

AGRICULTURAL ECOSYSTEM AND SUSTAINABLE DEVELOPMENT IN BRAHMAPUTRA BASIN, ASSAM, INDIA

**SHORT PAPERS
and
ABSTRACTS**

**INTERNATIONAL WORKSHOP
December 19-20, 2008**

Organised by

Centre for South East Asian Studies
Kyoto University, Japan
and
Department of Geography
Gauhati University, Assam, India



SHORT PAPERS AND ABSTRACTS

**International Workshop on
AGRICULTURAL ECOSYSTEM
AND SUSTAINABLE DEVELOPMENT IN
BRAHMAPUTRA BASIN, ASSAM, INDIA**

December 19-20, 2008

Edited by

A. K. Bhagabati

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Message

I am happy to learn that the Department of Geography, Gauhati University in collaboration with Kyoto University, Japan is going to publish a volume containing short papers/sbstracts of the presentation made in the international workshop held in the Department during 19-20th December, 2008. This kind of collaborative effort not only provides a common platform to share ideas and experiences, but also encourages institutional linkage, which is urgently required for quality education and research.

I wish great success of this innovative endeavour.

Date : 23.04.2010

A handwritten signature in black ink, appearing to read 'O.K. Medhi'.

(Prof. O.K. Medhi)

From Chairperson of the Organizing Committee

I am happy to learn that the Organizing Committee of the two-day International Workshop on '**Agricultural Ecosystem and Sustainable Development in Brahmaputra Basin, Assam, India**' held on 19-20 December, 2008 in the Department of Geography, Gauhati University is bringing out a volume containing the short papers/abstracts of the papers presented in the workshop. The workshop was organized jointly by the Department of Geography, G U and the Centre for South-East Asian Studies, Kyoto University, Japan where as many as twenty two research papers were presented by scholars from Japan, Myanmar, Bangladesh and India. It provided a platform to all of us to share ideas and experiences gained in different natural and human contexts.

I am grateful to Dr. Kazuo Ando of Kyoto University, Japan for coordinating the programme and taking the responsibility of publishing this volume. I thank all the participants of the workshop, especially my colleagues from the Department for their kind support. Professor A.K.Bhagabati deserves special thanks for kindly editing the volume.

I am grateful to Professor O.K.Medhi, honourable Vice-Chancellor of Gauhati University for kindly allowing us to hold the workshop in the Department and gracing the occasion as the Chief Guest in the inaugural session.

I wish all success of this collaborative effort

L. Datta
Professor and Head
Department of Geography, G U



Centre for South East Asian Studies
Kyoto University, Japan
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Kyoto 606-8501 Japan

From the Coordinator

I am happy to note that the short papers/abstracts of the presentations made in the International Workshop on “Agricultural Ecosystem and Sustainable Development in the Brahmaputra Basin, Assam, India”, as an output of JSPS (Japan Society for the Promotion of Science) supported joint research project of CSEAS (Center for Southeast Asian Studies), Kyoto University, on “Agro-ecosystem and Development in Region of Brahmaputra River Reaches-Potential of Sustainable Development” - (2005FY-2008FY), held in the Department of Geography, Gauhati University on December 19-20th, 2008 have been finalized for publication. The papers covering a range of fields related to the workshop theme will be of immense help for those who are working on similar issues. It may however be noted that the collaborative efforts of the concerned institutions will reach the expected meaning only when the full papers are successfully published.

We the Kyoto University counterpart are glad to take the responsibility of publication of the present volume and take the opportunity to appreciate the Department of Geography, Gauhati University for kindly holding the workshop. I thank the HoD, Geography and other faculty members for their active help and cooperation and also those who presented papers in the workshop for their scholarly contributions.



Ando Kazuo
Head, Department of Practice-oriented Area Studies
Center for Southeast Asian Studies
Kyoto University, Japan

Welcome Address

Honourable Vice-Chancellor of Gauhati University, respected Head, Department of Geography, Guest of Honour Professor Taher, Dr. Ando Kazuo and other friends from Japan, Myanmar, Bangladesh and India, former professors of the department, my learned colleagues from Geography and other departments of the University. It gives me immense pleasure to see you all from near and far east together under a single roof this morning. With the best possible, but may be inaudible hearty words, I extend my warm welcome to all of you to this international workshop on behalf of the Department and the University as well.

Respected Guests

I am happy to let you know the geographical and locational background of this premier institution: on the north of us quiet flows the winter Brahmaputra, on the east stands a holly hill with the famous temple Kamakhya on its top and on the south-west stretches a globally recognized Ramsar site called Deepar Beel. This is a land in the midst of all these remarkable features, where this oldest (60 years old) and the largest University of the north east magnificently stands.

I recall— one fine February morning (2003) Professor M.M.Das, my teacher, led a person with a Manipuri look to my chamber (Head's Cell). He was Dr. Ando Kazuo, a Japanese agricultural scientist by profession— the co-ordinator of today's workshop. Among other things, he asked me a straight question— Do you know, who (which community) did introduce plough culture in Assam? I answered— may be the Ahoms. He made a mild negative comment and humbly proposed- let us together search for an acceptable answer of this question.

This workshop is a bold step in the ladder of a collective journey organized by scholars from the far east, near east and near south towards answering questions of natural, historical and cultural relevance, pertaining particularly to India's North-East- the *land of seven sisters*. This is one of the unfinished agenda under the collaborative effort of the Department of Geography, G.U. and the Kyoto University, Japan initiated on the 28th day of September 2005. The then Vice-Chancellor of the University Dr. G.N.Talukdar was kind enough to lift the curtain for this first-ever international collaborative programme to go ahead with the objectives set and the terms and conditions agreed upon. This workshop on '**Agricultural Ecosystem and**

Sustainable Development in the Brahmaputra Basin, Assam' bears immense significance in so far as agro-ecosystems of South and South-East Asia are concerned. I am happy to announce that two young scholars –one from Japan and other from Assam are working in the field of agro-ecosystem and sustainable development in the Brahmaputra valley. Asada, a post-graduate from the Kyoto University has been working on an *Ahom* village near Lakhimpur. He speaks Assamese and writes the language with beautiful handwriting. Moreover, a network of 15 automatic rain-gauges has been installed covering all the major topographic and ecological units of Assam under the collaborative programme. All colleagues of the Department are joining their hands and academic support to make all the programmes a success. I owe a great deal of gratitude to Professor L.Datta, HoD and Chairperson, Organizing Committee for her active support and constant encouragement towards successful completion of the workshop as a part of the year-long celebration of golden jubilee of the Department.

I on behalf of the Department, once again welcome you all to this two-day international workshop to deliberate on the problem and share research experiences gained in different geographical contexts. Please forgive us for the lapses that may creep in, and encourage us for the hopes and aspirations that we have been harboring for the last three and half years to make our hands stronger to address new issues and emerging problems.

My best regards to you all
Have a good day

A.K.Bhagabati

Two-day International Workshop on Agricultural Ecosystem and Sustainable Development in Brahmaputra Basin, Assam, India

Department of Geography, Gauhati University, Guwahati

December 19-20, 2008

Programme

Date: 19.12.08

Inaugural Session (10.15-11.15)

Chairperson	Prof. L. Datta
Welcome address	Prof. A. K. Bhagabati
Background of the workshop	Dr. Kazuo Ando
Inaugural Address	Prof. O.K. Medhi Vice-Chancellor, Gauhati University

Guest of Honour	Prof. M. Taher
Chairperson's remark	
Vote of Thanks	Dr. A.K. Bora

Technical Session I (11.30-13.30)

Chairperson	Prof. H. N. Sarmah
Co-chairperson	Dr. Kazuo Ando

Technical Session II (14.30-16.30)

Chairperson	Prof. M. M. Das
Co-chairperson	Prof. Koichi Ushami

Date: 20.12.2008

Technical Session III (10.00-12.00)

Chairperson	Prof. D.C. Goswami
Co-chairperson	Prof. Khin Lay Swe

General Discussion and Concluding Session (12.30- 13.30)

Chairperson	Prof. A. K. Bhagabati
Co-chairperson	Dr. Kazuo Ando

Lunch (13.30-14.30)

Two-day International Workshop on Agricultural Ecosystem and Sustainable Development in Brahmaputra Basin, Assam, India

**Department of Geography, Gauhati University, Guwahati
December 19-20, 2008**

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Department of Geography
Gauhati University

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Mr. Kalicharan Das

3. Invitation Sub-committee

Prof. A. K. Bhagabati, Mr. Nityananda Deka
Mr. Pranjal P. Mudoi, Mr. Tanmoy Choudhury

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Department of Geography Gauhati University, Guwahati

The Department of Geography, Gauhati University was established in 1949, a year after the foundation of the University. It is one of the oldest geography departments in the country. The Department has attained its present status mainly through the untiring efforts of the faculty members, students, and the great potentiality attached to this part of the country for geography education and research. Having been upgraded to a post-graduate department in 1958, the Department gradually extended its activities to different areas of research including the emerging ones, besides the regular teaching programs.

