



Analysis of Power Dynamics and Livelihood Assets in Participatory Forest Management: Experience from Bangladesh

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Abstract: Participatory forestry (PF) plays a significant role to involve local communities and different actors in resources management and livelihood improvements. However, the power of important actors to misuse the PF for their self-interest has been stated as a key obstacle to success. Hence, this study seeks to identify the most powerful actors and the extent to which they affect PF decision-making and also to measure and evaluate the livelihood assets of participants. Empirical data were collected from Madhupur and Teknaf PF sites of Bangladesh during the different time intervals. The actors' power analysis found out that the forest administration evidenced itself as the most powerful and influential actors in PF. In the case of livelihood analysis, the overall results indicated that the total value of PF members' livelihood assets were 0.82 and 0.75 for Madhupur and Teknaf study sites. Livelihood asset conditions were significantly different between the PF members' and non-members' (0.65 and 0.62 for non-members'). However, the development of social and financial assets did not reveal a notable increase considering natural, physical and human assets. Therefore, it is very important to pay more attention to accelerate social and financial assets through intensive training, establishing conflicts resolution mechanism and adopting proper tree-crop technologies, and also provide alternative livelihood approaches to the forest dependent people. In addition, there is an immediate need to empower local PF members, by which the general members play the central role in decision making and governing all of their development activities.

Keywords: Actor, Power, Participatory Forestry, Livelihood Assets, Bangladesh

1. Introduction

In recent decades, there has been growing recognition internationally of the shift in forests resource management away from top-down, traditional management towards a participatory approach, which integrates local communities and all stakeholders in decision-making [1, 2]. Many countries have already developed or are in the process of developing changes to state laws and policies, which institutionalize PF

management approaches. However, the experiences of PF throughout the world have revealed that although decentralization and devolution policies yield benefits for local people, in reality there are also lots of limiting factors [2, 3, 4].

The PF is characterized by many stakeholders due to the economic, ecological and social functions and values that forests delivers. Besides the local communities, other groups at regional, national and international levels also have an impact on local communities/peoples' access to forests [5].

Theoretically four broad stakeholders are involved in forestry: the state, the local community, the private sector and the donors [6, 7]. All four stakeholders are important in forest management, and their cooperation is needed for sustainable forest management; often the state showed the most dominant and strongest role over other stakeholders [8, 9, 10].

In Bangladesh, PF management started in 1980s with the funding of donor agencies [11]. Till then PF was a government controlled and donor funded project in Bangladesh [3]. It has also had a political in nature due to its contestant type of access and control over forests in social and power relations. Bangladesh forests ecosystems, which are composed of the hill, sal and mangrove forests, display a great richness and diversity of culture and people, geographical features and biodiversity. PF covered both hill and sal forests while mangrove forests are restricted as a world heritage site. Forests management approaches in these forests have created great diversity in the social relations and interests among the actors. Therefore, the PF initiated an emblematic struggle between the diverse kind of actors in terms of dominance and power relations. Nevertheless, power has played a progressively important role in forest policy analysis since the implementation of PF programs in Bangladesh. It looks at PF from the perspective of local communities and main actors who use the forests in different ways for a wide variety of reasons [3, 9, 12, 13]. So, there is an immediate need to pinpoint the key issues relating to power, interests and outcomes in PF activities and their influence on the policy cycle in Bangladesh.

In developing countries, many forest resource management activities have been undertaken with the hope that they will simultaneously address the problem of the decline rural livelihoods and resources degradation [3, 14, 15]. The majority of the forest management regimes have tended to focus more on conservation than on helping to sustain local livelihoods. Conversely, PF is a better approach in forest management that has been applied to sustain livelihood and forest conservation. It is a people oriented, community based, resource focused and partnership based management approach, it is best to focus on the community and emphasize positive cooperation of different stakeholders in livelihood improvement and resource management [16, 17]. From a literature review, it is clear that PF does have the potential to contribute positively to the betterment of rural livelihoods and poverty alleviation [1, 18, 19]. Similarly, the success of PF throughout the world has revealed that decentralization and devolution of power among the PF actors often yield benefits to local participants [2, 20]. So, there is an enormous relationship between the actors' power and livelihood development in PF.

Livelihood analysis, particularly in a quantitative aspect, is a critical task because most scientists focus on qualitative analysis of livelihoods. Moreover, how to analyze changes in livelihood assets under the impact of PF is another challenge. Within the context of Bangladesh, these challenges are really immense due to the lack of previous research and reliable data. Therefore, the study first seeks to identify the most powerful

actors and the extent to which they affect PF decision-making and secondly, to measure and evaluate the livelihood assets of participants in the process of involvement in PF programs. These two objectives will outline a series of questions. Who are the participating actors and of them, who are the most powerful actors? How do we measure livelihood assets pentagon in the study areas? How changes in livelihood assets should be measured on a temporal scale? And how should livelihood assets be improved in the future in terms of data the study obtained from different indicators?

