



Khulna University  
Life Science School  
Forestry and Wood Technology Discipline

**Author(s):** Mondal Falgoonee Kumar

**Title:** Tourist carrying capacity assessment of different tourist spots of the Sundarbans

**Supervisor(s):** Dr. Mahmood Hossain, Professor, Forestry and Wood Technology Discipline, Khulna University

**Programme:** Masters of Science in Forestry

---

This thesis has been scanned with the technical support from the Food and Agriculture Organization of the United Nations and financial support from the UN-REDD Bangladesh National Programme and is made available through the Bangladesh Forest Information System (BFIS).

BFIS is the national information system of the Bangladesh Forest Department under the Ministry of Environment, Forest and Climate Change. The terms and conditions of BFIS are available at <http://bfis.bforest.gov.bd/bfis/terms-conditions/>. By using BFIS, you indicate that you accept these terms of use and that you agree to abide by them. The BFIS e-Library provides an electronic archive of university thesis and supports students seeking to access digital copies for their own research. Any use of materials including any form of data extraction or data mining, reproduction should make reference to this document. Publisher contact information may be obtained at <http://ku.ac.bd/copyright/>.

BFIS's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission you may use content in the BFIS archive only for your personal, non-commercial use. Any correspondence concerning BFIS should be sent to [bfis.rims.fd@gmail.com](mailto:bfis.rims.fd@gmail.com).

**Tourist carrying capacity assessment of different  
tourist sport of the Sundarbans**

**Mondal Falgoonee Kumar**

**Student ID. MS-130509**



**FORESTRY AND WOOD TECHNOLOGY DISCIPLINE  
LIFE SCIENCE SCHOOL  
KHULNA UNIVERSITY  
BANGLADESH**

**2015**

---

**Tourist carrying capacity assessment of different tourist spots of  
the Sundarbans**

**M.Sc. Thesis**

**BY**

**Mondal Falgoonee Kumar**

---

**FORESTRY AND WOOD TECHNOLOGY DISCIPLINE**

**LIFE SCIENCE SCHOOL**

**KHULNA UNIVERSITY**

**BANGLADESH**

**2015**

---

---

**Tourist carrying capacity assessment of different tourist spots of  
the Sundarbans**

**COURSE TITLE: Thesis Work**

**COURSE NO: FWT-5112**

*This work has been prepared and submitted to Forestry and Wood Technology Discipline,  
Khulna University, Khulna, Bangladesh for the partial fulfillment of M.Sc. degree in Forestry.*

---



---

***Dedicated To.....***  
***My Loving Family***

---

## ABSTRACT

This study was conducted to estimate the tourist carrying capacity of seven tourist spots (Kotka, Kochikhali, Hironpoint, Dubla, Harbaria, Koromjol and Kolagachia) of the Sundarbans. Estimation of tourist carrying capacity is very important to limit the number of tourist arrival on those particular spots to ensure sustainable ecotourism. Three levels of carrying capacity named Physical carrying capacity (PCC), Real carrying capacity (RCC) and Effective carrying capacity (ECC) were estimated of every single tourist spots. All necessary limiting factors and management capacity were calculated in this study. Finally estimated effective or permissible carrying capacities of this seven spots are: Kotka (Office site- 173, Kotka to Jamtala beach- 539), Kochikhali- 182, Hironpoint- 350, Dubla- 395, Harbaria- 932, Koromjol- 1145 and Kolagachia - 647 persons per day.

## ACKNOWLEDGEMENT

First of all, I am undoubtedly grateful to the Almighty God.

I feel grateful to Forestry and Wood Technology Discipline of Khulna University for providing me the opportunity and logistic support to conduct this thesis work.

I would like to acknowledge my indebtedness and sincere gratitude to my honorable supervisor Dr. Mahmood Hossain, Professor of Forestry and Wood Technology Discipline, Khulna University, Khulna for his guidance, advice, assistance, materialistic support, continuous co-operation and encouragement during this work.

My thesis work is a part of a project named “Carrying capacity assessment for eco-tourism and development of information hub for virtual tourism in the Sundarbans” conducted by Centre for Integrated Studies on the Sundarbans (CISS), Khulna University and funded by World Bank. I want to thank World Bank for financial support and CISS to give me this opportunity. I would also like to thank Forest Department, Metrological Department, local people and tourists of the Sundarbans for their help in collecting primary and secondary data regarding this purpose.

I would like to thank Manob, Pappu, Mamun and all my friends for their suggestions and encouragements. I am so grateful to Sanjoy Dada, Uzzal Dada and Shahed Bhai for their assistances in the field during the course of my study. My special thanks to all of my well-wishers, seniors and juniors for their jovial assistance during the preparation of this thesis work.

At last I want to say that, I am very much grateful to my family members for their co-operation, aspirations and blessings to me. Without their support I was unable to fulfill this work.

## DECLARATION

I declare that the work in the thesis entitled “Assessment of tourist carrying capacity of different tourist spots (Kotka, Kochikhali, Hironpoint, Dubla, Harbaria, Koromjol and Kolagachia) of the Sundarbans” has been performed by me under direct supervision of professor Dr. Mahmood Hossain in the Discipline of Forestry and Wood Technology, Khulna University, Khulna and it has not been accepted or submitted for a degree in any other University.

I hereby, give consent for my thesis, if accepted, to be available for any kind of photocopying and for inter library loans.

Mondal Falgoonee Kumar

Mondal Falgoonee Kumar

Student ID: MS 130509

Session:2012-2013

Forestry and wood technology Discipline

Khulna University, Khulna-9208

Bangladesh



---

## APPROVAL

This thesis submitted to the Forestry and Wood Technology Discipline, Khulna University, Khulna, Bangladesh, in partial fulfillment for the Masters of Science degree in Forestry. I have approved the work, style and format of the thesis.



(Dr. Mahmood Hossain)

Professor

Forestry and Wood Technology Discipline

Khulna University

Khulna-9208

Bangladesh

---

# CONTENTS

<b>TITLE</b>	<b>PAGE NO.</b>
DEDICATION	i
ABSTRACT	ii
ACKNOWLEDGEMENT	iii
DECLARATION	iv
APPROVAL	v
TABLE OF CONTENTS	vii
LIST OF TABLES	ix

# TABLE OF CONTENTS

<b>CHAPTER ONE: INTRODUCTION</b>	<b>1-3</b>
1.1 Introduction	1
1.2 Objectives	3
<b>CHAPTER TWO: LITERATURE REVIEW</b>	<b>4-22</b>
2.1 Tourism	4
2.2 Ecotourism	4
2.3 Economic aspects of Ecotourism	6
2.4 Role of Ecotourism in Biodiversity conservation	8
2.5 Negative impact of Ecotourism	11
2.6 Ecotourism in Bangladesh	12
2.7 Problems of Ecotourism development in Bangladesh	17
2.8 Tourist Carrying Capacity (TCC)	20
2.9 Significance of assessing TCC for sustainable Ecotourism in the Sundarban	21
<b>CHAPTER THREE: MATERIALS AND METHODS</b>	<b>23-26</b>
3.1 Location	23
3.2 Assessment of Carrying Capacity	24
3.3 Data collection	26

---

<b>CHAPTER FOUR: RESULTS</b>	<b>27-44</b>
4.1 Determination of Physical Carrying Capacity (PCC)	27
4.2 Determination of Real Carrying Capacity (RCC)	33
4.3 Determination of Effective/ Permissible Carrying Capacity	41
4.4 Final Carrying Capacities	44
<b>CHAPTER FIVE: DISCUSSION AND CONCLUSION</b>	<b>45-46</b>
5.1 Discussion	45
5.2 Conclusion	46
<b>REFERENCES</b>	<b>47</b>



---

# LIST OF TABLES

<b>TABLE NO.</b>	<b>TITLE</b>	<b>PAGE NO.</b>
Table 1	Contribution of Ecotourism Industry to the National Income and GDP in some countries.	7
Table 2	Number of fauna species and families found in Sundarbans	22
Table 3	List of corrective factors	39
Table 4	Manpower	42
Table 5	Final carrying capacities of spots	44

# Chapter 1: Introduction

## **1.1 Introduction**

Tourism is a popular global leisure activity. England Tourism Society (1976) says- "Tourism is the temporary, short-term movement of people to destination outside the places where they normally live and work and their activities during the stay at each destination." Tourism brings money into a country and create a lots of new job opportunities. It is a welcome boost to the country's economy, but especially in countries where there is a high level of poverty and a slow job market, tourism lends money to people very much in need of income (WTO, 2013).

In some regions tourism is viewed as one of the most important industries representing nearly 30 percent of world's international tourist arrivals and receipts from tourism. In the light of such big tourist demand some sensitive and vulnerable region is facing the problems of saturation and endangered environment in many marine and coastal areas. Although tourism is generally less dangerous for the environment then the majority of other activities (like- industry) it does contribute, directly or indirectly, to the increased pollution of air, water and land, and burdens the infrastructure systems due to its seasonal character (CCA, 1999).

Effective tourism marketing starts with research into what current tourism trends are, what tourists want, what they need, what they are interested in and what they will spend money. If tourism is not managed properly then it can contribute to the depletion of natural resources, increased pollution, and the degradation of natural environments and ecosystems. For conserving the natural areas from destruction caused by tourism new sustainable form of tourism named "Ecotourism" is developed (Wheeller and Brian, 1993). Ecotourism is a special kind of tourism for natural areas. The Ecotourism Society defines ecotourism as responsible travel to natural areas that conserves the environment and improves the welfare of local people. According to the Australian National Ecotourism Strategy ecotourism is a nature-based tourism that involves education and interpretation of the natural environment and is managed in ecologically sustainable way. Most conceptual definitions of ecotourism can be reduced to the following: "ecotourism is tourism and recreation that is both nature-based and sustainable." In ecotourism, natural areas and local populations are united in a symbiotic relationship through the introduction of tourism. Ecotourism is viewed as a means of protecting natural areas through the generation of

revenues, environmental education and the involvement of local people. In such ways, both conservation and development will be promoted in a sustainable form (Ross and Wall, 1999).

