Residents' Dependency on Forest Resources: A Case Study on Ratargul Freshwater Swamp Forest of Bangladesh

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ABSTRACT

The only freshwater swamp forest of Bangladesh namely Ratargul Freshwater Swamp Forest (RFWSF) has a great contribution to the livelihoods of the surrounding local communities. Local communities or residents of the area depend heavily on this biodiversity-rich swamp forest for income, employment, fuelwood, and non-wood forest resources. An exploratory study was carried out in the swamp forest to explore the availability and consumption pattern of various forest

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resources, and dependency levels of residents on the RFWSF. Data were collected using a semi-structured questionnaire from 301 respondents (randomly selected from the residents) of the surrounding nine villages. The study revealed that respondents were dependent largely on the RFWSF for fuelwood, bamboo, cane, murta, ornamental resource, and other raw materials for cottage industries. Among the respondents 27% were involved in the harvesting of fish resources, followed by fuelwood (23%), grass (11%), and fodder (6%) collection. Bamboo was the main source of fuel for 41 % of the respondents and 40% depended on twigs and branches of trees. The findings of the study revealed that residents were highly dependent on the non-wood forest resources of the RFWSF for their livelihoods. Besides, a substantial amount of wood resources was consumed by the residents as fuelwood. Excessive unscientific exploitation of the forest resources disturbed the ecological functions and threatened the wildlife habitats of the RFWSF tremendously. The study recommended raising awareness and capacity building among the forest-dependent residents, proper implementations of forest law, and sustainable management could be the effective pathway for the upliftment of the resident's condition with ecological rehabilitation in the RFWSF.

1. INTRODUCTION

Bangladesh, the largest delta of the world, located in the Indo-Myanmar region [1] has rich biodiversity and supports a wide variety of natural flora, wildlife, microbes, and several living organisms due to its unrivalled geographical location [2,3,4]. The tropical forests of Bangladesh comprise a mosaic of units with high (e.g., natural forests), moderate (e.g., semi-natural forests), and poor (e.g., plantations) floristic and faunal diversity [5]. The forests of Bangladesh were classified into four broad categories based on their ecological attributes, i.e. tropical evergreen and semi-evergreen forest, tropical moist deciduous forest, freshwater swamp forest, and coastal mangrove forest [6]. Freshwater swamp forest of Bangladesh, a specialized form of forest, gets flooded and inundated during the monsoon season [7].

Tropical evergreen, semi-evergreen, deciduous, and freshwater swamp forests of Bangladesh provide several ecosystem services along with the simultaneous maintenance of biogeochemical processes [8,9]. Along with forest functions like biodiversity conservation, climate change mitigation, and contribution to the national economy, these forest resources contributed greatly to the poverty alleviation of the rural livelihood through income and employment generation related to forest goods and services [10]. Das [11] reported that access to forest resources helps and supports the local communities living near fringe areas of the forest to diversify their livelihood base, and reduce their exposure to risk regarding unemployment. A huge number of forest households in Bangladesh generate income from forest goods, consume a distinct proportion of forest products (i.e. food, fodder, fruits, household and thatching materials, non-woody plants, etc.), and raise multi-working capitals for trading activities [12,13]. Besides, the population growth of the country is directly responsible for continuous increment in per capita wood consumption which creates an enormous gap between demand and supply of the wood resource [14]. Moreover, the consumption of fuelwood is four times higher than that of industrial round-wood as about 65% of the forest resource is consumed as fuelwood in the country [15]. In these regards, the natural forest of Bangladesh has decreased significantly in terms of areas and quality over the last five decades [7,16]. So, sustainable management of the existing natural forests of Bangladesh is needed along with the optimal consumption of woody and non-timber forest products (NTFPs) [17]. Similarly, evaluation is necessary for better realization of the levels, distributions, dynamics, collections, and consumption patterns of plant resources of a certain forest area [18]. It is also needed to know the status of biological resources with their depletion levels to acquire better conservation and management goals of the natural forest resources [19].

Das [11] evaluated the dependency levels of the forest communities through non-timber forest products in the north-eastern region (Rema-Kalenga Wildlife Sanctuary, Habigonj) of Bangladesh. Dutta et al. [20] reported the consumption patterns of several woody and non-woody plant species by the local communities in the Sitakunda Botanical Garden and Eco-park of south-east Bangladesh. Meanwhile, Hossain and Hossain [21] recorded the dependency level and uses of forest flora by the local people in Chunati

Wildlife Sanctuary of southern Bangladesh. Mukul et al. [22] explored the role of NTFPs in the life and livelihood of local people in and around the tropical protected forests (Satchari National park) of north-eastern Bangladesh.

There are several studies on the dependency levels and livelihoods of residents on the tropical evergreen and deciduous forests of Bangladesh [21,22], but scanty information is available on the dependency levels of residents and their consumption patterns regarding forest resources in the freshwater swamp forest. The Ratargul Fresh Water Swamp Forest (RFWSF), locally known as the Hijol-Koroch forests, distributed in the Gowainghat of north-western Sylhet, Bangladesh; and also recognized as the only tropical wetland forest ecosystem having high potentials of biodiversity values and other intangible benefits [23,24]. In this study, an attempt has been taken to assess the consumption patterns of forest resources, and utilization of woods and NTFPs by the residents in the only freshwater swamp forest (RFWSF) of Bangladesh. Evaluation of the extent and nature of dependency of the residents on the RFWSF was another objective of this exploratory study.

