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Does higher access ensure greater wellbeing? – In the perspective of forest ecosystem services of the Sundarbans mangrove forest, Bangladesh

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ABSTRACT

This study presents the effects of access to Ecosystem Services (ESS) on human wellbeing. In order to fulfil the research objective, we interviewed villagers from 104 households who were exclusively engaged in collecting ESS. Data were also collected from key informants, local leaders, and official records. Higher access (HA) to ESS significantly increased the availability of cleaner water for domestic non-drinking purposes. Access to sufficient food, however, was significantly lower across the HA households because of greater involvement in ESS collection. Overall, in this society, HA families enjoyed significantly greater freedom than Lower access (LA) families. Increased competition for ESS extraction resulting from higher access significantly reduced a collector's physical strength and had larger negative impacts on their mental health (self-esteem decreased and anger level increased) compared to LA collector. There were also significantly stronger financial conditions in the HA families than LA families. Greater access encouraged frequent collaboration and cooperation between HA collectors for collecting more ESS leading to a significant enhancement in social cohesion in compare to LA families. Composite wellbeing scores of the respective wellbeing criteria show that only physical health and economic security would significantly improve with greater access to ESS collection. Thus, ESS can have significant impacts on human wellbeing. However, without integration of other wellbeing improvement programs, sole dependency on the ecosystems would cause resource degradation. These results would greatly assist to improve the current framework of ESS and human wellbeing.

1. Introduction

Access broadly refers to the ability to benefit from material objects, persons, institutions and symbols, and is a precondition for enjoying the benefits of an ecosystem (Ribot and Peluso, 2003). Smith et al. (2013) explained this as the opportunity to benefit from Ecosystem Services (ESS) as well as maintain the flow of benefits for future generations. ESS include the benefits generated from our surrounding ecosystems that are either directly enjoyed or consumed to improve human wellbeing (Costanza et al., 2014). ESS of forests have already been identified as food, water, fuel, timber, fibre, climate regulation, flood regulation, disease regulation, water purification, and spiritual and recreational considerations (Fisher et al., 2014; MEA, 2003). The mechanisms of gaining access to ESS vary between people depending on their available livelihood capitals (Kibria et al., 2018; Ribot and Peluso, 2003).

The political-economic aspect of the concept of access further divides it into 'access control' and 'access maintenance'. Access control refers to the function or power of directing and regulating who can access a resource (Rangan, 1997). Access maintenance is a different issue that requires expending resources or powers to keep a certain type of resource access open (Berry, 1989). The level of access is described as the decisive factor for ensuring sustainable conservation and maintaining greater wellbeing of the dependent communities. As such, by defining access as the 'ability to benefit' from any resources of the forest we can inevitably draw attention to a wider range of material, economic and social elements that are gained from resources without solely focusing on property rights (Ribot and Peluso, 2003). It has been widely believed that adequate access to ESS would ensure greater community wellbeing and ecosystem conservation because forest dependent communities are mostly marginalized with little to no opportunities for alternative livelihoods (Angelsen et al., 2014; Naidu, 2011; Vedeld et al., 2007). Moreover, any development initiative that generates a range of positive externalities for the environment, and the social and cultural contexts is more likely to be more sustainable (Ashley et al., 1999; Donia et al., 2017).

Forests are one of the most important ecosystems as they support

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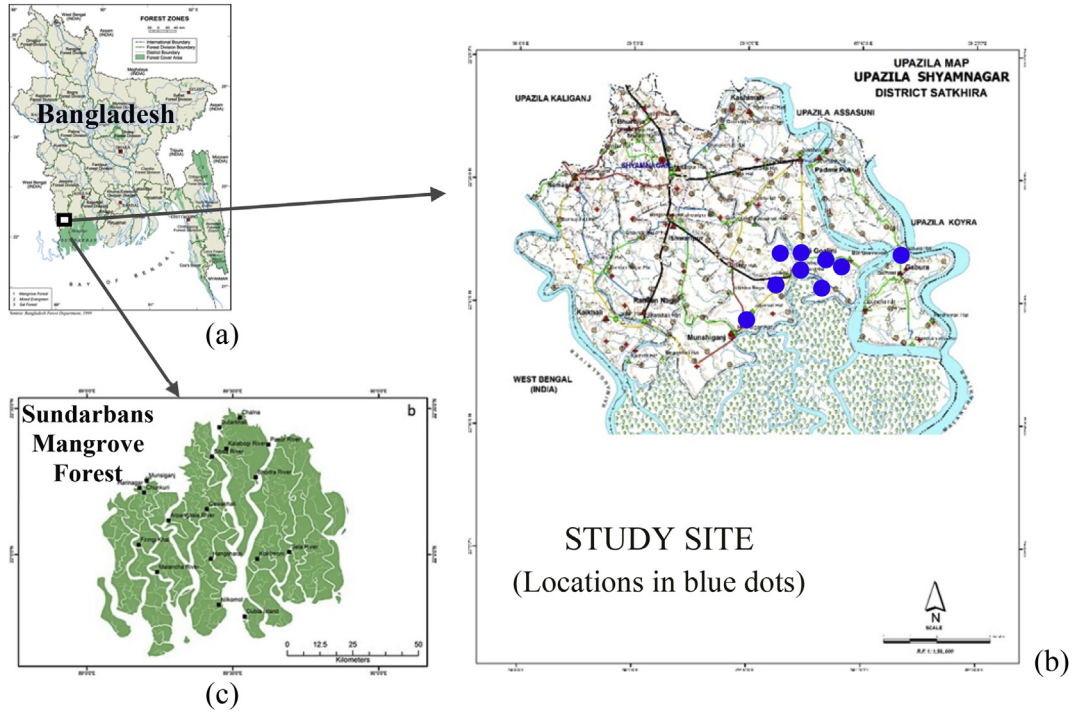

