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Open Access Journal of Waste Management & Xenobiotics
ISSN: 2640-2718

Evaluating Provisioning Services in Betana Wetland Area, Belbari, Morang, Nepal

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Research Article
Volume 3 Issue 4
Received Date: September 18, 2020
Published Date: November 02, 2020
DOI: 10.23880/oajwx-16000148

Annotation

The ecosystem services from the wetlands offer economic opportunities for beneficiaries as well as generate revenue that in turn be used for conservation of the wetlands but the research regarding this is very limited in Nepal. Thus, this research was objectively conducted to assess the value of provisioning ecosystem services in and around Betana wetland, Nepal. The primary data were collected organizing questionnaire survey with 65 beneficiary households, key informant interviews with 11 key experts, and direct observations in January 2020; whereas the secondary data were collected from the published and unpublished documents related to the wetland. Statistically, descriptive and inferential statistics were applied to analyze the collected data so, Friedmen test, Likert scale, multi-regression analysis, correlation analysis were performed. The result showed that, there are 6 major provisioning services of the Betana wetland, namely; (a) water for irrigation, (b) fish farming, (c) water for others purpose (domestic & livestock's), (d) fodder, (e) wild food and (f) medicinal plants. Amongst these services, the estimated highest rank was 4.8 of the water use for irrigation. It was found that a total 1121 households were using the Betana wetland to irrigate about 219 ha of land and farming the crops like maize, rice, wheat etc. The monetary value of these crops was approximately US$ 223,958.33 based on hedonic pricing. The second highest rank was 4.52 of fish farming and its monetary value was about US$ 100,000. Especially, the farmers keep Silver Carp (*Hypophthalmichthys molitrix*), Bighead Carp (*Aristichthys nobilis*) and Grass Carp (*Ctenopharyngodon idellus*) in and around the wetland. The other services used by local people were (a) wild vegetable and mushroom (about 723 households); (b) livestock farming (it's worth approximately US $ 137,766; (c) grass and fodder (which monetary value worth about US $ 3,571.16). Statically, the correlation was evaluated between willingness to pay for the services and social variables. It revealed that the age group of the respondents showed the highest correlation between these services with R^2 (0.725) and followed by the household income having R^2 value 0.678 at 95% confidence level (P=0.022). This research, therefore, concluded that the provisional ecological services of the Betana wetland are useful source to uplift the economic condition of beneficiaries and hence this will be an important insight for the policy makers and authorities working in wetland conservation.

Keywords: Ecosystem Services; Willingness to Pay; Provisioning Services; Irrigation

Introduction

There are many types of ecosystem services in the world [1,2]. Some important types of ecosystem services are provisioning, supportive, regulatory and cultural services. These include several types of services and the people have been benefited from utilizing them. The provisioning ecosystem services are one of the important types of services which include food, water, wood, fiber, fishery and fuel mainly [3-5]. Similarly, the supporting services are nutrient cycle,

soil nutrient and primary production, regulatory services are climate regulation, flood and disease control and water purification as well as the culture services are aesthetic, spiritual, educational and recreational values [6,7].

One of the important types of ecosystem service is the water ecosystem service. Billions people getting benefit from using water ecosystem services. The lake, water fall, pond, ocean, river, glaciers and Himalaya ice are the major sources of water ecosystem [8,9]. Farmers use water for irrigation and getting benefit to get high yield. Drinking water is the vital source of ecosystem services [10,11]. The boating, shipping, fishery, wet land tourism, snow sports, trekking and tour are the major source of income generation [12]. However, there are several problem associated with water ecosystem services and professional dependent on this [13,14]. Therefore, global concern is becoming conserve the water ecosystem services through Ramsar sites.

The Ramsar sites has been increasing these days aiming to conserve the water ecosystem services and assuring to conserve the aquatic animals and plants, generation of more employment and income as well. There are 2300 Ramsar sites covering 2.1 million square kilometers around world [15]. The reason behind the practice of Ramsar sites is to conserve the wetland, aquatic flora and fauna. It is unbelievable fact that around 64% of wetlands dried since last century [16,17]. The consequence is obvious on human beings, their profession and income generation. The Ramsar sites are very good source of employment and income generation.