2. MATERIALS AND METHODS

2.1 Background of the Study Site

The study was conducted in the only freshwater swamp forest of Bangladesh, namely Ratargul Fresh Water Swamp Forest (RFWSF). The RFWSF is the last existing freshwater swamp forest of substantial size [25]. The RFWSF is geographically located in the broad zone of Surma-Kushiyara flood plain, 45 kilometers away from the Sylhet city center towards the north-west, and distributed in the southern side of the river Gowain (Fig. 1) under the district of Sylhet, Bangladesh [23]. This biodiversity-rich freshwater swamp forest area was declared as 'Reserved Forest' under the 'Assam Forest Act' in 1932 [26]. The area of the forest is about 204.57 ha and three channels (locally known as Chengir Khal, Kaier Khal, and Shiali Chhora) flow through the forest area [27,24]. The general features of the RFWSF were expressed in Table 1.
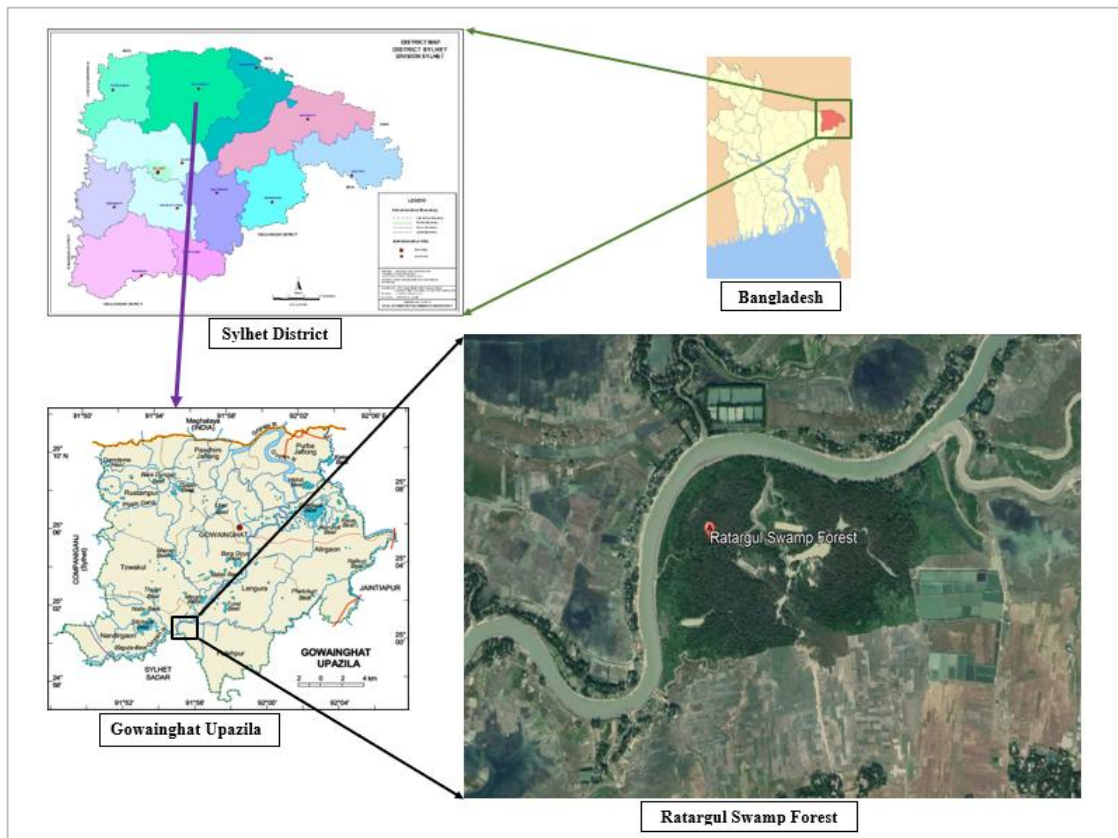

Fig. 1. Location of the study site (Mree et al. [25])

Table 1. General description of the RFWSF, Bangladesh

Parameters	Data	References
Elevation	35 feet above the MSL[*]	Choudhury et al. [23]; Hossain et al. [24];
Latitude	25°00.025'N	Islam et al. [26], Mree et al. [25].
Longitude	91°58.180'E	
Temperature (maximum)	32°C	
Temperature (minimum)	12°C	
Annual rainfall (average)	4162 mm	
Relative humidity	74%-90%	
Soil type	Silty clay loam	
Soil color	Gray	
Topography	Not uniform	
Inundation period	May-October	

MSL: Mean Sea Level

2.2 Experimental Design

The experimental design of the study contains a reconnaissance survey, development of the questionnaire, selection of the respondents from the nearby villages of the RFWSF, extensive field works, collection of data/information, and finally data analysis. A reconnaissance survey was carried out in the study area before the fieldwork to attain an overall conception about the dynamics and dependency level of residents on the RFWSF. This survey was useful to get familiar with the floral resources, access to the forest area, climatic factors, physiographic attributes, and management strategies of the ecological zones of this reserve forest. Another objective of the survey was to gather information for the preparation of questionnaires and to finalize the socio-economic objectives of the study.

2.3 Sampling Design

Ten field trips were conducted from December 2014 to March 2015 to assess the dependency level of the residents on the RFWSF. The RFWSF is surrounded by about 15 villages [25]. Considering their proximity and easy access to the forest area, 9 villages out of 15 were selected by following the approaches proposed by Mukul et al. [22], Mree et al. [25], and Mollah et al. [28]. Selection of village, community, households was done randomly using a random number table [29].

2.4 Questionnaire Development and Data Collection

An interview schedule was carefully designed to obtain all relevant information from the study area. The interview was done using a semi-structured questionnaire to obtain information about the dependency levels of residents on the RFWSF, and the questionnaire was pretested to fit in the fieldwork. The content of the questionnaire highlighted the demographic and socio-economic background of the residents, their attitude towards the collection and consumption of the forest resources as well as their perception regarding the current status of forest resources [11,29].