Fig. 1. Map of: a) the forest zones of Bangladesh (BFD, 1999) cited in (Roy et al., 2013), b) Shyamnagar upazila of Satkhira district marked with the study villages in blue dots (LGED, 2017), c) The Sundarbans Mangrove Forest (Hossain et al., 2015). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

the life of billions of people at local and global scales (Byron and Arnold, 1999). Thus, changes in forest ecosystems can influence all the components of human wellbeing, however the multidimensional attributes of human wellbeing make it difficult to measure. Despite this, human wellbeing can be broadly generalized under categories that include basic materials, health and sanitation, social relations, security, and freedom of choice and action (Costanza et al., 2007; Fisher et al., 2013; MEA, 2003; Narayan et al., 2000). All these categories of wellbeing are significantly influenced by forest ecosystem services (Babulo et al., 2008; Costanza et al., 2007; Ding and Nunes, 2014). While it is largely recognised that forest destruction results in a great loss of plants and wildlife, the impact that it has on human wellbeing has gone largely unrecognised (Davis et al., 2015; Laurance, 1999), which may be because a loss in ESS has not been identified as something that carries negative consequences in this respect. For instance, the loss of pollinators associated with deforestation has direct implications for agricultural production, in terms of growing fruits, vegetables, oil crops and stimulants (coffee, tea etc). This would then have knock-on effects for people relying on farming and agriculture for their wellbeing. Despite this, a reduction in forest destruction is generally not considered as an important step to fighting problems associated with losses in food production (Gallai et al., 2009).

The Millennium Ecosystem Framework (MEA) has attracted the attention of global ecosystem scientists to the relationship between ESS and human wellbeing. One major drawback of the current framework (Fisher et al., 2014), however is that it does not account for the multidimensional nature (Narayan et al., 2000) of wellbeing that goes beyond the financial benefit to include freedom and choice, health, good social relationships and security. This is apparent as to date much research has been focused on understanding the complex relationships between the forest and the people in terms of economic dependency of the people on the forest ecosystem (Abdullah et al., 2016; Babulo et al., 2008). Most studies focus on the economic contributions of ESS in terms of generating income, employment, and infrastructure. However, while the research has explored the contributions of the ESS on income and employment, little to no attention has been paid on the other dimensions of human wellbeing (Adam et al., 2013; Angelsen et al., 2014; Kar and Jacobson, 2012; Kibria and Jashimuddin, 2012). Irrespective to the policy views and national economic status, intensifying robust attention on this relationships that demand the harmonization of sensitive coupled socio-ecological systems is crucial for sustainable conservation (Viglizzo et al., 2012).

Although it is recognised that human wellbeing and ESS are linked, to date, the understanding of the relationship between ESS and human wellbeing is still conceptual (Coulthard et al., 2011; Naeem, 2009). This may be partially explained by the fact that the mainstream view of wellbeing is still heavily focused on economic growth (Blanchflower and Oswald, 2004; Stewart, 2005), which leaves a considerable research gap in understanding the effect of ecosystem services on the overall wellbeing of dependent communities including their physical and mental health, institutional organizations and social improvements (Costanza et al., 2007; Kusel, 1996; McElwee, 2008; Narayan et al., 2000). This study aims to fill this gap by exploring the relationship between access to ESS and human wellbeing in the Sundarbans forest ecosystem of Bangladesh. Findings of this study will greatly benefit policymakers and development organizations engaged in forest ecosystem conservation, as well as provide guidelines for sustainable growth in other sectors including agriculture, industries, tourism, and mining.

2. Methods

2.1. Study site

The Sundarbans Mangrove Forest (SMF) is situated in southwestern Bangladesh located between 21°30′ and 22°30′ N and 89°00′ and 89°55′ E extending over Khulna, Satkhira and Bagerhat districts (Fig. 1). The Sundarbans mangrove forest of Bangladesh was declared a World Heritage Site in 1999 by UNESCO (Hoq, 2007; Roy et al., 2013). The Forest Department is the responsible public agency for forest

Table 1
Variables of basic materials of life, and health of the ecosystem dependent people around the Sundarbans forest.