Several Ramsar sites or lakes are offering the employments for rural people and contribute to uplift their income. There are 37 Ramsar site in India which on which the local people depend on for employment and income as well. The Sundarban wetland is the largest wetland where thousands of people come to visit. Gangtey-Phobji wetland invites thousands of people to visit [18]. There are 64 Ramsar sites in China including Shanghai Yangtze Wetland [19]. There are 10 Ramsar sites in Nepal including Pokhara lakes which is famous ecotourism place in Nepal [20,21].

Some lakes Nepal are not under the Ramsar sites but that have been offering hundreds of employment and thousands of income [8,22]. One of the best examples of this is Betana lake in Morang district. Though, this is not managed under the Ramsar site, it is one of attractive ecotourism place conserving the aquatic ecosystem and providing the ecosystem services as well. The rural people have been getting benefit the provisioning services available in the lake. In this context, the value of provisioning services of this lake has not so far assessed. Thus, this research is objectively conducted to assess provisioning ecosystem services provided by Betana wetland and factors affecting the willingness.

Materials and Methods

Study area: Betana wetland of Belbari municipality, Morang in province number 1 was selected as the study of this study. The latitude of this is 26°39' N and longitude is 87°25' E. This site is situated at 115 meter altitude. It covers 5.5 ha at the fringe of the Charkoshe Jhadi which is the major of sources of its water. Generally, in rainy season when water level raises, over-water drained out through artificial outlets constructed at its southern bank.

Climate: The climate of the area is subtropical and characterized by three climatic seasons, namely hot, monsoon and winter. During summer time, there is extremely hot in the Terai region and extremely cold during the winter time. The hot season extends from March to June, the maximum temperature of Morang is 37.4°C, in the month of May and minimum 8.5°C, in the month of January. The average annual temperature is 24.4°C. Total annual rainfall is varying but it is about 1271 mm in general. Flora and Fauna: The forest area of wetland dominated by Sal (*Shorea robusta*) followed by Khair-Sissoo (*Acacia catechu- Dalbergia sissoo*) and mixed forest. The surrounding forest is the home for wild animals and birds like leopard, deer, Greyheaded fish eagle (*Icthyophaga humilis*) and Lesser Adjutant Stork (*Leptoptilos javanicus*).

Research design: Primary and secondary data were collected to meet the research objectives. The primary data were collected through beneficiary interview, key informant interview and focus group discussion while secondary information was collected from available written and unwritten literatures. Interview with different professionals. The list of total number of beneficiary was prepared and number of respondents were selected using formula given by Krejcie & Morgan.

$$S = \frac{x^2 NP(1-P)}{d^2(N-1) + x^2(1-P)}$$

Where, s= required sample size

$\chi 2$ = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841). N= the population size, P= the population proportion (assumed to be 0.50 since this would provide the maximum sample size) and d= the degree of accuracy expressed as a proportion (0.50). Beneficiary interview: There were 723 beneficiaries in total living surrounding to Betana lake. Out of this 65 beneficiaries were interviewed that were 35 male and remaining female. The check list was developed for this and Likert scale was used to collect the data.

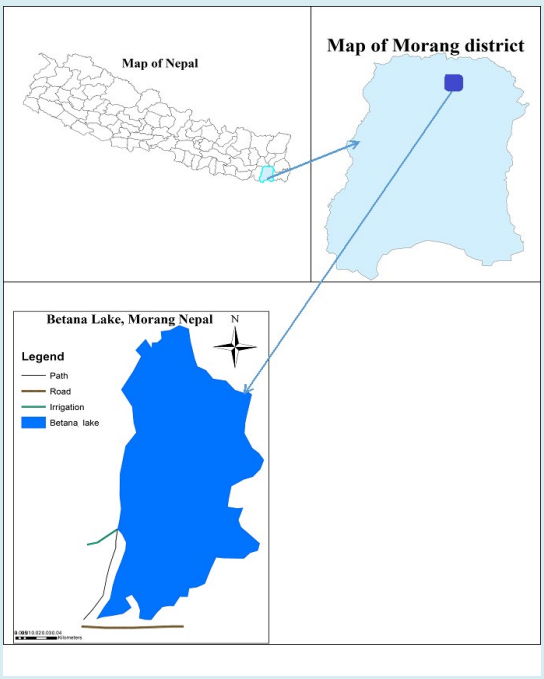

Figure 1: Map Showing Study Area.

