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Research Article

Assimilative Capacity of Mangrove Conversion to Salt Pond Industry "A Case Study of Bipolo Village, District of Kupang, Indonesia"

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Abstract

One coastline area abundant with over 600 ha of mangrove forest is Bipolo Village located on Kupang Bay in the District of Kupang, East Nusa Tenggara Province of Indonesia. Even though enacting the salt import substitution policy, by enhancing salt production through conversion of mangrove area into salt ponds in Bipoolo Village is economically and strategically beneficial for the development of NTT, it should be implemented in the spirit of environmental protection to make sure that the policy follows sustainable development guidelines. This study used accidental sampling to collect information regarding the benefit produced by mangrove. At the same time, a purposive sampling has been used to collect information regarding the technical details of the salt industry. The estimation of the cost has been calculated by using a regression model between total cost (TC) as dependent variable and production unit (Q) as independent variable for a consecutive scale of business. At least there two regression models to estimate the cost including Cubical Regression Model and Quadratic regression Model. The results of this analysis show that the maximum land conversion of mangrove to salt pond is 10 ha, that will generate a maximum Marginal Net Private Benefit (MNPB) for commercial companies. As the existing conversion of mangrove land being about 2.64 Ha, the local government might allow the existing companies to convert another 7.36 ha of land to salt pond industry. However, if the government continues the policy of encouraging salt industry along the coastline of Bipolo the problem of externality should be considered. In doing this the maximum mangrove vegetation that can be converted to salt pond is 8.45 ha only, with total production of approximately 1539 ton per year.

Keywords
Assimilative, Capacity, Mangrove, Salt, Indonesia

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Introduction

Background

Much of the coastline of Indonesia is covered by mangrove forests, which are abundant with natural resources that provide environmental protection, biological function, and economic assets for the people living in the coastal areas. Physically, mangroves serve as a wind and wave break, filter for pollutants, flood control, and prevention of sea water intrusion to land. Economically, mangroves can produce raw materials for arts and crafts, building materials, fuel and food and medicine. Furthermore, the three functions - physical, biological, and economic - are strategic functions for a primary product capable of supporting and stabilizing the marine and terrestrial ecosystems (Paoli, Montefalcone, Morri, Cassallo, & Bianchi, 2017)(Cury, Lynne, & Yunne-Jai, 2001).

One coastline area abundant with over 600 ha of mangrove forest is Bipolo Village located on Kupang Bay in the District of Kupang, East Nusa Tenggara Province of Indonesia. Mangrove in Bipolo Village is part of the ecosystem of the Marine Tourism Park of Kupang Bay established by Decree of the Minister of Forestry of Indonesia No. 18/Kpts-II/1993. The marine park's ecosystem includes various species of coral reef and 203 species of fish.

However, since 2018, the new NTT Provincial Government has a policy to enhance salt production in NTT, in accordance with an import substitution policy for the national salt industry, which includes a potential salt pond area within the Kupang District, adjacent to Kupang Bay. Under this new policy, the provincial government has a special target for salt production with potential capacity of approximately 1000 ton/hectare/year and potential land usage for salt ponds in NTT of approximately 21,000 Ha, including almost 100 Ha along the coastline of Bipolo Village. There are two companies that have invested in the salt pond industry in Bipolo so far, i.e. PT Garam Persero" established a potential salt industry approximately 305 Ha in 2016 and now has occupied 18 Ha for production activities. And PT. GIN established a potential salt industry approximately 21 Ha along the coast line and now has occupied 3 Ha of land for production.

Even though enacting the salt import substitution policy, by enhancing salt production through conversion of mangrove forest areas into salt ponds along the shorelines of Kupang Bay, is economically and strategically beneficial for the development of NTT, it should be implemented in the spirit of environmental protection to make sure that the policy follows sustainable development guidelines. Jickling & Wals (2008) emphasized that: "While the public sector becomes more privatized, the private sector is being reframed as essential for public well-being". At the same time, Stern (2000), mentioned that: "Through human history, environmental impact has largely been a by-product of human desires for physical comfort, mobility, relief from labor, enjoyment, power, status, personal security, maintenance of tradition and family, and so forth, and of the organizations and technologies mankind has created to meet these desires".

