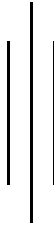


ENVIRONNER



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FOREWORD

All beings are the offsprings of the Earth. As the most intelligent and rational ones among all the beings, humans are aware of this fact. Hence, since the antique dawn of civilization, our forefathers expressed their gratitude to the Mother Earth, as may be evidenced in our ancient texts. We are here on this lovely planet with grace and favour of our Mother. It is therefore rightly expected that as responsible children, we should not be failing in our duties to take care of our Mother. That we have not inherited this earth from our forefathers, but it is borrowed from our children, may be a guiding statement in this respect.



It is with such backdrops that my esteemed colleagues of Physics and Zoology of Barbhag College have come up with a great venture of publishing some peer-reviewed research based write ups in a volume, fondly entitled the "Environner". It is a reflexion of their sincere concern for a very serious issue. Of course, mere academic articles loaded with magnificent data, are not sufficient to address this grave problem facing throughout the globe. Such writings will undoubtedly encourage others for taking some more concerted diverse efforts.

I congratulate all the academicians associated with the project and wish a success of their purpose.

(Dipak Kumar Sharma)

Professor, Deptt. of Sanskrit
Gauhati University

Date : 15-06-2023



FOREWORD



"In the ever-changing landscape of our planet, it is vital for us to understand the critical environmental issues we face and actively strive towards a sustainable and harmonious coexistence with nature. In a world where the interconnectedness of humanity and nature has become undeniable, the urgency to safeguard our environment has never been more apparent."

It is with great pleasure and enthusiasm that I introduce the edited book titled "ENVIRONNER," meticulously crafted by the esteemed editors, Dr. Birinchi Choudhury, Dr. Rantu Mani Deka and Pulama Talukdar and published by the department of Zoology and Physics, Barbhag College, Nalbari, Assam. This remarkable compilation delves into a diverse range of environmental issues, their impacts, and the pivotal laws and policies surrounding environmental pollution. "ENVIRONNER" stands as a beacon of knowledge and awareness, shedding light on the pressing challenges that our planet faces and offering insights into sustainable solutions.

One of the most encouraging aspects of "ENVIRONNER" is its emphasis on environmental awareness among college students. Education has always been the cornerstone of progress, and empowering the next generation with the knowledge and passion to protect our environment ensures a sustainable future. The book delves into the attitudes of students towards climate change, highlighting the role of young minds in advocating for environmental stewardship as well as the threats posed by climate change and global warming to human health and well-being, underscoring the urgency of collective action. The book's chapters resonate with the magnificence and vulnerability of our ecosystems. From the exploration of aquatic insect diversity, insectivorous bats to butterflies, the book underscores the crucial role of biodiversity conservation in maintaining ecological balance. Furthermore, the documentation of ichthyofaunal diversity and conservation status, along with the study of macrophytes and their economic utilization, provides a comprehensive understanding of the intricacies of nature.

Environmental pollution is a global concern, and "ENVIRONNER" acknowledges the efforts made towards detection and assessment. The inclusion of research on the design of a p-amino benzoic acid-based receptor for detecting potentially harmful environmental pollutants exemplifies the dedication of the scientific community in addressing this challenge. The impacts of e-waste on the environment and the potential of ecotourism in fostering sustainable development further enrich the book's narrative, offering a holistic approach to environmental protection. The documentation of farmer's cultivating practices and the nutritive value of native paddy varieties in the book also provide valuable knowledge for promoting sustainable agricultural practices. Water, a precious resource, is given the attention it deserves, with chapters on groundwater quality assessment and the Jal Shakti Abhiyan focusing on sustainable development and water conservation.

The book does not limit itself to ecological and scientific aspects but also delves into the socio-cultural dimension of environmental conservation. A particularly insightful aspect of the book is its exploration of the role of Indian religions and cultures in environment conservation. By drawing upon the wisdom of our heritage, we find inspiration to tread lightly upon the earth and protect our natural heritage. The editors also shed light on the often overlooked yet indispensable role of women in environment protection. Recognizing their vital contributions, the book portrays the transformative impact women can have on environmental conservation and sustainable practices. In pursuit of climate justice in India, the book aptly highlights the need for equitable solutions to combat environmental challenges, ensuring that no one is left behind.

I extend my heartfelt gratitude to Dr. Birinchi Choudhury, Dr. Rantu Mani Deka and Pulama Talukdar for their dedication in bringing "ENVIRONNER" to fruition and all the contributors for their unwavering commitment to environmental preservation and knowledge dissemination. This book will inspire a generation of environmentally conscious individuals who will champion the cause of preserving our planet for generations to come.

May "ENVIRONNER" spark a profound awakening and inspire action for a healthier, more sustainable planet.



Dr. Jaideep Baruah

Director

Assam Science Technology and

Environment Council

Date : 16-07-2023

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PREFACE

We are delighted to present the book entitled "ENVIRONNER" which aims to cover different environmental issues and their impacts, laws, policies about environmental protection to enlighten different groups of people of the society. Due to industrialization and other anthropogenic activities the physical, chemical and biological characteristics of the biosphere are degrading gradually. Deforestation, environmental pollution, water crisis, global warming, climate change, loss of biodiversity stand as the major consequences of environmental degradation which are creating a threat to our planet. To protect the environment from further degradation community participation is utmost important. Awareness and knowledge of environmental issues are the need of the hour. In addition to it, public participation in conservation of natural resources and environmental protection activities will ensure sustainable environment for present and future generations.

The research on environment plays the crucial role in making the people aware of environmental problems and their solutions. It is helpful in addressing the problems for proper utilization and conservation of limited natural resources. To be a part of the journey of sustainable environment we have decided to compile a book on different environmental issues. We hope that our efforts will make some contribution in this journey.

We are grateful to the authors who have contributed to make this book a success and we acknowledge to the respective reviewers Professor Debendra Chandra Baruah, Dr. Binode Kr. Baruah, Dr. Arup Bharali and Dr. Nandita Khakhlary for their valuable contribution in improving the quality of the contents. Our sincere gratitude goes to Dr. Birinchi Choudhury, Principal and the esteemed colleagues of Barbhag College, for their valuable suggestions and support. We also grateful to Dr. Kishore Kalita, Librarian, Barbhag College for his help in plagiarism checking.

Finally, we would like to thank Dr. Jayanta Kr. Das, Head, Deptt. of Zoology, Barama College for his valuable suggestions. We are also indebted to Rakesh Goswami, RG Publications, Ridip Barman and New S.R. Publishers and Distributors who helped in publishing the book in such a short time. Suggestive cooperation from the readers will always be welcomed.

Dr. Rantu Mani Deka
Pulama Talukdar
Editors, Environner

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ECOSYSTEM



Aquatic Insects Diversity of Boira Beel of Barpeta District, Assam, India

Dr. Alakesh Barman¹

Mr. Kabyajyoti Das²

Abstract

Boira beel is an important cultural and natural floodplain wetland in Barpeta district. The present study which was carried out on January 2019 to December 2019, is aimed to understand the aquatic insect biota of the Beel which play important role in nutrient cycling and overall smooth running of the ecological processes in the wetland. The study recorded 14 species belonging to 4 orders of aquatic insects viz. Hemiptera, Coleoptera, Diptera along with 2 unidentified species belonging to Odonata. Almost 10% of the beel, especially the banks of the beel always remained occupied by emergent and floating macrophyte vegetation, mostly consisting of Eichhornia crassipes, Hydrilla and Salvinia. Coleoptera and Hemiptera were mostly found associated with the macrophytes. The larvae of Odonata were found associated with the roots of floating macrophytes.

Key words: *Boira Beel, Aquatic Insects, Macrophytes*

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Introduction:

Aquatic insects are those members of Class Insecta which spend a part of their life-cycle or their entire life in water, either living beneath the surface of water or skating on the water-surface, and sometimes even residing above or below the bottom-surface of a water body. Aquatic insects, a very important component of metazoan life in freshwater ecosystem and the most taxonomically diverse group of aquatic organisms spread over 11 orders (Pennak, 1978) comprising about 25,000 to 30,000 species (Cheng, 1976). According to Pennak (1978) aquatic insects forms about 1% of the total animal diversity. Aquatic insects play in the overall ecosystem maintenance is often undervalued, but they help in the processing of nutrients. The inspection of the type and number of aquatic insects of a lentic ecosystem also help in estimating the anthropogenic stress and pollution occurring in the area.

According to Sweeney B.W. (1984) various aspects of nature, temperature and photoperiod are the most vital environmental factors that influence the life style of aquatic insects. These parameters affect the distribution and relative abundance of aquatic insects.

Objectives :

Boira beel is an important cultural and natural floodplain wetland in Barpeta district. Native people depend on it for agriculture and fishing. The present study undertaken is aimed to understand the aquatic insect biota of the Beel which play important role in nutrient cycling and overall smooth running of the ecological processes in the wetland. The objectives of the study were- to survey the Beel and collection of Insects, to identify the collected insect specimen and to find out the insects diversity of the Beel.

Review of Literature

The diversity of insects in Boira beel was referred by putting special emphasis on earlier work done in North-East Region of Assam. In 2007, Hazarika & Goswami carried out study for one year upto 2008 in two rain fed & perennial ponds of Aquaculture and Biodiversity campus of Zoology Department, Gauhati University. In 2010, Barman & Baruah during the entire study period upto 2012, recorded total 46 species of insects from the Kapla Beel. Choudhury & Gupta(2013) by 31 species species belonging to 18 families of 5 orders in Deepor beel. The study by Barman & Deka during 2013-2014 dealt with study of aquatic Coleoptera species of Ghaga Beel revealed presence of 12 species of aquatic Coleoptera comprising of 4 families.

The study dealing with the aquatic insects survey conducted from February 2016-May 2016, by Hasan et. al in three permanent ponds of Guwahati city, Assam and enumerated 25 different species belonging to 6 orders and 13 family. In 2018, Saha & Gupta assessed hemipterans in four sites of Sonebeel, the largest wetland in Assam (3458.12 ha at full storage level), situated in Karimganj District. recorded a total of 28 species of aquatic and semiaquatic hemipterans belonging to 20 genera under nine families.

Materials and Methods

Study area: The Boira Beel is a wetland located in Barpeta District of Assam at a distance of 6 kilometres to the north of Barpeta Town along the Barpeta-Kayakuchi-Bhabanipur Road. It covers an area of 30 hectares during monsoon and during dry season it's reduced to 25 hectares. The beel is located at 26°22'22" N latitude and 91°32' E longitude geographically. The average depth of this freshwater beel is 6 metres during monsoon and 3.5-4 metres during the pre-monsoon season. It has been

mentioned as a Cultural and Natural wetland by Prasanta Kumar Saikia (1993). The banks of the beel always remained occupied by emergent and floating macrophyte vegetation, mostly consisting of *Eichhornia crassipes*, *Hydrilla* and *Salvinia*. Rice plantation was done in nearby areas.

The study was conducted from January 2019 to December 2019 in a once in a week basis. The Beel was divided into 5 zones for sampling insects viz. North Zone, South Zone, East Zone, West Zone and Central zone based on vegetation.



Boira Beel partly inundated during Monsoon



North Zone (more macrophyte vegetation, at the edges) showed highest taxonomic diversity.

Collection of insect specimen in the Beel: Sampling was done on above mentioned sites by walking along the banks of the water and closely observing their movements at first. Then, the insects were caught with a hand operated nylon pond net, with its D-shaped scaffold made out of cane. Random scoops of water bottom in the two sites were done by sweeping the net in water. For the collection of insects from the bottom, the “all out search method” was used. The net had a diameter of 40 cm, depth of 80 cm and mesh size of 500 µm. If found necessary, then the macrophyte vegetation was spread out in a tray (Subramaniam, K A. and Sivaramakrishnan K G., 2007). The insects were collected in plastic and glass jars containing 70 percent ethyl alcohol and transferred to fresh 70 percent ethyl alcohol the next day.

Identification of insect specimens: Identification was done with simple and compound light microscopes of Bajali College, Pathsala, Assam and standard keys of Pennak (1978), Winterbourn (1981), Bal & Basu (1994a, 1994b), Biswas & Mukhopadyaya (1995), Biswas et al. (1995), Needham & Needham (1996), Bouchard (2004), Subramaniam (2005), Epler (2006), Thirumalai (2002, 2007), Subramaniam & Sivaramakrishnan (2007), Andrew et al (2008), Subramaniam (2009) and Bal & Biswas (2013). Secondary data were obtained from research papers on aquatic insects of North East India in various journals. The photographs of the collected insects were taken using microscopes of Bajali College, Pathsala, Assam.

Results

The study undertaken recorded 14 species belonging to 4 orders of aquatic insects viz. Hemiptera, Coleoptera, Diptera (Table-1) along with 2 unidentified species belonging to Odonata. Almost 10% of the beel, especially the banks of the beel always

remained occupied by emergent and floating macrophyte vegetation, mostly consisting of *Eichhornia crassipes*, *Hydrilla* and *Salvinia*. Coleoptera and Hemiptera were mostly found associated with the macrophytes. The larvae of Odonata were found associated with the roots of floating macrophytes. These could not be identified due lack of resources. Coleoptera were present more densely, but Hemiptera showed most diversity. The East zone was closer to the road and groups of fishermen, locally called “Xyla” and native people carried out private over-fishing without following any scientific method using nets that even caught the fries and fingerlings. This zone showed the least insect presence with only a few Hemiptera present. East Zone also had frequent visits by waterfowl, for swimming and feeding. Central zone contained only Diptera and this zone was cut off from the other zones during the lean season and hence the water in this region was sedentary and filled with algal blooms. North zone showed the highest diversity of aquatic insects among all the zones sampled. North Zone was farthest from the road and faced the least anthropogenic and fishing related stress. This zone also had no waterfowl during the study period. The areas near the beel were used for crop production, mostly rice plantations and water from the beel was used for the irrigation purposes which decreased water depth during this scanty-rain season. Moreover, weedicides and herbicides were used to kill water macrophytes which come along with irrigation water and this alters the chemical aspects of the water in the nearby beel by seepage thus affecting the aquatic insect population in a negative way.

Table 1 : Different species of insects found in Boira Beel of Barpeta district, Assam

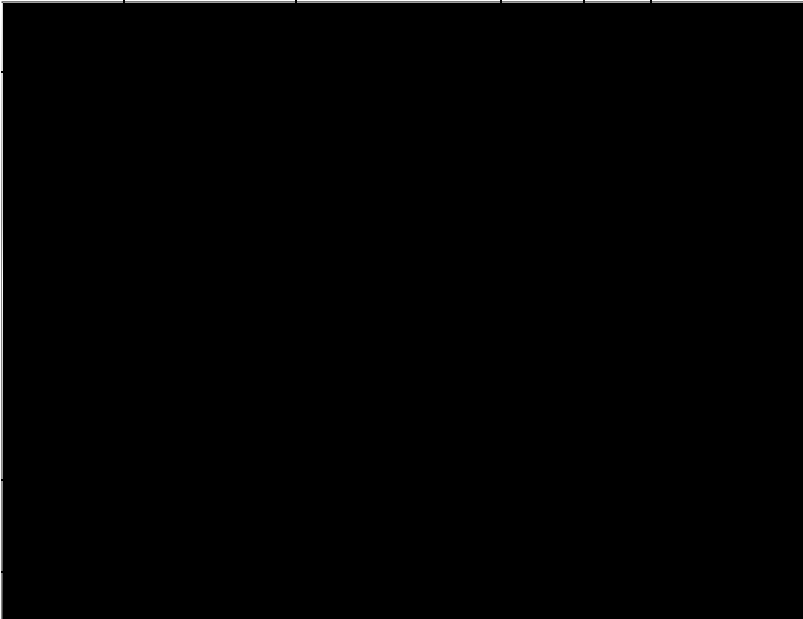
<i>Order</i>	<i>Family</i>	<i>Genus</i>
Hemiptera	Belostomatidae	1. <i>Diplonychus</i> sp.
	Mesoveliidae	2. <i>Mesovelia</i> sp.

	Nepidae	3. <i>Laccotrephes</i> sp.
	Gerridae	4. <i>Gerris</i> sp.
	Corixidae	5. <i>Micronecta</i> sp.
	Notonectidae	6. <i>Anisops</i> sp.
	Hydrometridae	7. <i>Hydrometra</i> sp.
	Pleidae	8. <i>Paraplea</i> sp.
	Hydrophilidae	9. <i>Berosus</i> sp.
Coleoptera	Dytiscidae	10. <i>Laccophilus</i> sp.
		11. <i>Cybister</i> sp.
Diptera	Chironomidae	12. <i>Chironomus</i> sp.

Fig 1: Percentage of insects in each of the 4 Orders of insects collected from Boira Beel

Hemiptera 64.28% (9 Spp.)
 Coleoptera 14.28% (2 Spp.)
 Odonata 14.28% (2 Spp.)
 Diptera 7.14% (1 Sp.)

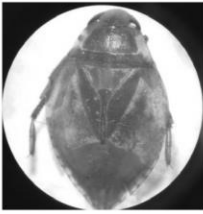
Table 2: Dominance status of different species of aquatic insects in Boira Beel during the study period



RA <1 = Subrecedent; 1.1-3.1 = Recedent; 3.2-10= Subdominant; 10.1-31.6 = Dominant and >31.7% = Eudominant

Dominant Status of the insects species of the Boira Beel

The study revealed that according to the Engelmann's scale (Engelmann 1976) out of 12 species of insects, 2 species viz. *Paraplea* sp. and *Berosus* sp. species were recedent, 7 species of insects viz. *Diplonychus* sp, *Laccotrephes* sp, *Micronecta* sp, *Anisops* sp, *Hydrometra* sp, *Cybister* sp, and *Chironomous* sp were found subdominant and 3 species viz. *Laccophilus* sp, *Gerris* sp. and *Mesovelvia* sp. were found dominant during the whole study period. Odonata was found to be subdominant. There were no subrecedent and eudominant species recorded from the wetland.



Diplonychus sp.



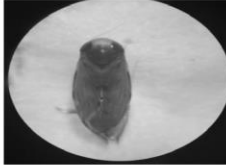
Mesovelgia sp.
(Nymphal stage)



Laccotrephes sp.



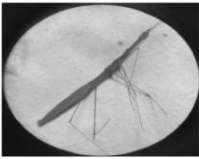
Gerris sp.



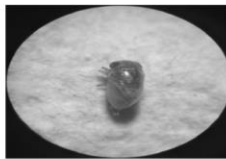
Micronecta sp.



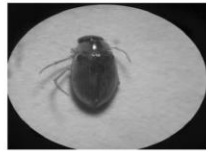
Anisops sp.



Hydrometra sp.



Paraplea sp.



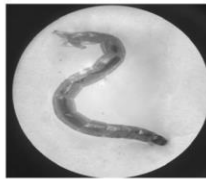
Berosus sp.



Laccophilus sp.



Cybister sp.



Chironomous sp.
(Larva)

12 Aquatic Insects collected in the Boira Beel

Discussion

The present study in a small wetland, Boira Beel revealed presence of species of 4 different orders *viz.* Coleoptera, Diptera, Hemiptera, Odonata. The order Coleoptera composed of 14.28%, Diptera composed of 7.14%, Hemiptera composed of 64.28% and Odonata composed of 14.28%. High number of Hemiptera species indicated rich diversity of this order in the Boira Beel.

In similar studies on aquatic insects of Deepor Beel (a Ramsar Site) Saikia (2007) recorded presence of 25 species including *Ranatra filiformis* as most abundant species and Kalita (2007) recorded 37 species of aquatic insects from the Deepor Beel. Hazarika and Goswami (2009) recorded 43 species of aquatic insects in two fresh water ponds located on Guwahati. Decline in the abundance of aquatic insects in the monsoon period may be due to water dynamics of the Beel caused by inflow of rain and flood water into Beel. Water dynamics affects the insects stability disturbing their habitat, growth and proliferation, in spite of nutrient input into the Beel along with the water flow. This was in agreement with the findings of Sarma and Baruah (2013) in their study on wetlands in Guwahati city. The study recorded reduction in the insect abundance in the pre monsoon period in the Beel area. The reduction was attributed to lack of inflow of nutrient as the water level of catchment area considerably reduced and utilization of existing nutrients of the Beel by already developed insects population.

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Studies on the occurrence and seasonal distribution of aquatic insects in relation to water quality of Akara wetland (*beel*) of Barpeta district, Assam, North East India

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Dr. Dipika Kalita²

Abstract:

A seasonal survey was conducted on aquatic insect community at Akara beel at three sites, DS1, DS2 and DS3 respectively of Barpeta district. The sampling of aquatic insects and water was done in replicates during 2021-2022. The study recorded 4 orders, 8 families, 12 genera and 12 species of aquatic insects. Highest density of order Hemiptera was recorded in pre monsoon and lowest and same density was recorded of order Odonata and Coleoptera in monsoon and winter. Seasonal variations of physicochemical parameters of water were found moderate. The survey revealed that a detail long term study might add some more species in the list of inventory of this wetland.

Keywords: *Aquatic insects, Akara beel, density, water quality, macro invertebrates.*

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Introduction

Aquatic insects constitute an important part of the aquatic ecosystems. They are among the most prolific animals on earth [1]. They are an important component of invertebrate assemblages in aquatic ecosystem where they are a controlling group in food webs. At the larval stage, they constitute the principal nutritive fauna of fish [2,3]. Aquatic insects and water quality are interrelated to each other as aquatic insects are potential indicators of water quality. Although there are studies on aquatic insects of north east India [4-10] till date no any study on aquatic insects has been recorded in this part of the region.

In Assam there are lots of wetlands exhibiting high diversity of aquatic organisms supported by the subtropical climate, a favourable ecological and geographical condition and auto stocking capacity. Akara *beel* (26.27° N and 91.12° E) is a 20.5 hector wetland situated in Barpeta district of lower Assam at a distance of 20 km from the Barpeta town. The area is surrounded by the river Manas on the west, the foothills of Himalayas on the North, the mighty Brahmaputra on the South and Nalbari district on the East. Till date, there is no any study on aquatic insect community in this part of the wetland. Therefore a qualitative and quantitative assessment of the aquatic insect community and environmental variables of water of this part of the river will enrich the aquatic fauna data base and reflect the water quality status of the wetland as well.

Materials and Methods

The present study was carried out for a period of one year i.e from October 2021 to May 2022. For this study three sites of the Akara beel were selected. The sites were DS1 (26-27¹ N and 91-12¹E), DS2 (26-27¹ N and 91-11¹E) and DS3 (26-28¹ N and

91-13¹ E). Aquatic insects were collected seasonally in replicates by a hand net having a mesh size of 60 µm fixed to a square wrought iron frame by “1 minute Kick” method [11] whereby the vegetation was disturbed and the net was dragged through the system for a unit time [12]. Three such drags constituted a sample. They were sorted, enumerated, and preserved in 70% ethyl alcohol and identification was done using Magnus (Olympus Model MSZ-TR) and Stereozoom microscope (Motic, Model – SMZ-168). Taxonomic identification was carried out using standard keys [13-24].

For analysing dissolved oxygen (DO), water samples were collected in 300 ml BOD bottle in replicates from each site. For analysing free CO₂(FCO₂), pH, electrical conductivity (EC), total dissolved solid(TDS), salinity, total alkalinity (TA),total hardness (TH), calcium, magnesium and chloride content of the water samples were collected in polyethylene bottles from each sampling site. Water temperature (WT) were recorded itself in the site by mercury bulb thermometer. pH was determined with the help of pH meter (Digital pH meter MK VI). Electrical conductivity (EC) was estimated by conductivity meter. DO, F-CO₂, TA, TH and Chloride were estimated by standard methods [25-27].

Diversity indices like Margalef Index (M), Shanon – Wiener Index (H/), Eveness Index (J), and Berger Parker Index of Dominance (d) for the insect community were worked out using the package Biodiversity Professional Version 2 for Windows 1997 (The Natural History Museum and Scottish Association for Marine Science). The dominance status of insect species was evaluated following Engelmann’s scale based on relative abundance [29].

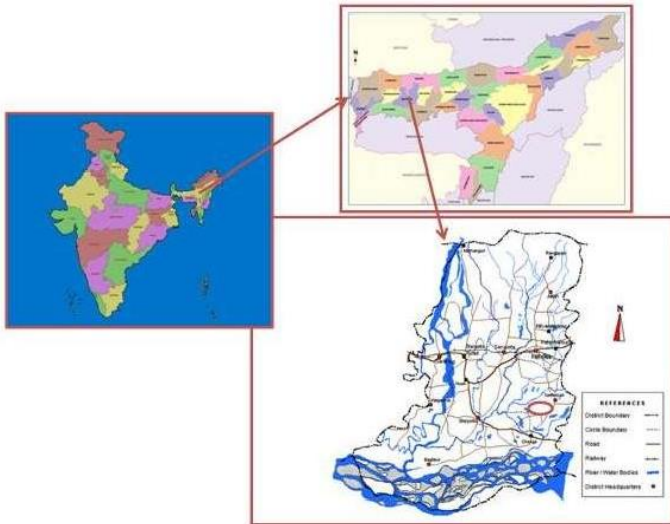


Fig. Map of Barpeta district of Assam showing the location of the Akara beel.

Results and Discussion

i) Diversity and density

A total of 4 orders, 8 families, 12 genera and 12 species of aquatic insects were recorded. The orders were Coleoptera, Hemiptera, Odonata and Ephemeroptera. The families were Coenagrionidae, Libellulidae, Baetidae, Gerridae, Corixidae, Hydrophilidae, Veliidae and Noteridae. (Table 1). Density and relative abundance of order Hemiptera was found highest in pre monsoon at DS2 and lowest and same density was recorded of the order Odonata at DS1 in monsoon and Coleoptera at DS2 in winter (Fig. 2 & 3). A study in the lower reach of Moirang River in Manipur, N.E. India also recorded high Hemiptera diversity and density [34]. This may be because of their ability to survive in water bodies with low levels of dissolved oxygen by utilizing atmospheric oxygen [35] and their broad range of habitats within a water body [36]. Hemipterans belonging to family Gerridae

were relatively abundant at DS2 in post monsoon and at DS1 in winter respectively (Fig 3). According to Engelmann’s Scale the eudominant species recorded were *Gerris lepcha* in post monsoon and *Microvelia plumbea* in monsoon. *Aquarius conformis* was found eudominant in post monsoon and winter seasons respectively [37] (Table 1). This is because during winter adults of Gerridae move to protected sites on land [38]. The causes of fluctuations in insect abundance and distribution include macroclimatic and micro climatic changes and variation in the availability of food resources[39, 40,41, 42, 43].

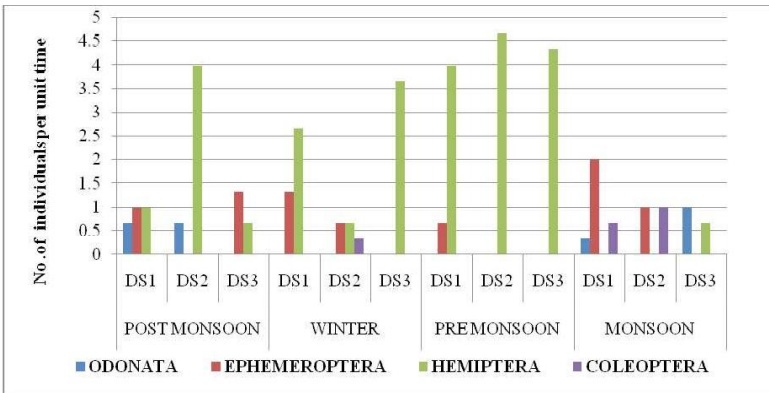


Fig. Seasonal variations in density (no. of ind/ unit time) of different orders of aquatic insects in three sites of Akara beel

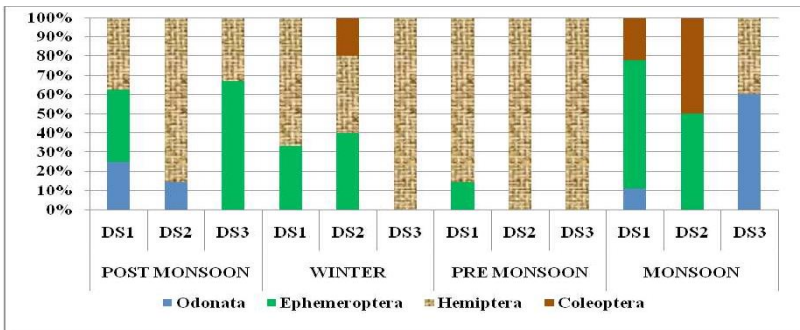


Fig. Seasonal variations in relative abundance (%) of different orders of aquatic insects in three sites of Akara beel

Table 1. Dominance status of different species of aquatic insect community found in Akara *bee* based on Engelmann's scale (1978). Relative Abundance < 1 % = Subrecent (SR); 1.1 - 3.1 % = Recedent (R); 3.2 - 10 % = Subdominant (SD); 10.1 - 31.6 % = Dominant (D), > 31.7 % = Eudominant (ED).

Order	Family	Taxa	Post monsoon			Winter			Pre monsoon			Monsoon			
			DS 1	DS 2	DS 3	DS 1	DS 2	DS 3	DS 1	DS 2	DS 3	DS 1	DS2	DS 3	
Odonata	Coenagrionidae	<i>Pseudagrion microcephalum</i> (Rambur, 1842)	25 D	7.1 4 SD	-	-	-	-	-	-	-	11.1 D	-	60 ED	
	Libellulidae	<i>Trithemis aurora</i> (Burmeister, 1839)	-	7.1 4 SD	-	-	-	-	-	-	-	-	-	-	
Ephemeroptera	Baetidae	<i>Cloeon inscriptum</i> (Bengtsson, 1914)	37.5 ED	-	66.6 7 ED	33.3 3 ED	40 ED	-	14.29 D	-	-	66.6 7 ED	50 ED	-	
Hemiptera	Gerridae	<i>Gerris lepcha</i> (Fabricius, 1794)	37.5 ED	35.7 1 ED	33.3 3 ED	16.6 D	-	-	21.4 3 D	14.29 D	-	-	-	-	
		<i>Aquarius confor-mis</i> (Uhler, 1878)	-	42.8 6 ED	-	50 ED	-	63.64 ED	35.7 ED	21.43 D	-	-	-	-	
	Corixidae	<i>Micronecta scutellaris</i> . (Kirkaldy, 1897)	-	7.1 4 SD	-	-	40 ED	36.36 ED	-	-	-	-	-	-	
	Vellidae	<i>Microvelia plumbea</i> (Westwood, 1834)	-	-	-	-	-	-	28.5 D	64.29 ED	46.15 ED	-	-	40 ED	
Coleoptera	Hydrophilidae	<i>Laccobius</i> sp. (Erichson, 1837)	-	-	-	-	20 D	-	-	-	-	-	-	-	
		<i>Cymbiodyta</i> sp. (Bedel, 1881)	-	-	-	-	-	-	-	-	-	-	-	16.6 7 D	
	<i>Phaenonotum</i> sp. (Sharp, 1882)	-	-	-	-	-	-	-	-	-	-	11.1 D	-	-	
	Noteridae	<i>Pronoterus</i> sp. (Sharp, 1882)	-	-	-	-	-	-	-	-	-	-	11.1 D	-	-
		<i>Suphisellus</i> sp. (Crotch, 1873)	-	-	-	-	-	-	-	-	-	-	-	33.3 3 ED	-

ii) Diversity indices

Diversity index can also be used to measure environmental stress [44]. The seasonal variations in the diversity indices of aquatic insects are presented in Table 2. The Shannon Weiner

Diversity Index was found to be maximum in pre-monsoon (0.58) and minimum in post monsoon (0.28). Maximum Berger-Parker Index of Dominance value in monsoon (0.67) indicated that the system was occupied by dominant species thus justified the lowest Shannon H' in that season. Evenness index was highest in post monsoon (0.99), which was near to 1.

Table. Seasonal variations of diversity indices of Akara beel during 2021-2022

Seasons	Shannon H' log Base 10			Evenness' J			Berger Parker Dominance(d)			Margaleff M base 10		
	DS1	DS2	DS3	DS1	DS2	DS3	DS 1	DS 2	DS3	DS1	DS2	DS3
Post monsoon	0.47	0.56	0.28	0.99	0.81	0.92	0.38	0.43	0.67	5.53	4.36	6.43
Winter	0.44	0.46	0.29	0.92	0.96	0.95	0.50	0.4	0.64	3.71	5.72	3.84
Pre monsoon	0.58	0.39	0.30	0.96	0.81	1.00	0.36	0.64	0.54	2.62	2.62	2.69
Monsoon	0.44	0.44	0.29	0.72	0.92	0.97	0.67	0.5	0.60	6.29	7.71	8.58

iii) Water parameters and correlation

Several factors are known to influence the distribution of aquatic macroinvertebrates but the important factors likely to affect the diversity and abundance in an aquatic ecosystem are water temperature, water velocity, nutrient availability etc. Ward and Standford also suggested that water flow, temperature and substrates are the major factors determining the composition and abundance of benthic invertebrates [45]. The water parameters such as WT, , pH, DO, F-CO₂, TA, EC, TDS, TH and Chloride were estimated in different seasons (Table 4). The range of pH between 6.07 and 6.98 is normally acceptable as per BIS [46] and WHO [47]. Although pH usually has no direct impact on consumers, it is one of the most important operational water quality parameters [48]

Alkalinity measures the various substances related to the basic property of water and high TA value is associated with poor quality of water. In the present study, the range of TA was found within the desirable limit of drinking water according to Indian Standard Specifications for Drinking Water (IS: 10500-1992) [49]. The ranges of PO_4^{3-} and NO_3^- were also found within desirable limit as per BIS [46] and WHO [47]. DO did not show much fluctuation and highest DO values were found in winter season. Similar DO values were recorded in River Ganga and Yamuna by several workers [50, 51].

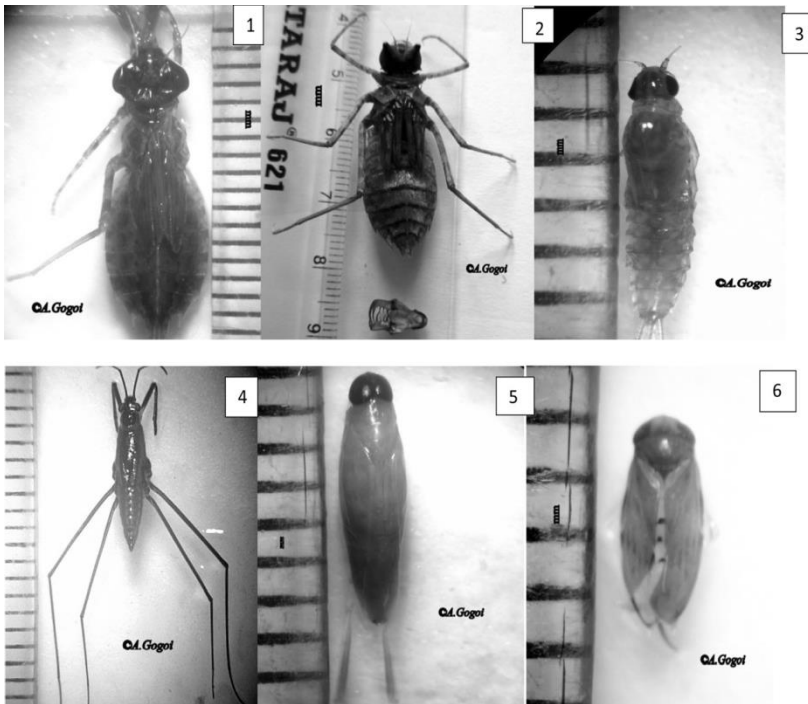


Plate 1: Images of some aquatic insects found in Akara beel during the study period (1. *Trithemis aurora* 2. *Cordulegaster* sp.3. *Cloeon inscriptum* 4. *Gerris lepcha* 5. *Anisops breddini* 6. *Micronecta scutellaries*)

4. Seasonal variations in physico-chemical parameters of water (Mean±SD) of Akara beel during 2021-22

	Post-monsoon, 2021					Winter, 2021					Pre-monsoon, 2022					Monsoon, 2022									
	DS1	DS2	DS3	Mean±SD	Mean±SD	DS1	DS2	DS3	Mean±SD	Mean±SD	DS1	DS2	DS3	Mean±SD	Mean±SD	DS1	DS2	DS3	Mean±SD	Mean±SD	DS1	DS2	DS3	Mean±SD	Mean±SD
WT (°C)	20.67 ±1.53	20.33 ±2.08	20.00 ±1.00	20.33 ±1.54	20.33 ±1.03	11.00 ±1.0	11.67 ±0.58	11.33 ±1.53	11.33 ±1.03	11.33 ±1.03	13.33 ±0.58	14.00 ±1.00	15.33 ±1.15	14.22 ±1.09	14.22 ±1.09	27.33 ±1.53	29.00 ±1.00	29.33 ±1.53	27.33 ±1.53	27.33 ±1.53	27.33 ±1.53	29.00 ±1.00	29.33 ±1.53	28.56 ±1.35	28.56 ±1.35
pH	6.67 ±0.15	6.73 ±0.12	6.80 ±0	6.73 ±0.09	6.70 ±0.21	6.50 ±0.26	6.93 ±0.15	6.67 ±0.21	6.70 ±0.21	6.07 ±0.12	6.07 ±0.12	6.87 ±0.06	6.98 ±0.07	6.64 ±0.08	6.64 ±0.08	6.13 ±0.10	6.30 ±0.10	6.50± 0.20	6.13 ±0.10	6.13 ±0.10	6.13 ±0.10	6.30 ±0.10	6.50± 0.20	6.31 ±0.17	6.31 ±0.17
EC (µS)	137 ±4.36	131 ±4.36	128.33 ±0.58	132.11 ±3.10	134.33 ±2.01	130.33 ±1.53	138 ±2.00	134.67 ±2.52	134.33 ±2.01	133 ±1	133 ±1	99.13 ±0.61	97.79 ±0.81	109.98 ±2.00	109.98 ±2.00	130 ±2.00	98.30 ±0.26	98.33 ±0.38	130 ±2.00	130 ±2.00	130 ±2.00	98.30 ±0.26	98.33 ±0.38	108.88 ±0.88	108.88 ±0.88
TDS (mg/L)	57.50 ±0.50	64.43 ±1.02	73.67 ±0.83	65.20 ±0.78	71.92 ±2.33	65.83 ±9.17	73.73 ±0.95	71.92 ±2.33	70.49 ±4.15	96 ±2.65	96 ±2.65	86.00 ±2.65	91.33 ±3.21	91.11 ±2.84	91.11 ±2.84	73.83 ±1.67	55.80 ±0.78	55.33 ±0.38	73.83 ±1.67	73.83 ±1.67	73.83 ±1.67	55.80 ±0.78	55.33 ±0.38	61.66 ±0.94	61.66 ±0.94
DO (mg/L)	4.90 ±0.20	4.47 ±0.30	5.12 ±0.41	4.83 ±0.31	6.11 ±0.52	5.97 ±0.91	6.19 ±0.48	6.17 ±0.16	6.11 ±0.52	10.30 ±1.31	10.30 ±1.31	11.17 ±1.27	10 ±0.70	10.49 ±1.09	10.49 ±1.09	6.40 ±0.81	6.45 ±0.28	6.65 ±0.61	6.40 ±0.81	6.40 ±0.81	6.40 ±0.81	6.45 ±0.28	6.65 ±0.61	6.50 ±0.56	6.50 ±0.56
F-CO2 (mg/L)	0.30 ±0.17	0.13 ±0.15	0.43 ±0.06	0.29 ±0.13	0.10 ±0.10	0.37 ±0.06	0.17 ±0.06	0.10 ±0.10	0.21 ±0.07	0.27 ±0.15	0.27 ±0.15	0.30 ±0	0.10 ±0	0.22 ±0.05	0.22 ±0.05	0.10±0. 10	0.07 ±0.06	0.23 ±0.06	0.10±0. 10	0.10±0. 10	0.10±0. 10	0.07 ±0.06	0.23 ±0.06	0.13 ±0.07	0.13 ±0.07
TA (mg/L)	46.33 ±2.34	42.62 ±1.47	43.00 ±0.56	43.98 ±1.46	45.48 ±1.82	50.12 ±1.14	50.16 ±1.98	45.48 ±1.82	48.58 ±1.64	30.00 ±1.00	30.00 ±1.00	33.00 ±2.65	32 ±1.00	31.67 ±1.55	31.67 ±1.55	46.57 ±2.91	46.87 ±1.68	44.47 ±1.86	46.57 ±2.91	46.57 ±2.91	46.57 ±2.91	46.87 ±1.68	44.47 ±1.86	45.97 ±2.15	45.97 ±2.15
TH (mg/L)	61.53 ±1.76	59.40 ±0.96	62.21 ±1.48	61.05 ±1.40	52.60 ±4.18	55.47 ±2.02	59.13 ±0.57	52.60 ±4.18	55.73 ±2.26	53.67 ±8.08	53.67 ±8.08	41.33 ±1.15	48.33 ±3.51	47.78 ±4.25	47.78 ±4.25	60.62 ±0.76	58.35 ±0.99	58.43 ±1.07	60.62 ±0.76	60.62 ±0.76	60.62 ±0.76	58.35 ±0.99	58.43 ±1.07	59.14 ±0.94	59.14 ±0.94
Calcium (mg/L)	18.33 ±1.15	16.33 ±1.53	17.33 ±1.53	17.33 ±1.40	16.33 ±1.15	16.00 ±1.00	17.33 ±1.15	16.33 ±1.15	16.56 ±1.10	15.67 ±0.58	15.67 ±0.58	15.67 ±1.53	13.67 ±2.52	15 ±1.54	15 ±1.54	17.00 ±1.00	11.33 ±0.58	14.00 ±2.00	17.00 ±1.00	17.00 ±1.00	17.00 ±1.00	11.33 ±0.58	14.00 ±2.00	14.11 ±1.19	14.11 ±1.19
Magnesium (mg/L)	43.20 ±2.16	43.07 ±2.06	44.88 ±1.85	43.71 ±2.02	36.15 ±3.65	39.47 ±2.25	41.80 ±1.41	36.15 ±3.65	39.14 ±2.44	38.00 ±7.81	38.00 ±7.81	25.67 ±2.52	34.67 ±5.51	32.78 ±5.28	32.78 ±5.28	43.62 ±1.70	47.02 ±1.56	44.43 ±1.93	43.62 ±1.70	43.62 ±1.70	43.62 ±1.70	47.02 ±1.56	44.43 ±1.93	45.02 ±1.73	45.02 ±1.73
Chloride (mg/L)	35.32 ±5.24	39.38 ±0.76	42.74 ±1.58	39.15 ±2.53	29.95 ±1.24	27.44 ±2.63	30.19 ±0.64	29.95 ±1.24	29.19 ±1.50	22.09 ±0.08	22.09 ±0.08	23.36 ±0.92	21.99 ±1.07	22.48 ±1.35	22.48 ±1.35	44.78 ±2.16	43.53 ±0.87	40.87 ±0.70	44.78 ±2.16	44.78 ±2.16	44.78 ±2.16	43.53 ±0.87	40.87 ±0.70	43.06 ±1.25	43.06 ±1.25

(WT= Water temperature, EC= Electrical Conductivity, TDS= Total Dissolve Solid, DO= Dissolve Oxygen, F-CO₂=Free Carbon dioxide TA= Total Alkalinity, TH=Total hardness)

Conclusion :

This is a preliminary study of aquatic insects at Akara *beel* of Barpeta district, Assam. A total of 12 species belonging to 12 genera, 8 families and 4 orders were recorded. A detail long term study might add some more species in the list of inventory. Hence a long term monitoring programme and use of variety of diversity and biotic indices might throw light on the health of the wetland and might influence the government policy of conservation of such other wetlands of the district.

