EVALUATION OF ECOSYSTEM SERVICES OF VILLORITA CYPRINOIDES IN VEMBANAD LAKE

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Abstract

Vembanad Lake, a wetland of international importance, famous for waterfowl habitat was designated a Ramsar site, for conservation and sustainable utilisation of the ecosystem. Millennium ecosystem assessment (2005) emphasises that the various services provided by the ecosystem benefitting human population needs to be identified and evaluated for judicious utilisation of the resources. Villorita cyprinoides is a major species contributing to the molluscan fishery of Vembanad lake. The study involving Villorita sp. was taken up with the objectives of development of a conceptual framework encompassing the different ecosystem services provided by the clam resources, estimation of the values of selected ecosystem services using appropriate proxies and analysis of the trade-offs between anthropogenic activities like dredging vis-a-vis clam resources utilizations following the principles of MEA (2005). The study identified that the clam fisheries in the lake is most acknowledged for its provisioning ecosystem services. Apart from the regulating services such as water quality maintenance and carbon sequestration, the cultural and the linking services provided by clam fisheries to human are also identified. In spite of the identification of the various services, the non-realisation of the value of the services provided by clam fisheries has prompted the destruction of the resource knowingly or unknowingly by our activities. One of the anthropogenic activities affecting the clam fisheries is the dredging of sub fossil deposits of clamshell or white clams which are good sources of calcium carbonate for cement manufacturers. Identifying the lacunae of non-realisation of the services of clam resources, the paper has judiciously attempted not only to evaluate the services of the ecosystem service provider but also to externalize the internalities in the ecosystem services evaluation process by considering the various social costs and benefits associated with the resource.

Keywords: *Black clam management, Ecosystem service provider, Ecosystem service evaluation*

Introduction

Vembanad lake in Kerala, a backwater, is one among the 26 wetlands designated as Ramsar sites globally. This is a unique ecosystem, found in Kerala, formed by the backward flow of seawater due to an obstruction in the natural current. This largest backwater in Kerala, covering an area of 2033 sq. km, is renowned as a major contributor to Inland fisheries. The ecosystem which forms an ecotone between brackish water and freshwater environment is an abode of aquatic biodiversity. The lake serves as a habitat for a variety of fin fishes and shell fishes, and a nursery for several species of aquatic life [1]. The major species supporting the fisheries include the molluscan bivalve, *Villorita cyprinoides (*Black clam*)* and *Etroplus suratensis* (Pearl spot). Nearly 99 per cent of total *Villorita* harvest (56700t) is contributed by the lake annually. The anthropogenic activities affected the phytoplankton production upon which *Villorita* sp (suspension feeders) are wholly dependent. Ignorance on the quantity and quality of the services provided by clam fisheries is a major limiting factor, which needs to be solved out at the earliest in-order to highlight the aspects of conservation and sustainable harvest of the species. And hence, we are in an attempt to destroy the resource knowingly or unknowingly by our activities. Identifying the lacunae, [2,3] emphasized that the various services provided by the ecosystem benefitting human population need to be identified and evaluated for judicious utilization of the resources. The value of provisional services was evaluated on the basis of works done by Sen [4] and Gopal et al [5]. The clam resources as seed and genetic resource service provider was emphasized based on the works of Pullin [6] and Davis [7] respectively. This paper evaluates the genetic resources on the basis of an early in-situ culture of the species reported by Narasimham [8]. Ebrahim and Kamal [9] reported a carbon sequestration rate of 4.04 Gg C year^{-1}from Lake Burullus, Egypt. The studies done by Laxmilatha and Appukuttan [10] have been used in evaluating the ancestral services provided by the species. MEA [3] which propounded the concept of the evaluation of ecosystem services asserts the need for the identification of ecosystem service providers (ESP) as the preliminary step in the evaluation process.

Materials and Methods

The study is conducted with the cooperation of seven black clam cooperative societies namely Aaryad, Muhamma, Vaikkom, Vechoor, Thycattussery, Kavalam and Kuthiathode. Almost four to five clam fishing villages come under the jurisdiction of each society [11]. Ten key informants have been identified from each co-operative society. A socio-economic survey was conducted to identify and evaluate the various services provided by the clam population to the human settlement in the area post a reconnaissance study. The survey schedule included various details encompassing socio-economic status, livelihoods, outlets of clam shell

