Economic Valuation of Sand and Gravel in Davao del Norte, Philippines

Tamayo, Adrian and Tagalo, Romulo

University of Mindanao, Davao City, Philippines, Provincial Environment and Natural Resource Office, Davao del Norte, Philippines

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Adrian M. Tamayo*, Romulo Tagalo**

*Research and Publication Center, University of Mindanao, Davao City, Philippines
a_tamayo@umindanao.edu.ph

**Provincial Environment and Natural Resource Officer
Davao del Norte, Philippines
tagalo_romulo@yahoo.com

Abstract

The study aims to quantify the economic value of the sand and gravel which is deemed as a non-renewable resource. A survey was conducted to extract the consumer surplus of the households, also construct the demand equation for the resource. With the demand equation for sand and gravel at $\log(P) = 796.43 - 8.79Qd$, the consumer surplus was estimated at P8271. Using the economic valuation technique, the economic value of sand and gravel was estimated at P729,568,368. Thus, a very high value imputed on the environmental resource. The survey showed that 82% of the population in Davao del Norte is amenable for a policy to regulate sand and gravel extraction.

With the new valuation measure of the sand and gravel, a new price may be introduced at price range between P125-P225 per cubic meter. The new price is set to be used as payment for environmental services and compensation projects at the quarry sites.

Also, the cost structures of permitees in Davao del Norte are too low compared to the operators in Compostela Valley, Davao Oriental and Davao City. The cost of operation in Davao del Norte is approximately 18% of the cost in Davao Oriental and 20% of the cost of Compostela Valley. The cost differences are largely due to the permit cost which is cheaper in Panabo and Tagum than in other areas. This is suggestive that the permitees may likely absorb the cost rather than transfer operation given their high producer surplus value.

INTRODUCTION

Davao del Norte. Davao del Norte covers a total area of 3,426.97 square kilometers and occupies the northern part of the Davao Region. It is consists of 8 municipalities and 3 cities. The economy is largely agricultural with rice, banana, copra, coffee, fruit and fruit crops among its main products. Davao del Norte is home to banana plantations with DOLE and Del Monte, Lapanday, TADECO and Marsman as big companies located in the province.

Davao del Norte is a major producer of gold and other mineral resources like silica, silver, copper and sulfur. Also, there are a number of quarries for gravel, sand and pebbles.

Environmental Resource Valuation. Too much extraction of sand and gravel due to its low cost could lead to environmental problem. The low cost imputed on the sand and gravel may perhaps be a result of the perception that the resource is a replenishable resource, hence, abundantly found in the environment. Resource utilization, spatial considerations, and environmental determination are important elements in regional development (Murdoch & Marsden, 1995). This includes the sand and gravel as a resource which are seldom given economic and environmental use. As an economic resource, it is used for construction of infrastructures, as an environmental resource, sand and gravel form integrated geomorphic assemblage (Knight, McCarron & McCabe, 1999) that services the landscape and ecosystem. Hence, there is the need to quantify the environmental resource for its economic value or for its preservation, in literatures this is referred to as economic valuation (Garrod & Willis, 1999) which can be manipulated in order to simulate models that would provide perspective of value (Bennet & Blamey, 200). Environmental valuation is carried out in order to achieve sustainable development (Howarth & Norgaard, 1992), development will never be sustainable if its economic value is not known. Hence, this study was conducted to determine the economic value of sand and gravel as manifested in the willingness of the people of Davao del Norte to protect the said resource without hampering the development objectives in both household and provincial levels.

METHOD

The study employs quantitative. A survey was conducted to obtain the cost model in the industry and the willingness to pay of the consumers. A comparison of the supplier and the consumers' demand makes for a consumer surplus. In determining the equilibrium market, the cost method with some interpolation was constructed (in comparison with the current market price). Then the equilibrium price (Pe) was determined. Given this, the consumer surplus was obtained. To determine the economic value, the consumer surplus was multiplied with the population who expressed willingness to pay for environmental services. Hence, the consumer surplus was determined using the equation

$CS = \int_0^{qe} D(q)dq$; Then a comparison with minimum and maximum pricing was conducted to arrive at recommended pricing as price of regulation.

RESULTS

Profile. A survey was conducted with 287 respondents across Davao del Norte and nearby provinces/city with a 6% margin of error and 91% confidence level. A systematic sampling was implemented in order to ensure that the findings possess generalizable features for inference.