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Ichthyofaunal Diversity and It's Conservation Status of Puthimari River of Kamrup District, Assam, India

Manoj Kumar Rajbongshi

Abstract

Puthimari river is an important north bank tributary of Brahmaputra river, lies between latitude 26°30'42"N and longitude 91°40'54"E. It flows from North to South through Baksa and Kamrup district. The present investigation was carried out in the Puthimari river during the year 2021-22 to document the ichthyofaunal diversity and conservation status of the fishes. The study revealed the presence of 74 species belonging to 27 families, 10 orders and 54 genera. Out of 27 families, Cyprinidae is highly dominant family representing 25 individual fish species, followed by Bagridae with 7 species and Channidae with 5 species. Mastacembalidae and Osphronemidae were 3 species in each. The conservation statuses of the fishes were also evaluated based on the IUCN. Among the identified species of fishes, 64 species were found as least concern (LC), 4 species were found as nearly threatened (NT), 5 species were found as vulnerable (VU) and 1 species was found as endangered (EN).

Keywords : *Puthimari river, Kamrup, ichthyofaunal diversity, conservation status.*

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Introduction :

India is a biodiversity rich country where different types of fish species present along with other species. There are different small and big rivers, lakes, streams, ponds, reservoirs in India as a habitat for different ichthyofauna. The North East regions of India have a good rank for its fish diversity. Among other vertebrates, fishes are the most ancient and most numerous forms. The Brahmaputra drainage system is one of the richest sources of fresh water ichthyofauna in India. The North-eastern part of India is gifted variety of fresh water habitats mainly in the form of mighty Brahmaputra and its major tributaries.

Puthimari river is an important north bank tributary of Brahmaputra river. Puthimari river lies between latitude 26°30'42"N and longitude 91°40'54"E. It flows from North to South through Baksa and Kamrup district. It is originated from the Himalayan mountain, south of the Bhutan range as two separate hill stream river- Lokhaitora and Suklai river. The upper part of the river supports the habitat of the hill stream fishes and lower part of the river falls within the plain regions. Extensive scientific study from the fishery point of view has not made till now in Puthimari river. Therefore the present investigation was carried out in the Puthimari river to document the fish diversity and conservation status of the fishes.

Materials and Methods

Study area

The present investigation was conducted during the period December, 2021 to June, 2022 in Puthimari river. The survey was conducted in four different sites of Puthimari river namely Suagpur (S1), Bagribari (S2), Puthimari (S3), Ketekibari (S4).

Each site is selected according to different physiochemical nature of water. The distance between each site is 15kms. The sites are as-

<i>Sl.no</i>	<i>Sites</i>	<i>Latitude and longitude</i>
1	Suagpur region	26°40'23.343 N and 91°41'30.3 E
2	Bagribari region	26°30'23.303 N and 91°40'23' E
3	Puthimari region	26°21'23.593 N and 91°39'30.3 E
4	Ketekibari region	26°16'23.133 N and 91°31'30.3 E

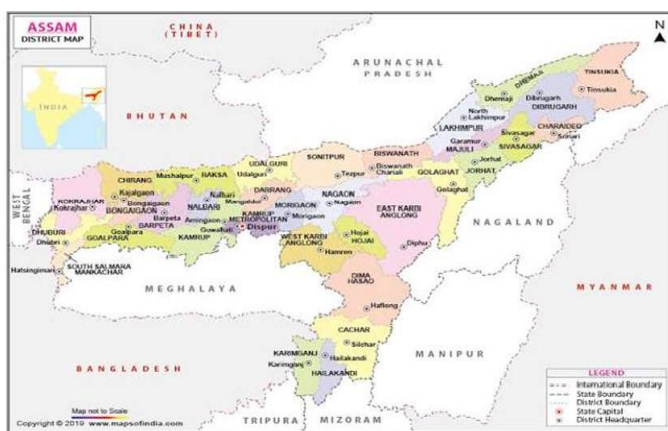


Fig. Locational map of study areas (source: google map)

Data collection, identification and preservation

The data were collected in early morning and late evening from the fish landing sites in a day. Fishes were caught by using different types of nets as gill nets, cast nets, drag nets, bamboo traps and angling with aid of local fisherman. As far as possible, the fish specimens were identified in the field itself. Collected specimens that could not be identified in the field were preserved in 10% formaldehyde solution and were brought to the fishery science laboratory of Bhattadev University, Bajali and were

identified following different literature like Talwar and Jhingran (1991) and Jayaram (2010).

Results and Discussion :

During the study period, 74 fish species were recorded from the Puthimari river belonging to 54 genera, 27 families and 10 orders (table:1). The recorded 10 orders comprised of Osteoglossiformes, Clupeiformes, Cypriniformes, Siluriformes, Beloniformes, Cyprinodontiformes, Synbranchiformes, Perciformes, Mugiliformes and Tetradontiformes. Among orders, Siluriformes contributed 9 families, Perciformes contributed 7 families, Cypriniformes contributed 3 families, Synbranchiformes contributed 2 families, Osteoglossiformes, Clupeiformes, Beloniformes, Cyprinodontiformes, Perciformes, Mugiliformes and Tetradontiformes contributed 1 family in each. Out of 27 families, Cyprinidae is highly dominant family representing 25 individual fish species, followed by Bagridae with 7 species and Channidae with 5 species. Mastacembalidae and Osphronemidae were 3 species in each. Nine families namely, Notopteridae, Botiidae, Cobitidae, Siluridae, Schilbeidae, Sisoridae, Erethistidae, Ambassidae and Nandidae were 2 species respectively. Thirteen families, namely, Clupeidae, Ailiidae, Pangasiidae, Clariidae, Heteropneustidae, Belonidae, Aplocheilidae, Synbranchidae, Gobiidae, Anabantidae, Cichlidae, Mugilidae and tetraodontidae were 1 species in each.

The conservation status of the ichthyofauna from the present study revealed that 64 species were under Least Concern (LC), 4 fish species were Near Threatened (NT), 5 species were Endangered (EN) and vulnerable (VU) was represented by 1 fish species as per IUCN list of threaten species.

Talukdar and Rajbongshi (2018) have carried out work on ichthyofaunal diversity of Puthimari beel of, Barpeta district and recorded 46 indigenous fish species belonging to 37 genera, 8 orders and 19 families. According to Kalita and Sarma (2015), ichthyofaunal diversity of Beki river of Barpeta, Assam and recorded 114 species belonging to 73 genera, 31 families and 11 orders. Kalita, Talukdar and Das (2022) have carried out work on ichthyofaunal diversity of Barnadi river of Darrang district, Assam and recorded 40 species belonging to 33 genera under 7 orders and 19 families.

Table.1: Fish fauna and conservation status of fish species of Puthimari river.

Sl. no	Order	Family	Species	Abundance in 4 sites				IUCN status
				S1	S2	S3	S4	
1	Osteoglossiformes	Notopteridae	<i>Chitala chitala</i> (Hamilton, 1822)	-	-	+	+	NT
2			<i>Notopterus notopterus</i> (Pallas, 1769)	-	+	+	+	LC
3	Clupeiformes	Clupeidae	<i>Gudusia chapra</i> (Hamilton, 1822)	-	-	+	+	LC
4	Cypriniformes	Cyprinidae	<i>Amblypharyngodon mola</i> (Hamilton, 1822)	-	+	+	+	LC
5			<i>Barilius barila</i> (Hamilton, 1822)	-	+	-	-	LC
6			<i>Barilius bendelisis</i> (Hamilton, 1807)	-	+	-	-	LC
7			<i>Cabdio morar</i> (Hamilton, 1822)	-	+	+	+	LC
8			<i>Gibelion catla</i> (Hamilton, 1822)	-	-	+	+	LC
9			<i>Cirrhinus mrigala</i> (Hamilton, 1822)	-	+	+	+	LC
10			<i>Cirrhinus reba</i> (Hamilton, 1822)	-	+	+	+	LC
11			<i>Ctenopharyngodon idella</i> (valenciennes, 1844)	-	-	+	+	LC

12		<i>Cyprinus carpio</i> (Linnaeus, 1758)	-	-	+	+	VU
13		<i>Danio rerio</i> (Hamilton, 1822)	-	+	+	+	LC
14		<i>Devario devario</i> (Hamilton, 1822)	-	+	+	+	LC
15		<i>Esomus danrica</i> (Hamilton, 1822)	-	-	+	+	LC
16		<i>Garra annandalei</i> (Hora, 1921)	+	-	-	-	LC
17		<i>Hypophthalmichthys molitrix</i> (Cuvier and Valenciennes, 1844)	-	-	+	+	NT
18		<i>Labeo bata</i> (Hamilton, 1822)	-	+	+	+	LC
19		<i>Labeo calbasu</i> (Hamilton, 1822)	-	-	+	+	LC
20		<i>Labeo gonius</i> (Hamilton, 1822)	-	-	+	+	LC
21		<i>Labeo rohita</i> (Hamilton, 1822)	-	-	+	+	LC
22		<i>Laubuca laubuca</i> (Hamilton, 1822)	-	+	+	-	LC
23		<i>Pethia conchonius</i> (Hamilton, 1822)	-	-	+	+	LC
24		<i>Pethia ticto</i> (Hamilton, 1822)	-	+	+	+	LC
25		<i>Puntius sophore</i> (Hamilton, 1822)	-	+	+	+	LC
26		<i>Rasbora daniconius</i> (Hamilton, 1822)	-	+	+	+	LC
27		<i>Rasbora rasbora</i> (Hamilton, 1822)	-	+	+	+	LC
28		<i>Salmostoma bacaila</i> (Hamilton, 1822)	-	-	+	+	LC
29	Botiidae	<i>Botia dario</i> (Hamilton, 1822)	-	+	+	-	LC
30		<i>Botia rostrata</i> (Gunther, 1868)	-	+	+	-	VU
31	Cobitidae	<i>Lepidocephalichthys guntea</i> (Hamilton, 1822)	-	+	+	+	LC

32		<i>Lepidocephalichthys annandalei</i> (Chaudhuri, 1912)	-	+	+	-	LC	
33	Siluriformes	Bagridae	<i>Mystus bleekeri</i> (Day, 1877)	-	+	+	+	LC
34			<i>Mystus cavasius</i> (Hamilton, 1822)	-	+	+	-	LC
35			<i>Mystus vittatus</i> (Bloch, 1794)	-	-	+	+	LC
36			<i>Mystus tengara</i> (Hamilton, 1822)	-	-	+	+	LC
37			<i>Sperata aor</i> (Hamilton, 1822)	-	+	+	-	LC
38			<i>Sperata seenghala</i> (Sykes, 1839)	-	-	+	+	LC
39			<i>Rita rita</i> (Hamilton, 1822)	-	-	+	+	LC
40		Siluridae	<i>Ompok pabda</i> (Hamilton, 1822)	-	-	+	+	NT
41			<i>Wallago attu</i> (Bloch and Schneider, 1801)	-	-	+	+	VU
42		Schilbeidae	<i>Eutropiichthys vacha</i> (Hamilton, 1822)	-	-	+	+	LC
43			<i>Clupisoma garua</i> (Hamilton, 1822)	-	+	+	+	LC
44		Ailiidae	<i>Ailia coila</i> (Hamilton, 1822)	-	-	+	-	NT
45		Sisoridae	<i>Bagarius bagarius</i> (Hamilton, 1822)	+	-	-	-	VU
46			<i>Gagata cenia</i> (Hamilton, 1822)	+	+	-	-	LC
47		Erethistidae	<i>Hara hara</i> (Hamilton, 1822)	+	-	-	-	LC
48			<i>Erethistes pusillus</i> (Muller & Troschel, 1849)	+	-	-	-	LC
49		Pangasiidae	<i>Pangasius pangasius</i> (Hamilton, 1822)	-	-	-	+	LC
50		Clariidae	<i>Clarias magur</i> (Linnaeus, 1758)	-	-	+	+	EN
51		Heteropneustidae	<i>Heteropneustes fossilis</i>	-	-	-	-	LC
+	+							

		(Bloch, 1794)						
52	Beloniformes	Belonidae	<i>Xenentodon cancila</i> (Hamilton, 1822)	-	-	+	+	LC
53	Cyprino- dontiiformes	Aplocheilidae	<i>Aplocheilus panchax</i> (Hamilton, 1822)	-	+	+	+	LC
54	Synbran- chiformes	Mastacem- belidae	<i>Macrogathus aral</i> (Bloch & J. G Schneider, 1801)	-	+	+	+	LC
55			<i>Macrogathus pancalus</i> (Hamilton, 1822)	-	+	+	+	LC
56			<i>Mastacembelus armatus</i> (Lacepede, 1800)	-	+	+	+	LC
57		Synbranchidae	<i>Monopterusuchia</i> (Hamilton, 1822)	-	-	+	+	LC
58	Perciformes	Ambassidae	<i>Chanda nama</i> (Hamilton, 1822)	-	+	+	+	LC
59			<i>Parambassis ranga</i> (Hamilton, 1822)	-	-	+	+	LC
60		Nandidae	<i>Badis badis</i> (Hamilton, 1822)	-	-	+	+	LC
61			<i>Nandus nandus</i> (Hamilton, 1822)	-	-	+	+	LC
62		Gobiidae	<i>Glossogobius giuris</i> (Hamilton, 1822)	-	+	+	-	LC
63		Channidae	<i>Channa gachua</i> (Hamilton, 1822)	-	+	+	+	LC
64			<i>Channa marulius</i> (Hamilton, 1822)	-	-	+	+	LC
65			<i>Channa punctatus</i> (Bloch, 1793)	-	+	+	+	LC
66			<i>Channa striatus</i> (Bloch, 1793)	-	+	+	+	LC
67			<i>Channa stewartii</i> (Playfair, 1867)	-	+	+	+	LC
68		Anabantidae	<i>Anabas testudineus</i> (Bloch, 1793)	-	+	+	+	LC
69		Osphronemidae	<i>Trichogaster lalius</i> (Bloch and Schneider, 1801)	-	+	+	+	LC
70			<i>Trichogaster fasciata</i> (Bloch and Schneider, 1801)	-	+	+	+	LC
71			<i>Trichogaster labiosa</i> (Day, 1877)	-	+	+	+	LC

72	Cichlidae	<i>Oreochromis mossambica</i> (W.K.H. Peters, 1852)	-	-	+	+	VU	
73	Mugiliformes	Mugilidae	<i>Rhinomugil corsula</i> (Hamilton, 1822)	-	-	-	+	LC
74	Tetradon- tiformes	Tetraodontidae	<i>Leiodon cutcutia</i> (Hamilton, 1822)	-	+	+	-	LC

Note: Conservation status: LC: Least Concern, NT: Near Threatened, EN: Endangered, VU: vulnerable, ‘+’: Present, ‘-’: Absence.

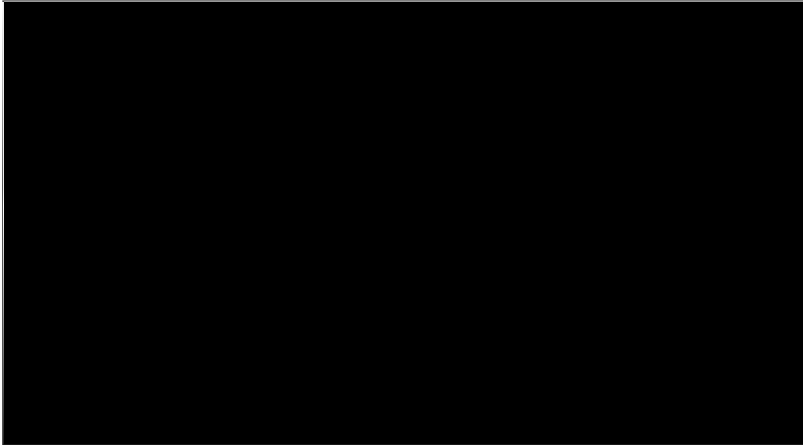


Fig. Numbers of fish family, genus and species under different orders.

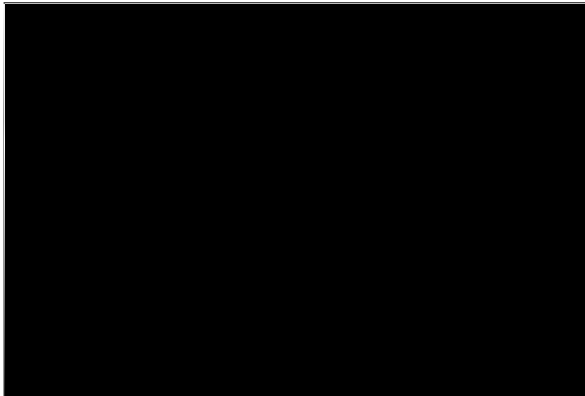


Fig. IUCN conservation status of fish fauna shown in pie diagram.

Conclusion :

The present investigation represented a rich ichthyofaunal diversity in Puthimari river. But the ichthyofaunal diversity of this river suffered a lot due to different factors caused by human including habitat degradation, pollution and irrational fishing. All species of fishes should be conserved, but it is impossible to identify which species of fish is threatened or critically threatened in selective part of river. So, different conservation scheme and regular scientific research will improve the ichthyofaunal production to be more sustainable and easy to maintain diversity.

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Studies on Butterfly Diversity and Conservation Biology in Kamrup District of Assam

Prativa Deka

Abstract

International union for conservation Nature and natural resources (IUCN) formulated an action plan for the conservation of butterflies throughout the world giving priority to some endangered species of this group. Considering the importance of this group from their status, aesthetic value, ecological importance, trade value habitat sensitiveness and the study area being a part of biodiversity hot spot of North-East India, The present study was conducted. The study area is located at 26 degree 11 inch N latitude 91 degree 45 inch E longitude with an altitude of 50 to 60 m above the sea level. It is situated in the Brahmaputra valley, Covering an area of this 473380 hectares, which is characterized by plain and hilly forest. From the survey ,it was observed that some species of butterflies found during my studies at Rani of Kamrup District. Being a Biodiversity hot spot, this part of the Country has immense potential & Scope of eco-tourism by developing “Butterfly parks’ and pursuing Butterfly watching a hobby like bird watching which will again contribute towards conservation and to protect their role & utility in ecological balance.

Key words : *Butterfly , Bio – indicator , Bio diversity , Trade , Conservation .*

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Introduction :

Butterflies, the fragile winged insects on the earth are the most beautiful & colourful creatures, They are found in a variety of habitats and hold an important place in the web of life supporting system. Being closely associated with plant life, butterflies are good bio indicators and serve to monitor ecological change in habitat and against deteriorating environment. Loss of habitat & ecological changes are the major threats to butterflies including other wild life. To initiate a conservation programme for these Insects, detailed study of their taxonomy, life histories and the factors governing their survival is very much Important. The present study is an extensive preliminary work on the diversity of butterflies, its role in bio monitoring and factors effecting to their survival in Kamrup district.

Insects are some of the most interesting and highly diversified creature of the world. There are about 15,000 species of butterflies in India that vary greatly in colour, habit and size. Butterflies are fragile winged insects on the earth are the most beautiful and colourful creatures belonging to the phylum Arthropoda. They are found in a variety of habitats and hold an important place in the web life supporting system. Being closely associated with indicators they monitor ecological change in habitat, losses of habitat, ecological changes are the major threats to butterflies including other wild life, To initiate a conservation programme for these insects, detailed study of their taxonomy life histories and the factors governing their survival is very much important. Most of the species of butterflies are diurnal, however, some of them are nocturnal, most of the species are sun hovers and enjoy a gambol in the open meadows. Some are forest dwellers preferring woodlands edges and few hover over flower. Each species has its favourite flying time. Their

style at flight is very peculiar flying in zigzag motion. In straight same flies like gliding and swipping, Female butterflies are very good botanists. Their identification of plants is based on both visual clues as well as chemical clues. Butterflies are found in a variety of habitats from the traffic island gardens in the middle of the busy roads to verdant forest, Like other insects, they hold an important part of the ecological specialization of butterfly, apart from their role in effecting crass pollination off flowers plants provided both larval and adults food through leaves and flowers and in turn butterfly takes a part in seasonal cross pollication. Butterflies are predominately tropical but a few species extend as far as cold temperature latitudes in both hemisphere (Talbot, 1939), Few species are wide spread and same have extremely limited distribution. Again many species are wide spread, and same have extremely limited distribution. Again many species have very restricred geographical distribution (Mani, 1986), The structural characteristics of these butterflies are very much ideal from the taxonomic view point (parsons, 1984) According to collies & Morris (1985) 107 species urgently need conservation out of 573 species of swallow tail butterflies have so far been identified. According to very old information (Evans, 1932 and Talbot, 1939), Out of total number of 105 species of butterfly found in kamrup district. The North Eastern region is known as one of the important biodiversity hot spots.

Materials and Methods :

The Study area is confined of Kamrup District of Assam which is located within the geographic limits of longitudes 91 degree E to 91 degree 58 inch E and latitudes 24 degree 41 inch N to 26 degree 46 inch N with and altitude of 50-60 m above the sea level. Total geographical area is 473380 hectares out of which 117260 hectares is forested area i.e. 24.77%. The study area

occupies a unique position amidst complex geologic and physiographic make up at the Assam State. It is bordered on the East by Morigaon District, on the south by the Meghalaya hilly ranges, on the west by Nalbari and on the North by Darrang District. The study area is situated in the Brahmaputra Valley and is characterized by several hilly areas along with some hillocks surrounded by agricultural land. The mighty river Brahmaputra passing through the middle of the study area and several tributaries from different hills contributed in it. Several small hills and hillocks in giving a unique physiographic appearance to the study area. The presence of numerous marshy lands, wetlands, ponds, lakes, beals give the area agroecological value. On the North bank the flood plain numerous swamps and beals and is fairly wide on kamrup District. Kamrup District has widely differing habitats. Each habitat is unique by its characteristic forest pattern in relation to physiographic appearance. The district covers approximately an area of 473380 hectares and more than 60 reserve forests were selected for ecological survey. These reserve forest areas were Garbhanga, Rani, Mandakata and Hajo reserve forests.

Methods :

Equipments and Methods of Butterfly collection :

First phase of survey was conducted for the collection of butterflies throughout the kamrup district covering an area of 473380 hectares. The survey was conducted according to pollard (1975), southern land (1997), Baihaum et al (1980-81).

During Collection bait also used. The bait was prepared by country liquor and ripe bananas. A mixture paste was prepared and placed along the forest path. The odor from the mixture was found to attract the butterfly species. The butterflies were caught during resting period and in the flying condition. The net was

used in a sweeping manner to easy entrance of the butterfly in to the net. At the moment of netting the shadow of the net was avoided as far as possible. The species inside the the net was caught between the thumb and index on the thorax to stop it fluttering in order to avoid the loss of scales. Out side the net insects were given a mild pressure on thorax there by the insects wing be come quite wide. The collected butterflies were carried to the laboratory putting them in some paper fold of various sizes and made up with soft paper. Again some butterflies were collected after rearing them form larval stage to adult stage in the laboratory. For rearing culture cage was used and fresh host plants leaves were supplied.

Mounting and Spreading

The collected butterflies were placed in a spreading board keeping the head wings, legs and abdomen properly visible. Before placing on spreding board butterflies were pinned through the middle at thorax without causing no damage to outer parts. The pin was inserted vertically in such away that the front part of body remain slightly raised.

Preservation :

Benzene solution was used as preservative. It was pushed in to the thorax and abdomen at the insect during the time of spreading.

Preservation and Storage:

The dried butterflies in the spreading board were transferred to the insect boxes. The boxes were cleaned with spirit and kept for some time in the sunlight. Inside the insect boxes were fitted with glass. For easy observation from outside insect boxes were allowed to dry in the sunlight once a week, to prevent bacterial attack.

Identification of Butterflies :

Identification were done according to Talbot (1939), Evans (1932), Winter Blyth (1957), Burton (1998), Varshely & Chanda (1971), Godden, Mair (1972), Mani (1986), Carter (1992), Haribal (1992) and Bingham (1905-07). Most of the species were identified by consulting literature, pictures, keys and direct comparison.

Results and Discussion :

The present study on conservation biology of butterflies in the prevailing ecological condition revealed that butterflies are the majestic jewels of nature. Their body language attracts the attention of all kinds of people right from layman to ecologist presently a few species of this group has been surviving in natural habitat within the forest of kamrup district. The floristic wealth of this area still has chances to harbour these butterflies with warm humid climate uptill now 157 species are found to be distributed amongst the forest area related with life supporting food plants. Both climate and veretation were found suitable for this group in the study area and their roll in the propagation of floristic diversity through pollination can not be denied. In the international market these insects have high demand both in dead and live state, but according to IUCN the entire group is now risk. From the present study it becomes clear that these species are not ecologically important as pollinator and environmental indicator , but equally important from economic point of view, Again their early stages deal with some plants, which have been proved to be high Medicinal importance. Due to ignorance and lack of interest are these invertebrates, human beings are causing serious habitat problems for them. At present tremendous expansion of human population in every nook and corner including hilly ranges, their natural habitats are declining day

by day. If the present situation prevails for a long time majority of the species of this group may disappear from the earth considering the suitable habitat criteria and survival problems. Importance of butterflies in forest ecosystem should be brought to the knowledge of people. Their role in propagation of forest resources should be understood. From the study within Kamrup district it has been found that Rani Reserve Forest has maximum diversity of butterflies. The topographic appearances, vegetation diversity and water resources from hilly streams created a fine warm humid climate, which is essential for butterflies. Butterfly farming and Breeding techniques are to be introduced to multiply more and more species especially those that are at risk. Woodland habitats are essential for butterflies in order to keep their body during sunny days. These types of forest should be maintained soil erosion in the hilly slopes must be minimized and proper vegetational cover should be maintained. Any developmental activities in the hills particularly where disturbance to the hill structure can be caused, should be done with care and considering the environmental needs.

Conclusion :

International Union for Conservation Nature and Natural Resources (IUCN) formulated an action plan for the conservation of butterflies throughout the world giving priority to some endangered species of this group. Considering the importance of this group from their status, aesthetic value, ecological importance, trade value habitat sensitivity and the study area being a part of biodiversity hot spot of North –East India, the present study was conducted. It has been found that to protect these species in their natural habitat, study of natural behaviour and life cycle is very necessary. Present study revealed that for better survival of these delicate creatures, the larval food plants and flowering plants for adults nutrients are equally necessary.

A habitat with tall three canopy and adequate water resources maintains the proper humidity level, which was found to be most essential in their every day life process. Survival of these species were found to be possible only by farming with sufficient knowledge and educating the common people to realize the need of these jewels of nature.

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Present Status of Macrophyte Diversity and their Economic Utilization of Bhalukmara Beel of Nalbari District, Assam, India

Manmi Kalita

Abstract :

The current study focused on the documenting of macrophytes from Bhalukmara beel (wetland) of Nalbari district, Assam. Macrophytes survey was conducted in beel for the period of one year and recorded the presence of 47 macrophytic species belonging to 26 families. Out of 26 families, Amaranthaceae and Hydrocharitaceae were most dominant families with 4 species in each followed by Pontederiaceae, Nympheaceae, Araceae, Alismataceae and Lemnaceae with 3 species respectively. Many free floating (FF), submerged suspended (SS), submerged anchored (SA), rooted with floating leaved (RFL), emergent anchored (EA), swampy and marshy (SM) have been observed. Among various ecological groups, swampy and marshy species showed the largest number with 12 species (26%) followed by emergent anchored with 10 species (21%), rooted with floating leaved with 9 species (19%), submerged anchored with 8 species (17%), free floating with 6 species (13%) and submerged suspended with 2 species (4%).

Keywords : *Macrophytes, Bhalukmara beel, Nalbari, Amaranthaceae.*

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Introduction :

The Northeast India is blessed with a wide range of physiography and ecoclimatic conditions with varied type of water resources in the form of rivers (19,150 Km), reservoirs (23,792 ha); beels, lakes and swamps (143,740 ha); ponds and mini barrage (40,808 ha) and low laying paddy cum fish culture systems (2,780 ha) (Mahanta *et al.*, 2003). The wetlands are reservoirs of much biologically diverse vegetation, aquatic macrophytes being one of them. Aquatic macrophytes refer to the macroscopic plants like angiosperms, ferns, mosses, liverworts, and some freshwater macro-algae that occur seasonally or permanently in wet environments (Chamber *et al.*, 2007).

Macrophytes found in aquatic ecosystem are known as hydrophytes, and provide an optimal environment for the colonization of different types of macrophytes with tremendous ecological significances and thus furnishes numerous ecosystem services besides being the respiratory of many other specific ecosystems (Meena *et al.*, 2016). Macrophytes are the important component of the aquatic ecosystem and contributed to primary productivity of the aquatic ecosystem. The aquatic plants are considered as source of multipurpose raw materials for food, foods, medicinal, ornamental, natural fertilizer, water purifier, rituals, dye and other economic purposes directly and indirectly by surrounded people (Saharia *et al.*, 2010). The aim of the present study is to document the macrophytes diversity, habit, life span , life form and economic utilization of macrophytes.

Materials and Methodology :

Study area

Bhalukmari beel (wetland) is situated in Niz Namati under Nalbari district of lower Assam covering an area of 75 bigha (approximately) at present. It is almost 5 km far in the northern side from Tihu town.

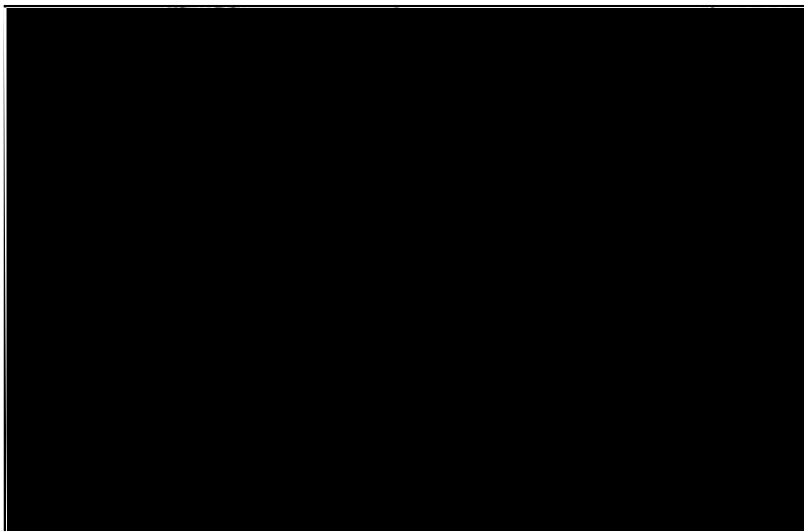


Fig. locational map of study area (source:google map).

Data collection, identification and preservation

An extensive survey was made on macrophytes by visiting the beel in 2022-2023. Different data and information were recorded about macrophytes among fringe villager with the help of structure format of questionnaires. Macrophytes were collected to the Department of Botany, Bhattadev University, Bajali and were identified with the help of literature Kangilal (1991).

Results and Discussion :

During the present study, 47 macrophytic species belonging to 26 families have been reported from the Bhalukmara beel. Among families, Amaranthaceae and Hydrocharitaceae were most dominant families with 4 species in each followed by Pontederiaceae, Nympheaceae, Araceae, Alismataceae and Lemnaceae with 3 species respectively. Five families namely Convolvulaceae, Poaceae, Cyperaceae, Polygonaceae and Trapaceae were 2 species in each. Fourteen families namely, Apiaceae, Araliaceae, Azollaceae, Salviniaceae, Onagraceae, Perkariaceae, Asteraceae, Apocynaveae Ceratophyllaceae, Najadaceae, Oxalidaceae, Typhaceae, Potamogetonaceae and Lentibulariaceae were 1 species in each.

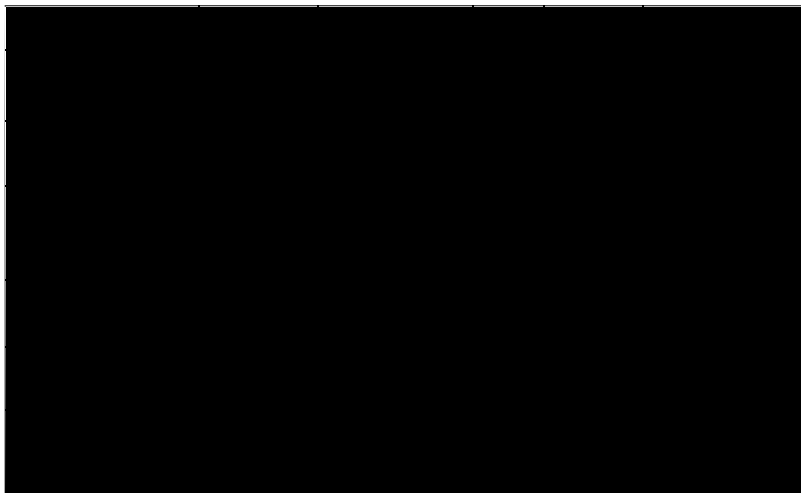
The macrophyte species were categorized into six categories such as free floating (FF), submerged suspended (SS), submerged anchored (SA), rooted with floating leaved (RFL), emergent anchored (EA), swampy and marshy (SM) following the system of Weaver and Clement (1929) and Daubenmire (1947). In terms of number of macrophyte species, swampy and marshy species showed the largest number with 12 species (26%) followed by emergent anchored, with 10 species (21%), rooted with floating leaved with 9 species (19%), submerged anchored with 8 species (17%), free floating with 6 species (13%) and submerged suspended with 2 species (4%).

According to Deka and Sarma (2014), 137 macrophytic species belonging to 114 genera and 53 families had been reported from the wetlands of Nalbari district of Assam India. According to Saikia (2013), 62 macrophyte species of 51 genera under 30 families have been recorded from the wetlands of Hojai Sub Division, Nagaon District. According to Dutta, Deka and

Rabha (2014), 68 plant species belonging to 49 genus and 28 families were recorded from the Kapla wetland of Barpeta district, Assam, India. Kalita, Talukdar and Sarma recorded 60 number of aquatic flora in 2022 from the Botha wetland. Deka, Dutta and Talukdar (2019) had carried out survey work on medicinal plants of the wetlands of the western Assam and recorded 31 species of medicinal plants belonging to 25 genera and 14 families. Choudhury (2020) surveyed the wetlands of the Barpeta district, Assam, North east india for documentation of aquatic and terrestrial plants and to identify the ethno medicinal plants out of those plant. The survey revealed that there are 85 species of plant belonging to 40 families from the study area. Out of 85 species 71 plants had been as ethno medicine for treating different disease by the surrounding village health practitioners.