Criteria	Determinants	Indicators	Scores
Basic materials of good life	Drinking water	a) Distance of water source	a) < 0.5 km = VHW, 0.5 km–1km = NHNLW, > 1 m = VLW
		b) Source of water	b) Village pond = VLW, Own pond = NHNLW, Common reserve tank = HW, Supply water = VHW
		c) Amount	c) Sufficient = VHW, Moderate amount = NHNLW, Insufficient = VLW
		d) Period of availability	d) Whole year = VHW, Seasonal scarcity = NHNLW, Irregular supply = VLW
		e) Taste	e) Good = High wellbeing, Fair = NHNLW, Bad = LW
		f) Cleanliness*	f) 1 to 5 scale where 1 = VLW and 5 = VHW
		g) Health risks	g) High risk = VLW, Minor = HW, Not at all = VHW
	Water for other purpose	a) Distance of water source	a) < 0.5 km = VHW, 0.5 km–1km = NHNLW, > 1 m = VLW
		b) Source of water	b) Sweet water pond = HW, River = NHNLW, Own pond = VHW
		c) Amount	c) Sufficient = VHW
		d) Period of availability	d) Whole year = VHW, Seasonal scarcity = NHNLW
		e) Cleanliness*	e) 1 to 5 scale where 1 = VLW and 5 = VHW
		f) Health risks	f) High risk = VLW, Minor = HW, Not at all = VHW
	Food availability	a) Purchased	a) Major amount = VLW, Moderate amount = NHNLW, Little supplement = VHW
		b) Chronic shortage	b) High = LW, Moderate = NHNLW, Low = HW
		c) Sudden shortage	c) > 3 month = VLW, 3months = LW, 2 to < 3months = NHNLW, 1–2 months = HW, < 1 month = VHW
Health	Good physical health	a) Physical weakness*	a) 1 to 5 scale where 1 = VLW and 5 = VHW
		b) Frequency of disease family^{-1}yr^{-1}	b) > 15 = VLW, 10–15 = LW, 5–10 = NHNLW, 3–5 = HW, 1-3 = VHW
		c) Chronic diseases of family members	c) The more severe disease, the less wellbeing
	Health knowledge	Awareness of health and diseases (e.g. diseases name, prevention, cure etc.)	Very little = VLW, Low = LW, Moderate = NHNLW, High = VHW
	Good mental health	a) Happiness*	a) 1 to 5 scale where 1 = VLW and 5 = VHW
		b) Self-esteem*	b) Codes are as (a)
		c) Stress*	c) Codes are as (a)
		d) Anger*	d) Codes are as (a)

VLW- Very low wellbeing, LW- Low wellbeing, NHNLW- Neither high nor low wellbeing, HW- High wellbeing, VHW- Very high wellbeing.
* Data were collected on the scale of 1- Strongly agree, 2- Agree, 3- Neither nor, 4- Disagree, 5- Strongly disagree. But for wellbeing the data were reversely coded i.e. 1 → 5 (VHW), 2 → 4 (HW), 3 → 3 (NHNLW), 4 → 2 (LW), 5 → 1 (VLW).

management, but several national and international NGOs, and local people also participate in forest management activities. The Sundarbans have been under systematic management for about 100 years (Aziz and Paul, 2015). Despite this management, the Sundarbans forest ecosystem has been degraded due to over exploitation, harmful development programs and climatic factors (Abdullah et al., 2016; Iftekhar and Islam, 2004).

The forest forms the single largest contiguous mangrove forest in the world covering an area of 6017 km^2 (Iftekhar and Islam, 2004) made up of 4143 km^2 land area (includes exposed sandbars- 42 km^2) and 1874 km^2 water area (including rivers, canals and small streams). The biodiversity in the region is much higher than that found in other large mangrove ecosystems in world (Wahid et al., 2007). Mangroves provide substantial ESS for local communities. The ESS, such as fish, honey, nypa palm, shrimp fry, fuel-wood, and water are the only sources of income and subsistence for many of the marginalized people in the vicinity of the Sundarbans (Getzner and Islam, 2013). Thus, over three million people are directly or indirectly dependent on the forest (Roy et al., 2013).

The SMF offers a diverse resource base for local people by supplying various goods and services (Abdullah et al., 2016). Its unique physical and physico-chemical environment has nurtured the growth of the most biodiverse mangrove in the world, supporting more than 300 species of plants representing 245 genera, more than 120 species of fish, 35 species of reptile, over 300 species of bird and 32 species of mammals (Choudhury, 2001). Hence the forest is of enormous importance ecologically and economically at local, national and global scales. This valuable forest ecosystem, however is currently under numerous threats including illegal timber extraction, poaching of wildlife, sea-level rise, upstream water extraction/divergence, over fishing and harvesting of aquatic resources, plant disease, and river pollution (Aziz et al., 2013; Mohsanin et al., 2013; Roy et al., 2013). Local people are also frequently attacked by pirates who are active inside the forest unless they buy a permit from a pirate group in advance (Kibria et al., 2018). Some of the poorest families are living in close proximity to the forest and a high dependence on the ESS of Sundarbans. Ensuring the well-being of the people is an essential step forward in order to achieve sustainable conservation of the forest (Abdullah et al., 2016).

2.2. Sampling, data collection and analysis

A complete list of villages in the area was obtained from the Centre for Natural Resource Studies (CNRS), Bangladesh, which was then used to randomly select the villages in which our study would be completed. The serial numbers of the sample villages were randomly selected from a written list. Initially 10 villages were randomly selected but the information provided by some households during the interview were identified unreliable by the key informants and in group discussions, hence we used the data of nine villages in our analysis. Within these nine villages, a total of 104 households (out of 4059 households) were randomly drawn to be invited to participate in interviews: Moukhali (N = 10), Burigoalini (N = 10), Gabura (N = 10), Kalbari (N = 15), Purbo Kalinagar (N = 10), South Kadamtali (N = 10), Harinagar (N = 13), Datinakhali (N = 14) and Dhankhali (N = 12), which are all situated in the Satkhira district. It was planned to interview at least 10 households from each village. After interviewing the first household in each village we walked a random distance (skipping several houses) to select the next household. Thus, we picked a sample that was scattered throughout the village. It was also strictly maintained that sample households were solely dependent on the ecosystem for their livelihoods to avoid the influence of other livelihood practices on their wellbeing. The head of each selected household was interviewed using a face-to-face interview. Data were recorded using a questionnaire that was pre-tested on a few households to decide the most appropriate

Table 2
Variables of security, social relation, and freedom of choice of the ecosystem dependent people around the Sundarbans forest.