Theoretical Frameworks

Power in general refers to the 'ability to impose one's will or advance one's own interest' [adopted from 21]. It is also anticipated that participation can overcome power imbalance by involving all actors in a process that meets their interests, and this study addresses the issue that power may alter the outcome of participation behavior. Maryudi (2011) defines actor-centered power as 'a social relationship in which the actor 'A' alters the behavior of actor 'B' without recognizing B's will'. Actor-centered power influences participatory forest management in aspects of the most powerful actors and their diversified interests. The research for this study, therefore, relies on Webber's (1964) theory on power against resistance (coercion and incentives) with a new dimension of power without resistance (trust) [22]; so power is clearly composed of coercion, incentives and trust elements. According to Webber (1964) acts of resistance could bring light power resting within social relations, and the resistance could be broken forcefully through coercion or softly by incentives. In addition to Webber's thinking, there is the possibility that power relation can be present without resistance, i.e. 'trust'. So, the study's elements of actor-centered power consist of coercion, incentives and trust [22, 23]. Simply, trust is a power element through which the subordinate changes his behavior by accepting the potentate's information [9]. Power is exercised by use of information. The practice whereby an individual or a group of people are forced by a different party to involuntarily behave in a certain manner is coercion. This is made possible by either action or inaction [24]. However, incentives are financial or non-financial factors that alternate a subordinate's behavior by motivation. Here motivation is the initiation of goal-oriented attitude and also the expectation of benefits that encourages people to change their behavior. So, the actor-centered power conception is regarded as more useful for the analysis of power in the case of forest management and policy issues.

A livelihood is comprised of the capabilities, various assets, strategies, activities and various factors required for a means of living [25]. A livelihood is sustainable when it copes with and recovers from stress and shocks, maintains or enhances its capabilities and assets, while not undermining the natural resource base [25]. A number of institutes (e.g. CARE, IISD, DFID) have been developing the Sustainable Livelihood Analysis (SLA) approach, and SLA's definition is based on the ability of a social unit to improve its assets under outside impacts [26]. SLA framework looks at the basic dynamics of livelihoods and how people are represented on a set of assets

as a basis for their livelihoods [27, 28]. So, SLA first looks to identify important assets, such as physical, human, social, natural and financial aspects related to livelihood. This study has focused on DFID's SLA framework in which the assets are represented as human capital (knowledge, skill, labor, good health), physical capital (infrastructure, transport, shelter and communication), social capital (relationship of trust and reciprocity, networks and membership of groups), natural capital (land, forests, water, wildlife and biodiversity) and financial capital (monetary resources- savings, credit and remittances). Improvements of the five livelihood assets could be termed as strong SLA, whereas improvement in only some of the assets that compensate for any decline in other assets could be termed as weak or poor SLA [29]. Participatory forest management is people oriented, community based, resource focused and a partnership-based resources model, which focuses on community and emphasizes natural resource management and livelihood development [16, 30]. Therefore, the study has attempted to measure the livelihood assets of participating people influenced by participatory forest management programs in the study areas.

2. Methodology

2.1. Study Area

In Bangladesh, the moist deciduous Sal forests and tropical evergreen and semi-evergreen forests cover an area of 120,000 ha and 670,000 ha respectively, and these forests are owned by the Bangladesh Forest Department [3, 31]. Sal forests are distributed over the relatively drier central and north-western part of the country consisting of mainly Tangail, Mymensingh, Gazipur and Dhaka districts. The majority of the Bangladesh Sal forests are located at the Tangail and Mymensing districts, which is called Madhupur Sal forests and considered one of the most successful PF programs in Bangladesh [3, 32]. The tropical evergreen and semi-evergreen forests are extended over the southern part of the country, consisting of Chittagong, Cox's Bazar, Chittagong Hill Tracts and Sylhet districts. The study was conducted at the Madhupur Sal forests and Teknaf (also a potential PF site) under the Cox's Bazar tropical evergreen and semi-evergreen forests area (Figure 1).