The respondents were the residents as they have been living in the area for more than 15 years. A total of 301 respondents were interviewed from surrounding nine villages (sampling intensity 36.88%) (Table 2). The number of respondents varied from village to village (not equal for every village) as the total number of families varied among the villages. The respondent number increases/decreases with an increasing/decreasing number of families in a village. All the respondents were selected randomly. Earning members or family heads answered most of the questions but other family members (mainly spouses) also attended during interviews and sometimes also answered some of the questions. Primary data were collected (i.e. income, expenditure, livelihoods, alternative livelihood preference, present status, and consumption pattern of forest resources, etc.) from the field level for the analysis of the dependency patterns. The respondents of the nine villages were categorized into three major groups (Group 1: BDT 0-7,000; Group 2: BDT 7,000-12,000; Group 3: BDT >12,000) based on their monthly income and expenditure. The occupation level (primary, secondary, and tertiary) of the respondents was assessed depending on their preference/ involvement.

Secondary data (i.e. forest map, physiographic description, etc.) of the study area were collected

from various secondary sources, such as published articles, journals, books, etc. and justified during the study. Scarce information was available regarding the study area because it was less explored. Personal communication and informal interview with several forestry personnel (i.e. forest guards, rangers, local key informers, etc.) of the RFWSF were conducted to collect precise information about the forest resources, plant vegetation, management practices, and residents' dependency.

Table 2. Village-wise family number and sample size in the study area

Village name	Total family	Sample size (n)[*]
Ratargul	111	40
Choiltabari	124	40
Aourartuk	107	40
North Dewanargao	99	40
Bagbari	103	40
Laxmi Haor	105	40
Gangpar	29	12
Puainkhata	78	29
Chanpur	60	20

Sample size (n)=Total number of respondents

2.5 Data Analysis

All information (qualitative and quantitative) was collected and sorted cautiously using spreadsheet software (Microsoft Excel, version MS 2010). The sorted data were analyzed to attain accurate findings using descriptive statistical tools, i.e. mean, median, frequency, percentages distribution. Finally, the major findings of this study were summarized and presented scientifically in the form of tables and graphs/figures.

3. RESULTS

3.1 Demographic Representation of the Respondents

The village-wise demographic representation of the 301 respondents (converted in percentages) is highlighted in Table 3. Though the respondents were found in almost all age classes, respondents were not found in two age classes (0-10, 11-20) for some villages. Out of nine villages, higher percentages of the respondents were found illiterate and with primary education in six and two villages respectively whereas, the village 'Laxmi Haor' exceptionally possessed a higher percentage of the respondents (45%) with secondary

education. Respondents were not found or hardly found in the higher education categories in most of the villages. In the case of marital status, higher percentages of respondents were found single in seven villages out of nine. The study revealed that the average number of people per household ranged from 5 to 8 in the studied villages. Compare to the other villages, the number of earning members per household was more in the village 'Laxmi Haor' (3 members). Higher percentages of respondents belonged to the nuclear family in five villages whereas, the rest four were dominated by the joint family. About 65% of the respondents of the village 'Ratargul' were directly or indirectly involved in tourism-based jobs. But in the case of other villages, engagement in the tourism-based professions was comparatively lower than 'Ratargul'. This indicated a decrease in the tourism-based job with an increase in distance between a village and the forest area but the exception was also found in the case of the village 'Gangpar' (Table 3).

3.2 Livelihoods in and around the RFWSF

The village-wise and average primary occupational status of the 301 respondents was shown in Fig. 2. The average percentages of the respondents in different primary occupation types were: Agriculture (26%), Skilled labour (25%), Tourism (10%), Fishing (9%), Work abroad (9%), Business (7%), Resource collection (7%), Civil service (2%) and others (5%). The 'Skilled labour' was mainly associated with the stone crushing industries of nearby areas. 'Resource collection' denotes the collection of forest resources from the RFWSF. The village-wise prominent primary occupations were: Ratargul (Agriculture, 40%), Choiltabari (Fishing, 42%), Aourartuk (Skilled labour, 33%), North Dewanargao (Work abroad, 27%), Bagbari (Skilled labour, 45%), Laxmi Haor (Agriculture, 48%), Gangpar (Skilled labour, 38%), Puainkhata (Others, 28%), and Chanpur (Agriculture, 53%). Contrarily, less involved primary occupations of the villages were: Ratargul (Work abroad, 4%), Choiltabari (Skilled labour, 1%), Aourartuk (Others, 5%), North Dewanargao (Civil service, 3%), Bagbari (Civil service, 3%), Laxmi Haor (Others, 2%), Gangpar (Business, 10%), Puainkhata (Work abroad, 3%), and Chanpur (Tourism, 12%). The respondents were involved in 'Agriculture' and 'Skilled labour' in all villages. Besides, respondents from eight villages were involved in 'Tourism' and 'Business'. Occupation type 'Work abroad' and 'Resource collection'

were found among the respondents from seven villages out of nine. The respondents from four and five villages were involved in 'Civil service' and 'Fishing' respectively (Fig. 2).