List of macrophytes diversity, habit, life span and economic values

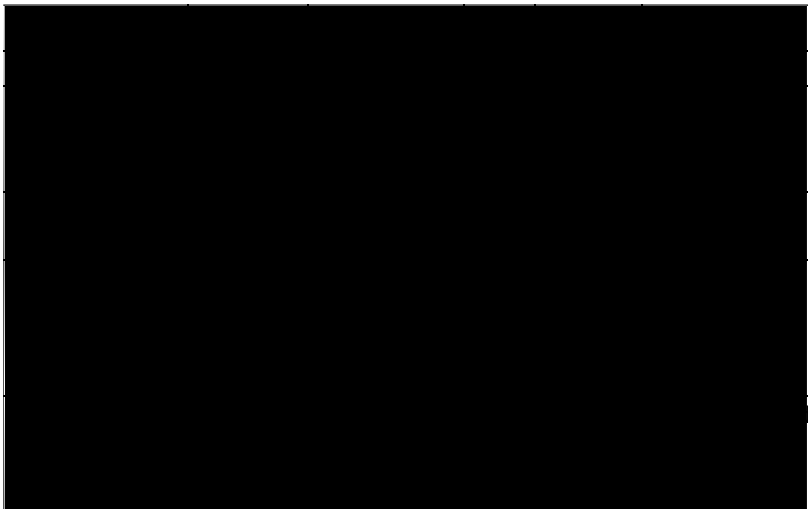
A. Free Floating hydrophytes



B. Rooted hydrophytes with Floating Leaved

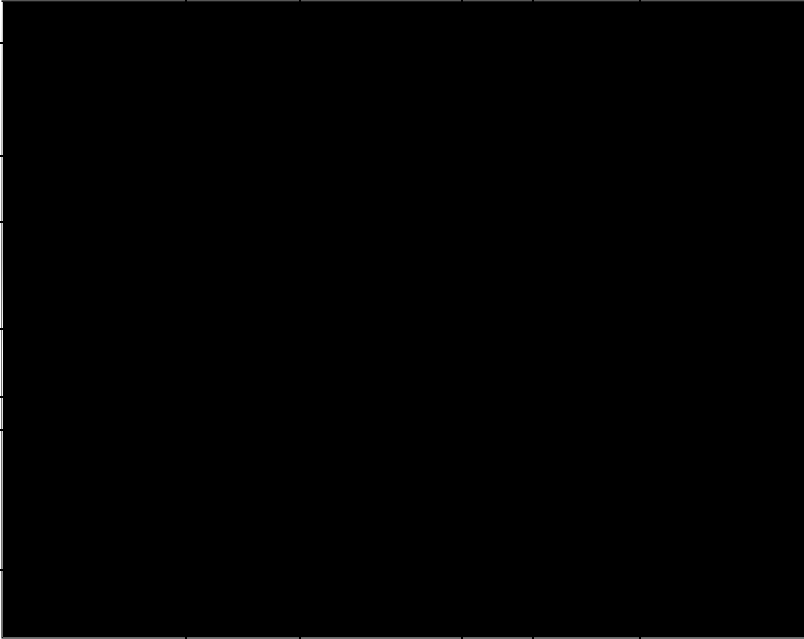


C. Swampy and Marshy hydrophytes



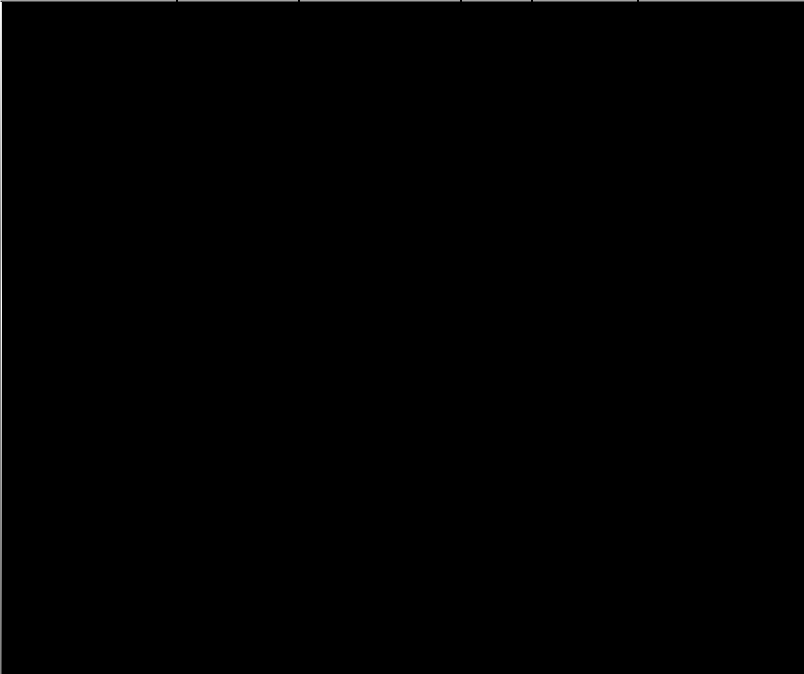


D. Emergent Anchored hydrophytes





E. Submerged Anchored hydrophytes



F. Submerged Suspended hydrophytes

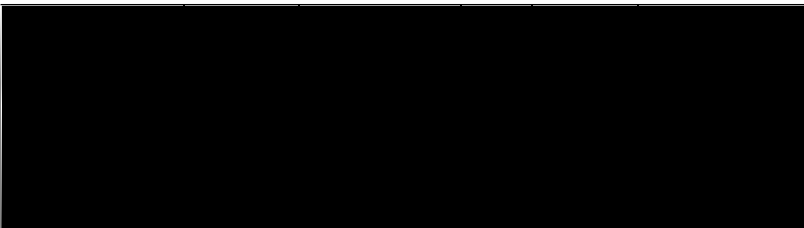




Fig. Pie diagram showing the composition of life form of macrophytes of Bhalukmari beel.

Conclusion :

On the analysis of relevant data it may come into conclusion that the anthropogenic interferences due to lack of awareness among the fringe villagers about the protection and conservation of environment, ichthyo-diversity of different species as well as the negligence of the competent authority without any suitable scheme of management are the main causes of degradation of the important aquatic bodies. All the factors should be analysed properly by the Govt, NGO and local bodies, providing practicable and scientific measures for the sustainability of the important aquatic ecosystem to raise the economy of the society.

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Study on Farmer's Cultivating Practices, Phenotypic Characteristics and Nutritive Values of three native paddy (*Oryza sativa*) varieties of Assam, India

Gautam Baishya

Abstract:

Assam is traditionally a rice-growing area, and the variation in micro-climate across the state has resulted in the evolution of a large number of indigenous rice varieties not found anywhere else in the world. Assam is one of the seven states of northeast India, which is located between 24°N and 28°18'N latitudes and 89°04'E and 96°00'E longitudes. As a biodiversity hotspot in North Eastern States, the crop has enormous diversity in the region, which has resulted due to highly variable rice growing ecosystems. Besides, the region is inhabited by a large number of ethnic groups whose preference also varies from one another. All these factors are responsible for evolution of a large number of varieties in the region. Most of these have been in use from time immemorial with traditional method of preparation. So Rice plays a pivotal role in the socio-cultural life of the people of the state.

In the present study, four indigenous rice varieties namely Phulpakhari, Kunkuni Joha and Tulsijoha have been selected for study of cultivating practices with Phenotypic characteristics and nutritive value. Thus, the study clearly showed that these indigenous rice varieties are not only traditionally important but also a good source of nutrients.

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Keywords: *Assam, Indigenous rice varieties, Phenotypic Character, cultivating practices, Nutritive value, Native paddy, Bio-diversity.*

Introduction:

Rice is a staple food of people living in our mother earth. It is roughly estimated that more than 30000 indigenous varieties of rice were grown in the past in North eastern region. These varieties are endowed with valuable genes for various stress condition like resistance to pest and diseases, tolerance to cold, draught and flood. These genetic resources are an indispensable part of local agriculture and cultural system. Knowledge about their traditional method, important genotypic and phenotypic (Phenotypic refers to an individual's observable traits) characteristics will enhance the value conservation of local biodiversity. Although species extinction is a natural process, but due to massive introduction of monocropping, lack of policy for conservation and promotion, native varieties of paddy rapidly disappearing from the locality. While lot of literature and research works are available for HYV and hybrid varieties, but detailed cultivating practices and phenotypic characteristics of native paddy varieties in written form is very limited. In view of the above an activity was undertaken for documentation of cultivating practices adopted by farmers for some important native paddy grown in selected villages of undivided Nalbari district of Assam and also undertaken a study for recording some important phenotypic characters. These works were done as a part of project on '**Promotion and conservation of native variety of paddy through sustainable agriculture practices with special emphasis on increasing the income of grower's family.**' Supported by UNDP SGP GEF CEE (India) and implemented by Lotus Progressive Centre (an NGO located at

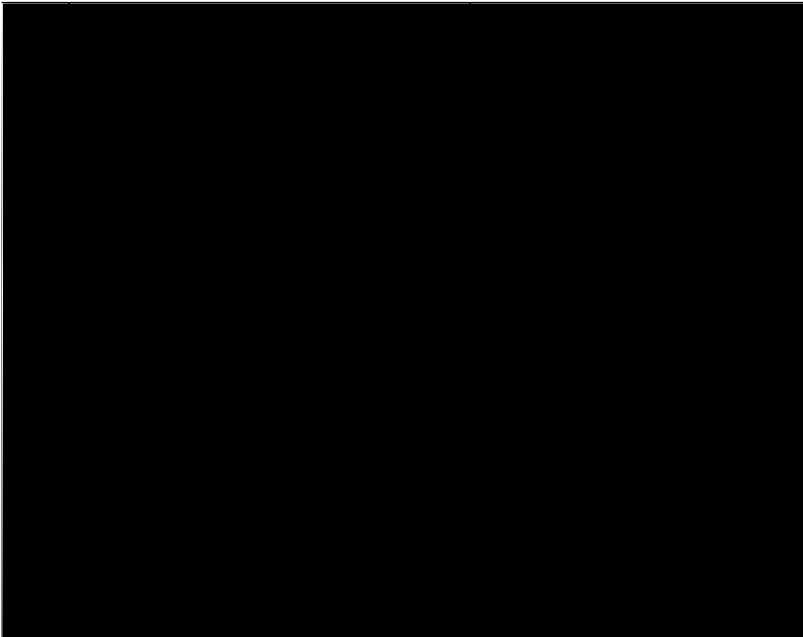
village Morowa, Nalbari, Assam) in 2017. The author was the principal investigator of the project.

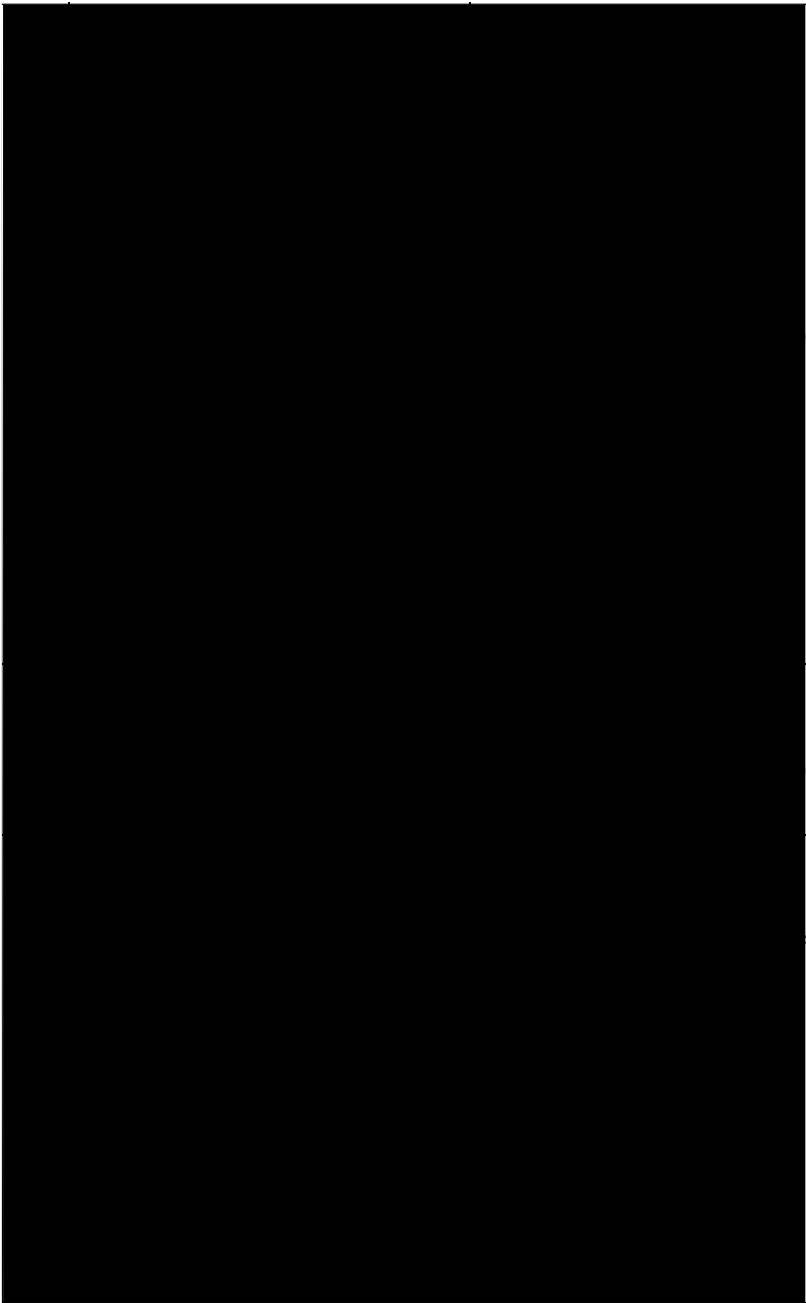
Materials and methods

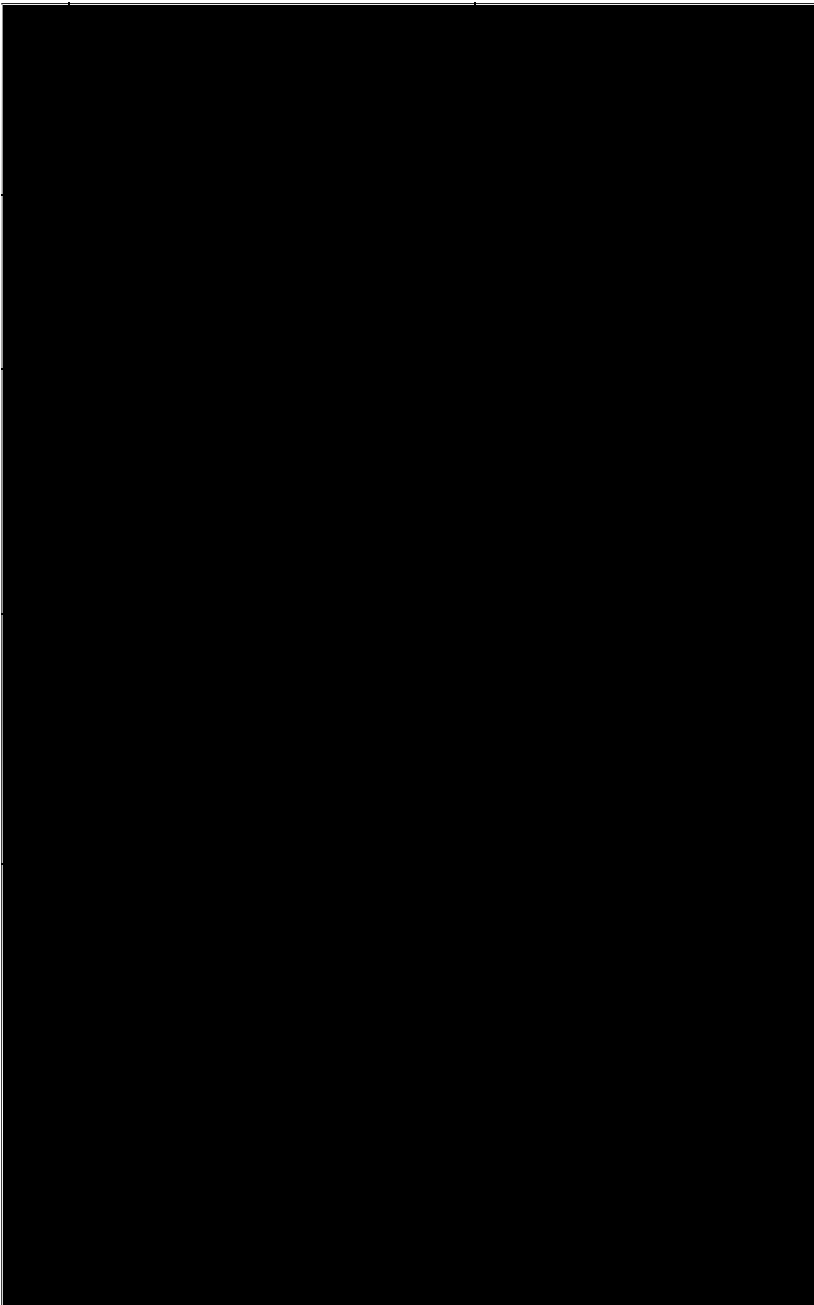
i) Sample collection: Three indigenous rice varieties of Assam were collected from the local farmers (Table 1) adopting the random sampling and primary data collection method. The important phenotypic characteristics as well as farmers cultivating practices were studied in the paddy field and from the interaction with farmers of these native varieties as per standard evaluation system and prescribed format guided by scientists of Regional Rained Lowland Rice Research Station, Gerua, Kamrup (Assam).

ii) Study of farmers cultivating practices and phenotypic characteristics:

2.2.1 Name of Native Variety: Phulpakhari

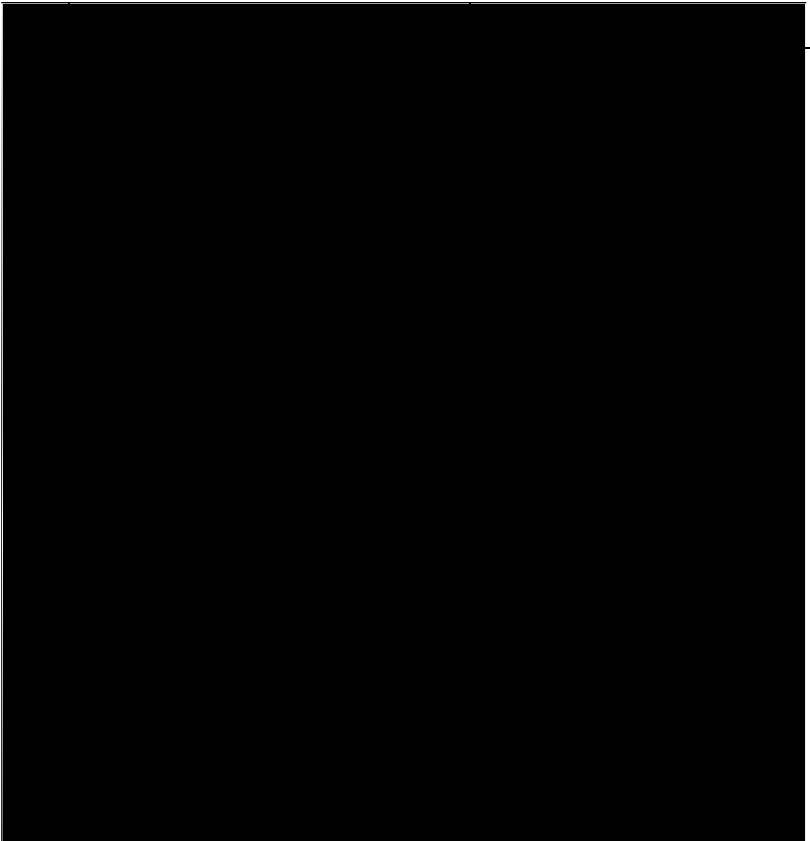


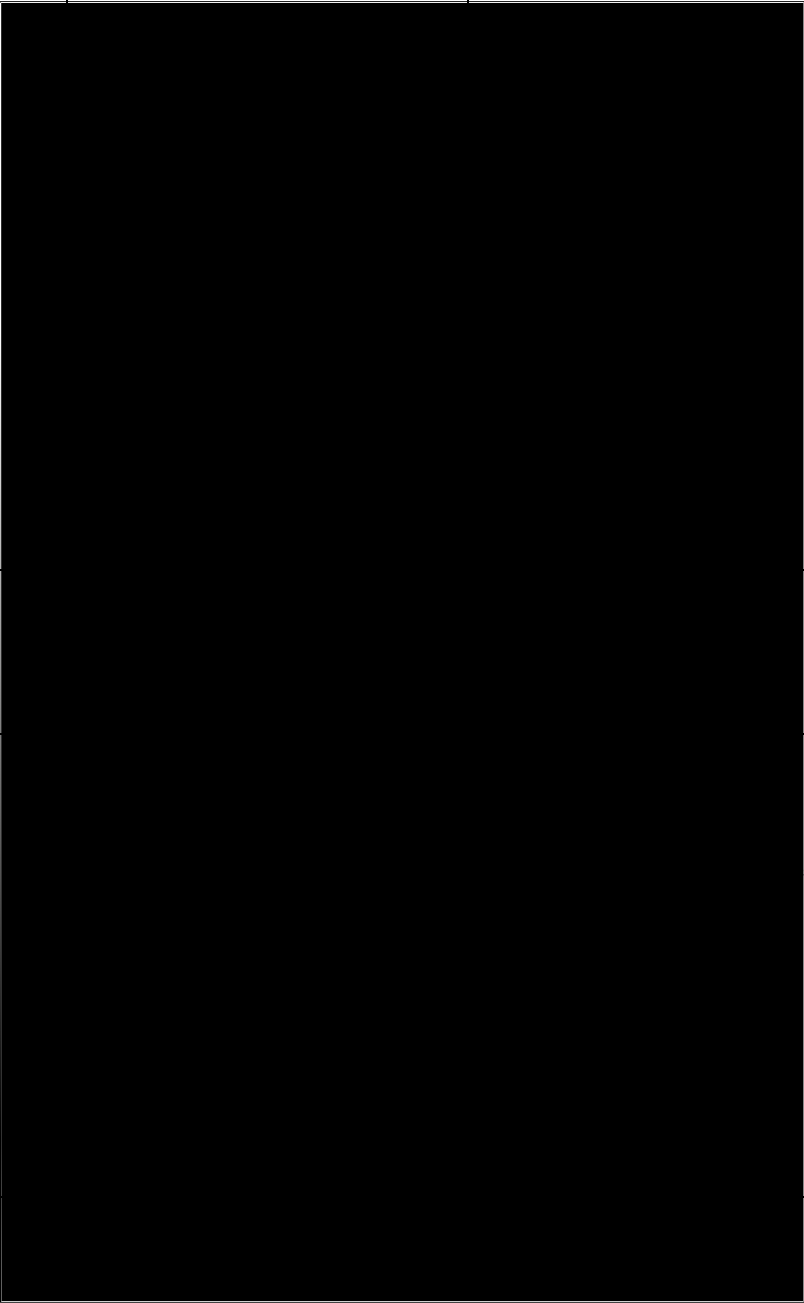


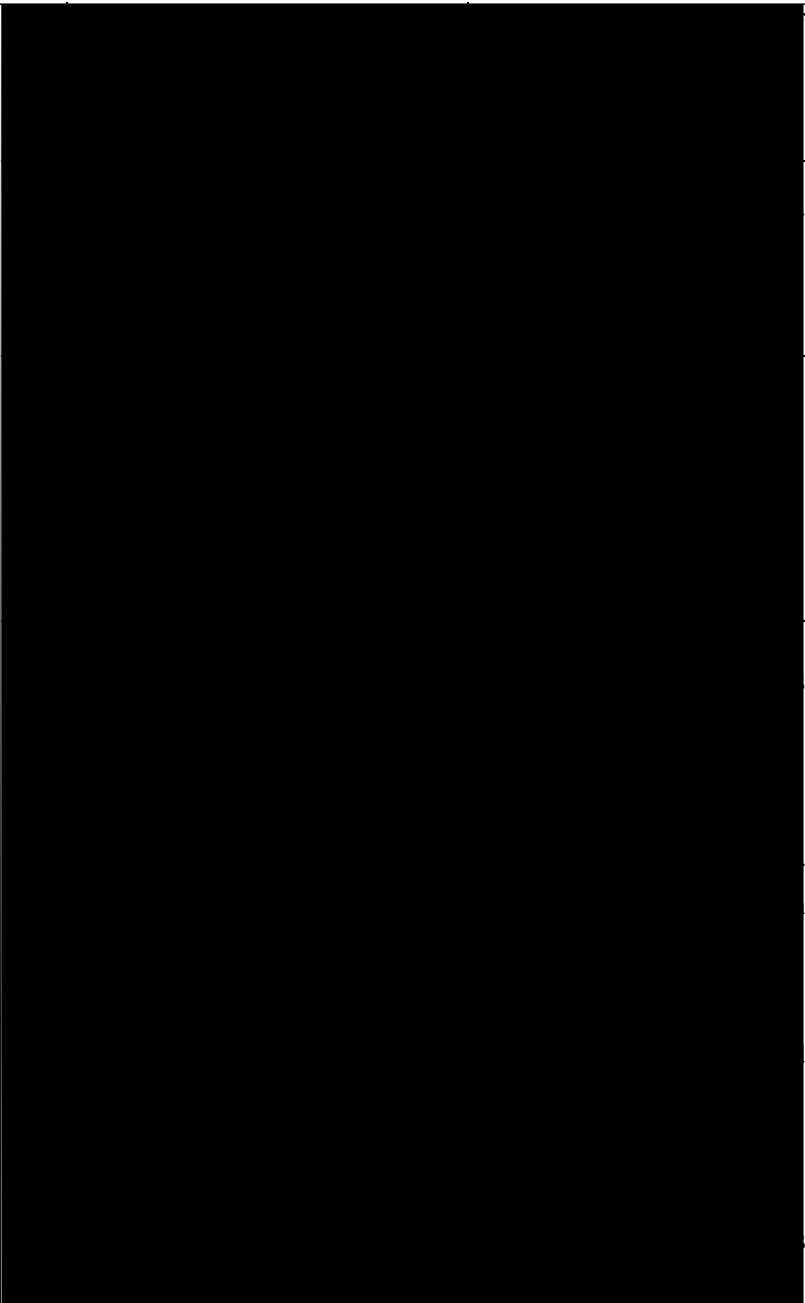


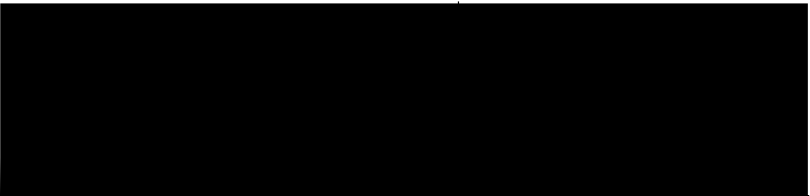


2.2.2 Name of Native Variety: *Kunkuni Joha*

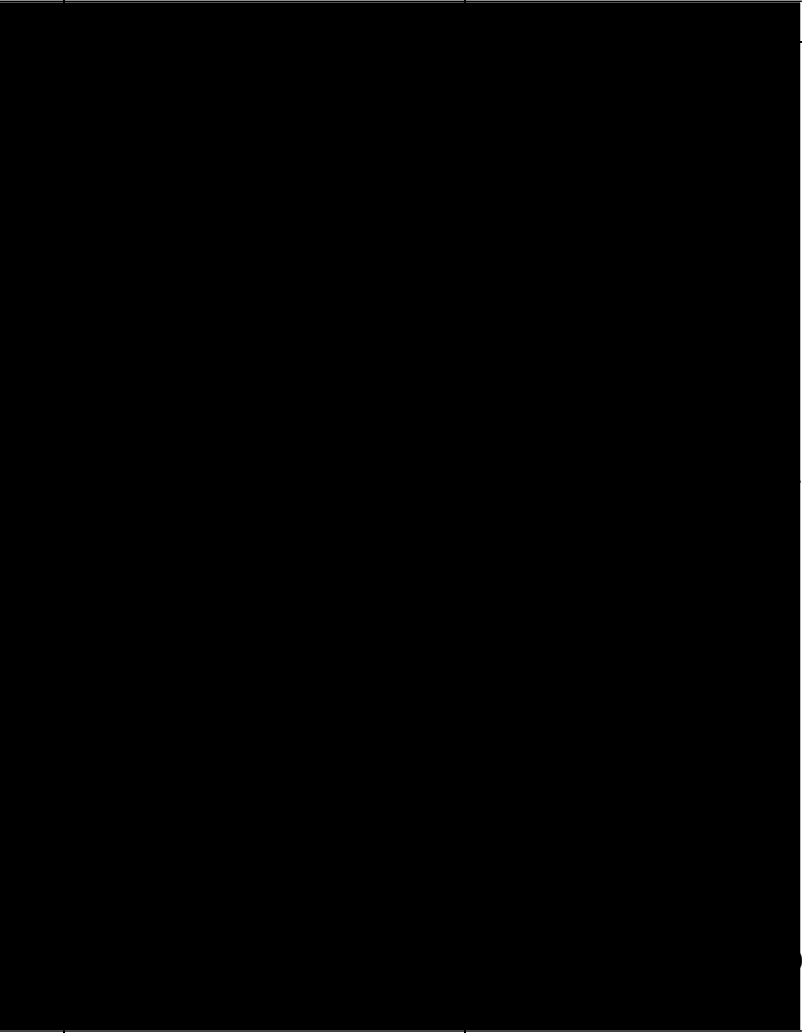


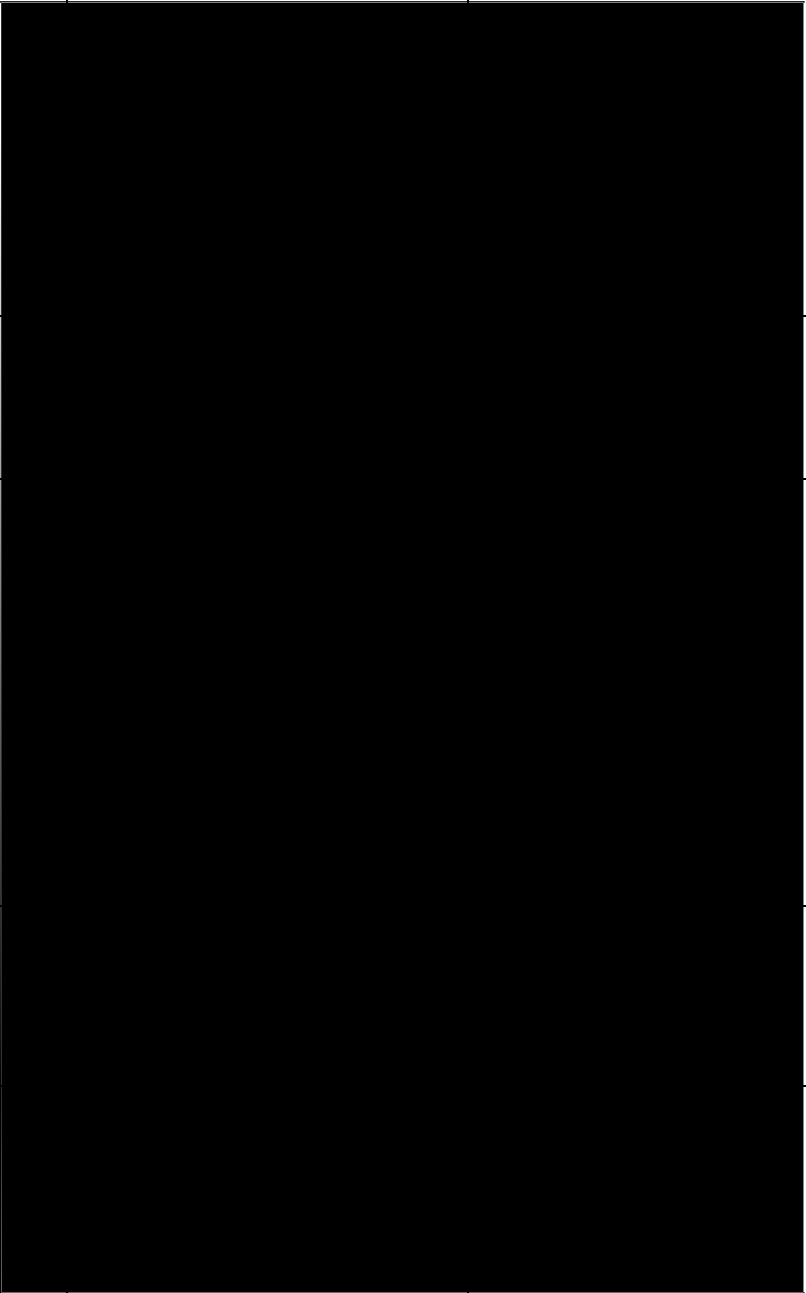


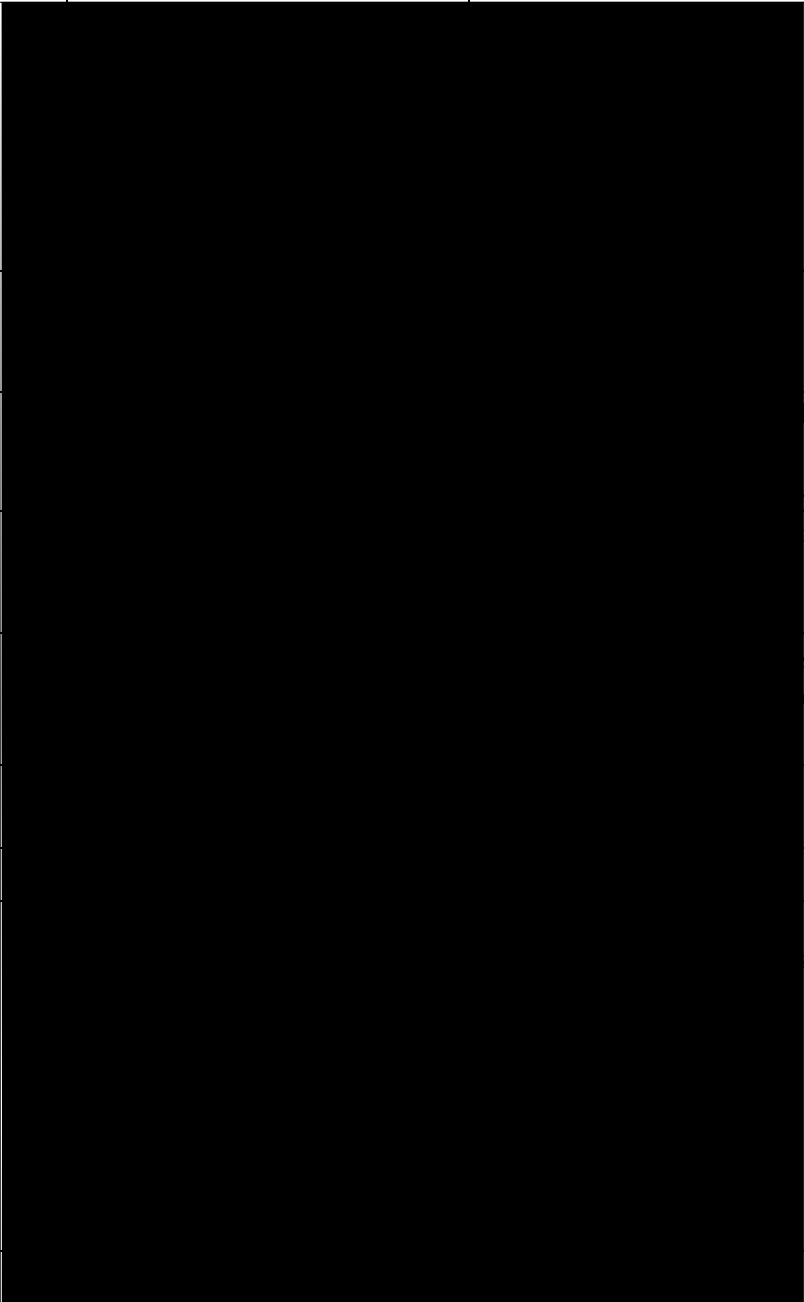




2.2.3 Name of Native Variety: *Tulsi Joha*









Phulpakhari



Kunkuni Joha

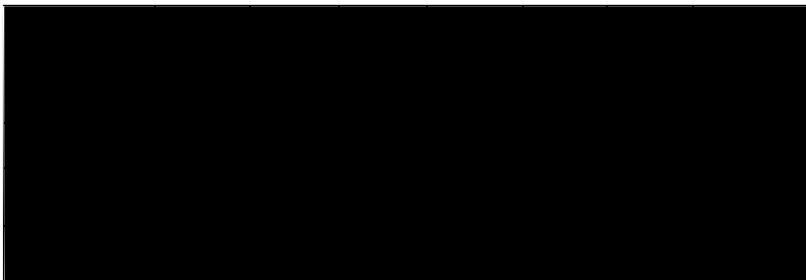


Tulsi Joha

iii) Study on Nutritive value: For this purpose the indigenous varieties in pure form were collected from farmers of different villages of Nalbari district. After that the varieties were sun dried, milled and prepared a sample of 100 gm of each. Then the samples are stored in separate airtight containers in a cool and dry environment for further analysis. The prepared samples were sent to the Regional Agriculture Research Station laboratory, Shillongoni, Nagaon for biochemical estimation of the nutrients. The qualitative as well quantitative tests were performed in these laboratories using following standard protocols.

a) Details of Rice Samples collected: Table 1

b) Analysis Report of Nutritive value: Table 2



Discussion

From the study of farmer's cultivating practices and phenotypic characteristics of these native paddy varieties it is seen that these varieties can be transplanted up to last part of September which is not possible with HYVs and Hybrids. These native varieties of paddy are capable to mitigate any eventuality of environmental changes. In the chemical intensive farming regime, rice bio-diversity has lost to a great extent because of HYVs and hybrids, insect bio-diversity and other animals are in danger because of haphazard use of chemical pesticides. Local varieties of paddy can be grown in organic way. Pest and disease infestation is less in these varieties requiring less pest and disease management practices. So by growing native varieties of paddy, not only we can face the adverse climatic condition, but also preserve our environment and bio-diversity. Kernels of *Kunkuni Joha* as well as *Tulsi Joha* (more scented) have pleasant smell and aroma of the boiled rice can spread up to 20-100 feet whereas *Phulpakhari* is not a scented variety. Again kernels of *Kunkuni Joha* and *Tulsi Joha* are smaller in size than *Phulpakhari*. Other phenotypic characteristics of these varieties are collected as per prescribed format of Regional Rained Lowland Rice Research Station, Gerua, Kamrup (Assam).

Nutritionally rice is one of the major food grains and is consumed by more than half of the world's population. However, the quantitative estimation of nutrients in rice shows significant

variation according to the genotype, geographical location, cultivation method as well as processing method. The nutritional analysis done by Regional Agriculture Research Station, Shillongoni, Nagaon has revealed that the protein content in these varieties has a range of 7.164-4.994(g/100g) where the variety *Kunkuni Joha* has the highest value of 8.330 (g/100g). The crude fat content has a range of 1.0-3.4 where the variety *Kunkuni Joha* has the highest value. The carbohydrate (starch) content in these samples has a range of 71.2-77.8 (g/100g) where the variety *Phulpakhari* has the highest value. Starch is the major source of energy stored as a carbohydrate in plants. Starch is composed of two substances: amylose, which is a linear polysaccharide and amylopectin, which is a branched polysaccharide. Both the forms of starch are polymers of α -D-glucose. Natural starch contains 10–20% amylose and 80–90% amylopectin. From the analysis it is seen that amylose content in each sample has a range of 19.6-25.0 (g/100g) where the variety *Tulsi Joha* has the lowest value of 19.6 (g/100g) and amylopectin content has a range of 51.6-56.6(g/100g) having the highest value 56.6(g/100g) in *Kunkuni Joha*. Though *Kunkuni Joha* has less aroma than *Tulsi joha*, the nutritional analysis suggests that it has the highest nutritive value.

Conclusion

In the chemical intensive farming regime, rice bio-diversity in Assam has lost to a great extent because of HYVs and hybrids, insect bio-diversity and other animals are in danger because of haphazard use of chemical pesticides. Being agriculture an important occupation, traditionally and culturally native rice varieties occupies an important position in the Assamese community. Local varieties of paddy can be grown in organic way. Pest and disease infestation is less in these varieties requiring less pest and disease management practices. Moreover these varieties have appreciable nutritive values and high demand in the market. So by growing native varieties of paddy, we can

not only improve our economic empowerment, but also preserve our environment and biodiversity.

Acknowledgments

The author is thankful to the scientists of Regional Rained Lowland Rice Research Station, Gerua, Kamrup (Assam) for necessary guidance in studying the cultivation practices and phenotypic characteristics of these varieties and the laboratory staff of Regional Agriculture Research Station, Shillongoni (Nagaon) for analysis of the nutritive values of the rice samples. The author is also thankful to the sponsoring agency UNDP SGP GEF CEE (India) and Project staff of Lotus Progressive Centre for their utmost help.

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Morphometric analysis, ecological role and distribution status of *Pipistrellus coromandra* (Gray, 1838), an insectivorous bat in Goalpara district of Assam.

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Dr. Akshay Kr. Haloi ²

Abstract:

The present study was conducted in Sarapara village (26.0125° N, 90.8127° E) of Goalpara district where a colony size (n=5) of microbat species were found roosting under a bamboo thatch roof house. The small microchiropteran species is identified as Pipistrellus coromandra after analyzing its morphometric parameters both for external measurements and cranio-dental measurements. Captured bat specimens (n=2) were examined at the NERC-Shillong Laboratory, Meghalaya ZSI (Zoological Survey of India) for taxonomic identification and species confirmation. Morphometric data were compared with other specimens preserved at the ZSI, according to the standard literature by Bates and Harrison (1997). The occurrence of this species is the first report from the study area and no previous work has been reported earlier. The recorded mean body weight of captured specimens was $4 \text{ g} \pm 0.282$ (S.D), average forearm length (FA) was $27.43 \text{ mm} \pm 0.332$ (S.D) and the tail length was measured at $24.1 \text{ mm} \pm 0.28$ (S.D) respectively. P.coromandra detailed skull measurements (n=2) revealed that the mean Greatest length of skull

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(GTL) was 11.35 mm with a standard deviation of 0.076, the Condylar basal length (CBL) width was 11.49 mm with a standard deviation of 0.056 respectively (Table 1). This bat occasionally roosts with the Least pipistrelle (*P.tenuis*), remaining isolated from each other while in the same roost. The *Pipistrellus coromandra* also known as the Indian Pipistrelle is extremely similar to Least Pipistrelle (*P.tenuis*) but the Indian pipistrelle averages are larger for all craniodental measurements. Therefore this species is very critical for identification and not possible only with external morphometric measurements. The species is categorized under Vespertilionidae family and ecologically plays an important role in controlling insect population throughout its geographic range. Globally, they are widely distributed in India, Pakistan, Nepal, Bangladesh, Bhutan, Myanmar and Thailand. Therefore, this work is a first hand attempt for *P.coromandra* from this region (Goalpara) to study the morphometric characters, its ecological role and distribution of the species is discussed.