The distribution according to location takes Sto Tomas (25%) as highest, then Kapalong and Panabo City with 23% each. Maco in Comval with 11% and Lasan in Davao City with 11%, Tagum City take 6% of the total respondents. 57% of the respondents are employed either working in a private organization (8%), public (3.4%), on-contract with the government (11%) and the self-employed (30%). The household income congregates in P6,000-10,000 (37%), P10,000-15,000 (23%). There are also few who are earning an income of P30,000 to 50,000 a month (2%).

Table 1 Payment of Consumers

Cost by type	Revealed cost/m^3	Average payment of purchase	Maximum payment
Cubic meter	25	979	3000

71% of the respondents indicated that their households or a relative purchased sand and gravel which are either paid by cubic meter (25%) purchase or every dump (36%). The cost of dump oscillates between a minimum of P25 to a maximum of P3000 and an

average of P979. The minimum cost of sand and gravel per cubic meter is P25 as the respondents indicated.

Economic valuation of sand and gravel. Economic valuation technique is often used to reflect the non-market services of a product that has been imputed a market value like ecotourism (Tobias, 1991) forests (Adger et al., 1995) mountain lakes (Bateman, 2005) and other environmental resource like sand and gravel. The first step in obtaining the economic value of the sand and gravel is to determine the consumer surplus. The concept is widely used to measure economic welfare because of its compensation computation ability (Turnovsky, Shalit & Schmitz, 1980) and protection of the public environment (Bergstrom, Dillman & Stoll, 1985). Before proceeding, there is a need to construct the demand curve for the sand and gravel. Using the revealed demand from the survey, the demand function is given as $P = 796.43 - 8.79Qd$. On this, the imputed market price which is $P_e = 979$ was used. Using the same equation, the equilibrium quantity is $Q_e = 48.35m^3$. Thus using the $CS = \int_0^{48} D(796.43 - 8.79q)dq$, the computed consumer surplus is P8271.

The economic value is then computed using the formula $EV = CS * \%Population$, where EV is the economic value, CS is the value of consumer surplus, and the % of population refers to the households signifying desire for policy to protect the resource using price mechanism. Survey reveals that 73% of the population is participating in the market of sand and gravel. With a total of 604166 population based on 2010 census of 4 municipalities/city in Davao del Norte, dividing the number with 5 (average household size is 5), hence estimated household is 120833. Multiplying by 73%, then total household with consumer surplus is 88,208. Thus, EV=P8271.11 X 88208 households, thus the economic value of the sand and gravel as revealed by the consumers in Davao del Norte is computed at 729,568,368.

Table 2. Distribution of those who bought and know that sand and gravel is non-replenishable

Type	Know	%	Did not know	%	Total
Bought	181	93	13	7	194
None	63	79	17	21	80
Total	244	89	29	8	362

Table 4 Distribution of respondents wanting policy and direction of policy

Table 3 Policy needed to regulate sand and gravel extraction

Type	Tighter policy to regulate							
	Yes	%	Not	%	Neutral	%	Total	Total
Policy to regulate	209	96	1	0.46	8	4	218	
No need to regulate	159	82	8	4	27	14	194	
None	2	14	1	6	3	43	6	
Neutral	59	75	7	9	13	16	79	14
Total	218	80	35	13	40	15	273	40
Total	225	83	7	3	40	15	272	

Willingness to Pay (WTP) for environmental protection. The respondents were then asked about the quality of the sand and gravel as a non-replenishable resource as these are eroded particles from the mountains deposited at the river banks, and too much extraction will not do well to the environment. To this, 93% of those whose households bought sand gravel indicated that they know of the quality of the resource, while only 7% indicated that they did not know [see table 2].

Also, it was noted as presented in table 3 that 82% of the population is amenable of a regulation on the sand and gravel extraction. Only 27% of those whose have bought sand and gravel signified ambivalence to introduction of a policy, while 4% do not want a policy to regulate the sand and gravel.

Of the population indicating the need for policy to regulate the sand and gravel [see table 4], 96% reveal that the policy should gear towards tightening of the extraction of sand and gravel, while the neutral on an introduction of a policy, may be pulled towards support for tightening of the policy to regulate extraction.