Table 3. Demographic features of the respondents in the study area

| Variable	Category	Ratargul	Choiltabari	Aourartuk	North Dewanarga	Bagbari	Laxmi Haor	Gangpar	Puainkhata	Chanpur
					Name of the villages					
Age (year) class distribution (%)	0-10	10	-	2	-	-	-	-	-	-
	11-20	42	-	10	5	-	8	-	16	12
	21-30	13	26	27	20	18	10	22	44	6
	31-40	20	20	49	45	32	30	22	16	24
	41-50	15	27	10	20	32	30	17	8	6
	≥51	10	27	2	10	18	22	39	16	52
Education level/Literacy rate (%)	Illiterate	35	70	42	64	45	12	78	60	76
	Primary	38	20	36	20	50	38	22	32	18
	Secondary	20	10	20	8	3	45	-	4	6
	Higher Secondary	5	-	-	8	2	5	-	2	-
	Graduate	-	-	2	-	-	-	-	-	-
	Others	2	-	-	-	-	-	-	2	-
Marital Status (%)	Single	42	78	68	80	85	88	83	48	82
	Married	58	22	32	20	15	12	17	52	18
Average number of people/ households	-	8	8	5	6	7	6	6	6	8
Average Earning member(s)/ household	-	1	1	1	1	2	3	2	2	2
Family type (%)	Nuclear	42	56	71	60	42	58	44	60	6
	Joint	58	44	29	40	58	42	56	40	94
Mean Distance from the forest (km)	-	0.56	1.77	1.81	3.75	4.53	1.85	0.28	2.28	3.00
Job type (%)	Tourism based	65	12	27	15	15	12	11	20	6
	Non-tourism based	35	88	73	85	85	88	89	80	94
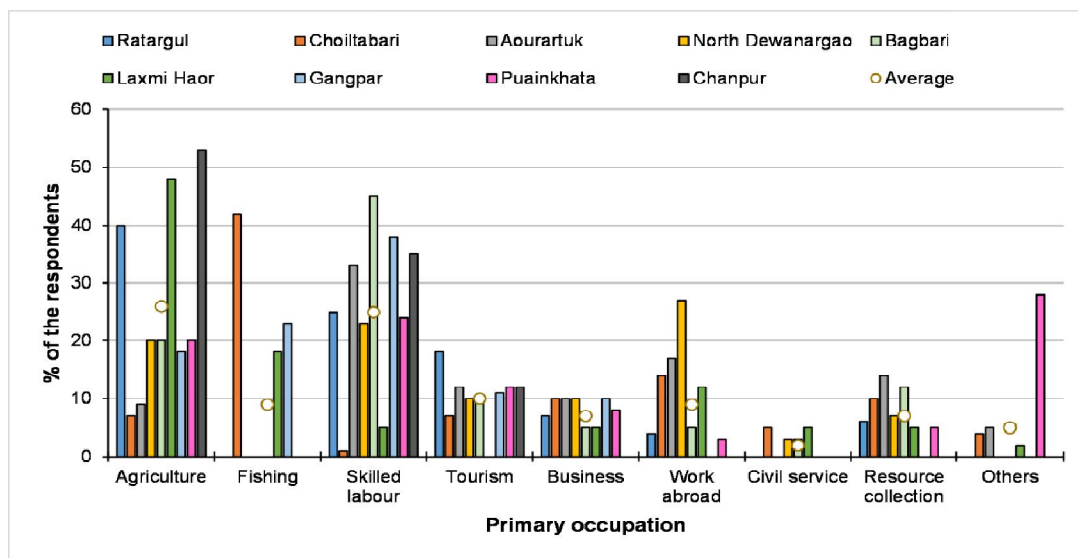
Fig. 2. Respondents' involvement (%) in different primary occupations in the study area
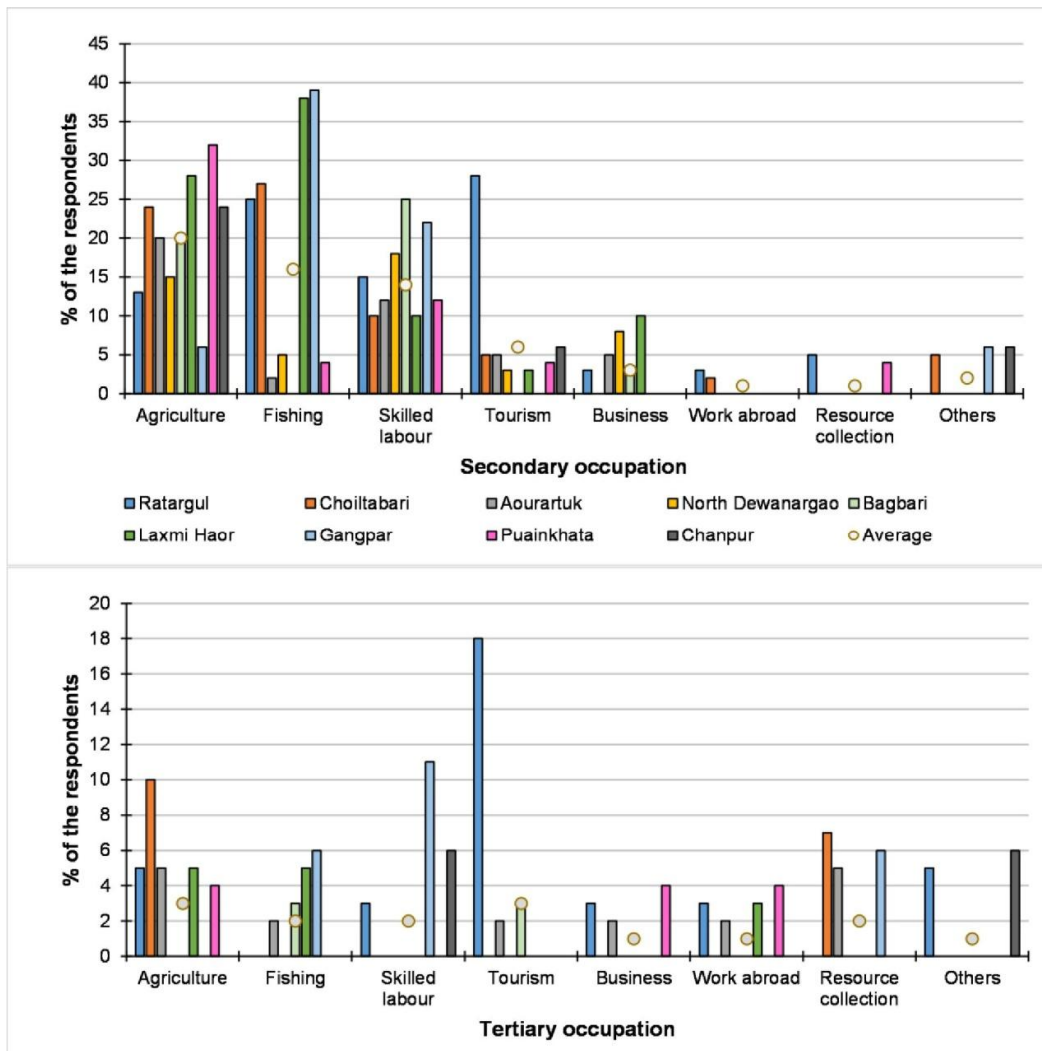
Fig. 3. Respondents' involvement (%) in different secondary and tertiary occupations in the study area

