

Master Thesis

**Analyzing the Forest Circularity and Inclusion of Local
Community: A Case Study from Kaptai and Karnafuli Forest
Range, Rangamati, Bangladesh**

Presented by

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Abstract

The total forest area of Bangladesh is 2.6 million hectares, which is nearly 17.4% of the total land area of the country. About 3% of the country's GDP is contributed by the forestry sector. Among these, the CHT alone covers about 40% of the total forest area. The district of Rangamati in CHT region is prominent for the presence of the Kaptai National park and the Karnaphuli paper Mills. Home to varied indigenous communities, the livelihood of the people in this region is highly dependent on the forest resources. The Karnaphuli Paper Mill is one of the oldest government infrastructure that utilizes the forest resources to produce different kinds of papers as products. In addition, the by-products from this industry and the forestry practices by the forest department are not officially monitored for creating economic value from circular forestry.

This thesis thus focuses on the core research question: "How has the forest sector of Rangamati in Bangladesh implemented circularity principles?" This question was answered through three sub-questions:

- What are the drivers and hindrances to enable circularity in the forest of Rangamati in Bangladesh?
- What are the local communities' perspective on achieving circular forest practices?
- How can the local communities be included in the practices, if they want that in the first place?

The answers of these questions were found through desk research, semi-structured interview of the officers of the local forest department, the paper mill, local people representatives and 10 focused group discussion consisting of 186 respondents. Literature on forest circularity, public participation and political ecology were studied before the field work and data collection. The questions were formulated from the selected indicators which were compiled from the reviewed literatures.

The hindrances of forest circularity were Geographic Remoteness of the forest, Geo-political Constraint and Local Law and Order Situation of Rangamati, Poverty of the local community, Lack of Awareness and Education within the communities, Land Use Change of the forest region, Lack of Facilities in Forest Department and the Paper Mill, Waste Management of the paper mill and the forest department and the Water Management done by the paper mill. The drivers which indicated the scope of circularity were the forming of new Liaison and Co-operation between the local community and the forest department, communities' Motivation to Work with the forest department and the Installation of Modern and Eco-friendly Technologies in the paper mill.

For the public perception regarding the forest circularity, 59.6% of the respondents wanted to participate as long as their demand of food and source of income had been met by the practice. 44% respondents were unsupportive of the current management practice of the forest region.

The research found that the forest department need to remove the tension between them and the ethnic communities and the effect of territorialization should be reduced to engage the communities and remove the hindrances for a functioning circularity. The paper mill should also upgrade their current production and discharge practice.

Keywords: Circular Economy, National Park, Paper Mill, Political Ecology, Protected Area, Public Participation

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List of Abbreviations

CE	Circular Economy
FD	Forest Department
FGD	Focused Group Discussion
KNP	Kaptai National Park
KPM	Karnafuli Paper Mill
PA	Protected Area
PP	Public Participation

1. Introduction

The aim of this research was to identify to what extent and how circularity was being practiced in the Kaptai and Karnaphuli range of forest region of Rangamati, Bangladesh.

This chapter includes background information on circular economy in forest, with a focus on Rangamati which is a Southern part of Bangladesh's Chittagong Hill Tracts forests. The problem statement, the research objective, and the research questions that are used as a baseline of this research are also included. A brief illustration of the outline of the thesis is presented.

1.1 Background

The biggest driver for forest degradation and deforestation all over the world is logging and timber extraction (Joseph et al., 2012). One of the crucial sources of global greenhouse gas emissions is forest degradation in developing countries (Pearson et al., 2017). Selective logging in the tropical forests not only causes degradation but also rapidly increases the emissions (Asner et al., 2005).

As per the records of Bangladesh Forest Department, Bangladesh has only 14.1% of the total land designated for forests (BFD, 2022). It has decreased than before. One of the crucial reason for this decline is the rapidly increasing demand of the woods, both timber and fuel woods (Nath et al., 2016). Chittagong Hill Tract (CHT) covers 43% of the total forest land in the country (Hossain, 2013). But this land coverage has also decreased since 1990 drastically (Reddy et al., 2016). There are currently 1.6 million people staying there.

One of the 3 region of CHT is Rangamati with an area about 6116 sq. km. It is one of the forest division of the country with some reserved and protected regions (S. N. Uddin, 2017). The forests which are reserved, everything is prohibited unless permitted in that forest i.e. entrance in the forest, logging, harvesting or even collection of resources are forbidden if there is no prior permission granted by the authority (Aftab, E., Hickey, 2022). So unless there is governmental permission, no one is allowed to cut trees or harvest from there. Kaptai and Karnaphuli are 2 ranges of the forest and together, they comprises Kaptai National Park (Miah, 2001).

There are 11 ethnic/indigenous communities in the CHT (Amnesty International, 2013). Their profession includes agriculture, fishing and business (Hossain, 2013). They cultivate in a special

method called “slash and burn” where they cut trees and burn them to make the land suitable for cultivation (Hossain, 2013). Due to the presence of Kaptai Lake and the hydroelectric project, these people had to move away from their land (Hossain, 2013) and had constant clashes with the Forest Department to keep their settlement and making the forest areas reserved (Rasul, 2014).

Karnafuli paper mill, a state-owned and the largest paper mill in the country (Al et al., 2018) takes wood (*Gmelina arborea*) from this forest for their productions. They have to rely on selective harvesting of the species for the production. They have no other option but to discharge their wastewater into the Karnafuli river which flows by right beside the Rangamati region (Al et al., 2018). The reserve forest in this region is tropical rainforest with semi-evergreen to evergreen vegetation (S. N. Uddin, 2017). Unless better conservation programs are initiated, a large amount of native species in this region is in danger of being extinct as well as the rapid degradation of the forest land itself (Chowdhury et al., 2018).

1.2 Problem Statement

The current problem in Rangamati is meeting the demand for forest bio-products, while maintaining the sustainability of the forest land and to ensure the habitat of the local people living within and nearby the forest region is not affected while the production from the forest is being carried on.

Since the Karnafuli paper mill is solely dependent on the woods from the local forest and the forest land is decreasing, for the longevity of their business, they should upgrade their business strategy (TEECE, 1997) i.e. their business model should be strong enough to ensure the constant supply of raw materials without hampering the production. They will need a corporate sustainability with sustainable policy ensuring the reasonable use of woods (Näyhä, 2019). As the river beside the paper mill is affected by this company particular (Al et al., 2018), while ensuring the sustainability of the forest, the concerns of the local people dependent on the forest and the river of that region should also be considered.

As per IUCN, apart from research purposes, any kind of product extraction is prohibited in the national parks (Dudley, 2008). But due to illegal felling and lack of proper security, the amount of covered land is decreasing in the national park. The local community, who have been dependent

on the Kaptai national park for generations have their hands tied for multiple factors regarding the decline of the forest land.

Circular Economy (CE) might be a possible solution for all these challenges contrasting with the linear economy (Tate et al., 2019) i.e. extract-produce-discard model. It will require eco-innovations (Prieto-Sandoval et al., 2018). Eco-innovation is defined as “the production, application or exploitation of a good, service, production process, organizational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resource use (including energy use) compared to relevant alternatives” (Kemp & Pearson, 2007). The R-ladder (Figure 1) is followed to minimize the closed loop of resource flow, minimization of extracting raw materials and waste generation (Velenturf & Purnell, 2021).

Practicing 3 of the basic principles i.e. reduce, reuse and recycle can be a good start to shift from linear economy to the circular one might be a good start. According to (Goyal et al., 2016), *Reducing* means the reduction of the consumptions of non-renewables and toxic materials, *Reusing* means extending the functional life of a product as long as possible, keeping them away from landfill and *Recycling* means the transformation of wastes into new products for use and consumption.

Since CE deals with environment, economy and people simultaneously and Bangladesh, being determined to make a good use of their resources and to achieve all the SDGs. CE favors the reuse and recycling of wastes (Azizuddin & Shamsuzzoha, 2021) so CE can be an important tool for them to achieve a more sustainable management of their forests.

Even though forest circularity is already in practice in the countries like Finland (Husgafvel et al., 2018), Brazil (Silva et al., 2020a), Portugal (Gonçalves et al., 2021), there were no official initiatives ever taken in the forestry sector of Bangladesh to implement circularity. Comparisons with the forests of those countries are essential because those forests have multiple industries dependent on them and yet they have been maintaining circularity.

In Rangamati, public participation is absent when it comes to forestry practices. Introduction of a new concept like CE might create a new perception from the local ethnic communities. Since they are often deprived of their multiple rights (Amnesty International, 2013), it is necessary to

understand the current scenario of public perception regarding the forestry practices in there to consider any kind of public participation for a new practice like CE.

1.3 Research Objectives

In this research, an analysis was made to find in which ways the forest region of Rangamati, in Bangladesh has embedded some of the circularity principles in the forest management. For that purpose different stakeholders of this specific forest sector like the leading paper mill of the country, local authorities and local community members were part of this research. The leading paper mill is state-owned, making them legally permitted for logging. Traditionally, forest activities have an important effect on water quality/quantity. In terms of circularity, it represents an important indicator for this research, even further according to Buchanan (2019) water quality can be affected by paper mill production. This research also aimed at trying to determine the drivers and hindrances to achieve circularity in the context of the Rangamati region and build upon recommendations to move towards circular economy practices. Provided the circularity is achievable, what will be the perception of the local community and how they can also be integrated were also detected.

The 3 specific objectives are:

- To find out the extent up to which circularity is practiced in the forest of Rangamati
- To identify the drivers and hindrances of achieving circularity in the forest of Rangamati
- To determine the local public reaction and perception about the CE concept being practiced in their area

1.4 Research Questions

The objective of this thesis were achieved by answering the following main research question:

“How has the forest sector of Rangamati in Bangladesh implemented circularity principles?”

To answer this question, two sub-questions are formulated:

- What are the drivers and hindrances to enable circularity in the forest of Rangamati in Bangladesh?
- What are the local communities’ perspective on achieving circular forest practices?
- How can the local communities be included in the practices, if they want that in the first place?

The forestry sector of Rangamati includes the Forest Department, the local ethnic communities around the forest and Karnafuli Paper Mill, who collects timbers from the forest and situated adjacent to the river which encircles the forest region.

1.5 Thesis Outline

The first chapter discussed about the motivation, problem statement and objectives of this research. Chapter 2 elaborated on the theories that were used to carry on this research in the form of literature review. Chapter 3 illustrated on the methodology, framework and strategy of the research and the methods of collecting and analyzing the data. The fourth chapter provided the results and outcomes of the research. Finally, the 5th chapter discussed the result on multiple scales, drew conclusion and provided further recommendations to achieve the circularity on a broad scale.

2. Literature Review

This chapter will discuss about the important keywords, terminologies as well as the theories on which this research is based on.

2.1 Circular Economy (CE) and CE in Forest

Extract-produce-discard has been a common practice of product usage and it is flawed (Ellen MacArthur Foundation, 2013). To avoid this inefficiency, circular economy came into practice. For bio-products, circular bio-economy is defined as "... inclusively considering the sustainable sourcing of biomass, sustainable design and production of bio-based products, the recycling and re-use of resources, and the sharing economy features." (Toppinen et al., 2020). To implement this model, 3 aspects i.e. social, economic and environmental dimensions must be taken into account at the same time. From the economic perspective, it ensures proper resource utilization, allocation and productivity. On the environmental dimension, it reduces the negative externalities from the redesign phase of the product manufacturing. Socially, it improves the well-being of the people, creates employment opportunity and equally distributed economic growth (Su et al., 2013).

To implement CE, 3R principles, i.e. reduction, reuse, recycle must be practiced in the production and consumption of the materials. Reduction indicates minimizing the input of primary energy and raw materials. Reduce means using the byproducts and the wastes of the production system. Processing of the recyclable materials into new products so that the use of the virgin materials is reduced is recycling (Su et al., 2013).

Forest circularity means reducing the use of virgin material and landfill disposal (Sauvé et al., 2016). Unlike the circularity in any given industry, the forest circularity focuses on the reinsertion of nutrient-based products in biological cycle of the forest (Ellen MacArthur Foundation, 2013). For establishing circular economy in a forest, an inter-organizational co-operation should exist between the supplier (in this case, the forest), consumer (the paper mill and the local community) (Silva et al., 2020b).