Research Problem

Under the new policy regime of the East Nusa Tenggara Provincial Government to enhance NTT's salt production as an import substitution policy for the national salt industry, there will be large areas of mangrove in Bipolo Coastline converted into salt ponds, with a total potential land (mangrove) conversion into salt ponds of almost 100 ha. A critical question that needs to be addressed regards the assimilative capacity of mangrove forests and its ability to sustain its ecological as well as its socio-economic function, for current and future generations.

Literature Review

Mangrove Resources

(Morelli, 2011) defined environmental sustainability simply as "the maintenance of natural capital". In relation to the issue of utilization of environmental resources for the purposes of the private sector, then according to (Benu, Muskanan, King, Asa, & Wulakada, 2020) : "local participation is actually the key issue that has to be addressed in the development process so that the process can produce sustainable benefits for all parties. Accordingly, the local people should

understand that their participation in the development process might produce a benefit for themselves in the long term".
Research conducted by Priyatna, Khomarudin, Ambarwati, & Sensing (2014) found that there are at least 19 different characteristics of coastlines in Indonesia, being (1) Coastline of Small Island (2) Settlement facing directly to Coastline, (3) Coast-Settlement-Hill, (4) Coast-Open land-Settlement, (5) Coast-Agriculture area-Settlement-Hill, (6) Settlement behind Forest, (7) Settlement behind Hill, (8) Coastal-Open land-Agriculture Area-Forest, (9) Fishpond and settlement facing directly to coastline, (10) Settlement behind mangrove, (11) Mangrove forest, (12) Gulf coast and settlement, (13) Coastal hill, (14) Fishpond-settlement-hill facing directly to coastline, (15) Gulf-settlement hill facing directly to coastline, (16) Coastal forestry, (17) Open land facing coastline, (18) Fishpond-hill facing coastline, and (19) Swamp-Open land facing coastline.

Sustainable Development

According to (Morelli, 2011a), the definition of environmental sustainability has been debated for several decades among professionals from various sectors (Mebratu, 1998); (Costanza & Patten, 1995); (Vos, 2007):
"A debate exists between those who support a three-legged approach (i.e., simultaneously benefitting economy, society and environment), and those who view it as a relationship between human society and nature (Robinson). The result is that the concept is now more open to individual political and philosophical interpretations than to scientific definition".
(Fou, 1990) explained that from an economic standpoint, sustainability requires that current economic activity not disproportionately burden future generations. Pearce and Turner (1990) also made their definition of sustainability from the perspective of economic development as "… Maximizing the net benefit of economic development, subject to maintaining the services and quality of natural resources over time …".
For a definition of sustainability from the perspective of natural resources and the environment, Fresco & Kroonenberg (1992) stated that the sustainability of the natural ecosystem can be defined as the dynamic equilibrium between natural inputs and outputs modified by external events such as climatic change and natural disaster. At the same time, Lynam & Herdt (1989) mentioned that sustainability is "… the capacity of a system to maintain output at a level approximately equal to or greater than its historical average, with the approximation determined by historical levels of variability".
Williams & Millington (2004) said that to define sustainable development is actually very difficult, slippery and elusive to pin down. That is why Fowke & Prasad (2010) have identified at least 80 different definitions of sustainable development, in some cases there are contradictions among the definitions. One of the best definitions for sustainable development according to Fowke & Prasad (2010) is given by the *Brundtland Report.* The diverse and contested meanings of sustainable development prompted Harlan Brundtland to report on environmental issues with the Brundtland Report emphasizing that sustainable development means "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".
As suggested by (Scoones, 1998), policy to create a sustainable livelihood is possible by analyzing context, condition and trend followed by analysis of livelihood resources, analyzing institutional/organizational influences on access to livelihood resources, and analyzing livelihood strategy and finally analyzing the outcome and trade-off of Assimilative Capacity

Assimilative Capacity

The impact of mangrove conversion into salt pond is not only on the economic value of mangrove that will be replaced by the asset and productive value of salt pond, but also the assimilative capacity of mangrove for the ecosystem that contribute to carbon and pollutant sequestration, water purification as well as flood and storm damage mitigation. According to (Turner, K., D. Pearce, 1994), to analyze the assimilative capacity of natural resources, we should understand the concept of marginal cost (MC), marginal revenue (MR), internal cost and external cost.
Marginal refers to calculations and measurements on a single unit. Thus, marginal revenue (or payment) is what a firm receives from selling one particular unit of output. Thus marginal revenue (MR) of the first unit of product sold is the same as the marginal revenue of the 10,000th product sold.

