviously, the multi-purposed development case revealed a better flow of NPV than the other case during 1987-2012.

Meanwhile, we also analyzed the economic results in two different cases in terms of timing for launching the Shiwha project. One case is the original schedule for starting in 1987 and the other case was assumed to start the project in 1992. We can observe the annual NPV results of these two cases in Fig. 5. In this figure, even if we delay the Shiwha coastal development project from 1987 to 1992, the gab of cumulative economic benefit in 2013 between two cases is not so significant due to technological change and higher value of marine resources over time. If we extend the analytical period to 2018, we may observe that the red line is over blue line in Fig 5.

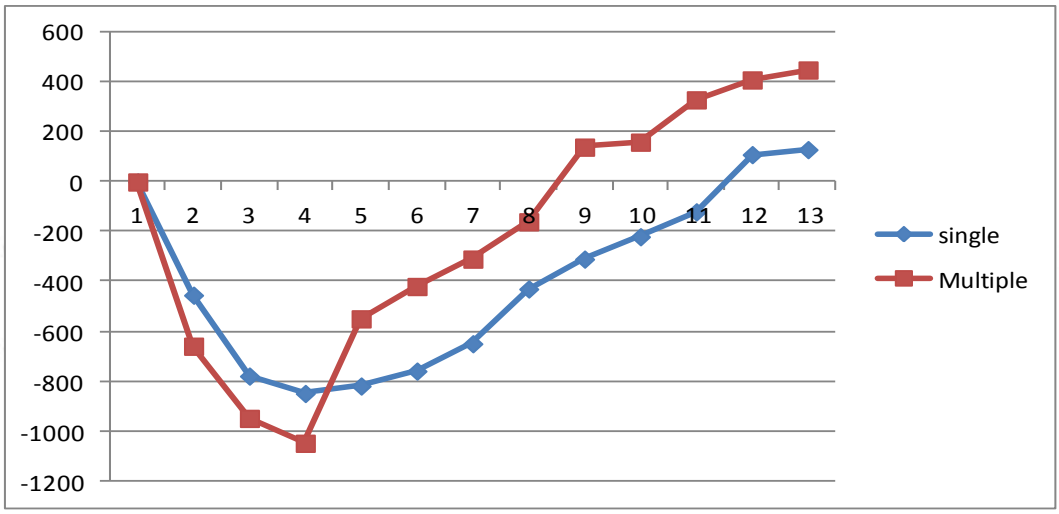

Fig. 4: Trend of NPVs for the Cases of Single and Multi-purposed Development of Shiwha Coastal Area

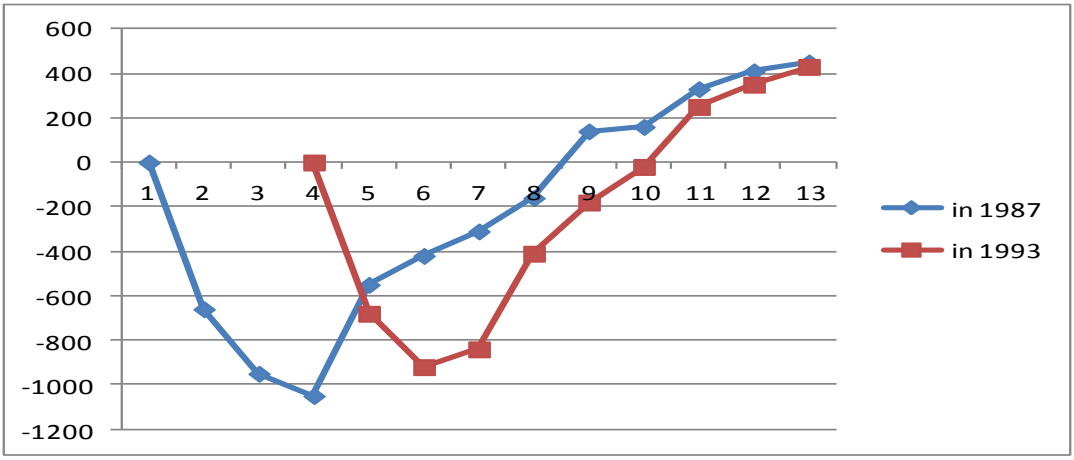

Fig. 5: NPVs trend for the Cases of Two Different Timings for the Development of Shiwha Coastal Area

As a result, it is not so good decision to rush any huge coastal reclamation projects damaging marine environment irrevocably. We may try some more what-if analyses, using the different condition in cost, benefit, and discount rate, in order to make an optimal decision associated with coastal development.

Conclusions

1. Top decision-maker is requested to properly evaluate both tangible and intangible opportunity costs associated with irreparable damages of marine environment which may turn out significant enough to offset the economic benefits concerned.
2) Research also suggests that the coastal development for reclaimed land be geared for multiple purposes rather than for single purpose in order to secure a better economic result.
3) Research emphasize the importance of timing to develop the huge coastal area, like the case of Shiwha, considering the technological advance as well as the utilization of existing marine resources available for value-added products.
4) Research also recommend a protection of specially designated coastal space as well as its efficient allocation among the feasible alternatives including sea-farming, port and harbour, marine recreation, tidal power, etc.

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