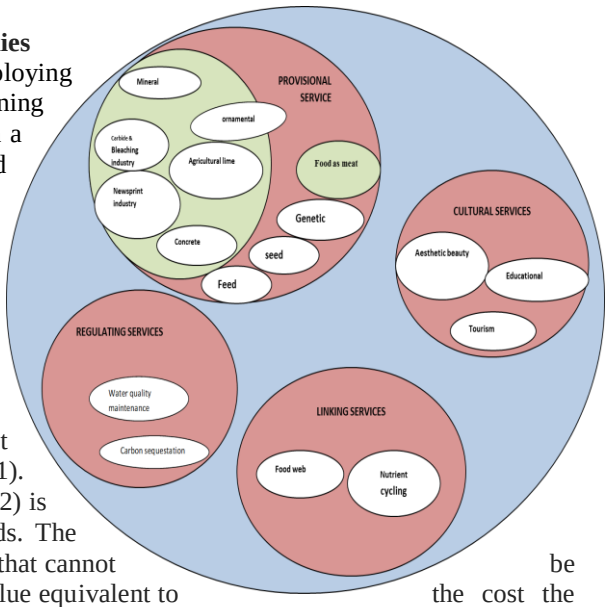
utilization and choice experiments on impact on dredging using key driver indicators etc. The sampling areas have been represented in the Fig 1.0. The clam production data for the quinquennial period from 2009-2014 were collected from the respective cooperative societies to arrive at clam production estimates and its utilisation.

Results and Discussion

Conceptual framework of the ecosystem services

The clams are providers of various ecosystem services, which are broadly classified under four categories as provisioning services, regulating services, linking or supporting services and cultural services. The services provided by (clams) benefactors are mainly provisioning services. The various services provided by clams vary with the necessities of the society. A conceptual framework of the services provided by clams is provided in Fig 2.0.

Fig 2.0: Conceptual framework of ecosystem services of clams



Evaluation of the ecosystem services using various proxies

The provisioning services of clams are evaluated employing diverse array of proxies. Prior to evaluation, the provisioning services are segregated into two subcategories, those with a pre-identified value *vis* food, mineral, feed and seed resources (Table 1) and those services with an unidentified value *vis* ornamental, genetic resources and food resources (Table 2). The provisioning services with identified values are mainly goods which are sold on a market. Such goods *viz* clam meat and clam shells disposed of, for various uses are evaluated using market price method, - a revealed pricing technique. The weighted averages of income from various channels of utilization of clam shells have been used as the market price for diversely utilized clam shell resources (Table 1). The unidentified category of provisioning services (Table 2) is evaluated with the help of alternative evaluation methods. The nutrient quality of clams like vitamins, trace elements etc that cannot be directly measured based on market prices, is assigned a value equivalent to the cost the people would possibly incur in the absence of the same in the resource. This value is obtained by considering the cost in procuring multivitamin medicament doses that would provide the concurrent quantity of nutrients in the food.

Table1: Evaluation of provisioning services of clams on the basis of market value

Sl. No	Provisioning services that are identified	Qty Utilized per ton of clams (kg)	Rate per ton(Rs)
1.	Food		
	A. Clam meat	97.50	9750
2.	Minerals		
	B. Clam shell	**900**	**2602.25**
	Lime for agriculture	303.66	391.72
	Lime for Vellore newsprint	459.25	464.82
	concrete mixing	36.62	405.13
	Lime for mineral companies	12.02	450.15
	Lime for agents (bleaching sugar, tanning etc)	30.51	570.19
3.	Feed		
	A. Feed for poultry(whole clam small size)	57.95	300.10
4.	Seed		
	A. Seed for clam culture	2.5	20.15
	Total(1+2+3)	**1000kg**	**12352.25**

Since the paper identifies the clams as a provisioning genetic resource, the value of clams may be arrived at by taking into account the cost for either the ex-situ conservation of the resource using selective breeding programmes or the in-situ culture of the resource. The third unidentified provisioning service, and ornamental resources are evaluated on the basis of the willingness to pay for the embellished clam resources. The cultural services and the attributes people attach to nature from a recreational, emotional or spiritual point of view were evaluated using travel cost method and willingness to pay method (Table 3). Aesthetic services existing in the lacustrine ecosystem and the availability of good water quality, patchy distribution etc provided by the clam resources have been taken into account in monetary terms using travel cost method which the person would forgo in order to get access to the particular service of the ecosystem (Table 3). Clam resources have attracted considerable interest for researchers over the past many years. A cost of one lakh per research has been imputed to arrive at the valuation of educational services based on the time spent , logistic costs and

remunerations for the contractual staff and key informants engaged (Table 3). Evaluation of cultural services has also been done by choice experiment in which two scenarios namely dredged and non-dredged are compared and analyzed based upon the perceptions of the affected persons (Table 3).