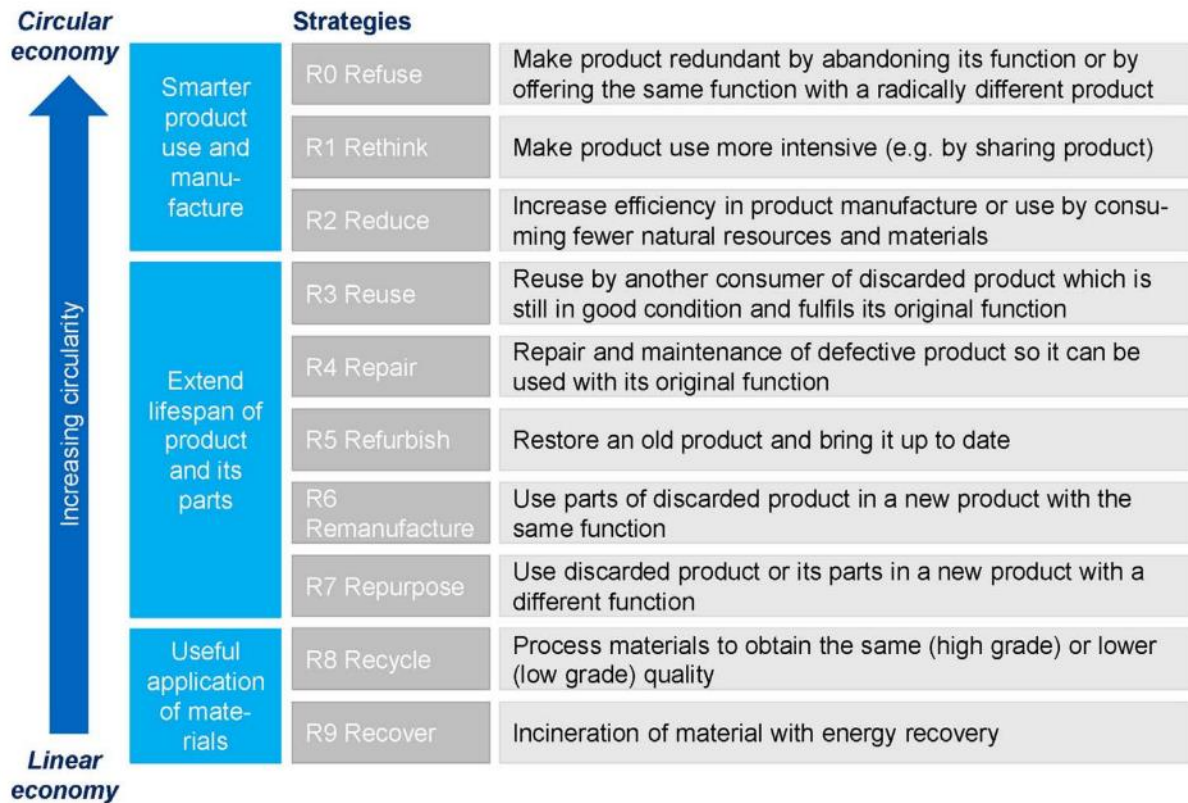


Figure 1 9R framework of Circular Economy (Potting et al., 2017)

There are a plethora of variables for circularity compiled (Su et al., 2013). But to assess the circularity in a specific sector, a set of indicators need to be determined (Moraga et al., 2019). Based on the works of (Silva et al., 2020b), 4 indicators and their associated variables are chosen to analyze the forest circularity in this research. Since the research only focuses on the selected 3Rs, these indicators mostly suit with them. The indicators and their variables are:

Table 1 Indicators and Variables for Measuring Circularity

Indicators	Variables
Raw material consumption	Virgin
	By-product
	Recycled
Waste generation and its usage	Reuse
	Nutrient cycling
	Energy recovery
	Land filling

Energy consumption	Electricity
	Steam
	Fossil fuels
Water	Source
	Main uses
	Wastewater destination

Raw materials include virgin: log, sawn wood; by-products: sawdust, bark, chips; recycled: cardboard, paper residues. For waste generation, reuse indicates the reusing of materials in the manufacturing process; nutrient cycling indicates the composting and the soil pH; energy recovery means the combustion in the boilers; landfilling means the dumping of the wastes. In energy consumption, steam indicates the fuel that derives from the forest wastes. In case of water, the sources, the primary purpose of the usage and where the effluent is discarded will be look after.

Based on the collected data, the extent up to which there are any practice of circularity in the aforementioned forest were measured. The drivers and hindrances for the success and failure of the practice were derived from the collected data and the interviews of the employees from the Forest Department, local communities and the paper mill.

After measuring the practice of circularity from the company level, the level of participation were measured for which the concept of political ecology comes which will be discussed next.

2.2 Theory on Political Ecology and Public Participation

Since forest is a natural resource and when the local community will be engaged in any kinds of practices regarding that natural resource, not only they will become one of the stakeholders but also the influence the sustainability practices of the products from the industry (Sharma & Henriques, 2005). That is why, for determining to what extent they will influence the natural resources, the frameworks of Political Ecology can be considered (Bryant & Bailey, 1997). Political Ecology is a combination of economic, political and socio-cultural aspects of the stakeholders (Escobar, 2006). From time to time, in multiple places all over the world, there had been clashes between the neighboring communities and the conservation of the protected areas and that is why to have a good understanding of the stakeholders from the political ecology perspective could facilitate the identification of potential ways to reduce those confrontations (Macdonald, 2005). One of those confrontations has been described as “Territorialization” i.e. introducing territorial units and defining what can take place within that territory and what not (Holmes, 2014). As per (Sack, 1983), territoriality is “the attempt to affect, influence, or control actions, interactions, or access by asserting and attempting to enforce control over a specific geographic area”. For any protected areas, internal territorialisation is done which entitles the state to define the right to access the area and resources (Vandergeest & Peluso, 1995).

Territoriality concerns with political ecology in 3 ways:

- Protected areas have always made a binary distinction between nature and human society (Holmes, 2014). Protected areas are made to preserve the wilderness (Cronon, 1996). To do that, the resident population are often removed against their will (Neumann, 2004). The evicted community often suffers economic and social deprivations (Craig et al., 2012). Even in cases where they are not physically removed, their livelihood or source of income are greatly restricted since they are usually dependent on the protected area (Adams & Hutton, 2007).
- Any benefits from the protected areas are reallocated to the distant authorities in lieu of local people especially if that distant authority writes the regulations and management plan for that protected area (Nelson & Agrawal, 2008). The distant authority might not be able to comprehend the land use of that area by the local people, making them deprived of all the facilities that land provides.

- The social impact of this territorialisation is never smooth, rather contested (Sikor & Lund, 2009). The radical change of the ownership of the resources creates new conflicts (Vandergeest & Peluso, 1995). Meaning of every actions changes. Hunting is redefined as poaching, resource usage becomes theft, access becomes trespassing (Holmes, 2014). It is quite evident that general, day-to-day activities of the local community somehow becomes a crime which the community does not take lightly.

In case of protected areas, the above discussion clearly indicates that the political ecology of the local people are often hampered. A possible solution for ensuring the political ecology and maintain the sustainability and circularity of the forest can be public participation. Given there are already successful cases of achieving sustainability in the forests of Bangladesh through public participation (Jashimuddin & Inoue, 2012)

Public participation is an important factor for political ecology for multiple reasons:

- Possibilities for environmental justice for the community
- Efficient way developing policies better for the environment
- Emphasizes more on effective and ecologically environmental conservation (Demeritt, 2015)

In case of forests and its resources, public participation, it means different things to different people. For some, it means the acquisition of power for the land whereas for the professionals, it is a stimulation of ongoing learning process and increasing awareness of collective responsibility within a community (Buchy & Hoverman, 2000). It has some default features:

- According to (Pateman, 1970), it ensures participatory democracy. To her, participation means “equal participation in the decision-making process”. It might be through democratic election process where there is community involvement in public affairs or devolvement of power to the local community to make decisions about their conditions.
- Role of power is one of the reason why people want to get involved in forest management even though the forestry agencies do not want to lose or give up control over the forest resources (Snowdon, P., & Slee, 1996).

- It provides the opportunity of consultation. Consultation is a process of involvement where the opinion of the people are asked which may or may not influence the decision (Buchy & Hoverman, 2000).
- Community empowerment or the decentralization of power in the community and the subsequent learning the proper use of the resources and increasing the self-esteem of the individuals takes place after a certain time of public participation (Chambers, 1997).
- Since there is constant communication, the relationship between the community and the authority, a bridge of understanding and trust forms between the parties (Chambers, 1997). In Sri Lanka, a positive relation between both the parties were found after 6 years of participatory forestry (Tacconi, L., Buchy, M., & Gamini, 1998).

According to (Mccool & Guthrie, 2001), public participation in nature resource management has 2 main dimensions (figure 2):

1. Product-oriented measures: It focuses mostly in output of the management process of the natural resource/protected area. It includes writing, implementing and acceptability of any plans taken for the area.
2. Process-oriented measures: The thoughts and behavior of the actors in managing the area is given more attention here. Responsibilities, representation of the interests of various actors, relationship building of actors and learning process are included here.

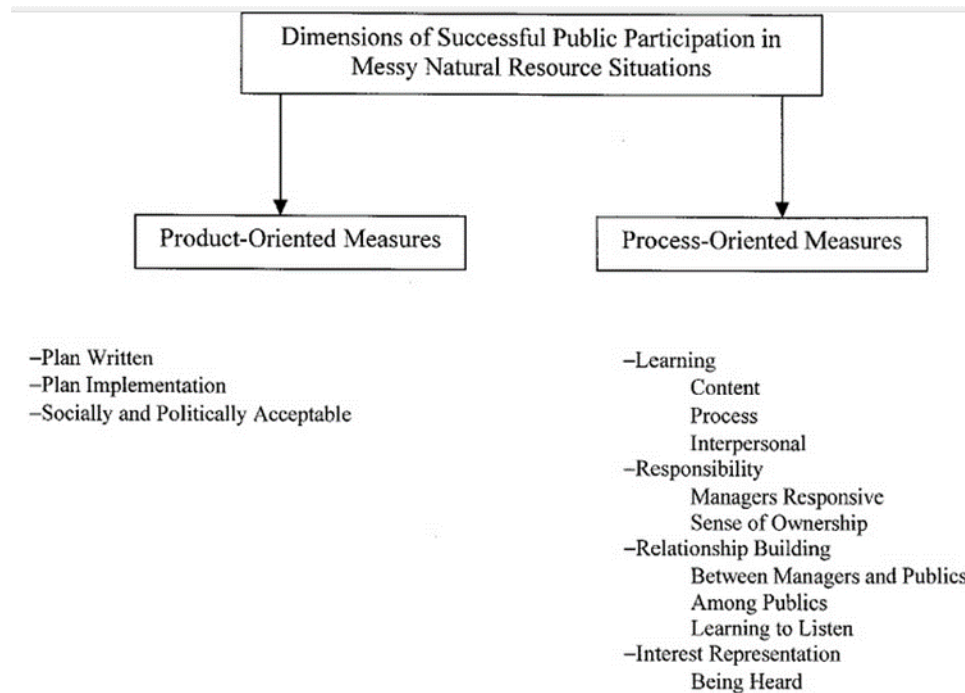


Figure 2 Dimensions of successful Public Participation (Mccool & Guthrie, 2001)

The product oriented measure means if there is any participation of the local community in writing and implementing the plan. The success of these two depends on the trust between both the authority and the community. Besides, the plan should be socially and politically acceptable by the community. Without the acceptance, the management will face problems while working. The indication of the acceptance by the community are understanding the roles, support to the management and following the management rules (Mccool & Guthrie, 2001).

This research will only focus on the learning and the responsibility of the community from the process oriented measures. Responsibilities indicates the responsiveness of the community in changing the condition of the forest and the attitude and behavior will show the sense of belonging for the community.

The parameters of political ecology and public participation that will be used to analyze the findings of the sub-question 2 of this research are displayed in table 2:

Table 2 Parameters of Political Ecology Perspectives and Public Participation (Mccool & Guthrie, 2001)

Variable	Dimension	Parameter
Political Ecology Perspective	Political Aspect	<ul style="list-style-type: none"> • Actor's ability to conduct their jobs • Actor's willingness to commit in similar protected areas goals
	Economic Aspect	<ul style="list-style-type: none"> • Revenues allocation to environmental maintenance and sustainable ecosystem management in the forest
	Social and Cultural Aspect	<ul style="list-style-type: none"> • Good information flow to and from local communities • Local communities' willingness to involve in the management
Public Participation	Product Oriented Measure	<ul style="list-style-type: none"> • Written and verbal consultation and representative • Actors' support to the management and follow management rules.
	Process Oriented Measure	<ul style="list-style-type: none"> • Actors' understanding of legal and policy of the forest (content), comprehension of ecosystem and nature function of the forest (process), and dealing with their personal values, beliefs, and interest of the actors (interpersonal) • Actors' responsiveness to the change of forest condition

In the Political Ecology Perspective, the capacity and the willingness of the community will be the determining factors. The rate of success of the public participation depends on how much the three aspects of the political ecology has been achieved (Bryant & Bailey, 1997).

From time to time, there had always been clashes between the local ethnic group and the forest department in Rangamati region (Amnesty International, 2013). So, unless they do not get anything in return, it is unlikely the communities will engage in some activities that helps the forest

department. For that reason, to understand the perception of the local community in terms of the public participation, both the current mindset (i.e. after being deprived) and the probable mindset (i.e. after their political ecology has been achieved) has to be taken into account.

To understand and determine the public perception of the local communities regarding the Rangamati forest and its circularity, the current condition, both the administrative and geographical condition of the place has to be understood.

2.3 Description of Rangamati Region

Rangamati, the largest district of Bangladesh is situated in the south-eastern region of Bangladesh. With an area of 6116.3 sq.km, it is located in between 22°27' and 23°44' north latitudes and in between 91°56' and 92°33' east longitudes (Banglapedia, n.d.). 4825 sq. km. is under forest vegetation.

In Figure 3, it can be observed that majority of the land has higher alleviation compared to the other two districts of Chittagong Hill Tracts. But the number of shrub land, human settlements and crop land is increasing, decreasing of the amount of land covered by hill forest. The biggest feature of this district is the Kaptai Lake (Figure 4) which is the largest man-made freshwater body in Bangladesh.

13 ethnic communities live in Rangamati. Only 23% of the population finished primary education (Saha et al., 2019). 45% of the total population own their private lands for cultivation whereas 47% of them are defined as poor. 88.23% of the population collect fuel woods and 58.8% extract timber from the forest for household purposes (Jannat et al., 2018).