In order to augment the teaching program as per need of the time and demand of the region, the Department has been restructuring the courses of study from time to time. Keeping track with the latest conceptual and methodological development in the subject, courses on Remote Sensing and Geographic Information System have been introduced. The Department introduced semester system in January, 2001 to make the post-graduate program more relevant, regular and useful. Apart from the post-graduate program, the Department has been carrying out Ph.D. program since the early 1960s. The research program received much impetus when the M.Phil. program was introduced in 1981. Mention may be made that the Geography department is the first department to introduce M.Phil. program in the University. Recently the department has acquired a new momentum in the field of teaching and research with the financial support received from the UGC under SAP and DST, Government of India under FIST program.

Villager-Subjective Development in the Brahmaputra Floodplain Agro-ecosystems

Kazuo Ando¹, Nityananda Deka² and A.K.Bhagabati³

1 CSEAS, Kyoto University, Japan

2 & 3 Department of Geography, Guahati University, Assam, India

Introduction

The villagers have been used to be considered as the object in the development programme of the Government, even of the NGOs. It has been the tradition particularly among the scholars and practitioners in India as well as other developing countries like Bangladesh and Myanmar and even Japan. From the later part of 1970s, this tradition was first challenged by the scholars who were engaged in agricultural development in South and Southeast Asian countries. Unfortunately, they were not Asian scholars, but western scholars, who were practically working with the rural people. Conway (1986) has proposed an alternative concept of agro-ecosystem against the traditional one. This concept presented a holistic system approach covering not only the narrow agricultural system but also the ecological and socio-economic systems. The rapid rural appraisal has emerged from their trial. The sensational book namely '*Rural Development: Putting the Last First*' by Chambers (1983) became popular in 1980s when the big wave of the green revolution prevailed in such countries. On the basis of its negative experience, this tradition was questioned by the practice-oriented scholars, who have been free from the traditional concepts of rural development. From the view point of the macro-economic indicators, e.g. GDP, GNP, population - production ratio etc, the above mentioned countries have had a lot of development problems as well as the environmental hazards including frequent floods, cyclones, drought, etc. However, the western scholars have discovered the rich experience, wisdom and knowledge inherited by the local communities of such countries through generations. They started to learn from the villagers and invite them to their research agenda so that development becomes "sustainable". At present, the wave of globalization paradigm is blowing on this academic approach because of the growing demand of the government and the people in general to realize the rapid development to catch up the attention of the western and other developed countries.

Two decades have passed since the introduction of Agro-ecosystem Approach and the idea of 'last put the first'. This academic approach still has its importance for sustainable development. However, conceptually or theoretically, it is easily understood that the villagers

Table 1: Change in cropping technology in Muktapur village, 1985-2006

Crops cultivated	Preparation of seedling beds		Land preparation for paddy		Kind of fertilizer/manure		Kind of pesticides		Type of irrigation		Method of weeding	
	Ploughing-harrowing (in number)		Ploughing-harrowing (in number)		Before 1986	In 2006	Before 1986	In 2006	Before 1986	In 2006	Before 1986	In 2006
	Before 1986	In 2006	Before 1986	In 2006								
Winter (Sali) rice	P=5 H=6	P=5 H=6	P=5 H=4	P=1 H=1	Cow dung, compost, bio-manure, oil cake, twigs	Urea, potash, DAP	Herbal concoction, wood ash, citrus fruits, limestone, oil cake etc	Malathian, Ustad, Gamaksin etc	Use of Khisani, Lahati	Use of Khisani, Lahati	Use of Zabaka, Akra,	Use of Zabaka, Akra
Bau rice	Nil H=6	Nil H=0	P=5	P=5	Nil	Nil	Herbal concoction, citrus fruits,	Herbal concoction, citrus fruits,	Nil	Nil	Use of Zabaka, Akra,	Use of Zabaka, Akra
Autumn (Ahu) rice (broadcasting on dry land)	Nil	Nil	P=6 H=0	P=2 H=0	Cow dung,	Urea, Potash	Herbal concoction, citrus fruits,	Malathian	Nil	Nil	Use of Zabaka, Bidha	Use of Zabaka, Bidha
Autumn (Ahu) rice (transplanting on wet land)	P=5 H=6	P=5 H=6	P=5 H=4	P=1 H=1	Cow dung,	Urea, Potash	Herbal concoction, citrus fruits,	Malathian	Use of Khisani, Lahati	Use of Khisani, Lahati	Use of Zabaka, Akra,	Use of Zabaka, Akra
Mustard	Nil	Nil	P=5 H=4	P=1 H=1	Cow dung, compost, bio-manure	Urea, Potash	Herbal concoction, wood ash, citrus fruits, oil cake etc	Malathian, Ustad, Gamaksin etc	Nil	Nil	Manually	Manually
Potato	Nil	Nil	P=15 H=50	P=15 H=50	Cow dung, compost, bio-manure, oil cake, twigs	Urea, potash, DAP	Herbal concoction, wood ash, oil cake etc	Malathian,	Nil	Nil	Manually	Manually
Black-gram	Nil	Nil	P=2 H=2	P=2 H=2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Jute	Nil	Nil	P=5 H=3	P=5 H=3	Cow dung	Urea	Nil	Nil	Nil	Nil	Manually	Manually

Source: Based on oral interview amongst the farmers of the study village, 2006.

Note: P and H indicate ploughing and harrowing

mainly in purchasing power tillers in terms of loan, and seed distribution against rehabilitation for flood and drought damages. Thus technological intervention is at its minimum. It can, therefore, be held that the villagers have developed their cropping systems mainly through their own efforts.

The change in the cropping technologies in the village Muktapur from 1985 to 2006 is shown in the Table 1 and its land use pattern in 2006 in Figure 1. The main crop of the village is the *Sali* rice. Remarkable change occurred in the method of land preparation for rice cultivation. Land is now prepared through a combination of traditional and modern methodologies. Table 1 reveals that the frequency of ploughing and harrowing with a pair of bullocks and wooden plough (*Nangal*) and harrow (*Moi*) has come down because of the use of power tiller and tractor. Before 1986, the villagers ploughed and harrowed the *Sali* rice fields five and four times respectively. At present, most of the villagers first plough their *Sali* fields vertically and horizontally by a power tiller and leave them fallow for 10-15 days. Secondly, the villagers plough and harrow the land once and then harrow once again for leveling the muddy fields with a *Nangal* and a *Moi* for transplanting the *Sali* rice. Only a few villagers plough and harrow their fields by power tiller completely.

Moreover, it is noticeable that two types of *Nangals* are used in the village, namely *Buta Nangal* and *Saja Nangal*. *Buta Nangal* is smaller than *Saja Nangal*. *Buta Nangal* is used for ploughing the muddy fields, while *Saja Nangal* for dry fields as it is difficult for a pair of bullock to draw *Saja Nangal* in the muddy fields.



Photo 1: Local weeder in Bangladesh



Photo 2 : Japanese weeder used in Bangladesh

Table 2: Change of Pbt number as per crop season from 2000-2008

Planting Method:	Transplant	Broadcast	Tansplant	Broadcast	Broadcast
Planting Month:	January	June	August	November	November
Main Crop:	Irri-Boro	Aman	Aman	Sharisha	Rabi shashya
Year, 2000	1055	475	500	130	230
2001	1575	500	447	80	269
2002	1550	400	450	140	150
2003	1497	470	520	19	170
Flood, 2004	1570	-	-	14	80
2005	1525	150	439	87	110
2006	1463	500	691	90	42
Flood, 2007	1472	-	280	477	8
Flood, 2008	1493	?	?	?	?

Source : JRDS Survey

Sustainable Crop Production in Dakshin Chamuria Village

The village Dakshin Chamuria is located at the Jamuna floodplain (Brahmaputra Floodplain) and represents a typical floodplain agro-ecosystem. The major crop of the village was deep water *Aman* Rice (broadcasting *Aman*) cultivated during rainy season up to 1987- 88. In 1987-88, two consecutive big floods seriously damaged the deep water *Aman* rice and then the cropping system gradually shifted to *IRRI-Boro* (HYV and irrigated rice) and *Shoriha* (mustard) in the dry season. In August of 1988, all the crops were submerged and the deep water rice fields were replaced by *Shoriha* to recover the loss of *IRRI-BORO* rice cultivation. The villagers have largely shifted their cropping pattern from the *Aman* based one to the *Rabi* and *Boro* based one. After the great flood, many embankments have been constructed around the village and as a result the flooding pattern has changed. In a particular year inundation is not enough for deep water *Aman* rice to grow at the *Modhyam Jami* (middle high land) as before and in another year

severe flood affects all kinds of land of the village. Therefore, the villagers have started cultivating the transplanted *Aman* rice in the rainy season in the intermediately high land to get better yield. In the *Nichu Jami* (low land), the deep water *Aman* rice is still cultivated as before. In accordance with this change, the villagers have earlier tried to transplant the IRRI-*Boro* rice even by skipping the *Shoriha*, because the villagers got higher yield of transplanted rice. But the harvest time of the transplanted *Aman* rice delays by two weeks (November – December) than the deep water *Aman* rice. This two-week period is a critical time for *Shoriha* cultivation. Sowing of *Shoriha* in December gives yield at the expected level. Thus, the importance of IRRI-*Boro* rice cultivation has substantially increased in the village. It is well illustrated in Table 2. The villagers have also tried to use a new tool to make the IRRI-*Boro* rice cultivation sustainable by reducing the labor cost. Weeding is an essential element of management for IRRI-*Boro* rice. The problem of weed generally does not arise in transplanting rice in the rainy season. But the fine weather and fertilizer use have created this problem. In order to tackle it, a new type of weeder (Photo 1) has been devised locally apart from the original Japanese weeder (Photo 2).