Criteria	Determinants	Indicators	Scores
Security	Personal security	How much security is for personal assets	1 to 5 scale where 1 = VLW and 5 = VHW
	Certainty of employment	How much certain is to conduct ESS extraction	1 to 5 scale where 1 = VLW and 5 = VHW
	Certainty of ESS availability	How much certain is to find and collect ESS	1 to 5 scale where 1 = VLW and 5 = VHW
	Difficulty with emergency money	Easiness to receive	The easier to get loan from a person/organization, the higher wellbeing
Social relation	Trust and solidarity relations	a) Most of the people can be trusted*	a) 1 to 5 scale where 1 = VLW and 5 = VHW
		b) How much public authority is trusted*	b) Not at all = VLW, Low = LW, 3- Moderate = NHNLW, High = HW
		c) Most of the people are willing to non-financial help*	c) Codes are as (a)
		d) Most of the people are willing to help financially*	d) Codes are as (a)
	Collective action and cooperation	a) How likely people work to protect ESS	a) 1 to 5 scale where 1 = VLW and 5 = VHW
		b) How often you attended community services	b) The more attendance, the more wellbeing
		c) How many people work in protecting forest	c) Everyone = VHW, Nobody = VLW
	Groups and network	a) No. of group membership	a) 0 = VLW, 1 = LW, 2 = NHNLW, 3 = HW, 4 or more = VHW
		b) No. of close friends/families	b) < 5 = VLW, 5 to < 10 = LW, 10 = NHNLW, > 10 to 15 = HW, > 15 = VHW
	Social cohesion	a) Togetherness*	a) 1 to 5 scale where 1 = VLW and 5 = VHW
		b) No. ceremonies attended per year	b) < 3 = VLW, 3 to5 = LW, 5 to 10 = NHNLW, 10 to 15 = HW, > 15 = VHW
Freedom of choice	Social Freedom	a) Free to do what is preferred*	a) 1 to 5 scale: 1 = VLW and 5 = VHW
		b) Villagers respect each other's preferences*	b) Codes are as (a)
		c) Other restrict him/her	c) Codes are as (a)
		d) Impartial justice exist	d) Yes = VHW, No = VLW
		e) Ability to react to livelihood perceived threat	e) Failed to react = VLW, Flee = LW, Apologise = NHNLW, Mutually solved/money = VHW
		f) Able to achieve anything in anyway*	f) Codes are as (a)
	Economic freedom	Open market	Free market = VHW, Restricted market = VLW
	Institutional protection	Institutions defend	On his/her own, NGOs, Public office = LW

VLW- Very low wellbeing, LW- Low wellbeing, NHNLW- Neither high nor low wellbeing, HW- High wellbeing, VHW- Very high wellbeing.

* Data were collected on the scale of 1- Strongly agree, 2- Agree, 3- Neither nor, 4- Disagree, 5- Strongly disagree. But for wellbeing the data were reversely coded i.e. 1 → 5 (VHW), 2 → 4 (HW), 3 → 3 (NHNLW), 4 → 2 (LW), 5 → 1 (VLW).

Table 3
Resource access of both lower and higher access groups in the Sundarbans forests.

Services	Lower access (US$yr^{-1})	Higher access (US$yr^{-1})	*t*	*p*
Honey	67.80	194.03	−2.445	.018***
Shrimp	355.32	436.81	−.984	.333
Shrimp fry	360.90	693.18	−1.540	.136
Mixed fish	338.83	459.77	−1.162	.252
Crabs	309.52	556.41	−3.873	.001***
Fuel wood	156.21	153.85	.221	.825
Avg. ESS income	629.44	1575.04	−7.959	.001***

*** Significant at α = 0.01 level.

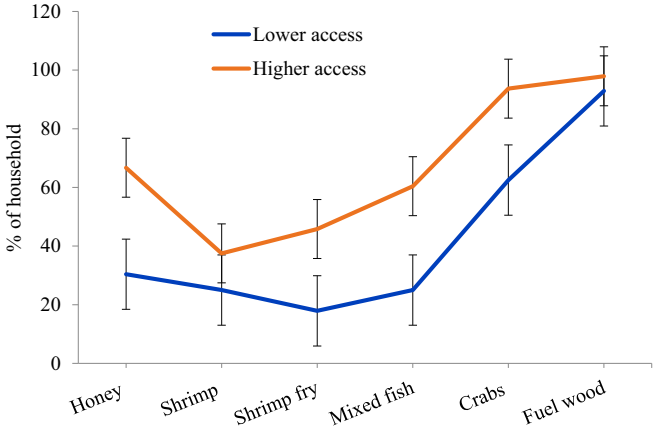

Fig. 2. Percentage of households collecting provisioning services from the Sundarbans.

questions (Del Greco and Walop, 1987). These test-questionnaires were not used for final analysis, instead used only to revise the questions and determine the techniques for conducting effective household interviews.