Keywords: Morphometrics, Indian Pipistrelle, Vespertilionidae, Assam.

Introduction

Bats belong to the order Chiroptera which means 'winged hand' (Hill and Smith, 1984). Rodents, which are about 1700 species, are the only mammalian order to out-number bats by some estimates, but they are certainly less diverse in their biology. With more than 1,400 species, bats are the second largest order of mammals and are the only mammals that can fly for extended periods of time. The order Chiroptera consist of two suborders: Microchiroptera (echolocating bats) and Megachiroptera (Old World bats). The majority of the Microchiroptera are insect feeders although other food sources include fish, amphibians and blood of other vertebrates (Hutson

et al.,2001). The Megachiroptera are phytophagous bats which feed on plant parts such as fruits, leaves, flowers, pollen and nectar. Bats range in size from the smallest mammal (the bumblebee bat, *Craseonycteris thonglongyai*) 1.5 - 2.0 g, to 1.0-1.5 kg flying foxes (*Pteropus* sp) with wingspans of over 1.5 m. Areas rich in bat diversity may reflect richness in flora and other food resources of bats (Kunz , 1988). The powerful flight of bats plays the most important role for their widespread distribution and diversity. Bats are known from all continents except Antarctica and their distribution ranges from the southern tip of South America to northern Scandinavia (Kunz and Pierson, 1994). They are absent only at polar regions and some isolated oceanic islands.

Talmale and Saikia (2018) listed 127 species of bats from India, divided into 41 genera and 9 families. Assam has about 39 different species of bats under 16 genera, of which 5 species are known as Megachiropteran species (fruit bats) and 34 species are known as Microchiropteran species (Ali, 2022). Of the 127 species of bats known from India, 74 species have been found in Northeast India, which is part of the Himalaya and Indo-Burma Biodiversity Hotspot (Saikia, 2019). 9 families of bats are represented in India out of these the family Vespertilionidae (often called evening bats), comprising 62 species, is the most diverse and abundant family of bats found in India (Saikia 2019; Ali, 2022).

Bats play important ecological role as pollinators and seed dispersers in tropical and subtropical habitats throughout the world (Kunz et al.,1998). Bats are an essential natural resource that play great role in providing many ecological and economic services. They act as keystone species and regulate nocturnal

insect populations (Mickleburgh et al., 2002). Insectivorous bats are the primary consumers of nocturnal insects. The relatively large volumes of insects consumed by insectivorous bats (up to 100 % of body mass per night, Kurta et al., 1998). The long distances travelled, these bats are thought to play a major role in suppressing nocturnal insect population.

The Indian pipistrelle (*Pipistrellus coromandra*) is a small bat with an average FA length of 32.2mm (Bates and Harrison, 1997). This species of bat belonging to the Vespertilionidae family is globally distributed in Afghanistan, Bangladesh, Bhutan, Cambodia, India, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand, and Vietnam. Generally found roosting in crevices, ceilings, chimneys, tree-holes, under barks, human dwellings, bamboo, abandoned hut etc. *P.coromandra*

occasionally roosts with the Least pipistrelle (*P.tenuis*), remaining isolated from each other while in the same roost.

Bats are a fascinating group of animals as well as a challenging group to study due to their nocturnal habits and biological diversity. A number of researchers from the Zoological Survey of India and other institutions have made significant contributions to the study of Indian bat taxonomy and geographic distribution in the post-independence era. Some of the most important revisions of the geographical range and taxonomy of Indian bats include Brosset (1962abc, 1963); Hill and Corbett (1992); Sinha (1970, 1999); Bates & Harrison (1997); Pradhan (2008); Das (2003); Csorba et al., (2003); Ramarkishna et al., (2003); Ghosh (2005, 2008); Srinivasulu (2001, 2006); Alfred, (2006). A monograph by Bates & Harrison (1997) listed 28 species of bats from Assam. Recently, there are only a few significant works on the study of different species of bats in the

state of Assam by Sinha (1999), Ghosh (2008) and Boro et al., (2013; 2015; 2018), Ali (2010; 2022), Rahman and Choudhury (2017), Saikia et al., (2018; 2019; 2021).

Goalpara is a district in western Assam, in between the Brahmaputra River to the north and Meghalaya to the south. The topography of Goalpara district is generally characterized by an almost flat plain, with the exception of a few low forested hills. The site studied is perfect for expanding the bat population as it is densely forested, has high tree canopy and is close to a water source. Therefore, this paper is a first-hand attempt from the study region (Goalpara) to examine the morphometric characters in comparison to the standard identification literature. their ecological role and the distribution status of the species (*P.coromandra*) are discussed.

2. Materials and Methods

Study area :

The study area is located in a very rural remote village, Sarapara (Goalpara), with its geographical coordinates (26.0125 N, 90.8127 E) 27 km from the district headquarters. The total geographical area of the village is 337.25 hectares. Total number of houses 383 (2011 census). The environment is very favorable for bat dispersal as most of the study area is covered with banana, hall, bamboo and teak trees. The site studied is favorable for roosting of bat population as it is densely forested, has high tree canopy and connected to a water source. The climate of the area is ideal for a humid subtropical region with dry winters (classification: Cwa). The district has annual temperatures of 27.55 °C and rainfall of 82.07 mm. Annual rainfall ranges from 3805 mm to 149.8 inches. Fig. 1 shows the study site. Altitudes of the study area between 100 and 500 m.

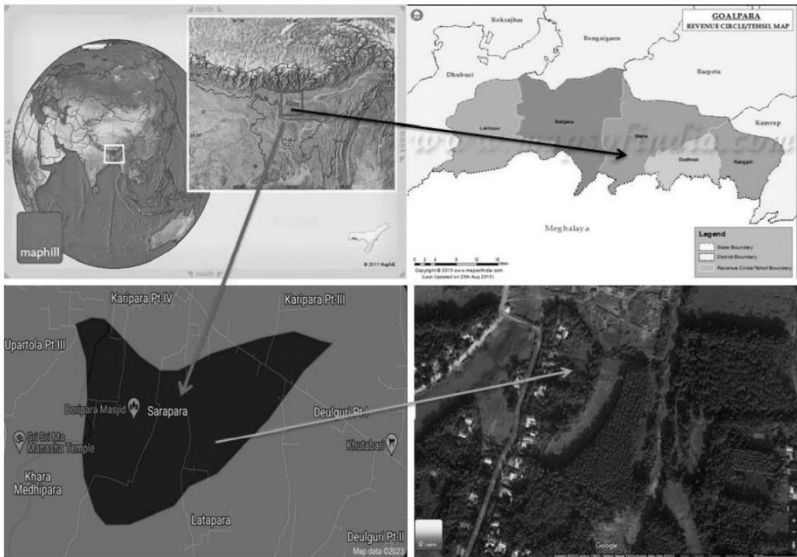


Fig 1. Map of the roosting site (Sarapara; 26.0125 N, 90.8127 E) of *P. Coromandra* in Goalpara, Assam.

Survey Method

From 18:30 to 20:30 in the evening, the villagers assisted in conducting the survey. (n=5) bats were discovered to be roosting in a small portion of the ceiling of an abandoned bamboo-thatched home in the village. The bats were forced out of the confined area using a modified butterfly net (59-inch extendable handle, a 14-inch net ring, and 0.8mm net holes). For additional taxonomic investigation, just a small sample (n=2) of bats were collected and stored in 70% ethanol. It was crucial to capture and preserve the specimen because, for this species, skull measurements (Cranio-dental morphometric data) aid in accurate specimen identification. Skull (cranio-dental) measures from the voucher specimen were compared to other specimens at the laboratory of NERC-Shillong, ZSI- Meghalaya.

Morphometric Analysis :

Chloroform was used to make the samples that were captured unconscious. In order to comprehend its shape, external body measures and cranio-dental measurements were taken. The morphometric characteristics were then measured using a millimetre calliper (Zhart-0-300 mm) with an accuracy as close as possible to 0.01 mm. Each individual sample was measured, and the measurements were documented for comparison with the pertinent literature (Bates and Harrison, 1997). According to Bates and Harrison (1997), the skulls of two individuals (one male and one female) of the same bat were prepared for examination in order to taxonomically identify the species. The comprehensive acronyms for the morphometric measurements are represented in (Table 1 & Table 2)

Statistical Calculation:

The mean of two samples and the standard deviation are calculated. The standard deviation is a statistical measure of the diversity or variability in a data set. A low standard deviation indicates that data points are generally close to the mean or average. A high standard deviation indicates greater variability in the data points, or greater deviation from the mean. For a number of n samples (Table 1; Table 2) the mean or average value for the measurement range is first calculated and later the standard deviation is calculated using an online software tool.

3. Result and Discussion

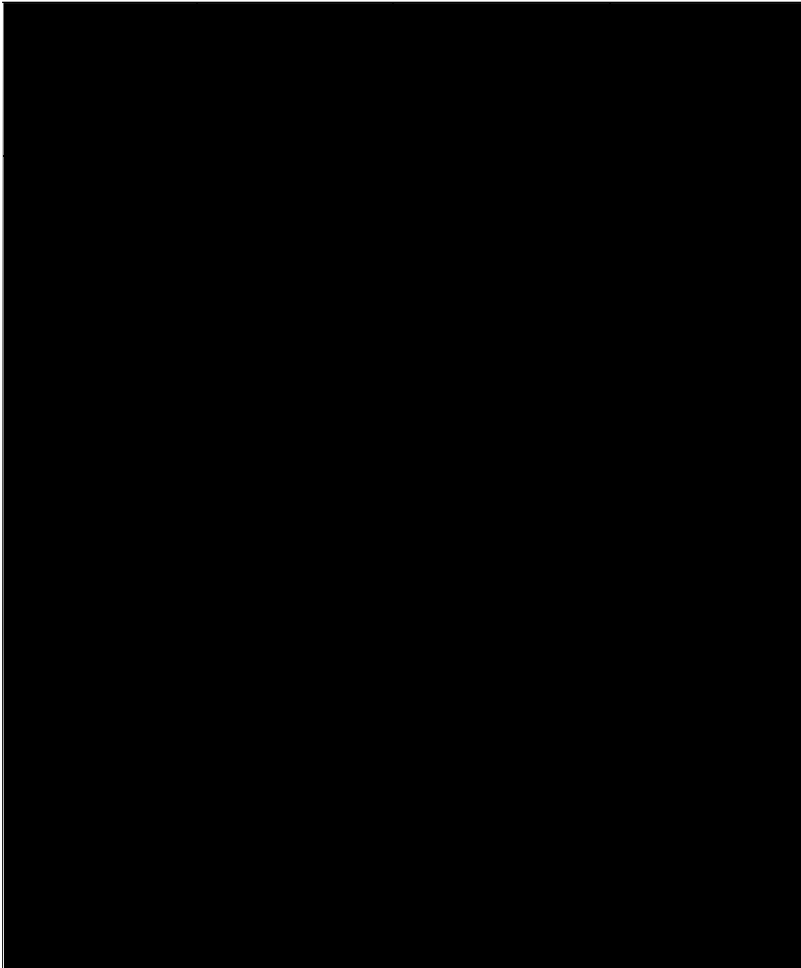
Pipistrellus coromandra is commonly known as Indian Pipistrellus, an insectivorous microchiroptera. Morphologically, this species was a small pipistrelle. The fur of the upper parts was generally dark brown and the base of the fur and the hair were noticeably darker. The ear was brown in appearance and

essentially bare with a crease at the mid-edge (Fig 3a.). The tragus was short, blunt, and round. The wing membrane was dark brown and the base of the wing membrane contained some hairs. The specimens collected for this study (n=2) had an average body mass of $4 \text{ g} \pm 0.282 \text{ g}$, a head and body length (HB) of $42.05 \pm 1.202 \text{ mm}$ and a forearm length (FA) of $27.43 \pm 0.332 \text{ mm}$. The mean lengths of the 3rd, 4th, and 5th metacarpals were ($29.05 \pm 1.202 \text{ mm}$, $29.35 \pm 1.343 \text{ mm}$, and $29.2 \pm 0.424 \text{ mm}$, respectively). Tail length was measured at 24.01 ± 0.282 , ear length (E) was $9.2 \pm 0.989 \text{ mm}$. The penis is short. It is difficult to distinguish *Pipistrellus coromandra* from its conspecifics on the basis of external characteristics alone (Bates and Harrison, 1997). Detailed skull measurements of this type (n=2) revealed that the mean GTL was 11.35 with a standard deviation of 0.070, the braincase width was 6,320,106 with a standard deviation of 0.106, and the mean carotid artery width (CA) was 7,290,240 mm. The mean CCL, CBL, and mandibular length (ML) were 11.17 ± 0.035 , 11.49 ± 0.056 , and $8.67 \pm 0.077 \text{ mm}$, respectively (Table 2). The tooth pattern was found to be 2123/3123=34. Total external morphometric data for external measurements are presented in Table 1 and craniodental measurements in Table 2.

Although the Indian Pipistrelle and the Least Pipistrelle (*P. tenuis*) are incredibly similar morphologically, the Indian Pipistrelle averages out to be larger for all cranial and dental parameters. The Javan Pipistrelle (*P. javanicus*) has a smaller skull than the Least Pipistrelle but a larger one than both. *Pipistrellus* species resemble *Myotis* species but differ in having smaller muzzles and fewer teeth. The Indian Pipistrelle has pelage that is typically uniformly brown on the dorsum and ranges in colour from dark chestnut to dark clove brown (BCI,

2022). The results of the morphometric data comparison with *P. tenuis* (Tables 1 and 2) clearly show that the average measurements are larger and more or less overlap than those of *P. tenuis*.

Table 1. External morphometric data of *P. coromandra*.



- Acronyms of the measurements are in ‘**mm**’ length and weight/body mass in ‘**g**’

Table 2. Skull morphometrics (Cranio-dental morphometric data) of *P. coromandra*.



- Acronyms of the measurements are in ‘**mm**’ length and weight/body mass in ‘**g**’

The Indian Pipistrelle is widespread and common throughout its distribution and is commonly found in disturbed and urban habitats. Distribution in India is throughout the country Andaman & Nicobar Island, North East India, South India, Bihar, Goa, Gujarat, Jammu & Kashmir, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Sikkim, Uttarakhand, Uttar Pradesh and West Bengal except Rajasthan (Gbif, 2022) In Goalpara district of Assam the occurrence of this species is firstly reported, however it was reported earlier from different localities in Assam such as Golaghat, Baksa, Sadiya, Palasbari , Goreswar (Ali,2022).

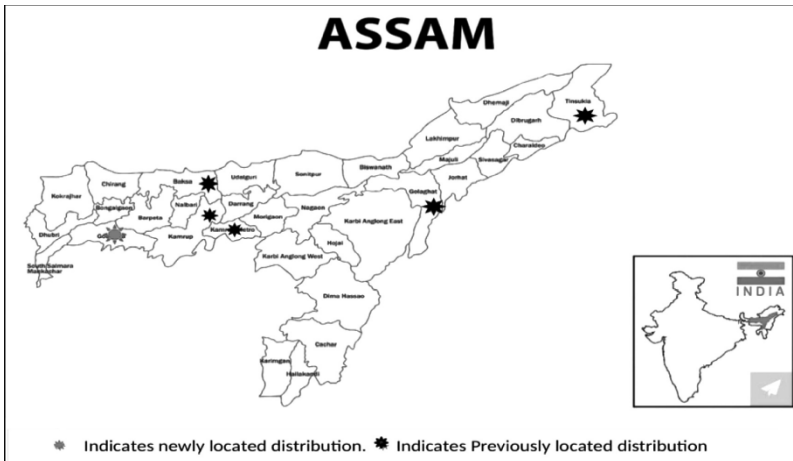


Fig 2. The distribution of *P. Coromandra* in Assam

Indian Pipistrelles live alone or in groups of 2 to 25 individuals in India. They occasionally roost with pipistrelle but remain isolated from each other in the same roost (Gbif, 2022). Food for Indian Pipistrelles are found 8 - 12 m above the ground or above water; along forest edges, streams and gorges; over corn fields; and in clearings. Slow and unpredictable fliers, they forage for food in the lush vegetation of India. This species typically hunts near the ground and prefers to eat tiny insects from many orders, such as Coleoptera, Hymenoptera, Diptera and Lepidoptera (Saikia et al., 2021). It uses echolocation to find its prey. The stomach contents of some individuals in Bihar, northern India, contained small ants and fly mouthparts (Gbif, 2022). Their prey size can vary from 1 mm (midges and mosquitoes) to as large as 50 mm long (beetles and large moths) based on the species of bat (Kunz et al., 1977 & Kurta et al., 1998). Obtaining accurate estimates of the amount of prey consumed by bats is challenging. However, its amount and type are confirmed as it varies with prey availability, time during night, species, sex, age, and the reproductive status of bats (Kunz 1995).

P. coromandra is not a scheduled species included under wildlife protection act, 1972 (ENVIS,

2022). Predation of bats can plant communities through b
ave direct effects on herbivore communities and indirect effects on th density mediated (consumption) and trait-mediated (behavioral) interactions and for nature balance (Schmitz & Suttle, 2001).

P. coromandra has likely spread throughout the Goalpara district as evidenced by the colony of the species that can be found in the research area. The presence of this species increased the likelihood of further nesting chiroptera in Assam and the other ecosystems of the district. If further in-depth research is



Fig 3a.
P. coromandra



Fig 3b. Dorsal view with
expanded wings



Fig 3c.
Hind Foot.



Fig 3e. Lower Jaw with distinct
teeth and mandibular

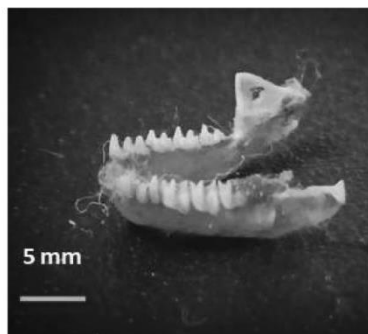


Fig.3d. Lateral view of Skull
with distinct zygomatic arch

conducted in Assam, it could reveal more details on bat diversity there. Ecologically, if this is the case, the insectivorous bat (*P. coromandra*) will disappear due to differential anthropogenic pressure. Insect populations will increase, causing crop failures and other economic damage throughout their habitat (ADW 2022; BCI 2022). Protection of this species is the need of the hour or loss of bats will destabilizes ecosystems and will completely affect the ecological balance of the food chain. Bats are therefore like any other species with great diversity, ecological role. By highlighting the morphometric characteristics, ecological importance and distribution of *Pipistrellus coromandra* in the Goalpara region of Assam, this study aims to fill the gap to assess the current status of bat diversity in Assam.

5. Acknowledgement

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ECOTOURISM



Ecotourism and Sustainable Development

Dr. Rantu Mani Deka

Abstract

The Ecotourism focuses on environmental protection and economic development. The sustainable development pay attention on the use of renewable sources of energy, environmental protection and pollution reduction. India's natural beauty and varied range of human culture has the potential to attract domestic and international visitors. Similarly the Assam has also lots of strength to attract the visitors. So to make ecotourism successful there is constant and active participation of local people as well as State Government in planning and management of ecotourism is urgent need for greater interest of conservation of biodiversity of the state.

Keywords : *Ecotourism, sustainable development Majuli, Kaziranga National Park.*

Ecotourism and Ecological tourism is a new concept of tourism and it is a subset of sustainable tourism which focuses on environmental protection and economic development. Ecotourism was first conceptualized in the early 1980s as a type of travel for people to learn about environment without causing any environmental destruction. The word Ecotourism was first initiated by Hector Ceballos Lascurain in Mexico in the year

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1983. In India, the Thenmala dam of Kollam, Kerala is the first planned ecotourism which was selected by the World Tourism Organisation. According to Tickell, ecotourism is defined as “travel to enjoy the world’s amazing diversity of natural life and human culture without causing damage to either”. Ecotourism is ecologically sustainable tourism that fosters environmental and cultural understanding, appreciation and conservation. As defined by the International Tourism Society, “Ecotourism refers to responsible travel that conserves the environment and improves the well-being of local people”. In recent years, acceleration of modern life and culture led to the destruction of natural habitats and increased land, air, and water pollution. So in the current era, ecotourism has grown significantly and is directly linked to growth and sustainable development. The World Trade Organisation (1988) formulated the principles of ecotourism, stating that resource management is to cover economic necessities, ecological processes, biological diversity, and systems that sustain life. The World Ecotourism Summit, held in Quebec City, Canada, from 19th to 22nd May, 2002, declared the year 2002 as the International Year of Ecotourism.

Ecotourism confers social, economic, and environmental benefits which are the three pillars of sustainable development. Ecotourism is a new form of tourism based on the idea of sustainability. The term sustainable development was used for the first time in 1970. It is a process in which natural, social, economic, trade, industry, agriculture, energy, and all other policies are designed for development that can be socially and economically sustainable. Sustainable development means conserving and managing natural resources which meet present and future needs of the individuals. It ensures sustainable growth

and development in all economic, cultural and social aspects. Ecotourism is a sustainable tourism which is ecologically safe, economically applicable, economically feasible and socially acceptable sustainable tourism will respond to tourists and the next generations current needs and balance environment, economic, social and cultural dimensions. The main aim of sustainable development is how to achieve continuous development regard nature and human beings. The principles of sustainable development which received international recognition as a result of Brundtland Commission Report (1987) and supported by all the nations. These are as follows-

1. Use and Conservation of natural resources.
2. Inter-generational equity.
3. Environmental protection.
4. The precautionary principle.
5. Principle of liability to help and co-operate.
6. Poverty eradication.
7. Principle of public trust.
8. The 'Polluter pays' principle.

The sustainable development pay attention on use of renewable sources of energy such as solar energy, wind energy etc; less use of non-renewable and polluting energy sources such as fossil fuels etc and environment protection and pollution reduction.

India's natural beauty and diverse topography includes mountains, plateaus, plains, deserts, islands, costal islands are the habitat for varied plants and animal life as well as wide range of human cultures has the potential to attract domestic and international visitors. There are 36 biodiversity hotspots

recognized in the world. Among those four are found in India, making it one of the 18th Mega biodiversity countries. At present India has 106 National Parks, 18 Biosphere Reserves and 567 Wild Life Sanctuaries. These are setup only to protect and conserve wild life resources of India (MoEF Annual Report). The government of India has also formulated certain policy guidelines for ecotourism known as 'Policy Guideline 1998'. In our country Kerala, Himachal Pradesh, Karnataka represents a unique picture of ecotourism. The Government of India has identified many ecotourism places in the country namely Guwahati, Kaziranga, Majuli, Tezpur, Sibsagar and Bhalukpong etc in Assam, Shillong and Cherrapunji in Meghalaya, Kohima in Nagaland and Tawang in Arunachal Pradesh. In India many Islands of Andaman Nicobar and Lakshadweep; Sitanadi, Udanti, Achanakmar Barnawapara Sanctuary and Kanger Valley National Park of Chattisgarh ; in Uttarakhand Rajaji National Park and India's first planned ecotourism, Thenmala in Kerala have been opened up for ecotourism.

The north-eastern region is situated on the foothills of the Himalayas, surrounded by hills and mountains on all sides. The region has vast green cover and habitat for different ethnic and religious groups. The Assam is the central state in the north-eastern region of India. Geographically Assam is divided into Brahmaputra valley, the Barak valley, and the Karbi plateau and North Cachar Hills. The natural beauty of Assam comprised of National Parks, Sanctuaries, Biosphere Reserves and Reserved Forests etc. These are the home of endangered one-horned rhinoceros, wild cat species, primates, herds of elephants, deer, different species of birds etc. Assam, the most prominent state of North East India is said to be the hotspot for tourists for its

natural beauty. There are five National Parks, seventeen Wildlife Sanctuaries, 2 biosphere Reserves and 2 World Natural Heritage Sites. A brief review of the ecotourism destinations of Assam are briefly discussed as follows.:

Kaziranga National Park :

Kaziranga National Park famous for **its one-horned Rhinoceros** is located in Golaghat, Nagaon and Sonitpur districts of Assam. Kaziranga was designated a UNESCO World Heritage site in 1985. The park has an area of some 430 square km and lies between the Brahmaputra River and the Karbi (Mikir) Hills. The park has a large number of **water bodies, hilly terrains, marshes and plains where dwell many species of unique flora and fauna. Kaziranga National Park a world heritage site is famous for the Great Indian one horned rhinoceros, as well as many mammals, including tigers, elephants, panthers and bears, and thousands of birds.**

Manas National Park:

Manas National Park, is located in the northern part of the Barpeta district on the bank of the river Manas. *Assam is the only place to be distinguished as biosphere reserve, a natural heritage site, Project Tiger Reserve, and Project Elephant Reserve.* It covers an area of 500sq km in the Himalayan foothill zone. The vegetation of Manas is marked by highland savanna, moist deciduous and tropical semi evergreen trees. This park is the habitat for many mammals, including tigers, elephants, panthers, bears, golden langur, pigmyhog, hispidhare, wild buffalo, leopard and thousands of birds., etc. Manas also contains Mathanguri- a unique picnic spot at the bank of the Manas River that provides rafting and angling facilities to tourists.

Nameri National Park :

It is situated at the foothills of the eastern Himalayas. Nameri National Park provides habitat for Bengal tiger, Indian leopard, clouded leopard, marbled cat, leopard cat, hog deer, sambar, dhole, gaur, barking deer, wild boar, sloth bear, Himalayan black bear, capped langur and Indian giant squirrel. On the 1st of March, 2000 it was stated a tiger reserve. The flora of this park includes evergreen moist deciduous trees, cane and bamboo breaks etc. Each year, the Jiabharali attracts anglers from all over the world. Regulated angling is permitted on a selected stretch of the river strictly on a 'catch-record and release' basis. The Tourism Department of the Assam Government has developed an ecotourism resort at Bhalukpong.

Orang National Park :

Situated on the banks of the Brahmaputra river, the national park has the distinction of being the oldest game reserve in the state of Assam. It serves as an important breeding ground for several varieties of fishes. It is an IUCN site and boasts of a rich flora and fauna comprising of several endangered, critically endangered, and threatened animals and birds including the Pygmy Hog, Royal Bengal Tiger, Great Indian One-Horned Rhinoceros, Bengal Florican, etc.

Majuli :

Majuli, in the state of Assam is the biggest river island of the world, situated on River Bramhaputra. It is the largest river island in India covering an area of 1,256 square kilometers but due to soil erosion it is reduced to only 875 square kilometers. It is one of the famous travel destinations of North East India, especially during the time of the Majuli Bihu, a traditional

dance festival. This island has been the cultural capital of Assam from as early as the 16th century. The island has been a home for Neo Vaishnavite tradition for a long time. In Majuli, there are about 22 Vaishnava Satras which are well known attractions of the place. Among the Satras, the first one was built by Sankaradeva, who is reckoned to be the father of the Neo Vaishnavism. Some of the important Satras of the area are Dakshinpath, Garamur, Auniati and Kamlabari. These count as the must visit tourism places of Assam too. A wetland of Majuli is a hotspot for flora and fauna, harbouring many rare and endangered avifauna species including migratory birds. Among the birds Greater Adjutant Stork, Pelican, Siberian Crane and the Whistling Teal etc. Besides these destinations other important places of the Assam are Chandubi Lake, Rani Reserved Forest, Hajo, Mayong etc, which have greater potential in ecotourism.

From the above discussion it is clear that, the state of Assam has lots of strengths to attract domestic and international tourists towards the ecotourism. In Assam the ecotourism is not growing very well. So, to make the ecotourism successful, there is consent and active participation of local people as well as the State government in planning and management of the ecotourism programme. Ecotourism is sustainable for the region's vast green cover. The rich natural beauty and its diversity, exotic cultural and ethnic diversities, unexplored rich biodiversity, provide tremendous potential for development of ecotourism in the region.

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**ENVIRONMENTAL
AWARENESS**



A study on Environmental Awareness among the College Students with special reference to Barbhag College of Nalbari District

Dr Nitumoni Das ¹
Kamal Baruah ²

Abstract:

Environmental Awareness is the understanding of natural protection and the activities that can cause harm to the environment. Environment plays an important role in healthy living and the existence of life on planet earth. Environmental awareness can help to minimize pollution and global warning. It was therefore decided to study the environmental awareness among students of Barbhag College. The present study has been conducted on a random sampling of 100 student of Barbhag College. The main objective of this research paper is to study the environmental awareness among college student of Barbhag College on the basis of different dimensions of Environmental awareness. Another objective of this study is to make a comparative study on environmental awareness in between male and female college students. The result revealed that the environmental awareness of college students is moderate. This study also advises some recommendations to safeguard the environment in India.

Keywords: *Environmental Awareness, Environment, College students*

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1. Introduction

Environmental awareness refers to an act of spreading information regarding the role and importance of environment for human life so as to take strong measure to protect the environment from a lot of environmental life hazards. The place we live in forms the environment. Environment is a sum total of all the things that surrounds us. It is a set of relationship between and among all these things. The environmental awareness is to understand the insubstantiality of our environment & the importance of its protection.

Environmental awareness is the ability to perceive & understand the environment around us .It is the understanding of how our actions impact the environment & how environment impact us. It comprises an understanding of environmental concepts, principles & laws. Environmental awareness also includes taking actions to protect the environment.

Environmental awareness is important for many reasons. Primarily, it is necessary for the survival of human and other species. We depend on the environment for our food, water and air. If we do not take care of our environment we will not be able to survive. Then, environmental awareness is important for the health of our planet. The earth is facing many environmental problems such as climate change, pollution and loss of biodiversity. These problems are mainly caused by human activity and they are having a negative impact on the earth's ecosystem. If we do not take action to protect the environment these problems will get worse & the earth will become less livable for human and other species. Thirdly, Environmental awareness is important for the future of our planet. Our action today will have an impact on the future of our planet. If we do not take care of the environment we will leave a legacy of environmental problems for future generation.

Environmental awareness is very significant in current days. Human should respect, protect and preserve the natural world from its destruction. Many times people do not realize what type of effect they have on the environment in their everyday life. However, even with the smallest changes a person makes in their daily routine can make enormous impact on the way the environment is going to be.

2. Significance of the Study:

A study on environmental awareness is one of the most important areas of study. Human should respect, protect and preserve the natural world from its destruction. It is said that environmental awareness is the key to protect our environment. Without which it is not possible to save our environment. Good environment plays a very important role to human being and other organism at large. Awareness of how good to conserve environment is can develop interest of keeping environment clean to avoid the consequences of unclean environment. Therefore it is necessary to create environmental awareness among the students. Our study is significant in creating environmental awareness among the college students. The researcher hopes that the findings would contribute to understand the importance of environmental awareness in every phases of life. The result of this study is significant in terms of its contribution to create environmental awareness among the college students.

3. Delimitation of the study

The present study is delimited to the college students of Barbhag College.

4. Objectives of the study :

1. To make a study on Environmental Awareness among the college students.

2. To study the differences between male and female college students in regard to Environmental Awareness.

Null Hypothesis

There is no significant difference among college students in regard to environmental awareness.

There is no significant difference between male and female college students in regard to Environmental Awareness.

5. Methods & Sample:

Keeping in mind the nature of the present problem the investigator used random sampling method & descriptive survey method to investigate the environmental awareness among the college students in their day to day life. For research study investigator has selected 100 college students from Barbhag College of Nalbari District. Out of 100 students 50 were male & 50 were female students. In this research studies all college students are eligible to participate.

Table no 1: Sampling Design

SI No	Variables	Category	No of Students	Total
1	Gender	Male	50	100
		Female	50	

6. Tools used:

A self-structured questionnaire named as “**Environmental Awareness Questionnaire**” has been developed for collecting data. Questionnaire has been developed on the basis of different dimension of Environmental Awareness such as Environmental

problems, Environmental activities, Plantation, Eco-friendly attitude, use of Dustbin, Environmental Ethics, Saving energy, sound pollution & Saving energy . Questionnaire has been developed with some close ended questions. Respondent have to give their responses by providing correct mark to Yes or No. Data have been analyzed by using simple statistical techniques such as percentage, histogram for the present study.

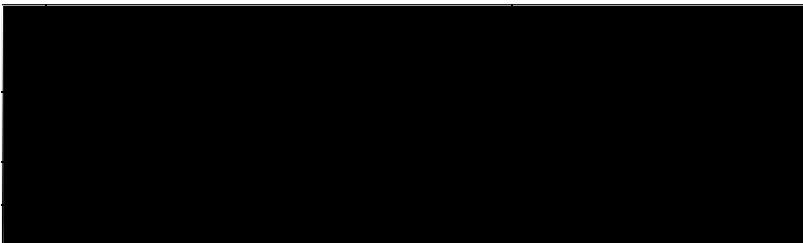
7. Data Collection :

Data were collected from college students included in the sample. Before actual administration of the tools the purpose of the researcher was told to the students & their cooperation was solicited. The procedure of responses was also explained to them. Test materials were administered on individual basis.

8. Analysis & Interpretation of Data:

Analysis of data means studying the organized material in order to discover inherent facts. The data are studied on the basis of some dimensions of Environmental Awareness. Data analysis and interpretation are two important phases in any research work. The main objective of this study is to study the environmental awareness among the college students of Barbhag College of Nalbari District. To achieve the objective of study following tables has been used-

Table no 2: Showing the percentages of college students in regard to Environmental Awareness by using Self Structured Questionnaire





Analysis of the Table no 2

- From the above table it has been observed that 76% of students were conscious towards environmental problems.
- From the above table it has been observed that 64% of students have taken participation in Environmental Activities.
- From the above table it can be said that 61.5% of students have their positive Willingness in Plantation process.
- From the above table it has been observed that 71.5% of students have eco-friendly attitude towards environment.
- As per analysis of the table 70% of students have interest in Preservation of trees.
- From the above table it can be said that 63.5% of students have their routine habit of using Dustbin in daily life.
- As per analysis of the table 60% of students have Environmental Ethics towards environment.
- From the above table it can be said that 100 % of students have their positive awareness in saving energy which is good mark for future generation.
- From the above table it has been observed that 72.5% of students have their awareness towards sound pollution.
- As per analysis of the table 55% of students have their consciousness in regard to recycling process.

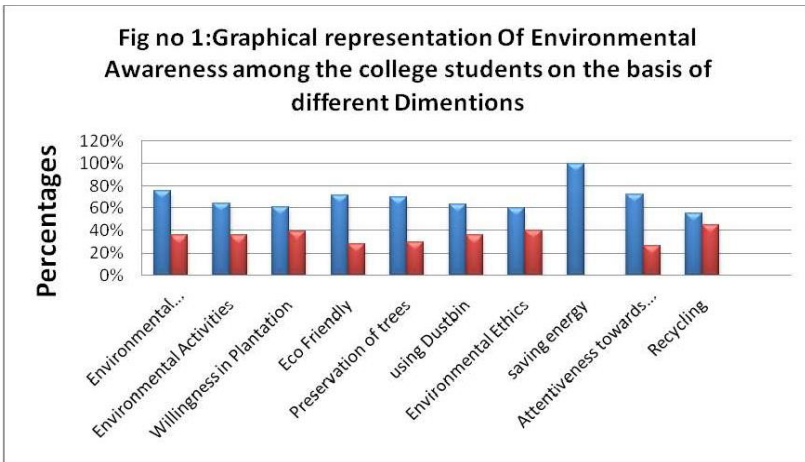
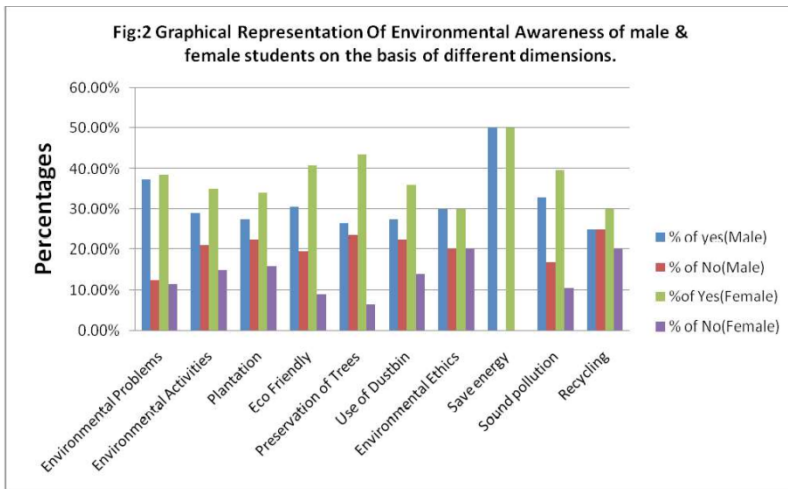


Table no 3: Showing the percentages male and female college students in regard to Environmental awareness

Analysis of Table no 3

- There is a significant difference between male and female college student in regard to different dimensions of Environmental Awareness.

- From the study it has been found that 37.5% of male and 38.5% of female students were conscious towards environmental problems.
- As per analysis of the table it has been found that 29 % of male and 35 % of female students have taken participation in environmental activities.
- Study reveals that only 27.5 % of male and 34% of female students have willingness in Plantation process.
- From the study it has been found that 30% of male & 30% of female college students have positive attitude towards environmental ethics.
- One of the major findings of present study is that the rate of percentage is equal in regard to awareness towards saving energy on the part of male & female college students.
- From the present study it has been found that 25% of male and 30% of female college students have their consciousness in regard to recycling process.



9. Findings of the Study

- Most of the college students have moderate level of Environmental Awareness.

- Male & Female college students are not equally aware for their environment.

- From the study it has been found that Female college students are more aware as compare to male students.

- There is a different level of environmental awareness among the college students on the basis of different dimensions of Environmental Awareness.

- Null hypothesis that there is no significant difference among college students in regard to environmental awareness is rejected.

- Null hypothesis that there is no significant difference between male and female college students in regard to Environmental Awareness is positively rejected.

- The findings of the study reveal that most of the college student has positive level of Environmental Awareness.

- The findings of the study reveal that most of the college student has positive level of Environmental Awareness.

10. Educational implication

The findings of the present study have identified the issues that are needed to be focused with great care & dedication for creating high level of Environmental Awareness among the college students. Findings reveal that there exists difference in opinion in some dimensions of Environmental Awareness among the college students. The findings of the present study cannot be considered as generalized one because of limited size of the sample students with a limited study area.

11. Suggestion for further study:

- An equivalent study can be done in other college and result can be compared with the present one.
- The present study is undertaken only on college students. A similar study with the same variables may be conducted on school students and university students.
- Comparative studies with the same variables among students studying in rural and urban colleges will be fruitful area of research.
- Similar study may be undertaken by considering the different demographic variables such as age, semester, class etc.
- The study of variables like environmental ethics, environmental problems among students can be also taken for fruitful research

12. Conclusion:

Environmental awareness is having an understanding of the environment, the impacts of human behavior on it, and the significance of its protection. It is an integral part of the environment & its protection. In order to create Environmental awareness among the college students it is very necessary to include Environmental Education as a compulsory subject at college level in their curriculum. Environmental education has developed an inevitable tool in creating awareness on issues impacting the environment upon which we all depend. Environmental education helps to study the environment in a systematic manner. It also enables the students to work for the betterment of our environment. Proper care must be taken in inculcating environmental ethics among the college students by organizing different environmental activities within the college campus. The findings of the study reveal that most of the college

student has positive level of environmental awareness. Proper education should be given to students so that they can realize the importance of protection of environment in every phases of their life.