Ecotourism satisfies the recreational demands of people like- tours, travels picnics etc. and fulfills as well as the conservation of environment and biodiversity (Gosling, 1999). "Carrying Capacity" is another buzz word appears when we talk about ecotourism. For proper ecotourism development and sustainable resource management, it is very much important to know the limit of tourist capabilities of that area known as tourist carrying capacity. Carrying capacity is the basic that provides the platform to ensure ecotourism. It identifies the number of tourist that a spot can sustain without potential impact. There are different methodologies to identify the carrying capacity of any particular site. The concept of tourist carrying capacity is based on a general statement that any form of development within the carrying capacity of ecosystem means a sustainable development (CCA, 1999). Tourism carrying capacity is the maximum number of people that may visit the tourist destination without causing destruction of the physical, economic and socio-cultural environment and an unacceptable decrease in the quality of visitors' satisfaction (CCA, 1999). Sustainable tourism development is a form of tourism development which uses natural resources and cultural heritage to increase the number of visitors and the profit from tourist activities, but preserves them for the future generations or more simply we can say a development of tourism within the carrying capacity of tourist resources (CCA, 1999). Chamberlain (1997) defined Tourism Carrying Capacity (TCC) as the level of human activity an area can accommodate without the area deteriorating, the resident community being adversely affected or the quality of visitors experience declining. The World Tourism Organisation (WTO) proposes the following definition of the carrying capacity "The maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic, socio-cultural environment and an unacceptable decrease in the quality of visitors' satisfaction" (UNEP, 2005).

In the context of a third world country like Bangladesh where population pressure is too high, job opportunities are limited and resource is scarce, sustainable Ecotourism can be a vital solution for these problems. Bangladesh is blessed with bounty of natural assets that are potential for developing ecotourism. Among them the Sundarbans (world largest single tract Mangrove forest) is of worth mentioning. Its rich biodiversity and ecological setting have made this

ecosystem suitable for ecotourism. The importance of the Sundarbans is huge for existence and subsistence of Bangladesh. The ecological, economic and social roles play by this great forest is just incomparable and these can't be replaced with anything else. Considering its role and importance, it has declared as a world heritage sites (Bhuiyan and Moss, 2001). Though urgency of promoting sustainable ecotourism was felt by different authors it is still a very sensitive issue (Salam *et al*, 2000; Bhuiyan and Moss, 2001; Iqbal *et al*, 2010).

Calculation of tourist carrying capacity is comparatively new concept for sustainable ecotourism development, especially for the countries like- Bangladesh. It has just come into practice in Satchari National Park (Habiganj) and Lawachara National Park (Maulavi Bazar). But in case of the Sundarbans, its role are far more important and sensitive as well as the opportunity of ecotourism development is much more here. The limit of tourist carrying capacity has not been evaluated so far in the Sundarbans. Due to this lacking, sustainable ecotourism is facing hurdles and danger of unsustainable tourism practice is also looking sever for this large forest community. So, assessment of carrying capacity into different tourist spots are must to promote sustainable ecotourism in the Sundarbans through conserving the environment and maintaining the integrity of the ecosystem.

## **1.2 Objectives**

Objective of this thesis work are-

- Assessment of tourist carrying capacity of different tourist spots (Kotka, Kochikhali, Hironpoint, Dubla, Harbaria, Koromjol and Kolagachia) of the Sundarbans



## **Chapter 2: Literature Review**

### **2.1 Tourism**

It is the temporary movement of people to destinations outside their normal place of work and residence. Such a pleasure-seeking tourist is a traveler moving from place to place or visiting the same place time and again. Tourism includes all economic activities which are organized around the needs of such travelers. Tourism refers to a temporary and voluntary movement of people mainly for holidaying, seeking pleasure or business collaboration (GTI, 2010). Tourism is the practice of travelling for pleasure or the business of offering information, accommodations, transportation and other services to tourists (Singh, 2010).

Effective tourism marketing researches with all aspects of tourism from tourists to resources. Improper managed tourism can contribute to the depletion of natural resources and increased pollution. So, overall degradation of environmental sustainability is the ultimate result. Sustainable Tourism involves social responsibility, a strong commitment to nature and the integration of local people in any tourist operation or development. According to UNWTO sustainable tourism is- "Tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, and the environment and host communities". For conserving the natural areas from destruction caused by tourism new sustainable form of tourism named "Ecotourism" is developed. Ecotourism is a special kind of tourism for natural areas.

### **2.2 Ecotourism**

The Ecotourism Society defines ecotourism as responsible travel to natural areas that conserves the environment and improves the welfare of local people. According to the Australian National Ecotourism Strategy ecotourism is a nature-based tourism that involves education and interpretation of the natural environment and is managed in ecologically sustainable way. Most conceptual definitions of ecotourism can be reduced to the following: "ecotourism is tourism and recreation that is both nature-based and sustainable." The definition clarifies the descriptive and

the prescriptive components of the ecotourism concept. The nature component is descriptive in the sense that it simply describes the activity location and associated consumer motivations. The sustainable component is prescriptive in the sense that it reflects what people want the activity to be. Some definitions focus on minimizing negative environmental and cultural impacts while maximizing positive economic impacts. Most components of ecotourism definitions either focus on the goal of sustainability or on means to achieve that goal. The World Conservation Unions (IUCN) Commission on National Parks and Protected Areas (CNPPA) defines ecotourism as “environmentally responsible travel and visitation to relatively undisturbed natural areas, in order to enjoy and appreciate nature that promotes conservation, has low visitor impact, and provides for beneficially active socio-economic involvement of local populations.” Ecotourism is a complex phenomenon, involving integration of many actors including tourists, resident peoples, suppliers, and managers and multiple functions. In ecotourism, natural areas and local populations are united in a symbiotic relationship through the introduction of tourism. Ecotourism is viewed as a means of protecting natural areas through the generation of revenues, environmental education and the involvement of local people. In such ways, both conservation and development will be promoted in a sustainable form (Ross and Wall, 1999).

Ecotourism is environmentally responsible travel and visitation to relatively undisturbed natural areas, in order to enjoy and appreciate nature (and any accompanying cultural features - both past and present) that promotes conservation, has low negative visitor impact, and provides for beneficially active socio-economic involvement of local populations (Gossling, 1999). Wight (1993) notes that “There seem to be two prevailing views of ecotourism: one envisages that public interest in the environment may be used to market a product the other sees that this same interest may be used to conserve the resources upon which this product is based. These views need not be mutually exclusive”. Ecotourism is travel to fragile, pristine, and usually protected areas that strives to be low impact and (often) small scale (Honey, 1999). It helps educate the traveler; provides funds for conservation; directly benefits the economic development and political empowerment of local communities; and fosters respect for different cultures and human rights” (Teguh, 2011).

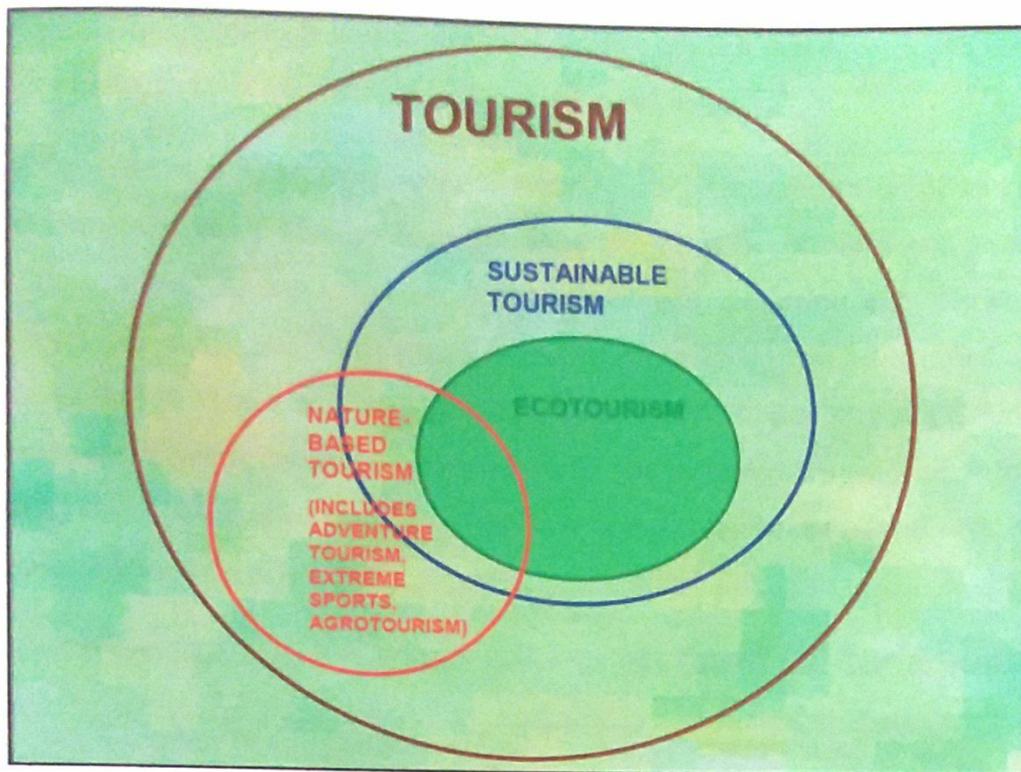


Fig: Ecotourism concept and principles (Ecotourism Society of Srilanka)

Ecotourism definitions highlights firstly location (nature), secondly nature conservation, thirdly cultural views, fourthly income generation for local people and fifthly education.

### 2.3 Economic aspects of Ecotourism

Ecotourism pays much attention to the economic development of tourism destinations and the improvement of the living standard of local residents; the income of ecotourism should not only be used to protect the ecological environment but also benefit the local residents.

Most estimates of ecotourism really are estimates of nature tourism. Ceballos-Lascurin (1993) reports a WTO estimate that nature tourism generates 7% of all international travel expenditure (Lindberg, 1997). Campbell (1994) reports that approximately 20% of all foreign tourists to Thailand (in 1990) visited nature tourism sites (FAO, 2010). The appropriate fee system will depend on the objectives for the area. If the objective is to generate revenue, fees should be



relatively high. If the objective is to maximize the number of visitors to provide job opportunities for local businesses, than the fees should be low or non-existent.

Ecotourism can help to achieve sustainable economic growth through protecting and enhancing culture and environment. It teaches both the local people and visitors about proper use of resources. Ecotourism creates a linkage between resource protection and tourism value – economic, personal and community enhancement. Ecotourism is being identified as nature-oriented travel that promotes and finances conservation and resource protection. Unlike mass tourism, ecotourism sends valuable contribution to the economy by way of income, jobs, government revenue, balance of payments, and investments-experiences from Kenya, Venezuela and Sri-Lanka (Moinuddin *et al*, 2004).