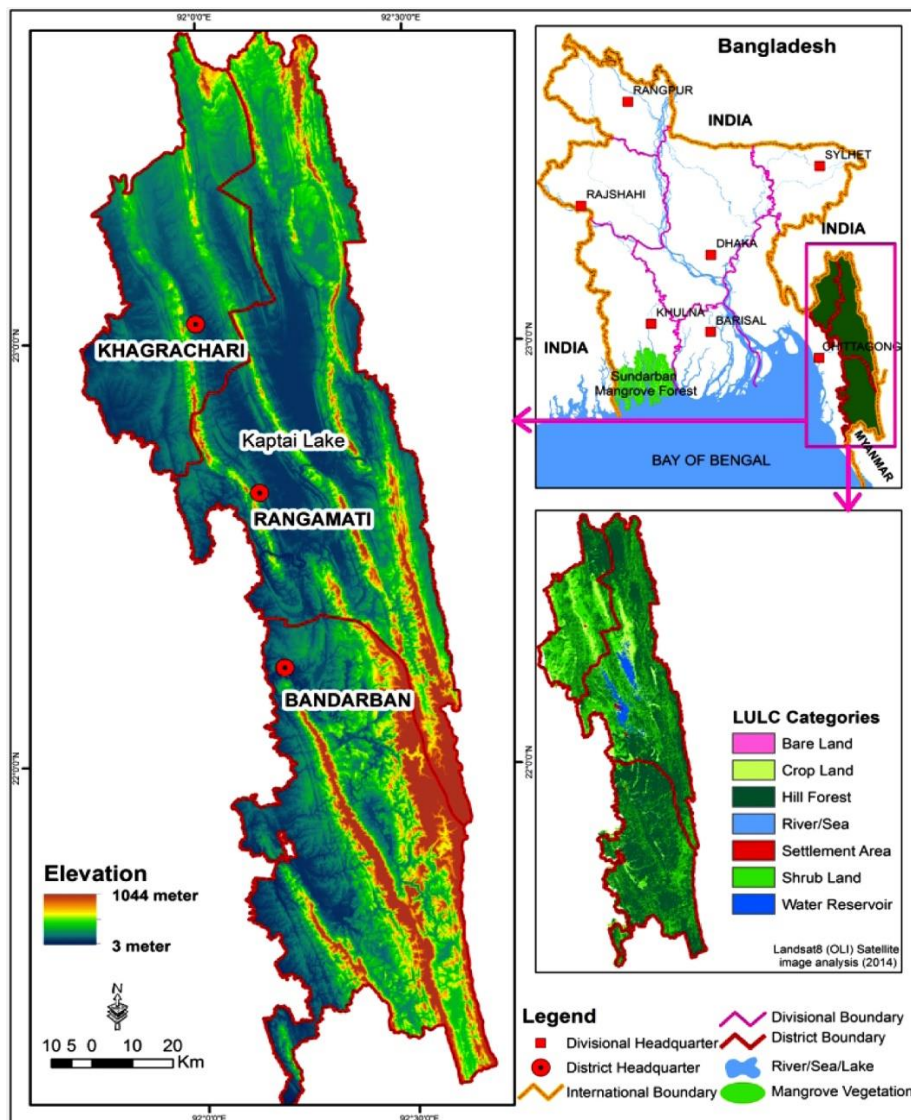


Figure 3 Map of Chittagong Hill Tract (Emran et al., 2018)

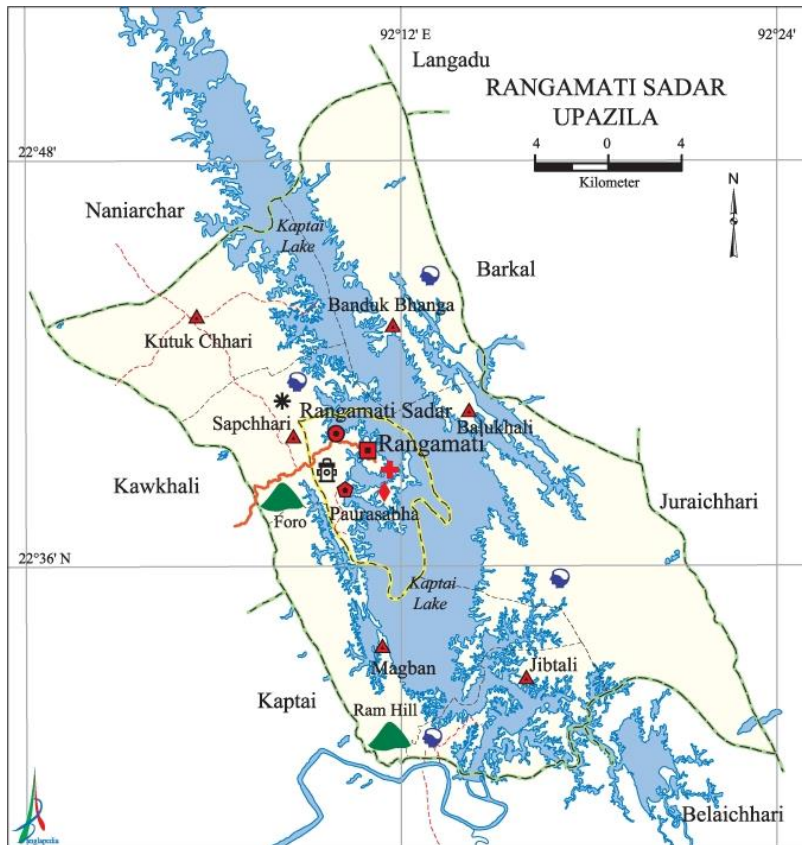


Figure 4 Map of Rangamati (Banglapedia, 2021)

A forest is made reserve so that no one can use its resource anytime and anyway they want. Ensuring the natural conservation, to maximize the economic efficiency of that forest are kept in mind while declaring an area as reserved. From the previous discussion, it was shown that how the forest area is decreasing day-by-day in Bangladesh but to keep up with the local demand of the woods, forests need to go with regular loggings. Circular Economy could be a tool to reduce the constant demand of the industries for woods which not only focuses on the less use of virgin materials, but also focuses on the reduction of wastes from the industry. For that, 4 pre-determined indicators were used to answer the first sub-question.

Secondly, it had also been discussed how territorialisation affects the social, economic and political aspects of the local community when any area is declared reserved. The map of the land cover showed how they have to be dependent on the forest for their economic activities and livelihood. But the declaration of the forest as reserved made their lifestyle harder than before.

Given the current sustainability practice is failing, public participation could be implemented in the management practice. For Rangamati, it would mean the introduction of public access on the

forest after a long time. Since for all these times, the political ecology of the local community had been hampered and they had constant, subtle clashes with the authority, it was not certain if they would be open with the idea of achieving circularity in the forest in exchange of their access in the forest. Even if they were open with the idea of engagement, the extent up to which they want/can be included is still in question. That is why, their political, economic and social and cultural aspects of their political ecology were used to answer the 2nd sub-question.

Since Circular Economy can be an option and public participation might accelerate the process, if the product oriented measures and process oriented measures are fully cooperated by the local community and if their political ecology is ensured, it can be assumed that like the previous successful cases of community engagement in forest managements in Bangladesh (Nath et al., 2016), another successful forest management through public participation can be made.

One of the most significant forest region within Rangamati is the Kaptai National Park (KNP). Since it is a national park, as per IUCN, no extraction should take place in the region. But not only extraction of resources take place, but the overall forest coverage is also decreasing there. Besides, KNP also provides pulpwood for the paper mill and the production system has direct impact in the region.

2.4 Kaptai National Park

The national park was specified in chapter IV of the Wildlife (Conservation and Security) Act, 2012. According to the act, any government forest or part of a forest or any government land with scenic beauty with a specific boundary and with a goal of wildlife habitat conservation or environmental development can be declared as a national park through an official notice or Gazette (*WILDLIFE (CONSERVATION AND SECURITY) ACT , 2012 CHAPTER I*, 2012) or in simple words, the national park is a relatively large region of exceptional scenic beauty with the goal of protecting and preserving the scenery, vegetation, and animals in their natural state, with access to be permitted for public recreation, education, and research (L. M. Rahman, 2005).

While declaring a National park certain issues must be acknowledged such as a national policy or management plan for the forest, its geomorphological features, and their significance, ecology, and environment (*WILDLIFE (CONSERVATION AND SECURITY) ACT , 2012 CHAPTER I*, 2012). In Bangladesh, National parks are considered protected areas where human intervention

is permitted unless prohibited and its management also comes under the National Forest Policy, 1994 along with all other types of Protected Areas. A list of acts are strictly forbidden in a national park which includes hunting, killing, or capturing any wildlife within the national park boundary as well as within a kilometer radius outside the national park area, firing, or any act that may disturb the wild animals, damaging, collecting or removing any plant or its parts, releasing pollutants in the water that flows through the national park.

Among the eight national parks, Kaptai National Park is one of the most important protected areas for its diverse biodiversity. The gazzeted area of KNP is (5,464.78 ha) within the jurisdiction of Kaptai and Karnaphuli Forest Ranges under the CHT (South) Forest Division. There are 39 villages, with estimated 1,805 households (around 11,990 people, with 46% female) in surrounding landscape.

In spite of having different national policies and plans, co-management approach was best suited for managing the national parks and at present the Kaptai national park (KNP) is also managed by community participation (M. M. Rahman, 2019). Although co-management is a very promising method for forest management yet the success of these kinds of approaches depends largely on the cooperation of the local community. At the past the KNP was managed as a reserve forest where local people were allowed to collect their daily necessities but later it has been declared a national park for conservation purposes which lead the local communities to rivalry with the forest officials. Hence, to ease up the conflict, the forest area was taken under the co-management project in 2009. Administratively KNP consists of the Kaptai Range and Karnaphuli Range where except for the Sitapahar region the rest of the Kaptai range is plantation forest. Although the co-management approach gave the native people some access to the forest area, their perception of it was still unclear (since no specific study has been made). Later, through different studies, the level of dependency, family solvency, and literacy was detected as the main factors that might hinder the co-management approach (Morshed, M. M., Asami, Y., & Kabir, 2016).

The forest management of KNP is unique compared to the other forests of Bangladesh since it is a national park in the hilly region of the country as well as being a tourist spot.

KNP Forest Management

The existing management of KNP is shortly illustrated below (USAID & UNDP, 2022):

- Mixed tropical evergreen and semi-evergreen forests developed naturally because of favorable climate, relief and forest soils.
- Natural forests altered by biotic pressure and a lack of resources for sustainable forest management. Degraded forest areas planted by Forest Department.
- Five broad forest ecosystems:
 - Remaining natural forests
 - Secondary forests including grasslands and bamboos
 - Plantations of both indigenous and exotic species
 - Wetlands and water bodies
 - Agriculture and villages

2.5 Water Condition in Kaptai Region

The water quality of the Karnafuli River is very poor. And one of the important reasons is the discharge of untreated water and effluents from the paper mill in the river (Al et al., 2018). The extent of the problem is showed below:

Table 3 Sample Test Result of Physicochemical Parameters in Karnafuli River (Al et al., 2018)

Sample Location	pH	Turbidity (NTU)	TDS (Total Dissolved Solid) (ppm)	Temperature (°C)	DO (Dissolved Oxygen) (mg/L)
Upstream	5.5	36	300	32	5.6
Middle stream	5.2	37.2	1021	34	4.2
Downstream	5.4	36	751	32.3	4.8

These data are quite concerning because the tolerable limits compared to the standard of surface water in Bangladesh are:

Table 4 Standard value for surface water in Bangladesh (Al et al., 2018)

pH	Turbidity (NTU)	TDS (Total Dissolved Solid) (ppm)	Temperature (°C)	DO (Dissolved Oxygen) (mg/L)
6.5-8.5	10	Below 2100	20-30	Above 6

Circular Economy, as a concept is not widely spread in Bangladesh. In case of forests, the vegetation coverage in Bangladesh is decreasing especially in the Rangamati region; more specifically, in Kaptai National Park. Again, in that region, the relation between the local ethnic communities and the forest department is not friendly. As a result, there are a lot of misconception and miscommunications between both the parties. One of the stakeholders of this research, the paper mill is also being accused of polluting the river. That's why, to achieve circularity, if engaging public is a consideration, the political ecology of the communities should be looked after and water, being one of the key variables for achieving circularity, should be properly managed by all the stakeholders.

3. Research Design

This chapter discusses the steps followed to find the answers of the research questions of this thesis. Focused Group Discussion, Semi-structured interviews, surveys and desk research were done for data collection. This chapter is organized accordingly: research framework, research questions, concepts definition, the research strategy, research materials, and methods of accessing and analyzing the data.

3.1 Research Framework

As per (Verschuren & Doorewaard, 2010), a research framework must have the following seven steps:

- 1. Briefly characterizing the research project objective:**
The main goal of this research was to determine the extent up to which forest sector of Kaptai, Rangamati had implemented circularity and given circularity is achieved, how will the local people can be engaged or benefitted from this implementation.
- 2. Determining research object:**
The research object of this thesis was the forest circularity in the context of Rangamati; more specifically the Kaptai range and Karnafuli range which comprises the Kaptai National Park. This region was chosen because of its significance for the national park and the reliance of the people and the industry on it.
- 3. Establishing the research perspective nature:**
The research provided a conceptual design of forest circularity in the Kaptai of Rangamati region. It identified the drivers and the barriers of implementing forest circularity in that region. This research was an assessment-model introduction research design and the theoretical problem that was dealt with is the extension of circularity in the forest of Rangamati which was done by determining if the chosen circularity model will fit the case site.
- 4. Determining the sources of the research perspective:**
The conceptual model used in this research is derived from scientific literature reviews. The concepts that were discussed in this research are shown in table 5.