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Attitude of Post Graduate Students towards Climate Change

Dr. Yodida Bhutia ¹

Dr. Rashmi Mili ²

Abstract :

Climate change has been the major concern in the world today. The impact of climate change is evident in every part of the world and to every living organism. The climate change has gone worst with the human activity. The industrialization, urbanization to accommodate growing population has taken toll on the well being of mother earth. In return the earth's climate is being modified and altered by the human activity. When we think of solution to this problem, one major agency to spread awareness and inculcate proper knowledge, skill and attitude is done by education as stated in Tbilisi conference, 1977 and Burtland Conference, 1987. The educated growing individuals in school, colleges and university have responsibility as well as moral duty to play a role to protect and conserve the environment. Of all these levels, students of university level are most matured and have established their own values towards environment and surely society expects more from their side. Therefore, the research will focus on the attitudes towards climate change among post graduate students of North Eastern Hill University. The sampling will be cluster sampling based on schools of the University. The method will be descriptive survey which is known to be common and widely used in social sciences (Mason & Bramble, 1997). The research will focus on the awareness, seriousness and urgency and ability to see

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the effect on each individual life, by the post graduate students of the university.

Key words: *Climate change, earth, attitude, post graduate students, university.*

Introduction :

Climate change is a continuous physical phenomenon of nature and generally influenced by anthropogenic forces. The nature, complexity and magnitude of such change are universally recognized to be governed by the rules of environmental conditions, ecological balance of nature; and more importantly by human interferences of various kinds. Climate change is a change in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the average weather or a change in the distribution of weather events around an average. Climate change may be limited to a specific region, or may occur across the entire globe. Documented evidences shown by the World Meteorological Organisation (WMO), IPCC, UNFCCC and others clearly point towards various adverse impacts of the climate change at alarming rates in the form of melting glaciers, outbreak of diseases, loss of biodiversity, erratic and scanty rainfalls causing drought and acute shortage of irrigation and drinking water and repeated crop failures in a vast stretch of landscapes of the planet (Sarkar, 2010)

The whole issue of climate change is centred on the generally expected global warming which has been confirmed by the Intergovernmental Panel on Climate Change (IPCC) in its final report, published in August 1990. In the context of climate change, carbon dioxide (CO²) is the most important of the greenhouse gases, the others being chlorofluorocarbons (CFCs), methane, nitrous oxide and ozone. The amount of carbondioxide

in the atmosphere has been increasing, mainly due to industrialisation and the burning of coal, oil and gas (fossil fuels) (Agrawal & Aggarwal, 1996).

NASA reports that the evidence for rapid climate change is compelling. The rising sea level, global temperature rise, warming oceans, shrinking ice sheets, declining Arctic Sea level, glacial retreat, ocean acidification, decreased snow cover, extreme events of high temperature and rainfall are evidences of unprecedented climate change over the years. Ninety-seven percent of climate scientists agree that climate-warming trends over the past century are very likely due to human activities, and most of the leading scientific organisations worldwide have issued public statements endorsing this position.

Justification of the study

As research evidences and government reports shows that unmindful human activities has been one of the major reasons for global climate change taking a toll on mother earth, it has become indispensable to create awareness among the people regarding the same. When we think of solution to this problem, one major agency to spread awareness and inculcate proper knowledge, skill and attitude is done by education. The educated growing individuals in school, colleges and university have responsibility as well as moral duty to play a role to protect and conserve the environment. Of all these levels, students of university level are most matured and have established their own values towards environment and surely society expects more from their side. Therefore, the research will focus on the attitudes towards climate change among post graduate students of North Eastern Hill University.

North-Eastern Hill University is one of the pioneer institutes in north-east India in disseminating quality higher education.

Situated in the beautiful town of Shillong, Meghalaya; North-Eastern Hill University was set up by an act of Parliament and notified on 19th July, 1973. The objectives of the University, as laid down in the act, are ‘to disseminate and advance knowledge by providing instructional and research facilities in such branches of learning as it may deem fit; to pay special attention to the improvement of the social and economic conditions and welfare of the people of the hill areas of the north-east region, and in particular, the intellectual, academic and cultural advancement.

Review of Related Literature

Climate change is a burning issue in recent times that has aroused curiosity among researchers worldwide to investigate in this arena. It is worth discussing some studies here on the attitudes of students towards climate change and environmental issues.

Taber and Taylor (2009) conducted a study where a hands-on science unit dealing specifically with global warming was prepared and taught over a period of eight weeks to 29 primary school students and their findings indicated that after the unit, students had a clearer understanding of the science of climate change, with the largest improvement in student knowledge occurring where the students had engaged in hands-on activities or had effective visual aids. The data also indicated that an increase in knowledge was accompanied by an increase in levels of concerns and overall increase in students’ belief about their ability to make a positive impact in relation to global warming and climate change.

Bhardwaj and Behal (2011) studied on the Environmental Awareness and attitude among college students of Delhi and their results revealed that environmental awareness was overall moderate while environmental attitude was high. There was no

significant difference observed between sex groups while environmental awareness results indicated that there was a significant difference among different levels of education. They also found that the media positively affected the level of environmental awareness and attitude among students.

Sinatra, Kardash, Taasobshirazi and Lombardi (2011) examined the relationship among cognitive and motivational variables impacting college students willingness to take mitigative action to reduce the impact of human-induced climate change. One hundred and forty college students were asked to read a persuasive text about human-induced climate change and were pre and post tested on their attitudes about climate change and their willingness to take action to mitigate its effects. Students showed statistically significant changes in their attitudes about climate change and their willingness to commit to take action. The research demonstrates that a persuasive text has the potential to promote change around complex socio-scientific issues.

Tranter and Skrbis (2011) studied the attitudes towards global warming, climate change and other environmental issues among young Queenslanders and the results show young Australians to be strongly supportive of action to prevent the impact of human induced global warming and favoured practices that promote sustainable development. Social background is an important determinant of environmental attitudes. Young women are more concerned about environmental issues than young men, including global warming and climate change, and are more likely to view global warming as a serious threat to Australia. Students whose parents are university educated and those planning to attend university after leaving school exhibit pro-environmental attitudes to a greater extent than other students,

demonstrating the importance of childhood socialisation in the formation of pro-environmental attitudes.

Ali, Chethan and Udaya (2013) found from their study that majority (80.5%) of the students considered global warming as an issue of major concern. Contributing factors for global warming was not known by 23% of the students. Majority (40.2%) believed that it does affect human health. Around 90% had a positive attitude towards the prevention of global warming.

Bhatia and Bhatia (2013) studied the Environmental awareness among post-graduate students and found that there exists no significant difference between post-graduate male and female students and Arts and science students regarding environmental awareness. But there exists significance difference between rural and urban students on environmental issues, where rural students were found to be more aware of environmental issues.

Mishra and Shukla (2013) found that university students strongly favour the consciousness, responsiveness as well as optimistic behaviour towards environmental issues as a key factor to resolve the environmental issues.

Gemeda (2015) investigated on the perceptions of climate change among natural resources management students at Jimma University, Ethiopia. The outcome of the study indicates that climate change is one of the top environmental problems and 92.9% of the respondents perceived that climate change affects the Ethiopian economy and 87.9% of the respondents agreed that climate change is a real problem of a country, 85.2% agreed that climate change affects human health and 74.7% of the respondents perceived that climate change disturb the ecosystem services.

Bruinders, Canavan, Johnstone, Mabuza, Mottushek and Spenser (n.d) made an assessment of knowledge, attitude and practices of P.G students of Rhodes University towards climate change and their results indicate that on the whole students have a significant understanding of climate change and most importantly show a real interest in the issue and willing to participate in climate change mitigating measures. The researchers further suggested that in order for students and in turn Rhodes University to become effective partners in combating global climate change, it is the onus of the university to create opportunities for students to do so.

Rizwana and Pallavi (2015) conducted a pilot study on attitude of PG students towards environmental issues and found that majority of the students are interested to know about the significance of environmental sustainability and also willing to help the society to acquire basic understanding of environmental protection. The correlation analysis shows a significant relationship between the students concern towards environmental issues and their willingness to work towards environmental protection.

Sah, Bellad and Angelkar (2015) assessed the knowledge and attitude regarding Global Warming among high school students and their results shows that nearly three quarters of the students had average level of knowledge and attitude towards global warming. None of the students had good attitude towards the same.

Research Questions

- a. Are the post graduate students aware of elements of climate change?
- b. How serious do they consider climate change?
- c. How do they view the effect of climate change on life?

Objectives of the study

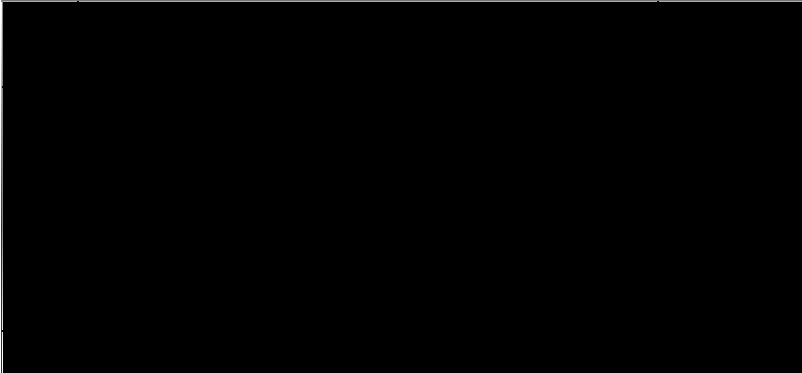
- a. To study the awareness of post graduate students towards the elements of climate change.
- b. To study the attitude of post graduate students towards the seriousness of climate change
- c. To study the view of post graduate students towards the effect of climate change on life.

Methodology

Descriptive method of study is followed for the present study.

Population and Sample

Table Showing the distribution of the Sample:



Tools

The tool used for the study is a self-constructed questionnaire. It consists of dimensions like awareness about climate change, urgency and effect of climate change in our life.

Results

Awareness

1. Major gas for Global Warming

Only 45.38 percent post graduate students correctly answered that major gas for global warming is CO₂.

2. Causes for frequent natural calamities

37 percent post graduate students still believe that earthquake is due to natural calamities.

3. Alternative form of energy to conserve the natural energy

92 percent post graduate students believe that it is good to use alternative forms of energy to conserve natural energy, even economic growth is slow. 8 percent post graduate students do not believe that it is good to use alternative forms of energy to conserve natural energy.

4. Choice of branded automobiles as compared to fuel efficiency automobiles

62 percent post graduate students would like to choose branded automobiles; they do not want to bother about fuel efficiency. The reasons stated by them are that branded automobiles are of quality, safe, its tested so fuel efficient, and they are with safety regulations for environment. Whereas only 28 percent post graduate students would like to choose fuel efficiency automobiles. They have expressed the preference to environment and saving fuel then riding on branded car.

5. Limited coal fired power plants

99 percent agrees that government limit coal fired power plants. They mentioned that human beings should not exploit natural resources and some reasons explained were that it is necessary to think of alternatives as coal takes millions of years to renew depleted coal as coal is a non-renewable resource and needs to be preserved. Coal pollutes the environment and leads to death of humans, harmful gas are emitted in the atmosphere from these power plants leading to health issues and degeneration of flora and fauna. Unchecked power plants often lead to the production of excessive waste which destroys natural elements. It pollutes the environment.

6. Responsibility of country

92 percent post graduate students think that our country has responsibility to take steps to deal with climate change. They mentioned that citizens of the country can protect the earth and conserve for future generation. The government should encourage planting more trees, use CNG in cars, using renewable sources of energy, should not allow old cars that lets out lots of smokes, encourage the citizens to control population, strict laws should be regulated in incorporating cleanliness, use of eco-friendly products, control deforestation, avoid indiscriminate littering and serious introduction of swach bharat, planting of trees, curbing of coal mining. They also stated that there is a need of educating people about the effects of global warming as earth is the only place to survive and to keep our race going, government should enact laws for curbing pollution, enacting laws to reduce coal use, CFCs, CO etc. They also opined that every citizen should take steps in dealing climate change.

The above data shows that the post graduate students are aware of climate change.

Seriousness or urgency

49 percent post graduate students think that climate change is very much a serious problem, whereas 32 percent think that climate change is somewhat a problem and still 1 percent thinks that climate change is not much a problem. This indicate still 50 percent do not consider climate change is an urgent issue to be addressed.

48.46 percent post graduate students mentioned that the effect of climate change is now. However still 16.92 percent students mentioned that impact of climate change is after 10 years and 10 percent students mentioned that impact of climate change is after 30 years and 3 percent students mentioned after

50 years. This indicates that only 49 percent that is even below 50 percent students think that issue of climate change is a matter of urgency.

Effect of Climate Change in our life

1. 96 percent students mentioned that plants and animals of our country will grow at fast rate, if climate keep changing. 3 percent students mentioned that plants and animals of our country will be extinct, if climate keep changing. 3 percent students mentioned that plants and animals of our country will not have effect even if climates keep changing.

2. 60 percent students stated that economy will be affected as all flora and fauna will be affected if climate change is unchecked.

3. 56 percent students think that Earth will live long, whether there is climate change or not however 44 percent do not think earth will live long when there is climate change. Those who think earth will live long mentioned that nothing is permanent, earth is ephemeral and transient, the earth has its own natural way of surviving. Earth is dynamic, we cannot predict actually what will happen, earth has been through 6 mass extinction, some of which due to climate change e.g. Ice age, earth is million years old and has adapted to the various changes.

4. 96 percent students think that shortage of food is inevitable one day if climate change is not curbed.

5. 96 percent students think that climate change effect human health

6. 64 percent post graduate students strongly disagree that climate change is a natural phenomenon and human being have nothing to do with it. 40 percent post graduate students disagree that climate change is a natural phenomenon and human being have nothing to do with it. 18 percent post graduate students

strongly agree that climate change is a natural phenomenon and human being have nothing to do with it.

Conclusion

Education is one of the major sources that can be used to combat and create awareness on the environmental issues and climate changes that are taking place in the world today. The students studying in the university level are the most valuable asset in this aspect as they are matured enough to give their views and opinions on the environmental problems. So, the present study investigated on the attitudes of post graduate students towards climate change and the data shows that they are quite aware of climate change having opinions like there should be use of alternative forms of energy to conserve natural energy, government should limit use of coal fired power plants, country has responsibility to take steps to deal with climate change. Majority of them are concerned about the effect of climate change in our life mentioning that plants and animals will get extinct, flora and fauna will be affected, shortage of food, effect on human health and the earth will be degraded and will become extinct one day. While 49 percent of the students are concerned about the seriousness and urgency of the problems of climate change, which has to be dealt with urgently.

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Environmental Awareness among Higher Secondary Students of Golaghat District, Assam

Dr. Shewali Bora

Abstract :

Environmental degradation is one of the major concerns of the world today. Several activities of the human beings have contributed immensely towards degradation of the environment. In the name of development man has been ruthlessly exploiting natural resources and polluting natural environment. Educating and creating awareness among the people is the only way to prevent this problem of environmental degradation. Therefore, the investigator conducted a survey on environmental awareness among higher secondary students of Golaghat District, Assam as the young generation plays an important role in this context. Descriptive survey method is followed in the study. A tool of 'Environmental Awareness Ability Scale (EAAS)', constructed and standardized by Dr. Praveen Kumar Jha was used to measure Environmental Awareness Ability. The investigator selected a representative sample of 150 higher secondary school students to collect data for the purpose. Data gathered was analysed and interpreted by using statistical techniques like mean, S.D. and t-test.

Keywords: *Environmental Awareness, senior secondary students*

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Introduction :

Environment includes all the biotic factors like human beings, plants, animals, trees, grass, bacteria and abiotic factors like water, sunlight, oxygen, soil and temperature etc., that surrounds us. All these factors are essential for the survival of any type of life in this beautiful world. Keeping in mind early human beings maintained a harmonious relationship with the nature. They respected, cared and were in awe of the wonders of nature. But with the passes of time, the mindset of people has changed and in the name of population explosion, urbanisation and industrialisation, people started exploiting the environment and as a result environmental degradation took place. Environmental degradation threatens the survival of human life causing enormous issues like global warming, ozone depletion, drought, soil erosion, deforestation, and pollutions etc. Keeping in mind all these issues Environmental education- a subject through which people can explore environmental issues, engage in problem solving and take action to improve the environment has been included in all the stages of education from primary to higher level. Because, it is very much important to create a sense of awareness among the people for the survival of our present and future generations.

Literature review

1. Asthana and Divedi (2015) studied about the level of environmental awareness among B Ed students of Dehradun district, Uttarakhand. It was found that their level of environmental awareness was remarkably high.

2. Singh (2016) carried out a study on environmental awareness among undergraduate students in relation to their stream of study and area of residence in Ambala District. The

researcher conducted the study among 224 undergraduate students studying in government/ government aided colleges. The findings of the study revealed that good average level of environmental awareness among undergraduate students. The study also revealed that there exists significant difference in the level of environmental awareness among undergraduate students in relation to their stream of study.

3. Panigrahi (2016) conducted a study on environmental awareness of secondary school students of Boudh district and found that secondary school students of Boudh district are aware about environment. It was also found that boys are more aware about environment than girls.

4. Dutta (2017) conducted a study on environmental awareness among the college students of Dhakuakhana sub-division, Assam. It was found that 75% of total respondents were aware about environment. Moreover, there is not much difference between Arts, Science and Commerce stream students regarding environmental awareness. However, students studying in science have a relatively high level of environmental awareness and difference exists between male and female students. Regarding locality, urban students are more aware of environment than the rural area.

5. Biawas (2017) conducted a study on environmental awareness of secondary school students in relation to gender, locale of study and medium of instruction in Mursidabad district of West Bengal. It was found that boys and girl students differ significantly in their environmental awareness. Moreover, urban students are more aware of environment as compared to rural students. It was also found that students studying in Bengali medium are more aware than students studying in English medium.

6. G. Sudhakar et.al. (2020) conducted a study on level of environmental awareness among secondary school students in Guntur District, Andhra Pradesh. That study revealed that there is no significant level of environmental awareness among the students but it is significant with gender and location of students.

Need and Significance of the study

Studying environment and environmental issues is one of the important area in the present time. Creating awareness among the masses can only help and protect our environment from environmental degradations. Moreover, students being the representative of our broader world can bring changes if proper education can be provided to them through various activities. Therefore, keeping in mind all these issues, a study has been conducted to know the level of environmental awareness among higher secondary students of Golaghat district, Assam.

Objectives of the study

Major objectives:

To find out the level of environmental awareness among boys and girls students of Golaghat district of Assam studying in class 11 and 12.

Specific objectives:

To compare the level of environmental awareness between boys and girls senior secondary students of Golaghat district of Assam.

Hypotheses

Ho: there is no significant difference between boys and girls of senior secondary school students in their level of environmental awareness.

Methodology of the study

Descriptive survey method is used in the study. Data have been analysed using mean and SD. To compare the sub group's level of awareness, t-test has been used.

Population of the study

The present study is conducted in Golaghat district of Assam. All the provincialised junior colleges of Golaghat district constituted the population of the study. Golaghat district has a total of 4 provincialised junior colleges viz. Barpathar Jr College, Kamarbandha jr College, Maranji Mahavidyalay (Jr) and Melamora Junior College. All the students studying in class 11 and class 12 constituted the population of the study.

Sample of the study:

A total of 150 students have been randomly selected for the present study from these four junior colleges of Golaghat District.

Tools used:

For the smooth conduct of the study, Environmental Awareness Ability Measure (EAAM) scale has been used. This scale has been developed and standardized by Praveen Kumar Jha in 1998. The scale consists of 51 items including 41 positive and 8 negative statements. The scale includes the dimensions like Causes of pollution, conservation of soil, forest, air etc, Energy Conservation, Conservation of Human Health, Conservation of wild life and animal husbandry.

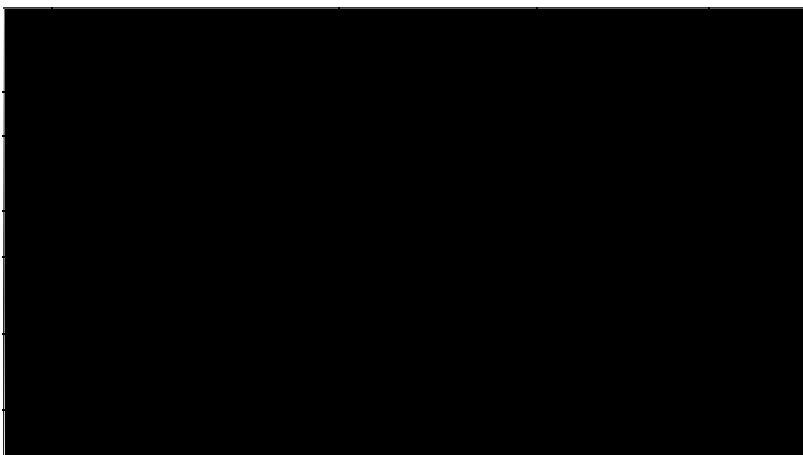
Delimitation of the study:

The study is limited to Junior colleges of Golaghat District.

Analysis and interpretation

The data have been analysed and interpreted using t-test to achieve the objectives of the study.

Table 1: Mean and SD scores of boys and girls higher secondary students of Golaghat district, Assam



*Significant at 0.01 level

From the table, it is observed that boys and girl differ significantly on the dimensions as conservation of soil, forest, air etc where the t value is 4.33 which are significant at 0.01 levels. Similarly, on the other dimensions like conservation of wild life and animal husbandry a significant difference was found where the t-value is 4.6. When we compare the mean score of boys and girls, it is observed that girl students score higher mean values in all the dimensions of the study. When we compare all the dimensions, a significant variation was found between boys and girls students ($t=3.25$) which is significant at 0.01 level.

Findings of the study

1. The study revealed that there exists a significant difference on the two dimensions. Firstly, on conservation of soil, forest, air etc and secondly, on conservation of wild life and animal husbandry. Therefore, we can reject the null hypothesis on the basis of these two dimensions.

2. No significant difference was found between boys and girls, on the other dimensions like causes of pollution, energy conservation, conservation of human health, conservation of wild life. Therefore, we can accept the null hypothesis on the basis of these dimensions.

3. From the findings, it is also observed that girls mean score is higher than boys in all the dimensions.

4. While comparing the overall score of girls and boys, a significant difference was found. Therefore, we can reject the null hypothesis on this ground.

Conclusion:

Environmental degradation being an issue of global concern needs more attention. More strict and rigid rules and regulations needs to be framed for the betterment of the people. It is observed that to create a sense of awareness, from school to college level in almost all the classes environmental studies have been included along with other subjects of study. But the acquired knowledge needs to be applied in real sense and attempts should be made in this regard.

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**ENVIRONMENTAL
CONSERVATION**



Sustainable Development and Water Conservation in India: An Analysis of Jal Shakti Abhiyan

Umanjyoti Das

Abstract:

Water, a scarce natural resource, is essential to life, livelihood, food security, and long-term development. Water is at the core of sustainable development and is critical for socio-economic development, energy and food production, healthy ecosystems and for human survival itself. As such, prioritizing proper water conservation and management is crucial. Water conservation is a process that comprises policies, strategies, and techniques for managing natural water sources in a sustainable manner, protecting the hydrosphere, and meeting present and future human water supply demand. This study discusses various water conservation strategies adopted by the government of India throughout the years. An attempt has been made to critically examine Jal Shakti Abhiyan, a water conservation campaign adopted by the government to address the growing issue of water scarcity.

Keywords: *Water, Conservation, Sustainable Development, Public Policy, Jal Shakti Abhiyan*

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Introduction

Water is indispensable to sustain life. The availability, access to, and quality of, water are crucial factors for determining the quality of life of human beings as well as other living beings. India is facing the challenge to serve 18% of the world population with 4% of the world's freshwater resources. Presently designated as a water stressed nation, India stores less than one-tenth of annual rainfall. Furthermore, disproportionate use of water for agricultural use, excessive ground water pumping and deficient monsoon in the last couple of years make the demand-supply balance more critical. Low consciousness about the scarcity of water and its life sustaining and economic value results in its mismanagement, wastage, and inefficient use, as also pollution and reduction of flows below minimum ecological needs (Ministry of Water Resources, 2012). Access to safe water for drinking and other domestic needs still continues to be a problem in many areas of India. According to NITI Aayog, India is currently experiencing its first water crisis, and if preventative measures are not taken, the demand for drinkable water may exceed the supply by the year 2030.

In recent years, water issues have become a source of growing international concern and discussions. The existence of a human right to water has been recognized in several international documents. For instance, Convention on Elimination of Discrimination against Women, 1979: Article 14(2) (h) explicitly mentions about provision of adequate water and sanitation to women. Similarly, Convention on the Right of the Child, 1989: Article 24 (2) (c) mentions right to safe drinking water of a child from a non-polluted source. United Nations General Assembly Resolution 64/292, 2010 recognizes the right to safe and clean drinking water and sanitation as a human right (Understanding Human Rights and Climate Change, n.d.).

The United Nations has long been addressing the global crisis caused by insufficient water supply to satisfy basic human needs and growing demands on the world's water resources to meet human, commercial and agricultural needs. The United Nations Water Conference (1977), the International Drinking Water Supply and Sanitation Decade (1981-1990), the International Conference on Water and the Environment (1992) and the Earth Summit (1992) - all focused on this vital resource. The 'Water for Life' International Decade for Action 2005-2015 helped around 1.3 billion people in developing countries gain access to safe drinking water and drove progress on sanitation as part of the effort to meet the Millennium Development Goals (United Nations, n.d.).

Sustainable Development: Goal 6 (SDG 6) focuses on "clean water and sanitation for all". It is one of the 17 Sustainable Development Goals that the United Nations General Assembly established in 2015. SDG 6 includes eight global targets that are universally applicable, six of which are to be achieved by the year 2030. These targets cover the entire water cycle including provision to achieve universal and equitable access to safe and affordable drinking water for all, treatment and reuse of wastewater and ambient water quality, water-use efficiency and scarcity and protecting and restoring water-related ecosystems. Further, Sustainable Development Goal 6 extends beyond drinking water, sanitation and hygiene to also address the quality and sustainability of water resources, which are critical to the survival of people and the planet. The 2030 Agenda recognizes the centrality of water resources to sustainable development and the vital role that improved drinking water; sanitation and hygiene play in progress in other areas, including health, education and poverty reduction (GOAL 6: Clean Water and Sanitation, n.d.).

In December 2016, the United Nations General Assembly adopted resolution 71/222 proclaiming the International Decade for Action, "Water for Sustainable Development", 2018-2028, commonly referred to as the 'Water Action Decade'. The Decade aims to advance sustainable development and integrated water resources management to achieve internationally agreed water-related goals and targets, including those contained in the 2030 Agenda for Sustainable Development. The new Decade focuses on the sustainable development and integrated management of water resources for the achievement of social, economic and environmental objectives. The Decade commenced on World Water Day 22 March 2018, and will terminate on World Water Day, 22 March 2028 (Water Action Decade, 2018).

Methodology

This study is primarily based on qualitative research. The information in the study has been gathered through secondary sources of knowledge, such as books, newspapers, articles, journals, websites, internet archives, and so on with an objective to critically analyze water conservation strategies and policies adopted by the government and how 'Jal Shakti Abhiyan', a major water conservation campaign can play a vital role in this regard.

Water Conservation in India: Policy Overview

The Indian Constitution does not expressly mention a basic right to water. Instead, this right has been asserted on the basis of the basic right to life enshrined in Article 21 of the Constitution. Unlike India, however, the constitutions of some countries such as South Africa and Uruguay expressly include access to water as a fundamental human right.

The Supreme Court of India and various High Courts have confirmed this right and the obligation of the government to

provide water. For instance, in *Subhash Kumar vs. State of Bihar*, AIR 1991 SC 420, the court ruled that the right to life is a fundamental right under Article 21 of the Constitution and it includes the right of enjoyment of pollution free water and air for full enjoyment of life. Besides the judgments of courts, however, there is relatively little in the legal and policy framework that recognizes the fundamental right to water.

The government exercises control over surface water resources in India. However, this control is not absolute and the government continues to owe a responsibility to the people in relation to surface water resources. The legal basis for this obligation is derived from the public trust doctrine, which states that the government is not an owner but a trustee of natural resources (such as water) and it is responsible for their protection and preservation. The government is required to manage and develop water without depriving any individual or group of access or significantly affecting ecosystem needs. Neither the government nor individuals can exercise absolute rights over water. The Supreme Court of India has applied the public trust doctrine to redefine the relationship between water and the government. The application of the public trust doctrine may influence the type of rights and privileges that can be claimed over surface water. However, the applicability of the doctrine to other sources of water, such as groundwater, remains unclear (Sarkar, 2016).

In India, the government formulated 'National Water Policy' (NWP) to govern the planning and development of water resources and their optimum utilization. The first National Water Policy was adopted in September, 1987. It was revised and updated in 2002 and later in 2012.

National Water Policy, 2012 considers that water should be treated as 'economic good' so as to promote its conservation and efficient use. Water is viewed as an economically valuable and finite good. This view is inspired by the Dublin Principles; a key outcome of the International Conference on Water and the Environment 1992, which expressly promotes the economic perspective on water. The Policy also calls for constituting a system to evolve benchmarks for water uses for different purposes, i.e. water footprints, and water auditing developed to ensure efficient use of water. Most importantly, it argues that water resources projects and services should be managed with community participation and the private sector can be encouraged to become a service provider in public private partnership model to meet agreed terms of service delivery (National Water Policy, 2014). The management of the water resources for diverse uses should be done by adopting a participatory approach: by involving not only the various governmental agencies but also the users and other stakeholders in an effective and decisive way in various aspects of planning, design, development and management of the water resources schemes (Kathpalia & Kapoor, 2002).

In the case of water sector reforms, participation is understood as a way to make water users (and not the public at large) more responsible for water management. Water sector reforms encourage private sector participation, particularly in urban water supply, as a means to ensure more efficient management and delivery of water services. The water related services should be transferred to community and/or private sector with appropriate "Public Private Partnership" model. Water needs to be managed as a community resource held, by the state, under public trust doctrine to achieve food security, livelihood, and equitable and sustainable development for all (Singh et al., 2013).

Jal Shakti Abhiyan: A Brief Analysis

In order to address water scarcity, it is important to undertake efforts for conservation, restoration, recharge and reuse of water. To this end, a unified Ministry of Jal Shakti was launched in May, 2019 as an immediate response to the escalating water crisis in India (Bora, 2019).

The Ministry of Jal Shakti (MoJS), Government of India launched Jal Shakti Abhiyan (JSA) in 2019 as a time-bound, mission-mode water conservation campaign. It is a campaign for water conservation and water security in the country through a collaborative effort of various ministries of the Government of India and state governments. The focus of the campaign is on water stressed districts and blocks. Ministry of Jal Shakti (MoJS) has identified 255 Districts and 1,597 Blocks across the country as water stressed, and total 756 Urban Local Bodies (ULBs) have been identified as water stressed.

The Abhiyan has been designed for implementation in two Phases: Phase 1 from 1st July to 15th September 2019 for all States and Union Territories; and Phase 2 from 1st October to 30th November 2019 for States and UTs receiving the retreating monsoon (Andhra Pradesh, Karnataka, Puducherry and Tamil Nadu).

In the short run, the campaign has focused on integrated demand and supply-side management of water at the local level, including creation of local infrastructure for source sustainability using rainwater harvesting, groundwater recharge and management of household wastewater for reuse. For the long run, the government has launched the 'Jal Jeevan Mission' (JJM) with an aim to ensure piped water supply to all rural households by 2024 (Bora, 2019).

The Jal Shakti Abhiyan specifies some major intervention areas such as Water conservation and Rainwater Harvesting (RWH), Renovation of traditional and other water bodies/tanks, Reuse of water and recharging of structures, Watershed development and Intensive afforestation.

Rain Water Harvesting (RWH) is collection and storage of rainwater from roof tops, roadside, open areas, etc. which can be stored for further usage or recharged into ground water to augment water resources. The National Water Policy 2002 as well as the Karnataka State Water Policy 2002 also recognizes the role of traditional water conservation practices like rainwater harvesting, including rooftop rainwater harvesting to further increase the utilizable water resources. Urban Local Bodies (ULBs) should constitute a 'Rain Water Harvesting Cell' for effective monitoring of Rain Water Harvesting in the city. National Water Mission's (NWM) campaign "Catch the Rain" with the tagline "Catch the rain, where it falls, when it falls" is designed to encourage states and stakeholders to build adequate Rain Water Harvesting Structures (RWHS).

JSA aims to explore alternatives to fresh water. To optimize the use of water, it is important to undertake treatment of waste water and reuse it. JSA also strives to rejuvenate Urban Water Bodies. These water bodies, if revived can store water and recharge ground water besides improving amenity value of the area. Plantation plays a significant role in absorption of storm and rainwater for maintenance of ground water table, prevention of soil erosion and run-off and encourages growth of natural habitat for flora and fauna. As such, Urban Local Bodies should undertake plantation near water bodies, public spaces, parks and on roadside to improve green cover and water cycle. Further, Jal Shakti Abhiyan has been designed to achieve greater public

participation in the efforts to conserve water. As such, Local communities need to be mobilized to play a vital role in efforts being undertaken under JSA. Urban Local Bodies should undertake measures to encourage collective ownership in management of water available locally.

The Central Government assistance to States for rural water supply began in 1972 with the launch of Accelerated Rural Water Supply Programme. It was renamed as 'National Rural Drinking Water Programme' (NRDWP) in 2009. Government of India has restructured and subsumed the National Rural Drinking Water Programme (NRDWP) into Jal Jeevan Mission (JJM) to provide Functional Household Tap Connection (FHTC) to every rural household i.e., Har Ghar Nal Se Jal (HGNSJ) by 2024.

Jal Jeevan Mission (JJM), a central government initiative under the Ministry of Jal Shakti, aims to ensure access of safe and adequate drinking piped water for every household in India. This mission aims to generate maximum community participation in the form of 'Jan Andolan' to achieve the target of functional household tap connection by 2024 (Jal Jeevan Mission (JJM), n.d.).

In order to address and contain the problem of groundwater depletion, the Indian Government introduced the 'Atal Bhujal Yojana' (ABY) in December, 2019. It has been launched under Jal Jeevan Mission and implemented and looked over by the Jal Shakti Ministry. Atal Bhujal Yojana as a Central Sector Scheme is related to groundwater usage and conservation in India. The scheme aims to improve ground water management through community participation in identified priority areas in seven states, viz. Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh (Atal Bhujal Yojana | Department of Water Resources, RD & GR | GoI, 2020).

Jal Shakti Abhiyan: A Way Forward

Jal Shakti Abhiyan (JSA) is an intensive water conservation campaign built on citizen participation to accelerate water conservation across the country (Bora, 2019). The government has given broader plans of JSA but there is a critical need to spell out the specific outcomes and targets in a tangible and achievable manner. In the absence of targets, the focus on objectives may be constrained. The scheme should also cover 'wastewater recycling and reuse', since considerable amount of piped water supply to urban areas that have potential for recycling, go to sewage unutilized. While renovation of traditional and other water bodies is a crucial step, strict administrative measures must be adopted to prevent and remove encroachment near water bodies. Watershed development is a long-term endeavour that calls for accurate technical knowledge for site identification, substantial human efforts, ample time, and adequate funding. JSA must have a comprehensive blueprint for developing watersheds with appropriate resources and objectives (Bora, 2019).

There is a need for 'wastewater policy' that promotes water use efficiency, recycling, and reuse in both urban and rural areas, so that programmes like JSA can have more tangible goals. JSA cannot claim much progress until excessive extraction of groundwater is prevented (Bora, 2019). As early as in 1987, the National Water Policy (revised in 2002) recognized need for regulation of groundwater. Suitable measures to control groundwater extraction in this context become just as crucial as recharge. In order to ensure strict compliance with the treatment and disposal of sewage and effluents prior to discharge into water bodies, JSA should design a monitoring mechanism in conjunction with the district authorities. Though afforestation has been on the JSA agenda, it should make sure that there is no

deforestation in and around the affected districts. Artificial forests cannot substitute natural ones. Artificial plantation leads to loss in biodiversity and native forests. Therefore, preventing continued deforestation is a more appropriate policy action than planting trees with insufficient scientific and environmental knowledge (Bora, 2019).

Some critical steps must be taken which could lead the JSA campaign to achieve timely, result oriented, and measurable outcomes. Jal Shakti Abhiyan should adopt a knowledge-based approach to water conservation. Though Jal Shakti Abhiyan aims at making water conservation a Jan Andolan through community participation, the lead in planning and training should be undertaken by a group of experts from the community and district-level departments comprising of hydrologists, para-hydrologists, engineers, and Village Water and Sanitation Committee (VWSC). The availability of dedicated funds for the JSA, in addition to funds from other departmental schemes, will allow the district to spend in capacity building, recruiting technical specialists, and meeting the campaign's infrastructural needs. In addition, JSA should establish reliable reporting and monitoring mechanisms to ensure the scheme's effective implementation (Jal Shakti Abhiyan: Analysis and Learning | WaterAid India, n.d.)

Conclusion

Water is a prime natural resource, a basic human need and a precious national asset. A national water policy for the twenty-first century must acknowledge water as a national resource for the purpose of national development goals and planning.

With an aim to address the issue of water scarcity, the government of India has initiated the 'Jal Shakti Abhiyan' as a strategy to revive India back to a sustained system of water conservation. It has specified major intervention areas in an

attempt to conserve water in a sustainable manner. The JSA scheme seeks to generate public awareness about water conservation and harvesting, which is crucial to ensure citizen participation. There is a need to educate people about the 'value' of water as well as its conservation. While JSA indicates the government's positive intent at water conservation, the desired results can be achieved only through active participation and cooperation from all sections of society. Water will always be a basic necessity of man and our collective future depends on its sustainability today.

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Role of Indian religions and culture in environment conservation

Barshneyee Bhattacharyya

Abstract

Indian society believes nature as the mother of creation and if any harm is caused to Mother Nature, she might start crying in the form of natural disaster. Indian religions have always worshiped Mother Nature and have valued environment a lot. All the religions that have existed in India in different period of time have considered the environment as god's creation which must be protected at any cost. Indian culture has always tried to spread awareness about the importance of environment. Values and customs practiced in Indian society have valued the nature every time.

Keywords : *Indian Religion, Culture and Environment Conservation.*

Introduction

Every religion and culture has something to offer when it comes to conservation of the environment. Several injunctions or exhortations from each religion can be brought forth to form a code for environmentally sustainable development. This is amply and extensively demonstrated in the various religions' codes. Living in harmony with nature has always been an important aspect of Indian culture. From time immemorial, this has been abundantly reflected in a variety of traditional practices, religious beliefs, rituals, folklore, arts and crafts, and the daily lives of the Indian people. In comparison to India's long tradition and cultural ethos of nature conservation, the current global concerns for sustainable development and conservation of natural resources spanning the

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two decades between the Stockholm Conference on Environment in 1992 and the United Nations Conference on Human Environment and Development (Earth Summit) in Rio de Janeiro in 1992 are of recent origin. Mother Earth worship is a universal phenomenon in many indigenous cultures. There are numerous examples of festivals, rituals, songs, and myths all over the world that celebrate Mother Earth's gifts, revealing the intimate sense of togetherness and harmony that exists between man and nature in tribal societies.

Objective:

The objective of this paper is to look at the ways in which different religion in India have helped in conserving the environment. The paper also highlights the values and ideas that the Indian culture provides in reference to nature. It focuses on how Indian society has embraced the power of nature.

Methodology:

The methodology used in this writing is purely descriptive and analytical. The study is based on secondary source of information. Different books, journals and internet along with some personal observations are used as secondary sources of information.

Role of Indian religion in environment conservation

Many religious faiths instill a sense of reverence for nature. Many Hindu gods and goddesses are depicted riding on animals. Sacred groves and sacred forests have long been revered in Hindu and Buddhist culture. Conservation of the environment is based on the principle that God created nature and its components, and humans are entrusted with the responsibility of protecting them in both Christianity and Islam. Many religions and moral philosophies have declared the interconnectedness of all life on Earth and the obligation of humans to care for it.

Role of Hinduism

All lives have the same right to exist, according to Hindu scriptures. Humans have no authority over other creatures. They are forbidden from exploiting nature and are instead advised to

seek peace and live in harmony with it. To maintain and protect the harmonious unity of God and nature, the Hindu religion requires veneration, respect, and obedience. The doctrines of karma and rebirth are presupposed by Hindu philosophy, which provides a solid foundation for the doctrine of Ahimsa (nonviolence). The Hindu belief in the cycle of birth and rebirth, in which a person may reincarnate as an animal or a bird, means that other species are treated with not only respect, but also reverence. This provides a solid foundation for the doctrine of ahimsa - nonviolence (or non-injury) against animals and humans alike - in which Hindus have a strong belief. Nature is regarded as 'God's body' in Hinduism. Different birds and animals are associated with different Gods and Goddesses and are worshipped, or their protection and preservation is emphasized. Finally, Hinduism offers a moral framework for environmental preservation and conservation. Nature abuse and exploitation are considered unjust and sacrilegious.