Table1: Contribution of Ecotourism Industry to the National Income and GDP in some countries

Country	Income in million dollar (US\$)		Percentile share in GDP	
	1980	2000	1980	2000
Costa Rica	0.03	1.27	1.31	23.11
Ecuador	0.037	1.10	0.52	19.00
Belize	0.59	8.43	2.41	46.46
Kenya	0.31	4.09	2.66	29.63
South Africa	0.027	4.271	1.79	15.87
Hawaii	0.2	6.24	2.38	38.17
Malaysia	-	1.00	-	7.13
Sri Lanka	-	0.79	-	7.04
Australia	0.0113	3.11	0.17	4.25
New Zealand	-	2.09	-	4.18

(Source: Lindberg *et al*, 2001)

Ecotourism provides a wide range of indirect jobs ranging from the construction trade to professions in accounting, law, and education. In addition to that, eco-tourism would provide extra employment opportunities in environmental science, heritage and the arts, recycling, handicrafts, etc. Although there are no formal studies yet, the evidence suggests that eco-tourism would provide higher multiplier values compared to mass tourism and therefore, have a greater

per unit contribution to the economy (Pratt, 2011). This occurs due to greater linkages (purchases of goods and services) in the local economy and, thus, fewer leakages. Leakages are ways in which income “leaks” out of the economy through:

- imports of goods and services;
- expatriated wages and salaries of imported labor;
- remittances of profits, interests, and rent;
- travel abroad by residents;
- purchases abroad by residents, and
- Non-local taxes.

Eco-tourism, which promotes the use of local products and labor, encourages local ownership and entrepreneurship and can substantially raise the multiplying effect of the tourist expenditure compared to mass tourism. Eco-tourism, by default, can provide relatively more income and jobs per visitor dollar when compared with mass tourism, which maximizes the total amount of income and jobs. Hence, the trade-off is between the goals of profit maximization for mass tourism versus income optimization for eco-tourism. In other words, eco-tourism “optimizes” (finds the best use of) resources by retaining proportionately more of the tourist expenditure. This is particularly valuable for destinations that have limited resources for residents, as well as visitors (Moinuddin *et al*, 2004).

## **2.4 Role of Ecotourism in Biodiversity conservation**

The growth momentum of ecotourism industry is very prosperous in the whole world, with 20-30 percent increase each year. Good ecological environment is not only the premise and basis of ecotourism, but also the important guarantee of state ecological safety. Therefore, in order to develop the ecotourism well, the ecological environment should be depended on, so as to promote the ecotourism development. The progress of ecotourism emphasizes on the principle of ecological protection. Ecotourism pays much attention to the protection during its development and uses development to promote protection, which is the harmony and unification among economic benefit, social benefit and environmental benefit (Wang and Shao, 2009). Ecotourism

is the green industry of high scientific and technological content. It is a kind of unique sustainable tourism and responsible tourism form that pays more attention to the continuity of ecology and cannot result in the environmental destruction or the decrease of the environmental quality. The development of ecotourism must be based on the carrying capacity of ecological environment, once over this limit will make the ecological environment overload, then leads to ecological imbalance (Wang and Shao, 2009).

Only under the promise of scientific planning can ecotourism play its function of protecting the ecological environment, achieve the sustainable development of tourism. Before developing a new ecotourism project, the experts of sociology, environmental science, culture, economics and other fields should conduct a comprehensive and scientific demonstration (Drumm and Moore, 2002). Finally, the planning can be implemented only after the approval of relevant departments. And environmental impact assessment system of ecotourism resources' exploiting should be set up. To standardize the behavior of ecotourism enterprises, bring their development activity implied principle of protection truly, the standard must be set by the government or profession association macroscopically to distinguish ecotourism from common tourism. It will arouse tourist's attention on their own tour and custom activity. And it makes them more care about environment factor when they choose the tour operators, resorts, hotels and other tourist service providers. These will contribute, directly or indirectly, to environmental protection. Ecotourism is not able to realize consciously the coordination between tourism development and the ecological environment because it is with the "eco" label (Wang and Song, 2009). So if we really want to achieve coexist and co-prosperity of ecotourism and ecological environment, we must stress that this form of tourism is managed by scientific and effective environmental ways. And the environmental management takes an important part in the whole process of ecotourism and environmental protection, which has become the crux of tourism sustainable development. Using the experience of foreign tourism management system and implying the unified management to all levels of tourist areas which are developing ecotourism to improve management efficiency and protect the environment (Wang and Song 2009).

Many people who travel to natural areas do so specifically to indulge in experiences with nature, regardless of what activities they choose to do. It is the responsibility of the managers of a protected area to ensure the quality of the available natural experiences and to work towards

instilling “transformative values” (values which, through a learning experience with nature, yield greater environmental awareness, appreciation and respect for nature). Protected areas can be viewed as natural laboratories, living museums, retreats, havens, and outdoor schools, and provide unique, interactive opportunities for promoting environmental stewardship for both locals and visitors. Education, through passive (in the form of reading materials, maps, signs, information centers) and perhaps active interpretation (such as guided tours, talk groups, theatre), if not too intrusive and depending upon program objectives, are forms of tourist management in themselves (Wang and Shao, 2009). They also can add to the visitors experiences, direct people towards appropriate behaviors and, again, encourage appreciation of natural areas which can result in environmental advocacy. Furthermore, people who enjoy a high-quality experience in nature will be more willing to pay fees which can be used to maintain the protected area. The Tourism can contribute to sustainable development by having less impact on environment in comparison to other industries, by playing a positive role in awareness generation for conservation, by providing economic incentives to protect habitat and since it depends on environment as part of its product, it is motivated to protect them (Dwyer and Spurr, 2010). Though it holds good at an industry level– but less at an individual operator level, whose business is affected by seasonality.

Environmental degradation is a major concern of modern times. Different approaches are applied to mitigate this problem like- laws, advertising, economic incentives etc and tourism has been perceived as one of the potential tools in global conservation (Markovic *et al*, 2009). Ecotourism can help to enhance successful conservation through five sectors-

- Can act as a finance source needed for Biodiversity conservation
- Can provide economic justification for protection
- Enhance economic benefits to local community
- May generate awareness to promote conservation
- May encourage private sectors to involve with Biodiversity conservation

## **2.5 Negative impact of Ecotourism**

If we talk about the negative impact of promoting Ecotourism, we should remember one thing clearly that is the problems depends on that persons who are trying to promote Ecotourism on that area along with the promoting strategy and system. If sustainable Ecotourism development is possible then negative impacts are almost negligible for environment, society and economics. However Ecotourism's impacts often are categorized using groups like "direct" and "indirect" or "on-site" and "off-site". Using the latter groups, some on-site impacts include:

- soil erosion and compaction
- disturbance of wildlife
- trampling of vegetation
- removal of vegetation (e.g., collection of plants or firewood)
- accidental introduction of exotic species
- increased frequency of fire and
- Litter and vandalism

Some off-site impacts include:

- Reclamation of land for infrastructure (e.g., clearing of forests for hotels)
- Generation of solid waste (e.g., rubbish/garbage)
- water and air pollution (e.g., effluent in rivers and oceans) and
- Purchase of souvenirs utilizing threatened or endangered species (e.g., black coral)

A medium number of visitors may cause significant change, but additional visitors may not cause significant additional change. For some sites, experiential impacts may be a greater limiting factor than environmental impacts. In some areas local residents have been sufficiently unhappy with ecotourism development that they sabotaged the natural resource on which this development was based. Many ecotourism activities involve relatively intense interaction between greatly differing cultures, and these differences may exacerbate the negative socio-cultural impacts of ecotourism.



Some operators construct some buildings and tourism infrastructure in the core region which prohibited exploiting by law, making some regions loss the continuity of landscape and the integrity of ecological system permanently. Create many artificial attractions in some region, changing the original natural or human landscape, leading to serious urbanization for scenic spots. The construction of ecotourism infrastructure has destroyed the animals' living environment, causing the deterioration in the quality of living environment for animals, so that these animals live there were forced to move. The ultimate aim of the operators is to pursuit high profits, therefore, they will pour the waste water of catering, accommodation and other living waste water directly into the water, waste oil of the motorboat and so on can permeate the water, automobile exhaust and the dust of diet will be directly discharged into the air, these will create the environmental pollution (Wang and Song, 2009).

## **2.6 Ecotourism in Bangladesh**

Bangladesh government first recognized tourism as an important industry and framed it in National Tourism Policy in 1992. Tourism was declared a thrust sector and tax exemption and other incentives were given in 1999. Bangladesh is blessed with a rich diversity of nature like- Sea in Cox's Bazaar, islands in Teknaf, mangroves in Sunderban and the northeastern hill tracts in Sylhet. Because of these natural resources tourism is a fast growing industry in the country. It is estimated that the contribution of travel and tourism to Gross Domestic Product is expected to rise from 3.9% in 2010 to 4.1% by 2020 (UNWTO, 2005). There are other places in this country that are usually used to large scale tourism purpose. Some resources like- the Sundarbans, Lawachara National Park, Satchari National Park etc. are trying to practice ecotourism while other resources like- Cox's Bazaar are practicing mass tourism. This depends on the nature of the resource. Tough complete practice of ecotourism is rarely seen in Bangladesh. The ecotourism industry of Bangladesh has great potential both as a foreign exchange earner and provider of job opportunities with resultant multiplier effect on the country's economy.

### **2.6.1 Ecotourism in Lawachara National Park, Bangladesh**

Lawachara National Park (LNP) is located northeast of Dhaka in Kamalganj sub district of Maulvibazar district. Declared in 1996, LNP is located between 24<sup>0</sup>30' to 24<sup>0</sup>32' n and 91<sup>0</sup>37' to

91°47'E and covers an area of 1250ha a part of 2740 ha west Bhanugach reserve forest. The park lies between Dholai River on the east and the Manu River on the north (Ahsan, 2007). The topography of the park is undulating with slopes and hillocks ranging from 10-50 metres along with numerous streams flowing through the park (Aziz, 2007). In this area there are- high natural forest, monoculture of exotics, grassland and bamboo, wetlands, tea estates and cultivated fields. The forests are mixed tropical evergreen and semi green forests. The forests area was earlier used for jhum cultivation by forest dwelling communities. Lawachara National Park is rich in avifauna and is home to 237 species of birds which is representing nearly one third of the country's known bird species (Nishorgo, 2006). There are villages of four ethnic communities namely Khasia, Tripura, Manipuri and Santhal in and around the national Park.

The key strengths of Lawachara lies in the exotic ambience, ethnic community in and around and its wilderness areas. It is one of the few protected areas in the country that can offer this diversity of products. Being easily approachable this park is a major attraction amongst visitors. The park is open for visitors throughout the year, although visitation reduces considerably during the rainy season i.e May to August each year. The visitors to Lawachara are attracted by the area covered with terraced tea estates, patches of tropical rain forest, pineapple plantations and lemon groves. Both attended and unattended services are present in the national park for making the visitors visit enjoyable and educative. Ethnic Community Village like- Khasia, Manipuri and Tipra are of huge attraction to the visitors. The products produced by those ethnic communities are also attractive to the tourists. In case of security matters there are Tourist police who maintain security of the visitors (IPAC, 2012). There are three entry points in Lawachara National park. There are picnic spots within the park area. Tea states, seven colored tea, wildlife and natural environment along with different handicraft are major attractions to the visitors of this park. Tourist carrying capacity of this park is already evaluated to promote sustainable ecotourism.