Table 5 Sources of Research Perspective

Key Concepts	Concepts and Documentation
Circularity in Forest	Circular Economy Concepts and Framework
Theory on political ecology and public participation	Information about the local community
	Forest management of Rangamati
	Preliminary research on current practices

5. Schematic presentation of the research framework:

The research framework is described through the following flow chart:

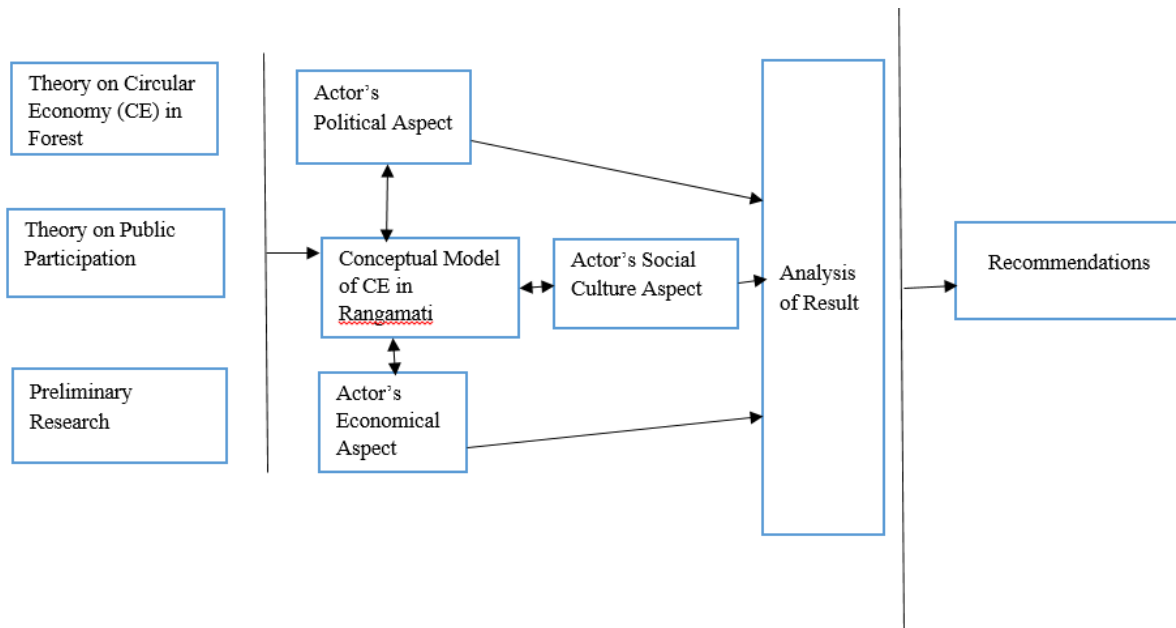


Figure 5 Schematic Presentation of the Research Framework

6. Formulating the research framework in the form of arguments:

- a) An analysis on the theories of circular economy, forest circularity, preliminary research on the local community and how does the Karnafuli paper mill works based on the production from the forest and for the second section the perception of the local community were done
- b) Identification of the research object; how would forest circularity function in the designated location, what would be the drivers and hindrances for achieving the circularity and for the second section, identifying if the local community wants to be involved and if they do, in which way
- c) For the sake of this research, only Reduce, Reuse and Recycle part were analyzed. Reduce would indicate how same or better efficiency is achievable using less amount of woods from the forest. Reuse would stipulate on if the previously used paper or woods are used in the manufacturing of new papers or other products with/without any treatment. Lastly, “Recycle” would designate if the used materials were/could be disintegrated into raw materials to be used in the new manufacturing process.
- d) Analysis of the results as the basis for recommendations were made

e) Conclusion and Recommendations to address the problem statement were provided

7. Checking whether the model requires any change:

No changes were made to the framework during or after the data collection and analysis.

Before focusing on the key concepts and the research strategy, the research questions of the thesis is mentioned again below:

Main Research Question

How has the forest sector of Rangamati in Bangladesh implemented circularity principles?

Sub-Research Questions

- What are the drivers and hindrances to enable circularity in the forest of Rangamati in Bangladesh?
- What are the local community's perspective on achieving circular forest practices?
- How can the local communities be included in the practices, if they want that in the first place?

3.2 Defining Concepts

For the research purpose, the following key concepts are defined:

Circular Economy: A model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible.

Political Ecology: The study of the relationships between political, economic and social factors with environmental issues and changes.

Public Participation: Inclusion of the public in the activities of any organization or project.

Reserved Forest: A forest where everything is prohibited unless permitted.

National Park: A national park is an area set aside by a national government for the preservation of the natural environment.

3.3 Research Strategy

This research used a selection of research methods to answer the research questions, methods that are presented in table 6 (data collection) and 7 (data analysis).

3.3.1 Research Unit

The selected units of the research were the local community, both ethnic and non-ethnic, Karnafuli paper mill and its employees and local representative of the forest department. Due to the limited amount of time, only Rangamati district of Chittagong Hill Tracts, Bangladesh was selected as the reference point. The research units were the key informants regarding the sub-questions of this research.

3.3.2 Research Boundaries

Research boundaries are set in order to achieve certain goals in the given timeframe of the thesis. The researcher chose the Kaptai and Karnafuli range of Rangamati district of Bangladesh as the geographical scale for this research. Rangamati was the reference point of this thesis paper.

3.3.3 Research Limitations

This research had the following limitations:

- Time frame; due to the time constraints, the researcher had to focus only on one of the district of a greater forest region.
- Scale; the research scale of the thesis did not represent all the forest types of Bangladesh. It only represented a forest region which is reserved and only a governmental bodies including the paper mill can use it legally.
- Interviews; some of the interviewees were reluctant to share their knowledge and information. For example, workers in general were uncomfortable to share their first hand experiences of working in their respective jobs.
 - Information; for some information, the researcher had to rely on the secondary data e.g. forest management techniques.
- Lack of data; crucial data, which might have been required to make quantitative analysis like the amount of extracted fuel woods were not available; which made it a big barrier to make better understanding and analysis.

3.4 Data Sources and Collection Methods

Data and information were collected by 10 focused group discussion sessions which had 186 respondents, semi-structured questionnaires and through reviewing the literatures of circular economy. The table 6 provides an outlook on the required information and their sources for answering each of the research questions.

Table 6 Data and Information Required for the Research and Collection Method

Research Question	Required Information	Research Method	Accessing Data
What are the drivers and hindrances to enable circularity in the forest sector of Bangladesh?	Main motivators and challenges that accelerate or delays the transition to achieve circularity in the forest of Rangamati and Karnafuli paper mill	Desk Research Interviews	Content analysis and Semi-structured interviews to 8 people (officials and field worker) from the Forest Department
How much the local community is interested to achieve circularity in the Rangamati forest region and how can they be included in the process?	The perception of the local community regarding the practice of circularity in the forest of Rangamati and the inclusion method for them in the system of forest management and eventually achieving circularity	Focused group discussion	Arranging multiple meetings with the local community (10 meetings engaging 186 respondents)

Desk Research

The previous successful cases of forest circularity were studied. Each of those cases had some drivers and had to avoid some hindrances to achieve the circularity. The history of the forest management of Rangamati was also studied to find any relevant information to answer the first

sub-question. For similar type of forest, why the achievement of circularity were not achievable were also be studied to determine if any of those factors are present in the case of Rangamati.

Interviews

The interviews were taken as semi-structured questionnaires. The group of informants were: the forest officer, the manager of the paper mill. The questions were asked to the field level workers as well to gather their knowledge regarding the current practice of 3Rs. The chosen 4 indicators i.e. raw material consumption, waste generation and usage, energy consumption and water were also analyzed based on their responses and available current up to date literatures and the annual reports. The questionnaire has been provided in the Appendix section.

Focused Group Discussion

For the second question, the opinions of the local community mattered most since before including them into the process, it seemed crucial to evaluate how they actually feel about the process and the inclusion. 186 people were engaged in the focused group discussion divided into 10 different groups from different localities. While forming the groups, gender, age-group, profession, and education level were taken into account such that there were no abundance of any specific class group. A Stratified Random Sampling was done. The groups were made from different localities or neighborhoods in Kaptai. Local officials helped to select the locations. While forming the groups, it was looked after that the groups were not saturated with any specific profession, gender or age group. 76.34% of the respondents were either directly or indirectly dependent on the forest for their livelihood. Firstly, how forest circularity works in reality and how they can be impacted by it was discussed with them. The respondents were free to ask any questions and after they were free to leave the session, it was also asked if they wanted to be engaged in any way to accelerate the achievement.

Finally, the main question was answered based on the answers collected for the three sub-questions.

For the whole data collection, there were two associates of the researcher who had previous experiences in data collection in the region. While the researcher asked the questions, the associates helped by tracking the responses and record them in the data sheet. Audio recordings were taken in cell phones as well for further cross-checking while analyzing the result. For the

convenience of analysis, the responses were tabulated in an excel file which has been provided in the Appendix.

The focused group discussions were made in between 14/06/2022 to 17/06/2022. Each group took 80 to 120 minutes for the discussions. The discussions mostly took place in the open spaces of the neighborhoods and local shops where people usually gathers as their common place to pass leisure. Participants provided oral consent to collect and record their data since a lot of them were unable to give written consent due to their lack of education.

3.5 Ethical Aspects

Since the research included the involvement of people during interviews and focused group discussion, ethical issues might have arisen. Therefore, a consent form was set up by the researcher which includes prior consent for the recording and the transcription of the recorded data. The consent form included other ethical considerations, like the interviewee’s privacy and confidentiality. For the focused group, oral and recorded consent were taken. All the guidelines according to the Faculty of Behavioral, Management and Social Sciences of University of Twente were followed before and after the interviews.

3.6 Data Analysis

Data collecting activities were carried out by desk research, semi-structured questionnaires and focused group discussion. The methods used for these analysis are discussed here below.

Methods of Analyzing Data

This research used the qualitative method as content analysis. The table 7 exhibits in detail the data and method of data analysis:

Table 7 Data and Method of Data Analysis

Required Information	Method of Analysis
Main motivators and challenges that accelerate or delays the transition to achieve circularity in the forest of Rangamati and Karnafuli paper mill	Qualitative by means of Content analysis method: Identifying the major drivers as well as the inhibitors to implement circularity in the forest of Rangamati and analyzed them against the pre-determined indicators
The perception of the local community regarding the practice of circularity in the	Qualitative by means of Content analysis method: Determining the opinions and the

forest of Rangamati and the inclusion method for them in the system	demands of the local community on how they wanted to be engaged, given they want to be in the first place
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All the answers were cross-checked with multiple sources and informants to filter out any risk of false data.

All the responses from the focused group discussions were recorded in an excel file where each sheets were dedicated to each of the 10 groups. From the sheet, percentages for each of the responses were calculated.

4. Findings

In this chapter, current extent of circularity in forest of Kaptai and Karnafuli Range of Rangamati Forest division has been estimated according to findings during data collection phase. In addition, drivers and hindrance of achieving circularity and determination of reaction of local people about the concept of CE has been discussed based on data collected from desk research, interviews and focus group discussion.

4.1 Extent of Circularity

Major part of economy centered on raw material from aforementioned forested area was pulp wood collected by the Paper Mill, timber and Fuel wood collected by the local community. These two sectors were evaluated based on indicators (Silva et al., 2020b) like raw material consumption, waste generation and its usage, energy consumption and water resources. These 4 indicators were directly or indirectly concerned with the harvest from the forest itself and/or the paper mill. Together, these 4 indicators had effect on the circularity of the forest. Since, circularity concerns with not only environmental and economic aspects but also the social aspects of the stakeholders, one of the three stakeholders of this research, the local community also effected or were being affected by these indicators. Even though not all the variables concerned them, some of the variables do had impacts based on their own practices.

4.1.1 Raw Material Consumption

Apart from the pulp wood garden within the national park and a small patch of rubber garden, there were no extraction of timber from the forest legally (Anonymous, Forester, Kaptai Pulp Wood Garden, Personal Communication, 2022). So legally, the only extracted virgin material was *Gmelina arborea* and *Hevea brasiliensis* along with some bamboo. The by-products including the bark and chips were burnt down in post-harvesting phase (Anonymous, Forester, Kaptai Pulp Wood Garden, Personal Communication, 2022).

From the aspect of paper mill, they use the *Gmelina arborea* and bamboo as virgin product to produce paper. According to their production pattern, they needed 60-70% bamboo and 30-40% pulp derived from the pulp wood species to produce paper. As their by-product of the production, they produced a small amount of HCl which comes from the chlorine used during the paper production (Anonymous, Manager, Kaptai Paper Mill, Personal Communication, 2022).

The local ethnic communities still had the necessity of collecting fuel woods from the forest. Sometimes they just collected what they found on the ground but often they had the tendency to break portions of the trees (like long branches). As a result, the natural growth of the tree was hampered (Tanaka & Yagisawa, 2009). Also, the demand of fuel woods in the neighboring areas influenced them to sell in the markets (Anonymous, People Representative, Ethnic Communities of Kaptai, 2022). KNP was rich with expensive timber like *Tectona grandis* which had high demand and price in the national market. So often these trees were stolen.

As previously discussed, since the decreasing of forest land was caused by the illegal extraction of woods, the majority of the raw material consumption was actually done by the local communities; either for their cooking or as an income generating source.

4.1.2 Waste Generation and Its Usage

When it comes to reusing, the paper mill could simply use the defected products again in the machine as the raw materials for paper. Besides, they had a converting section which makes carton boxes as an approach for recycling. The paper mill had no initiatives for nutrient cycling as they dump all the solid wastes in the river adjacent to the mill, Karnafuli (Anonymous, Manager, Kaptai Paper Mill, Personal Communication, 2022). They had 10% loss for wastage in their current production practice i.e. the efficiency of their machines in the ratio of product output by material input is 90%. The combustion in the boilers were done with the barks and chips collected during the debarking phase of the pulp wood (Anonymous, Manager, Kaptai Paper Mill, Personal Communication, 2022).

Any waste that was created in the pulpwood garden during the harvest period was burnt down before the start of the replantation in the area. So, even though the waste was not used, the ashes produced from the burning could represent a good source of nutrients (Holopainen, 2010) for the newly planted saplings (Anonymous, Manager, Kaptai Paper Mill, Personal Communication, 2022).