However, the cost of producing the first unit of output (the marginal cost of the 1st product) may not the same as the costs of producing the 10,000th unit of product (the marginal cost of the 10,000th product). While the marginal revenue is constant as production rises, the total revenue (the total amount received by the business) obviously increases as production rises.

The amount of profit which the firm makes (the marginal profit) is simply the difference between the amount of money it receives for selling that output (marginal revenue) and the amount of money it cost to produce that output (marginal cost). Each output in turn needs to have its marginal profit calculated by subtracting marginal cost from marginal revenue.

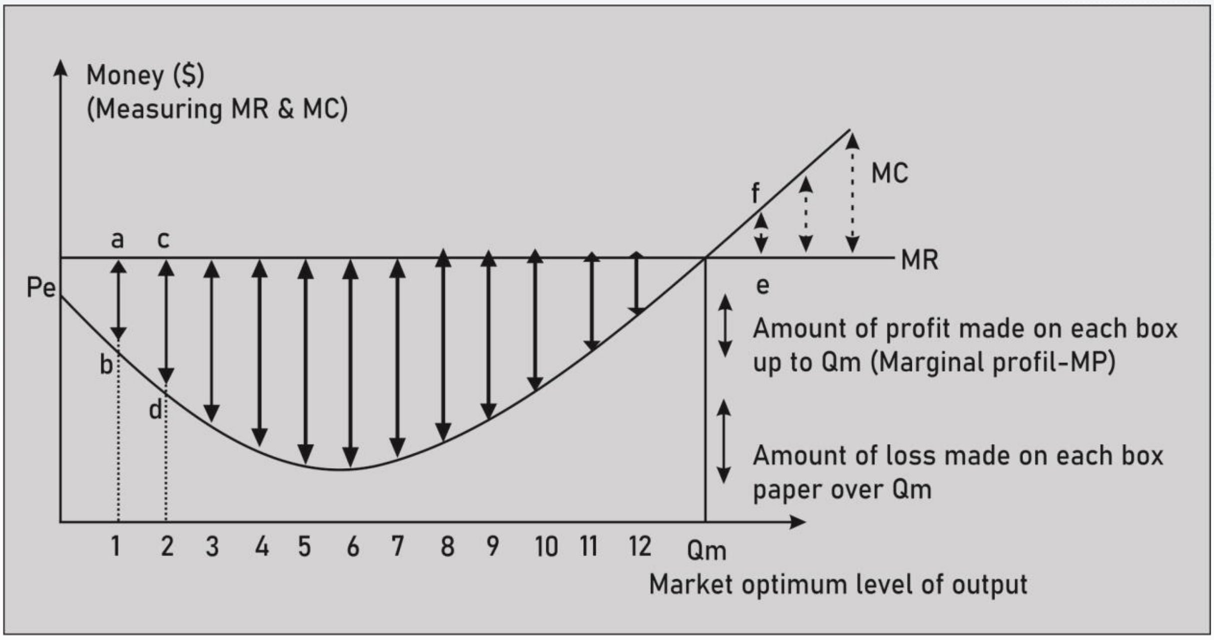


Figure 1. The Market Optimum Level of Output
Source: (Turner, K., D. Pearce, 1994)

Figure 1 presents the case of a paper mill that makes a single box of paper (marginal profit-MP). Here we have superimposed the MR curve onto the MC curve. The profit made on the 1st box of paper is the different between the MR of that box (distance *1a*) and the MC of that box (distance *1b*), i.e. the MP of producing the 1st box of paper will be the amount of *ab* as measured on the vertical axis. Similarly the MP of producing the 2nd box is *cd*. The firm will produce each unit of output where the MR it receives from that unit exceeds the MC of producing that unit. Consequently, the firm produces units up to the output level *Qm*. This is the market optimum level of output.

If the above case is compared with the case of mangrove conversion then we assume that the profit gained on the 1st unit output of salt as the different between the MR of that unit output of salt (distance *1a*) & the MC of that unit output of salt (distance *1b*), i.e. the MP of producing the 1st unit output of salt will be the amount of *ab* as measured on the vertical axis. Similarly the MP of producing the 2nd unit output of salt is *cd*. The business will produce each unit of output where the MR it receives from that unit exceeds the MC of producing that unit. Consequently, the firm produces units up to the output level Qm. This is the market optimum level of salt output.