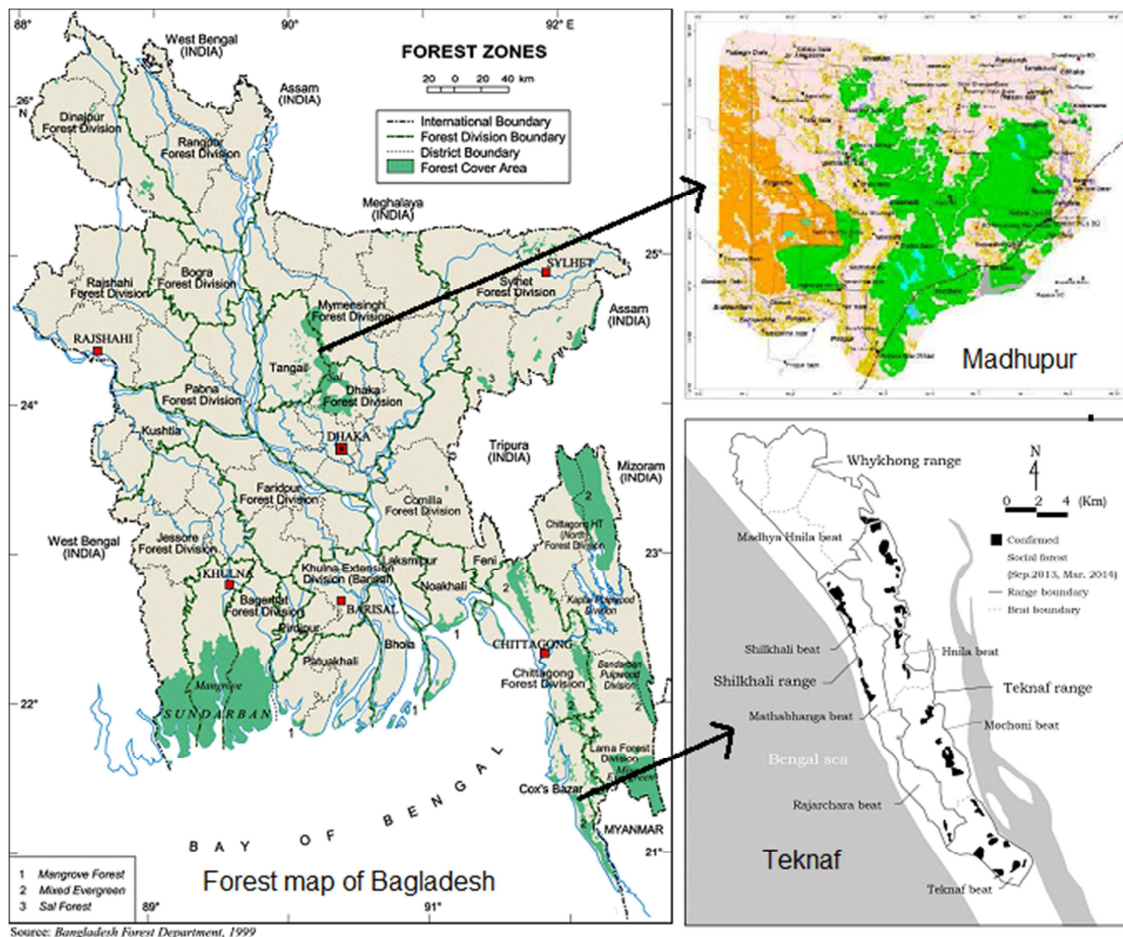


Figure 1. Forests cover map of Bangladesh showing study area.

2.2. Description of the Participatory Forestry Program

The criteria, rules and regulations are similar for all participatory forestry (also called Social Forestry) programs in Bangladesh. In this program, each member was allocated 1 ha

of degraded forest land for a PF plantation duration of 10 year rotation cycle. Each farmer can continue up to three rotation cycles (30 years) if he/she maintains the PF criteria properly. The fast growing firewood tree species (e.g. *Acacia*

auriculiformis) was selected for plantation with a space of 2m×2m (total 2500 tree/ha) (Figure 2). After 4 years, 50% of the standing trees were thinned out (1st thinning), and this technique was repeated after 7 years (2nd thinning). The remaining 625 (approximately) trees were finally harvested at the end of the 10-year cycle. The FD and members shared the benefit of the 2nd thinning and final tree harvest outputs at a

ratio of 45%:45%, and the remaining 10% benefit will store for the next rotation tree plantations which is called (Tree Farming Fund = TFF). The member could grow annual crops in association with trees at any time of the 10-year rotation cycle, and the crops together with 1st thinning benefits were granted solely to the member. These types of people-oriented programs gained popularity all over the Bangladesh.



A 8-year old PF program at Madhupur



A 9-year old PF program at Teknaf

Figure 2. Participatory forestry programs at the study area.

2.3. Data Collection

This study collected both quantitative and qualitative data, and quantitative data were collected through a semi-structure questionnaire survey. For qualitative data this study used discussion with FD staff, local people, focus group discussion, personal observation and literature review. Participatory forestry programs were mainly implemented with the active guidance of forest Beat offices (lowest FD administrative office) and Madhupur Sal forests consisting of 12 Beat offices in which participatory forestry programs were executed under 10 Beat offices. Teknaf forests consist of 11 Beat offices, and the study covered 7 Beats. It was also noted here that only the poor people (such as landless) of the community have been selected for PF programs. Although there were some exceptions but majority of the poor people were involving in PF programs which was also mentioned by Muhammad et al. (2008); Islam et al. 2012 in their studies. In total 3,327 members were involved in Madhupur and about 200 running PF programs at Teknaf area, and this study randomly selected 80 and 40 poor members from Madhupur and Teknaf PF area. In addition, this study selected 30 and 15 non-PF members respectively who were poor and possessed similar socioeconomic conditions as the PF members (before PF started) in order to compare and visualize the changes of livelihood assets. Non-members' were selected according to the FD lists which had a strong evidence that both people were poor before involved in PF [24]. During field visits, actors were asked about their views on other actors, and this study tried to cover all PF actors listed in the result section. Furthermore, the most powerful actors were re-interviewed in

order to assess the outcome analysis using semi-structured questionnaires. Interview questionnaire were pretested and improved before conducting the final interview, and a research team consisting of 5 members was involved in the data collection at the Madhupur area during different months of 2011 to 2013. However, a 7 member research team was involved in data collection at the Teknaf area during the months of March to September 2014.

