Available online at www.elixirpublishers.com (Elixir International Journal)

Civil Engineering

Elixir Civil Engg. 67 (2014) 21283-21285

ISSN: 2229-712X

Benefit Cost Analysis of Dredging Bonny Channel

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ARTICLE INFO

Article history:
Received: 8 July 2013;
Received in revised form:
20 January 2014;
Accepted: 1February 2014;

Keywords
Dredging,
Bonny,
Channel.

ABSTRACT
A series of models were developed and analysed to determine the relative weight of local political, infrastructure, and economic gains to lake user as well as physical-natural characteristics of the lakes and their respective communities on allocation of dredging fund. The also estimated the benefits of dredging and performed cost-benefit analysis to compare the costs of dredging to benefits of dredging for Bonny channel. These estimates were then forecasted in order to view the benefit stream over time.

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Introduction

A review of published literature on the sensitivity of corals to turbidity and sedimentation was presented, with an emphasis on the effects of dredging (Erftemeijer et al., 2012). The risks and severity of impact from dredging (and other sediment disturbances) on corals are primarily related to the intensity, duration and frequency of exposure to increased turbidity and sedimentation. From 77 published studies reviewed 89 coral species were sensitive to turbidity and sedimentation.

Zilio et al. (2003) estimated the social cost of a dredging process in the Bahia Blanca Estuary. Considering the loss of the nursery service as the main impact of the project, and taking into account the loss of jobs associated with fishery activities, they found a social cost of the dredging process between 5 and 6.5 million dollars. Lehman et al., (2012) presented a cost-benefit analysis to compare the costs of dredging to benefits of dredging for two lake user groups; lakeside property owners and non-resident boaters. These estimates were then forecasted in order to view the benefit stream over time.

Methodology

Data Acquisition

Data were collected from dredging companies and the Nigerian Ports Authority, Port Harcourt. Other necessary information like the types of dredging machines, costs of various important items and impacts of dredging on the environment were obtained from literature.

In addition to the above sources, some individuals who have one thing or the other to do with dredging were interviewed. They include a chief hydrographer with the Nigeria Authority, workers in dredging companies, fisher men, tourism and hotel workers in Nigerian Ports Authority Onne and Bonny. The number of respondents in each location are presented in Table 2.1.

Cost Analysis

Three kinds of costs involved in the management of dredging and its sediments are:

❖Costs of dredging, sediment transport, treatment, land acquisition.

❖Cost of foregone port services as a consequence of capacity constraints and channel restrictions.

❖Environmental costs, that is costs incurred due to damages to natural resources.

Table 2.1 Number of respondents in each location

No	Location	Fishers men	Officials	Tourist/Hostel Operators
1	Onne	5	3	12
2	NPA PH	2	8	2
3	Bonny	15	6	20
	Total	22	17	34

Cost of dredging pertain to any action taken to dredge the channel to allow vessels with high draught length to pass through the channel while the second type of cost is associated with the impact of not dredging the channel on ports. Failure to maintain channels by dredging restricts shipping. Ships may be able to enter only at high tide, or they may have to lighten their loads by transferring cargo to other ships outside of port. Restrictions, delays, and extra handling add costs to the movement of cargo through the port. Ultimately, these costs are absorbed by the general public in the form of higher prices for transported goods (Cropper and Freeman, 1991).

The last component, ecological costs, includes the economic costs of damage to the ecological functioning of a natural resource. These costs can sometimes be measured, for example when wetlands provide habitat for a species that is harvested commercially. In most cases, however, the term "ecological cost" is an admission that some aspects of the environmental effects of policies cannot be measured and must be assessed qualitatively.

The costs component considered are environmental cost of dredging, benefits of increased navigation and tourism.

B_d = Direct benefits
B_e = Environmental benefits
C_d = Direct cost
C_e = Environmental costs

A linear model can be used to calculate environmental cost. These linear equations estimate linear impact of dredging

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directly to navigation and indirectly to fish ecosystem, certain variables were used to estimate the impact of dredging.
This criteria is net present value (NPV) and is given as

The value of the costs and benefits are evaluated using the net present value expressed by

$$NPV = \sum_{t=1}^{n} + \frac{(B_t - C_{dt} - C_{et})}{(1-r)^t} \quad (2.1)$$

Where
B_t= Benefit at time t,
C_{dt}= Cost at time t,
C_{et} = Environment cost at time t,