### **2.6.1 Ecotourism in Satchari National Park, Bangladesh**

Satchari National Park (SNP) is located about 130-140 km northeast of Dhaka in the Paikpara Union of Chunarughat Upazila of Habigonj district. SNP stands on the Dhaka-Sylhet old highway in Sylhet division. SNP is governed by the Forest Act of 1927 as well as the Wildlife Conservation Act of 1974, subsequently Wildlife (Conservation and Security) Act of 2012. The national park was established in 2006 and covers an area of 243 ha and is a part of the 6205 ha of

the Raghunandan Hills Reserved Forest (IPAC, 2013). The forests of the park are mixed tropical evergreen and semi-evergreen. Hillocks, locally known as tillas, are scattered throughout the landscape and their altitudes range from 10-50 meters. A number of small, sandy bedded streams flow throughout the forest, all of which dry out following the end of rainy season in October-November, and are subject to intensive commercial harvesting of sands during the dry period. The park is surrounded by tea estates which are eco-tourism attractions. It is characterized by high rainfall and a multi-tier vegetation of rich biodiversity. Satchari national park originally supported an indigenous vegetation of plant species.

As like Lawachara national park high natural forest, monoculture of exotics, grassland and bamboo, wetlands, tea estates and cultivated fields. The forests are mixed tropical evergreen and semi green forests are seen here. This park supports a number of animal species (mammals, birds, reptiles and amphibians) which are both forest-dwelling and wetland-associated species of different genera and families. Satchari has a wildlife diversity consisting of 197 species. There are more than 6 species of amphibians, 18 species of reptiles, 149 species of birds and 24 species of mammals. Satchari is home to many primates including the globally endangered Hoolock Gibbons, Pig-tailed Macaque and Capped Langur. Other mammals such as the Orange-bellied Himalayan squirrel and Barking Deer are found in the park. A number of bird species including the Greater Racket-tailed Drongo, Hill Myna, Oriental Pied Hornbill, White-crested Laughing Thrush, Puff-throated (Spotted) Babbler and White-rumped Shama are found in the park. This area is home to an ethnic community of the Tripura tribe.

As a nature-based tourism site, SNP is easily accessible and it is the next popular tourist destination after Lawachara National Park (IUCN 2008). However, level of visitation is comparatively low to Lawachara and so SNP still has a tranquil natural environment. The number of tourist arrival in 2011-12 is more than 5000 (IPAC, 2013). Sighting of wildlife, especially Capped Langurs and Pig-tailed Macaques, is common and so this park is one of the major eco-tourist attraction sites. From 2009 a new fee system was introduced here, before that the entry in this park was free. The entry fee is collected at the main entrance where locals from the Tiprapara manage visitors. The park provides guide service and currently there are 12 trained eco-guides to take visitors around the park and to interpret nature. The park supports an interpretation center, information center and shops for buying food and beverages. The

interpretation center was set up in 2010 to enhance visitor experience by educating them about the biodiversity of the park. The information center has brochures and other informative materials about the park and also sells T-shirts, caps and products from the ethnic community. The shops inside the park are run by locals and so the development of Satchari National Park has generated jobs for the locals and has provided them with alternative means of earning income and depending less on the forest for their livelihood (IPAC, 2013).

### **2.6.2 Ecotourism in the Sundarbans, Bangladesh**

The prospect of ecotourism in the Sundarban is enormous because of its biodiversity, species composition and land escape with physical fetchers. The Sunderbans supports a very rich and diverse flora and fauna that include about 334 species of plants and 425 species of wildlife species. The multiple attraction of ecotourists in Sundarban include scenic beauty of the forest, unspoiled wilderness and tranquility, wildlife viewing, jungle trails, boating, bird watching, walking and exploration, beach relaxation etc. Total area of Sundarbans is about 5770 sq km of which 1700 sq km is open water bodies and 4000 sq km is forest land (Bhuiyan *et al.*, 2001). Sundarban reserve forest is world largest single tract mangrove forest.

The Sundarban is a very unique ecosystem that has been recognized globally for its importance in terms of biodiversity and resources. The Sundarban supports as wide range of important flora and fauna, both in quantity and diversity, some of which are endangered, both domestically and worldwide. Presence of the Royal Bengal Tiger, estuarine crocodile, a variety of dolphins, reptiles and a certain number of birds and highly endangered species has created lot of importance to ecotourism in Sundarban.

Some of the important, unique features and positive factors that can benefit the development of the eco-tourism activities in Sundarban are summarized as follows:

1. The wilderness and condition of one of the largest mangrove forest on the world.
2. The forest and UNESCO sites are protected from encroachment and for conservation purposes.
3. The variety of wildlife (specially birds).

4. The importance of one of the remaining natural habitats of the Royal Bengal Tiger, education and conservation awareness initiatives and studies.
5. Life in the river. The Riverine experience and low impact on the natural and physical environment.
6. Understanding of the conservation dilemmas and problematic in the highly populated country as Bangladesh. The human context of individuals living in the impact zone and the exposure of conservation and biodiversity initiatives (Siddiqui, 2003).

The Sundarbans is a unique ecosystem. Its exceptional scenic beauty and rich wildlife can be source of attraction to different levels of people and is convenient for outdoor recreation. Eco-tourism may be developed without causing damage to vegetation and wildlife. Because of weather condition tourism may be limited to winter months when the climate is favorable. The only way to visit the Sundarbans is by water transport. Adequate water transport and accommodation facilities inside the forests are to be created to attract local and foreign tourists. In fact the recreational potentiality of the Sundarbans has never been utilized. Facilities needed for the tourists have not been developed. There is immense potentiality of the Sundarbans for earning through tourism. Eco tourism spots in this World Heritage site can easily attract the tourist from everywhere. Some of these sites are as following:

Katka is an eye catching and Quiet Island located in the north-west part of Sundarbans. Katka is an excellent and favorable spot, where visitors can enjoy bird watching, wildlife especially Royal Bengal Tiger and deer, roaming around by country boat through small creeks and canals and also by walking through the forest. One can also enjoy swimming and sun bathing at Katka's desolate white sand beach (Chowdhury *et al.*, 2011).

Kachikhali is a roaming and breeding ground for the Royal Bengal Tiger and is also known as "Tiger Point". There is a Forest Department resort, which is used by the tourists. Visitors spend their time by walking around the tiger point, Katka-Kachikhali beach and visiting the Egg Island or Dimer Char, a small island close to Kachikhali.

Nilkamal is a beautiful place along the Bay of Bengal. The World Heritage plaque was unveiled at Hiron Point of Nilkamal. The combined beauty of sea and green mangroves Nilkamal must

attract visitors from the watchtower of Keorasuthi another attractive spot there. Thousands of spotted deer, birds and sometimes a Royal Bengal Tiger can be seen from the tower (Chowdhury *et al.*, 2011).

Dublar Char is an island famous for drying fish during the month of November-February in the winter season. This place is also famous for religious festival of Hindu community popularly known as "Rashmela" that takes place at the end of November. Visitors come here to see the life of fisherman and their unique fish drying. These dry fish or 'sutki' is exported to domestic and foreign markets as a delicacy.

## **2.7 Problems of Ecotourism development in Bangladesh**

The problems facing the development of a sustainable Ecotourism sector is diverse its own touristic features, level of development, and national development priorities and policies. SWOT analyzed the following problems of tourism development in Bangladesh (Tuhin & Maajumder, 2011).

### **2.7.1 Unknown TCC of different tourist spots**

Every tourist spot have a limit of carrying tourists. If this limit is crossed and much more tourists visit that area then the site become vulnerable for degradation. TCC or tourist carrying capacity of a site is that limit and it varies site to site. But here in Bangladesh TCC of any tourist spot is not calculated yet. So, the authority even doesn't know their limits of permitting tourists. This is the biggest problem for ecotourism development.

### **2.7.2 Lack of knowledge and awareness**

In Bangladesh, there still is a fundamental lack of basic cognizance of the economic importance of tourism as an industry and its positive impact as a potential source of foreign exchange and employment.



### **2.7.2 Lack of quality service**

Quality of service needs to be improved. For the purpose, training at different levels from top management down to door boys – should be initiated at national and regional levels. In this context, Thailand, the most successful country in tourism within BIMSTEC, can take the lead.

### **2.7.3 Lack of training**

In Bangladesh, there is lack of training knowledge between tourist guides. Training should also be provided to promote activities that are indirectly linked to tourism, such as printing, dying and folk-arts. Special training for women might be needed in many cases.

### **2.7.4 Lack of tourism-related infrastructures**

Bangladesh has the lack the sufficient infrastructures necessary for the development of a successful tourism sector. Primary amongst these are hotels and lodging services, transportation and communication, safety and security and tourism information services. This makes it difficult to provide the standards of facilities and services which tourists require.

### **2.7.5 Lack of inherent tourism potential**

In Bangladesh, the development of tourism is impeded by their lack of inherent natural, historical or cultural tourism resources. However, as mentioned earlier, though it is a crucial factor, tourism heritage assets alone cannot make a successful tourism industry.

### **2.7.6 Lack of technical knowledge and weak promotional activity**

Even when that fundamental awareness is there, in many cases there is generally a lack of tourism knowledge and professionals. Tourism, as a modern industry, is recent in the world. It is also a new and unfamiliar activity in Bangladesh. Another related problem is the absent or weak publicity promotion and mass media exposure due, in many cases, to the limited technological services available.

### **2.7.7 Lack of tourism investments**

While investment in services is a well-established economic activity in the developed countries, it is still lagging behind in developing ones. Investment in service-oriented

projects, particularly tourism, in developing countries is often regarded as a high-risk task. Accordingly, though they may have a natural tourism potential, it is very difficult for Bangladesh to gain access to reasonable financing for their touristic projects even when they manage to tackle the problems of project identification and planning.

#### **2.7.8 Lack of consistent tourism strategies and policies**

In Bangladesh, there are still difficulties in getting integrated tourism policy-making due, in general, to policy conflicts between the government departments and the tourism private agencies. This is coupled in many cases with the lack of effective administration, regulation and institutional frameworks of touristic activity.

#### **2.7.9 Lack of tourism diversification**

For many years, international tourism has been characterized by its concentration in coastal or watercourse areas, and in summer for rest, relaxation and leisure. However, modern touristic activity has shown a growing tendency towards diversification and change. This makes it difficult for Bangladesh, including those with a relatively developed tourism sector, to keep pace with the rapidly changing and complex requirements of tourists. In a highly competitive international tourism market, and considering the emergence of new touristic destinations, improvement of the conditions that foster modern tourism development is not an easy process.