The study also reported that a substantial number of respondents preferred secondary or tertiary occupations for more income generation. As a secondary profession, about 20% and 16% of the respondents preferred agriculture and fishing respectively. Fishing was also a very popular tertiary occupation due to the availability of canals and water-bodies in the study area. Similarly, most of the respondents from the nearby villages preferred tourism, collection of forest resources, and skilled labour (stone crushing industries) as both secondary and tertiary occupations. Meanwhile, day-laborers from all the nearby villages also preferred collection of forest and fish resources from the RFWSF in their off days and during agricultural off periods (Fig. 3).

3.3 Alternative Livelihood Preferences of the Respondents

The study revealed that the respondents wanted to change their occupation due to less income from existing occupations. The study recorded some alternative sectors which were prioritized by the respondents for alternative income generation. Maximum (20%) respondents were trying to involve in the tourism sector as an alternative job because of low investment opportunities. The other alternative livelihood preferences preferred by the respondents were handicraft activities (17%), agriculture (16%), shrimp/prawn farming (11%), fruit/vegetable cultivation (10%), day-labor (8%) and poultry farming (5%). Respondents were more inclined

to generate income by performing handicraft activities because several non-wood forest resources are available in the forest area even in their homesteads. Few respondents (8%) opined that they were trying to work in the stone industry as day-laborer. About 13% of the respondents were unwilling to change their livelihoods even they did not prefer any alternative income generation activities (Fig. 4).

3.4 Status of Available Forest Resources from the Study Area

The RFWSF is the harbour of a wide variety of forest resources e.g. trees, bamboo, cane, grass, fuelwood, fodder, fish, bird, snail, and ornamental species. The present status of forest resources, which was assessed based on field observation, secondary forest data, and respondents' perception, was represented in Table 4.
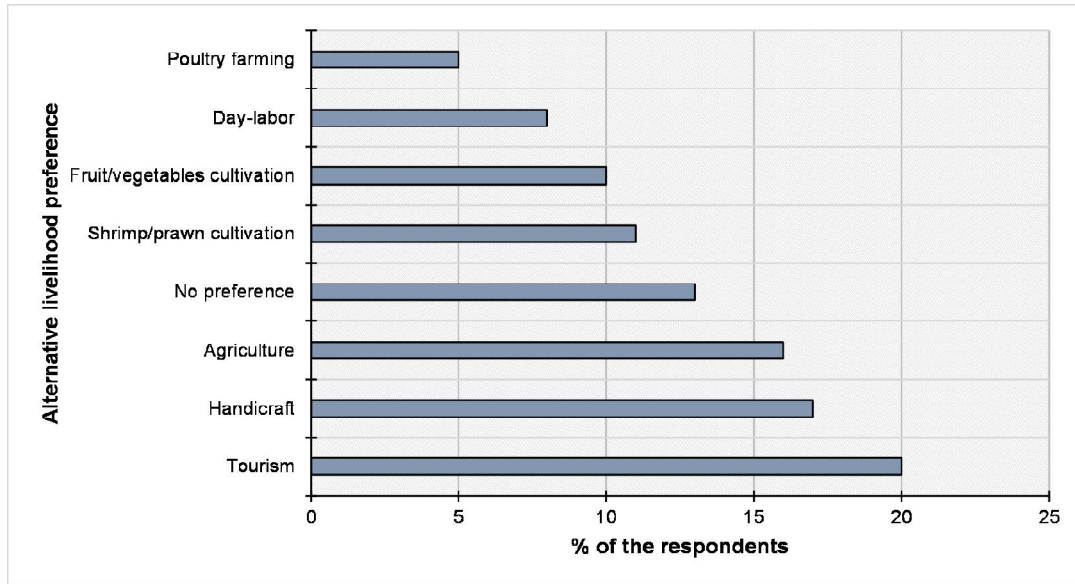