Society benefits and cost are based on welfare, effects being measured by willingness to pay and costs by opportunity costs of resource uses forgone.
This can be shown as (Pearce and Turner, 1990)

$$NPV = B_d + B_e - C_d - C_e \quad (2.2)$$

The total cost (C_T) and benefits (B_T) for dredging, navigation and tourism represented by I = 1, 2 and 3 can be expressed as

$$C_T = \sum_{t=1}^{3} C_i + \sum_{i=1}^{3} E_i \quad (2.3)$$

and

$$B_T = \sum_{t=1}^{3} B_i \quad (2.4)$$

where
C_i = direct cost of cost item i,
E_i = environmental cost of cost item i and
B_i = benefit of dredging to item i
$\therefore$ the total NPV is

$$NPV = \frac{\sum_{t=1}^{3} B_i + \sum_{i=1}^{n} C_i - \sum_{i=1}^{3} E_i}{(1+i)^i} \quad (2.5)$$

Indirect impact to each activity may be estimated with the equation

$$p_j = a_j + b_j E_j, \quad j = 1, 2, 3 \quad (2.6)$$

Results and discussion

Cost Estimates

The results obtained are presented in Table 3.1 to 3.4. Table 3.1 showed the impacts of various activities such as dredging, navigation and tourism on the environment. The impact of dredging was that the fishermen would stop fishing along the channel due to high tidal waves.

About 60 fishermen in the area involved in fishing make average of N500 daily from fish sales. Seventeen (17) NPA and LNG dredging experts interviewed, estimated the benefits of dredging the channel to NPA and LNG. Further information were gathered from their annual reports. Thirty-four (34) people (mainly tourist, hotel operators and workers) provided the estimates for the gain of tourism before and after dredging the channel. Based on the information that there were 3 major hotels in Bonny, the cost on Table 3.2 were obtained. Table 3.3 gave the benefit of tourism to the Bonny community per month.

Table 3.1Imparts of various activities on the environment

No	Activity	Input	Output	Impact
1	Dredging	Dredger, engine gear	Dredging increased navigational use for big ships	Fish stock damage, ecosystem damage noise pollution air pollution, turbidity etc
2	Navigation	Boat and engine gear	Navigational use for moving goods in and out of the country	Less fish stock damage, less noise pollution less air pollution less turbidity
3.	Tourism	Tourist facility	Tourist number	Increase in tourist due increase in navigational activities due to movement of ships, increase in prostitutions in the community, corruption to community

Table 3.2 Benefit/cost of hotels A, B and C

Items of Benefit/cost	Hotel A	Hotel B	Hotel C
Total money made from tourist workers lodgement			
Maximum amount (N)	60,000	51,000	55,000
Minimum amount (N)	46,000	19,000	32,000
Average – monthly income (N)	53,000	35,000	435,000
Total annual income (N)	1,578,000		
Total income after dredging*	4,734,000		

*Those interviewed are of the opinion that the income will triple after dredging

Table 3.3: Benefits of fishermen before dredging

No	No of fishermen/day	Amount made per day (each make 500 per day)	Annual income	Impact (N)
Max no	60	30,000.00	360,000	360,000

Average Annual Income

The fishermen annual income (Table 3.3) becomes the environmental cost after dredging as they can no longer fish alone the channel due to high tidal waves. Some of the activities could not be quantified in monetary terms due financial constraints and non-availability of data.

Environmental cost of navigation was calculated from Table 3.1 as N10,980,000 while direct cost of dredging was obtained as shown below:

Calculation of Dredging Cost

Dredge the Channel to 14m depth
The length is 17.5km
The width is 400m but should be reduced to 250m
Present average depth is 12.5m – (NPA Annual Report, 2000)
International charge rate for dredging is $4 per cubic meter
Specification for gradient should be ¼ to reduce erodibility
Tidal range of the channel is about 2.5m
NLNG management wants the channel to be dredged further to 14m.
Calculation of volume of spoil to be removed along 17,500m – length
The volume of spoil to be removed = 17500m x 1.5m x 250m = 6,562,500m^3

The estimated cost becomes $\$4/m^3$ x $6,562,500m^2$ = \$26,250,000

The estimated cost of dredging the estuary based on the international dredging cost ($\$4/m^3$) becomes \$26,350,000, however dredging companies have different charges for different dredging machines (Balogun, 2006).

$\therefore C_T$ = 10,980,000 + 26,250,000 + 360,000

= N37,590,000.00

Dredging will result in increased navigation due to big vessels.

The total benefit of Navigation is expected to triple after dredging and the annual income was obtained from NPA.

$\therefore$ B = N1,389,970,000 x 3 = N4,109,910,000

The benefit to tourism was obtained as N4,734,000 (see Table 3.2)

$\therefore B_T$ = (4,109,910,000 + 4,734,000) = N4,114,644,000

Using equation 2.5, NPVN3,920,244,231

The results show that dredging is beneficial and should be encouraged. The benefit – cost ratio is 109.5 which is very high.

Conclusion

Dredging Bonny approach channel will lower the cost of transportation since it will allow bigger vessels to ply along the channel. Analysis showed that, in spite of the negative impacts of dredging, the benefit cost ratio is quite high. Hence, the dredging should be implemented. However, researches on better approaches of cost estimation of various environmental impacts of dredging should be conducted.

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