4.1.3 Energy Consumption

Assessing the circularity in the energy consumption gave a mixed result. When it came to electricity, it was derived from the hydroelectric project, also known as Kaptai Hydroelectric Project, which was nearby the mill giving them a clean, sustainable source of electricity (Kaunda et al., 2012). But again, when it came to the production of steam to run the factory, the turbine

which was running was run by natural gas which itself is a fossil fuel. Since the natural gas reserve of Bangladesh is depleting and new gas reserves must be discovered to keep up with the demand (Shetol et al., 2019), the current practice could not be considered as sustainable as the energy sources were not from alternative green energy sources (solar, wind, bio, etc.).

4.1.4 Water

As previously stated, the one and only source of the water for the mill was the adjacent Karnafuli River. The main use of the water was twofold: to be used in the dryer as steam and to spray water in the pulp during the production phase. Due to the lack of any Effluent Treatment Plant (ETP) in the mill, all the wastewater was dumped in the Karnafuli River without going through any treatment at all (Anonymous, Manager, Kaptai Paper Mill, Personal Communication, 2022). This practice was not only harming the species in the river, creating water pollution in it (Parvez et al., 2006), but also the forest area was also affected (Matysik et al., 2001). Since the forest land was surrounded by the river, many patches of land had become barren and the Forest Department is finding it very hard resistant to grow any species in those lands (Anonymous, Employee, Forest Department Training Centre, Personal Communication, 2022).

So, to summarize the extent of the circularity based on the selected indicators (Table 1) with respect to the paper mill and the forest i.e. KNP to a little extent, the findings are gathered in table 8.

Table 8 Extent of Circularity in the Forest and the Paper Mill based on the Indicators and Variables

Indicators	Variables	Forest	Paper Mill
Raw material consumption	Virgin	Circular	Circular
	By-product	Not Circular	Not Circular Enough
	Recycled	Not Applicable	Not Circular Enough
Waste generation and its usage	Reuse	Not Circular enough	Not Circular enough
	Nutrient cycling	Not Circular	Not Circular
	Energy recovery	Not Applicable	Not Circular enough

	Land filling	Not Applicable	Not Circular
Energy consumption	Electricity	Not Applicable	Circular
	Steam	Not Applicable	Circular
	Fossil fuels	Not Applicable	Not Circular
Water	Source	Not Applicable	Circular
	Main uses	Not Applicable	Circular
	Wastewater destination	Not Applicable	Not Circular

In the table above (Table 8), “Circular” meant that the current practices are sustainable, environmentally friendly and economically convenient. For raw material consumption, both the paper mill and forest department extracts raw materials for the same purpose; for production of paper. Since they did it in a specific, assigned garden and they have the rotation system in practice for extractions, it can be dignified as circular. For energy consumption, the paper mill had direct supply of electricity from the hydroelectric project and they had their own boilers to produce steam, whose source was also the river. For these two components, they did not have to use any expensive materials or technologies and they necessarily did not harm environment as well. That’s why, they were circular.

“Not Circular Enough” meant the current practices covered either one of the environmental and economic aspects of circularity; not both. For example, waste generated in the forest after harvesting was not circular enough from the forest department. They burnt down the remaining (like barks, stumps) of the ground in the post-harvest period. Studies (Nourtier et al., 2021) showed that burning the remaining regenerates soil, which was eco-friendly but the opportunity of using the remaining as resources was also being missed. Similarly, for the paper mill, energy recovery was done by boilers. Though the source of water was circular, the method of producing steam, i.e. using natural gas was not a circular practice. So the total process was not circular enough.

“Not Circular” means there were no existing practices which indicated any hint of circularity.

Although majority of the variables concerned with the paper mill, some of the variables were also associated with the practice of forest department as well. The consumption of raw material was

affected by the local communities whereas the wastewater destination affects the lifestyle of the local communities.

4.2 Hindrances and Drivers to Enable Circularity in Rangamati

From the indicators and variables discussed in section 4.1e, it seemed to be evident that even though few of the indicators showed a positive approach towards the circularity in the forest region, most of the indicators had been poorly assessed in order to give indications of some level of circularity practices. Of course, the used indicators were merely explorative and further and deeper research might be needed to draw some conclusions about the circularity performance on the area studied but, the 4 indicators could be presented to start developing more ad hoc circularity metrics with the support of stakeholder's participation. With this in mind, this section initially discussed the hindrances found in the region to practice circularity based on the indicators and finally shows what the drivers to enable circularity in the region were.

4.2.1 Hindrances for Circularity

The findings of the hindrances were elaborated from the interviews taken to the officials of the Forest Department, employees of the National Park and the Pulp Wood Garden and officials from the paper mill. Besides, during the data collection, the researcher was present in a consultation workshop arranged by Ministry of Chittagong Hill Tracts Affairs (MoCHTA) and UNDP for a project namely "Strengthening Inclusive Development in Chittagong Hill Tracts (SID-CHT)" which highlighted some of the crucial problems currently being faced in the region. In some cases, the opinions of the local residents were also taken into account.

4.2.1.1 Geographic Remoteness

The forest region, including the national park being too dense, made any developmental activities in that region very difficult. Due to the presence of illegal felling within the core region of the forest, the Forest Department were often required to plant new saplings to cover the cleared land. But the remoteness of the forest and its density along with the lacking of infrastructure to enter the core region makes the work of the forest rangers and foresters to work in there (Anonymous, Range officer, Kaptai range, Personal Communication, 2022). Due to this geographic remoteness, wastages from the forest could not be carried outside for using them as resources.

4.2.1.2 Geo-political Constraint and Local Law and Order Situation

These two issues cause problems in two ways. Firstly, the local ethnic communities felt agitated due to the territorialization and to control them, the actions taken by the authority made them more

triggered. Secondly, these triggered communities felt field workers of forest department were “outsiders” and caused hassle for them which made the workers unwilling to work and provide security on the forest. Consequentially, the illegal extraction of the virgin materials became easier for the local people.

There were always political turmoil between the ethnic community and the local government. Even though a peace accord was signed in 1997, the local ethnic community still had grudges due to the presence of Army and Armed Police Battalion, who often puts various restrictions in the day to day practices of the community (M. A. Uddin, 2009). And this is still in practice. As a result, it seemed to be difficult for the forest office to implement any new strategies that could boost the circularity, sustainability and productivity of the forest since the ethnic communities felt that some “outsiders” were trying to impose something in their life (USAID & UNDP, 2022).

As a result, even though the local law and order situation might seem peaceful to someone who did not live there, the reality was frightening. The foresters were often insecure to go inside the forest and work. There were instances of them being attacked by some aggressive members of the ethnic communities. Even the Army in that region is afraid to move alone unless they are moving somewhere as a squad being armed (Anonymous, Range Officer, Karnafuli range, Personal Communication, 2022).

But the blame of the unrest did not indicate majority of the people. Rather, it was often found that there were very few members of each community who were aggressive and desperate enough to cause troubles. They usually carried arms and randomly attacked the forest officers if the officers caused any hamper in their illegal activities (Anonymous, Member of Local Ethnic Community, Personal Communication, 2022). There were many incidents where these gangs attacked the rangers and officers when the gangs found out that they have sufficient manpower to do so (Anonymous, Range Officer, Karnafuli range, Personal Communication, 2022).

4.2.1.3 Poverty

Majority of the population living around the forest area is below poverty line due to the geographical constraints, being distanced from the cities and lack of job facilities. As a result, they have to be heavily dependent on the forest to collect their resources. Their dependency included extraction of fuel wood, small timber, and bamboo and non-wood forest products like honey. Since the majority of the people often did not understand the importance of maintaining the sustainability

of the forest, new projects often got hampered. Multiple times projects like plantation of the indigenous species were taken but the local community, being unable to find any instant profit of the project, cut down the young trees and sold them to earn some quick and easy money (Anonymous, Member of Local Ethnic Community, Personal Communication, 2022).

4.2.1.4 Lack of Awareness and Education

A good number of people from the ethnic communities were unaware about the fatal effect of cleaning the forest land like landslide in the hills (Liesbet Vranken, Goele Vantilt, Miet Van Den Eeckhaut & Poesen, 2014). They were deprived of conservation awareness on forest ecosystem function and services. They did not properly understand the problem of illegal felling and how this affected them in the long run. As a result, not only they were taking out a large number of virgin material from the forest, being unaware, they were also unable to produce and by-products or any recyclables (Anonymous, People Representative, Ethnic Communities of Kaptai). But from the focused group discussion, it was found that 67% of the respondents are concerned about illegal felling whereas 68% did properly understand the role of the forests in their lives.

4.2.1.5 Land Use Change

After the ethnic communities cleared out patches of forest land, they started agricultural and horticultural practices in those lands. The problem for these practices is two-fold. Firstly, it was not as easy to convert an agricultural land to a forest land as much it was to do the opposite. The land itself lost a plethora of nutrients and capacity to grow new plants after it had gone through multiple agricultural practices on it (Mclauchlan, 2007). The situation was worse for horticultural practices. As per study, this practice harmed the land more and make the soil infertile to grow plant species in future (USAID & UNDP, 2022). Secondly, since these practices were done after going through slash and burn technique, the soil could not regenerate as much as in the past (Nourtier et al., 2021).

Due to expansion of businesses (M. A. Uddin, 2009) and tourism (Md. Kamruzzaman, 2018), new roads were being networked within the forest. These were the roads that supported the transportation for the tourism and day-to-day life purposes of the common people. As a result, the forest ecology was being hampered due to the disturbance which affected the lifecycle of the trees and their regeneration (USAID & UNDP, 2022).

Poverty, unemployment and the increasing population was causing encroachment (USAID & UNDP, 2022). The amount of land to regenerate trees was decreasing and there was already the pressure of declining land due to infrastructural activities. Combining everything, change of land use and the shortage of land was a concerning issue to be dealt before ensuring the circularity.

4.2.1.6 Lack of Facilities in Forest Department and the Paper Mill

The forest department itself was facing a lot of hindrances. Firstly, they lacked adequate manpower to have proper control in both the ranges and the national park (Anonymous, Range Officer, Karnafuli range, Personal Communication, 2022). Since a lot of area of the forest was inaccessible, the department should have had more manpower to keep control of the forest and ensure security. Secondly, due to lack of sufficient funding, the field level officers were not equipped with up to date communication devices and weapons to keep them safe in the core regions. Often during clashes with the local goons, they were outnumbered both in aspect of manpower and arsenal.

Along with the lack of manpower, there was also the absence of proper skill and knowledge. Many foresters do not know how circularity can be implemented in the forests. Not only reducing the use of virgin materials but also lack of ideas on reusing and recycling materials was prominent. They were unaware on how to maintain the sustainability and circularity of the forest at the same time (Anonymous, Forester, Kaptai Pulp Wood Garden, Personal Communication, 2022).

The paper mill was still practicing old technologies and process to manufacture paper which were irrelevant now in the modern paper mills (See 4.2.2.3). Lack of funding and facilities was the reason the mill was lagging behind in production (Anonymous, Manager, Kaptai Paper Mill, Personal Communication, 2022).

4.2.1.7 Waste Management

Officials in the forest department as well as the officials of the paper mill have acknowledged that they did not have any proper practices of recycling and reusing of the ingredients. After harvesting, the barks and wood chips remaining in the forest were burnt down (Md. Abu Musa, Forester, Kaptai Pulp Wood Garden, Personal Communication, 2022). Even though it was not such a bad practice, there are alternate and more sustainable ways to deal with them (Anonymous, Forester, Kaptai Pulp Wood Garden, Personal Communication, 2022).

According to the sources involved in this research during the fieldwork, the paper mill itself do not do anything significant with their wastes. The researcher was informed that paper mill dumps their wastes in the river without processing them (Anonymous, Employee, Forest Department Training Centre, Personal Communication, 2022), which not only could harm the environment itself but also the mill itself was losing the potential to recycle or reuse the waste.

4.2.1.8 Water Management

The condition of water management was poor in the region (Chakma et al., 2021). Not only the local residents dumped their wastes on the river but also the paper mill dump their effluent and solid wastes in the river. This is not only affecting the local people and the species in the river, but also damaging the forests and the local users who had to use and collect waters from the downstream. Recently, the soil test of the forest found the presence of unwanted inorganic chemicals like melamine, chlorophenols, resins and fatty acids (Lacorte et al., 2003) in the samples which prohibits to grow any plants in those soils (Anonymous, Employee, Forest Department Training Centre, Personal Communication, 2022).

When it comes to water, due to the lack of circularity in the paper mill, the water of the river being affected was harming the circularity of the forest. Unless no new plants were developed, it would be impossible to ensure circularity (Anonymous, Employee, Forest Department Training Centre, Personal Communication, 2022, Queiroz, 1996).

To summarize, the hindrances for the forest circularity in the Rangamati region is tabulated below.

Table 9 Hindrances for the Forest Circularity in Rangamati

Hindrances	How does it affect the circularity
Geographic Remoteness	The density of the forest and lack of forest roads made it difficult to work and provide security
Geo-political Constraint and Local Law and Order Situation	The historical political turmoil between the ethnic communities and the local government made many local people agitated and aggressive. As a result, the forest officers were often afraid to work inside the forest
Poverty	Lack of income often pushed the local ethnic people to cut down trees for profit
Lack of Awareness and Education	Being unaware about the side effects, many people remove virgin materials and while doing so, misses the opportunity to reuse or recycle the available materials
Land Use Change	Changes in the forest land for the sake of agriculture and making new roads for tourism hampers the growth of the existing saplings

Lack of Facilities in Forest Department and the Paper Mill	Lack of manpower, funding and knowledge regarding the reuse and recycle of the forest materials diminishes the practice of reusing and recycling and reducing the use of virgin materials
Waste Management	Lack of proper waste management hampers the practice of reuse and recycle and affects the water of the Karnafuli river
Water Management	Presence of harmful chemicals from the effluents of the paper mill destroys the water quality, affecting the forest land

4.2.2 Drivers for Circularity

In this section the drivers for circularity in the area of study are presented and described. To start with, the researcher provides a definition of “drivers” framed in the purpose of this research: drivers are those actions or indications that shows either the practice of circularity or the possibility of practicing. Just like the way the hindrances were observed and identified, the drivers were also identified through the interviews of the forest department officials and the local residents. Additional literature was also integrated to their analysis to incorporate previous research works to the descriptions.