Table 2: Evaluation of provisioning services not yet identified

Sl. No	Provisioning services that are to be considered	Qty utilized	Amount
1.	Food		
	A. Clam meat		
	Calcium (gm)	32g	770
	Trace elements and vitamins, fatty acids (IU)		265.95
	Genetic (conservational aquaculture cost in Rs)	1 ton	8058
	Ornaments (lakhs)	1 ton	4.67

Table 3: Evaluation of cultural services

Sl. No	Cultural services	Amount(lakhs)
1.	Tourism (500Rs/boat*6 boats*15days/month*10months)	4.50
2.	Educational and political services	33.00
3.	Aesthetic service (cost for tour in lake/day=Rs.10000) for 15 days of operation of boat/month*10 months in an year	15.00
	Total	52.50

Analysis of the tradeoff between anthropogenic activities like dredging vis-a-vis clam resources utilizations

MEA (2005) single out an alternative method for evaluating ecosystem services on the basis of the impact of a driver. One of the many competing drivers affecting the clam resources is dredging. An attempt is made in this paper to analyze the tradeoffs between the highlighted clam resources and the dredging activities carrying through in the dredged area. For the study, the wetland is divided into two regions as dredged and non-dredged area for the purpose of comparative economic evaluation of the biological resource harvested by the clam fishers as well as the non-biological resource dredged out using dredger. The dredged area, in the northern part of the lake, is located near Vaikkom region, where as the non-dredged area is located in the southern part of the lake encompassing Muhamma, Aryaad and Kuthiathode regions . Following MEA, the key attributes to assess the value of the various services offered by clams are identified by interviewing nearly seventy clam fishers (Table 4).

Table 4. Key indicators for evaluating and assessing the value of ecosystem services impacted by dredging as perceived by fishermen (N = 70)

Ecosystem services	Key indicators (attributes)	How the services are affected by dredging	Perception of fishers (Numbers)
Provisioning services	Average weight of clams	-ve	100(70)
	Number of clams per predetermined area	-ve	100(70)
	Shell weight of clams	-ve	100(70)
	Survival rate of clams	-ve	100(70)
Cultural services	No. of fishermen involved in clam collection	-ve	85.8(60)
	No. of fishermen following clam collection from ancestors	-ve	100(70)
	No. of tourists that watch clam collection	-ve	100(70)
	No. of visits in the site related to tourism	-ve	100(70)
	No. of scientific papers published on clams	-/+ve	57.2(40)
	No. of committee to study clams	-/+ve	100(70)
	No. of surveys on clams	-/+ve	100(70)
	No. of black clam co-operative societies	-ve	71(50)
Regulating services	Trophic level of clams	Change to detritus	
	Concentration of carbon in water	+ve	

*Figure in parentheses shows the total number of respondents

Table 4 indicates that the provisioning services provided by clams would be negatively affected along with the majority of the cultural services due to dredging. The educational and the political services would be positively benefitted or adversely affected in the advent of dredging as the driver may or may not trigger the inquisitiveness of researchers to pursue a work on the related impacts of dredging as well as the public to organize a meeting in connection with the impacts of dredging on clam fisheries as represented in Table 4. The current visible services namely the provisioning services ie the value of clam meat and clam shell have been comparatively evaluated for the impact study (Table 5).

The clam production from dredged area though comparable with non-dredged area, certain aspects on comparison as mentioned in Table 5 suggests that the comparable production in the former area is mainly attributed to the harvest of the clams below the minimum legal size (MLS) of 20mm and the corresponding mean legal weight of 3.4g. The reduced growth rate on account of reduced plankton abundance along with mortality of the clams due to their smothering with re-deposition of substrata moved by dredge and the subsequent growth overfishing by the clam fishers to sustain their livelihood may be attributed as the limiting

factors of the clam biomass of that region ([12,13]. This reduced growth rate in turn fetches them a lower market value as highlighted in the Table 3.2. There is also an anticipated loss in revenue that the resource may provide, specifically on the basis of the area from where it is harvested affecting the economic value of the various ecosystem services they provide. Table 5 evaluates the loss of revenue from clams due to dredging.

Table 5: - Comparative evaluation of the dredged and non- dredged area

Criteria	Non-dredged area	Dredged area
Size of shell(minimum size) caught	10.24-15.10g(weight) 31-50mm(Length)	0.12-5.96g(weight) 9-15mm(length)
Average rates of clam shell from various outlets	Rs. 3075-3786/ton	Rs. 2000/ton
Market value of clam meat	Rs. 80-100/Kg	Rs. 40-60/kg
Yield of clam shell per annum	8015.62	10951.9
Mean yield of the clam meat per annum	890t	1216.88t
Loss in revenue in clam meat (annual)	Rs.19256	
Loss in revenue in clam shell sales (annual)	Rs. 56 lakhs	

Conclusion

It is appropriate to emphasize that when the public undertaking (cement manufacturing company) is wholly dependent on the white clams in the lake for their raw materials, their development and sustenance of livelihood of the workers of the company, the clam fishers on the other hand are exclusively dependent on the live black clams for their sustenance level of livelihood. It would be challenging for the policy makers to evaluate the two means of livelihood of the societies and suggest the governing authority in support of the strategically 'societal gains for community losses'. In this context, the paper would be of immense help as it throws light on the value of the services provided by the resources and has judiciously attempted to externalize the internalities in the ecosystem services evaluation process by considering the various social costs and benefits associated with the resource. Extensive works in future involving various other stake holders may provide a better evaluation of the services provided by these ESPs.

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