Conclusion

The two cases of recent change in cropping system in Assam and Bangladesh disclose that the villagers have tried to change their technologies as per the change in their natural and socio-economic environments on the basis of their long experience. They seem to follow the rhythm of the floodplain ecology. The life style and production behaviour of the villagers in the floodplain cannot be separated from this rhythm of nature. The villagers try to evolve new ideas and technologies on the basis of their traditional knowledge and wisdom. They efficiently use their own technological resources and socio-economic capabilities. Thus, their devices become so natural and small that it becomes difficult for the scholars from outside to recognize them and they generally try to implement programmes from their own objectives and perspectives. It may therefore be concluded that it is one of the hidden causes which makes learning from the villagers difficult particularly for the scholars and practitioners who are not intimately associated with the system.

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Transformation of Resource Utilization and its Influence on Rural Life : Case Study of a Village in Tangail District, Bangladesh

Keiko Yoshino
University of Tokyo, Japan

Introduction

After the introduction of “green revolution”, farming system in Bangladesh changed drastically. Besides the change in main products, green revolution influenced other resource utilization also (Shiva,1988); but such change is less focused. This paper examines the change of resource utilization giving attention to the resources with little economic value, but with importance in maintaining everyday life.

Study Area and Methodology

The study was conducted in Dakshin Chamuria village, Tangail district, Bangladesh. The village is located in the floodplain of the Jamuna river, and all the lands except for the homesteads and a few public places are inundated by flood water during the rainy season. The study pertains to the periods 1992-95 and 2004-08 and the changes during the period were examined.

Results and Discussion

The traditional farming system in Dakshin Chamuria village was the combination of cultivation of *aus* rice, *aman* (deep water) rice, and jute in rainy season, and upland crops (beans, cereals, mustard, vegetables and spices) in winter season (Ando and Uchida, 1993). But with the introduction of HYV since 1975, such farming system changed gradually. Rice cultivation shifted from using local varieties to HYVs, and the cultivation of various winter crops was replaced by irrigated HYV rice. With the advent of “white revolution”, the style of cattle raising also changed from grazing in the fallow lands and feeding on personally produced pulses and rice straw to raising within the homesteads with purchased feeds.

Such changes brought about change in the utilization of by-products too. With the decrease of winter crops, residues of mustard and wheat also decreased, which the poor women

used to work out for helping post-harvest work, and got some portion as rewards for fuel. The lower parts of rice straw of the deepwater rice called *nara* (the upper part of straw cut and brought to homesteads with paddy is called *kher*) could be taken by anyone. It used to be a very important source of fuel for the poor households. But it also decreased. Cowdung scattered in the fields or roadsides were also important source of fuel for the poor households; but it also decreased. The unwritten rule that “fallen things can be taken by anyone” helped the poor households. But the decrease of such freely available resources such as *nara* and scattered cowdungs affected the poor households, especially the women folk who are entrusted to procure fuel. To cope with the decrease in fuel resources, women had to spend more time in gathering

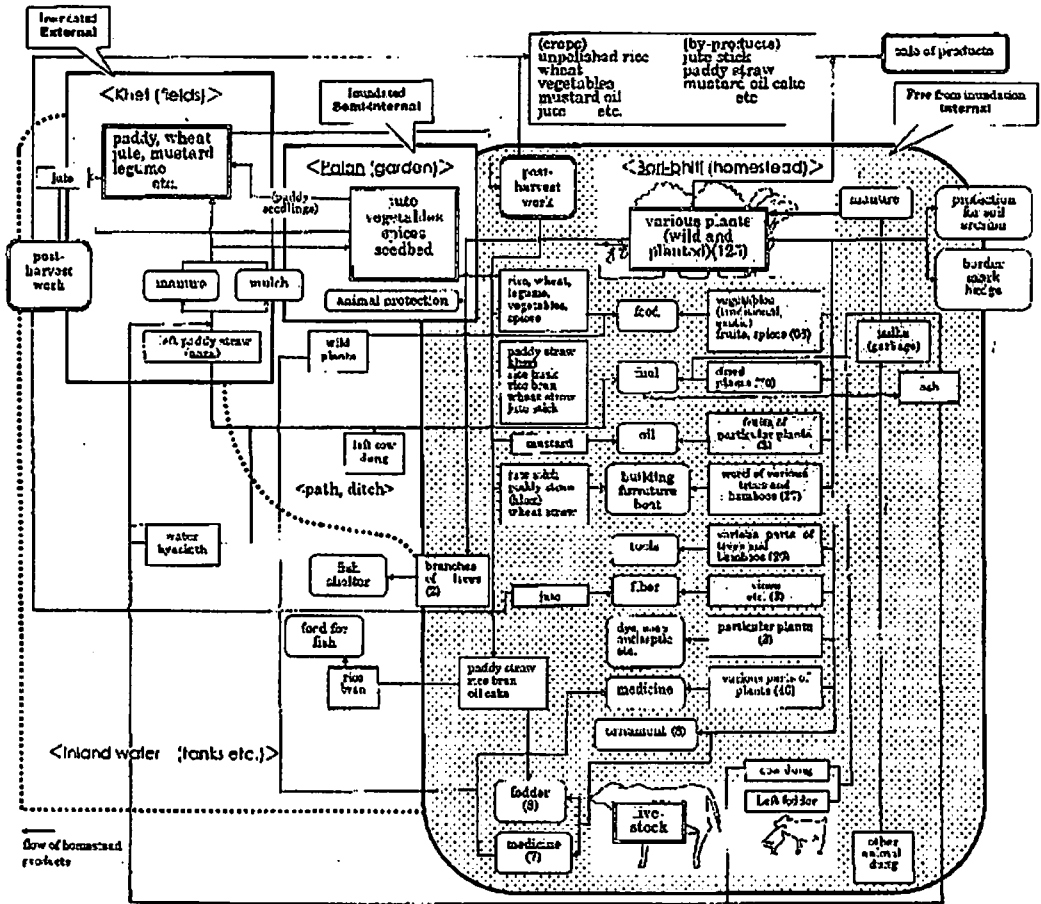


Figure 1: The flow of resource utilization in the village (revised from Yoshino, 1999)

fuel, and also relying more on fallen leaves in their homesteads, which caused significant decrease in the diversity and number of plants in the homesteads. It was also felt by the villagers that the use of pesticide and closing of canals adversely influenced the catch of wild fish. In this way, the change of farming system altered not only the crops cultivated but also reduced the flow of various resources which arise secondarily. The figure below shows the pattern of resource utilization in 1992 (at that time, mono-culture was already expanding), and many paths of resource utilization that almost disappeared in 2004.

Conclusion

It is announced that the green revolution was quite successful especially in Asia and Latin America (Cantrell and Hettel, 2004). But it paid no attention to the existing flow and cycle of natural resource utilization. Production of targeted crops may have increased, but many other resources were oppressed, which affected especially the poor households. Utilization of local resources needs to be evaluated in an integrated manner paying required attention to various activities that are performed without money, and the policy planning needs to aim at increasing total improvement (not only economic) of rural life.

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Farming System Research: Change of Traditional into Commercial Floating Island Agriculture in Inlay Lake, Southern Shan State, Myanmar

Khin Lay Swe

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Introduction

The Inlay Lake is a productive high altitude wetland ecosystem supporting a great variety of flora and fauna as well as the livelihood of the lake-dwellers through its natural floating inlands. Floating island agriculture is a unique and traditional way of utilizing natural resources by the Intha, and is economically and ecological important for its inhabitants. Several decades ago, floating island agriculture was a traditional version of the hydroponics model, using its natural resources in a sustainable way. At present, however, the lake is facing serious problems caused by watershed degradation, gradual shrinking of the lake's water surface and application of agro-chemicals. The survey was carried out in 2006 and 2007 in ten floating villages which are involved in intensive tomato production. The objectives were to document the existing agricultural practices of the local growers on the floating islands and the information thus collected serve as the base line study for developing an eco-friendly technology in the lake area. Because of its agro-ecological setting, tomato can be grown very well all the year round and the growers produce off-season crops for the whole country. The high productivity has been achieved through the use of hybrid varieties, high inputs of fertilizers and plant protection chemicals. After land clearing, they add a layer of mud and aquatic plants on the floating beds for a growing media for crops. As an indigenous crop management practice, they apply them again as bio-fertilizers at about 2 weeks intervals. The research findings showed that the growers generally use various pesticides and fungicides (10-15 in number) and apply them 10-18 times with an interval of 7-12 days in a cropping season. Their injudicious use of chemical fertilizers and pesticides brings detrimental effects not only on the growers themselves, but also on the aquatic biota of the lake.