4.2.2.1 Liaison and Co-operation

Recently some bipartisan steps were taken in the region between the local ethnic community and the Forest Department. A regeneration project had been taken into the Karnafuli range where local species would be planted until 2026 in a large amount to increase the biodiversity of the region as well as to start the practicing of planting local species rather than the exotic species only for timber (Anonymous, Range Officer, Karnafuli range, Personal Communication, 2022). And the local community were given the duty to safeguard the young saplings. The local community responded to the co-operative approach more positively than the approaches taken before. From the focused group discussion of 186 people, it was found that 76.4% of the people were taking this approach in good will.

When asked why co-management approaches are not as successful in the region as much as in the other parts of Bangladesh, respondents from the forest department as well as some experienced members of the community admitted that even though the approaches were unsuccessful in the past, things are changing now. At least the people who were getting education are understanding the effect of cutting down trees at earlier stage and now they are protecting the forest land more than ever. True that a handful of people were still aggressive and not understanding when it comes

to the protection of forest, the number of these people are decreasing day by day (Anonymous, People Representative, Ethnic Communities of Kaptai).

One of the current projects that seemed to be working on in the region namely “Strengthening Inclusive Development in Chittagong Hill Tracts (SID-CHT)” was getting some positive feedbacks from the local people since this project engaged the local ethnic communities. This project was supposed to run up to 2026 and the experts of the project are optimistic enough that even if only one of the goals of the project was successful, it might create a new bridge between the local community and the forest department which might make any further co-operative measures to be implemented easier (Anonymous, Employee, Forest Department Training Centre, Personal Communication, 2022).

Sharing of knowledge from both the parties might contribute to put in practice circularity tenets. This was mentioned by one employee of the Forest Department Training Centre and also that the forest department might be in charge of planting and harvesting trees but for the time in between, the local community could take care of the forest in their own traditional way ensuring their access and freedom in the forest (Anonymous, Employee, Forest Department Training Centre, Personal Communication, 2022).

4.2.2.2 Motivation to Work

According to one people representative, members of the ethnic community illegally cut and steal timbers because they did not have any source of income or food (Anonymous, People Representative, Ethnic Communities of Kaptai; Abu et al., 2007). Their agricultural practice i.e. slash and burn only provided them crops for a few months of the year. Even the fishermen also did not have their income source year round due to the banning on fishing in the reproduction period of the fishes. As a result, unless a family had any business or someone in the family who worked outside of Rangamati, they have no permanent source of income. So they were willing to work in any sector which ensures their livelihood. Provided their livelihood is fulfilled, they (66.66%) are willing to work in any activities assigned by the forest department that ensures circularity.

These ethnic communities were mostly the followers of Buddhism or their own orthodox religions. And they respected and obeyed their religious leaders a great deal. One of the concerning issues for the local authorities in Rangamati was the consumption of bamboo shoot. It was a very tasty and traditional food within the ethnic communities. But this was not a staple food in the community

rather taken as a delicacy. The problem was, mass consumption of these shoots were disrupting the production of bamboo in the region drastically. But in some villages, it was observed that the local people have stopped the consumption because their religious leaders advised them against it, making them understand the problem of the practice (Anonymous, Employee, Forest Department Training Centre, Personal Communication, 2022). So, one of the techniques to motivate the local community might be the influence of the religious leaders. If they forbade the community to illegally steal the wood and motivate them to work towards the circularity, the lack of manpower of the forest department would be mitigated to some extent and the unemployment among the local people will decrease (Anonymous, Employee, Forest Department Training Centre, Personal Communication, 2022).

4.2.2.3 Installation of Modern and Eco-friendly Technologies in KPM

Bangladesh Chemical Industries Corporation had recently decided to introduce new machineries in the Karnafuli Paper Mill which were not only the latest technologies in the field but also eco-friendly. The technologies included:

- Integrated Paper Mill with Forestation
- Soda Ash Plant; as an alternative for caustic soda in Kraft process
- Sodium Sulfate Plant; as the source to generate Na₂S in Kraft process
- Synthetic/Polyester Fiber Plant; to make papers stronger than the ones produced from pulp

If these were installed, it was expected that not only the capacity of the mill will increase, but also the environmental aspects would also be looked after which were currently overlooked (Anonymous, Manager, Kaptai Paper Mill, Personal Communication, 2022; (Priti Shivhare Lal, Vimlesh Bist, Arvind Sharma, 2013). It meant, reducing the use of virgin materials and increasing the reuse and recycle of materials. Also, the proper treatment of the effluents would also be in practice.

To summarize, the drivers for the forest circularity in the Rangamati region is tabulated below.

Table 10 Drivers for the Forest Circularity in Rangamati

Drivers	How it enhances the circularity
Liaison and Co-operation	Recent ongoing projects indicated a positive approach of the local communities. They were involving themselves in the project which indicated the reduction of the circularity hindrances caused by them
Motivation to Work	Since the local community wants to work to remove their poverty, introducing circularity

	in the forest might create new job opportunities making them to stop extracting virgin materials
Installation of Modern and Eco-friendly Technologies in KPM	New technologies would not only create less waste but also will reuse and recycle the wastes and the materials for production

4.3 Local Communities’ Perspective on Achieving Circularity of the Forest

This section summarizes the findings obtained during 10 focused group discussions that involved 186 respondents to understand their perspective on achieving circularity in the forest and to what extent they are willing to cooperate. Answers were collected to be analyzed and provide an answer to the sub-question 2 for this research. Here a brief description on how the focus groups were organized, firstly, the concept of circular economy in forest was explained to all the groups. Then an open floor was provided to the groups to share their feelings and understandings regarding this topic. Subsequently, the researcher asked semi-structured questions to the participants regarding their political ecology and willingness to participate in any circularity practices. Though the questions were formulated in a more simplistic fashion. In the following sections, the population sample was demographically described and afterwards the findings were classified and presented accordingly to the elements of the Political Ecology theory.

4.3.1 Demography of the Participants

Among 186 respondents, 32% were female and the rest were male. 38% of the respondents were in between 18-25 years age range, 34% respondents were in between 25-40 years and the rest were 40+ years old. Only 28% of the respondents finished high school. 23% of the male respondents were either boatman or fisherman, 19% were involved in small local businesses like grocery shop, tailor. 8% respondents work in different cities in different jobs. Around 41% were involved in agricultural or horticultural activities. And the other 25% respondents had no permanent job that they could do all year round. Among the female, 84% were housewives and the other 16% had either their own or family-owned business. Monthly income of 61% of the respondents were below 50 Euro per month. 33% respondents had 51-150 Euro per month in their family to spend. Only 6% respondents had more than 150 Euro per month in their family and all the respondents of this 6% had at least one member in their family working in different places, bigger cities.

4.3.2 Perspective on Political Ecology

All the focused groups admitted that they believe their political ecology is being hampered since the scope of their entrance in the forest is getting narrower day by day. Rather than just using the terminology, the idea of political ecology was explained in the local language along with the factors that covers it. Territorialisation¹ did not leave a good impact in them i.e. they still consider the representatives of forest department as their “enemies” or “outsiders” When asked about their opinions on each of the dimensions of political ecology, they had wide range of opinions. They are discussed in the following paragraphs.

4.3.2.1 Political Aspect

Political aspects included the actor’s ability to conduct the job and the willingness to commit and achieve the goals for a protected area. When asked what kind of measures they were willing to take to ensure the circularity practice in the forest, around 67% responded (Figure 9) that they were willing to do anything as long as they got a stable source of food and income. According to them, the works might include pre-plantation treatments, post-plantation treatments, providing security to the plants and harvesting. When asked if they were willing to abide by the protected area goals, 43% responded that they believed the protected area goals were often too strict for them and if the rules are made a bit lenient, it would be comfortable for them. To them, being lenient meant giving access in the forest to collect fuel woods, bamboos and honey. Unless any alternate source of income was made available for them, they wanted this access.

4.3.2.2 Economic Aspect

Economic aspects indicated the allocation of revenues to environmental maintenance and sustainable ecosystem management of the forest. 55% of the respondents believed that new improved funding and budget should be allocated for the national park. 18% believed that it was possible to initiate the changes with the current allocation. 33% believed that a fund should be made where the revenues from the selling of timber and non-wood forest products which will then be used for the circularity management in the forest like reusing the wastes, arranging better transportation of the virgin materials from the core zone or impact zone of the forest.

¹ Territorial strategies used by modern states to control populations and to manage critical resources within the borders of the state (Vandergeest & Peluso, 1995)

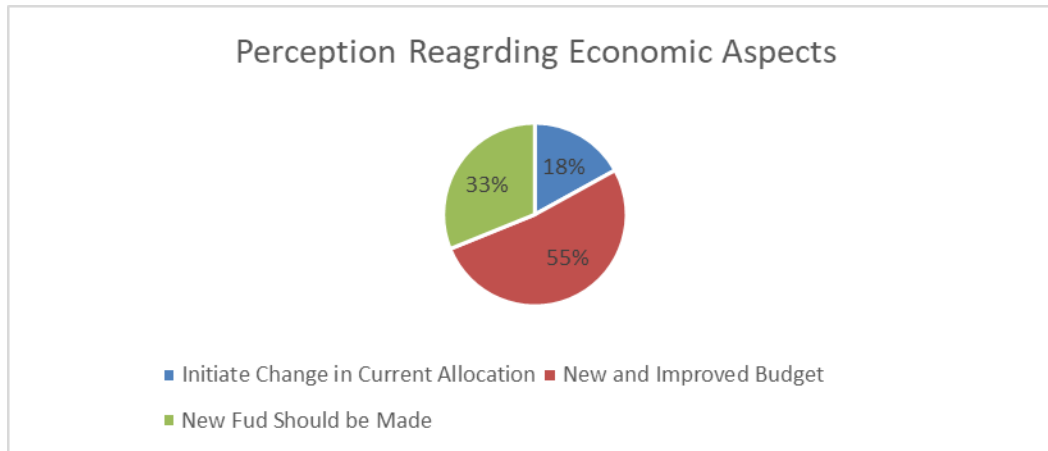


Figure 6 Respondents' Perception Regarding Economic Aspects

4.3.2.3 Social and Cultural Aspect

This aspects dealt with the information flow from the local level and the willingness of the community to commit with the goals. All the focused groups believed that an information and communication gap exists between the forest department and the ethnic communities. 71.3% of the respondents believed that more information should be provided to them from the forest department concerning how circular economy works and how both the parties could be benefitted from it. 23.7% respondents believed that they have something to offer to the forest department as well when it comes sharing knowledge. The ethnic communities had their own indigenous, traditional way of safeguarding forest and they wanted to implement those if the opportunity was provided (Clark, 2010).

As a whole, when asked if each of the ethnic communities were willing to be engaged in a process where both the circularity of the forest was achieved and their participation in the process was ensured, each of the communities (Marma, Chakma, Tanchangy and Pankhua) would provide people to be engaged in the management practices.

All the 10 focused group concluded that they had shortage of food and shortage of income source. 81.7% of the respondents were skeptical that unless these two shortcomings were met, any steps concerning public participation would fail in that region.

4.3.3 Perspective on Public Participation

The focused groups admitted that the relationship between the forest department and the ethnic communities had always been haphazard when rights and restrictions regarding the forest area of Rangamati were concerned. 63% of the respondents believed that their environmental justice had been hampered by the forest department. When asked about both the product oriented measures and process oriented measures to the respondents, the researcher found different answers with some insights on how, in general, the communities perceived the concept of public participation. Product oriented measures focused on the outcomes of the forest and how they could be properly achieved including writing, implementing and acceptability of any plans taken for the area by the community. Process oriented measures dealt with the thoughts and behaviors of the community concerning the present situation and its changes after new implemented plans. These two measures focuses on the actions and reactions of the actors for a new plan which in this case is participation. That's why these two measures were looked after.

4.3.3.1 Product Oriented Measures

22% of the respondents were eager to provide any written or verbal consultation to the authority regarding the sustainability and circularity practice in the forest. Their consultation was not only limited on the planting and harvesting of trees but rather the whole management plan of the forest as well as how the participation of the local communities could be ensured.

44% of the respondents did not support the current management rule. They believed, these rules obstructed them from finding their livelihood. 56% of the respondents believed that the current rules were too strict. When asked what would make them follow the management and its rules, their responses included:

- Better communication between both the parties (57.8%)
- Removing the opaque political barrier (like enforcing military to control their lifestyle) that exists between the governmental bodies and the ethnic communities (72.6%)
- If the communities are promised about sources of income (e.g. after providing technical trainings) and the promises are kept (66.66%)

Overall, a clear trust should exist between the authority and the communities to properly implement the product oriented measures which currently do not exist (Chakma & Maitrot, 2016).

4.3.3.2 Process Oriented Measures

Currently, a mere 12% of the respondents had any proper understanding of the rules and regulations of the forest region or the protected area or about the national park. Compared to that, 68.2% of the respondents had clear understanding about ecosystem and nature function of the forest. But for most of them, their understandings were limited to the tangible and visible functions. Many of them (33.33%) were not bothered or did not understand the aftermath of illegal felling and overharvesting. They were also unaware about the impact of prioritizing their interests above the others when a natural resource like a forest was concerned.