Fig. 4. Alternative livelihood preferences of the respondents in the study area

Table 4. Forest resources utilized by the residents residing near RFWSF

Forest resource	Origin of the resources	Present status*[+]	Extent of exploitation[+]
Tree	*Barringtonia acutangula* (L.) Gaertn. [Hijol][#] *Lagerstroemia speciosa* L. [Jarul] *Pongamia pinnata* (L.) Merr. [Koroch] *Trewia polycarpa* Benth. [Pitali]	✓✓✓	Medium
Shrub	*Calamus viminalis* Willd. [Cane] *Schumannianthus dichotomus* (Roxb.) Gagnep. [Murta]	✓✓	Medium
Bamboo	*Bambusa vulgaris* Schrad. [Bansh]	✓✓	High
Grass	*Eranthus ravannae* [Ekra] *Phragmites kakra* [Nol] *Sccharum spontanium* [Khagra]	✓✓	Medium
Fuel/firewood	All woody trees	✓✓	High
Forage and fodder	Various plant species	✓✓✓	High
Fish	From canals and wetlands	✓✓	Medium
Snail	*Helix pomatia* [Shamuk]	✓	Low
Ornamental resources	Plants and animals	✓	Low
Bird	Several species, i.e. Cuckoo, Dove, Junglefowl, Heron, Owl	✓✓	Medium

[#]*scientific name and local name of the species. *Key: ✓✓✓= good, ✓✓ = medium, ✓ = poor*
[+]*Assessed using the perception of the respondents*

3.5 Dependency of the Respondents on the Forest Resources

Respondents' dependency levels on the forest resources were evaluated by using the perception of the respondents. It was influenced by several factors (available resources, the distance between a village and the forest, the number of collectors, alternative income sources, etc.). Hence, the pattern of harvesting varied from village to village, household to household, even sometimes season to season. In comparison with other natural resources, three floral resources (i.e. fuelwood, grass, and forage/fodder, etc.) and fish resources were collected extensively by the respondents of the study area. The average percentages of the respondents involved in the collection of different forest resources were: fish resource (27%), fuelwood (23%), grass (11%), and forage/fodder (6%). Few respondents (8%) were also involved in the collection of raw materials (for cottage industries), ornamental resources, snails, as well as in hunting of birds from the forest. The NTFPs were mainly collected for households' self-consumption and rarely sold to the local markets. The study also revealed that about 25% of the respondents were not involved in any sort of resource collection. The village-wise exploitation of several forest resources by the respondents was also presented in Fig. 5.

3.6 Consumption Pattern of Fuel/ Firewood by the Respondents

The study revealed that respondents were involved in the collection and utilization of several floral resources for multiple purposes. Collected parts of trees, grasses, and bamboos were mainly used as fuel/firewood. On average, about 41% of the respondents of the study area utilized bamboo as the main source of fuel, whereas another 40% used the branch, twigs, and parts of several trees. The rest of them (19%) not only used grasses and shrubs from the RFWSF but also used sawdust from the nearby saw-mills as the sources of fuel. Meanwhile, grasses were only collected by the respondents of the village 'Gangpar' (Fig. 6). So, the respondents were highly dependent on the forest to meet their fuel/firewood demand. They exploited the forest resources from the RFWSF for their household consumption rather than selling or trading purposes.

3.7 Monthly-based Income and Expenditure Pattern of the Respondents

The study divulged that the maximum respondents (56%) in the study area earn below 7,000 Bangladeshi Taka (BDT) per month. About 24% of the respondents earn within the range of
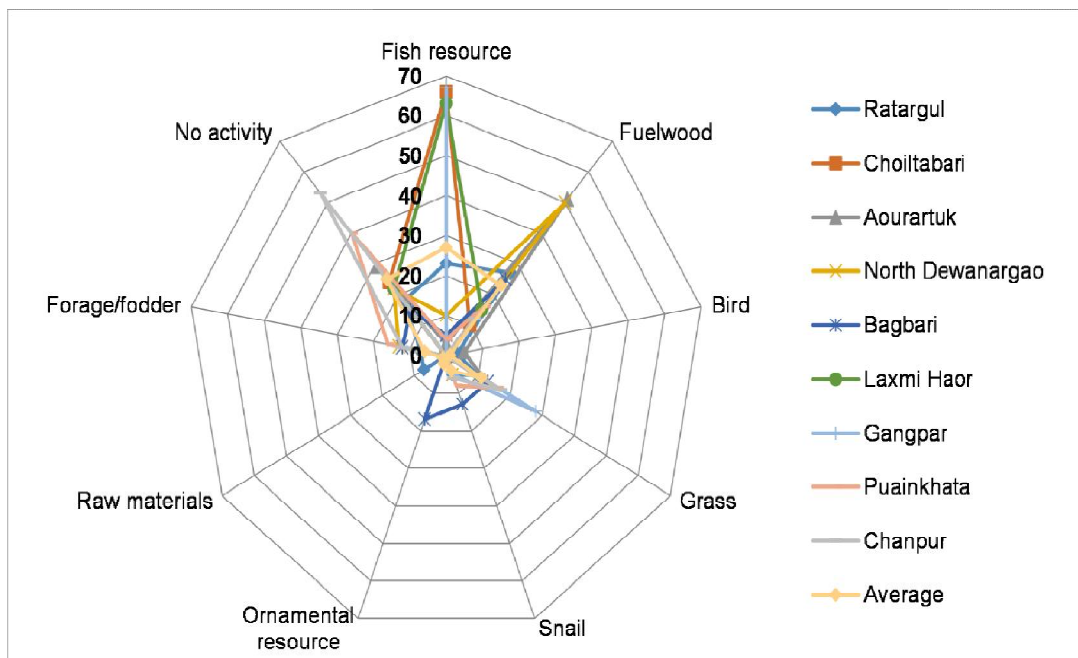