2.4. Analytical Frameworks

The study's questionnaires collected information that identifies power status, based on the power elements of trust, coercion and incentives by actors within the PF networks. The study covered every actor and also asked each actor their judgment on the power elements coercion, incentives and trust of the other actors. The findings on three power elements were categorized using a scale of 0 to 3 (0= not power and 3= complete/highest power), and each actor gave specific power dimension of other actors in the networks. Finally, the average round value of each actor was used and overall value of all actors to a particular actor was coded, determining the most powerful actor and the less powerful one: the study applied a dominance degree analysis model [33] which categorized the most powerful actors. The analytical techniques used to differentiate the most powerful actors from the less powerful ones was developed by Schusser (2013) in which the individual relative power (X_i) and dominance degree (D_i) were used to identify the powerful groups in PF networks by using the following formulas: (Source: 34, 35)

$$h_i = \frac{X_i}{\sum_{i=1}^n X_i} \text{ and } r \leq n \quad CR_r = \sum_{i=0}^r h_i \quad D_i = \frac{\frac{CR_i}{i}}{\frac{1 - CR_i}{n - i}}$$

Here, n= total number of actors identified, X_i = sum of answer per actor, h_i = is the ratio of power per actor and power element (i), with $0 < h_i \leq 1$, r= number of powerful actors considered.

The above formulas were used for analyzing the dominance degree (D_i) is calculated by first sorting the data from the highest value to the lowest. After that all values (X_i) are brought in relation by calculating the relation (h_i) between the individual power element per actor (i) and the sum of the power elements for all actors. After calculating h_i of each actor under each power elements, the cumulative accumulated value (CR_i) of each actor in the network can be calculated. Finally, the dominance degree (D_i) can be calculated with the above formulas.

On the contrary, this study selected the most important indicators (see Table 3) to measure the livelihood assets, which are related to the reality of local peoples' livelihood conditions and the characteristics of PF performance in the selected areas. Various scaling and indexing methods was adapted to measure the human, physical, social, natural and financial assets so that it was possible to make them comparable and to allow meaningful interpretation. Most of the indicators would make determinations using rating scale methods in terms of different weight: 0.33, 0.66 and 1.0 interpreted as poor, medium/average and good. The questions have three answer choice measured as: $I = \text{Good}\% \times 1 + \text{Medium}\% \times 0.66 + \text{Poor}\% \times 0.33$ (Chen et al. 2013). The two answers to questions like Yes or No were interpreted as: $I = \text{Yes}\% \times 1 + \text{No}\% \times 0$. The economic benefit questions related to money were measured in different ways. Less than the mean value was classified as poor with weight of 0.33; more than the mean but less than $1.5 \times \text{mean}$ treated as medium/average with weight of 0.66; and more than $1.5 \times \text{mean}$ was classified

as good with a weight of 1.0. Similar types of calculation procedure were followed for participants' tree stocks and livestock indicators. After weight calculations of each indicator, we calculated the value of each type of livelihood asset and finally the overall livelihood assets value.

3. Results

3.1. Actors Power Analysis

The study first identified the actors involved in PF networks and eventually observed who are deemed to be the most powerful using the simple 0 to 3 scaling systems (Table 1 & 2). In Madhupur PF, the study identified 20 actors while in Teknaf PF the number of actors was 17. In each PF networks, the individual relative power 'Xi' and dominance degree 'Di' calculation was used to identify and justify the powerful actors. Both the Madhupur and Teknaf PF networks showed that the forest administration, in particularly the beat officer, were the most powerful actors in all three domains (trust, incentives and coercion) of power dynamics (Table 1 & 2). Table 1 and 2 also represents that all of the government actors (i.e. Ministry of forest and environment, Park management authority) including forest administrations have had the highest power in PF networks and control the PF programs.

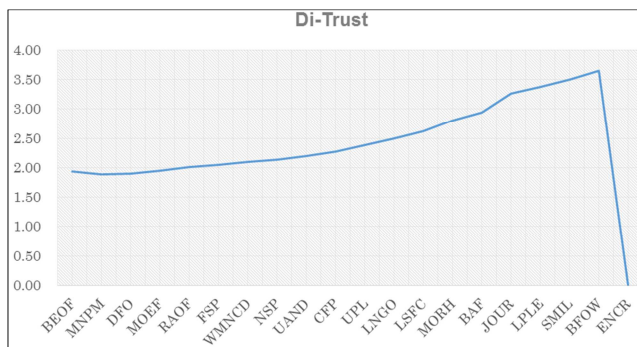
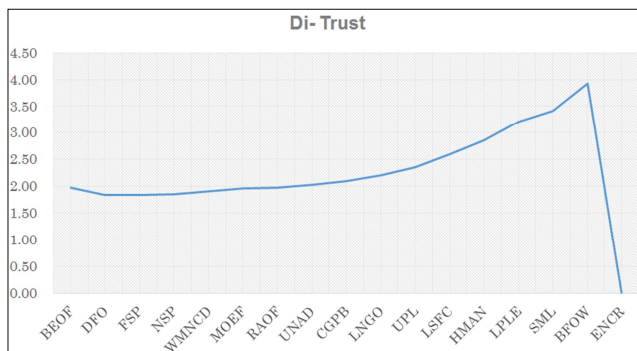
The dominance degree (D_i) calculation gave a chronological sequence (powerful to less powerful) of the dominant actors and also graphically showed the most dominant actors in trust power element according to their D_i value in PF networks (Figure 3). In Madhupur PF, the beat officer was the most dominant actor followed by Madhupur park management, and divisional forest officer (Figure 3). However, in Teknaf PF, the dominant actor was also the beat officer followed by the divisional forest officer (Figure 4).