Background Statement and Purpose

The Inlay Lake is situated at 900 m above the sea level in Nyaung-shwe township and is about 30 km south of Taunggyi, capital of the Shan State. It is a remnant with an average length of 25 km, width of 10 km and a depth of 3 m, and lies between 20°-10' and 20°-53' North

latitude and 96°-50' and 96°-57' East longitude. It is the most famous agro-tourism site in Myanmar with beautiful landscape and scenery, floating gardens and unique way of life of the Intha, the tribe who are living around and on the lake. They traditionally build their houses on the lake water surface with wooden piles fixed into the lake floor. Settlements are seen as floating villages in a cluster of houses and they go around the village and nearby cultivated floating islands by rowing their traditional small flat boat with one leg. Transportation is entirely by waterways and now-a-days motor boats with diesel engines are also being used. At present, floating islands occupy about 80 km² of the lake and about 280 floating villages are there on the lake and its fringes with a population of more than 15,000. The ethnic groups, namely Intha and Palaung etc. have been practicing upland or shifting cultivation around the lake since time immemorial. To date, as a consequence, severe soil erosion and sedimentation in the lake are clearly noticeable. Cultivation on floating islands/beds started at subsistence level more than four decades ago. It has gradually changed into commercial cultivation during the last 15 years. This change has a great impact on the socio-economic life of the people and the lake ecosystem. Because of its peculiar agro-ecological setting, tomato can be well grown through out the year in Inlay Lake and it enables the growers to produce off-season crops. Over 20 villages are involved in commercial tomato production. To maximize their yields, growers use high input of chemical fertilizers and pesticides. The survey was conducted to document the existing agricultural practices of local growers in floating islands and the information will, in turn, serve as the base line study for developing an eco-friendly agricultural technology in the lake area.

Farmers' Survey

Farmers' survey was done four times (April and October in 2005 and in 2007) at ten floating villages on the lake which had the largest tomato sown areas. For farmer's interview, 15 tomato growers were randomly selected from each village and data on their socio-economic condition such as land holding, cropping pattern, annual on-farm income, off-farm income, non-farm income, input use and cost of production, etc., were collected. Detailed questionnaires about pesticides and fungicide application of each grower were also prepared. The results were then statistically analyzed.

Research Findings

Formation of the floating islands

Floating islands are soilless and composed mainly of some Graminae and Cyperaceae. Among them are two Graminae-*Phragmites karka* (Kyu-phyu) and *Phragmites communies* (kyu-ni), three Cyperaceae, *Cyperus digitatus*, two unidentified species locally known as *Shalone* and *Sha-pya* and one Zigeraceae, *Hedychium coronarium* (Taw-ngwe-Pan). According to

the information obtained from the natives *Sha-lone* and *Sha-pya* are the pioneer plants followed by Gramine after a few years. Finally the natural occurrence of *Taw-Ngwe-Pan* reveals that the floating island has reached a mature state and can be used as a floating garden, which took at least 10-15 years. By that time the thickness of the submerged portion is about 1-2 m in depth, composed of running stems, roots, rhizomes and hair-like numerous adventitious roots tightly interwoven as a thick compact mass serving as a mattress for floating agriculture. The anatomical structures of these underwater part clearly reveal a waxy thick cuticle and suberized/cutinized epidermis, large air cavities and wide hollowed pith, by which these characters make these plants much lighter for buoyancy. Besides, it can survive for more than 10 years in water without decomposition. The Inthas notice that when the plants of *Colocacia antiquorum* (Pein Yar) emerge, it indicates that the floating island is no longer in use. They believe that the roots and rhizomes of *Colocacia* destroy the compact mass, which leads to the destruction of buoyancy. Consequently cultivation can no longer be done on it.

Problems

The farmer's survey reveals the following disadvantage of the current agricultural practices. Side dressings of chemical fertilizers were generally carried out at 10-15 days intervals throughout the tomato growing season. Chemical fertilizers were placed (spot feeding) on the floating beds between the tomato plants. They neither spread nor covered the fertilizers so that volatilization and flow down of fertilizers to the lake water could easily happen before the plants consumed them. They did not do such a labour intensive work because they were ignorant of the negative effects of their method of fertilizer application. In the study villages, it was also found that shortage and high cost of labor was a major limiting factor for the proper crop management. Since particular skills such as doing work while standing or squatting down on a boat were needed for the floating island agriculture, there was no migrant labor from other places. Only the family labour and voluntary labor for each other were available for tomato growing.

Most growers started spraying pesticides and fungicides at about 5-15 days after transplanting and regular spraying (calendar based system) was done at every 7-12 days throughout the growing season. Total number of sprays ranged from 10 to 18 times, depending on the market price and weather condition. When the tomato price was high, growers applied more input (pesticides and fertilizers) to get more yield. When the weather condition was rainy and cloudy for 2-3 days which was favourable for the occurrence of insect and diseases, they sprayed at least twice a week. Tomato was harvested at about 10 days interval depending on the market demand. Pesticide spraying and fertilizer application were done on the following day after each harvest. The residual effect of most pesticides used by the growers lasted for at least

Table 1: Cost and benefit of tomato production on floating islands (for 100Alan)

Input cost	Rate	Price	Values/ Kyats
Tomato hybrid seeds	3 bags of 5g (15 g)	4000	12000
Fertilizers			
Urea (from seedling stage to Flowering)	2 bags (50 kg/bag)	30000	60000
Bat guano	1 bag (50 kg/bag)	5000	5000
Pesticides and Fungicides			
Carbofudan	2 times (2 kg in total)	2000	4000
Losbin	1 time (1/2 kg)	10000	5000
Mancozeb	6-7 times (1.5 kg)	7000	10000
Copper oxichloride	3 times (500 g)		
Deconil	200 g (2 times)	1000	2000
Matarazil	200g (2 times)	2000	4000
Sulphur (Cumulex)	500g (3-4 times)	3000	3000
Benomyl	200g	4000	4000
Cypermethrin	200 cc	3000	3000
Aephate	250 g (2 times)	2000	4000
Prophenophos	250 cc (2 times)	2000	4000
Chlopyriphos	150 cc (2 times)	1500	3000
Apametin	50 cc	2000	2000
Neem pesticide	1 litre (2 times)	500	1000
Total input cost			126000

Table 2: Cost and benefit of tomato production on floating islands (for 100 Alan)

Input cost	Rate	Price	Values/Kyats
Land clearing	2 man/day	2000	4000
Adding muds and water	1 man/day	2000	2000
Weeds for land preparation			
Application muds and water	6 times	2000	12000
Weeds as bio-fertilizers			
Bamboo staking	1 md x 5 times	1000	5000
Weeding	1 md x 6 times	1000	6000
Leafing, reducing old leaves	1 md x 2 times	1000	2000
Pesticide application	15 times	1000	15000
Harvest	100 basket	100 Kyats	10000
Total labor cost			56000
Total cost of production			182000
Yield per 100 Alan	3000 viss	150 Kyats	450000
Benefit per 100 Alan			268000

Table 3: Agro-chemicals most commonly used in Inlay Lake (2006-2007)

Fungicides	% farmers	Disease incidence
Mancozeb	98	Early blight
Carbendazim	95	Late blight
Matalaxyl	95	Downy mildew
Ritonil	86	Leaf spot
Topsin	82	Fusarium wilt
Sulphur	80	Damping off
Pesticides	% farmers	Pest occurrence
Monocrotophos	92	Leaf miner
Carbofuradan (granule)	86	Soil borne pests
Acephate	85	Aphids, Jassids
Diazinon (granule)	80	Soil borne pests
Cypermethrin	80	Aphids, jassids
Dimethoate	76	Scale, leafminer, spider mites
Chlorophyrifhos	75	Leaf miner
Endosulphan	75	Fruit borer

7-10 days. Therefore, pesticide application during the harvest time could create a hazard to consumers. Besides, almost all growers, while spraying, never used protection materials such as glove and nose-guard, which posed a great harm to the operators. They used the sprayers with high pressure and high volume which caused high contamination by spill, drift drench to the lake water and its environment.