Table 5 Willingness to pay preferences for a regulation

WTP	f	%
Option 1. Discourage too much extraction through increased price (add P100 on top of current price)	96	39
Option 2. Discourage too much extraction through increased price, pay for environmental cost (add P120 on top of current price)	52	21
Option 3. Discourage too much extraction by increasing price, pay for environmental cost, increase social projects in the quarrying sites (add P200 on top of current price	99	40
Total	247	100

Table 6 Constructed pricing using the WTP option and market prices

Unit	**Proposed pricing**

	Pricing 1 (minimum)	Pricing 2 (maximum)
Cubic meter	125	225

A policy option had been presented as reference for a regulation. Each of the option had corresponding measures and cost implications. The bundle of regulation for each policy include increasing price to discourage excessive extraction, pay environmental cost, and social projects at the quarry sites. A total of 247 respondents (86%) indicated response to the willingness to pay for environmental cost. Note, these are the respondents who possess the consumer surplus relative to the earlier computation. Table 5 displays the preferred option which is almost a two-way split: 39% of the respondents who possess consumer surplus are willing to pay P100 on top of the current price (option 1) while the other set of respondents (40%) are willing to pay P200 on top of the current price. Note that the option 1 is plainly price mechanism technique to reduce extraction by making the product expensive. Option 3 is a combination of environmental payment and compensation projects for the affected households along the quarry sites.

Using the price table extracted from the survey as presented in table 1, there are two ways to impose the willingness to pay (WTP). Table 1 identifies two preferred pricing, the minimum and the maximum which were constructed from the willingness to pay of the consumers [see table 6]. The price at which the consumers are willing to pay per cubic meter ranges between P125 to P225. Given the new pricing, it was determined that the consumers are willing to spend P1079 on the average to buy sand and gravel.

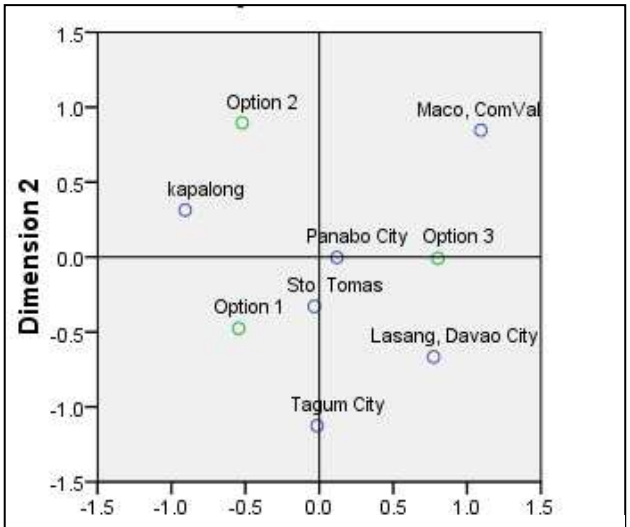

Fig 2. Correspondence analysis for WTP and municipalities

The correspondence analysis was employed to determine geographic association of WTP preference. It was noted as presented in figure 2 that Panabo City manifest preference for Option 3. A stronger association for preference for Option 1 than Option 3 was observed for Sto Tomas, while Tagum City is drawn to Option 1 than Option 3. Option 2 is patently attached to Kapalong.

Producer cost analysis. A cost construct was done for the permitees which were group widely as variable cost, fixed cost and shadow. The variable cost is composed of labor, fuel and other costs necessary in the extraction and disposal. The fixed cost includes acquisition of vehicles, permit to extract and business permit. Finally the shadow costs are other costs they deem informal in the cost structure of their business yet needing payment as well. Of the areas compared, total cost of Tagum and Panabo permitees are two lowest cost structures. This is because of the cheap permit to extract fee in Tagum City (P30, 000 permit cost) while P35, 000 for Panabo City. These are much lower compared to the permit cost for Comval (P80, 000), Davao Oriental (P115, 000), and Davao City (P65, 000). Tagum City's total cost is 18% compared to that of Davao Oriental and 20% of Compostela Valley. Given the gross difference among the permitees, it is likely that any increase in the cost may likely be absorbed by the Davao del Norte permitees than transfer operation in other areas with prohibitively expensive fees for permit to extract. The producers also possess a surplus of P23, 496 which can be used to absorb cost due to introduction of new pricing of the sand and gravel.