Vedic literature (about 1500 BC) clearly speaks that there is an integral balance in Man, Nature and The God. Natural forces were considered to be expressions of the Lord Himself and are venerable entities. Vedas envisage a beautiful natural environment on earth and command the man not to pollute. During the **puranic** period (320 BC on ward) a popular belief emerged that each tree had its own deity. People offered water and circled trees with sacred threads in order to protect them.

Role of Buddhism

Buddhism is a religion full of love, understanding, and compassion dedicated to nonviolent ideals. Buddhism's fundamental tenets are simplicity and ahimsa. The sustainability-based simplicity principle teaches that man should not overexploit natural resources. The principle of ahimsa, or nonviolence, or not killing animals, demonstrates a love for fauna. Buddhism's teachings have focused on the theory of Karma and the theory of cause and effect. They show how unthinking disregard for these principles of right living can lead to chaos and, as a result, an environmental crisis. Rivers,

forests, and mountains are highly respected and regarded as bliss bestowals in Buddhism, and Buddhists had great respect for the Sun, Moon, and other planets. Buddha also set down rules forbidding the pollution of rivers, ponds and wells in Sutta-Nipata.

Role of Jainism

The principle of resuming from avoidable acts that are harmful to oneself or others is highly valued in Jainism. 5 Ahimsa (nonviolence) is a fundamental tenet of the Jain way of life, and it is clearly associated with realism, common sense, personal worth, and responsibility. Environmental harmony through spirituality should be pursued by all, according to the Jains. This can be accomplished by adhering to three precepts: correct belief, correct knowledge, and correct behaviour. Everyone should be kind to all living things, compassionate to the weak, forgiving of the arrogant and glad for the virtuous. This is the Jain approach to achieving environmental harmony.

Role of Sikhism

Nature was endowed with divine attributes by Guru Nanak, the founder of the Sikh religion. People should respect God's creations and understand the eternal truth about their place in the universe, according to Sikhism. The human race is an inseparable part of nature, inextricably linked to the rest of creation. The Guru Granth Sahib extols God's glory in nature and the environment. The Almighty God, according to Sikhs, created the universe. A balance between all of nature's elements is required for the universe to continue. Any disturbance in the balance causes distress and disaster. Many stories about the gurus' love and special relationship with the natural environment, including animals, birds, vegetation, earth, rivers, mountains, and the sky, can be found in their history. Thus, Sikhism teaches that the natural environment and the survival of all life forms are inextricably linked in nature's rhythm. Many stories about the gurus' love and special relationship with the natural environment—with animals, birds, vegetation, earth, rivers, mountains, and the sky—can be found in their history.

Role of Islam

The Holy Qur'an and Prophet Mohammed's divinely inspired words form the foundation and rules for nature conservation in Islam. The message of the Qur'an is one of unity, harmony, balance, and order. It emphasises the importance of adhering to nature's laws and not exceeding defined boundaries. Man was created to be a manifestation of divine attributes and to serve as a mirror to reflect God's image. According to the Holy Qur'an, everything is made of water. Allah is regarded as the owner of land, and mankind is regarded as the trustee or guardian, with other living creatures regarded as the beneficiaries. Allah is unity, and the unity of mankind and nature reflects His unity. His trustees have been charged with preserving the unity of His creations, as well as the integrity of the earth, including its flora, fauna, wild life, and natural environment. As a result, the environment is not solely for the benefit of the current generation. Rather, it is God's gift to all ages—past, present, and future. Surah 2:29 contains this message. In Islam, anything that causes pollution or deterioration of the environment is considered 'Fasad.'

Role of Christianity

According to Christianity, a harmonious triadic relationship exists between the divine and humanity, as well as between humans and nature, and failure to maintain the harmony may alienate humanity from its creator as well as from Nature. While churches have participated in small acts of protection, primarily tree planting efforts, they can be more beneficial as a method of gathering and spreading conservation education. There are several hundred verses in the Bible that discuss environmental protection. As a result, Christians bear environmental responsibility and promote behavioral change for the sake of the future. Humans have a responsibility to the environment, according to Christianity. Christians have a responsibility to do everything possible to ensure that they are environmentally responsible. Each person is responsible for their

contribution to the environment and must therefore take steps to protect it.

Role of Indian culture on environment conservation

India's cultural heritage demonstrates a strong concern for environmental protection and preservation. According to Indian tradition, the earth was referred to as "Mother." Lokmata Rivers are described. India is a land steeped in rites and rituals. Through sacred incarnations and systematised rituals for the sustenance of life on Earth, Indians have articulated the need to sustain and promote nature's ecological balances. Because almost all of the major world religions are represented on Indian soil, and their religions, in turn, realised the closeness of mankind and nature, they regulated human behaviour in a way that was environmentally friendly. Indian culture demonstrates an ecological evolution toward peace. Peace and harmony to all elements of nature and humanity. The culture lessons were applied on two levels by Indians. First, there is the relationship between society and nature, and then there is the relationship between people within society. Eco-cultural socialisation was practised in Indian society. The second lesson was about renewable energy and sustainability. It is founded on the understanding that sustenance comes from the forest, not from man-made cities: from the fields, not from factories. Thus, 'environmentalism' is an integral part of Indian culture. Historically, the protection of nature and wildlife was a fervent article of faith that was reflected in people's daily lives and enshrined in myths, folklore, religion, arts, and culture. Some of the fundamental principles of ecology—the interdependence and interrelationship of all life—were conceptualised in Indian ethos and reflected in the ancient scriptural text, the Isopanishad, over 2000 years ago.

There are a number of other trees and plants that are revered and grown on temple grounds, as well as those that are protected in other areas. In India, more than a hundred such tree/plant species are revered by various communities and religious faiths. Sandalwood,

beetlenut, palm, neem, coconut palm, juniper, champa, lotus, tulsi, pepper, and other plants fall into this category. Though based on religious faith, such traditional cultural attitudes have made significant contributions to the protection and propagation of various tree and plant species in India.

Conclusion

There is a huge role played by Indian culture and religion in environment conservation. As our own religion and culture has been conserving the environment from long back, it is also our responsibility to do the same. It is founded on the understanding that food comes from the forest, not from factories. All the religions and cultures around the world respect and protect the environment around them and everyone certainly knows that the environment is keeping us all alive. All religion and culture and we as an individual can come together and conserve the environment we are living in. For the survival of life on Earth, Indians have defined the necessity to protect and enhance natural ecological balance through sacred incarnations and systematized rituals. As a result; ‘environmentalism’ is an integral component of Indian culture. Religion and culture is the key factor in the conservation of the environment because people are holy to their religion and culture which guide people to save or conserve the environment.

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Role of Women in Environmental Protection

Dr. Nandita Goswami

Abstract

Women and environment are closely connected. They are the manager of resources of the family and directly collect water and fuel from the nature. Women are playing a key role in protection of environment and its preservation. Ester Boserup made emphasized on women role in protection and preservation of environment in her book “Women’s Role in Economic Development” in 1970. Women are gradually understand the impact of environmental degradation on society and therefore they are working for the protection of environment for the future generations. The World Bank report, 1991 said that women were playing an essential role in management of natural resources. India’s Chipko movement, Narmada Bachao Andolon, Kenya’s Green Belt movement and others various women movement took place for the protection of environment. Environmentalist activist like Jane Goodall, Greta Thunberg, Malaika Vaz, Katherine Hayhoe, Julia Lorraine Hill, Rachel Carson, Vandana Shiva, Sunita Narraine, Sumaira Abdulali, Kinkari Devi, Medha Patkar, Menaka Gandhi and many more are playing a key role for the protection of environment.

Keywords: *Women, environment, Conservation, movement*

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Introduction:

In various studies considerably shows that women were also an important contributors in the field of environment protection and preservation. They have a direct connection to environment with their day to day activities and deep knowledge of it. Mostly in developing countries of the world Women engage in agricultural farming and collect water and firewood directly from nature. The family and social obligations of women are closely interlinked with the environment. Therefore, they know about the soil, plants, trees, water and others resources of nature. Generally, they do not abuse them. As Women were closely associates with nature, they makes a culture for conservation and preservation of environment for ensuring that the future generation should get their needs available from environment and also learn how to preserve nature and environment for their next generation. Protection of environment and its resources cannot be possible without the participation of women. In our society women are managing water, firewood for fuel, food and others item from the forest and Agricultural field in every family. Women in different parts of the world are actively involved in saving the environment, but there is still limited recognition of their contribution. If sustainable development is a goal of the global community, the role of women in achieving this has to be underscored.

Women in different parts of the world are actively involved in saving the environment. The Millennium Development Goals include both, gender equality and environmental sustainability. Involving women in protecting the environment would help societies develop the sense of responsibility needed to maintain a good balance between humans and the earth's resources. The women's movement and the environmental movement share a close association, in the concept of Eco feminism. With growing

evidence of the environmental crisis, the focus on women as agents of change has intensified. Global environmental agencies and institutions now increasingly admit to the key role women play in conservation and protection of environment.

The UN Earth Summit (Rio) in 1992, India's Chipko movement, Narmada Bachao Andolon, Kenya's Green Belt movement and others various women movement and the works of the environmentalist activist highlighted the roles of women for sustainable development. Women like Jane Goodall, Greta Thunberg, Malaika Vaz, Katherine Hayhoe, Julia Lorraine Hill, Rachel Carson, Vandana Shiva, Sunita Narraine, Sumaira Abdulali, Kinkari Devi, Medha Patkar, Menaka Gandhi and many more are playing a key role for the protection of environment. The present Paper tries to focus on women's participation in environmental protection and conservation in global as well as national and state level.

Objective: The main objective of the paper is to describe the involvement of women in different environmental movement in Global as well as national and state level.

Data Accessibility :

All supporting data were obtained from previously published work available via references below and from the output of the international and national articles on which the paper is based.

Analysis:

Role of women in environmental movements differs from the developed to the developing countries. In the developed countries the issues that women are raising are largely related to pollution and the urban context, while in the developing countries the issues are linked to livelihood concerns in rural areas.

Globally, there are many examples of women writing and fighting to save the environment. One of the first well known

environmentalists was Rachel Carson, whose concern for the environment was voiced in her seminal book, 'Silent Spring' in 1962. Carson warned about the dangers of using chemical pesticides, particularly DDT, as it has serious effects on human health. Many see Carson as the mother of the environmental movement through the questions she raised in her book.

The environmental movement grew significantly after the industrial revolution, a result of the increasingly evident environmental pollution and degradation in our air and waterways. In response, some conservation groups are formed. One such group is the Emergency Conservation Committee, which was founded by *Rosalie Edge* in 1929. Edge was an outspoken leader of the conservation movement, focused her efforts on expanding protections for birds in order to preserve more species.

Environmental Movements lead by Women around the World:

Green Belt movement:

It was one of the biggest Environmental movement which was led by women. Green Belt movement was founded by Nobel Prize winner Wangari Maathai. The movement was initiated to stop Kenya's rapidly diminishing forest resources. It was the one of the biggest women movement for the protection of environment to bring environmental restoration along with society's economic growth and to empower rural women through environmental preservation. The movement led by Wangari Maathai on the day of world environment day on 5th June 1977 when very few women planted seven trees in Wangari Maathai's backyard, till 2005 there are 30 million trees had been planted by its participants in private lands. The Green Belt movement aims to bring environmental restoration along with society's economic growth.

Kenyan land takeover:

In Kenya, in the mid-1980s, women protested against the elites and big foreign corporations who were coerced and controlling the production of the land. Rather than allowing food to be grown for survival, women were pressured by both their husbands and the government to cultivate coffee for foreign profit. The protests continued and gained strength over the next couple of decades. The protests eventually ended in a Kenyan power shift enforcing democratic national elections, which resulted in the redistribution of land possible.

Role of Indian women in environmental conservation:

Women have contributed greatly to the conservation movements in the past. In India, a number of women are there who worked hard to save the environment from destruction

1. **Amrita Devi:** An Indian woman Amrita Devi who is popularly known as *Amrita Bai* lost her life in the attempt to protect the Khejri trees from cutting in Rajasthan. She protested to the felling of trees for building a palace for the Maharaja of Jodhpur. Amrita Devi belonged to the Bishnoi community, which is known for its love of nature.

2. **Gaura Devi and Bachni Devi:** The chipko movement started under the leadership of Gaura Devi and Bachni Devi who organized the women to hug the trees and prevent their cutting. Gaura Devi was the head of the mahila Mangal Dal, at the Reni village. The women decided to hug the trees to stop them from being felled. They guarded the trees all night until the lumbermen surrendered and left. The Chipko movement is known as the mother of all environmental movements in India. Same acts were repeated in other parts of Uttarakhand and thus women were seen as providing environmental solutions.

3. **Medha Patkar**– She is a popular environmental activist who is known for her active role in the Narmada Bachao Andolan, a powerful mass movement against the construction of a large

dam on the Narmada River. The proposed Sardar Sarovar Dam is a multi-crore project and would have displaced more than 320,000 people. She formed the NBA in 1989, and has been involved since. She followed democratic and non violent means of protest NBA has subsequently created high level awareness.

4. **Sunita Narain**– She is the Director General of Centre for Science and Environment (CSE), and publisher of Down to Earth. She began her work in the 1980s along with Anil Agarwal, another prominent environmentalist, and co-edited State of India’s environment report. Sunita chaired the Tiger Task Force for conservation in 2005. She is a member of the Prime Minister’s Council for Climate Change and National Ganga River Basin Authority (which employ practices to clean the river).

5. **Maneka Gandhi**– She was an environmentalist of India and a frontline worker of protection of animal rights. In 1994, she founded People for Animals, the largest organisation for animal’s welfare in India. She believed in the fact that India was in need of a movement to stop the unkind treatment meted out to animals. So she anchored a TV program “Heads and Tails” and authored a book.

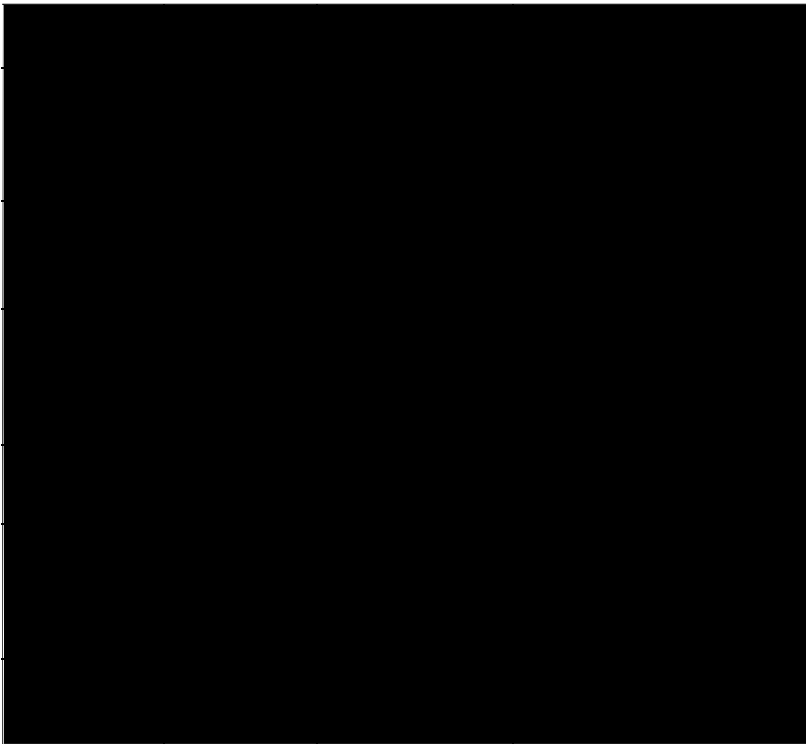
6. **Vandana Shiva**– She is an environmentalist and eco feminist of India. she is well known for her proletarian efforts to protect forests, organize women’s networks, and conserve local biodiversity. She has authored books such as Monocultures of the Mind, Staying Alive: Women, Ecology and Development, Biopiracy and Soil Not Oil: Environmental Justice in an Age of Climate Crisis. She was awarded many titles, in 2003, she was honored as ‘environmental hero’ by the Time Magazine for her works towards the environment. She was the leader of Navdanya movement also. She has founded and advised various organizations.

7. **Sugathakumari** – Sugathakumari, A poet and environmentalist, have dedicated most of her writings to Mother Nature. She is a frontline worker of environmental and feminist

movements in Kerala, South India. Prakriti Samrakshana Samithi was founded by her. She also participated in the ‘Save Silent Valley’ protest, a social movement aimed at the protection of Silent Valley, an evergreen tropical forest in the Palakkad district of Kerala.

8. **Radha Bhatt** – She fought against the hydroelectric power projects on Ganga and Actively formulating in the Uttarakhand Nadi Bachao Abhiyan in 2008. The projects not only threatened the flow of the Ganga and most of its tributaries but imperiled the fragile, heavily deforested ecosystem of the Himalayan state. She organized a 2000 km march for the rights for water.

There are several environmental movements in India and participation of women is very significant in different movements. The following table shows different environmental movements lead by women.



ROLE OF WOMEN IN ENIRONMENTAL MOVEMENTS IN ASSAM

Assam is a land of culture, history, biodiversity, natural resources. The forest area of Assam is decreasing day by day due to human encroachment. History shows that the tribal people are more inclined towards the environment as their livelihood depends upon nature. Especially, the women play an important role in the conservation of biodiversity and the environment from destruction.

Most of the tribal people of Assam are dependent on nature. Different traditions, festivals, cultures of the various tribes are closely connected with the nature. For example: Bihu festival of Assam, Bathou Puja of Bodos, Ali Aai Lrigang of Mising, Baitho of Kacharis etc. The tribal women of Assam have tremendous knowledge about nature and natural medicine. Tanushree Sarkar, in her study showed that in Assam, Bodo women conserve about 48 different plants to use for socio-cultural and religious purposes in the BTC (Bodoland Territorial Council) area (Goswami,2020).

Rupjyoti Gogoi, a resident of Bocha Gaon, near Kaziranga National Park, started an enterprise named 'Village Weaves' who gather the wastes- plastic bottles, packets of snacks, water bottles to create handloom products from it. From 2004 this enterprise has empowered more than 2300 women from different villages of Assam contributing towards the conservation of nature (Lal, 2021).

Dr. Purnima Devi Barman known as 'Hargila Baido' (Miss Hargila) is a well known environment activist of Assam. She is a member of the NGO (Non Governmental Organisation) 'Aranyak'. She is continuously giving her efforts to save the 'Greater Adjutant Stork' (Hargila in Assamese) from extinction. The New Zealand High Commission is also extended its helping

hand for the ‘Hargila Army’ consists of the rural women of Assam (WiNN News, 2019). Barman also achieved the prestigious Green Oscars Award 2017 for her relentless works to save Hargila in Dadara, Pachariya and Hingimari villages of Kamrup (United News of India, 2022).

Recently, Nizara Phukan, a PhD student of Jawaharlal Nehru University completed a 2000 km march from her home district Charaideo to New Delhi ‘to save mother Earth’. She wanted to create awareness among the people for planting trees. She, with her friends started an organization named ‘Brikhyabandhu’ which works to save environment and tackle climate change (The Telegraph, 22nd Dec, 2019)

Conclusion:

Role of woman into the protection of environment has been noticed very remarkable since ancient times. Women are always closely connected with the nature; they are the manager of the resources in all the families of the communities and directly collect resources for the household from the nature. Women were playing key role in protection of environment from the time unmemorable. Women in national or international level working for the betterment of environment by different movements, strikes, protest etc. Women were led Chipko movement, Bishnoi movement, Green Belt movement and many more. Women environmentalist activist like Greta Thunberg, Jane Goodall, Medha Patkar, Kinkari Devi, Vandhana Shiva and many more are working for the protection of environment. Throughout the above discussion it has found that women were working whole heartedly for protect and improves the environment, this will be become more active and fruitful when other parts of the society stand with the women by holding hand in hand

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**ENVIRONMENT AND
HUMAN HEALTH**



Climate Change and its impact on Human Health

Dr. Jayanta Kr. Das

Abstract

Climate change is one of the biggest and serious threats to human health as well as other organisms' survival. Our health is closely correlated to the environment we live in. Without realizing its threats, we and our ecosystem are suffering from the evil conditions as a direct or indirect result of climate change. Climate change gravely affects the viability of many plant and animal species including human health. The global warming is the main cause of climate change which dramatically alters natural cycles and weather patterns that include extreme heat, prolonged drought, increased flooding, more intense storms, and rising sea levels. Climate change can be due to natural external forcing or it can be human induced. Since the 1800s, human activities have been the main driver of climate change, primarily due to burning fossil fuels. Changes in the climate affect the air we breathe both indoors and outdoors. It is estimated that more people suffer from heat stroke and dehydration, as well as cardiovascular, respiratory, cerebrovascular diseases and severe weather-related accidents, and mental health issues due to exposure to extreme heat of climate change. Besides, changes in temperature, and extreme weather events increases the geographic range of diseases spread by vectors and can lead to various vector borne illnesses.

Key-words: *Climate change, ecosystem, illnesses, mental health, survival, temperature*

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Introduction:

Climate is the average weather in a particular area over a longer period of time usually followed for at least 30 years. The global climate is more than the “average” of the climates of specific places. The global climate is the connected system of sun, earth and oceans, wind, rain and snow, forests, deserts and also human activities. Climate Change is a concerning issue in the present world. It poses as a serious threat to ecosystem, biodiversity, and health for our planet. It refers to significant changes in land and water surface with temperature, precipitation, storm and wind patterns, or other weather-related events that can occur over a long period of time. The study of historic climate change is called *paleoclimatology*.

Our environment is changing, with the changing of climate. Our health is closely linked to the environment we live in. As a result of this, some significant consequences on our health, food security and safety of biodiversity have been observed by rapid and widespread changes in the environment. Human activities are the leading forces behind the decline of the environment as well as climate change. The effects of climate change are already being felt through more frequent severe extreme weather events such as floods, severe storms and heat waves in many places in the world. **Moreover, malnutrition is** one of the major concerns for a number of developing countries such as Africa, Asia and Latin America, as the impacts of climate change fall on food security, particularly in relation to floods and drought. **The imminent threat of climate change isn't just a threat to biodiversity, but also a direct consequence of mass extinction.**

It is seen that some invasive or nuisance species, like lionfish and ticks, may thrive in even more critical conditions of increasing temperatures and changing of climate. It is also found that the ocean absorbs about 30% of the carbon

dioxide that is released into the atmosphere from the burning of fossil fuels. As a result, the water is becoming more acidic, affecting marine or other aquatic life in addition to melting ice sheets and glaciers. Climate change refers warming of biosphere and side effects of warming rises surface temperature. Rising temperature due to climate change popularly affect humans' health (Pandhy *et al.*, 2015). The temperature rise also leads to high multiplication of pests like mosquitoes and other disease-causing bacteria and viruses. Two trends hot and dry and hot and wet have a different effect on the climates and, in return, on human health (Hajat, *et al.*, 2014). Climate Change is a serious environmental threat to humanity and for sustainable development. Along with continued warming of the atmosphere, unpredictable rainfall pattern are emerging and as result new patterns of droughts and floods are being observed, which are likely to get more frequent and severe in future given the warming of the earth because of the anthropogenic emissions of greenhouse gases. The Earth is now about 1.1°C warmer than it was in the late 1800s. Greenhouse gases such as carbon dioxide and methane are causing climate change. As greenhouse gas emissions blanket the Earth, they trap the sun's heat. This leads to global warming and climate change. A portion of green house comes from our day to day use of electronic luxurious devices.

The World Health Organization (WHO) projects that there will be approximately 250,000 deaths annually from climate change worldwide between 2030 and 2050(Kendrovski, & Schmoll, 2019). Climate change leads to production of key pollutants such as carbon monoxide, carbon-di-oxide (CO₂) and ozone (O₃) which are leading global risk factors for premature death. Droughts can increase the risk of vector-borne diseases spread by container-breeding mosquitoes in communities (Chretien *et al.*, 2007). Droughts reduce yields and nutritive value of crops, contributing to food insecurity, malnutrition, starvation,

and mass migration (Fried et al., 2014). In 2017, approximately 22 million people around the world were forced to leave their homes because of “sudden onset” adverse weather events such as flooding, forest fires, droughts, and intensified storms.

The Intergovernmental Panel on Climate Change (IPCC) has decided to prevent catastrophic health impacts and millions of climate change-related deaths suggesting the world to limit temperature rise to 1.5°C. Global heating of even 1.5°C is not considered safe for people’s lives and health. As temperature increases, more water evaporates from the oceans and other water sources into the atmosphere, causing further increase of the temperature. India is both a major greenhouse gas emitter and one of the most vulnerable countries in the world.

Methodology:

The present article is initiated with identification of research problems followed by a literature review and secondary data collection. The inclusions of the present published literature include on the peer reviewed articles on climate change and its impacts. The most of the secondary data are taken based on the reputed journals including Scopus, Web of Science database and Google Scholar. The journal databases are chosen based on their reputation and accessibility to author. The present review and data of the paper are based on published literature for the last two decades. The discussions and data are analyzed and interpreted after aggregation.

Observation and interpretations:

Climate change is the single biggest health threat facing humanity worldwide. Climate impacts are harming health, through air, water, soil pollution, extreme weather events, and poor nutrition in places where people cannot grow or find sufficient food. Decline in agricultural productivity is the main impact of climate change

on India also. Every year, environmental factors take the lives of around 13 million people. Changing weather patterns are expanding diseases, and extreme weather events increase deaths and make it difficult for health care systems to keep up. Climate change is impacting human lives and health in a variety of ways. Human health is increasingly threatened rapid and widespread changes such as rising temperature, pollution, flood, droughts and wildfire etc. Hundreds of millions of people across the globe are experiencing the impact of climate change.

At present, we are witnessing the impact of climate change on our biodiversity such as plants, animals including humans. We have seen the impact of extreme rainfall that caused historic flooding as seen recently in China, Pakistan and Nigeria. Our India including Assam has already been experiencing changes in climate and the impacts of climate change such as water stress, drought, severe storms and flood which result the negative consequences on health and livelihoods of the people of the locality year after year. Among the 12 states in the Indian Himalayan Region (IHR), Assam is found to be the most vulnerable to the changing climate, according to a Department of Science and Technology (DST) vulnerability assessment. 'Our Sustainable Future' sets out the challenges to promote clean energy, more sustainable approach to agriculture and transport, and for the conservation and management of our natural resources to ensure their sustainability for future generations.

Climate change does not affect people equally; indeed certain people are more vulnerable than others. The low-income people, the very old or very young people and especially children, workers in certain hazardous occupations, people living in environmentally fragile areas, people with disabilities are in gravest danger and more vulnerable to climatic impacts. Studies warn that economic development alone cannot protect humans from various upcoming

diseases due to climate changes. Eventually, currently populations of rich countries with vast resources are seen to be more at risk because, they are not well prepared to cope with extreme weather events. Climate change is contributing to slower-onset environmental shifts that can force human migration, such as desertification, sea-level rise, ocean acidification, air pollution, rain pattern shifts, and loss of biodiversity.

Impacts of climate change: The climatic changes have various impacts on the entire **ecosystem**. Each of the consequences of climatic change impacts on many different aspects of lives and livestock. The world is now warming faster day by day due to climate change. Warmer temperatures over time are changing weather patterns and disrupting the usual balance of nature. These stand as risks to human beings and other species of plants and animals. At the same time, many crops fail due to these extreme weather conditions. This consequence not only impact on the farmers themselves, but also for global food security.

It is seen in some places including Assam that flood and prolonged droughts have been associated with elevated levels of anxiety, depression, and post-traumatic stress disorders. In 2019, climate-sensitive diseases, including Malaria, were estimated to contribute to nearly 70% of deaths across the planet. Heart-related diseases due to heat and other climate factors account for a large part of this number, but region-specific diseases are also an important contributor. For instance, Africa accounts for 92% of global deaths due to malaria, a disease spread by the *Anopheles* mosquito, whose habitat range depends on climate. Asia currently experiences 96% of the world's deaths from dengue fever, which is spread by the *Aedes aegypti* mosquito. Between 2030 and 2050, climate change is expected to cause approximately 250 000 additional deaths per year from malnutrition, malaria, diarrhea and heat stress alone. Higher

temperatures increase the risk of food-borne infections such as gastroenteritis (gastro), caused by increased growth of pathogens such as *Campylobacter*, *Salmonella*, and *E. coli*. Some significant overall consequences of climate change are mentioned as follows.

(A) General consequences of climate change:

(a) Loss of species:

Climate change may be one of the major drivers of species extinction in the 21st century. **Climate change alarms the survival of near threatened species.** The world is losing species at a rate 1,000 times greater than at any other time in recorded human history. One million species are at risk of becoming extinct within the next few decades. Forest fires, extreme weather, and invasive pests and diseases are among many threats related to climate change.

(b) Insecurity of food:

Changes in the climate lead to increases in extreme weather events which are considered as the reasons behind a global rise in hunger and poor nutrition. Fisheries, crops, and livestock may be destroyed or become less productive. With the ocean becoming more acidic, marine resources that feed billions of people are at risk. Changes in snow and ice cover in many arctic regions have disrupted. Heat stress can diminish water and grasslands for grazing, causing declining crop yields and affecting livestock.

(c) Poverty and displacement:

Climate change increases the factors that put and keep people in poverty. Floods may sweep away urban slums, destroying homes and livelihoods. Most refugees come from countries that are most vulnerable and least ready to adapt to the impacts of climate change. Over the past decade (2010–2019), weather-related events displaced an estimated 23.1 million people on average each year, leaving many more vulnerable to poverty.

This article mainly tries to focus impacts of climate change on human health.

(B) Impacts of climate change on human health:

Millions of people across the globe are experiencing **the impact of climate change. Climate change has bought some new and rising health issues, including** unbearable and increase the risk of cardiovascular, respiratory, renal diseases **and other extreme events.** First of all, extreme events such as high temperature, droughts and storm and flood cause water-borne diseases or vector borne diseases. For Example, mosquitoes and other animals that carry infectious diseases like malaria from place to place (person to person) can only flourish in certain environments. This paper highlights the impact of climate change that **affects both physical and mental** health of human beings.

Physical health: Worldwide, **more than 5 million deaths each year** are linked to abnormally hot and cold temperatures. Air pollution produced by wildfires is associated with **respiratory and cardiovascular illness.** In 2019 alone, fine particulate matter in the atmosphere resulted in at least **1.8 million deaths globally.** Extremely hot weather and heat waves can **lead to heat stroke and exhaustion** and worsen chronic health conditions. As temperatures rise, research shows that **approximately 5,600 heat-related deaths** occurred each year from 1997–2006 in 297 counties where more than 60 percent of Americans live. The June 2021 heat wave in the Pacific Northwest **led to 600 excess deaths** in Washington and Oregon in one week alone.

Mental health: The impacts on mental health caused by climatic change are harder to quantify than the effects on physical health. Climate change also increases mental health disorders due to weather disasters, forced migration, food insecurity, and extreme heat waves. Post-traumatic stress disorder, depression, domestic abuse, general anxiety, and substance abuse have all been

associated with climate change in some contexts (Padhy *et al.*, 2015). **Extreme heat** can fuel mood and anxiety disorders and lead to suicide, interpersonal violence, and aggression. **Alterations to the natural environment** can cause grief, emotional pain, and disorientation; they can also lead to poor work performance, lower self-esteem, and harm interpersonal relationships. **Geographic displacement, which could be brought about by climate change**, can produce distress, anxiety, depression and can even weaken social cohesion. Enlarging refugee camps have high rates of diarrheal diseases, measles, acute respiratory infections, malaria and other vector-borne diseases, sexually transmitted infections, malnutrition, and chronic disease complications (Toole & Waldman, 1997).

Reasons of Climate Change: Scientists have accessed that higher greenhouse gas emissions, particularly from human activity have contributed to global warming. Global warming will occur when concentrations of greenhouse gases (heat-trapping gases) rise and thus keep more heat in the atmosphere than can escape into space and/or be absorbed on Earth. More heat in the atmosphere, less absorption of greenhouse gases on Earth, and solar and volcanic activity may contribute to an increase in global average surface temperatures (Morales, 2015). The average global temperature on Earth is directly linked to the concentration of green house gases in the atmosphere. Moreover, small rises in temperature have major impacts on weather and climate systems, causing detrimental impacts for life and society. Global warming hampers access to health services as well as the quality of services provided. There are many reasons for the climatic change and all the reasons can be included in two broad categories such as the natural and manmade (human) reasons.

(i) **Natural Causes of Climate Change:**

Natural phenomena such as, **volcanic eruptions**, fluctuations in **solar radiation**, tectonic plate movement, orbital variations etc are the causes of climate change that effects on planetary warming and cooling patterns. Due to these activities, the geographical conditions of an area become quite harmful for life to survive. Also, these activities raise the temperature of the earth to a great extent causing an imbalance in nature. Over the course of Earth's existence, such natural phenomena have been being observable. Natural causes are not the main culprits behind climate change. According to **NASA**, "these natural causes are still in play today, but their influence is too small or they occur too slowly to explain the rapid warming seen in recent decades."

(ii) **Man-made Causes of Climate Change:**

Human activities due to his need and greed are not only affected the environment but himself as well. Human activity is the main driver of climate change worldwide. The unchecked burning of fossil fuels over the past 150 years has drastically increased the presence of atmospheric greenhouse gases, most notably **carbon dioxide**. Right now, atmospheric concentrations of greenhouse gases like carbon dioxide, **methane**, and nitrous oxide etc. Other greenhouse gases, like **hydrochloro-fluorocarbons (HFCs)**, do not even exist in nature. By continuously pumping these gases into the air, we helped raise the earth's average temperature by about **1.9 degrees Fahrenheit** during the 20th century. These green house gases mainly carbon dioxide primarily driven by human activities come from using fossil fuels (e.g., burning coal, oil, and natural gas). When fossil fuels burn, they release greenhouse gases - mostly carbon dioxide (CO₂). These gases trap the Sun's heat and cause the planet's temperature to rise. From a reliable source, it is found that the world is now about 1.1⁰C warmer than it was in the 19th Century.

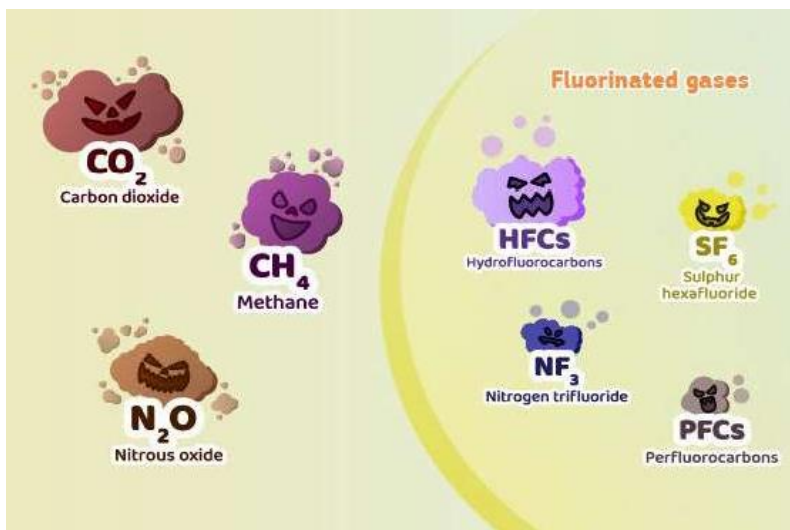


Figure- The main driver of climate change is the greenhouse effect

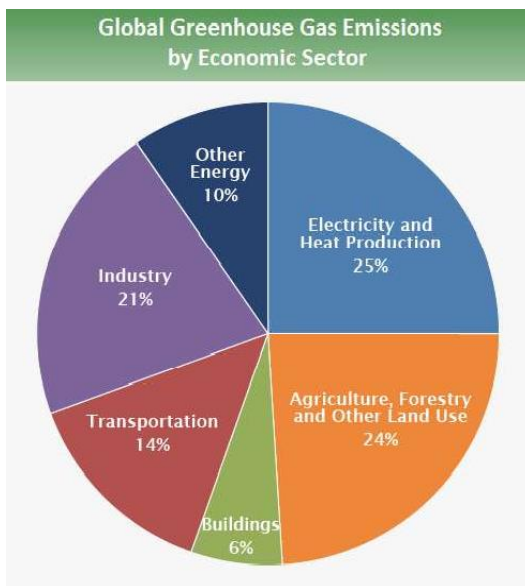


Figure: Pie diagram of global green house gases emitted factors

Some significant anthropogenic causes of climate change are mentioned below.

Fossil fuels:

Gases such as **carbon dioxide** and methane trap heat in the Earth's atmosphere. They are mostly created by humans burning fossil fuels. Some greenhouse gases, like **hydro chlorofluorocarbons (HFCs)**, do not even exist in nature. By continuously pumping these gases into the air, we helped raise the earth's average temperature by about **1.9 degree Fahrenheit** during the 20th century.

Generating power

Generating electricity and heat by burning fossil fuels causes a large chunk of global emissions. Most electricity is still generated by burning coal, oil, or gas, which produces carbon dioxide and nitrous oxide that powerful greenhouse gases that blanket the Earth and trap the sun's heat.

Manufacturing goods

Manufacturing industries produce greenhouse gas emissions mostly from burning fossil fuels for making things like cement, iron, steel, electronics, plastics, clothes, and other goods. Mining and other industrial processes also release harmful gases, as does the construction industry. The manufacturing industry is one of the largest contributors to greenhouse gas emissions worldwide.



Figure: Steam and smoke rises from a coal power station

Deforestation: Deforestation, together with agriculture is responsible for roughly a quarter of global greenhouse gas emissions. Since forests have been traditionally viewed as the lungs of the planet, absorbing carbon dioxide and releasing oxygen, destroying them or cutting down trees at an alarming rate also limits nature's ability to keep emissions out of the atmosphere. A total of 8,712 square kilometers of forest cover – almost the size of Puerto Rico – was destroyed from August 2020 to July 2021, according to satellite data from Brazil's space agency INPE.

Transportation:

The cars, trucks, ships, and planes that we use to transport ourselves are major source of global greenhouse gas emissions. Transport accounts for nearly one quarter of global energy-related carbon-dioxide emissions. Burning petroleum-based fuel in combustion engines releases massive amounts of carbon dioxide into the atmosphere.

Use of chemical Fertilisers:

Farmers use fertilisers to boost their agricultural output. But chemical fertilisers containing nitrogen produce nitrous oxide emissions, which increases the warming effect on the Earth's atmosphere.

Powering buildings:

Globally, residential and commercial buildings consume over half of all electricity. As they continue to draw on coal, oil, and natural gas for heating and cooling, they emit significant quantities of greenhouse gas emissions.

Fluorinated gases:

Our lifestyles have a profound impact on our planet. The damaging gases such as fluorinated gases are emitted from

equipment and products such as commercial and industrial refrigerators, air-conditioning systems and heat pumps. Such emissions have a very strong warming effect, up to 23,000 times greater than that of carbon dioxide.

As greenhouse gas concentrations rise, so does the global surface temperature. As temperatures rise, more moisture evaporates, which exacerbates extreme rainfall and flooding, causing more destructive storms. The frequency and extent of tropical storms is also affected by the warming ocean. Cyclones, hurricanes, and typhoons feed on warm waters at the ocean surface. Such storms often destroy homes and communities, causing deaths and huge economic losses.



Figure: The consequence of drought

Suggestive measures:

Our earth is now in grave danger due to rising global temperature. Rising global temperature leads to increasing extreme weather events such as flooding, droughts, air pollution, and wildfires around the world. The **climate change** leads to extreme weather events have adversely **impacted on human** health and other livestock too. Today, the conditions for life itself are severely threatened. If we do not do anything and

things continue to go on like right now then a day in future will come when humans will become extinct from the surface of the earth. But instead of neglecting these problems we start acting on our new activities to save the earth and our future. To save our earth from her illness, we have to be conscious of ourselves regarding climatic change and its consequences. There are options other than using fluorinated gases in the life-styled electrical equipments. For instance, hydrocarbons and ammonia, used in refrigeration, are considered safe and energy-efficient. The **renewable energy systems like solar or wind** may reduce the emissions driving climate change. **Fossil fuel production must decline** by roughly 6 per cent per year between 2020 and 2030 to keep warming below 1.5°C. Mitigation for climate change includes “Mitigation of greenhouse gases involves less dependence on fossil fuels, developing and using **alternate efficient** power sources, reducing encroachment and lowering social capitals (Rocque et al., 2021).”