#### **2.7.10 Lack of tourist security**

The safety of tourists is among the primary factors for any successful tourism industry and should, thus, be one of the basic objectives of tourism planning and provisions. Safety-related tourism problems, whether real or perceived, exert a negative impact on the reputation of host countries. In this regard, negative perceptions appear to play a detrimental role in the prospects of tourism in Bangladesh. Even such factors as rumors may cause great damage to complete tourist seasons.



## **2.8 Tourist Carrying Capacity (TCC)**

The concept of carrying capacity was developed from the fields of biology and ecology, where it was applied to wildlife management to ascertain “the number of animals that can be maintained in a given habitat before undue biological or ecological impacts occur” (Lime and Hof, 1996). Carrying capacity was then applied to park management when increasing numbers of visitors became a concern. The added human component broadened the concept of carrying capacity from a purely biological one to a complex issue with both biological and social components. Shelby and Heberlein (1986) define carrying capacity as “the level of use beyond which impacts exceed levels specified by evaluative standards”.

Carrying capacity determination is not a matter of computing and rigidly enforcing a single, explicit maximum value. Instead, carrying capacity includes an element of perception from recreation area users and managers, who add the human component to recreational carrying capacity (Bosley, 2005). For this reason, the carrying capacity determination is never purely objective. As such, capacity is often reported in the form of a range of estimates as opposed to an optimum or maximum value. Capacity will vary from site to site in accordance with visitor behavior and preferences, as well as management goals.

Tourism carrying capacity is based on a general sense that any form of development within the carrying capacity of ecosystem means a sustainable development. In the light of carrying capacity sustainable tourism is a form of tourism development which uses natural resources and cultural heritage to increase the number of visitors and the profit from tourist activities, but preserves them for the future generations (CCA, 1999). The desirable sustainable tourism development functions as a kind of compromise between generally intensive forms of tourism development promoted mainly by investors/entrepreneurs and generally restricted forms of tourism development promoted mainly by ecologists. Such a methodology has a starting point in a view that the assessment of limits for carrying capacity can rarely be measured precisely – it is almost always judged subjectively depending on which view is represented by subjects responsible for the assessment. In this sense WTO definition of tourism carrying capacity as the maximum number of people that may visit the tourist destination without causing destruction of the physical, economic and socio-cultural environment and an unacceptable decrease in the quality of visitors' satisfaction (CCA, 1999).

In 1997 Chamberlin says carrying capacity is the level of human (tourist) activity that an area can accommodate without degradation of nature. Carrying capacity assessment is the pre-condition for Ecotourism development.

## **2.9 Significance of assessing TCC for sustainable Ecotourism in the Sundarban**

The Sundarban plays diversified role for this country. The actual role of this great forest cannot be described in words actually. Sundarban is a great source of tourism development, it is mentioned. But tourism or massive tourism always have some adverse impact on the ecosystem and environment. So, in another word tourism is also threat to the Sundarbans. The ecological balance of the great forest has to be maintained must and alongside that tourism have to be developed in a sustainable way. Overall, tourism development has to be done within the limit that the forest will not be affected. That is the tourist carrying capacity of a site, beyond which tourism or ecotourism have to be developed.

In Sunderbans, there are varieties of tree, climbers, shrubs, grasses and epiphytic species. These plant species appear at different successional stages. These trees appear pneumatophores and some have viviparous germination. These variations are of good tourist attraction. Sundarbans is said to be the home of famous Royal Bengal Tiger. Spotted deer, salt water crocodile, monkey, wild boar, otter, lizard, python etc are found frequently in this reserve forest. The avifauna of the Sundarbans is one of the biggest attractions for bird watchers. The birds not only feel the sound effect that make the jungle come alive but also they add color and beauty of Sundarbans. There are ample opportunities for recreational activities in Sundarbans. The pleasure of cruising in rivers and seek of the Sundarbans knows no bounds. Equally interesting in Sundarbans is fishing (Bhuiyan and Moss, 2001). In addition there are some other recreational activities like- beach relaxations, walking, jungle trails, wildlife watching, educational study tour, participatory ecology, art touring, herbal tour etc.

Table2: Number of fauna species and families found in Sundarbans

Groups	No. of families	No. of species
Mammal	14	49
Bird	39	314
Reptile	16	50
Amphibian	04	08

Source: Bhuiyan and Moss, 2001

The Sundarbans comprises 45 percent of the total productive forest of the country, contributing about one-half of the forest related revenue. About 50 to 60 thousand people work regularly and continuously for about six months, while the number of people entering the forest in a year can be as high as 3.5 million for minor forest product collection and fishing. Of these about 25 thousand work for fish drying, 200 thousand get engaged in shrimp fry collection in the rivers and creeks around the Sundarbans. About 2.5 million people live in the villages surrounding the Sundarbans, while the number of people within 20km of the forest boundary is 3.14 million. The main forest products are timber, firewood, thatching material, newsprint raw material, honey and wax, fish and crabs, shrimp fry and miscellaneous items. Of all the products the fishery of Sundarban represents the most important non-wood component which constitutes 5 percent of the total fish harvest of Bangladesh. Eco-tourism is a major component of the Sundarban Biodiversity Conservation Project. It comprises a range of integrated activities (Rahman, 2007).

As the negative sides of tourism are discussed before, then one thing is clear and that is excess population is much responsible for any particular site damage. If we are able to calculate the carrying capacity of any particular site or spot of the Sundarbans, then we can make our tourism plan for sustainable development. Without knowing the limit actually there is no plan. TCC gives us the number that how many tourists a site can sustain. Under this limit the damage of any site is negligible. If number of tourists crosses the TCC limits the severe damage of site can be happen. So, through knowing the limits and identifying present features tourism can be developed in a sustained way only. Then the Sundarban will survive within its ecological balance as well as ecotourism will be developed.



# Chapter 3: Materials and Methods

## 3.1 Location

The Sundarbans is located in the southern part of Bangladesh and some parts of India. It is a coastal forest and the largest mangrove forest, which is very rich in biodiversity. Salinity, tidal inundation etc are common here. Here we have collected data to calculate carrying capacity of seven most common and visited tourist spots named- Kotka, Kochikhali, Hironpoint, Dubla, Harbaria, Kolagachia and Koromjol. Data are collected regarding to different attributes of those spots. Due to different settings sometimes several spots data are collected partly.

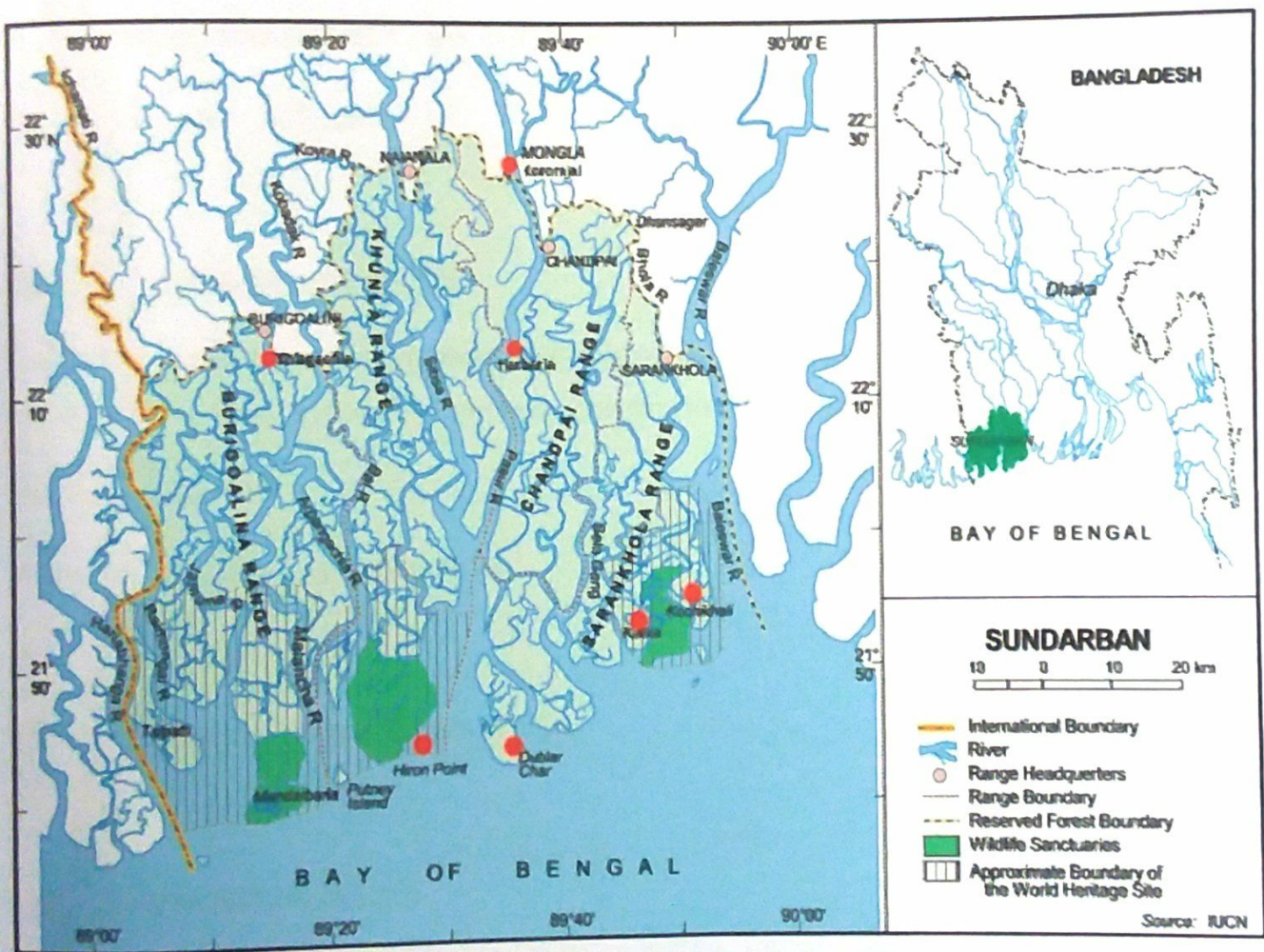


Fig: Map of the Sundarbans with seven renounced tourist spots (study areas)

### **3.2 Assessment of Carrying Capacity**

The calculation of tourist carrying capacity of different spots of the Sundarbans was conducted according to Cifuentes (1992).