Serious pest and disease occurrence was not found during the study period. However, rats were the major problem to all growers. As a control measure, growers placed paddy seeds on the floating beds to feed the rats instead of killing them. Their concept was that when rats get paddy seeds to eat they would eat fewer tomato fruits (as a matter of fact, rats could proliferate more and destroy more plants). It was also observed that most growers were reluctant to use poison baits and traps because they did not want to kill them. That might be one of the reasons why they sprayed pesticides regularly before they noticed the pests on the plants. They did not want to kill them but they preferred to make prevention before infestation. This custom might be related to their religious perception of avoiding the killing of living things since the Inthas were known to have very deep devotion to Buddhism.

Several decades ago, vegetable growing was at a subsistence level. Fishing, working with gold and metal, weaving traditional cotton Shan bags and silk products, and making cheroots were the main occupation of the Inthas. The result of this study indicates that the cropping

pattern in the study villages was mainly based on mono-cropping and double cropping of tomato in a year. Growing the same crop at the same place continuously encouraged building up of pathogenic organisms and insect for a particular crop. Plant residues were usually left on the floating beds until the growing of the next crop. Growers usually did not care for disposing plant residues, which were very important for preventing the next crop from pest and diseases. Based on the farmer's survey and personal observation, it was clearly noted that the above mentioned agricultural practices have been threatening the environmental conservation and biodiversity of flora and fauna of the lake as well as the health of the people living on the lake.

Advantage of Traditional Practice

As an indigenous agricultural practice, local growers always applied aquatic (water, algae and mosses), and some silt or mud from the bottom of the lake on the floating bed during land preparation and before fertilizing the tomato plants (10-15 times in crop season). This kind of recycling of aquatic plants was a great contribution towards mitigating the problem of eutrophication of the lake. Moreover, water weeds were used as animal feeds for poultry, pigs and horses and they were sold at Nyaungwe market. The harvest of these dense aquatic plants from the lake made the navigation easier.

Conclusion

High productivity of tomato is derived at the cost of indigenous genetic diversity, environmental condition and human health. The government has declared the Inlay Lake a protected area and launched a greening and reforestation project to prevent further degradation. Further extension of floating islands by the locals has been prohibited. However, environmental awareness and cooperation of the local people are essential to preserve their unique cultural identity and way of life for ever.

Japanese Encephalitis Transmission in Relation to Agricultural Activities

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Introduction

Japanese Encephalitis (JE) is a mosquito borne arboviral infection which is the leading cause of viral encephalitis in Asia²⁻⁴. The virus was isolated for the first time in the world from a post mortem human brain in Japan in 1933, although descriptive accounts of the disease date back to the late 1800s. In 1954, it was shown that the virus could also infect pigs, bovines, dogs and sheep²⁰. A growing number of cases have been seen in horses in China and humans in India, Nepal, the Phillipines, Sri Lanka, Northern Thailand, Vietnam and Myanmar. About 50,000 sporadic and epidemic cases of JE are reported annually from the People's Republic of China, Korea, Japan, South East Asia, the Indian Subcontinent and parts of Oceania¹⁵. JE has been considered one of the most serious health problems in Asia and the North Eastern Region of India has been periodically experiencing JE epidemics since the late seventies. JE cases have been regularly reported from the districts located in the Upper Brahmaputra Valley. Dibrugarh, Lakhimpur, Sivasagar, Sonitpur, Jorhat and Golaghat districts report JE cases almost every year and thus form the core group of districts endemic for JE.

Dynamics of Japanese Encephalitis and Role of Mosquitoes

JE has its natural cycle with animals (Figure 1). Infections in human beings are caused as a result of opportunistic infection from the zoonotic cycle. The zoonotic cycle is usually :
“mosquito → ardeid bird → mosquito” or
“mosquito → pig → mosquito”.

Common birds like pond herons, egrets, cattle egrets, ducks and animals like pigs are implicated in this JE transmission cycle. Virus from wild birds through vector mosquitoes

spread to peri-domestic and domestic birds and then to mammals like cattle and pigs and eventually spills over to man who happen to be the dead end for the virus (as the virus in the peripheral blood of human beings is very short lived).

In India, fifteen species of mosquitoes belonging to genera *Culex*, *Anopheles* and *Mansonia* have been incriminated so far from different endemic regions of the country. These are *Culex tritaeniorhynchus*, *Culex vishnui*, *Culex gelidus*, *Culex psedovishnui*, *Culex bitaeniorhynchus*, *Culex fuscocephala*, *Culex whitmorei*, *Culex epidesmus*, *Anopheles barbirostris*, *Anopheles annularis*, *Anopheles subpictus*, *Anopheles vagus*, *Mansonia annulifera*, *Mansinia uniformis* and *Mansonia Indiana*¹⁷. Transovarian transmission has been observed in some *Culex* species only.

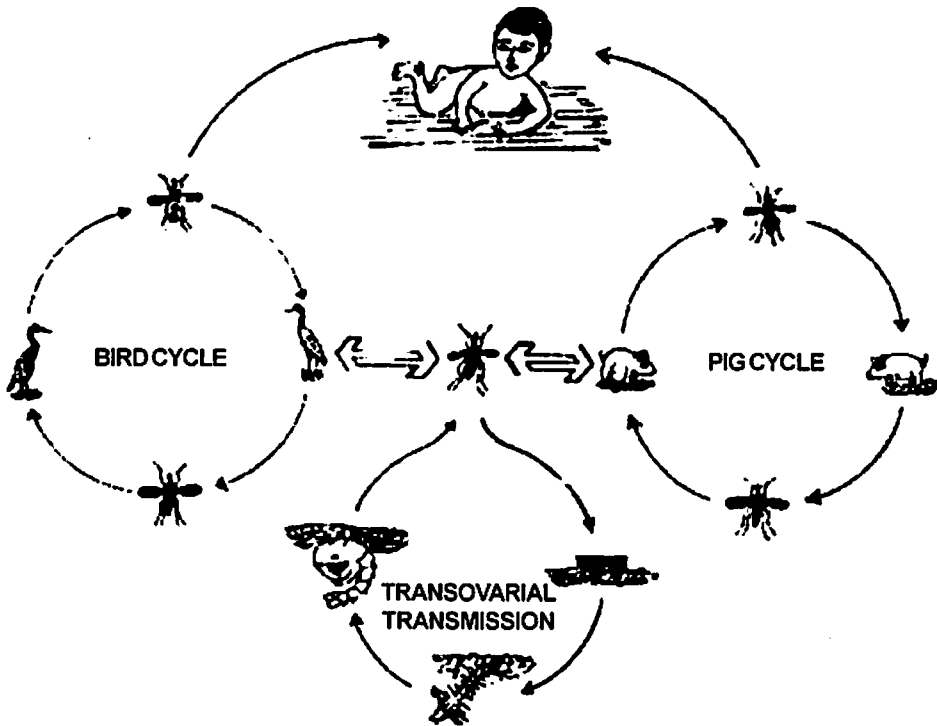


Fig1: JE Transmission cycle

These species of mosquitoes are prolific in rural areas where their larvae breed in ground pools and especially in flooded rice fields. All elements of the transmission cycle are prevalent in rural areas of Asia and human infections occur principally in this setting because the virus amplifying host like pigs and water birds are usually situated near the rural areas and in the periphery of the cities.

Japanese Encephalitis Scenario in South East Asia

At present due to good and sustained vaccinations of children upto 15 years of age JE is rarely seen in Japan. Sporadic cases have been reported from all islands except Hokaido. Transmission season in Japan is June to September except Ryukyu islands (Okinawa) where transmission of JE takes place during April to October. In Hokkaido islands enzootic transmission of JE without human cases have been observed. In Japan the number of JE patients has significantly decreased since 1967. Surveillance has revealed that the decrease of patients is related to the rarified spread of the JE virus. Then, the spread of the JE virus was reactivated to increase the number of patients mainly in the western part of Japan. Since 1980, the annual number of patients has been around 20-40 but more than 50 cases were reported in 1990 after an interval of 11 years. However, the number of patients has started to decrease again in 1999 and only four cases were reported in 1996¹⁵.

In Japan, inactivated JE vaccination started in 1954. Since then the potency and purity of the vaccine have been repeatedly improved. Since 1989, the strain for vaccine production was changed from the previously used Nakayama-Yoken strain to the Beijing-1 strain with better neutralising antibody. In Japan JE vaccination is significantly effective and plays an



Source : Tsai TR, Chang GW, Yu Japanese encephalitis vaccines. In Plotkin SA and Orenstein WA, eds., *Vaccines* – 3rd edition, WB Saunders, Inc., Philadelphia, PA, 1999; 672-710

important role in acquiring immunity among young people. Also there is less chance to be bitten by mosquitoes carrying the JE virus because of isolated swineries away from cities and change in the living environment in the recent years. So Japan now depends heavily on vaccination to acquire increasing immunity against the JE virus.