The random selection of 104 households ensured a big enough sample size to divide them into two groups for analysis. This was also intended to meet the assumption of normality of data distribution to perform a *t*-test for comparing two groups. For analysing the difference between the wellbeing of the access groups, we divided the sampled households into two categories based on the income they earned from the ESS: Lower access or LA (income < BDT70000yr^{-1} or US $893yr^{-1}) and Higher access or HA (income ≥ BDT70000yr^{-1} or US $893yr^{-1}). In previous research, the notion of access to resources has primarily focused on 'property rights' which discounts the robust relationships among the socio-economic factors to gain access. As such, we define access as the 'ability to benefit' based on the income from the forest ESS which has been considered one of the reliable ways to measure the ability of a household (Ribot, 1998; Ribot and Peluso, 2003). In the LA category there were 56 households and in the HA category there were 48 households. In each village we also conducted a focus group discussion and interviewed key informants and elderly people to gain information regarding the general aspects of their livelihoods, assist in identifying wellbeing criteria, and information that would be used in contextualising results. Information regarding demography, history of the area, and climatic conditions, were also collected from various secondary sources including published books, and both NGO and government reports.

Based on the group discussions and key informant interviews,

Table 4
Comparison between the basic materials of life of lower and higher access groups around the Sundarbans forest.

Criteria and indicators	Lower access	Higher access	*t*	*p*
Air is clean (% of household)	100	100	–	–
Water for drinking/cooking				
Distance from source of water (km)	0.99	0.81	1.122	.265
Source of water (% of household)				
Common sweet water pond	46.4	43.8	.271	.787
Supply water	26.8	43.8	–1.824	.071
Common reserve tank	25.0	12.5	1.617	.109
Own sweet water pond	1.8	–	1.0	.322
Availability[3]	1.14	1.21	–.580	.564
Taste of water[3]	1.52	1.58	–.617	.538
Cleanliness[5]	2.51	2.54	–.093	.926
Health risk of the water[3]	2.32	2.54	–2.024	.046***
Water for other purposes				
Distance from source of water (km)	0.16	0.21	–.723	.472
Source of water (% of household)				
Own sweet water pond	44.6	37.5	.734	.465
River	12.5	18.8	–.864	.390
Village pond	42.9	43.8	–.091	.928
Availability[2]	1.12	1.02	2.007	.047***
Cleanliness	2.69	3.31	–3.193	.002***
Health risk of the water	2.50	2.54	–.339	.736
Food				
Food is enough to feed family[5]	3.16	3.27	–.567	.572
Purchasing food[3]	1.08	1.14	–.232	.817
Chronic food shortage[3]	2.02	2.02	–.021	.983
Sudden shortage for how long (months)	2.80	2.48	.808	.421

Superscript values represent the scales of measuring respective indicators.
*** significant at α = 0.01 level.

Table 5
Comparing freedom of choice between higher and lower access groups around the Sundarbans forest.

Criteria and indicators	Lower access	Higher access	*t*	*p*
Institutions for freedom of choice				
Organization/person to defend right (% of household)				
On his/her own	96.4	97.9	–.457	.649
NGOs	3.6	2.1	–.108	.914
Government authorities	1.8	–	1.000	.322
Impartial judiciary exists (% of household)	100	100	–	–
Organization to restrain the right (% of household)				
Forest-pirates	100	100	.586	.559
NGOs	16.4	18.7	–.622	.536
Government authorities	8.9	10.4	–1.142	.256
Social freedom				
Free to do what is preferred[5]	3.57	3.42	.525	.600
Members respect each other's preferences[5]	2.50	2.25	.979	.330
Others restrict my livelihood[5]	2.57	2.18	1.544	.126
Punishment for damaging other's rights (% of household)				
Yes	7.1	14.6	–1.227	.223
No	1.8	4.2	–.697	.488
Not always	57.1	56.3	.091	.928
Mutually solved	16.1	8.3	.159	.874
Bribe if required	17.9	16.7	1.186	.238
React against any threat (% of household)				
Money	64.2	83.3	–2.213	.029***
Flee away	5.4	4.2	.283	.778
Apologise	3.6	6.3	–.619	.538
Mutually solve	32.1	52.1	–2.082	.040***
No need to react	7.1	2.1	1.199	.233
Failed to react	19.6	4.2	2.423	.017***
Able to achieve in anyway (interference or hindrance)	3.65	3.51	.651	.517
Economic freedom (% of household)				
Open markets for everyone	98.2	97.9	.109	.913
Can produce free whatever wants to	100	100	–	–
Can extract and sell the forest resources freely	100	100	–	–

Superscript values represent the scales of measuring respective indicators.
*** significant at α = 0.01 level.

common ESS collected by the villagers in that part of the forest were identified. We also collected data on four general wellbeing criteria. The effect of each criterion on wellbeing was measured through the use of scores varying from small to large impacts (Table 1 and Table 2). The collected data were then recoded on the scale of 1–5 (1 = Lowest wellbeing, 5 = Highest wellbeing). The contribution of the wellbeing of each criterion was determined by asking the individual about how each service influenced each criterion of their wellbeing. Their responses were then coded on the scale mentioned above, in order to determine the scores of wellbeing (Tables 1 and 2). These overall scores were calculated by adding up the individual score from each respective indicator within each criterion. The differences of the two access groups-LA and HA were tested by performing independent sample *t*-test (significant p-value < 0.05) with SPSS V22.0 software.