Method

Sampling Technique

This study was conducted along the coastline of Kupang Bay in the District of Kupang, East Nusa Tenggara Province (NTT) of Indonesia. The study rely on both primary data collection and the use of secondary data sources. Data collection methods used are in relation to the mangrove habitat and local community impacts. The accidental sampling technique has been used to collect information regarding the benefit (products and services) produced by mangrove for people who have socio-economic (livelihood) activities along the bay coastline. At the same time a purposive sampling technique has been used as well to collect information from the investors and the laborers in the salt pond industry regarding the technical details of the salt industry as well as for the production of salt.

Tools of Analysis

A tool of analysis to evaluate the assimilative capacity of mangrove, when existing mangrove is converted into salt pond, is marginal concept including marginal revenue (MR), marginal cost (MC), marginal profit (MP), and marginal external cost (MEC).

$$MR = \frac{\delta TR}{\delta x} = \frac{\delta (X * Px)}{\delta X}$$

$$MC = \frac{\delta TC}{\delta x} = \frac{\delta (FC+VC)}{\delta X}$$

$$MP = MR - MC$$

Where: MR = Marginal Revenue; MC = Marginal Cost; MP = Marginal Profit (or Marginal Benefit); TR = Total Revenue; TC = Total Cost; FC = Fixed Cost; VC = Variable Cost; X = Number of Output; and Px = Price per unit of output.

Impacts from the exploitation of mangrove and the conversion process of mangrove to salt pond include costs and benefits derived from the total process. The estimation of the cost might be calculated by using a regression model between total cost (TC) as a dependent variable and production unit (Q) as an independent variable for a consecutive scaling of business level. There are two regression models to estimate the cost:

1. Cubical Regression Model

$TC = a + bQ + cQ^2 + dQ^3$

2. Quadratic regression Model

$TC = a + bQ + cQ^2$

Where: TC = Total Cost of salt production (Rp); Q= Production of salt (Kg/unit of business); Q^2; Q^3 = Quadratic and Cubical models of regression for salt business
and a; b; c; d = Regression coefficients

Some indicators that should be considered in choosing the best model of estimation are (i) the test of the goodness of fit with R^2; (ii) test of significance of the parameter estimates; (iii) confidence interval of the parameters; and (iv) test of significance for the sample correlation coefficient (Koutsoyiannis, 1977; Kmenta, 1971; Intriligator, 1978; Judge, et. al., 1982).

Results and Discussion

Estimation of Cost Function, Profit and Externality

Cost of Production and Estimation of the Parameters

There are two mathematical formulas to calculate Total Cost (TC) that have been chosen to help derive the parameters; they are Quadratic and Cubic mathematical models. At the same time the Marginal Revenue (MR) parameter is estimated using the first differential of linear mathematical formula for Total Revenue (TR). Furthermore, the parameters of MC and MR can be estimated by using regression analysis. Data collected from the field shows that the Total Fixed Cost of running a salt pond industry is IDR 166,871,228 **(**US $ 11,409) per ha per year, and the Total Variable Cost is IDR 38,253,913 (US $ 2,615) per ha per year.

The Cubic Model of cost function is $TC = a + bQ + cQ^2 + dQ^3$ where a; b; c; d are the parameters; TC = total cost; and Q = quantity of production. The results of the regression analysis show that the overall independent variables of quantity of production (Q, Q^2 and Q^3) together have a significant influence on the dependent variable of total cost of production (*F-value*). At the same time, each independent variable of quantity of production (Q_i) has a partial significant influence on total cost of production (*t-value*), meaning that the cost of production depends on the scale of business of

the salt pond industry. This interpretation is supported by the value of R^2 (0.998), indicating that 99.8 % of the variation in total cost of production is determined by variation in quantity of production (scale of business).
Furthermore, the regression equation for a Cubic mathematical model, produced by regression analysis, is TC = 207417811.437 + 219953.972Q – 158,399Q^2 + 0.101Q^3 where the value of R square is 0.998 and standard error of estimation being 20237360.703. These indicators show that the model of total cost ceases being fit to be used to estimate profit maximization level of production when Marginal Revenue (MR) equals Marginal Cost (MC) (Koutsoyiannis, 1977; Kmenta, 1971; Intriligator, 1978; Judge, et. al., 1982).