Two fatal cases of JE occurred in mainland Australia (Cape York) in 1998. Seropositive pigs were also detected in mainland Australia. Vertebrate hosts in the form of water birds are widespread across the mainland, plus there are many wild pigs in northern Australia to act as amplifier for the virus. There is also concern that migratory birds could carry the virus further south in Australia. The Australian quarantine and inspection service maintain herds of sentinel pigs in Torres Strait, Northern Cape York and North NT to detect Japanese Encephalitis virus activity.

In Asia the rice field breeding mosquitoes, mainly *Culex tritaeniorhynchus*, usually transmit the Japanese encephalitis virus (JEV). However, in the occurrence of JEV disease in Papua New Guinea (1997) and Timor and probable spread into the Torres Strait (1995) islands or northern Australia, the mosquito vector implicated were *Culex annulirostris*.

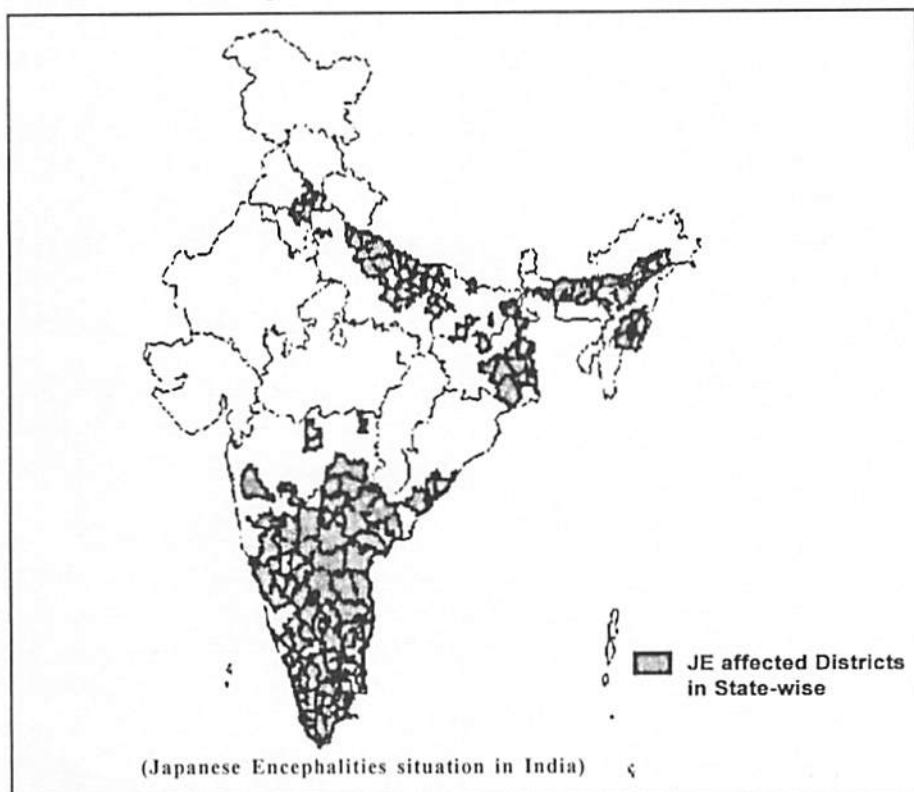
In some tropical locations irrigation associated with agricultural practices is a more important factor affecting vector abundance and transmission may occur year round⁹⁻¹². Patterns of JE viral transmission vary from region to region within individual countries and from year to year. JE virus is transmitted seasonally in most areas of Asia. In Temperate regions, JE virus is transmitted during the summer and early fall, approximately from May to September²⁻⁶. In Sub-tropical and tropical areas seasonal patterns of viral transmission are co-related with the abundance of vector mosquitoes and of vertebrate amplifying hosts (pigs etc.). These mosquito population in turn fluctuates with rainfall, with the rainy season and with migratory patterns of avian amplifying hosts like ducks, pond herons, egrets, cattle egrets etc. The spread of JE to new areas is probably due to agricultural development and intensive rice cultivation supported by irrigation schemes¹⁶.

Japanese Encephalitis Scenario in India

In India, JE cases have been reported from all states except Arunachal, Dadra Daman and Diu, Gujarat, Himachal, Jammu & Kashmir, Kerala, Lakshadweep, Meghalaya, Orissa, Punjab, Rajasthan and Sikkim. Transmission season varies from region to region. In North India it is usually July to December, Andhra Pradesh– September to December, South India– May to October, Goa– October to January, Tamil Nadu– August to December, Madhya Pradesh– April to June and in Assam– April to September.

Societal changes such as agricultural practices and deforestation increase the risk for vector borne disease transmission. Many irrigation systems and dams have been built in the past

Annual incidence ranged between 1765 and 3428 and deaths 466 and 707



National Vector Borne Disease Control Programme, India

50 years without regard to their effect on vector-borne diseases. Similarly, tropical forests are being cleared at an increasing rate and agricultural practice such as rice production have also increased¹⁸.

In areas where JE is endemic annual incidence ranges from 1-10 per 10,000¹³. Children below 15 years of age are principally affected. Seroprevalence studies indicate nearly universal exposure by adulthood. In developed countries of Asia and in areas where children are protected by immunization, secondary increase in JE incidence has been observed in the elderly in Assam.

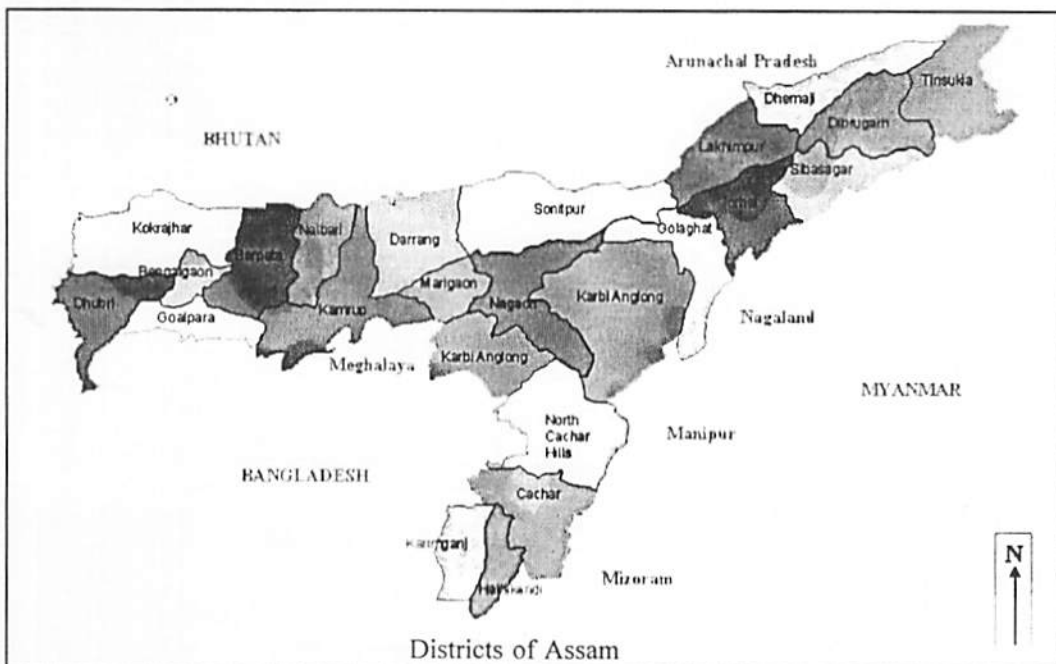
In India JE vaccination using live attenuated SA-14-14-2 JE vaccine has been started phase-wise. The strategy adopted is one time campaign covering at risk children, i.e., 1-15 years, followed by inclusion of the JE vaccine into the national routine immunization programme in the same district to cover the new cohort of 1-2 years. In Assam this one time campaign of JE vaccinations of 1-15 years children have already been done in the districts of Dibrugarh,