Table 1. Summary of power analysis of Madhupur PF.

Actor category	Power Dimension (X_i)			Actors in the networks
	Trust	Incentive	Coercion	
Forest Department (3) (Regional to Local level)	33	10	3	Divisional Forest Officer (DFO)
	31	10	3	Range Officer (RAOF)
	39	13	6	Beat Officer (BEOF)
	28	12	1	Forestry Sector Project (FSP)
Donor (4)	24	10	1	Nishorgo Support Project (NSP)
	23	7	0	Upazilla Afforestation and Nursery Development Projects (UANDP)
	22	10	0	Community Forestry Project (CFP)
State Ministry 1 (Central level)	32	12	1	Ministry of Forests and Environment (MOEF)
State Ministry 2 (Central level)	16	7	0	Ministry of Roads and Highway (MORH)
Forest Department (Central level)	27	10	0	Wildlife Management and Nature Conservation Division (WMNCD)
	34	12	1	Madhupur National Park Management (MNPM)
Private Sector	8	4	0	Saw millers (SMIL)
	7	4	0	Brick fields (BFOW)
Leader	9	8	1	Local Political Leader (LPLE)
	21	10	2	Union Parishad Leader (UPL)
Social Forest Association	17	9	4	Local Social Forest Committee (LSFC)
Development Organizations	19	8	1	BRAC, Christian Missionary (NGOs)
Individual	6	5	0	Encroachers (ENCR)
State Ministry	13	4	0	Bangladesh Air Force (BAF)
Print media	18	5	1	Journalists (JOUR)

Table 2. Summary of power analysis of Teknaf PF.

Actor category	Power Dimension (X_i)			Actors in the networks
	Trust	Incentive	Coercion	
Forest Department (3)	28	8	4	Divisional Forest Officer
	20	9	3	Range Officer
	35	12	5	Beat Officer
Donor (4)	20	6	2	Upazilla Afforestation and Nursery Development Projects
	19	12	1	Costal Green Belt Project
	27	12	1	Forestry Sector Project
	26	11	1	Nishorgo Support Project
State Ministry (Central level)	24	12	1	Ministry of Forests and Environment
Forest Department (Central level)	25	11	0	Wildlife Management and Nature Conservation Division
Private Sector (2)	8	4	0	Saw millers
	7	4	0	Brick fields
Leader (2)	11	9	0	Local Political Leader
	17	15	0	Union Parishad Leader
Social Forest Association	16	10	4	Local Social Forest Committee
Development Organizations	18	11	0	BRAC, CREL (NGOs)
Individual (2)	13	4	3	Head Man (HMAN)
	4	6	0	Encroachers

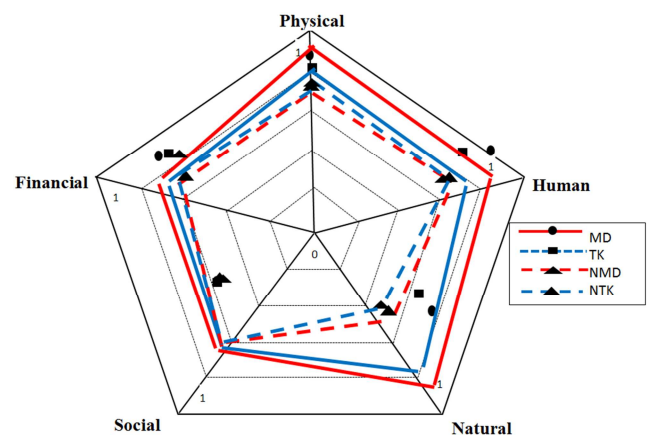
**Figure 3.** Assessment of degree of dominance factor on trust for Madhupur PF.**Figure 4.** Assessment of degree of dominance factor on trust for Teknaf PF.

Concerning the incentives element of power analysis, the result showed that many actors provided incentives, but the dominant one was the forest administration including different projects funded by the donor agencies. On the contrary, the coercion element of power analysis clearly showed that only the forest administrations had the most dominant power compared to other actors (Table 1 & 2).