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change. The IPCC’s Sixth Assessment report, published in 2021, found that human emissions of heat-trapping gases have already warmed the climate by nearly 2 degrees Fahrenheit (1.1 degrees Celsius) since pre-Industrial times (starting in 1750). The global average temperature is expected to reach or exceed 1.5 degrees C (about 3 degrees F) within the next few decades. These changes will affect all regions of Earth. Besides, we need **large-scale investments** to get more **zero-emission vehicles** on the road. We need to emphasize on renewable energy sources like wind and solar energy for corresponding decrease in pollutants. Cows and sheep produce large amounts of methane when they digest their food, and this gas adds to the greenhouse effect on the Earth. Furthermore, animals need

fields to graze on, and this leads to deforestation. Climate change activists suggest humans should choose to eat less meat.

The widespread adoption of **chemical fertilizers**, combined with certain crop-management accounts for nearly three-quarters of the nitrous oxide found in our atmosphere. We can fight climate change simply by changing what we eat. Choosing local foods when possible and buying food with less packaging. Saving water at home is another way to fight climate change. Limiting the use of fossil fuels such as oil, carbon and natural gas and replacing them with renewable and cleaner sources of energy, all while increasing energy efficiency. A mobile using Wi-Fi consumes less energy than one connected to 3G or 4G. Many plant and animal species go extinct due to human activity. Human activities that harm the climate include deforestation. However, sustainable land management practices, such as using more efficient irrigation systems and crop rotations, can protect ecosystems and the communities that depend on them, as well as help to regulate local climate patterns, improve water quality, and safeguard biodiversity. In a nutshell, we should remember, “to save the climate we must also save biodiversity”.

Conclusion:

Humans’ mistake has caused great damage to the climate and ecosystem. But, it is not late to start again and try to undo what we have done until now to damage the environment. Greenhouse gas emissions that result from the extraction and burning of fossil fuels are major contributors to climate changes. The ruthlessness of effects caused by climate change will depend on the path of future human activities. Many policies and individual measures, such as transport, food and energy use choices, have the potential to reduce greenhouse gas emissions and produce major health co-benefits, particularly by abating air pollution. Climate change

is expected to intensify health problems that already pose a major burden to vulnerable populations.

It is true that the Earth's changing climate is a natural occurrence, and that periods of both heating and cooling have occurred numerous times throughout the planet's history. Today, most scientists agree that humans have a significant impact on climate change and the overall warming of our planet. The more climate extremes and their widespread damaging effects across our planet will depend on the total amount of carbon dioxide we emit. So, if we can reduce emissions, we may avoid some of the worst effects of climatic change.

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Climate change and Global Warming; A Threat to Human Health

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Abstract

Environment is the whole of the water, air, and land as well as the relationships they have with one another, with humans, with other living things, and with property. Environmental ethics, on the other hand, relates to the concerns, values, and principles surrounding human interaction. The instruments for efficient environmental management and protection are provided by environmental legislation. Climate is a region's typical weather pattern. It is a region's average weather, seasonal variations, and weather extremes. Climate refers to such situations that average out over a lengthy time of at least 30 years. The atmosphere of the planet naturally contains carbon dioxide. At least in the lower atmosphere, it is not inherently a pollutant, but as its concentration rises, it has a negative impact on biological populations by altering the thermal environment and the balance of heat and radiation on the planet. Only carbon dioxide and water vapour, which make up the majority of the atmosphere, powerfully absorb IR radiation (14000–25000 nm) and effectively block a significant portion of the earth's radiated energy. Carbon dioxide and water vapour partially re-emit the radiation that has been absorbed by them back towards the

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earth's surface. Because carbon dioxide is more or less transparent to incoming short wave solar radiation but absorbs the majority of the outgoing long wave radiation emitted from the earth's surface, an ever-increasing amount of it from anthropogenic sources changes the composition of the atmosphere and the overall heat balance. Hence, the annual addition of more carbon dioxide to the atmosphere increases the earth's surface's ability to absorb radiation. The lower atmosphere warms as a result of this action. This warmer lower atmosphere distributes heat back to the earth's surface, warming it even more. The combined effect of all these mechanisms is a steady rise in earth's surface temperature in the lower atmosphere, which alters the climate on a local, regional, and global scale. The environment that gives us clean air, food, water, shelter, and security is impacted by changes in climate and climatic variability, notably changes in weather extremes. Many natural and man-made health stressors, including climate change, pose a danger to human health and wellbeing.

Keywords: *Environment, Earth, Carbon-dioxide, Climate, Radiation, Greenhouse gases, Health.*

Literature Review

According to the “Global Warming Problem, Causes And Solutions,” the greenhouse gas (GHG) impact is what causes global warming, which is defined as a change or an increase in the heating temperature of the atmosphere and the earth's surface. As global warming is not a recent issue, there are numerous studies, papers, researches, publications, and personal accounts regarding it. Several authors and scientists are able to create them. As an illustration, the 1999 study “Global warming: Introduction” by Robert J. Ruhf focuses on studies conducted in the early to mid-1990s. According to Robert J. Ruhf, the causes

of climate change are both human activity and natural occurrences.

The phrase “global warming” is used to characterise the heat and warming that are occurring as a result of the greenhouse gases, but according to Robert H. Friis, there were natural reasons that created the problem in the past. Under the heading “Naturally Occurring Air Pollution,” Robert H. Friis discussed a few natural occurrences or variables that may have a significant impact on the development of air pollution and global warming. Along with “Naturally Occurring Air Pollution,” Robert H. Friis also cited “Stationary Sources and Movable Sources of Air Pollution” as other forms of air pollution.

Three components will absorb the sunshine, according to Jane Genovese’s study. The landmass, the sea, and the remaining components will return to space. Due to the presence of greenhouse gases (GHG), the heat from the heated earth’s surface will trap and return to the surface of the planet. In addition, Jane Genovese discussed the historical contrast between before and after the industrial revolution and how it developed into a significant issue as a result of the CO₂ that can result. Global warming and GHG emissions will rise as a result of CO₂. Studies have shown that, in contrast to the Southern Hemisphere, the warming in the Northern Hemisphere has not changed much.

Introduction

There is no doubt that the Planet has warmed during the past century. These changes are unprecedented across decades to millennia, according to numerous studies of air and ocean temperatures, sea level, snow and ice, and other environmental variables. This warming has primarily been caused by human

activity. Climate change is a general word that can apply to both the causes and the results of changes in the Earth's climate at local, regional, and global stages. Many actions across the world can contribute to climate change. The temperatures may rise sharply as a result of climate change. Several distinct changes on Earth may take place as a result of rising temperatures. In addition to more frequent and severe heat waves, it may lead to greater floods, droughts, or extreme rain. Seas are warming and become more acidic, glaciers are melting, and sea levels are increasing. Oceans and glaciers have also undergone some modifications. These changes will probably pose difficulties for our culture and ecosystem as they happen regularly in the coming decades.

The observed century-scale increase in the Earth's average temperature and its repercussions are collectively referred to as "global warming." Given that it is one of the most significant indicators of global changes, the terms "global warming" and "climate change" are frequently used interchangeably. The rise in average global temperatures, known as "global warming," has a significant impact on ecosystems, animals, and people all around the world. The phrase "climate change" is used to refer to these extra effects since there are more variables and consequences than just an increase in surface temperatures. As of early 2020, there were 413 parts per million (ppm) of carbon dioxide in the atmosphere compared to a pre-Industrial average of roughly 280 ppm. In recorded history, there has never been a carbon dioxide concentration this high. According to scientists, in order to stop global warming, we must go back to a "safe" concentration of 350 ppm by the year 2100. Reliance on fossil fuel-based energy sources must remain, which makes it difficult to reduce emissions, especially as global energy demand rises.

Rising sea levels, glacier retreat, alterations in the timing of seasonal events (plant blossoming, migratory patterns), and an increase in the frequency and intensity of extreme weather events are only a few of the far-reaching repercussions of global warming. People and wildlife are affected by these impact categories in both direct and indirect ways. Communities in poverty are more likely to be exposed to environmental risks, are frequently more reliant on livelihoods based on natural resources, such as agriculture, and have fewer means to deal with climate change consequences.

Effects of Climate change on Human Health

The health crisis caused by climate change is severe. With its extensive effects on both human health and the surroundings that support health over the long term, it has been dubbed by WHO as the biggest danger to world health in the twenty-first century. Extreme heat and heat waves, which raise mortality rates, especially among the elderly and vulnerable, heat exhaustion, heat stroke, and the deterioration of pre-existing medical disorders are all direct health hazards associated with climate change. The effects of rising temperatures and weather extremes are mediated by how they affect things like agricultural yields, the development of waterborne, vector-borne, and other infectious illnesses, as well as rising poverty and emigration.

Human health would be impacted by global climate change through paths that varied in complexity, size, directness, and timeliness. Local population vulnerability, environmental, and geographical factors play a part, just as consequences differ around the globe. There would be both positive and bad results (although expert scientific reviews anticipate predominantly negative). Given that climate change will impact or disrupt a

wide range of biological and physical processes that are crucial to the planet's ability to support life, this is not surprising. Increases in other severe weather occurrences (floods, cyclones, storm-surges, droughts), changes in exposure to weather extremes (heat waves, winter cold), and increased generation of certain air pollutants and aeroallergens (spores and moulds) are among the most immediate effects on health. Increases in summer mortality brought on by the increasing frequency of heat waves may be offset by decrease in winter mortality brought on by warmer winters. It's still unclear how much climate change will alter the frequency, severity, and location of extreme weather occurrences.

There are many different health effects of natural catastrophes. They include short-term consequences of physical harm, sickness, and mortality, as well as possibly long-term consequences for mental health. Rapidly rising floodwaters are to blame for the majority of flood-related deaths because of the elevated danger of drowning. Both high-income and low-income nations have observed an upsurge in diarrheal and respiratory infections after floods. Transmission is accelerated where displaced people are crammed together. Particularly in low-income nations, droughts may have a variety of negative consequences on health, including those on nutrition, infectious illnesses, and air pollution brought on by forest fires.

The spread of several infectious illnesses (particularly water, food, and vector-borne diseases), as well as regional food productivity (especially cereal grains), might be impacted by climate change working through less direct mechanisms. Several physical (temperature, precipitation, humidity, surface water, and wind) and biotic conditions (vegetation, host species, predators, competitors, parasites and human interventions) have an impact

on the distribution and abundance of vector organisms and intermediate hosts for vector-borne illnesses . According to some integrated modeling studies, an increase in ambient temperature would result in net global increases in the geographic distribution of specific vector species (such as malarial mosquitoes), however some localised declines would also happen. Additionally, changes in the life-cycle dynamics of both vector species and pathogenic organisms (flukes, protozoa, bacteria, and viruses) due to changes in temperature would increase the likelihood that many vector-borne diseases, including malaria (mosquito), dengue fever (mosquito), and leishmaniasis (sand-fly), would be transmitted.

Discussion and Recommendations

Climate change already has an impact on human health, and those consequences will get worse with time. Long-term changes to environmental, ecological, and social living circumstances will pose a larger health risk to many people. Epidemiologists and public health professionals should actively participate in the creation of plans for reducing the negative health effects of climate change at national, regional, and international levels, just as lead was gradually phased out of gasoline and steps were taken to slow down stratospheric ozone depletion. This is because protecting and improving human health is one of the ultimate goals of sustainable development.

A considerable global decrease in greenhouse gas emissions is necessary to really avert harmful climate change consequences on human health (along with many other elements of the biophysical world), and this reduction is doable with current technology. The recent agreement by the world community to reduce greenhouse gas emissions over the next few decades and

keep the increase in global temperature this century to under 2° Celsius over pre-industrial levels is promising. To guarantee adequate emissions reductions at the global level, a worldwide implementation strategy for climate policy is urgently required. The G20 countries' inaugural meeting of the Environment and Climate Sustainability Working Group (ECSWG), presided over by India, signals the start of fruitful discussions for a sustainable future. The Ministry of Environment, Forestry and Climate Change (MoEFCC), Government of India, served as the meeting's host over its three days from February 9 to 11, 2023. Marine litter, the preservation and improvement of coastal and marine ecosystems, and marine spatial planning were only a few of the topics discussed at the Oceans and Blue Economy talks. The technical research on “Accelerating the transition to Sustainable & Climate Resilient Blue Economy” that would include all G20 Countries and give inputs for creation of high-level principles on “Sustainable and Climate Resilient Blue Economy” was introduced by the Presidency.

The monitoring, assessment, and improvement of established policies and actions requires well planned surveillance and study. Effective public health adaption techniques are little understood. To find, use, and improve these tactics, interdisciplinary research is necessary. It is obvious that more has to be done in this regard. Although the majority of temperature-related deaths are now caused by cold, and days with severe temperatures have considerably less of an impact than days with warmer but less desirable weather, this position might quickly change if global warming continues. Health authorities should focus on preparing for seasonal changes in mortality patterns and a significant increase in heat-related morbidity and mortality in the near future. Therefore, in order to address the milder but more substantial temperature excursions and increasing temperature

unpredictability, public health measures must be developed and put into place.

As long as climate change continues, severe weather events (such as cyclones, heat waves, floods, bushfires, and droughts) are anticipated to become more frequent, intense, long-lasting, and geographically widespread. To respond to these disasters, it is necessary to improve infrastructure for public health, disaster management, and community resilience. It is important to establish and/or enhance early warning systems for heat waves, floods, and other catastrophes so that their negative effects on public health can be reduced and/or avoided.

Infectious illnesses that are on the rise and in resurgence pose a serious health danger. The development of vaccinations for illnesses susceptible to climate change requires increased effort. Quantifying how climate change is affecting the spread of infectious illnesses is also essential.

By taking into account sociodemographic and technological change scenarios, it is critical to construct scenario-based forecasting models to calculate the implications of climate change. These models may then be utilised for assessment and making evidence-based decisions about policy. There has to be an established and assessed standard methodology for creating scenario-based forecasting models.

Climate change impacts must be incorporated into a system of global health monitoring and surveillance (such as an evaluation of the global burden of illness) (WHO 2014; GBD 2013 Mortality and Causes of Death Collaborators 2015). Climate change poses an increasing number of health problems, and no nation will be safe from them. Health systems that are climate resilient are critically needed (WHO 2015).

Materials and Methods

The window of opportunity to ensure a living and sustainable future for everybody was swiftly closing as all studies available on PubMed, EMBASE, and Cochrane published from 1996 to June 2019 were evaluated. Without putting a time limit on it, we conducted an electronic search on PubMed using the terms “climate change”, “climate variability”, “global warming”, “meteorological factors”, “weather”, “heat waves”, “extreme weather”, “ambient air pollution”, “outdoor”, “particulate matter”, “PM”, “air pollutants”, “mortality”, “human health”, “health effects”, “infectious disease”, “diarrheal disease”, “cardiovascular disease”.

Conclusion

The ideals of sustainable development outlined in Agenda 21 and the UNFCCC (United Nations Framework Convention on Climate Change) should be referenced in international agreements dealing with global environmental challenges like climate change. They include the equity concept, which holds that those who cause pollution or environmental harm should pay for it, the precautionary principle previously discussed, and the notion of costs and responsibilities. Fairness or equitable considerations can be applied within a country, across borders, and over time (between generations). Equality is the idea of having equal or comparable possibilities, allowing everyone to maintain a reasonable standard of living or quality of life. For instance, the distribution of the costs and advantages of climate change will likely vary between rich communities in wealthy nations and marginal people in developing nations, as well as between the present generation (some may profit from early warming) and the following generation (costs will outweigh

benefits, if forecast warming trends continue). Following these guidelines would significantly help to avert any potential threats to the global environment and lessen those that already exist. Although the effects of climate change are already being felt, efforts must also concentrate on determining the necessary interventions or adaptation alternatives, as well as analysing present and future vulnerabilities. Although adaptation is not anticipated to completely avert damages from climate change, it has the ability to lessen its negative consequences. Early health planning is therefore crucial to minimising and, ideally, avoiding the short- and long-term health effects of global climate change. Yet, governments, society, and each person are responsible for finding the best answer, which is a commitment to a shift in values that will allow for a full transition to sustainable development.

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Environmental pollutions, an ignored factor of recent high cancer incidence

SarowarAlom

Abstract :

If we can control the starting of the huge battle of cancer at its root cause by controlling pollutants which trigger it, we can win the battle. For the reason of cancer, lifestyle has always been blamed. Obesity, smoking or chewing tobacco, alcoholism, sedentary life, and food habit have always been linked with cancer mortality. However, environmental pollution should also be considered one of the major factors in cancer incidence and mortality. Several chemicals present around us have been linked with cancer. Occupational exposure to a number of chemicals has increased cancer incidents in recent days. Besides the ban imposed on certain hazardous chemicals, carcinogens have been accumulating in the air, water, and soil. There is none of us exposed to environmental pollutants. We all carry a detectable amount of carcinogens in our bodies. Considering that the number of cancer patient number has never decreased, precautionary measures towards environmental pollutants must be much more reactionary.

Keywords: *Environmental pollutants; carcinogen; cancer; health.*

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Introduction

Cancer is not one disease, it encompasses more than 200 types of diseases which are different from each other in terms of their origin, rate of growth, organs they affect and many more. Cancer is one of the leading causes of death worldwide. Almost 10 million people die from cancer annually, and this toll has never decreased since the 19th century (WHO, 2022). Worldwide, cancer is the second leading cause of death and breast cancer is the leading cancer type followed by prostate, colon, rectum, cervical, pulmonary, uterine, stomach, bladder, and other forms (WHO, 2022). The overall risk of developing cancer is about 1 in 9 for both sexes in their lifetime in India (0-75years) (<http://cancerindia.org.in/cancer-statistics/>), and breast cancer in females and lip and oral cavity cancer in males have the most incident number. North-Eastern states of India are the leader in cancer. The Aizawl district of Mizoram and the Papumpare district of Arunachal Pradesh have the highest incidence.

For the reason of cancer, lifestyle has always been blamed. Obesity, smoking or chewing tobacco, alcoholism, sedentary life, and food habit have always been linked with cancer mortality (Khan et al., 2010; Osório-Costa et al., 2009). However, environmental pollution should also be considered one of the major factors in cancer incidence and mortality. Almost 16,000 deaths are caused due to lung cancer who were non-smokers (Ihsan et al., 2011). Similarly, obesity and alcoholism are also not the sole cause of cancer (Cao & Giovannucci, 2016; Deng et al., 2016). Exposure to a mixture of pollutants, psychological and social stressors, genetic susceptibility, and epigenetic modifications increases the probability to develop cancer significantly (Kim et al., 2018; Reaves et al., 2015). In this era of industrialization, no place on the Earth is safe. Occupational exposure to several chemicals has increased the incidence and

about 220 breast cancer carcinogens were identified till now (Rodgers et al., 2018; Rudel et al., 2007) paternal exposure is one of the reasons for increased children's cancer nowadays (O'Leary et al., 1991; Vinson et al., 2011).

Researchers have linked several chemicals present around us to various ailments. Chemicals which are commonly used in various household products such as phthalates present in personal care products, children's toys, vinyl coatings, detergents, food packaging, pharmaceutical products, etc. impair male development and reproduction (Hannon & Flaws, 2015). Polychlorinated bisphenyls (PCBs) widely used in electronic items such as capacitors and transformers reduces testosterone level (Desdoits-Lethimonier et al., 2012; Goncharov et al., 2009). Perfluoroalkyl and polyfluoroalkyl substances (PFAS) a group of chemicals used in surface resistance to stains, grease, and water, is used in making non-stick pans for decades and can cause cancer of kidney and testis (Steenland & Winquist, 2021). Bisphenol A (BPA) present in various kitchen utensils and the epoxy lining of food cans is found to be linked with various endocrine diseases as well as precancerous lesions of the prostate and mammary gland (Durando et al., 2007; Ho et al., 2006; Snedeker, 2007; Wilson et al., 2007).

Outdoor exposure to chemicals particularly used for the agricultural purpose has emerged to be a major health hazard. Banned organochloride insecticide DDT was the most used insecticide. DDT has been detected in fish for long period (Gilliom et al., 1992). DDT was detected in migratory songbirds, in forest soils, in breast milk, and on the kitchen floor along with other chemicals such as diazinon, permethrin, chlorpyrifos, etc (Authman et al., 2015; Bouwman et al., 2012; Cohn et al., 2007; Harper et al., 1996; Quirós-Alcalá et al., 2011; Smith et al., 1993; Stout II et al., 2009; Straub et al., 2007; Xin

et al., 2011). Researchers have warned after finding a high level of DDE (a common by-product of DDT in vertebrates) in breast cancer (Wassermann et al., 1976). Hormonal effects of parabens and atrazine in mammary and ovary cancer were reported by many authors. Occupational exposure of textile workers to synthetic dye has raised bladder cancer (Gregory, 1980).

Besides the ban imposed on certain hazardous chemicals, carcinogens have been accumulating in the air, water, and soil. We are focusing more on a tough battle, without controlling the triggers. In this chapter, we will discuss the links of pollutants present in three domains (water, soil, and air) with cancer and at the end, we will discuss some future directions.

Carcinogens present in water

The evolution of first life started in water. Water is one of the most essential elements of life. About 70% of the human body is made of water. It is very concerning that recently numerous chemicals reported to be found in water are classified as carcinogens. Most of the chemicals identified and reported are in contaminated drinking water (Cohn et al., 2007). Chemicals such as triazine herbicides atrazine and symazine, acrylamide, DBCP, 1,2 dibromoethane, 1,2 dichloropropane, 1,2-dichloroethane, benzene, carbon tetrachloride, 3,3-dimethoxybenzidine, styrene, and vinyl chloride are reported to be mammary carcinogens are present in water (Rudelet al., 2007). Of these chemicals, many affect the endocrine system and modulate their functions, therefore considered endocrine disruptors. Overused nitrates in agriculture ultimately leach into water and pose a serious risk of cancer development (Cantor, 1994; Ward et al., 2005).

Carcinogens such as chloroforms and trihalomethanes present in water possess a serious risk to women and infants

who usually come in contact with them while bathing or showering, which increases the risk of developing a tumour (Gordon et al., 2006; Weisel & Jo, 1996).

Since the end of the 20th century, various studies have confirmed the link between contaminants in water with cancer, such as leukaemia by dissolved radioisotopes. Heavy metal pollution of water bodies is another serious risk. Chromium and arsenic can be found naturally in some soil but are present in high concentration in water bodies containing industrial emissions and both chromium and arsenic are a serious concern for developing bladder cancer, kidney cancer, and prostate cancer at a low or moderate dose (Bulka et al., 2016). Arsenic at high concentrations in drinking water can cause skin and lung cancer (Marshall et al., 2007; Yu et al., 2000). Even though a small amount of chlorine is used in tap water disinfection, it is found that chlorine is responsible for bladder cancer (Cantor, 1994; Rudel et al., 2007).

Carcinogens present in the soil

The link between contaminants present in soil and cancer has been reported by many authors. Aromatic amines can be found in tobacco, however, the highest dissemination has been through agricultural pesticides. Bladder cancer is most common among farmers (Koutros et al., 2009). Aromatic amine such as atrazine is responsible for this situation. Many countries have banned atrazine such as Europe, however, in India, atrazine can be found in many chemicals used in agriculture.

Some of the chemical contaminants are classified as endocrine disruptors, mainly modulating the hypothalamo-pituitary-ovarian axis (Cooper et al., 2000, 2007), ovarian cancer has also been linked to this (Donna et al., 1989). Atrazine also impacts breast development (Enoch et al., 2007).

Chemicals such as endosulfan, lindane, and parathion, are examples of persistent and dangerous pesticides. Endosulfan is an organochloride pesticide largely been sprayed on vegetables, apples, melons, and cotton for decades. The Stockholm Convention on Persistent Organic Pollutants forbids lindane, which was extensively employed in the commercial tree business by an international treaty negotiated by the United Nations Environment Programme (UNEP) (Chambers, 1992). Due to its severe toxicity, parathion was restricted in the 1980s (Chambers, 1992). These three pesticides all appeared to have a connection to cancer, especially occupational exposure(Engel et al., 2019; Purdue et al., 2007).

Aldrin and Dieldrin have extensively used pesticide in agriculture and is banned in many countries. In India, Aldrin and Dieldrin were banned in 2003. Aldrin converts to dieldrin, one of the most persistent of all pesticides. Dieldrin is frequently found in soil, sediment, and the fatty tissues of animals and has a long half-life in the environment. The use of chlordane and heptachlor, which were primarily restricted in the 1980s, can raise the chance of acquiring non-Hodgkin's lymphoma. Since these chemicals may still be detected in soil and structures even after being used to treat certain crops or insects (Najam&Alam, 2015). People were often exposed to these compounds through the consumption of meals that contain them, such as those in animal fat, meat, fish, and dairy products. Unfortunately, the vertical mother-foetus transmission of carcinogens is not just limited to heptachlor and chlordane but is rather prevalent to most pesticides, and it can explain paediatric and early-life cancers, including brain cancer and leukaemia.(Infante-Rivard&Weichenthal, 2007; Ma et al., 2002; Rosso et al., 2008; Rudant et al., 2007; Soldin et al., 2009). For women themselves, a new concern is emerging regarding the link between pesticide

use and breast cancer risk (Ellsworth et al., 2018; Lewis-Michl et al., 1996; Niehoff et al., 2016; Teitelbaum et al., 2007). Large amounts of glyphosate have been demonstrated to be harmful (Andreotti et al., 2018). It “probably” causes cancer, according to the International Agency for Research on Cancer of the World Health Organization (Rocco et al., 2016). Recent research has established a strong association between glyphosate-based herbicide exposure and an elevated risk of non-Hodgkin’s lymphoma and breast cancer (Thongprakaisang et al., 2013; Zhang et al., 2019).

Illegal disposal of garbage and even legal landfills are other sources of carcinogens’ percolation and soil contamination. When people are exposed to the burning and unlawful disposal of hazardous wastes, the risk increases.

Carcinogens present in air:

It is the most studied domain and there is numerous evidence of carcinogens in the air. Ample evidence of carcinogens present in the air is sourced from industries, road traffic, intensive farms, etc (Mudipalli, 2015; Pinter et al., 1990). Many authors have reported an increased number of lung adenocarcinoma, a strong link between air pollutants and cancer mortality and a relationship between industrial pollution with cancer and cancer-related mortality (Brody et al., 2007; Charloux et al., 1997).

Carcinogens present in the air not only cause lung cancer but are considered a risk factor for bladder and breast cancer (Brody et al., 2007; Sakhvidi et al., 2020). People residing near industries or high-traffic areas have a higher risk to develop breast cancer (Hystad et al., 2015; White et al., 2018). Benzopyrene release due to the burning of fuel such as coal and petroleum derivatives is considered a DNA mutagen of mammary gland cells (Korsh et al., 2015; Morris & Seifter, 1992). The area

having industrial petrochemical pollution has the highest incidence of bladder cancer (Liu et al., 2009; Pan et al., 1994; Trichopoulos&Petridou, 1994).

Garbage management also is a key to polluting all of the three domains. Waste burning releases dioxins(Nzihou et al., 2012; Zook&Rappe, 1994). Dioxin is very harmful even in trace amounts (Schecter, 2013), and laboratory animals were exposed to dioxin even at a very low concentration-induced cancer (Jenkins et al., 2007). If the waste material has PVC in it, like hospital waste, it releases the highest dioxin. Domestic fireplaces, kitchen chimneys, heating firewood, agricultural staple burning, etc. are also sources of air pollutants. As dioxin is sourced from waste material polluting air, water, and soil, it is pertinent that food may become a source of dioxin. Chlorinated dibenzo-p-dioxin was found in cow's milk near incinerators (Connett& Webster, 1987; Liem et al., 1991), and in fish, soils, and crops(Schecter, 2013). Dioxin has been found in several studies can induce liver and lung cancer (Lucier et al., 1993; Tritscher et al., 1992). Asbestos is also one of the components of air pollutants. Asbestos exposure is associated with malignant mesothelioma, a cancer of the membrane surrounding the lung (Noonan, 2017).

Conclusions:

Cancer has become the leading cause of death, and types which were once rare and has a link with the environment are increasing. After decades of study, it was confirmed in the late 1980s that environmental pollutants tend to cause cancer. However, experimenting with humans to know the dose and most important of exposure is difficult. One of the reasons is that no one of us has ever been exposed to environmental pollutants. We all carry a detectable amount of carcinogens in our bodies

(Morris & Seifter, 1992). An epidemiological study comparing people with high exposure to people with less exposure has put forward the conclusion that there are some pollutants which are responsible for high cancer incidents in the exposed group. To get more data, future environmental and epidemiological studies should focus on comparing populations to understand some key information.

Considering that cancer patient number has never decreased, precautionary measures towards environmental pollutants must be much more reactionary. Release of any pollutants, which may not be found to be potential carcinogens at the initial stage or have been suspected to be carcinogens must be considered as an unauthorized experiment on the human being, as exposed people become an involuntary guinea pig.

If we can control the starting of the huge battle of cancer at its root cause by controlling pollutants which trigger it, we can win the battle.

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Assessment on quality of ground water of Barigog Banbhag development block of Nalbari district, Assam

Mukut Ch. Baishya

Abstract:

Water resources have played critical and vital role throughout history in the growth and continue to be factor of importance in economic development. The quality of ground water of Barigog Banbhag Development Block of Nalbari district was investigated by collecting from various sources like tube well, water supplies and ring well. Ten water samples were taken for analysis of various physico-chemical parameters including temperature, pH, turbidity, TDS, Total alkalinity, Total hardness, conductance, calcium, magnesium, iron and chlorine. The analysed data were compared with standard value recommended by BIS and WHO. In the present investigation most of the parameters were found within the permissible limit. But the results of iron and hardness are not found in the satisfactory range. Moreover in connection with some parameters like pH, TDS, Iron, Chlorine, Conductance etc were not found in satisfactory range of water in ring well sources. So necessary treatment is required for drinking water in ring well sources.

Keywords : *Ground water, Hardness, Parameters.*

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Introduction:

Water is the essence of life. Fresh water is a finite and a vulnerable resource, essential to sustain life, development and the environment. Groundwater though contributes only 0.6% of the total water resources on earth, it accounts for nearly 80% of the rural domestic water needs and 50% of the urban water needs in the developing countries like India .(Meenakshi and Maheshwari 2006). Water quality of index is one of the most effective tools to communicate information on the quality of water to concerned citizen and policy makers. It does become an important parameter for the assessment and management of ground water. The longevity of human health depends on the drinking water quality. Man uses water for various daily activities like bathing, washing, laundering, agriculture and industries.

In the present study area majority of the population depends on agriculture and maximum agriculture areas are rain fed.

Rural people use common agrochemicals in the agriculture field. This enhances pollution level of ground water. In monsoon season some water borne diseases are very common in the study area. So study of harmful contaminants are very important in drinking water. Socio-economic conditions of inhabitants in the study area are not so sound and they are not conscious about drinkg water pollution problems. Several workers studied about the drinking water quality of various sources, such as Sarma (1991) [12], Patowary (2000) [11], Das *et al.* (2001) [4]. Barman (2002) [2] , Meenakshi and Maheshwari R.C. (2006) [9], Kumar and Reddy (2007) [8], Sarkar *et al.* (2022) [13], Kalra *et al.* (2012) [7], Dohare *et al* (2014) [6], Sunitha *et al.* (2014) [14] and Borah *et.al.*(2020) [3] The present study was therefore undertaken to carry out study on some physic-chemical characteristics of different drinking water sources in Barigog Banbhag development block of Nalbari district, Assam.

Study area:

Barigog Banbhag development block is situated in the eastern part of Nalbari district. The district lies at the intersection of 91°7' to 90°47' E Longitude and 26°0' N to 58°5' N latitude. The total geographical area of the district is (1046.44 sqkm) and the area of the study area is 134.2sqkm. The climate of the district is warm humid in summer followed by cool in winter. The average temperature is between 17°-38°c. The population of the development block is 90376 (2011 census).

Source : District office of Economics and Statistics, Nalbari

Materials and Methods:

During the study, ten water samples were collected from various sources such as tube well, water supply, ring well in 2019. These were carefully brought to the laboratory for analysis of various physico-chemical parameters. All physic chemical parameters of ground water samples were carried out according to the standard of methodology of APHA(1995).

Objective of the study:

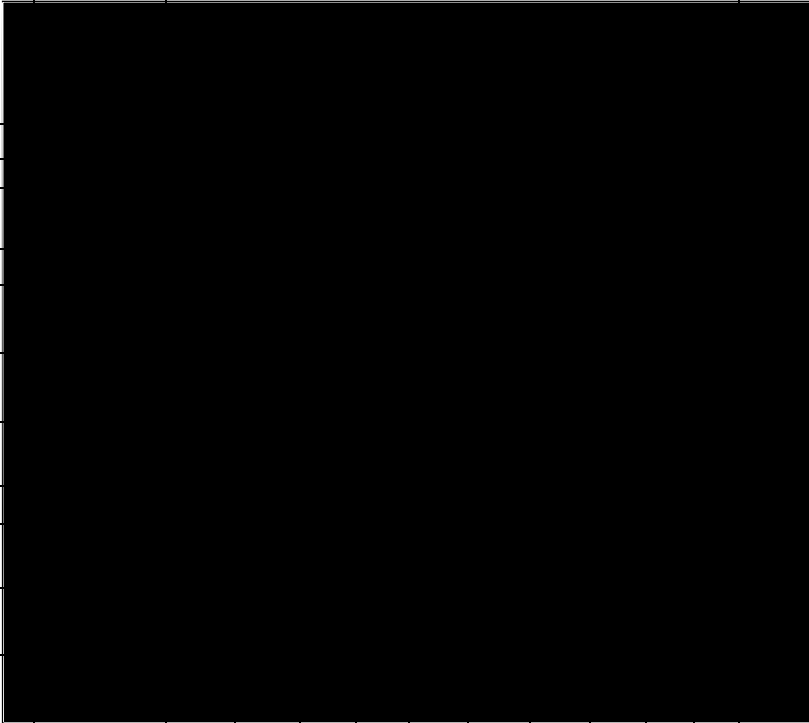
The objective of the present study are given as follow:

- To estimate the various physic-chemical parameters in connection with quality of ground water
- To compare the results of various parameters with the standard values of WHO and BIS.

Result & Discussion:

The result of analysis of physicochemical characteristics of ground water is presented in table 1.

Table : 1 : Physico-chemical characteristics of ground water in Barigog Banbhag development block



TW- Tube well, RSW- Rural Supply Water, RW- Ring Well : 1. Sathomo, 2. Akna, 3. Ponorkounia, 4. Dalua, 5. Kayakuchi, 6. Barazole, 7. Bhitha, 8. Allia, 9. Japjapkuchi, 10. Nilpur.

The discussion on different parameters are explained as follows:

1. **Temperature** : No proper guidance is available in connection with temperature of ground water. In the present study temperature varies from 24.4⁰ C- 30.9⁰ C.

2. **pH** : It is the measure of acidity or alkalinity of water. pH values of study area are within the permissible limit of WHO standard (6.5-8.5). The value of pH is found in lie between 6.6-

7.4, the highest pH value is recorded at sampling point 9 & the lowest pH value is recorded at sampling point 10.

3. **Turbidity** : All water samples collected from different sources are below the limit prescribed by BIS (1991). As per the table the highest value 6.1 is recorded at the sampling point 10. Turbidity of water samples of ring wells are comparatively higher than that of other sources. The high turbidity in ring wells may be due to aquatic plants and their decay products and suspended garbage.

4. **TDS** : The TDS content is found maximum in sampling point no 10 and minimum at Sampling point 6. The study showed ring well water had high TDS and not suitable for drinking purpose without proper treatment . The palatability of water with TDS level 500 mgL^{-1} is generally considered to be good and TDS value greater than 500 mgL^{-1} is unpalatable (Kumar *et al.* 2007).

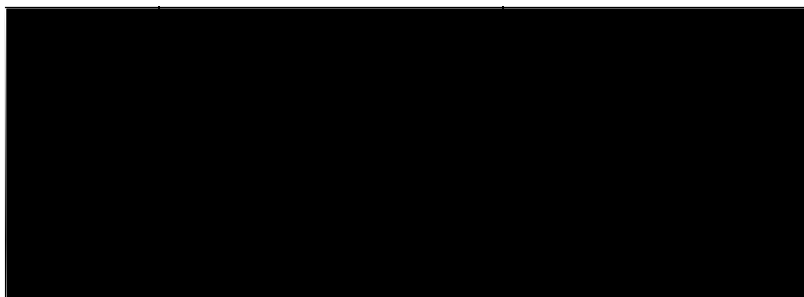
5. **Total alkalinity (TA)** : The ranges of alkalinity have been found to lie in between 80.2-115.2. Alkalinity due to natural carbonate and bicarbonate is not health hazard unless the value exceed 400 mg/L . The total alkalinity is found to lie in between the prescribed limit by WHO standard.

6. **Conductance** : The presence of salts in water can be determined by evaluating the conductance. The conductivity of water samples are varied from $169.1 (\mu\text{S cm}^{-1})$ to $1020 (\mu\text{S cm}^{-1})$.

All water samples are below the prescribed limit of BIS (1991). The highest conductance value is recorded at sampling point no 10. Due to the presence of higher amount of soluble ionic substance indicates the high value of conductance in the sampling point 10.

7. **Hardness** : The total hardness is the indicator of the capacity of water to precipitate soap.

The highest hardness is found at sample point no 10 and lowest value is found at sampling point no 3. The hardness value of ring wells are generally higher than the other sources of water. The increase in the maximum level of total hardness is due to the presence of carbonate and non carbonate compounds(Ramesh *et al.*,2013) All the hardness value cannot exceed the permissible limit prescribed by WHO and BIS (1991) standard.



8. **Iron** : The Iron content is found maximum in sampling point no 10 and minimum at sampling point no 2. In sampling point 1, 2, 5, 7, 8, 9 & 10 limit of Iron exceed from WHO standard. This is due to the structure of soil. Iron in excess of 0.3mg/ L is known to cause straining of clothes and utensils. The tendency of vomiting may causes due to the presence of higher concentration of iron in ground water.(Karla *et. al* 2012)

9. **Calcium** : Calcium has no hazardous effect on human health. The highest value recorded in sampling point no 8 and lowest value is found in sampling point no 3. All samples do not exceed the limit of WHO and BIS standard. Higher concentration of calcium is undersirable in washing and bathing because it suppresses the formation of lather with soap.

10. **Magnesium** : The concentration of magnesium should be lower than calcium content in ground water. In the present

study also the concentration of magnesium is found to be lower than calcium concentration. In the study no water samples exceeds the limit of WHO and BIS standard. The predominant source of magnesium in groundwater is through dissociation of dolomite ($\text{CaMg}(\text{CO}_3)_2$). (Borah *et al* 2020).

11. **Chloride** : The chloride content is found maximum in in sampling point no 10 and minimum at sampling point 3. Water in ring well sources are found to be maximum content of chloride.

Conclusion :

The analysis of the water quality parameters of groundwater from ten different stations in Barigog Banbhag development block of Nalbari district shows that the pH, electrical conductivity, calcium, magnesium, chloride are well within the permissible limits. In the present study most of the water samples show high concentration of iron. Actually the permissible limit prescribed by WHO (1993) for iron is 0.1mg/ L. But due to the structure of soil the concentration of iron was found little high. So proper treatment of water samples are necessary for drinking purpose to remove iron from water. The study also reveals that the hardness of water is not satisfactory. So proper treatment is also necessary to remove hardness of water . Further the analysis showed that the values of most of the parameters were found on elevated range in the water samples of ring wells. Therefore necessary treatment is required for water of ring well.