Key Informant Interview (KII)

Total 11 key informant interviews were conducted to know the factors affecting the management of Betana lake. So, the check list was prepared for this which was tested before going to field. Observation: The researcher observed the site for one month to conduct the beneficiary interview, key informant interview as well as to involve the participation of monetary analysis. The data regarding the willingness to pay was collected from the people perception. These data were categorized according to gender, occupation, age, education, and distance from the lake, land holding, house hold income and ethnicity. Secondary data: Secondary data were collected from various published reports and unpublished documents, thesis, project documents, journals etc.

Data Analysis

The descriptive statistics and unitary methods were applied to analyze the collected data. The Factors were analyzed using Mitchell and Carson [23] model. Willingness to Pay (WTP) = (-1.220) Occupation + (-.381) D.F.L+ (-1.152) Land holding + 7.012. Multiregression was applied to evaluate the correlation between several variables with willingness to pay [24]. In addition, Friedman test was applied to compare the rank of the factors affecting the management of Betana lake. Moreover, the valuation of provisioning services was done using the hedonic price method [25].

Results and Discussion

A. Provisioning ecosystem services in and around Betana lake

➢ **List of ecosystem services in and around Betana lake**

There are several types of ecosystem services in around the Betana lake. Water for irrigation, drinking purpose, fisheries, trees growing (fodder production), wild food and medicinal plants are major provision ecosystem services offered by the Betana lake (Table 1). Total 1121 households were using the water of Betana lake for irrigation. Around 723 households were benefitted using the wild vegetable and mushroom.

Provisioning Services	Functions	Details	Total beneficiaries
Water for Irrigation	Irrigation for agricultural land and vegetable farming	Five canals were established to irrigate agricultural land. At most 100 ha of land were irrigated from the outlet water of Betana wetland.	Total 1121 households
Water for various purpose (domestic & livestock)	For animal husbandry and for Aahal (stay in water)	Outlet water is used for various domestic and livestock purpose.	At least 500 households
Fisheries	Fish farming inside and outside the outland area	Taltalaiya wetland conservation committee itself farm fishes inside Betana wetland area. Some of indigenous people also farm fishes outside wetland.	At least 25 households
Fodder	Grass for cattle	Farmers grow some tress for fodder production	Total 512 households
Wild food	Niguro (fern), Mushroom	Near the wet land	Total 723 households
Medicinal plants	Plants like Amala, Neem for medicinal purpose	In the forest and around the lake	Total 221 households

Table 1: List of provisioning ecosystem services nearby Betana lake.

➢ **Ranking of provisioning services at Betana lake**

The ranking value was varying according to ecosystem services. Specifically, estimated highest ranking value was found of water for irrigation with 4.8 which was followed by fish farming with 4.52. However, the lowest value was recorded of wild plants used for medicinal purpose. The Freidman test showed that there was a significant difference in the ranking value of the provisioning service in and around Betana lake (Table 2).

Ecosystem Services	Mean Rank	Std. Deviation	Freidman test
Water for irrigation	4.8	0.751	Chi-Square=
Fish Framing	4.52	1.002	160.443
Domestic uses (Livestock pond, *aahal :to stay livestock in water*, etc)	4.32	1.42	P=0.000
Plant use for fodder	3.25	1.33	
Wild plants use for vegetable	2.05	1.01	
Wild plant use for medicine	1.57	1.21	

Table 2: Ranking of ecosystem services.

Valuation of provisioning services

➢ **Value of services irrigated from Betana lake**

Around 219 ha of land have been irrigated from the water available of Betana lake. Generally, farmers grow maize, rice, wheat and some other crops. Farmers have been using the water avialbel for irrigating the different crops. Total value of crop was around US$ 223,958.33. Out of this, the highest value was of rice with US$ 95,625 (Table 3).

Crops	No of farmers	Season	Area irrigated (ha)	Monetary value (US$)
Maize	40		60	75,000
Rice	55	Winter	85	95,625
Wheat	45		40	32,500
Others	42		34	20,833.33
Total				2,23,958.33

Table 3: Use of water for irrigation and monetary value.