Table 7 Estimated Cost of Permitee to operate

Areas	Variable cost	Fixed cost	Shadow cost	Total cost
Tagum	2,498.00	31,823.00	86	34,407.00
Panabo	2,980.00	33,544.41	100	36,624.41
ComVal	2,246.67	169,293.33	50	171,590.00
Davao Ori	2,312.50	188,571.00	100	190,983.50
Davao City	815	91,900.00	45	92,760.00

Source of data: survey

CONCLUSION

The study found that the buyers of sand and gravel in Davao del Norte possess consumer surplus valued at P8271. Using the economic valuation technique, the computed economic value of sand and gravel was obtained at P729, 568,368 an indication of very high imputed valuation of the environmental resource. In fact, the survey shows that 82% of the population in Davao del Norte is amenable for a policy to regulate sand and gravel extraction. Of those who are indicating the need for a policy, 96% of them want a tighter regulation on the extraction of sand and gravel.

Using the willingness to pay, a tool in economic valuation of environmental resource, it was found that 40% are willing to pay an additional P200 on the current price, while the other 39% are willing to pay an additional P100 pesos over and above the current price. On this, a new price may be set at the price range between P125-P225 per cubic meter. The new price is set to be used as payment for environmental services and compensation projects at the quarry sites. Sto. Tomas and Tagum City are willing to pay an additional P100 pesos, while Panabo is willing to pay P100 or P200 pesos more for environmental services.

The permitees cost structures in Davao del Norte (Panabo & Tagum), Davao Oriental, Compostela Valley, and Davao City show that Davao del Norte costs are much cheaper than other areas, it is only 18% of the cost of Davao Oriental and 20% compared to cost of Compostela Valley. The cost differences are largely due to the permit cost which is cheaper in Panabo and Tagum than in other areas. This is suggestive that the permitees may likely absorb the cost rather than transfer operation in other areas.

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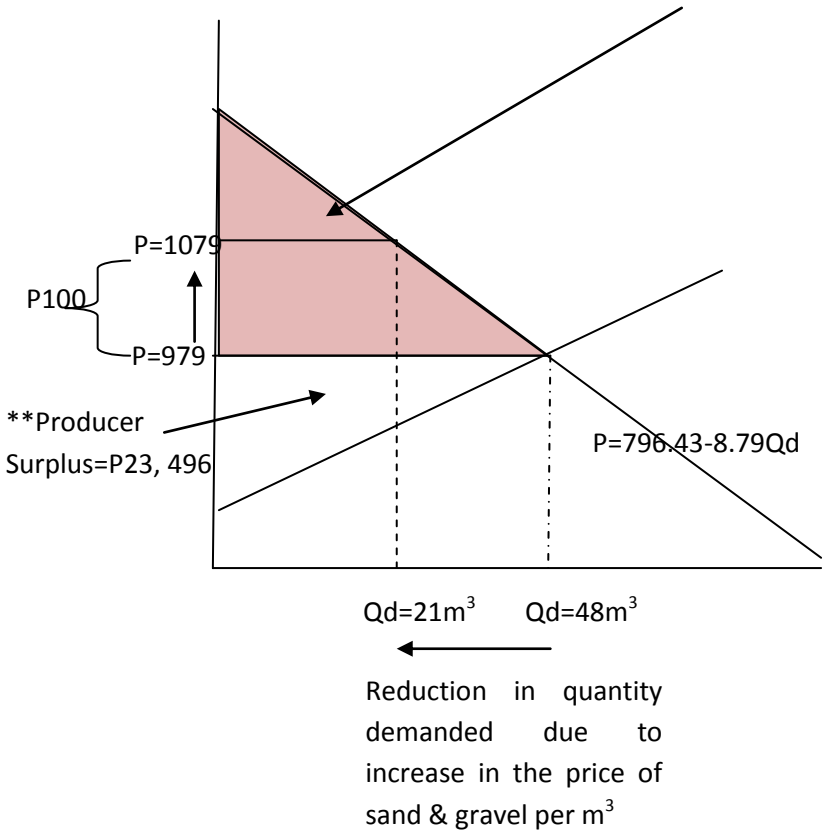
*Consumer Surplus = P1329



The consumer surplus is estimated at P8271.11 at price P979. An additional P100 for environmental regulation on extraction of sand & gravel will increase cost up to P1079 which is a capture of consumer surplus. With the increase, the demand will reduce to $21m^3$.

Meantime, the producers possess a surplus of P23, 496. Revenue still is highly viable among the permitees even if new market price is introduced. The new price will not hurt the revenue flow of the permitees significantly

*consumer surplus refers to the difference between the amount consumers are willing to pay and the amount they actually pay

**producer surplus is the difference between the price the consumers are willing to sell and the actual price