3. Results and discussion

3.1. Level of access to ESS

The income from ESS is one of the best indicators of level of access to ESS. The income from ESS of HA families (US$1575yr^{-1}) was significantly higher than that of LA families (US$629yr^{-1}), primarily because of significant differences in the amount of honey and crabs collected between the two types of families. LA families made the most income from shrimp fry (US$361yr^{-1}) followed by shrimp (US $355yr^{-1}), mixed fish (US$338yr^{-1}), crabs (US$310yr^{-1}), honey (US $68yr^{-1}) and fuel wood (US$156yr^{-1}). Most income of HA families was from shrimp fry collection (US$693yr^{-1}) followed by crabs (US $556yr^{-1}), mixed fish (US$459yr^{-1}), shrimp (US$164yr^{-1}), honey (US$130yr^{-1}) and fuel wood (US$154yr^{-1}) (Table 3). The highest number of low access households collected fuelwood (93%) followed by crabs (62.5%), honey (30%), mixed fish and shrimp (25%), and shrimp fry (18%). In the case of the HA families the highest involvement was also in the collection of fuelwood (98%) followed by crabs (94%), honey (67%), mixed fish (60%), shrimp fry (46%) and shrimp (37.5%). It is also clear that a household's engagement in shrimp and fuelwood collection showed no significant difference (Fig. 2). Shrimp catching requires an individual to stay awake at night which was the profession for specific group of people. In many studies it has been found that skill is one of the most important decisive factors of determining livelihood strategies of a family (Leinbach, 2003; Speranza et al., 2014). On the other hand, fuelwood was the everyday necessity for all the households. Hence, there was no significant difference between LA and HA people. Dovie et al. (2004) also argued that the change in family income has no significant effect in fuelwood consumption in the areas where biomass is the primary energy source.

3.2. Wellbeing of the access groups

3.2.1. Basic materials

Basic materials of a good life include availability of water for drinking and other uses, and the status of food sufficiency of the families. Results found that for drinking purpose HA households were more dependent on supplied water than natural water compared to LA people (Table 4). Water for non-drinking domestic purposes was significantly more available to LA families than that of HA families. They also had significantly higher health risks from waterborne diseases than LA families. Emch (1999) found that the poor are more reliant on unsafe drinking water and thereby more vulnerable to water borne

Table 6
Comparing health and sanitation between lower and higher access groups around the Sundarbans forest.

Criteria & indicators	Lower access	Higher access	*t*	*p*
Physical health				
Physically feels weak[5]	3.25	2.60	2.288	.024***
Diseases per year (frequency yr^{-1})				
Male	5.12	5.06	.138	.891
Female	4.13	4.56	–.800	.426
Children	5.48	5.72	–.218	.828
Chronic diseases/health issues				
Male (%)				
Broken limb	1.8	2.1	1.320	.190
Diabetes	1.8	–	1.000	.322
Piles	3.6	4.2	.889	.376
Hypertension	1.8	–	1.000	.322
Lower back pain	1.8	2.1	–.108	.914
Female (%)				
Lower back pain	7.2	-	1.632	.106
Hypertension	1.8	4.2	–.718	.474
Children (%)				
Asthma	–	2.1	–1.081	.282
Health awareness				
Toilet facility (% of household)				
Sanitary	98.2	100	–1.000	.322
Unsanitary	1.8	–	–1.000	.322
Knowledge of health[4]	2.02	2.37	–2.188	.031***
Mental health[5]				
Generally feels happy	2.86	2.94	–.350	.727
Self-esteem is high	2.52	3.04	–1.815	.073
Regularly stressed	1.86	2.06	–.848	.398
Regularly angry	3.25	2.98	1.167	.246

Superscript values represent the scales of measuring respective indicators.
*** significant at $\alpha = 0.01$ level.

Table 7
Comparing good social relations between lower and higher access groups to ecosystem services around the Sundarbans forest.

Criteria & indicators	Lower access	Higher access	*t*	*p*
Trust and solidarity relations				
Most of the people are trusted[5]	1.53	1.36	1.133	.260
How much local govt./authority is trusted[4]	1.71	1.67	.260	.796
Many people are willing to financial help[5]	4.56	4.81	–1.673	.097
Most of the people willing for non-financial help[5]	2.79	2.95	–.567	.572
Emergency money				
Source (% of household)				
Neighbours (with interest)	25.0	8.3	2.274	.025***
Local lenders (with interest)	1.8	-	1.000	.322
Microfinance organization	73.2	87.5	–1.545	.125
Ability to manage[5]	3.46	1.69	16.067	.001***
Collective action and cooperation				
How likely people work for protecting forest[5]	2.05	2.27	–.784	.571
How many people work together in protecting forest[5]	2.75	2.85	–.425	.672
Groups and network				
Group membership (No.)				
Livelihood group (informal)	1.36	1.38	–.133	.894
Co-operatives	0.48	0.67	–1.308	.195
Others (e.g. mosques, temple)	0.43	0.66	–1.059	.293
Close friend/families (No.)	9.93	7.87	.914	.363
Social cohesion				
Togetherness[5]	3.10	3.27	–.784	.435
Sharing ESS (No. of household)	2.60	3.04	–1.421	.158
Ceremony attended in last 12 months (No.)	7.79	10.4375	–.953	.343