Marginal Analysis Approach

The business will produce each unit of output where the MR it receives from that unit exceeds the MC of producing that unit. Consequently, the business produces units up to the optimum output level. Based on the results of the regression analysis, the Total Cost equation is
TC = 207417811.437 + 219953.972Q – 158.399Q^2 + 0.101Q^3.
At the same time the Total Revenue function is TR = P.Q, where "P" is the price of the product and "Q" is the quantity of the product. Information collected during the survey revealed that the price of salt is IDR 700,000/ton or US $47.86/ton, at market price. Therefore, the production level that creates maximum profit (MR = MC) of salt pond industry, with the price at market level, IDR 700,000 (US $ 47.86) per ton, might be calculated as:

TR = P.Q = IDR 700,000 or US $ 47.86Q
MR = δTR/δQ = δP.Q/δQ = P = IDR 700,000
TC = 207417811.437 + 219953.972Q – 158.399Q^2 + 0.101Q^3
MC = δTC/δQ = 219953.972 – 316.798Q + 0.303Q^2
Maximum Profit (π_{max}): MR = MC
700000 = 219953.972 – 316.798Q + 0.303Q^2,
This equation is the Marginal Net Private Benefit (MNPB). Furthermore:
700000 – 219953.972 = – 316.798Q + 0.303Q^2
480046.028 = – 316.798Q + 0.303Q^2
= – 480046.028 – 316.798Q + 0.303Q^2

The optimum quantity of output, that will derive a maximum profit for the salt industry in Bipolo Village, is approximately 1886 ton (Turner, K., D. Pearce, 1994). Knowing that the productivity of the salt industry in Bipolo Village is 182 ton/ha, then the optimum area of mangrove that can be converted into salt industry in Bipolo Village is approximately 10 ha.

Profit Maximization

The above mathematical derivation shows that the quantity of Q that will derive a maximum profit is Q = 1889 ton, then profit maximization can be formulated as follow:

Profit function (π) =TR – TC
= 700000Q – (207417811.437 + 219953.972Q – 158.399Q^2 + 0.101Q^3)
= – 207417811.437 + 480046.028Q + 158.399Q^2 – 0.101Q^3
If we substitute Q into the equation then a maximum profit level will result;
π_{max} = – 207417811.437 + 480046.028Q + 158.399Q^2 – 0.101Q^3
= – 207417811.437 + (480046.028 * 1886) + (158.399 * 1886^2) – (0.101 * 1886^3)
= 583815666.719 or (IDR 583,815,667)

If the optimum level of output of the salt pond industry in Bipolo Village is 1886 ton derived from 10 ha of land, a maximum profit of IDR 583,815,667 or US $ 39,919 is generated. The quantity of output Q = 1886 ton and the maximum profit π_{max} = IDR 583,815,667 or US $ 39,919 are calculated based on private costs. For environmental and sustainable development, the level of output and the maximum profit derived from 10 ha of land should also consider the loss of assimilative capacity of mangrove converted into salt pond. This consideration is a function of Marginal Net Social Benefit (MNSB)(Turner, K., D. Pearce, 1994).

Assimilative Capacity of Mangrove

Assimilative capacity actually refers to the physical carrying capacity of a mangrove forest, in relation to the activity of converting mangrove areas to salt pond areas. According to (Hartanti, Patria, & Utomo, 2018), the carrying capacity of mangrove is not only calculated based on physical capacity but also on the relative carrying capacity (RCC) and effective carrying capacity (ECC). The Assimilative capacity in this research refers to the physical carrying capacity of mangrove forest regarding all processes involved with the converting of mangrove area to salt pond area in Bipolo Village. The assimilative capacity of mangrove includes the capacity of mangrove to overcome the problem of abrasion.

As calculated above, the optimum level of output of salt pond industry in Bipolo Village is 1886 ton derived from 10 ha of land, which generates a profit of approximately IDR 583,815,667 or US $ 39,919. As the existing amount of land occupied by salt pond along the coastline of Bipolo is approximately 2.64 ha, the companies might wish to extend the land occupation for salt pond by about 7.36 ha.

However, extending land occupation for salt pond could destroy a number of mangrove vegetation areas and hence reduce the assimilative capacity of the mangrove ecosystem to overcome the problem of abrasion. One of the solutions that might be introduced to overcome this problem according to (Suharti, Darusman, Nogroho, & Sundawati, 2016) is an alternative livelihood for the local people. Furthermore, a regression analysis was conducted to estimate the impact of land occupation for salt production and the ensuing destruction of mangrove vegetation with the production of salt, from those ponds. The analysis used salt production as a dependent variable and the mangrove density loss as an independent variable.