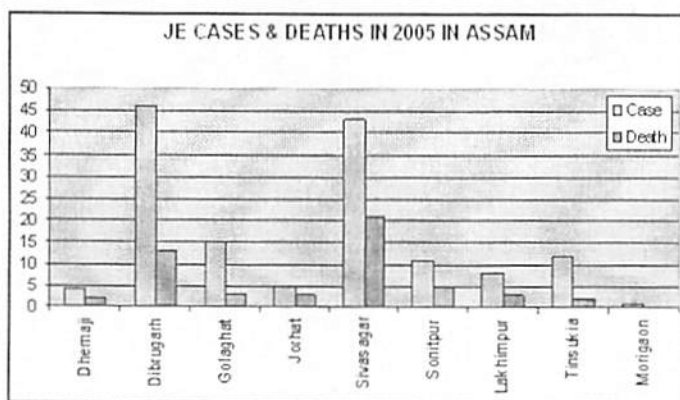
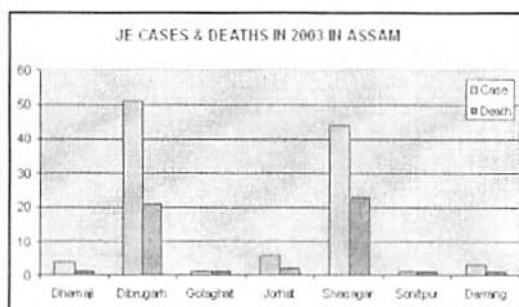
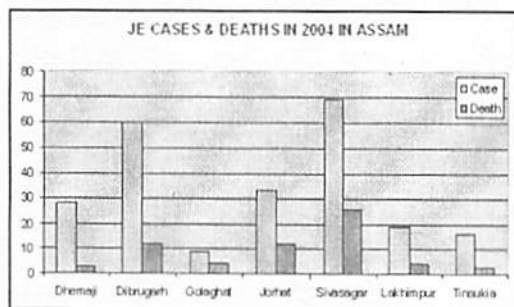
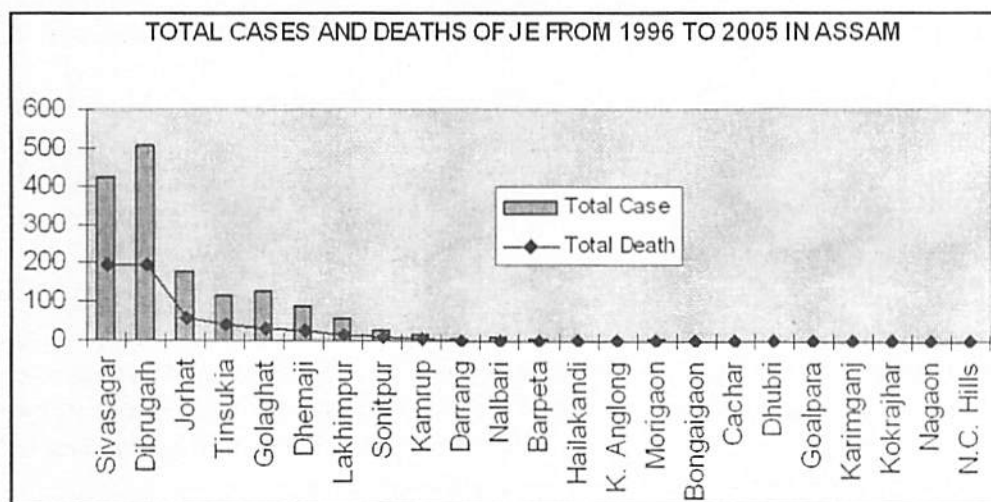
Sivasagar, Golaghat, Jorhat, Lakhimpur, Tinsukia and Dhemaji. A total of 101 districts in 12 States of India will be covered in the next four years. JE control has been a priority for the Ministry of Health & Family Welfare, India, considering the huge burden of disease and high mortality rate in children (20-40%). Vector control alone has not yielded the desired results. There is enough global evidence of control of JE by planned and sustained vaccinations.

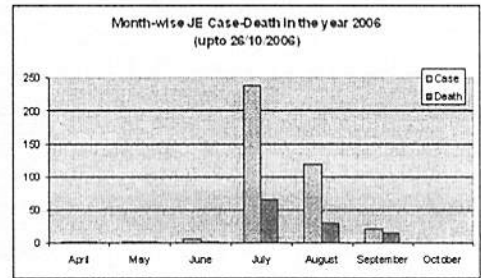
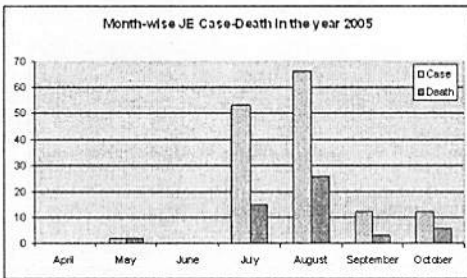
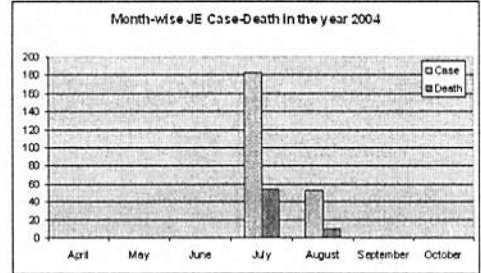
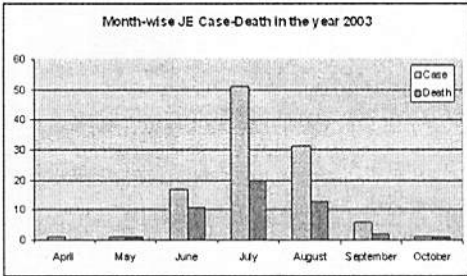
Japanese Encephalitis Scenario in Assam

In Assam, highest concentration of pigs are found in Lakhimpur with pig density of 39.7 per sq.km. , followed by Kokrajhar, Jorhat, Dhemaji, Nalbari, Golaghat, Kamrup, Morigaon, Sivasagar, Darrang, Dibrugarh. The lowest concentration is in Karimganj and Hailakandi district with density of 13.8 per sq.km. In 1951, there were 1.60 lakhs of pigs which rose to 10.8 lakhs in 1997. Thus registering an increase of 85 times of growth in pig population over four and a half decades. No other animals have registered such a growth¹⁹.

Studies of pig rearing habits of different communities reveal that Sonowal Kachari, Boro Kachari, Deuri and Mising communities contribute to highest pig population followed by Ahom, Chutia, Moran, Motok, Mech etc. and even lesser by tea tribes, Nepalis and Bengalis. Lowest population of pig rearing has been observed among communities like Kalita, Brahmin, Kumar etc.¹⁷.







Summary

Japanese Encephalitis (JE) has been considered one of the most serious health problems in Asia, affecting most countries in East, Southeast and South Asia including India. The North Eastern Region of India has been periodically experiencing JE epidemics since the late seventies. The case fatality ratio has been observed to be very high specially in the plain districts of Assam – Dibrugarh, Sivasagar, Jorhat, Golaghat, Tinsukia, Dhemaji, Lakhimpur and Sonitpur. Transmission months are April to October with peaks during July and August. Transmission season varies in other regions of the country. Agricultural activities like rice cultivation have been observed to be linked with the incidence of JE in most of the Southeast Asian Region. The favourable ecology is clean water logged areas like rice fields, abundance of vector mosquitoes like *Culex tritaeniorhynchus*, *Culex vishnui*, *Culex gelidus*, *Culex psedovishnui*, *Culex bitaeniorhynchus*, *Culex fuscocephala*, *Culex whitmorei*, *Culex epidesmus*, *Anopheles barbirostris*, *Anopheles annularis*, *Anopheles subpictus*, *Anopheles vagus*, *Mansonia annulifera*, *Mansinia uniformis* and *Mansonia Indiana*. Pigs and water birds act as amplifiers of the virus. It is observed that societal changes such as agricultural practices and deforestation increase the risk for vector borne disease transmission. Children below 15 years of age are principally affected and mortality rate is also high (20-40%), hence prevention and control of the disease forms a public health challenge. Vector control alone has not yielded the desired results. There is enough global evidence of control of JE by planned and sustained vaccinations. Newer strains of the vaccine like Beijing strain SA 14-14-2 is now widely used for routine vaccinations in JE endemic areas.

Preventive measures for Japanese Encephalitis transmission

- Avoid having domestic pigs near residential areas. If pigs are to be reared to construct piggeries/swineries at least 3-5 kms away from the human dwellings.
- Search for and eliminate breeding sites of mosquitoes like collections of water in and around the dwelling places like old tyres, empty vessels/containers etc.
- People working in irrigated rice fields should wear protective clothing to protect from mosquito bites specially in the JE endemic areas.
- Health advisors advocate the use of mosquito repellents, mosquito nets and other methods of personal protection if JE virus is detected in a community.
- Routine vaccination of all children 1-15 years of age preferably with the new Beijing-1 strain SA-14-14-2

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Rain-fed Rice Cultivation in the Brahmaputra Floodplain, Assam: A Case Study in Lakhimpur District

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Introduction

Northeast India is one of the least developed regions of the country. Many ethnic groups live in this area and have unique culture. For political reason, it was restricted for outsiders to enter the area for a long period since 1980s. Therefore, sufficient studies have not been done on Northeast India, and information on the present status is very limited.

Assam in the Brahmaputra basin is one of the agricultural states of Northeast India. About 70 % of the state's total population are engaged in agriculture and associated industries, and nearly 40 % of Net State Domestic Product comes from the agricultural sector. However, due to its peculiar physiographic condition, agriculture in Assam is much influenced by physical factors like rainfall and floods. The objective of this study is to reveal the problem of rice cultivation at village level.