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**ENVIRONMENTAL
LAWS**



Climate Justice In India: Constitutional and Legal Framework and It's Effectiveness

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Abstract:

The term 'Climate Justice' is relatively a new concept in the contemporary studies centered on the subject of "climate" or "environment". The new thrust of economic development along with science and technology and manmade activities around the world have greatly undermined the needs of a healthy and conducive environment for the humankind. Specially, the whole new goal of economic advancement adopted by almost all the countries is putting the lives of men at risk by creating environmental pollution. The climate has changed resulting in the change of the whole environment. Subsequently, a new concept has emerged i.e. "climate justice" that was brought with the sole objective of ending all the challenges faced by the world climate. In the light of this new development, countries are taking steps to ensure climate justice. Even, in India, the Constitution of India shows provisions for climate justice. In addition to this, the legal procedure in India also stressed on maintaining climate justice. Therefore, the paper is an attempt to analyze the concept of climate justice and to throw light on the different provisions of the Indian Constitution and legal system that deal with climate justice along with its effectiveness.

Keywords: *Climate, justice, Constitution, legal procedure, community*

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Introduction:

The issue of climate change has become a reality of the contemporary time. It refers to long-term changes in the overall climate elements, like temperature, humidity, atmospheric pressure, wind, precipitation, weather etc. in a particular place over a longer period of time. Due to the manmade activities, mainly the unprecedented use of fossil fuels and its adverse effects on the emission of greenhouse gases and carbon di oxide are mainly responsible for the shift in global climate. Because of all these, the normal temperature in the Earth has increased. This has led to an imbalance in the natural environment. Mankind has become the main victims of this global climate change and is facing major respiratory and other health issues. In this crucial junction of time, a new concept has emerged known as “climate justice”. This broad term refers to a whole gamut of environmental degradation issues, like global warming, pollution along with the demand to provide environmental justice to humankind. This tries to identify the root causes of climate change around the world and simultaneously addresses the broad area of social, racial and environmental injustice as well. The University of Colombia defines Climate Justice as “*the disproportionate impacts of climate change on low-income communities and communities of color around the world, the people and places least responsible for the problem.*”¹ Therefore the term has now emerged as a broad social movement aiming to provide justice to the least advanced classes who got victimized due to the effects of climate change all over the world. Climate justice suggests some alterations to modify the badly effected climate: emphasis on the renewable sources of energy, indigenous climate action, community resilience and adaptation, natural climate solutions, climate education and engagement etc to make people aware of the global climate change scenario and to

encourage them to be a part of the climate justice movement. Thus, climate justice signifies both legal and policy perspective to address the issue of climate change and to tackle the vulnerabilities and inequalities imposed by climate change on the communities. With the coming of the new concept of climate justice, a new awareness has started and the countries are adopting different strategies to fulfill their commitment to ensure climate justice. In contemporary India, the concept of climate change had arrived very late, but the Constitution that was adopted in 1950 is itself is a reflection of different provisions related to climate justice. Alongside constitutional provisions, India has also adopted legal framework to ensure climate justice. In the light of this development, it would be interesting to analyze climate justice in the context of India.

Methodology:

The objective of the study is to analyze and to interpret the constitutional and legal provisions of India that deal with climate justice and to study the effectiveness of such provisions in providing climate justice to the people of India. In the present paper, an attempt has been made to outline the provisions that are primarily and more relevant to the present study. The proposed study is descriptive and comprehensive in nature to understand climate justice in Indian context. To meet the above objectives of the study, the required data have been collected from secondary sources, like the internet, websites, professional magazines, referred journals, newspapers and conference books and in addition to government press notifications and reports.

Climate Justice in India:

The issue of climate or environment protection has always been a discussed issue in India. In the ancient India, protection and cleaning up of environment was considered as the essence of the Vedic culture. The conservation of the environment formed

an ardent article of faith and it was reflected in the daily lives of the people and also enshrined in myth folklore, art, culture and religion of India. In Hindu theology forests, trees and wildlife protection held a place of special reference. But later on, the adoption of land revenue policy by the British rulers in India devastated the forests and affected the daily lives of people. With the advancement of the concept of human rights, a free and healthy environment has been recognized as collective human rights in international sphere. Regardless nationality, class, creed, gender, every human being is entitled to the right to live in a free and fair environment with dignity. 1972 Stockholm Declaration affirms that “*Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of quality that permits a life of dignity and well-being, and he bears a solemn responsibility to protect and improve the environment for present and future generations...*”² Thus it has been internationally recognized that man’s fundamental rights embraces the need to live in an uncontaminated environment. Climate, being a part of environment, has been equally emphasized and protected by the international agencies through the adoption of different mechanism.

The free India of 1947 upholds its new aspiration of environment protection in India. It is worthwhile to mention that with the environment protection awareness, India adopted different strategies. The Indian Constitution, for instance, has enumerated numerous provisions. The Directive principles of the Constitution directed towards ideals of building welfare state which also includes healthy environment. Article 47 provides that the State shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties. The improvement of

public health also includes the protection and improvement of environment without which public health cannot be assured. Likewise, Article 48-A of the constitution states that the state shall endeavor to protect and improve the environment and to safeguard the forests and wild life of the country.

The Constitution of India under part III guarantees fundamental rights which are essential for the development of every individual and to which a person is inherently entitled by virtue of being human alone. Right to environment is also a right without which development of individual and realization of his or her full potential shall not be possible. Articles 21, 14 and 19 of this part have been used for environmental protection. Article 21 guarantees fundamental right to life. Right to environment, free of danger of disease and infection is inherent in it. Right to healthy environment is important attribute of right to live with human dignity. The fundamental duties mentioned in the Indian Constitution clearly impose duty on every citizen to protect environment. Article 51-A (g) says that “It shall be duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures.”

The judiciary, in their quest for innovative solutions to environmental matters within the framework of public interest litigation, looked to constitutional provisions to provide the court with the necessary jurisdiction to address specific environmental issues. Furthermore, Article 142 afforded the Supreme Court considerable power to mold its decisions in order that complete justice could be done. As the Supreme Court is the final authority as far as matters of constitutional interpretation are concerned, it assumes a sort of apex position in the Indian environmental legal system

Under the 74th amendment of the Constitution, a state legislature can enact legislation on ‘urban forestry, protection of the environment and promotion of ecological aspects.’ This is only in relation to the powers and function of municipalities. At local and village level also, Panchayats have been empowered under the 73th amendment of the Constitution to take measures such as soil conservation, water management, forestry and protection of the environment and promotion of ecological aspect. The 5th and the 6th Schedules of the Indian Constitution recognizes the cultural distinctiveness of the tribal communities and provides protection to the tribal to maintain their tribal identity without coercion on account of their economic disadvantages.

In addition to the constitutional provisions, the Government of India has tried to ensure climate justice through legal procedure too. India is a member of the United Nations Framework Convention on Climate Change (UNFCCC) and upholds many legal policies towards its commitment on climate change. India also set up National Council for Environmental Policy and Planning was set up in 1972 which was later merged into Ministry of Environment and Forests (MoEF) in 1985. Similarly, Environmental Action Programme (EAP) was formulated in 1993 with the objective of improving environmental services and integrating environmental considerations into development programmes. National Environment Policy (2006), Water (Prevention and Control of Pollution) Act, 1974, Air (Prevention and Control of Pollution) Act, 1981, Motor Vehicles Act ,1988, The Wildlife (Protection) Act, 1972, The Forest (Conservation) Act, 1980, National Environment Tribunal Act, 1995, Environment Impact Assessment (EIA) Notifications are some of the initiatives adopted by India to reduce climate change and its impacts.

In spite of having all the constitutional and legal provisions, India has not achieved climate justice. According to the Global Climate Risk Index of 2021, India has been ranked in the 7th position in the most climate-affected countries of the world. The main thrust of climate justice i.e. to reduce climate change vulnerabilities for the communities is not ensured in present time. In case of India, with more than 705 ethnic groups recognized or unrecognized, the statistics show the underprivileged positions of different communities. They are marginalized and are living in vulnerable social-economic conditions. These groups are lagging behind in almost all the constitutional and legal facilities provided to them. Climate change has not brought only health issues, but also different types of sociopolitical, economic, legal problems for the communities. These marginalized communities of India, predominantly Adivasis, Dalits and other backward classes are living in a vulnerable ecosystem with existential crisis. Life of these communities are directly related to forest for different purposes like livelihood. These communities are encountering two types of climate injustice in their lives: first, they experience crisis by the economic development framework of India that extracts natural resources from forests and second, utilize differently and with outrageous inequality among social classes. This matter has become incredibly concerning as these communities are facing climate consequences without having roles in climate change.

The United Nations High Commissioner for Human Rights in its report of climate and racial justice, 2022 mentioned, ***“The worldwide increase in positive emissions, fueled by the “no-holds-barred development agenda”, is to blame for the impending climate crisis. Concurrently, the pressure to counterbalanced emissions through large-scale land and forest-based mitigation measures and carbon capture and storage***

technologies without rapidly reducing positive emissions - and is also the premise of nations' net-zero commitments - is contributing to a methodology of incorporating indigenous peoples' and local communities ('IPLCs') customary lands and forests around the world, including in India."³The same report also suggested, *"Due to various their significantly greater exposure to excessive climatic incidents, high reliance on natural resources, and economic and political stigmatization, India's forest-dependent communities, the Scheduled Tribes and Other Traditional Forest Dwellers (hereinafter 'STs/OTFDs') is one of the most vulnerable to climate change. Because of grossly unequal responsibility allocation, paucity of land rights, and asymmetrical access to decision-making processes, women are disproportionately affected within them."*⁴

The states of India, like Odisha, Jharkhand and Chhattisgarh with the largest numbers of ST population have been identified as the most vulnerable to climate change. These Forest-dwellers are at high risk because of disasters like forest fires, which are growing more often and more intense as a result of climate change. Forest fires are becoming more prevalent as a result of monoculture tree plantings in forests, which are a typical forest management strategy used by India's forest authorities to restore damaged forests. Again, the customary lands of these communities and other forest areas have been taken over by the state for establishing new mines, hydroelectric projects, and other large-scale projects depriving these communities from their subsistence and livelihood. The North-East India, the most culturally diverse area of the country has also been facing major climate change crisis and injustice. The tribal communities of this region have faced adverse effects of new economic development framework ongoing in this particular area. The policy to transform this area into a power hub resulting in the

construction of Etalin Dam, Dibang multipurpose Project, Lower Subansiri Dam project and likewise other 169 dams confronted by the local tribal people for the fear of losing their ancestral homeland. One of the recent environmental disasters of Assam is the Oil India's Oil leak at Baghjan oil field of 2022, where more than 7000 people from the nearby areas were displaced. Similarly, the displacement of the Kodar tribes because of the Athirapalli Dam project of Kerala during 2021 was an issue of major concern. All these examples pointed towards the ill fate of the communities living in the marginalized category, who are far away from getting climate or environmental justice. The constitutional and the legal procedures adopted in India to bring about cultural justice are not sufficient enough.

Suggestion and Conclusion:

The climate Justice of the different communities in India has remained as a conceptual idea. It requires more people friendly policies and legal system to ensure better participation of the people in the decision-making process. To ensure climate justice, the requirement is to ensure representation of people and to form an inclusive policy-making procedure where people's right to safe environment is protected. The gap between the authorities and the people who are most vulnerable and prone to crisis should be narrowed down and a new bridge should be constructed to promote equity and equitable access to basic resources among the communities to promote climate justice.

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Footnotes

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- 2 <https://www.un.org/en/conferences/environment/stockholm1972>
- 3 <https://www.ohchr.org/sites/default/files/documents/issues/racism/sr/climateandracialjustice/2022-11-02/submission-ecological-crisis-ga77-academia-sarthak-gupta.pdf>
- 4 <https://www.ohchr.org/sites/default/files/documents/issues/racism/sr/climateandracialjustice/2022-11-02/submission-ecological-crisis-ga77-academia-sarthak-gupta.pdf>



**ENVIRONMENTAL
POLLUTION**



E-Waste and Its Impact on Environment: Indian Scenario

Pulama Talukdar

Abstract:

Rapid development of communication technology increases the usage of electronic equipments exponentially. The innovation, dynamism in product design and globalisation have replaced the older equipments by the upgraded one in a very short duration which made a rapid increase of Electronic waste (E- waste) Globally. The increasing amount of E- waste and its proper management has become a matter of concern as it contains some toxic and hazardous substances which can adversely affect the environment as well as the human health if these are not properly managed. In the present study an attempt has been made to discuss the concept of E-waste, present scenario of E-waste in India and the environmental and health concerns related to it. The study reveals that the generation of e-waste in India is very high. In the year 2019 India has generated more than 3.23 million tonnes of e-waste and has become the world's third largest e-waste generating country whereas recycling percentage is very low, less than 10%. In India E-waste management is done mostly by unorganised private sector where the workers have not adequate skill and awareness. The study concluded that the informal sector of e-waste management should be controlled by the government adopting new law for management of e- waste. Non Governmental Organization may extend supporting hand for controlling the pollution generated by e-waste. Awareness among the workers and consumer involving

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with the electronic equipments and training of workers for skill management of e-waste are the need of hour. New thoughts of recycling the electronic waste may start a new horizon in controlling the pollution as well as strengthening the economy.

Keywords: *E-waste, Environment, Toxic, Hazardous, Management.*

Introduction

Electronic waste or e-waste is an emerging problem of the world due to the volume of e-waste being generated and its toxic content. Over the past three decades the rapid advancement of technology has led to continuous advancement in the electric and electronic equipments (EEE) which makes the usage time or life span of those products shorter and shorter. Rapid economic growth coupled with urbanization has increased the consumption as well as the production of EEE.(Balabanic et al,2011; CPCB.,2007) Across the world the growing amount of e-waste has made a threat to environment. Perkins et al, 2014 pointed out that the amount of e-waste generating each year is increasing at an alarming rate. In 2019, the world generated a striking 53.6 Mt of e-waste, an average of 7.3 kg per capita (.Blade et al., 2019).The global generation of e-waste grew by 9.2 Mt since 2014 and is projected to grow to 74.7 Mt by 2030 – almost doubling in only 16 years. This huge amount of e-waste is a diverse combination of more than 1000 toxic substances (Byster et al,2002) including toxic metals such as barium(Ba), beryllium(Be), cobalt(Co), lead(Pb), mercury(Hg)etc. and persistent organic pollutants such as dioxin, brominated flame retardants (BFRs), polycyclic aromatic hydrocarbons (PAHs), chlorofluorocarbons (CFCs) etc. The increasing levels of e-waste, low collection rates, and non-environmentally sound disposal and treatment of this waste stream pose significant risks to the environment and to human health.

India discarded approximately 1.85 million tonnes of e-waste in 2016 which is about 12 percent to the global e-waste production and has emerged as fifth largest Electronic waste producer in the world. Whereas in 2019 it has become the 3rd largest electronic waste producer in the world discarding approximately 3.2 million tonnes of e – waste. (ASSOCHAM Report)

Objectives of the study:

- * To study the current scenario of e-waste in India
- * To study the environment and health impact of e-waste.

Research Methodology:

This study has been carried out with the help of secondary data only. The data was collected from the various issues ASSOCHAM’s Newsletter, Report of ASSOCHAM-KPMG, various journals, newspapers and websites particularly from the Ministry of Electronics & Information Technology, Government of India & ASSOCHAM.

Global E-Waste Scenario:

A huge amount of e-waste is generated every year across the world. ‘The Global E-waste Monitor’ by Blade et al., 2019 reported that total global e-waste (excluding PV panels) documented in the year 2019 was approximately 53.6 million metric tons (Mt) or 7.3 kg per capita and estimated to grow up to more than 74 Mt in 2030. Thus, the global quantity of e-waste is increasing at an alarming rate of almost 2 Mt per year. **Fig.1** depicted the global annual increase in the generation of e-waste.

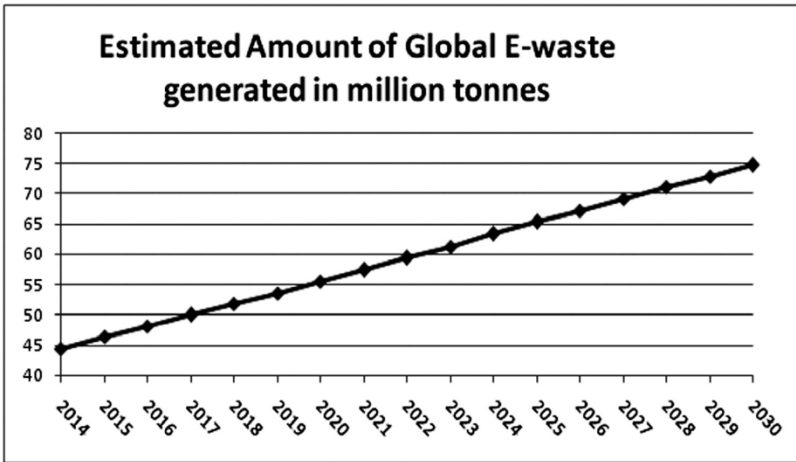


Fig.1: Global e-waste 2014-30 (Source: Balde *et al.*, 2019)

With this increasing rate of generation the formal collection and recycling activities are not keeping pace. In 2019, only 17.4% of total e-waste generated that is 9.3 Mt was formally collected and recycled which shows that the large majority of e-waste generated (82.6%) was most likely not formally collected and not managed in an environmental sound manner. Sometimes these are shipped to developing countries. E-waste generation and collection per continent in the year 2019 is tabulated as **Table1**.

Table1: E-waste generation and collection per continent in the year 2019 (Source: Balde *et al.*, 2019)

The table shows that Asia ranked 1st in e-waste generation with 24.9 Mt while stood 2nd in documented recycling with the rate 11.7%. The continent that generated the most e-waste in kg per capita was Europe (16.2 kg per capita) which was also the continent with the highest documented formal e-waste collection and recycling rate (42.5%)(Balachandran,2017)

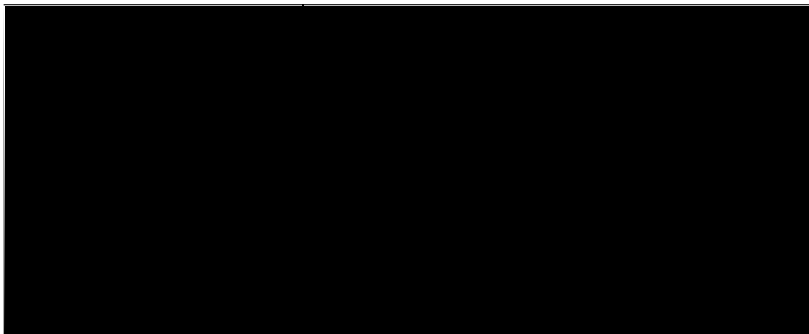
Vast quantities of e-waste are now being moved around the world for recycling in developing countries using manual processes in backyards of residential properties, resulting in significant contamination of soil, water and air in these countries.

E-Waste in India:

India discarded approximately 3.2 million tonnes of e-waste in 2019 which is about 12 percent to the global e-waste production and has become the 3rd largest Electronic waste producer in world after China (10.1) and United States (6.9) (Blade et al., 2019). An overview of e-waste generation in

India from the time the E-waste (Management) Rules were notified in 2016 is provided in **Table 2**:Year-wise e-waste generation in India. Year-on-year growth in e-waste generation is approximately 13 per cent.

Table 2: Year-wise e-waste generation in India
(Source: Biswas & Shing, 2020.)



This huge amount of e-waste generated annually is comprised of 70% computer devices, 12% telecom sector devices, 8%, medical equipment, 7% electric equipments and 3% other equipments including household e crap which is depicted in **Fig.2**



Fig.2: Composition of e-waste (Source: Balachandran.V. 2017)

The Government, public sector and private sector companies generate nearly 75% of e- waste; with the contribution of individual household being only 16%. With the contribution of highest e-waste, 13.9% of the total e-waste generated annually in India, Maharastra ranked 1st. Top ten e-waste generating states in India are depicted in Fig. 3. All these states house at least one metro and multiple tier 1 and tier 2 cities, indicating that the penetration of EEE is highest in urban and peri-urban areas. (Biswas & Shing, 2020)

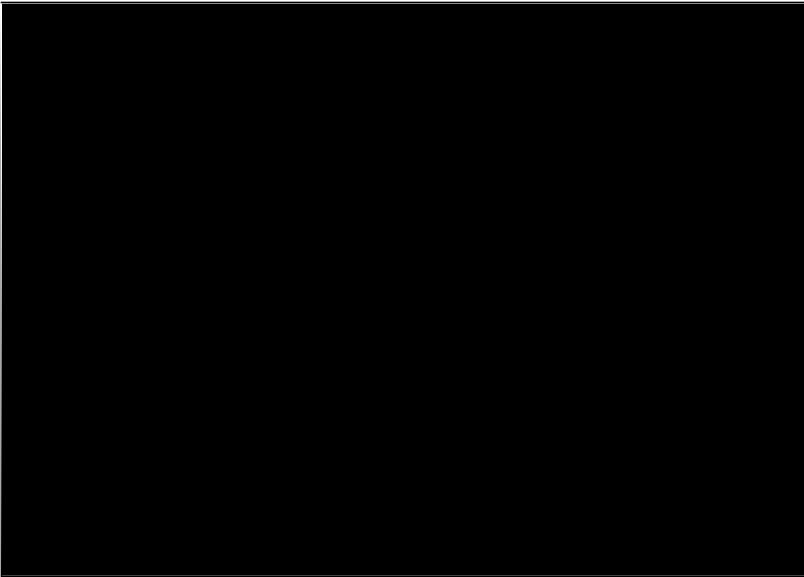


Fig.3: Percentage of Contribution of states to annual e-waste generation in India. (Source: Biswas & Shing, 2020)

Ninety-five percentage of the e-waste in India is being recycled in non-formal sector and five percentage of the e-waste volume are handled in formal unit. Non-formal units of e-waste recyclers are distributed all over India. They collect the e-waste from the rag pickers and disassemble the products for their useable parts. The rest is chemically treated to recover precious metals. Due to inadequate means, it may cause leaching of hazardous substances to the air, soil, and water. This recycling method has low efficiency and recovery is carried out only for valuable metals like gold, silver, aluminium, copper, etc. Other materials such as tantalum, cadmium, zinc, palladium etc. could not be recovered. The dominant role of the informal sector, and the health and environmental challenges that accompany informal e-waste handling were key reasons for the introduction of regulation in the form of E-waste (Management and Handling)

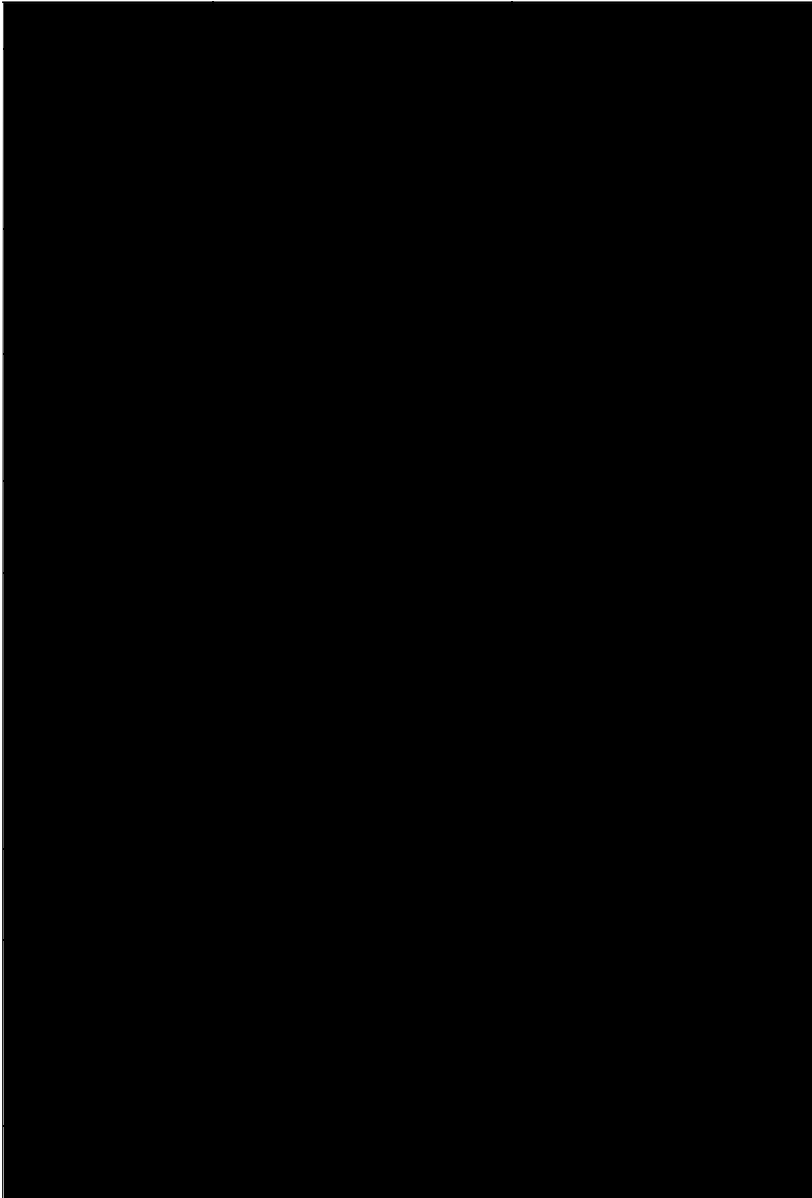
Rules in 2011. These Rules came into effect from 1 May 2012. However, the implementation of these Rules was not very effective due to shortcomings on multiple fronts. To address the shortcomings, and to make the legal framework effective and functional, E-waste (Management) Rules 2016 were notified in March 2016. They came into effect from October 2016, superseding the 2011 Rules. In March 2018, these Rules were amended. The primary objective of the 2016 Rules is to ensure environmentally sound management of e-waste. The Rules also endeavor to ensure protection against adverse effects of inappropriate handling and management of e-waste.

Impact of E-Waste on Environment and Health:

E-waste consists of a large variety of materials (Zhang and Forsberg, 1997), some of which contain different types of toxic substances that can contaminate the environment and threaten human health if not appropriately managed (**Table 3**). Toxic substances of e-waste disposal and primitive recycling processes can contaminate the food chain and thus affect human health. Current disposal methods of e-waste including landfill, incineration and recycle pose considerable contamination risks. Combustion in an incinerator can emit toxic gases into the atmosphere while landfills containing e-wastes can cause groundwater contamination (Schmidt, 2002; Yang, 1993). Pollutants have the potential to migrate through soils and groundwater within and around landfill sites (Kasassi et al., 2008). Organic and putrescible material in landfills decomposes and percolates through soil as landfill leachate. Leachates can contain high concentrations of dissolved and suspended organic substances, inorganic compounds and heavy metals.

Table 3: Common toxic substances associated with e-waste and their health impacts.

Sources: (Byster et. al., 2002) and (Kiddee et.at.2013)





Recycling of e-waste can also distribute hazardous substances into the environment and may affect human health. Blood, serum, hair, scalp hair, human milk and urine from people who lived in the areas where e-wastes are being recycled showed the presence of significant concentrations of toxic substances. (Eguchi et al., 2012; Ha et al., 2009) and (Asante et al., 2012). The danger of e-waste toxicity to human health, both in terms of chronic and acute conditions, has become a serious problem (Kiddee et al., 2013). Recently, research has found that unregulated e-waste recycling is associated with increasing numbers of adverse health effects such as adverse birth outcomes (Zhang Y et al. 2018), altered neurodevelopment (Huo X et al. 2019b), adverse learning outcomes (Soetrisno et al. 2020), DNA damage (Alabi OA et al. 2012.), adverse cardiovascular effects (Cong X et al.2018), adverse respiratory effects (Amoabeng Nti AA et al. 2020), adverse effects on the immune system (Huo X et al. 2019b), skin diseases (Decharat S et al. 2019), hearing loss (Xu L et al. 2020), and cancer (Davis JM et al. 2019).

Conclusion:

The emerging problem of e-waste needs to be dealt with efficiently. To do so strict implementation of rules on proper collection and authorized recycling is needed. Moreover, the government should rework on laws for waste management and create a separate department to deal with e-waste. The unorganized sector should also be brought under proper supervision and monitoring, so that majority of the e-waste generated could be recycled systematically. The manufacturers have to take responsibility for adopting the guideline for manufacturing sound environment product and sustainability management should be started from the product manufacturing stage. Manufacturer should also try and initiate a take back program to handle the waste so that proper management and disposal of e-waste can be done. The workers of the informal sector should be made aware about the consequence of improper electronic waste management. Awareness among the consumers is also the need of the hour.

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Design of p-amino benzoic acid based receptor and its use for detecting potentially harmful environment pollutant

Dr. Dipjyoti Kalita

Abstract:

A ligand capable of detecting environment pollutant in solution medium is synthesized and used to detect heavy metal ions in solution. The amide linked carboxylic acid derivative capable of complexing with metal ions by chelating effect is prepared by a conventional method of amide formation by refluxing phthalic acid with thionyl chloride followed by addition of two equivalents of para-aminobenzoic acid. The ligand was reacted with various transition metal salts such as Copper, Nickel, Manganese, Zinc, Iron etc. It is observed that different metals form metal complexes with different colours which also change on overnight standing in many cases.

Keywords: *Environment pollutant, chelating effect, supra-molecular self assemblies, multidentate ligand, co-ordination polymer.*

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Introduction:

Metal ions have hazardous effect on environment as well as on body. Particularly ions of heavy metals are known for their toxicity even in micro level. Toxicities of water bodies through the discharge of industrial effluents are a worldwide environmental problem. Industrial wastewater often contains considerable amount of heavy metals and organic pollutants that would endanger public health and the environment if discharged without adequate treatment. Heavy metal ions are the most serious contributors of water pollution as they are highly toxic, non-degradable and have a tendency to bioaccumulate and biomagnify as a result of food chain. Copper (Cu(II)) and Cadmium (Cd(II)) are toxic heavymetals normally found in industrial wastewater. It makes its way to water bodies through wastewater from metal plating industries, industries of Cd–Ni batteries, phosphate fertilizer, mining, pigments, stabilizers and alloys. Cu(II) in low concentration ($<5\text{mgL}^{-1}$) is generally considered to be toxic for man. The impacts of this water pollution have forced researchers to develop suitable techniques for the detection and quantification of heavy metal contaminants.

Para-aminobenzoic acid (PABA) is a well known biomolecule. PABA is an intermediate in the bacterial synthesis of folate. Some bacteria in the human intestinal tract such as E. Coli generate PABA from chorismate. Human lack the enzymes to convert PABA to folate, and therefore require folate from dietary sources such as green leafy vegetables. Many drugs, particularly sulfonamides are structurally similar to PABA and their antibacterial activity is due to their ability to interfere with the conversion of PABA to folate by the enzyme dihydropteroate synthesis. On the other hand, Phthalic acid is an aromatic dicarboxylic acid of modest commercial importance. It provides two reactive sites that can be derivatized to produce multidentate ligands.

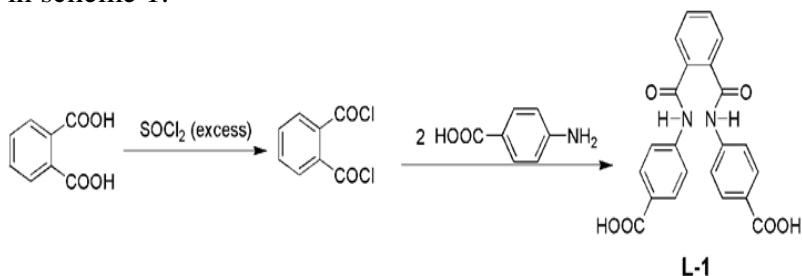
Amide based receptors always find more vital application in every field of science owing to their vast biological utility. Among many biomolecules the structural features of proteins are controlled by amide bonds and their weak interactions. Different types of receptors having amide bonds are synthesized and studied systematically. Receptors having amide linkages are also studied for their metal recognition properties.

Taking account of this outstanding biological importance we have designed a receptor by introducing amide linkage to *para*-aminobenzoic acid. The receptor is used to detect and remove heavy metals from solution so that it may mimic biological detoxification process.

Result and Discussion:

The enormous significance of amide linkages and as *para*-aminobenzoic acid prompts us to design some receptors containing both amide linkage as well as PABA moiety. In this context we have been able to design a multidentate ligand (**L1**) which is expected to have both metal and anion reorganization properties. The ligand is also potentially capable of removing metal ions by chelating effect.

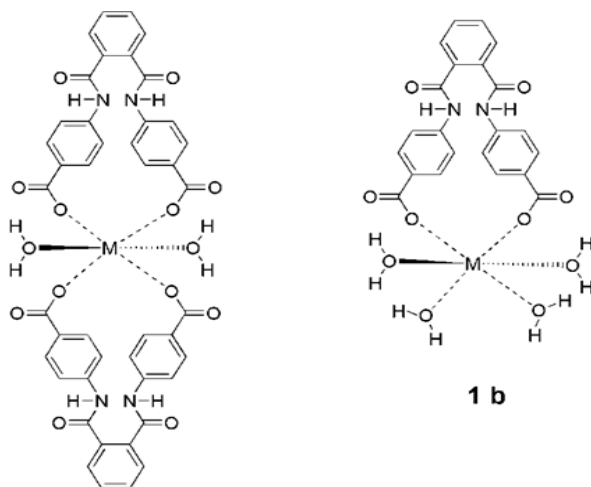
The amide linked carboxylic acid derivative (**L1**) is prepared by a conventional method of amide formation by refluxing phthalic acid with thionyl chloride followed by addition of two equivalent of *para*-aminobenzoic acid. The reaction is depicted in scheme 1.



Scheme 1: Method of preparation of receptor L1

The prepared ligand is then recrystallized from methanol and its metal binding properties are studied. Due to the presence of large number of hydrogen bond donors and acceptors in L1 it is expected to form different types of supramolecular self assemblies. Moreover, the presence of more than one binding sites it leaves probability of formation of wide variety of metal complexes. Some of the predicted types of metal ligand interactions are described in figure 1. It may lead to either 1:2 or 1:1 metal ligand complexes as shown in figure 1a and 1b respectively. On the other hand it may also lead to formation of co-ordination polymers as shown in figure 1c.

The ligand **L1** was reacted with various metal salts such as Copper, Nickel, Manganese, Zinc, Iron etc. It is observed that different metals form metal complexes with different colours. The Mn(II) d^5 (half filled d- orbital) forms a faint pink coloured complex and Zn(II) d^{10} (full-filled d-orbital) complex is found to be colourless. Whereas, Cu (II) forms a greenish blue complex.



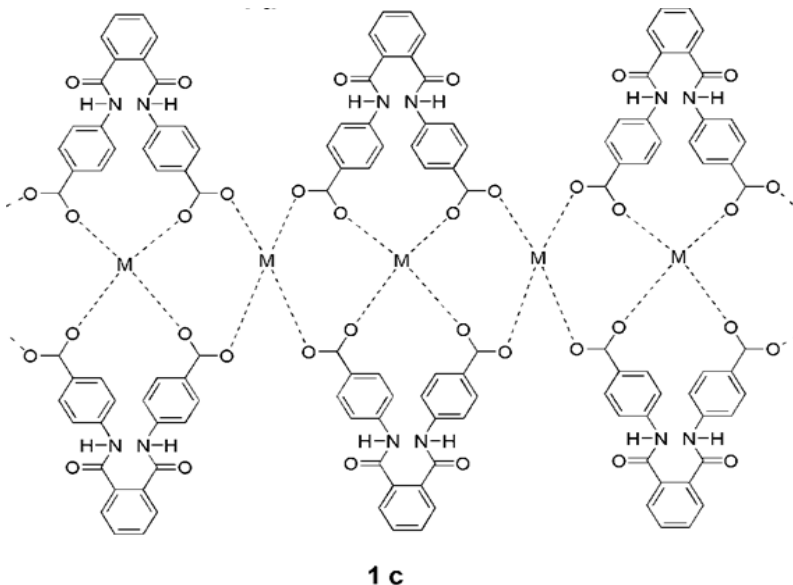


Figure : (a) 1:2 complex formation (b) 1:1 complex formation
(c) Formation of coordination polymer

On the other hand the complexes of Fe(II) and Ni(II) changes colour on overnight standing. The blue colour iron complex changes to brown and yellow colour nickel complex changes to light blue. This suggests that the initially formed complex is rearranged to another stable form. The solutions of the different metal complexes are shown in the following figure 2.

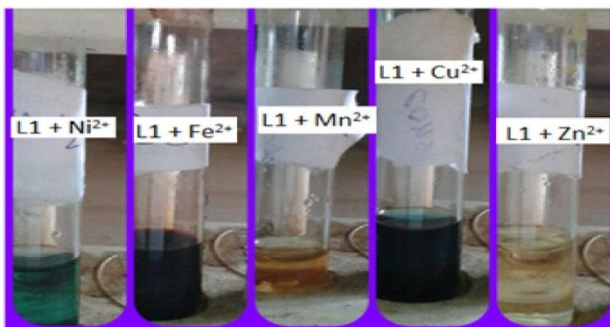
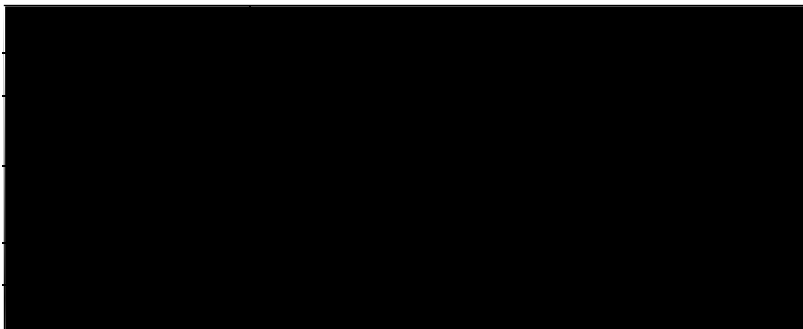


Figure 2: The solutions of metal complexes of Ni(II), Fe(II), Mn(II), Cu(II) and Zn(II) (from left to right)

The colorimetric observations of the various transition metal complexes of **L1** are listed in table 1:



* The changes in colour were observed on standing the solution of the respective metal-complex overnight.

Table 1: Colorimetric observations of the various transition metal complexes of **L1**

The ligand **L1** is capable of forming metal complex in water medium which leaves further probability of using the ligand for biological detoxification process. The quantification of detection level of different metal ion is yet to be done.

Conclusion:

In conclusion a polydentate ligand is synthesized and it is complexed with various transition metals. The metal complexes were of different colours and a change in colour on standing overnight is also observed. Hence, the ligand **L1** has a potential application in colorimetric metal recognition processes. Further owing to the similarities of the ligand with biologically active molecules, it might find application in the biological metal recognition processes. Although the biological and drug activity studies are beyond the scope of this study, however, such studies may unearth many interesting biological properties of this ligand. The ligand may further find application in detecting heavy metals on industrial waste and waste water management.

Experimental:

Preparation of ligand (L₁):

About 3.325 gm of phthalic acid is dissolved in about 10 mL of thionyl chloride in a round bottom flask and few drops of pyridine are added to the flask. The reaction mixture is then heated under reflux for about 30 minutes. The excess of thionyl chloride is then allowed to evaporate to obtain the acid chloride. The acid chloride is dissolved in DCM and about 5.487 gm of *p*-aminobenzoic acid is taken and added to the solution. Then it is again heated for two hours. The reaction mixture is allowed to cool. The crude product is obtained by evaporating the solvent. The ligand L₁ is then purified by crystallization. The product obtained with a yield of 65.3 %. The melting point of the ligand is 131°C.

Preparation of metal complex with ligand:

(a) Complex with Cu: 0.407 g of sample is dissolved with pyridine in a test tube. Then 0.249 g of CuSO₄·5H₂O is added to the solution. Then the solution turns to greenish blue colour.

(b) Complex with Zn: 0.407 g of sample is dissolved with pyridine in a test tube. Then 0.287 g of ZnSO₄·7H₂O is added to the solution. There is no characteristic colour change observed in the solution.

(c) Complex with Ni: 0.407 g of sample is dissolved with pyridine in a test tube. Then 0.237 g of NiCl₂·6H₂O is added to the solution. The solution turns to yellow colour immediately, but after standing for one night the colour changes to light blue.

(d) Complex with Fe: 0.407 g of sample is dissolved with pyridine in a test tube. Then 0.278 g of FeSO₄·7H₂O is added to the solution. The solution turns to light blue precipitate immediately. But after standing for one night the colour changes to brown.

(e) Complex with Mn: 0.407 g of sample is dissolved with pyridine in a test tube. Then 0.169 g of MnSO₄·H₂O is added to

the solution. There is no characteristic colour change is observed in the solution.

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