The results of the analysis show that the area of land occupation has a significant influence on the amount of mangrove vegetation loss at a level of significant α = 1 %, using the regression equation Y = -19.714 + 2.753Q and adjusted R^2 is 1.000.

The identification of the assimilative capacity of mangrove refers to the Decree of Minister of Environment of Indonesia No.201/2004 that a good standard for mangrove vegetation density is ≥ 1000 individual / ha. The density of mangrove vegetation plays a significant environmental function in overcoming abrasion along the coastline.

If the optimum mangrove vegetation density is considered as the level of assimilative capacity (AC) for mangrove and substitutes the density number into regression equation estimation, then:

$$Y = KA$$

$$-19.714 + 2.753Q = 1000;\ Q = \frac{1019.714}{2.753} = 370.40$$

Hence, it can be concluded that the level of salt production at the optimum assimilative capacity of mangrove is about 370.40 ton. The above analysis shows that when the line of the assimilative capacity level of mangrove is overlaid with the function of density of mangrove as an externality cost of salt production, then the intersection point of the maximum level of production is roughly 370.40 ton that can be produced from approximately 2.03 ha of land. If the companies want to extend the land occupation for salt production above 2 ha, then it could trigger an externality problem, regarding the reduction in the capacity of mangrove ecosystem to overcome the problem of abrasion. It should be understood that mangrove loss in Indonesia is responsible for just under half of all global mangrove deforestation that has occurred in the 21st Century (Hamilton, 2013). According to (Spaninks, Frank and Van Beukering, 1997), Possible approaches to the valuation of the mangrove's protective service are hedonic prices and averting behavior methods. However, their appropriateness is probably limited because the conditions necessary for their application will not always be fulfilled.

From this point, calculations about the production levels of salt can be conducted while taking into account the externality costs, if the companies determine to extend their production capacity above the assimilative capacity of the mangrove forest. To achieve this, the marginal external cost curve (MEC) is overlaid with the marginal net private benefit curve (MNPB) of the company, as applied in the formula. The estimation of wood value lost is actually the economic value of mangrove that would be lost if the companies extend their land occupation by an additional 7.36 ha to reach an optimum production of 1886 ton per hectare. The estimation of total externality cost is calculated based on the regression analysis between the losses of wood value (externality cost) as a dependent variable and the quantity of salt production as an independent variable if the companies extends their land occupation above mangrove

assimilative capacity.
The results of the regression analysis show that based on the result of "t-student" test (partial analysis) as well as "F-test" (overall analysis), the quantity of salt production (Q) has a significant influence on the total external cost (TEC) with R-square = 0.997.

$$TEC = -157789613.745 + 535425.684Q - 342.103Q^2 + 0.108Q^3.$$

Externality and Marginal Net Social Benefit (MNSB)

This research only considers the external costs of mangrove vegetation lost (the value of wood), if the companies decided to extend their capacity of salt production above the level of assimilative capacity of mangrove. By considering the external costs, a Marginal Net Social Benefit of the company (MNSB) can be generated. A Marginal Net Social Benefit can be calculated by setting up Marginal Net Private Benefit (MNPB) equal to MEC (Marginal External Cost). MEC is calculated from the first differential of the function of Total External Cost (TEC). At the same time, MNPB is the first differential of the function of maximum profit (π_{max}).

Total External Cost (TEC) $= - 157789613.745 + 535425.684\ Q - 342.103\ Q^2 + 0.108\ Q^3$
Maximum Profit function (π_{max}) $= - 207417811.437 + 480046.028\ Q + 158.399Q^2 - 0.101\ Q^3$