In this method the following three levels of carrying capacity will be assessed:

- Physical carrying capacity (PCC)
- Real carrying capacity (RCC)
- Effective or permissible carrying capacity (ECC)

PCC is always greater than RCC, and RCC is greater or equal to ECC:

$$PCC > RCC \quad \text{and} \quad RCC \geq ECC$$

#### **Physical carrying capacity (PCC):**

PCC is defined as the maximum number of visitors that can physically fit into a defined space, over a particular time, and can be expressed according to the following formula:

$$PCC = A \times V/a \times Rf$$

Where, A = available area for public use,

V/a = one visitor per m<sup>2</sup> and

Rf = rotation factor (number of visits per day)

#### **Real carrying capacity (RCC):**

RCC is defined as the maximum permissible number of visits to a site, once the corrective (i.e. reductive) factors derived from the particular characteristics of the site have been applied to the PCC. These corrective factors will be obtained by considering the biophysical, environmental, ecological, social and management variables of the targeted spots.

RCC may be expressed by the following general formula:

$$RCC = PCC - Cf_1 - Cf_2 - \dots - Cf_n,$$

Where Cf is a corrective factor expressed as a percentage. Thus, the formula for measuring RCC is:

$$RCC = PCC \times \left[ \frac{(100 - cf_1)}{100} \times \frac{(100 - cf_2)}{100} \times \dots \dots \dots \frac{(100 - cf_n)}{100} \right]$$

Corrective factors (Cf) are expressed in percentage terms, using the following general formula:

$$Cf = (M_l/M_t) \times 100$$

Where, Cf = corrective factor,  $M_l$  = limiting magnitude of the variable,  $M_t$  = total magnitude of the variable.

**Effective or permissible carrying capacity (ECC):**

Effective (or permissible) carrying capacity (ECC) is the maximum number of visitors that a site can sustain, given the management capacity (MC) available. ECC is obtained by comparing real carrying capacity (RCC) with the management capacity (MC) of the corresponding protected area administration.

ECC may be expressed by the following general formula:

$$\text{Effective carrying capacity (ECC)} = RCC \times MC$$

- MC is defined as the sum of conditions that the water resource management requires if it is to carry out its functions and objectives;
- Measuring MC is not easy, involving many variables, including inter alia policy measures, legislation, infrastructure, facilities, amenities and equipment, staff (both number and competency), funding, available budget, motivation and commitment;

- Limitations in management capacity constitute one of the most serious problems confronting recreational water resource management;
- As the capacity to manage recreational water resources increases, the ECC will increase, yet never be greater than the RCC, even in the most favourable conditions; and MC is determined by the following formula-
- $MC = \text{Current staff and budget capacity} / \text{required staff and budget capacity}$

### 3.3 Data collection

Data related to calculate carrying capacity are collected by both on field measurement and from secondary sources. Information about tourists and tourism requirements like sanitation, resting, security, site seeing, etc are collected by public survey and secondary data related with area, river, administration capacity, recreational facilities, environmental factors etc are collected from related administrative setup. Trail length and width, ground walk way etc are directly measured on field. In different cases like wildlife and others internet is used widely to collect information. So, the data collection method will be divided into two categories-

Primary data collection: through field measurement and tourist interview.

Secondary data collection: from secondary source like Forest Department office, weather office, internet etc.



## Chapter 4: Results

Average and maximum group size and average visit duration were calculated prior to analyzing carrying capacities with the data collected from the questionnaire survey.

The average group member and average visit duration varies spot to spot in the Sundarbans. So, each spot carrying capacity is calculated separately.

### **4.1. Determination of Physical Carrying Capacity (PCC)**

The PCC only provides a base level to calculate the following levels of recreation carrying capacity.

**Site Name:** Kotka

**Spot- 1:** Office Site

Total length of trail- 2100 m (Wooden trail + earth trail + Brick soling)

Average group size- 50

Theoretically available group number- 21 [(21×50) + (20×50) =2050, <2100]

Available area for tourist A= 1050 m (21×50= 1050)

Total open time- 9 hours (8 am – 5 pm)

Average time for one visit- 2 hours

So, rotation factor  $R_f$  = total open time/ average time for one visit

$$= 9/2 = 4.5 \text{ (So, } R_f \text{ will be- 4)}$$

Minimum distance between groups= 50 m

$V/a = 1$ , one visitor per  $m^2$



$$PCC = A \times V/a \times R_f$$

$$= 1050 \times 1 \times 4$$

= 4200 visitors per day.

### Spot- 2: Kotka to Jamtala

Total length of trail- 2800 m (Wooden trail + earth trail + Brick soling)

Average group size- 50

Theoretically available group number- 28 [(28×50) + (27×50) = 2750, <2800]

Available area for tourist A= 1400 m (28×50= 1400)

Total open time- 9 hours (8 am – 5 pm)

Average time for one visit- 3 hours

So, rotation factor  $R_f = \text{total open time} / \text{average time for one visit}$

$$= 9/3 = 3$$

Minimum distance between groups= 50 m

$V/a = 1$ , one visitor per  $m^2$

$$PCC = A \times V/a \times R_f$$

$$= 1400 \times 1 \times 3$$

= 4200 visitors per day.

### Site Name: Kochikhali

Total length of trail- 3400 m (Wooden trail + earth trail + Brick soling)

Average group size- 50

Theoretically available group number- 34 [(34×50) + (33×50) =3350, <3400]

Available area for tourist A= 1700 m (34×50= 1700)

Total open time- 9 hours (8 am – 5 pm)

Average time for one visit- 3 hours

So, rotation factor  $R_f$  = total open time/ average time for one visit

$$= 9/3 = 3$$

Minimum distance between groups= 50m

$V/a = 1$ , one visitor per  $m^2$

$PCC = A \times V/a \times R_f$

$$= 1700 \times 1 \times 3$$

= 5100 visitors per day.

**Site Name:** Hironpoint

**Spots:** Keora Shuti + Trail behind the office

Total length of trail- 1250 m (Keora Shuti) + 1463 m (Trail behind the office) = 2713 m  
(Wooden trail + earth trail + Brick soling)

Average group size- 50

Theoretically available group number- 27 [(27×50) + (26×50) =2650, <2713]

Available area for tourist A= 1350 m (27×50= 1350)

Total open time- 9 hours (8 am – 5 pm)

Average time for one visit- 1.5 hours

So, rotation factor  $R_r = \text{total open time} / \text{average time for one visit}$

$$= 9 / 1.5 = 6$$

Minimum distance between groups= 50 m

$V/a = 1$ , one visitor per  $m^2$

$$PCC = A \times V/a \times R_r$$

$$= 1350 \times 1 \times 6$$

$$= 8100 \text{ visitors per day.}$$

**Site Name: Dubla**

Total length of trail- 800 m (Wooden trail + earth trail + Brick soling)

Average group size- 50

Theoretically available group number- 8  $[(8 \times 50) + (7 \times 50) = 750, < 1463]$

Available area for tourist  $A = 400m$  ( $8 \times 50 = 400$ )

Total open time- 9 hours (8 am – 5 pm)

Average time for one visit- 1.5 hours

So, rotation factor  $R_r = \text{total open time} / \text{average time for one visit}$

$$= 9 / 1.5 = 6$$

Minimum distance between groups= 50 m

$V/a = 1$ , one visitor per  $m^2$

$$PCC = A \times V/a \times R_r$$

$$=400 \times 1 \times 6$$

= 2400 visitors per day.

**Site Name: Harbaria**

Total length of trail- 1593 m (Wooden trail + earth trail + Brick soling)

Average group size- 50

Theoretically available group number- 16 [(16×50) + (15×50) =1550, <1593]

Available area for tourist A= 800 m (16×50= 800)

Total open time- 9 hours (8 am – 5 pm)

Average time for one visit- 1 hour

So, rotation factor  $R_f$  = total open time/ average time for one visit

$$= 9/1 = 9$$

Minimum distance between groups= 50 m

$V/a = 1$ , one visitor per  $m^2$

$PCC = A \times V/a \times R_f$

$$=800 \times 1 \times 9$$

= 7200 visitors per day.

**Site Name: Koromjol**

Total length of trail- 2080 m (Wooden trail + earth trail + Brick soling)

Average group size- 50

Theoretically available group number- 21 [(21×50) + (20×50) =2050, <2080]

Available area for tourist A= 1050 m (21×50= 1050)

Total open time- 9 hours (8 am – 5 pm)

Average time for one visit- 1 hour

So, rotation factor  $R_f$  = total open time/ average time for one visit

$$= 9/1 = 9$$

Minimum distance between groups= 50 m

$V/a = 1$ , one visitor per  $m^2$

$PCC = A \times V/a \times R_f$

$$= 1050 \times 1 \times 9$$

= 9450 visitors per day.

**Site Name:** Kolagachia

Total length of trail- 1065 m (Wooden trail + earth trail + Brick soling)

Average group size- 50

Theoretically available group number- 11 [(11×50) + (10×50) =1050, <1065]

Available area for tourist A= 550 m (11×50= 550)

Total open time- 9 hours (8 am – 5 pm)

Average time for one visit- 1 hour

So, rotation factor  $R_f$  = total open time/ average time for one visit

$$= 9/1 = 9$$

Minimum distance between groups= 50 m

$V/a = 1$ , one visitor per  $m^2$

$PCC = A \times V/a \times R_f$

$= 550 \times 1 \times 9$

$= 4950$  visitors per day.

## 4.2 Determination of Real Carrying Capacity (RCC)

The influential factors for the RCC are mainly taken from last 20 year climatic data. Characteristics related to the RCC are: excessive heat ( $>25^\circ\text{C}$ ), rainy day (average 6 hours per day), weather signal (signal exceeds 3), soil compaction (in case of ground trail through the jungle) and disturbance of most common wild animals of the Sundarbans (in breeding period). These are the corrective factors which can limit the entry and visit of tourist in different spots.

In the Sundarbans some limiting factors for Sundarbans are same for all spots and some factors may vary site to site (like- compaction). Here are the calculations of particular corrective factors considered for our study and determining real carrying capacity (RCC) is given below-

### 1) Excessive heat:

256 days temperature  $>25^\circ\text{C}$ , total day = 12 hours and excessive sun= 4.5 hours/day

So, limiting magnitude=  $256 \times 4.5 = 1152$  hours, and

Total magnitude=  $256 \times 12 = 3072$  hours

Corrective factor for heat ( $C_{f_{heat}}$ ) =  $(1152/3072) \times 100 = 37.5\%$

## 2) Rainfall:

Limiting magnitude/ no. of rainy days per year= 126 days = 126×6 hours/day = 756 hours

Per day avg. 6 hours rain (Ref: IPAC report on Ecotourism in Satchari National Park, 2013).

Total magnitude/ total no. of days in a year= 365 days = 365× 9 hours visit per day = 3285 hours

Corrective factor for rainfall ( $C_{rain}$ ) =  $(756/3285) \times 100 = 23.01\%$

## 3) Weather signal:

45 days per year weather signal above 3.

So, limiting magnitude= 45 days

Total magnitude= 365 days.