When asked how these gaps could be filled up, their suggestions included:

- Arranging multiple short workshops in different areas engaging everyone in the neighborhoods
- Engaging at least one person from each region or village so that they can influence others of their own area
- Not to take any measures that go against their religious or cultural beliefs

Upon asking if they understood or felt the changes in the forest area, in contrast to the area, species diversity and the ecology, 78.4% respondents replied that they are aware about the changes. But when asked about the responsiveness concerning the changes, almost 80% responded that they do not know how to respond to that. 92% had no sense of ownership when it comes to the forest. They believe the strictness imposed by the forest department, the unfriendly attitude they face on daily basis from the army and finding all the business sectors within the region being saturated by people coming outside of Rangamati makes them feel unwelcomed in their own birthplace. As a result, they do not tend to feel responsible for the forest any more than any outsider of the region.

A quantitative summary of all the responses from the FGD regarding the Political ology and Public Participation are tabulated below.

Table 11 Summary of the Responses from the FGD

Responses	Number	Percentage
Believes current PA rules are too strict	80	43

Food and/or job being the reason to join PP	111	59.6
Believes new and improved budget should be allocated in KNP	102	55
Believes change is possible with the current allocation	33	18
Believes fund should be made from revenue collected from the KNP	62	33
Require more information from the FD for CE	133	71.3
Believes they can provide FD with their knowledge and expertise	44	23.7
Believes their Environmental Justice has been hampered	117	63
Can provide verbal or written consultations	41	22
Do not support current management rules	82	44
Wants better communication between them and the FD as the motivator for joining PP	107	57.8
Wants the removal of political barrier as the motivator for joining PP	135	72.6
Wants guaranteed source of income as the motivator for joining PP	124	66.6

Understand the rules of PA	22	12
Understands the functions of a forest	127	68.2
Not bothered about overharvesting	63	33.3
Aware about the changes currently taking place in the forest	148	78.4
Had a sense of ownership about the forest	15	8

5. Discussion

In the Findings chapter, many hindrances for practicing circularity in the forest of Rangamati were identified during the literature review and the field work in the region of Kaptai, Rangamati. Similarly, some drivers to enable circularity practices to take place in that context were presented. These latter might potentially represent opportunities to implement circularity practice in the future. Hindrances and drivers were in the core of the first sub-question of this thesis. The second sub-question was about public participation of local communities in the circularity deployment of forestry management. In this section, the researcher tried to move one level upper to the findings analysis and discussed the gaps regarding the successful implementations of both circularity in the region and the public participation. The views or ideas presented here are not by any means elements of the solutions but rather reflections on the findings in the process to develop the conclusions and recommendations. For supporting the claims, some findings from the data from interviews, focused group discussion and desk research have been included. The aspects to be discussed in this section are related to the drivers and hindrances for circularity in the region and the current public perception regarding the circularity.

5.1 Relation between the Drivers and Hindrances of Circularity and the Selected Indicators

In this section the researched tried to identify potential relationships between drivers and circularity indicators (performance) and between hindrances and circularity performance. All the 4 indicators and 13 variables were connected with the drivers and hindrances for the circularity in the Kaptai range of the forests of Rangamati. Even though it required a large number of case studies to be able to demonstrate cause-effects relationships, on this explorative study, it was possible to have general indications from the hindrances about possibilities to mitigate them towards circularity.

Even though in case of the consumption of virgin materials, both the forest department and the paper mill were circular since they used woods from a specific garden for the paper mill, the national park itself was losing its land coverage. The poverty of the ethnic community, their lack of awareness and the change in land use was causing the deforestation. Studies (Zwane, 2007) have showed that there are positive relation between deforestation and poverty since it generates

an income source. So from the public perspective and their practices, the forest was not in circularity at all. When it came to the use of by-products, lack of skill, knowledge and facilities within the field officers of the forest department had to be mentioned. When asked why they did not use the by-products of their harvest in any other way than burning down, the response was that they were not ordered or advised to do anything else rather than that (Anonymous, Forester, Kaptai Pulp Wood Garden, Personal Communication, 2022). The same thing goes for the paper mill as well. The by-product of their manufacturing process, chlorine, was not used in a circular way due to lack of proper technologies. Also they were not recycling the old or wasted papers since they did not have that kind of manufacturing process within the mill.

When it came to the wastes, the nutrient cycling was not done in a circular way. Since the forest officers took no other ways to reuse or recycle them, after they burnt them down, the only remaining were ash which is nothing but dried carbon. During the burning process, a lot of nutrients were combusted into the air. As a result, the p^H , nutrient content of the soil did not remain same. Geographic remoteness was one of the factor why the officials could not use the wastes. Carrying out the timber itself was a hard job due to lack of proper infrastructure. So, carrying out the wastes and using them again was a hassle for the field level employees (Anonymous, Kaptai Pulp Wood Garden, Personal Communication, 2022). Due to the lack of proper waste management system, the paper mill was also missing the opportunity to reuse and nutrient cycle. Besides, the wastage dumping was also done in the river that hampered the overall ecology of the forest and the river. Lack of technology and alternative, renewable sources was also forcing the paper mill to use natural gas for their combustion was not very sustainable approach. The researcher believed that in a natural resource which was constantly depleting, to initiate circularity that resource must be made sustainable at first.

For energy consumption, the paper mill was circular in the sense of using electricity and steam in their production process. But this circularity was being affected for using the natural gas as fossil fuel. If proper facilities and funding were made available, the dependency on the fossil fuel could have been replaced by renewables (Anonymous, Manager, Kaptai Paper Mill, Personal Communication, 2022).

The water and waste management being poor in the paper mill was hampering the circularity of the forest. The mill was dumping both of its solid waste and effluents in the river causing the

ecology of the forest being disturbed and disrupting the natural growth and regeneration of the plants (Al et al., 2018).

It could be said that both the forest department and the paper mill had their own shortcomings to implement the circularity. But for the local public sector, it was observed that they were a prime reason for the decreasing of the forest land. Again, when asked, it was found that they rely heavily on the forest since they did not have any other options. The factors for this could be looked after if proper governmental initiatives like generating new income sources, providing education could be taken. On the bright side, when asked, majority were willing to work and help with the forest department to implement the circularity if their basic needs were fulfilled. The current co-operative measures (as discussed in the findings section) were being accepted by the majority of the local residents which indicates any future endeavors were most likely to be accepted as well when they see the economic opportunities for them. Also, the upcoming development project that would be undertaken in the KPM, if successful, would generate circularity in the mill which would eventually help to maintain the circularity of the forest.

5.2 Education

The local communities being unaware about the harms of cleaning the forest land was harming the biodiversity of the forest as a whole (Researcher's observation). Studies had shown that in case of national park, if the local community was made aware and provided trainings and workshops, they would be more than eager to take necessary steps to conserve biodiversity as well as uphold the rules of a national park (Truong, 2022). Also, as most of the ethnic communities had their own language and culture, if primary education was provided to them in their own language, then it would be easier to make them aware about the forest through schools (USAID & UNDP, 2022).

More funding could be allocated to train the employees of both the forest department and paper mill. Since the science and technology of the concerned sectors had progressed a lot with the presence of superior management tools and techniques (Singh & K.S. JAYACHANDRAN, 2020), to initiate a practice like circularity, which had not been practiced in the forestry sector in a wide scale, funding and training must be provided from the government.

5.3 Land Use Change

Since horticultural crops absorbed a lot nitrogen from the soil, unless new digestates were added before the start of new production, the future crops could not get enough nitrogen (Albuquerque et al., 2012). So in any land that went through horticulture cultivation at least once, silvicultural production become tough. Besides, slash and burn techniques caused soil degradation and loss of soil nutrients (Kukla et al., 2019). Unless these two practices were halted, it was not possible to implement the circularity because then, regenerating new trees would be itself a challenge. Otherwise the species diversity as well as the number of vegetative land would continue to decrease, making the initiatives of the forest department more difficult to implement. Eventually, the local communities would also be deprived of the forest resources.

Creation of forest roads caused disturbances in the existing forest ecology and hampered the growth of forest regeneration (Mozaffar et al., 2018). The land use changes might have to be minimized to a significant amount if year-round circularity were to be maintained since the regeneration of plants would be done yearly.

5.4 Facilities in Paper Mill

The wastes from a paper mill consists of different kind of biomaterials with industrial and medical applications. When the paper mill was not reusing or recycling their wastages, they were depriving themselves of resources which were not only economically beneficial but also reduce their amount of wastes. So multiple aspects of circularity was not being practiced currently (Haile et al., 2021). The resources include:

- High-performance carbon fiber
- Bioplastic from black liquor
- From cellulosic wastes to resin (Haile et al., 2021)

These resources had demands on the market which, if sold, could have generated more money for the paper mill. In the current world of waste minimization, these wastes turned resources were extremely valuable since they reduce the carbon footprint (Haile et al., 2021). Since reduction and reuse of wastes were two of the big pillars of circularity, the current condition of the paper mill was far behind in these two regards.

5.5 Waste Management

As previously mentioned, the wastes of the KNP were dumped in the Karnafuli river; the river which provided water supply to the whole forest. But new techniques had been invented specifically for reducing the wastes from a paper mill. The techniques were:

- Microbial fuel cells
- Anaerobic digestion
- Bleaching technologies
- Transformation pathways (Gupta et al., 2019)

These new technologies were proven to reduce wastages and effluents from a paper mill. Unless the wastes from the paper mill was reduced, not only the aquatic life of the river and the people dependent on it would be threatened, the expansion of the forest area, leading to the forest circularity would never take place.

In case of forest circularity, generating energy from wastes was one of the important aspects (Silva et al., 2020b). The paper mill was lagging behind in this aspect which if improved, could accelerate the circularity in the forest of Rangamati (Anonymous, Manager, Kaptai Paper Mill, Personal Communication, 2022).

5.6 Water Management

In Section 2.5, the previous condition of water was shown. The data was from 2018 which indicated the deteriorating condition of the river water. But up to the time this research was conducted, no studies showed any changes in the water condition. Even when asked to the forest department officials, they claimed that no new measures had been taken to control the water pollution. Besides, the decreasing of forest land was causing soil and mountain erosion which also polluted the water. The researcher found the river around KNP to be carrying plastics and the river water was turbid.

5.7 Existing KNP Management Plan and Circularity

As mentioned in section 2.4, the Kaptai National Park had some ongoing Management practices. Not only they were focusing on the existing forest land, they are also taking steps to increase the secondary forest land and vegetation. Looking after the adjacent wetlands and focusing on the agriculture and villages indicate that they were taking initiatives which were not only eco-friendly and economically better options, but also they were looking after the socio-economic

conditions of the local communities as well. Since these were newly taken master plan, these would take some time to have impacts after application. But these steps concerned some of the crucial hindrances found in this research. Firstly, these steps increased the amount of virgin material in the forest which could tackle down some of the impacts the forest was currently facing from over-extraction. Secondly, through the wetland management, one of the key indicators, water, would be properly managed; both in the aspect of the forest and the local people. Thirdly, it would create a bridge between the authorities and the ethnic communities which would remove the barriers of sharing knowledge and mutually benefitting each other.

5.8 Territorialization and Current Public Perception

Territoriality was affecting the current political ecology of the ethnic communities. Because:

- Declaring KNP as National Park put restrictions in the livelihood and food source for the communities. Not only they could not extract resources, but due to tourism and the expansion of businesses by the people outside of the region (Hossain, 2013) hampered their scope of generating incomes.
- Being deprived of the right to access, the communities were unable to use their right on the land which in return was making them to have hostile feelings towards the forest department.
- These day-to-day activities were being considered crime to the forest department and the communities are not taking these allegations lightly; thus making them more agitated in an already complex geo-political context.

Even in this situation, when asked regarding the default features of public participation as per (Buchy & Hoverman, 2000), the respondents were eager to participate and provide consultations if given the opportunity. They wanted to share knowledge with the forest department and through this exchange, want to help both the parties.

Territorialization was bound to caused discord between the authority and the local people (Vandergeest & Peluso, 1995). But to protect a natural resource like KNP, territorialization was a necessity. But the researcher believed from his observation that if scopes were made, the current negative relation can be put aside by engaging the public in ensuring circularity while providing them an economic opportunity and ensuring their social rights.

5.9 Steps to be taken by Each Stakeholders

Circular Economy concerned with environment, economy and social aspects of the region where it was taking place (EMF, 2017). The same idea goes for the Rangamati as well. For that reason, all the 3 stakeholders i.e. paper mill, forest department and the local ethnic communities must take actions from their ends to ensure circularity in the forest.

For the forest department, their steps might include:

- Improve the resilient livelihoods of local populations by providing them with trainings or loans or leasing them lands to work with
- Improve the existing nature tourism facilities based on wildlife, recreational, educational, cultural and aesthetic values so that they could generate more income which they could use in various co-operative projects with the local communities.
- Improve the welfare, motivation and capabilities of FD staff so that they were not discouraged to work in the geographically remote regions being afraid of their life while working.
- Support and improve community-based conservation approaches in the KNP and its surrounding landscape and determine the participatory forest management practices through consultation.

The paper mill could:

- Introduce new technologies that reduced waste, like microbial fuel cells
- Introduce new machineries and systems that could turn their wastages in to other money generating resources like bio-plastic and resin
- Implementing proper ETP and minimizing the waste water discharge since it directly affected the river
- Invest in state of the art machineries which were both eco-friendly and economically beneficial.

As for the local ethnic communities, they can:

- Start using stoves that run on bio-methane produced from cow dung rather than using stoves that requires fuel woods. Not only it reduces the extraction of virgin materials but these stoves are relatively eco-friendly than the traditional stoves.

- The group of people who had proper knowledge and idea on the side effects of illegal extractions could motivate others to stop illegal felling. Besides, they could work as the communicator between the forest department and communities.
- Since the ethnic communities were obedient to their religious leaders, these leaders could motivate them to co-operate with the forest department and stop illegal extractions.