Superscript values represent the scales of measuring respective indicators.
*** significant at $\alpha = 0.01$ level.

diseases than wealthier families. Our contradictory results may be because many LA families used stored rain water, which was in fact cleaner than the supplied tap water used by HA families that often included dirt (e.g. black particles, iron) and the fact that HA families were less cautious about treating their water before drinking, resulting in worse health outcomes. This suggests that with greater access to the ecosystem people move to more convenient alternative drinking water sources, but if the water is not safe either then their wellbeing deteriorates. This is supported by the statement that people would not return to using natural sources as it would represent a loss of their capital and be socially demotivating. Studies in Asia and Africa found that although piped water was safer and reduce the waterborne diseases, health concern due to water quality of piped water in the rural areas remains a major issue (Mbata, 2006; Rosa and Clasen, 2010). But HA group used cleaner water for non-drinking purpose more than LA households who used brackish water fetched from the mangrove estuaries or ponds, because many families had domestic water supply connection at their home, hence did not go to harvest from natural sources.

There was no significant difference between HA and LA households in food conditions. Results show that all families had a moderate level (LA: 3.16, HA: 3.27) of food sufficiency and all of them had been suffering from a moderate level (2.02) of chronic food shortage. As the mangrove forest does not offer a diverse range of food items and there is a limited amount of food that is available in the SMF, there was a lot of competition over access to food. This explains why fish was collected by almost all the villages and families with other food items being purchased from the market by the income earned from the ESS, which is similar to the way food systems work in similar forests (Abdullah et al., 2016; Uberhuaga et al., 2012).

3.2.2. *Freedom of choice*

Freedom of choice includes social and economic freedom, and institutional influences on the individual freedom of the collectors. A significantly greater number of HA families (83%) offset any threat (e.g. pirate attack, natural disasters etc.) with money as they earned more than LA households (64%). Greater access to the ecosystem allowed HA families to extract more and thereby earn more than LA people. They were also significantly more capable (52%) than LA families (32%) in mutually solving an issue posing a threat to their livelihood by using their socio-economic influence. This may be because of their higher social status and thus, enhanced negotiating power, which resulted in significantly fewer HA families (4%) needing to sacrifice their interests in response to any obstacles compared to LA families (20%) (Table 5). Ribot (1995) also stated that lack of access to the natural resources and associated services diminishes the ability of the poor forest dependent communities to continue their desired livelihood activities. Although changing economic conditions of the poorer communities is a long complex process, to ensure greater wellbeing it has to be ensured that if not gain, they do not lose their control on existing livelihood (Abdullah et al., 2016; Akwetairehoa and Getzner, 2010; Vedeld et al., 2007).

There was very little difference between the groups in terms of any institutional support to defend their rights, as both groups felt this was inadequate. This mirrors the results of other studies where it was also identified as one of the greatest problems in the sustainable conservation of natural resources (Clements et al., 2010; Gibson et al., 2000). Economic freedom between the access groups was also not significantly different. It was mentioned that, while some NGOs sporadically run projects to help in improving forest management and human wellbeing, the Forest Department primarily manages the forest through restricting illegal activities while NGOs encouraged people to minimise dependency on the forest ecosystem. However, all households agreed that none of this effort was making any significant changes to their livelihoods, hence they live on their own. All of them agreed that pirates were the strongest groups to restrain their rights to the ESS of the forest.

Table 8
Comparing wellbeing scores of lower and higher access groups around the Sundarbans forest.

Wellbeing criteria	Lower access (Score)				Higher access (Score)				*t*	*p*
	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD		
Water for other purpose	3.83	4.83	4.45	.246	4.00	4.83	4.37	.203	1.846	.068
Water to drink	2.71	4.29	3.84	.360	3.00	4.43	3.87	.338	−.516	.607
Food availability	1.33	4.67	2.94	.830	1.33	4.33	2.88	.770	.335	.738
Physical health	1.83	4.11	2.98	.532	2.33	4.22	3.24	.486	−2.330	.017***
Mental health	1.00	4.25	2.94	.693	1.75	3.75	2.77	.584	1.372	.173
Personal security is good	1.00	5.00	4.73	.674	2.00	5.00	4.69	.719	.325	.746
Certainty of employment	1.00	5.00	3.05	1.420	1.00	5.00	3.25	1.509	−.680	.498
Certainty of ESS availability	1.00	5.00	3.95	1.313	2.00	5.00	4.06	1.262	−.459	.647
Emergency money manageability	2.00	4.00	3.46	.538	1.00	3.00	1.69	.589	15.955	.001***
Trust and solidarity relations	1.25	4.00	2.46	.656	1.25	3.50	2.31	.597	1.260	.210
Collective action and cooperation	1.50	5.00	3.23	1.128	1.50	5.00	3.45	1.081	−1.043	.300
Groups and network	1.00	3.00	1.88	.533	1.00	3.75	1.95	.594	−.661	.510
Social cohesion	1.50	5.00	2.92	.706	1.00	5.00	2.88	.802	.299	.766
Social Freedom	1.67	3.50	2.55	.508	1.50	3.50	2.65	.497	−.899	.371
Economic freedom	4.67	5.00	4.99	.044	4.67	5.00	4.99	.048	.108	.914
Institutional protection	1.50	2.67	1.92	.318	1.67	2.83	2.03	.368	−1.684	.095

SD = Standard deviation.
*** Significant at α = 0.01 level.