3.2. Livelihood Analysis

Physical asset: In addition to general indicators of household fixed and durable assets and livestock assets, the

study reveals the dependency on forests for firewood uses, alternative sources of firewood uses and collective action for common infrastructure development indicators to measure the physical asset. Firewood is the main energy source of Bangladesh with most of the firewood coming from the local forests [3] in the study area. This study shows how PF projects have changed the household energy structure and whether alternative energy sources are used to sustain livelihood improvement. Moreover, collective action is considered an asset for sustainable natural resource development. The results showed that the overall physical assets values were 0.82 and 0.77 in Madhupur and Teknaf PF respectively. Physical assets development was better in the Madhupur area compared to Teknaf, and the PF member of Madhupur area had significantly used the alternative sources of firewood energy more than the Teknaf area (Table 3). On the contrary, the physical asset values were 0.64 and 0.69 for non-members respectively, and the improvement of Madhupur area's physical value was 0.118, which showed a considerable improvement (Figure 5).

**Figure 5.** Comparison of livelihood assets among Madhupur (MD) and Teknaf (TK) PF members with non-members (NMD and NTK).

Human asset: The study selects the leadership indicator to judge the member's leadership ability together with other

general indicators such as skill and knowledge, education and health condition. Results revealed that the human asset values were 0.83 and 0.74 for Madhupur and Teknaf PF, and the value were 0.68 and 0.62 for non-members (Figure 5). Like physical assets, the improvement of human assets was remarkable in Madhupur PF compared to non-members value.

Natural asset: For natural assets this study reveals perceptions on biodiversity conservation, required activities for forest protection and conservation and member's dependency on natural forest together with members' own tree

stock as important indicators. Considering the difficulties to enter into deep forests of the study area, the study empirically selected indicators to measure the improvements of natural capitals of the members, and these types of indicators were also considered by Chen *et al.* (2013) in their livelihood measurement study. The results revealed that both of the study areas had positively improved (0.91 in Madhupur and 0.81 in Teknaf) the human capitals, but the asset value of Madhupur area showed better improvement than Teknaf (Table 3).

Table 3. Evaluation of overall livelihood assets capitals.

Capitals	Indicators	Madhupur PF		Teknaf PF	
		Indicator weight	Capital value	Indicator weight	Capital value
Physical	-HH durable assets	0.72	0.82	0.78	0.77
	-HH fixed assets	0.66		0.72	
	-Livestock assets	0.88		0.81	
	-Dependency on forests for firewood	0.82		0.65	
	-Alternative sources of firewood uses	0.9		0.71	
	-Collective action for common road structures	0.96		0.94	
Human	-Skill and knowledge due to PF trainings	0.88	0.84	0.72	0.74
	-Leadership ability	0.82		0.63	
	-Education level/status	0.74		0.86	
	-Children education status	0.88		0.82	
	-Health condition/status	0.82		0.68	
	-Perception of biodiversity conservation	0.92		0.9	
Natural	-Necessary for forest protection	0.96	0.91	0.92	0.81
	-Forest protection activities	0.89		0.86	
	-Dependencies on natural forests	0.86		0.68	
	-Tree stocks	0.93		0.69	
Social	-Relationship to the community	0.76	0.75	0.82	0.76
	-PF training	0.94		0.86	
	-PF decision made by	0.48		0.56	
	-Involvement in social organizations	0.82		0.8	
Financial	-Total HH income	0.68	0.76	0.82	0.69
	-SF income	0.92		0.68	
	-PF decision affect SF income	0.56		0.48	
	-Annual expenditure	0.84		0.78	
Livelihood assets		0.82		0.75	



*FD= Forest Department

Figure 6. Overall social relationship of the PF members in the community.

Social asset: Social asset is a valuable and important resource for poor people, especially during times of crisis and socioeconomic changes [3]. The study gives the highest priority on members' relationship to the community and involvement in social organizations indicators. Because of

training and participation in PF programs, members have many more opportunities to access outside information and communication with other people of the society. In a measurement scale of 2, 1, 0, -1, -2 (2=strongly positive and -2= strongly negative relationship) the study had measured PF members' social relationship with FD staff, other PF members, non-PF members, elites and political leaders of the community. Results showed that Madhupur area's PF members have had a strong negative relationship with FD staff, but the situation was better in the Teknaf area. Both of the PF members' had a negative relationship with the political leaders, but the social relation with other group of peoples' were positive (Figure 6).

The study also determined the decision making power of PF, and majority of the participants' (96%) mentioned that the FD staff took the major decisions. That means the focal decisions (e.g. selection of tree species) were taken by the FD staff and the local participants' voice were ignored. It affected the relationship between participants and FD and also have negative influenced on social assets of participants'. The overall social asset values of the Madhupur and Teknaf PF members were 0.75 and 0.76 showed not so improvements compared with non-members' value of 0.75 and 0.74 (Figure 5).

Financial asset: Concerning financial indicators, household income and expenditure are treated as the two main indicators [3, 30]. The main sources of household incomes were PF, farming, day labor, small business, and fishing. However, PF income considered as one of the main income sources of the poor participants and it has already mentioned by the Muhammad et al. (2008) and Islam & Sato (2012) in their studies. For expenditure, this study considered living expenditure and production expenditure of every family and finally calculated the percent of annual expenditure compared with their total annual income. The study found that PF members in the Teknaf area have a better annual income than the Madhupur area, but the PF income was high in the Madhupur area (Table 3). Together with these financial indicators the study also determined whether PF decision making power affected the participants' (especially PF) income or not. The overall financial asset of the Madhupur and Teknaf PF areas were 0.76 and 0.69; at that time the non-members' value were 0.62 and 0.65. The results showed that Madhupur PF members had positively improved their income level compared to Teknaf PF members (Figure 5).