Corrective factor for Weather signal ( $C_{ws}$ ) =  $(45/365) \times 100 = 12.33\%$

## 4) Compaction:

Here, limiting magnitude will be length of earth trail which is vulnerable for compaction and total magnitude will be total length of trail. Compaction amount is different in different spots-

**Site Name:** Kotka

**Spot- 1:** Office Site

Limiting magnitude= 1500 m

Total magnitude= 2100 m

So, Corrective factor for compaction ( $C_{compaction}$ ) =  $(1500/2100) \times 100 = 71.43\%$

**Spot- 2:** Kotka to Jamtala (Approximately 300 m road lies within the jungle, only this length is considered as subject to compaction)

Limiting magnitude= 300 m

Total magnitude= 2800 m

So, Corrective factor for compaction ( $Cf_{\text{compaction}}$ ) =  $(300/2800) \times 100 = 10.71\%$ .

**Site Name:** Kochikhali

Limiting magnitude= 2700 m

Total magnitude= 3400 m

So, Corrective factor for compaction ( $Cf_{\text{compaction}}$ ) =  $(2700/3400) \times 100 = 79.41\%$

**Site Name:** Hironpoint

**Spot:** Keora Shuti and Trail

Limiting magnitude= 1905 m

Total magnitude= 2713 m

So, Corrective factor for compaction ( $Cf_{\text{compaction}}$ ) =  $(1060/1250) \times 100 = 70.22\%$

**Site Name:** Dubla

Limiting magnitude= 800 m

Total magnitude= 800 m

So, Corrective factor for compaction ( $Cf_{\text{compaction}}$ ) =  $(800/800) \times 100 = 100\%$

**Site Name:** Harbaria

Limiting magnitude= 192 m



Total magnitude= 1593 m

So, Corrective factor for compaction ( $Cf_{compaction}$ ) =  $(192/1593) \times 100 = 12.05\%$

**Site Name:** Koromjol

Limiting magnitude= 375 m

Total magnitude= 2080 m

So, Corrective factor for compaction ( $Cf_{compaction}$ ) =  $(375/2080) \times 100 = 18.03\%$

**Site Name:** Kolagachia

Limiting magnitude= 227 m

Total magnitude= 1292 m

So, Corrective factor for compaction ( $Cf_{compaction}$ ) =  $(227/1292) \times 100 = 17.57\%$

**5) Wildlife Disturbances:**

	J	F	M	A	M	J	J	A	S	O	N	D
Tiger	Green	Green									Green	Green
Spotted Deer	Black											
Monkey										Blue	Blue	Blue
Wild Boar			Red	Red	Red	Red	Red					
Estuarine Crocodile			Red	Red	Red	Red	Red					
Dolphin			Red	Red	Red	Red	Red					
King Fisher			Red	Red	Red	Red	Red					
Fish Owl	Orange	Orange	Orange	Orange	Orange							Orange
Fish Eagle	Yellow	Yellow	Yellow								Yellow	Yellow
Lesser Adjutant			Pink	Pink	Pink	Pink	Pink					

### **Disturbance for Tiger:**

Breeding season duration from November to February, 4 months or 120 days.

Limiting magnitude= 120 days

Total magnitude= 365 days

So, Corrective factor for Wildlife Disturbances ( $Cf_{tiger}$ ) =  $(120/365) \times 100 = 32.87\%$

### **Disturbance for Spotted Deer:**

Peak breeding season is from January to July that means 7 months/ 212 days.

Limiting magnitude= 212 days

Total magnitude= 365 days

So, Corrective factor for Wildlife Disturbances ( $Cf_{deer}$ ) =  $(212/365) \times 100 = 58.087\%$

### **Disturbance for Monkey:**

Breeding season mainly October to December 3 months or 92 days.

Limiting magnitude= 92 days

Total magnitude= 365 days

So, Corrective factor for Wildlife Disturbances ( $Cf_{Monkey}$ ) =  $(92/365) \times 100 = 25.21\%$

**Disturbance for wild Boar, Estuarine Crocodile, Dolphin, King Fisher and Lesser Adjutant:**

Breeding season duration from March to July, 5 months or 153 days.

Limiting magnitude= 153 days

Total magnitude= 365 days

So, Corrective factor for Wildlife Disturbances ( $Cf_{wds}$ ) =  $(153/365) \times 100 = 41.92\%$

**Disturbance for Fish Owl:**

Breeds during December to May, 6 months or 182 days.

Limiting magnitude= 182 days

Total magnitude= 365 days

So, Corrective factor for Wildlife Disturbances ( $Cf_{Fish Owl}$ ) =  $(182/365) \times 100 = 49.86\%$

**Disturbance for Fish Eagle:**

Breeding during November to March, 5 months or 153 days.

Limiting magnitude= 153 days

Total magnitude= 365 days

So, Corrective factor for Wildlife Disturbances ( $Cf_{Fish Eagle}$ ) =  $(153/365) \times 100 = 41.91\%$

The average corrective factor for Wildlife Disturbance ( $Cf_{wd}$ )

$$= (32.87 + 58.087 + 25.21 + 41.92 + 49.86 + 41.91) / 6$$

= 41.64%

Here, is list of all corrective factors we have considered for our study-

Table 3: List of corrective factors

Corrective Factors		%
Excessive heat		37.5
Rainfall		23.01
Weather signal		12.33
Wildlife Disturbances		41.64
Compaction	Kotka Spot 1	71.43
	Kotka Spot 2	10.71
	Kochikhali	79.41
	Hironpoint	70.22
	Dubla	100
	Harbaria	12.5
	Koromjol	18.03
	Kolagachia	17.57

### RCC of Kotka

$$RCC = PCC \times (100 - CF_{\text{compaction}})/100 \times (100 - CF_{\text{excessive heat}})/100 \times (100 - CF_{\text{rainfall}})/100 \times (100 - CF_{\text{weather signal}})/100 \times (100 - CF_{\text{wildlife disturbance}})/100$$

### Spot- 1: Office Site

$$RCC = PCC \times (100 - 71.43)/100 \times (100 - 37.5)/100 \times (100 - 23.01)/100 \times (100 - 12.33)/100 \times (100 - 41.64)/100$$

$$= 4200 \times 0.2857 \times 0.625 \times 0.7699 \times 0.8767 \times 0.5836$$

$$= 296 \text{ persons}$$

**Spot- 2: Kotka to Jamtala**

$$\text{RCC} = \text{PCC} \times (100 - 10.71)/100 \times (100 - 37.5)/100 \times (100 - 23.01)/100 \times (100 - 12.33)/100 \times (100 - 41.64)/100$$

$$= 4200 \times 0.8929 \times 0.625 \times 0.7699 \times 0.8767 \times 0.5836$$

=925 persons

**RCC of Kochikhali**

$$\text{RCC} = \text{PCC} \times (100 - 79.41)/100 \times (100 - 37.5)/100 \times (100 - 23.01)/100 \times (100 - 12.33)/100 \times (100 - 41.64)/100$$

$$= 5100 \times 0.2059 \times 0.625 \times 0.7699 \times 0.8767 \times 0.5836$$

=259 persons

**RCC of Hironpoint**

$$\text{RCC} = \text{PCC} \times (100 - 70.22)/100 \times (100 - 37.5)/100 \times (100 - 23.01)/100 \times (100 - 12.33)/100 \times (100 - 41.64)/100$$

$$= 8100 \times 0.2978 \times 0.625 \times 0.7699 \times 0.8767 \times 0.5836$$

=594 persons

**RCC of Dubla** (here, compaction factor is excluded because this trail is totally on ground but not through the forest in any point)

$$\text{RCC} = \text{PCC} \times (100 - 37.5)/100 \times (100 - 23.01)/100 \times (100 - 12.33)/100 \times (100 - 41.64)/100$$

$$= 2400 \times 0.625 \times 0.7699 \times 0.8767 \times 0.5836$$

=591 persons

### **RCC of Harbaria**

$$\text{RCC} = \text{PCC} \times (100 - 12.5)/100 \times (100 - 37.5)/100 \times (100 - 23.01)/100 \times (100 - 12.33)/100 \times (100 - 41.64)/100$$

$$= 7200 \times 0.875 \times 0.625 \times 0.7699 \times 0.8767 \times 0.5836$$

$$= 1552 \text{ persons}$$

### **RCC of Koromjol**

$$\text{RCC} = \text{PCC} \times (100 - 18.03)/100 \times (100 - 37.5)/100 \times (100 - 23.01)/100 \times (100 - 12.33)/100 \times (100 - 41.64)/100$$

$$= 9450 \times 0.8197 \times 0.625 \times 0.7699 \times 0.8767 \times 0.5836$$

$$= 1908 \text{ persons}$$

### **RCC of Kolagachia**

$$\text{RCC} = \text{PCC} \times (100 - 17.57)/100 \times (100 - 37.5)/100 \times (100 - 23.01)/100 \times (100 - 8.78)/100 \times (100 - 41.64)/100$$

$$= 4950 \times 0.8243 \times 0.625 \times 0.7699 \times 0.8767 \times 0.5836$$

$$= 1005 \text{ persons}$$

## **4.3 Determination of Effective/ Permissible Carrying Capacity**

$$\text{Effective carrying capacity (ECC)} = \text{RCC} \times \text{MC}$$

Here, RCC is Real carrying capacity and MC is Management capacity.

To calculate management capacity different factors are needed to be analysed like- manpower, infrastructure, budget etc. But here in the Sundarban infrastructural development is not supported for ecotourism, because it increases disturbance into the natural condition. In case of day tourist spots the tourists don't stay there and in case of package tours the residence for tourist are managed within the water vessels. Though Bangladesh is a poor developing country this ecotourism sector faces budget scarcity. Basically it is not possible to increase budget to a notable amount compared to the present budget. All we can do that is develop tourism within existing infrastructure and budget. So, in case of calculating MC we will not consider infrastructure and budget. We will take only manpower in account of calculating MC, to determine ECC.

$$\text{Management Capacity} = (\text{present manpower} / \text{required manpower}) \times 100$$

Here as present manpower we will consider the number of staffs we found in the site and as required manpower we will consider the total numbers of staffs are needed to manage that specific site actively. This required numbers for different sites are derived from interviewing the forest department personnel and tourists visited on that area.