Implementing circularity in Rangamati would require a joint initiative by all the three stakeholders. Since a lot of hindrances are related with the local communities, engaging them in public participation could be the first step for a proper implementation of the forest circularity. Then if the forest department and the paper mill improved their internal infrastructures, the current status-quo indicated that achieving complete forest circularity in KNP might be actually possible.

6. Conclusions and Recommendations

The conclusions and recommendations chapter is the place where the findings and methods to obtain them are analyzed from the perspective of the research questions. Hence, in this section the main findings per sub-question are highlighted to afterwards discuss the methods used to obtain the findings and what can be suggested to try to overcome the limitations of the applied methodological approach to respond the questions.

6.1 Conclusions

The main question of this research is “How has the forest region of Rangamati in Bangladesh implemented circularity principles?”. Since the Rangamati forest region was really big, the southern division of the forest was chosen which was adjacent to the Karnafuli Paper Mill. The theoretical model used in this research was a combination of Circular Economy Theory, Theory of Political Ecology and Theory of Public Participation. The hindrances and drivers for circularity and the status-quo of public participation found in the research were strictly linked to the theoretical model used to find out the answers of the sub-questions.

The hindrances of the circularity included geographic remoteness, geo-political constraints and local law and order situation, poverty, lack of awareness and education, land use change, lack of facilities in the paper mill and water and waste management. The drivers for circularity included liaison and co-operation between the local ethnic communities and the forest department, communities’ motivation to work and installation of modern and eco-friendly technologies in KPM. Throughout the findings, it was observed that the current problems the forest department and the paper mill was facing to implement the circularity could be resolved if few steps like providing alternative source of incomes to the communities, treatment of effluents before releasing were taken by the authority and stopping extractions from the forest by the people; or so the local ethnic communities believed. The drivers indicated that both the forest department and the ethnic communities were willing to work together to initiate circularity. If sufficient funding were made available and transparency is ensured, then it might be possible to formulate circularity eventually.

From the focused group discussion to answer the sub-question 2, it was observed that for majority of the respondents, they believe their political ecology had long been hampered. This conclusion was made when the researcher asked the respondents simple questions like if they feel the current PA rules are too strict or not, if they have any sense of ownership for the forest etc. But they were

also interested to be involved in achieving circularity as long as they did not have to worry about their hunger anymore, they got entrances to the areas which were legally off-limit to them now and their social and cultural norms were not disrupted like extracting fruits, pigs or hens from the forest for their festivals. The researcher found that if their needs were met, they are willing to help the forest department in any way they can like consultation or providing securities themselves.

Overall, to answer the main question, forest region of Rangamati has not yet achieved circularity. If measured against the selected indicators, the pathway seems to be a long and complex one. In any case, measures should be developed like ensuring adequate funds for the forest department and the paper mill to add manpower and invest in new technologies for paper production respectively.

6.2 Recommendations

The recommendations provided here were mostly for the forest department since to ensure circularity, they had to take the most of the workloads compared to the other two stakeholders.

6.2.1 For Practitioners

The gaps found during the research, which required further actions were illustrated here. The recommendations for the forest department and the recommendations for engaging public are discussed in the following paragraphs

6.2.2 Provide for Resilient and Diversified Livelihoods

Since the communities were asking for alternate source of income other than collecting timbers and fuel wood, provision of a variety of subsistence uses like fisheries, livestock rearing, cottage industries as well as arranging training programs while ensuring the sustainable supply of these resources for future generations should be made. Providing loans from various NGOs could also be an option. The use of forest resources could be made based on the consultations of key stakeholders.

6.2.3 Support and Improve Community-based Conservation Approaches

The forest department might facilitate and engage with the local communities and stakeholders in determining participatory forest management practices.

6.2.4 Promote Education in Native Language

Since the mother tongue of the ethnic communities were different than the rest of the country, they often felt discouraged to go to schools (T. Rahman, 2011). So, if education was provided to them in their native language, they would feel more inclusive. Eventually, providing trainings for participatory management will be easier.

6.2.5 Change of Stoves and Fuel Wood Collection

Currently, the most of the communities used stove which require fuel wood. But there was a stove called “Bondhu Chula” which loosely translates to “friendly stove” was getting popular to the other parts of Chittagong Hill Tracts. This stove used far less fuel wood and cuts carbon emission by 50%, which saved a lot of fuel wood and fuel costs. Besides, fuel wood plantation in the homesteads can also be done.

6.2.6 Income from Tourism Services

Since the region is quite popular as a tourist spot, charging fees for entrance or usage of certain roads and spots can be initiated. These monies can be used in the fund for community engagements.

6.3 Directions for Future Research

As any research project, this research had several limitations. Firstly, the responses from the interviews as well as the focused group discussion might have been biased since they might have taken the researcher as an outsider. But due to time constraints, the researcher was unable to approach large sample of experts. So, interviewing large sample of experts and some neutral experts on forest circularity and public participation are recommended for further research. Even though the findings during the research contributed in understanding the circularity condition of Rangamati, different and possibly contradicting ideas could have had presented a more holistic answer to the research question. The semi-structured questionnaire helped to gather information but restricted the explorative nature of the research.

Quantitative data collection and multivariate analysis of them are also advised to determine the circularity. The decision makers at a strategic level of forest department as well as the paper mill can provide their opinion to implement circularity properly. A combined and simultaneous data analysis from both the forest department and paper mill can be made to determine the practicality and limitations.

Due to time, geographic and climatic constraints the researcher had to shift from his initial plan to engage 300 people in focused group discussion to 186. To achieve the practical goal of the thesis, the researcher had to narrow down his research boundaries and units multiple times. So, even though other hindrances and drivers and perspective of public participation exists in reality, only the significant, trending ones from the interviews and literature reviews are presented here.

Lastly, the researcher fixed his scope only on analyze the status-quo. Further research might provide insights on the instruments that offer better solutions to the current problems.

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Appendix I Questionnaire

Thank you for taking the time to talk to me. As you may have already understood, I am a Master students at the University of Twente. I am doing a Master's in Environmental & Energy Management and my thesis specialize in environment. For this specialization, I am doing research into the circularity of forest of Rangamati in Bangladesh. As a researcher I try to remain as objective as possible.

For the officials of the paper mill:

1. Do we have the consent to record the interview?
2. How much wood do you harvest from the forest each year?
3. How much of it are recycled/reused?
4. How does the company manage the waste from the production?
5. Where do the company dump the solid wastes?
6. What is the source of the energy to run the mill? What percentage of the energy comes from the forest directly?
7. What is the company's source of water?
8. How does the company treat the effluents before releasing?
9. Is circularity being practiced in the company?
10. Is it possible to implement circularity in the paper mill? If not, why?
11. What are the issues the company is facing that obstructs the practice of circularity?

For the officials of the forest department:

1. Do we have the consent to record the interview?
2. How much wood is harvested from the forest each year?
3. What is the management plan currently running to manage the forest?
4. What is the trend of the forest resource of Rangamati? Is it increasing, decreasing or stable?
5. Apart from the paper mill, what do you do with the rest of the harvest?

6. What do you think are the barriers for achieving the forest circularity?
7. What might be the drivers for achieving the circularity?
8. What is the current relation between the local ethnic community and the forest department?
9. To what extent the local community is engaged in the current management practice of the forest?
10. How can you accelerate the sustainability and the circularity of the forest by engaging the local community?
11. How can you implement public participation ensuring the political ecology of the local ethnic community?

For the focused group discussion:

- Do we have the consent for recording the discussion?
- What is your current relation with the forest department for the access in the forest
- Can you collect any resources from the forest?
- Are the current PA rules too strict for you?
- Why do you think the forest area is decreasing even though there is limited access in the forest for the non-authorized personnel?
- Given your right to enter forest and take resources from there is ensured, do you want to be included in achieving the forest circularity i.e. less harvesting more recycling and reusing?
- What is your motivation to for public participation to implement Circular Economy?
- Which of the following Economic Aspects do you feel is relevant: A) Require new/improved budget B) Improvement is possible with current allocations C) Revenue collection should be made from KNP?
- Do you think FD should provide more information to you or you can share your knowledge with them?
- Why Public Participation might fail?
- Can you provide consultation for Public Participation?
- Do you support the current management plan of KNP?
- Are the current management plans too strict?

- What are your motivations to follow the management rules?
- Do you understand what is a national park and protected area?
- Are you concerned about the illegal felling of the trees in KNP?
- Do you think your environmental justice is being hampered? (After briefly explaining what it is)
- What approaches should be taken to ensure your maximum participation?

Appendix II Consent Forms

Informed consent form for individual interviews for studies in MSc MEEM

Title research: Analyzing the Forest Circularity and Inclusion of Local Community: A Case Study from Rangamati, Bangladesh

I declare to be informed about the nature, method and purpose of the investigation. I voluntarily agree to take part in this study. I keep the right to terminate my participation in this study without giving a reason at any time.

My responses may be used solely for the purposes of this study. In its publications, they may (please tick one of the options):

- be cited with my name or function revealed
- be cited anonymously, thus without identifying context
- only used as information source

During the course of the interview I keep the right to restrict the use of (some of) my answers further than indicated above.


Name participant: ... Monir Hossain, Range officer, Kaptai

Date: 16.6.22 Signature of participant: 

I declare to fully adhere to the above.

Name researcher: Mashfiq Ahasan Hridoy

Date: 16/6/22

Signature researcher: 

Informed consent form for individual interviews for studies in MSc MEEM

Title research: Analyzing the Forest Circularity and Inclusion of Local Community: A Case Study from Rangamati, Bangladesh

I declare to be informed about the nature, method and purpose of the investigation. I voluntarily agree to take part in this study. I keep the right to terminate my participation in this study without giving a reason at any time.

My responses may be used solely for the purposes of this study. In its publications, they may (please tick one of the options):

- be cited with my name or function revealed
- be cited anonymously, thus without identifying context
- only used as information source

During the course of the interview I keep the right to restrict the use of (some of) my answers further than indicated above.

Name participant: ... *Md. Bakhtiar Nur Siddiqi, Director, FDTC, Kaptai*

Date: *16.6.22* Signature of participant: *[Signature]*

I declare to fully adhere to the above.

Name researcher: Mashfiq Ahasan Hridoy

Date: *16/6/22*

Signature researcher: *[Signature]*

Informed consent form for individual interviews for studies in MSc MEEM

Title research: Analyzing the Forest Circularity and Inclusion of Local Community: A Case Study from Rangamati, Bangladesh

I declare to be informed about the nature, method and purpose of the investigation. I voluntarily agree to take part in this study. I keep the right to terminate my participation in this study without giving a reason at any time.

My responses may be used solely for the purposes of this study. In its publications, they may (please tick one of the options):

- be cited with my name or function revealed
- be cited anonymously, thus without identifying context
- only used as information source

During the course of the interview I keep the right to restrict the use of (some of) my answers further than indicated above.


Name participant: ... Keosi Marma

Date: 16/06/22 Signature of participant: 

I declare to fully adhere to the above.

Name researcher: Mashfiq Ahasan Hridoy

Date: 16/06/22

Signature researcher: 

Informed consent form for individual interviews for studies in MSc MEEM


Title research: Analyzing the Forest Circularity and Inclusion of Local Community: A Case Study from Rangamati, Bangladesh

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- be cited with my name or function revealed
- be cited anonymously, thus without identifying context
- only used as information source

During the course of the interview I keep the right to restrict the use of (some of) my answers further than indicated above.

Name participant: ... **MD. ANWAR HOSSAIN, Range officer, Karnaphuli Range.**
Date: **20/06/2022** Signature of participant:
16/06/2022 

I declare to fully adhere to the above.

Name researcher: Mashfiq Ahasan Hridoy

Date: **16/06/22**

Signature researcher: 

Informed consent form for individual interviews for studies in MSc MEEM

Title research: Analyzing the Forest Circularity and Inclusion of Local Community: A Case Study from Rangamati, Bangladesh

I declare to be informed about the nature, method and purpose of the investigation. I voluntarily agree to take part in this study. I keep the right to terminate my participation in this study without giving a reason at any time.

My responses may be used solely for the purposes of this study. In its publications, they may (please tick one of the options):

- be cited with my name or function revealed
- be cited anonymously, thus without identifying context
- only used as information source

During the course of the interview I keep the right to restrict the use of (some of) my answers further than indicated above.

Name participant: ...

Ali Ahmed
manager (Forest)

Date: Signature of participant:

16.06.22

KPM Ltd


I declare to fully adhere to the above.

Name researcher: Mashfiq Ahasan Hridoy

Date: 16.06.22

Signature researcher:



Informed consent form for individual interviews for studies in MSc MEEM

Title research: Analyzing the Forest Circularity and Inclusion of Local Community: A Case Study from Rangamati, Bangladesh

I declare to be informed about the nature, method and purpose of the investigation. I voluntarily agree to take part in this study. I keep the right to terminate my participation in this study without giving a reason at any time.

My responses may be used solely for the purposes of this study. In its publications, they may (please tick one of the options):

- be cited with my name or function revealed
- be cited anonymously, thus without identifying context
- only used as information source

During the course of the interview I keep the right to restrict the use of (some of) my answers further than indicated above.

Name participant: ... স্না; মাহ-সুহা, রংগামাতি

Date: ১৬.৬.২০২২ Signature of participant: 

I declare to fully adhere to the above.

Name researcher: Mashfiq Ahasan Hridoy

Date: 16/6/22

Signature researcher: 

Appendix III Data Sheet for FGD

The data sheet was too big to take screenshots and paste. That's why, a drive link has been provided herewith which will contain the file. For ethical reasons, the name of the respondents have been removed from the uploaded data sheet.

Link: <https://docs.google.com/spreadsheets/d/1w7-MwXBJwzIPWdc2gAY8J-PwM5JEZz6N/edit?usp=sharing&oid=100819271552519238868&rtpof=true&sd=true>