4. Discussion

4.1. Actor Power Dynamics

The power analysis provides the basis for the quantitative analysis that focuses on how the identified powerful actors shape and accrue their power [22]. In every instance, the forest administration showed the strongest preferences on the simple pattern of quantitative analysis of actor's networks (Table 2). Forest administration, especially the beat officer, remains the most powerful actor in trust (35 points), incentives (12 points) and coercion (5 points), elements of power analysis. It was due to this fact that the beat officer was officially responsible for the selection of PF members, evaluation of the PF programs and benefit sharing process [3]. However, the donor-funded projects such as the forestry sector project and coastal green belt project have provided the maximum incentives as well as being trusted in the network (Table 2). The local social forestry committee was also indicated to have a certain degree of power, although the results suggested that their power appears to have been limited to the account of trust placed by other actors in the networks. In a community forestry study of Nepal, Devkota (2011) found that forest administrations have gained the highest level of power in trust, incentives and coercion elements of actor power analysis. Similarly, forest administration remains one of the most powerful actors not only in coercion strategies but in also providing incentives as well as being trusted in the actor dynamics analysis network of community forestry in Indonesia, Namibia, Albania, China, Philippines and Cameroon [10, 22, 24, 34].

The actor network survey results of both PF sites were found using the rule, which mentions that each actor who was a part of the powerful actors, with regard to at least one power element, was considered to be part of the most powerful actors [34]. The dominance degree (D_i) value clearly shows the point

of separation between the group of powerful actors, and less powerful actors can be found at the maximum of the dominance values. In Madhupur PF, the D_i value for the last powerful member (i.e. brick field owner=BFW) was higher than the D_i value of the first member (i.e. Encroacher= ENCR) of less powerful actor. Based on dominance degree value the most powerful actor was identified [34] and figure 3 and 4 clearly shows the dominant actors in their networks considering the trust element. Schusser (2013) used dominance degree calculation systems to determine the power dynamics in the community forestry of Cameroon. However, a ranking system to determine the effect of community forestry on the forest using quantitative data had also been applied by Coleman and Fleischman (2012). In PF research, a number of scientists' stated that decentralization practice was rarely followed by genuine power devolution to the local members [2, 3]. The more powerful actors have a tendency to manipulate devolution outcomes to suit themselves in forest management regime [37]. So, the local forests users were the less powerful actors in decision making of any people-oriented forest management approaches [3]; although the PF policy clearly outlined the decentralization and devolution of power to local level. However, the proper execution of such policy was not visualized in Bangladesh as well as other developing countries.

4.2. Livelihood Assets

Based on the results and comparison performed at temporal scales, the study revealed that PF programs indeed have a positive impact on livelihood assets improvements. With regard to physical assets, PF members' household fixed and durable assets had not improved a lot, but the dependency on natural forests for firewood had improved. Compared to Teknaf, the alternative sources of firewood uses (such as- environmental friendly burner and rice husk/ pellet/ kerosene stoves) options have remarkably increased in the Madhupur area. Madhupur FD supplied environmental friendly burners through a forestry project, and almost all PF members received the benefit [3] yet this activity was not executed in the Teknaf area. So, the adjustment of the energy structure or alternative sources led to an increase in indicator weight. Another notable increase was observed in the application of collective action for making villages common roads. Due to PF training, a sense of collective action arose among the PF members, and the impact was higher in Madhupur area compare to Teknaf.

The study considered skill and knowledge as one of the key factors that affect the human assets of the PF members. Training on tree plantation, agroforestry, farm management, etc. have had a substantial impact on the income level of the PF members. Madhupur PF members had received intensive long training compared to Teknaf, and this training also helped to improve PF members' leadership ability as well as family health awareness. Similarly, Islam & Sato (2012a) and Chen et al. (2013) observed that training had significantly improved participants' capacity building towards human assets. The study previously prescribed that the data on natural assets were mainly based on the perceptions of PF members related

to biodiversity conservation and forest protections activities. The natural asset value of 0.91 and 0.81 in Madhupur and Teknaf area indicted that the majority of the local community was willing to protect forests resources and biodiversity. The overall value of natural assets was significantly different between PF members and non-members in both of the study areas. It indicated that the PF programs objectives and processes have had a noteworthy effect on the local communities. However, the dependency on natural forest indicator revealed that still the Teknaf area's people have relied on forests resources for a living, but the scenario was better in Madhupur area.