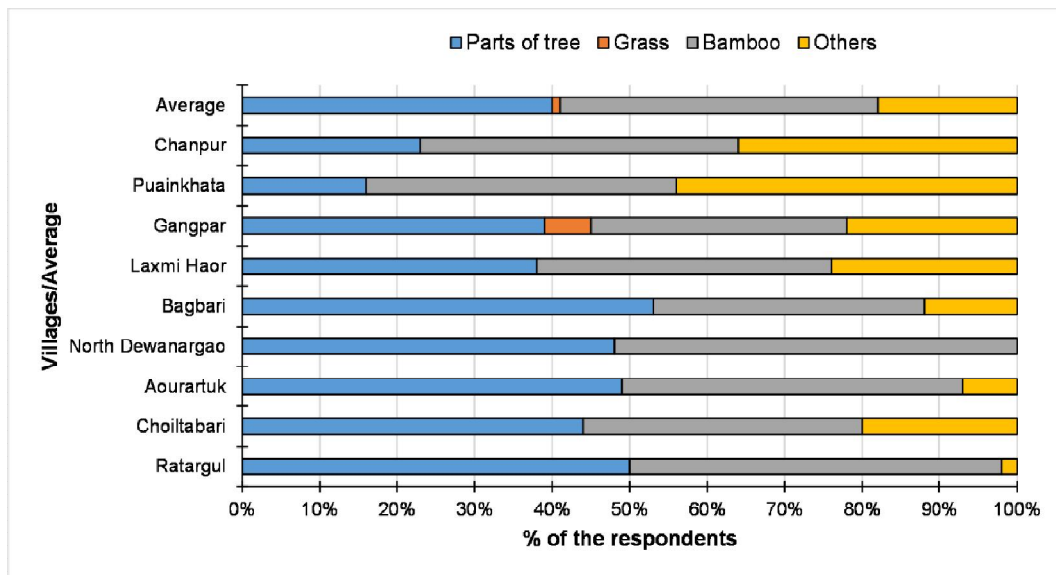**Fig. 5. Respondents' involvement (%) in the extraction of forest resources from the RFWSF**

Fig. 6. Consumption pattern (%) of fuel/firewood by the respondents in the study area
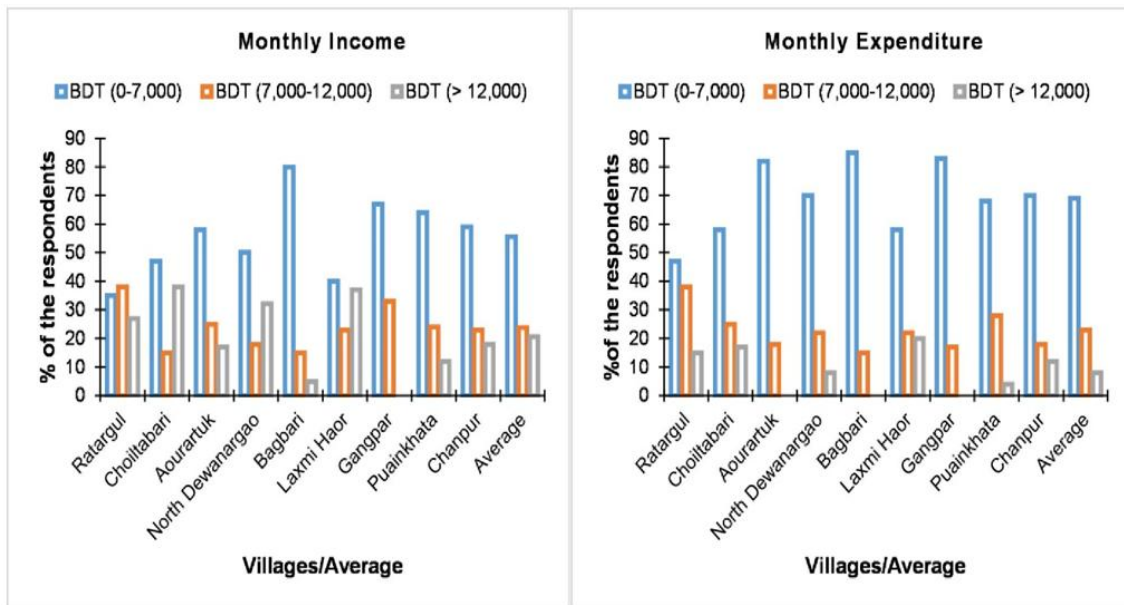

Fig. 7. Monthly income and expenditure pattern (%) of the respondents in the study area

7,000-12,000 BDT/month. A few (21%) respondents' income was above 12,000 BDT. Contrarily, maximum respondents (69%) spent below 7,000 BDT/month, whereas 23% of the respondents spent within the range of 7,000-12,000 BDT. Only 8% of the respondents spent above 12,000 BDT every month in their daily life. In most cases, the income from primary occupation was quite low in comparison with their expenditure. Hence, most of them were dependent on several forest resources for alternative income sources and livelihoods. The monthly-based income and expenditure pattern of the respondents residing in different villages was shown in Fig. 7. Higher percentages of respondents had monthly income within the range of 0-7,000 BDT in most of the villages. Similarly, most of the respondents spent within the range of 0-7,000 BDT in all villages. Fewer respondents were found within group 3 (>12,000 BDT) for both income and expenditure in most of the villages (Fig. 7).

4. DISCUSSION

In the present study, it was clearly stated that the residents of the study area have continuous and intimate interaction with forest vegetation as they have been deriving most of their basic requirements (such as food, fodder, fuel, fruit, and fiber) from the RFWSF. Extraction, processing, and marketing of these forest goods/products are still a major source of employment and income to the vast majority of the residents. These products are easy to collect, readily available, need no investment, and yields immediate returns. Because of these features, the residents are easily attracted to exploit forest resources. The study also revealed that residents want to collect forest resources due to their extreme level of poverty. Residents of Chittagong Hill Tracts (CHTs) are greatly dependent on forest resources for their livelihoods due to their poverty [30]. Kamanga et al. [31] also found the higher dependency of poor people on forest resources for income generation in Chiradzulu of Malawi.