This is table 4 representing the present manpower and required manpower according to the survey results-

<b>Spots Name</b>	<b>Present manpower</b>	<b>Required manpower (at least)</b>
Kotka	7	12
Kochikhali	7	10
Hironpoint	10	17
Dubla	10	15
Harbaria	9	15
Koromjol	12	20
Kolagachia	9	14



### **ECC of Kotka**

$$MC = (7/12) \times 100 = 0.583 \times 100 = 58.3\%$$

#### **Spot- 1: Office Site**

$$ECC = RCC \times MC = 296 \times 0.583 = 173 \text{ persons}$$

#### **Spot- 2: Kotka to Jamtala**

$$ECC = 925 \times 0.583 = 539 \text{ persons}$$

### **ECC of Kochikhali**

$$MC = (7/10) \times 100 = 0.7 \times 100 = 70\%$$

$$ECC = 259 \times 0.7 = 182 \text{ persons}$$

### **ECC of Hironpoint**

$$MC = (10/17) \times 100 = 0.588 \times 100 = 58.8\%$$

$$ECC = 594 \times 0.588 = 350 \text{ persons}$$

### **ECC of Dubla**

$$MC = (10/15) \times 100 = 0.6667 \times 100 = 66.67\%$$

$$ECC = 591 \times 0.6667 = 395 \text{ persons}$$

### **ECC of Harbaria**

$$MC = (9/15) \times 100 = 0.6 \times 100 = 60\%$$

$$ECC = 1552 \times 0.6 = 932 \text{ persons}$$

### **ECC of Koromjol**

$$MC = (12/20) \times 100 = 0.6 \times 100 = 60\%$$

$$ECC = 1908 \times 0.6 = 1145 \text{ persons}$$

### **ECC of Kolagachia**

$$MC = (9/14) \times 100 = 0.643 \times 100 = 64.3\%$$

$$ECC = 1005 \times 0.643 = 647 \text{ persons}$$

### **4.4 Final Carrying Capacities**

The total three levels carrying capacity of seven popular tourist spots of the Sundarbans are presented in the table below-

Table 5: Final carrying capacities of spots

<b>Spots Name</b>	<b>PCC/day</b>	<b>RCC/day</b>	<b>ECC/day</b>
Kotka Office Site	4200	296	173
Kotka to Jamtala	4200	925	539
Kochikhali	5100	259	182
Hironpoint	8100	594	350
Dubla	2400	591	395
Harbaria	7200	1552	932
Koromjol	9450	1908	1145
Kolagachia	4950	1005	647

## **Chapter 5: Discussion and Conclusion**

### **5.1 Discussion**

Cifuentes and Ceballos- Lascurain method of carrying capacity assessment provides opportunities to evaluate ecological and biophysical factors influencing the tourism but it discourages some other important factors like- social and political conflict, damage of trail etc. In the public survey of visitors some dissatisfactions are also addressed like lackings of recreational and sanitation facilities, communication and security problems etc.

Conflict with the management operation is seen everywhere. In some cases co-management can be a good option but in others issue related with conservation and ethics this approach may create problem. Co-ordination between different government ministry and agency is very much needed and conflict with different policy should be resolved.

Effect on vegetation is another important factor. Different illegal practices also affect biodiversity as well as tourism. Cultural and religious festivals like Rash mela increase tourist arrival but it can be sensitive to forest. This type of occasions needs special attention and management. Infrastructure development can increase tourist number but it is harmful in natural forest like- the Sundarbans. In some cases the actual number of tourist is pretty much higher than our calculated number of carrying capacity.

The natural and cultural resources of the Sundarbans or the complete body of ecosystems and historical heritage should be sustained within the actual conditions. Any kind of visitor limitation is not needed under ECC and ECC can be considered as the maximum number of visitors to the spots. However, these are the mean numbers. In practice there is still a risk of saturation or carrying capacity overload particularly in the peak seasons. Since visitation to the forest and the use levels of trails depend upon the season, weather, and trail conditions and the intensity of the different seasons. Certain management actions are needed to balance the visitor use throughout the year, such as reorganizing the visitation hours, provides proper guideline to regulate tourist activities etc. A new trail system is needed since there are encountering, accessibility, and compaction problems. High visitor use on trail should be regulated, such as one-way trails could be adopted to balance the use.

The balance between protection of the natural and cultural resources, quality of recreation experience, and economic sustainability can be established through comprehensive carrying capacity studies. Methods used in this research are applicable for the physical and cultural dimensions of carrying capacity. Further studies should focus on the social carrying capacity and crowding condition and other socio-economic options.

## **5.2 Conclusion**

The Sundarbans have huge potentiality in ecotourism sector. Considering the ecological importance of this great forest community regarding to Bangladesh, mass tourism should not encourage here. To conserve the nature of the Sundarbans tourism should be developed under the limit of tourist carrying capacity. Present infrastructural condition, manpower, security, sanitation, health issues, emergency options and other conditions should also important regarding to proper development of this sector.

## References

Ahsan, M. (2007). Perceptions of tourism by indigenous communities living in and adjoining Lawachara National Park.

Aziz, M.A. (2007). Co-management of Protected Areas without Local Knowledge and Participation: A Case Study of Lawachara National Park.

Bhuiyan, M.R. Moss, P.V. (2001). BIODIVERSITY AND ECOTOURISM IN SUNDERBANS: PROSPECTS AND PROBLEMS. Environment and Agriculture: Biodiversity, Agriculture and Pollution in South Asia. PP: 32-36. Ecological Society, Nepal.

Bosley, H.E. (2005). Techniques for Estimating Boating Carrying Capacity: A Literature Review. North Carolina State University. Department of Parks, Recreation & Tourism Management.

CARRYING CAPACITY ASSESSMENT (CCA) FOR TOURISM DEVELOPMENT. (1999). Coastal Area Management Programme (CAMP) FUKA-MATROUH – Egypt. United nations environmental programme (UNEP).

Chamberlain, K. (1997). Carrying capacity, UNEP Industry and Environment 8. Paris: UNEP.

Chowdhury, M.S. Ullah, M.M. Hasan, M. R. (2011). Impact of tourism in Bangladesh Economy.

Cifuentes, A.M. (1992). Determinación de Capacidad de Carga Turística en Areas Protegidas. CATIE, Turrialba, Costa Rica.

Drumm, A. Moore, A. (2002). Ecotourism Development- A manual for conservation planners and managers, Vol-1. The nature conservation agency, USA. USAID.

Dwyer, L. Spurr, R. (2010). Tourism Economics Summary. STCRC centre for Economics and policy.

FAO. (2010). Ecotourism and other services derived from forests in the Asia Pacific region,

Gossling, S. (1999). Ecotourism: a means to safeguard biodiversity and ecosystem function? Ecological Economics 29. P: 303-320.

Honey, M. (1999). Ecotourism and sustainable development. Who owns paradise? Island Press, Washington DC.

- INTEGRATED PROTECTED AREA CO-MANAGEMENT (IPAC) Report. (2012). STUDY ON ECOTOURISM: LAWACHARA NATIONAL PARK. United States Agency for International Development (USAID).
- INTEGRATED PROTECTED AREA CO-MANAGEMENT (IPAC) Report. (2013). ECO-TOURISM IN SATCHARI NATIONAL PARK.
- Iqball, M.S. Parvin, M. Salequzzaman, M. Haque, S.E. Islam, M.R. Ahmed, M.S. (2010). Ecotourism in Sundarbans and its surroundings- A possible sustainable option for livelihood development. Bangladesh Research Publication Journal. 4(3), 244-253.
- IUCN. (2008). Nature Based Tourism in Bangladesh.
- Lindberg, K. (1997). Ecotourism in the Asia Pacific Region: Issues and Outlook. The International Ecotourism Society.
- Lindberg, K. (2001). Policies for maximizing nature tourism's ecological and economic benefits. International conservation financing project working paper, Washington D.C. World Resource Institute.
- Manning, R.E. Lime, D.W. Hof, M. (1996). Social carrying capacity of natural areas: Theory and application in the U.S. National Parks. Natural Areas Journal, 16 (2), pp. 118-127.
- Markovic, M.M. Satta, M.A. Skaricic, M.Z. Trumbic, M.I. (2009). Sustainable coastal tourism: An integrated planning and management approach. United Nations Environmental Programme.
- Moinuddin, G. Begum, H. (2004). Eco-Tourism: An Investigation into the Conceptual Framework and Policy Requirements for its Growth in Bangladesh. Jahangir nagar Planning Review, Vol. 2, pp. 67-82.
- Nishorgo. (2006). Management plans of Lawachara National Park Vol 1 & 2 Nishorgo Support Project: Dhaka, Bangladesh.
- Pratt, L. (2011). Tourism: investing in energy and resource efficiency. Green Economy. United Nations Environmental Programme.
- Rahman, M.A. (2007). Promoting eco-tourism in the Sundarbans. The Daily Star. <http://archive.thedailystar.net/newDesign/news-details.php?nid=322>
- Ross, S. Wall, G. (1999). Ecotourism: towards congruence between theory and practice. Tourism Management: 20: 123-132. Elsevier Science Ltd.
- Salam, M.A. Lindsay. Ross, G. Malcolm. Beveridge, C.M. (2000). Eco-tourism to protect the reserve mangrove forest the Sundarbans and its flora and fauna. Anatolia. P: 56-66.

Saveriades, A. ( 2000). Establishing the social tourism carrying capacity for the tourist resorts of the east coast of the Republic of Cyprus. *Tourism Management* 21. PP: 147-156

Shelby, B. Heberlein, T.A. (1986). *Carrying capacity in recreation settings*. Corvallis, OR: Oregon State University Press.

Siddiqui, R. (2003) *Eco-tourism and Sundarban Reserved Forest in Bangladesh*. Paper submitted in World Forestry CongressXII. FAO, Rome.  
<http://www.fao.org/docrep/ARTICLE/WFC/XII/0435-A2.HTML>

Singh, J. (2010). *Ecotourism*. IK international publishing house private limited. New Delhi-110016. ISBN-978-93-80026-96-1.

Teguh, F. (2011). *INDONESIAN POLICY IN SUPPORTING SUSTAINABLE TOURISM AND DEVELOPING ECOTOURISM DESTINATION*. UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT.

Tuhin, M, K, W. Majumder, M, T, H. (2011). *An Appraisal of Tourism Industry Development in Bangladesh*. *European Journal of Business and Management: Vol- 3, No.3*. [www.iiste.org](http://www.iiste.org).

UNEP and UNWTO. (2005). *Making Tourism More Sustainable - A Guide for Policy Makers*. P: 11-12.

Wang, H & Shao, S. (2009). *Study on the Eco-tourism Environment Protection-Based on the External Theory*. *Asian Social Science; Vol-5, No-1*.

Wang, H. Song, D. (2009). *Research on the significance and measure of community participation in Ecotourism Environment protection*.

Wheeller, Brian. (1993). "Sustaining the ego", *Journal of Sustainable Tourism* 1(2), pp. 121-129.

Wight, P, A. (1993). *Sustainable Ecotourism: Balancing economic environmental and social goals within an ethical framework*. *The journal of Tourism studies*, vol-4.

WTO. (2013). *2013 Tourism Highlights*. <http://mkt.unwto.org/en/highlights>