The social asset is an attribute of an individual in a social aspect [38]; the development of social asset depends on the relationship, institutions, attitudes and values that govern interactions among the peoples and contribute to the economic and social development [39] and are therefore difficult to measure. Together with the common social indicators, this study also tried to measure the social relationship of the PF members. Figure 6 clearly shows a remarkable difference between the relationship of Madhupur and Teknaf areas PF members with the FD. Due to sever conflicts on forests land tenure, the local communities of Madhupur have revealed a negative relationship with local FD [3, 40]. On the contrary, Teknaf area's people have maintained a good relationship with local FD. The most negative side of the social assets was the decision making ability that solely controlled by the FD. That means the local participants' had totally ignored to take any decision regarding to the planning and management aspects of PF. In a study on Sal forests, Islam & Sato (2012) also mentioned that the FD had controlled the PF program which was severely affected their social assets. In general, the PF programs have created a small social network among the members and other peoples' of the communities to some extent. Lastly, the financial asset of the study showed a minor increases, and a small difference was detected between PF members and non-members. However, the PF income positively differs in the Madhupur and Teknaf areas, and the result showed an enhancement in the Madhupur PF area. The study found that the PF-members in Madhupur have cultivated seasonal/annual crops in association with trees; thus, the members received a good amount of additional income throughout the year. In Madhupur area, the seasonal crops yield of PF programs generated financial capital and seasonal cash flow to the farmers [3, 41]. Almost all PF members have invested their PF income toward their children education and family health care and also to cover the household expenditure that partly sustains their livelihoods.

4.3. Linking Actors Power and Livelihood Outcomes

The study also determined the linkage between various outcomes and powerful actors' power/interests who have expressed their influence through the power dynamics of the PF networks. It was clear that FD influenced and negotiate donor in order to get funds, and also imposed donor criteria to the lower level by means of legal authority and technical orders. Moreover, formal rules and restrictions on Sal forests

have given FD ability to control PF activities whenever required [3, 11, 40]. The study observed that PF have been limiting the accessibility and decision making capacity of members'; hence, the expected social outcomes become limited or not at desirable level. This study on the other hand, told us that real empowerment remains rhetoric in PF. Here, empowering participants' means encouraging them to plan and develop own strategies for improving their livelihoods with the emphasis on different access on livelihood assets and related resources. Moreover, financial benefits from the PF clearly fall short of the expectation and it was due to the improper tree species selection by the FD officer. The FD did not considered the market value of planted tree species, rather they followed the imposed criteria of top official and donors and it was also mentioned by Islam and Sato (2012a, 2013) in their study on Sal forests. Formally, all powerful actors have desired to improve forest condition and healthy species; thus, the ecological/natural assets were positive. However, the other powerful actors' such as political leader and elites were mainly influences the participants' selection and local level decision making process, strategically collaborated and exercised power with the FD that allows them to continue their influence in the outcomes of PF [3]. So, the ongoing decision-making process of PF showed an unbalance power relationship between FD and members' which would facilitate conflicts and obstacle the usual outcomes [3, 41]. Nevertheless, FD have overlooked local or traditional knowledge on PF management. For example, majority of the participants' mentioned that the exotic tree species decided by the FD as a part of maintaining donor criteria had reduced the PF income as well questioning the forest future [3, 41].

The overall evaluation of the actors' power and outcomes of this study holds that the power of powerful actors had driven the PF outcomes, hence they can easily influence the PF process to suit their interests. PF outcomes especially social and economic highly reflect the interests of powerful actors; thus, the study may summarize that there is a strong link between the actors' power and livelihood development in PF. Although the PF has some negative impacts due to the imbalance of power among the actors, the overall results included many impressive results concerning the development of the livelihood assets of the participants. Some positive outcomes were - increased interaction among the actors, participants' capacity building through intensive training, improvements of livelihood assets, increased overall incomes and revenues, marginal and disadvantaged groups have involved in forest management, infrastructure development, increased awareness and collective action along with the sustainable management of forests. Therefore, the overall discussions argue that PF has clearly impacted the local level and livelihoods of the local communities augmented; however, the powerful actors are highly relevant for the sustainable livelihood development in Bangladesh.

5. Conclusions

Participatory forestry programs in Bangladesh have no

doubt introduced a new interpretation of forest management with an approach to include local communities together with rural development and resource conservations. This approach also includes many actors due to the economic, ecological and social functions and values that forests deliver. In both study sites, the results found out that the forest administration proved itself as the most powerful and influential actors in PF. The forest administration is the most powerful actor in all three power elements of actors' power analysis, and they gained numerous power features through the bureaucratic forest management and policies of the country. The actors' power analysis of this study argued that there is an immediate need to empower the local people and their committees, in which the PF members play the central role in decision making and governing all of their development initiatives. The study also revealed that PF has impacted the livelihood assets and the changes in livelihood assets among the PF members and non-members were considerably different. So, PF is an effective management approach which provides certain insights regarding the microcosm of livelihood assets development. However, the PF had not received desirable livelihood support from the output of the social and financial assets. Often social and economic outcomes depend on the interests and power of the powerful actors. Therefore, it is very important that more emphasis should be given to enhancing social and financial assets through empowering local participants', intensive training, adopting appropriate tree-crop production technologies, workshop and awareness building according to the local needs. Likewise, an iterated approach including alternative livelihood options are necessary to deal with the basic needs of the forest dependent people and the sustainable management of forests.

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