Output at Social Optimum level: MNSB = MEC

$$MEC = 535425.684 - 684.206Q + 0.324Q^2$$

$$MNPB = 480046.028 + 316.798Q - 0.303Q^2$$

MNPB = MEC

$$480046.028 + 316.798Q - 0.303Q^2 = 535425.684 - 684.206Q + 0.324Q^2$$

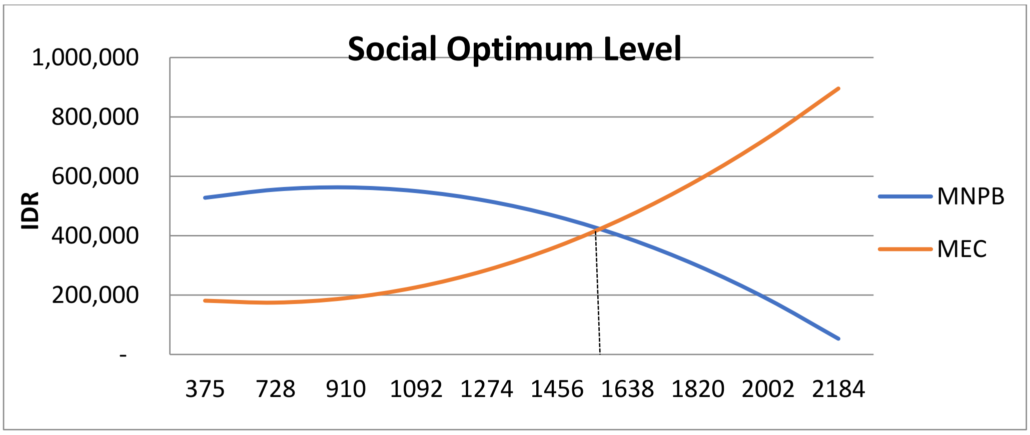
$$480046.028 - 535425.684 = (-684.206Q - 316.798Q) + (0.324Q^2 + 0.303Q^2)$$

$$-55379.656 = -1001.004Q + 0.627Q^2$$

$$= 55379.656 - 1001.004Q + 0.627Q^2$$

$$Q_{12} = \frac{-b \pm \sqrt{b^2 - 4.a.c}}{2a};\ Q_1 = 1539.11$$

When taking into account the external costs resulting from the salt pond industry, the above analysis shows that the quantity of salt production at the social optimum level is 1539 ton. This quantity of salt production is slightly lower than the quantity of salt production without considering the issue of external costs (1886 ton), as seen in Figure 2.



Source: Primary data analysis, 2020
Figure 2. Social optimum level of salt pond by considering externality

Research revealed that the productivity of the salt industry in Bipolo Village is 182 ton / ha. Hence, the optimum area of mangrove that can be converted into salt pond industry in Bipolo Village is approximately 8.45 ha. The existing occupation of land for salt pond along the coastline of Bipolo is approximately 2.64 ha, which means that the company could extend the land occupation for salt pond by 5.81 ha only. This total area of land occupation for salt pond is slightly smaller than the 10 ha area of land occupation calculated without considering externality costs.
If Q is substituted into the equation then the maximum profit at social optimum level is:

$$\pi_{max} = -207{,}417{,}811.437 + 480{,}046.028Q + 158.399Q^2 - 0.101Q^3$$

$$= -207{,}417{,}811.437 + (480{,}046.028 * 1539) + (158.399 * 1539^2) - (0.101 * 1539^3)$$

$$= 538{,}383{,}847.8$$

Conclusion

Based on the analysis, it could be concluded that: (i) The salt pond industry is a new type of livelihood for the local people in many places around Indonesia. While the people living along the coast line in two neighboring villages have had the salt industry as their main livelihood, for those living in Bipolo farming has been their main livelihood over many generations; (ii) The population in Bipolo has tended to increase over the last 5 years, causing the amount of arable land to decrease as productive land is converted for settlements, infrastructure and other economic activities. One possible alternative livelihood is the salt pond industry as this village also is located along the coastline; (iii) Mangrove resources in Bipolo Village have decreased from 93.94 ha in 2017 to 76.67 ha in 2019 as a result of human activities, especially after the provincial government of NTT enacted a new policy for the salt industry, making it a priority programs in 2018; (iv) The optimum level of output of the salt pond industry in Bipolo Village is 1886 ton derived from 10 ha of land, which generates a profit of approximately IDR 583,815,667 (US $ 39,919). In fact, the current usage of land for salt pond along the coastline of Bipolo is about 2.64 ha, which the companies might extend by approximately 7.36 ha; (v) Considering the problem of externality in the salt pond industry, the optimum level of salt production in Bipolo Village is 1539 ton derived from 8.45 ha of land, which would generate profit of approximately IDR 538,383,847 (US $ 36,812). As the existing occupation of land for salt pond along the coastline of Bipolo is about 2.64 ha, the companies might extend the land occupation for salt pond by about 5.81 ha.

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