➢ **Value of water used for domestic cattle**

The total value of water used for the local people have been keeping the domestic animals nearby Betana lake. Total value of domestic animal was around US $ 137,766. Out of this, it was highest value of goat with US$ 43,750 and followed by pig with US$ 33,200 (Table 4).

Cattle category	No. of cattle	No. farmers	Monetary value US$
Cow	50	32	16,650
Buffalo	110	45	27,500
Goat	450	62	43,750
Pig	560	32	33,200
Others	510	40	16,666
Total			1,37,766

Table 4: Water for various purpose (domestic & livestock).

➢ **Value of fisheries**

Several people have been involved in fishing business in and around Betana lake. Total value of fish was around US$ 100,000 from fish farming. The local people were using the water coming from Betana lake for fishing different species like Silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*) and grass carp (*Ctenopharyngodon idellus*) and they were generating the income (Table 5).

Farming land	Number of fish	Fish spp	Farming Area	Monetary value (US$)
Inside Betana wetland	15000	Silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*) and grass carp (*Ctenopharyngodon idellus*)	2.5 ha	62,500
Outside Betana wetland(Farming by local farmer)	7000	silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*) and grass carp (*Ctenopharyngodon idellus*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*) and Catla (*Catla catla*)	3 ha	37,500
Total	22000		5.5 ha	1,00,000

Table 5: Water for fisheries.

➢ **Value of fodder and grass species**

Total value of grass and fodder species was US $ 3,571.16. Out of this, the highest value was US$ 498 of *Artocarpus lakoocha* planted trees which was followed by the value of fodder species *Bauhinia variegate*, *Litsea monopetala* and *Melia azedarach* with US$ 415 (Table 6).

SN	Name of Species		Measured quantity (headload)	Monetary value (US$)
	Local Name	Scientific Name		
1	Amriso	*Thysanolaena maxima*	3000	249
2	Bakaino	*Melia azedarach*	5000	415
3	Kutmiro	*Litsea monopetala*	5000	415
4	Badahar	*Artocarpus lakoocha*	6000	498
5	Tanki	*Bauhinia purpurea*	2500	207.5
6	Kimbu	*Morus alba*	2000	172
7	Bamboo	*Bambusa sp*	4000	332
8	Koiralo	*Bauhinia variegata*	5000	415
9	Ipilipil	*Leucaena sp*	10000	16.66
10	Dabdabe	*Garuga pinnata*	4000	164
11	Kabro	*Ficus lacor*	4000	164
12	Khanayo	*Ficus semicordata*	3000	123
Total			53,500	3,571.16

Table 6: Monetary value of fodder and grass species.
Note: 1 head load is 40-50 kg.

➢ **Value of medicinal plants and wild vegetable**

There are many types of medicinal plant speies in the forest nearby Betana lake. Local people have collecting these medicinal products from the forest and generating income. They collect *Phyllanthus emblica, Terminalia chebula* and *Terminalia bellerica*. Annually, they are generating about US $ 4323.33 in total. The highest income was generated from *Terminalia chebula* and *Terminalia bellerica* around US$ 1500. Another source of income was of fern and *Nasturtium officinale* from the forest (Table 7).

Medicinal plants wild vegetable	Uses	Measured unit	Monetary value US$
Aamala (*Phyllanthus emblica*)	Uses for Trifala, Aayurvedic medicinal purpose	500 Kg	350
Neem plant (*Azadirachta indica*)	Uses as Aaayaurvedic medicine (used for skin related problems)	200 Kg	1000
Harro (*Terminalia chebula*) /Barro (*Terminalia bellerica*)	Uses for Trifala, aayurvedic purpose medicine	1000 Kg	1,500
Niguro (fern)	For vegetable purpose	5000 bundles	833.33
Sim saag (Nasturtium officinale)	For vegetable purpose	4000 bundles	640
Total			4323.33

Table 7: Medicinal plants and wild vegetable.