Cottage industries play a significant role in the socio-economic development of rural communities in Bangladesh [20]. Bamboo and cane are the two important raw materials of these industries. Agricultural tools, household equipment, furniture, fence, etc. are also made by rural people with the help of bamboos [32]. Cane and Murta are also used to make toys, ornamental things, furniture, etc. Murta (*Schumannianthus dichotomus*) is a very demandable non-wood product to the residents of the study villages which provides high-income generations to them. According to Miah et al. [33], about 32% of the total income of the rural Chakma community was directly contributed by forest products in Rangamati. The result of the study indicated the availability of several NTFPs (bamboo, cane, and shrubs) in the study area which was quite similar to the findings of several studies conducted at Rema-Kalenga Wildlife Sanctuary [11], Sitakunda Botanical Garden and Eco-park [1], Satchari National Park [22], and Rangamati Hill Tract [34] of Bangladesh. These studies reported that bamboo, cane, murta, and several shrub species are the available and easily exploitable NTFPs in the several tropical forests of Bangladesh.

Moreover, some people are hunting wild animals like different types of mammals, birds, reptiles, etc. to continue their livelihoods in the RFWSF. So, shooting and hunting of native wildlife by the local hunter is a great threat to wildlife conservation in the RFWSF. Hence, the floral and faunal diversity of the RFWSF is enormously disturbed by the rural communities or residents. During the fieldwork, it was found that residents were highly dependent on the RFWSF for fuelwood, which intentionally or unintentionally disturbed the native forest resources, biodiversity, and biological functioning of the ecosystems. In that regard, wildlife habitats in the RFWSF are being threatened severely. A similar finding was recorded from the tropical mixed evergreen forest of the Chunati Wildlife Sanctuary (CWS) by Hossain and Hossain [21]. Hossain and Hossain [21] reported that the biodiversity of CWS is being reduced due to several anthropogenic disturbances. The present study revealed that about 55% of rural households/residents involved in the fuelwood and other NTFPs collections in the study area which was lower than the result mentioned by Das [11] in another forest of the Sylhet division where the researcher recorded about 75% rural people's dependency on the NTFPs and related raw materials. Bahuguna [35] reported that about 37-76% of rural communities were highly dependent on forests of different states of India.

The study fairly stated that residents of the RFWSF area are mostly engaged in agricultural activities. In the study villages, agricultural lands are harvested annually, and rarely harvested bi-annually. During agricultural off periods, residents search for alternative livelihood options. So, they try to improve their socio-economic condition by engaging themselves in different types of jobs like tourism, handicrafts, poultry farming, etc. A large number of tourists visit the RFWSF for its scenic beauty during the rainy season. In this period, most of the residents prefer the boating profession. After harvesting crops in summer, generally many of them work in the stone-crushing industry. In the RFWSF area, fishing is one of the prime occupations. Extensive fishing activities in the study area are causing degradation of fish resources along with amphibians and other wildlife. But there is no legal approach against excessive fishing activities; even adopted measures are very inadequate to address such issues.

All types of economic activities are occurring in the RFWSF without any interference by the respective Forest Department (FD) and other authorities. These types of activities in forest lands are disturbing some vital issues regarding sustainable forest management. The forest

department is facing a negative impact due to more extraction of forest flora. Furthermore, the regeneration of several plant species is tremendously hampered due to over-exploitation. The regenerating potentiality of the native species is decreasing faster which intensifies the reduction of the floral resources. Unplanned tourism and residents' illegal over-extraction are the major factors directly affecting the regeneration of forest plants [36].

In the RFWSF area, it is important to recognize that the extent of dependency on NTFPs is strong and its sudden withdrawal will severely affect the employment and income of the associated stakeholders. Therefore, a phased withdrawal of the extent of dependency is one of the desirable options. According to the report of Mallik [37], the local households should be gradually weaned away directly by providing income-generating activities through development programs, or indirectly through a systematic effort by providing them training in alternative vocations. Other than the withdrawal policy, it will be better to provide scientific training to the collectors and quantify the forest resources that can be collected annually without having an impact on the forest health. Besides, value addition to the NTFPs helps to generate additional income.

On the other hand, the Forest Department (FD) and non-government organizations (NGOs) should offer micro-credit loans to the residents as incentives to cultivate cane or other plant species scientifically within the forest area to meet growing demand. Sustainable resource management, awareness-raising among the forest-dependent residents, adequate implications of forest law and policy, improvement of livelihood opportunities, and incentives, as well as capacity building among the residents, should be considered for the environmental amelioration of the RFWSF by ensuring socio-economic upliftment of the residents.

5. CONCLUSION

Forest resources of the RFWSF have a great contribution to the livelihood of the residents. Due to the less opportunity for income generation, most of the residents tended to change their existing professions to earn more. Residents, residing around the RFWSF area, were highly dependent on forest vegetation for fuel/firewood, food, forage, and fodder. Although the residents know the proper utilization of the forest resources, indigenous knowledge is not

adopted in forest conservation practices. Proper documentation as well as the adoption of the knowledge in forest management strategies would be more fruitful for the upliftment of residents' livelihoods, conservation of existing vegetation, and amelioration of the ecosystems simultaneously. In the study area, several floras, specifically non-wood plant species are greatly vulnerable due to overexploitation. So, conservation strategy is needed to protect them in their natural habitats. Meanwhile, policy implementation may serve as a better tool, and a holistic view should be a better path for the improvements of residents' living standards and environmental sustainability. Policy-makers and foresters should provide more emphasis on plant conservation, and consider improving awareness of residents about sustainable utilization of natural resources of the RFWSF. Further study is also suggested for realizing the major impacts of residents' livelihoods on the RFWSF and vice-versa.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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