3.2.3. Health and sanitation

In terms of physical strength, we found that significantly more HA collectors were physically weak than LA collectors. This may be because of the high physical requirements of collecting ESS including living inside the forest and sleeping on small boats (especially when collecting honey, shrimp, mixed fish deep into the forest, shrimp fry) compared to their counterparts. Based on the response to the question "How much do you know about health, diseases and causes, sanitation and precautions to avoid diseases?" it was found that LA families had significantly lower knowledge about health than HA families (Table 6). This may be because HA families had to utilize higher amount of livelihood capitals (human, natural, financial, physical and social) than LA families, which eventually exposed HA households to more information on health and sanitation while LA households mentioned that they were too busy in managing their very basic needs for food, hence education was not their first priority. Moreover, due to their lower socio-economic condition caused by lower access, they were less exposed to or not interested in awareness programs run by public and private organizations. It was surprising that there was no significant difference in mental health conditions of these two groups of people. The level of happiness and self-esteem were found low in both HA and LA families. This suggests that providing higher access in a forest ecosystem would not ensure higher health and sanitation of dependent communities and that the income earned from the extraction of ecosystem services was not enough to meet even the basic family needs, making the benefits of limited health care facilities a luxury (Angelsen et al., 2014; Kamanga et al., 2009).

3.2.4. Social relations

To understand the effect of ecosystem dependence on trust and solidarity relations, we compared collective action and cooperation, groups and network, and social cohesion of the villagers in the two groups. LA collectors were significantly more dependent on their neighbours for taking loans than HA families. This reduced dependency of HA collectors on their neighbours or other members of society might be the result of their higher ability to get loans from microfinance organizations. Studies in Africa and Asia previously suggested that poverty has a significantly negative effect on access to formal credit (Beck et al., 2007; Okurut, 2006; Yunus, 2007). The ability to manage money of HA families was significantly lower than LA households (Table 7). Thus, higher access to ESS made HA households more affluent to borrow money from financing organizations. However, their ability to manage money was lower than LA because they needed larger amounts of money that were not easily available from the formal credit organizations. Manig (1990) also showed that formal credits markets are dominated by the higher income households in the rural areas which eventually lead the poor to depend on the informal credits from the neighbours, relatives or cooperatives. In case of other parameters of social relations including collection action and cooperation, group and network, and social cohesion there was no significant difference between the groups of forest dependent villagers.

3.2.5. Wellbeing scores

The mean score for physical health was moderate in both categories of households (LA: 2.98, HA: 3.24), but a significant difference was observed in the physical health of the two access groups. Although physical weakness was found to be higher among HA collectors, the combined score of physical health wellbeing of the family was significantly higher among the HA families. HA collectors sacrificed their individual wellbeing but were able to maintain greater wellbeing of their families. Wunder et al. (2014) also reported greater physical hardship in harvesting ESS from forests is one of the main reasons of vulnerabilities of ecosystem dependent communities. Literature has also suggested that the forest acts as a safety net for family wellbeing (i.e. low wellbeing of a family could potentially increase the pressure on adjacent ecosystems (McSweeney, 2004; Pattanayak and Sills, 2001). But our study found that low wellbeing of a family reduces ESS extraction. Physical wellbeing of the family was crucial for the households around Sundarbans as they had to enter into the mangrove forest leaving their families behind for one week to one month or more. The wellbeing status of emergency financial assistance was significantly higher across LA families (3.5) than HA families (1.7) (Table 8). This is may be because the HA families required higher financial capital for collecting profitable ESS than LA families. Moreover, HA families were more reliant on the formal credit organizations while the LA households were predominantly dependent on informal credit sources. This result suggests that with higher access to the ecosystem services, collectors lose their ability to manage emergency money i.e. increased income did not ensure greater economic security. The higher the amount of money required, the lesser the source becomes available. But there was no significant difference between two groups in other criteria of wellbeing.

4. Conclusion

ESS had significant influences on some aspects of the wellbeing of ecosystem dependent communities. In this study, we found social

freedom, social cohesion, and economic security tend to be significantly higher with a higher level of ESS extraction, whereas food sufficiency was significantly reduced with any increase in ESS collection. This means that as the economic status of the people increases, so does their demand for food, which then becomes even harder to afford. In the case of the mental and physical health of the collectors, there was a significantly negative impact of higher ESS access. Therefore, ESS may have both positive and negative effects on the wellbeing of the local people. Sole dependency on the ESS from forest ecosystems, per se, would not generate sustainable conservation outcome. Our research suggests that incorporating other development initiatives such as water and sanitation, education, and psychological and social improvement into conservation efforts are essential to ensure greater wellbeing and, eventually, forest ESS conservation. While this research explores the overall effect of ESS on human wellbeing criteria, an additional study showing the link between each wellbeing criteria and ESS at local and spatial levels would add more context and information to the understanding of relationships between ecosystems and human wellbeing.

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