Factor affecting willingness to pay for ecosystem services

The correlation of willingness to pay was varied according to gender, occupation, age, education, distance from the lake, land holding, house hold income and ethnicity. The highest R^2 value was 0.725of the correlation between age and willingness to pay. The second highest correlation was found between household income and willingness to pay with R^2 value 0.678 and it was significant at 95% confidence level (P=0.022) (Table 8).

Independent Variable	t-test (P-value)	Willingness to Pay (R^2 value)
Gender	0.488	0.152
Occupation	0.000*	0.35
Age	0.059	0.777
Education	0.13	0.346
Distance from the lake	0.014*	0.381
Land holding	0.023*	0.152
Household income	0.022*	0.678
Ethnicity	0.322	0.212
Constant	6.092	

Table 8: Correlation between the willingness to pay and different variable.

Discussion

The resources provided by wetland greatly affect the livelihood of local people. The ecosystem services are found to support a significant proportion of the surrounding of Betana wetland households. There are more than 1500 households living in the nearby Betana wetland area. The present study shows that Betana wetland is suitable place to provide provisioning ecosystem services. Decade of years ago the canal was constructed to managed the wetland overflow water for irrigation support to nearby agricultural land. Now day fish farming also created in wetland and nearby area, which managed the livelihood of nearby huge number of people. In the research about provisioning services and its valuation in Beeshajari lake [26] identified four types of provisioning services with important prioritization of firewood and fodder but study on provisioning services of Betana, the services become different. The reason may be because of geographical variation and availability of services in and around the Betana lake. Most of the people prioritized water for irrigation and fish farming as a top most services in the study area. According to millennium ecosystem assessment [27] provisioning ecosystem services particularly fresh water was kept under the high priority. In our study, some local people have been using the water of Betana lake for drinking. Similar study done by Subedi [28] showed that provisioning services delivered by Taltalaiya, Itahari was at high priority. Provision services include the water for irrigation, water for household purpose, fish farming, fodder, food and medicinal plant [7,29,30]. Our finding is matching with these researches. Among the provisioning services most of the respondent ranked irrigation water and fish farming as top ecosystem services [31,32].

Income generation from Betana lake utilization of different types of ecosystem services is the base of livelihood of the local people. The fishing business, agriculture activities, cattle keeping are major source of income for local people. These activities are due to sufficient water availability from Betana lake. Rural people depends on wetlands for water, medicine, food, building materials and hence the wetland is significantly contributing to livelihood promotion [33-35]. The water coming from wetland is boon for the farmers [36, 37]. Similarly, water use from Betana lake is utilized by majority of the people living nearby for different purposes.

The study also emphasized on the factor affecting willingness to pay for provisioning ecosystem services (ES). The significant factors are occupation of the respondent, distance from the lake and land holding which affect WTP by respondent. Residents from nearby wetland area were not interested for financial contribution for ecosystem services but were willing to contribute volunteer physical labour for conservation of wetland and also for social mobilization support. Shrestha, et al. [38] conducted study in Begnas Lake showed that, distance from the lake, occupation status and education of the people are the factors which affect willingness to pay for ecosystem service and our study also favour this logic. Occupation and distance from the lake directly affect the WTP for the proper conservation of wetland resources. Farmer was more interested to pay than other occupational group for continuing utilization of irrigation water and fodder [39-41]. With increased in distance from the lake people was less prefer to pay for utilizing service [42,43].

Conclusion and Recommendation

The study area emphasizes on the key provisioning services received from the study area and the willingness to pay for the conservation of wetland. The major provisioning services delivered by Betana to local people was found to be water for irrigation, water for household purpose, fish farming, fodder, food and medicinal plant. Among the provisioning services most of the respondent ranked irrigation water followed by fish farming as top ecosystem

services.

Occupation of the respondent, distance from the lake and land holding directly affect the WTP for the proper conservation of wetland area resources. Farmer was more interested to pay than other related occupational group for continuing utilization of irrigation water and fodder. Households within 1km zone were more attracted towards WTP. With increase in distance WTP was decreased. The total beneficial monitorial value for provisioning services obtained from Betana wetland is extremely attractive. Implementation of PES in Betana in coming days should consider irrigation, fish farming as major issues. Further detail research on other ecosystem services will give clear picture of PES in Betana wetland.

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