Study Area

The study village is located in Lakhimpur district of eastern Assam. The altitude of the village is about 90 m above sea level. Topographically the land consists of alluvial plain and floodplain of the Brahmaputra and the Subansiri. The annual rainfall amounts to more than 3000 mm. In summer monsoon season from May to September, monthly rainfall exceeds 400 mm, but rainfall is very little in dry season from November to February. The soil is mainly sandy loam.

The total number of households in the village is 96 and the population is 454 (male 244, female 210). Most of the villagers (92 households, 439 people) are Ahom (Tai-Ahom). Other villagers are Koch. Both Ahom and Koch belong to OBC (other backward classes). They are Hindus and speak Assamese.

The founders of the village came to this place from Sibsagar district in the southern bank of the Brahmaputra during 1910s. At that time, the village was a swampy wetland area. Embankment was constructed along the right bank of the Subansiri in 1957, and therefore the frequency of floods became less.

Method

Field work was carried out in the periods from July to November 2007, and from January to July 2008. Primary data in the study village were collected by household survey, participant observation and hearing survey. Maps of the village and land ownership pattern were prepared using GPS and GIS software. Census data, rainfall and water level data were collected from local government offices.

Results

In the study village, 43 households are engaged in full-time farming, 47 households are in farming with other jobs and 6 households are completely not in farming. All farmers cultivate rice, and there are three kinds of rice in the village: *Ahu* (March - June), *Sali* (June - November) and *Bao* (March- November).

Farm Size and Ownership Pattern

The average farm size in the village is 0.78 ha. Only 5 households have no agricultural land. The maximum farm size in the village is 3.38 ha. More than 70 % of the households are small farmers with farm area less than 1.0 ha. As many as 21 households practice sharecropping (*Adhi*) and 11 households lease in farm land from other households (*Bandhaki*). The rice fields can be classified into two categories based on water level. The low land is inundated with water from May to October and water level rises up to 1.5 m. Many households own both low land and high land to reduce the risk of production loss due to erratic rainfall (Fig. 1).

Rice Variety and its Utilization

There are at least 54 rice varieties grown in the village. The number of rice varieties grown in each household is 5.3 on an average, and the maximum is 11. The rice varieties are selected to suit the water level in the field. In addition, some varieties such as *Bora* and *Chakua* are grown for making *Pitha* and *Chirra* which are used in ceremonial functions.

Hydrological Environment and its Effect on Rice Cultivation

Erosion of the Subansiri river is the biggest environmental problem in the village. In 1980s, the main channel of the Subansiri shifted westward, and its width began to increase.

About 70 households had farm land in the river bank of the Subansiri, where *Ahu* and vegetables were grown, but most of the lands have been eroded.

Along with the decline of water level of the Subansiri (Fig. 2), the water level of the rice fields also goes down gradually (30-40 cm/10 yr). *Ahu* and *Bao* were cultivated in more fields before, but many households gave up cultivating *Ahu* and *Bao* due to less water and more weeds. As for *Sali* rice, more households tend to plant *Aijung* which is grown in a shorter period (Table 1).

Discussion and Conclusion

Rice cultivation in the study village is a traditional one and not mechanized at all. Production is variable and greatly influenced by physical factors such as rainfall and local topography. Farmers traditionally devised cropping calendar, land ownership pattern and combination of rice varieties to secure the rice production in the unstable environment. These are adaptive

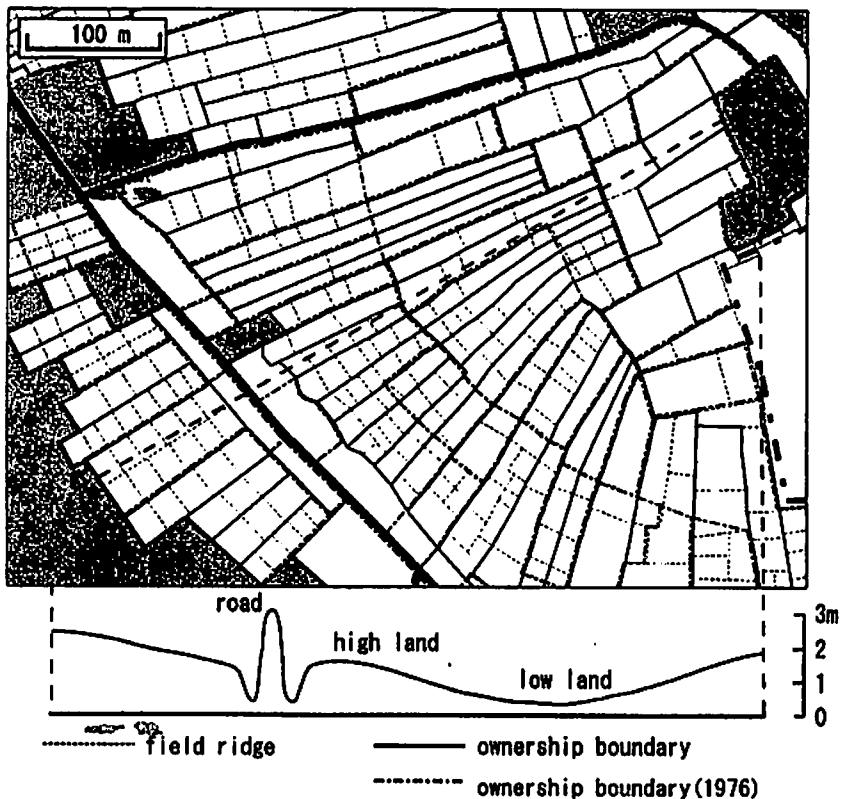


Fig. 1 Land ownership pattern and transection in the village

Table I: Rice varieties grown in the village

2007			1990		
Variety	Class	No. of households	Variety	Class	No. of households
Bora	sali	60	Bora	sali	32
Aijung	sali	51	Bor jahinga	sali	23
Bor jahinga	sali	36	Maguri	bao	23
Chakua	sali	25	Chakua	sali	15
Hor puna	sali	21	Aijung	sali	12
Maguri	bao	21	Ranga bao	bao	12
Bor moni	sali	16	Hor puna	sali	11
Biyui	sali	15	oìmpaki	sali	10

Source: Field survey results from 72 households in 2007 and 51 households in 1990

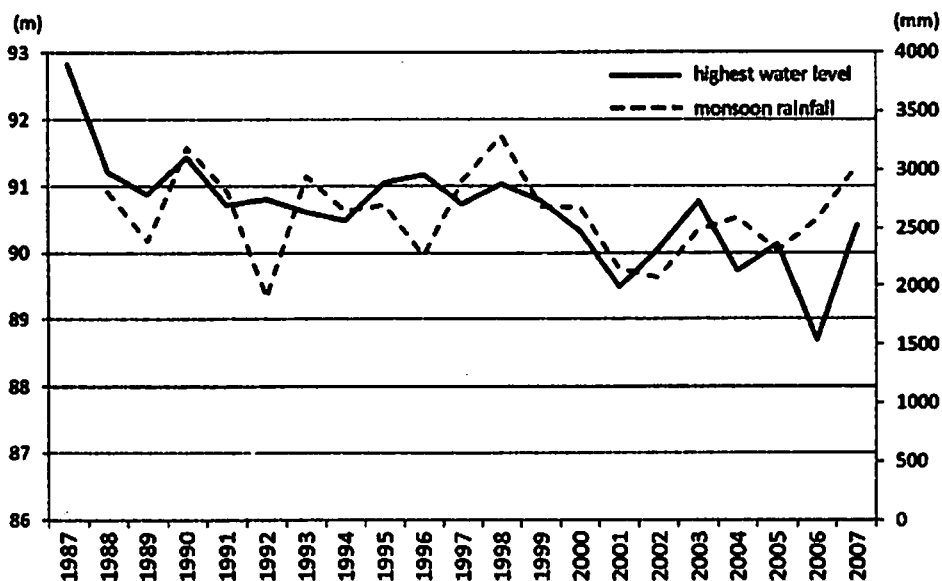


Fig. 2: Highest water level of the Subansiri and monsoonal rainfall in North Lakhimpur

methods mainly for floods. However, the changing environments, both short and long term, affected rice cultivation in the village, and farmers find it too difficult to adapt to the recent environmental changes such as river bank erosion and declining water level. New strategy to cope with the changing environment should be evolved.

Improvement of *Aman* Rice Cultivation against Flood Damages in Jawar Village, Haor Region of Bangladesh

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Introduction

Aman rice cultivation in the rainy season takes a leading part in Bangladesh still in spite of recent spread of *boro* rice cultivation in the dry season. But rice cultivation in the rainy season is apt to be damaged by the flood. In 1987, one of the devastating floods of these days damaged Bangladesh. In this paper attempt has been made to discuss the 1987 flood in Jawar village located in the fringe of a large inundated area called *haor* (Fig.1) with reference to *aman* rice cultivation. At first, the characteristics of flood and damages caused to *aman* rice cultivation have been discussed, and then a plan towards improving the environment of the small paddy fields to stabilize cultivation in the rainy season has been proposed.

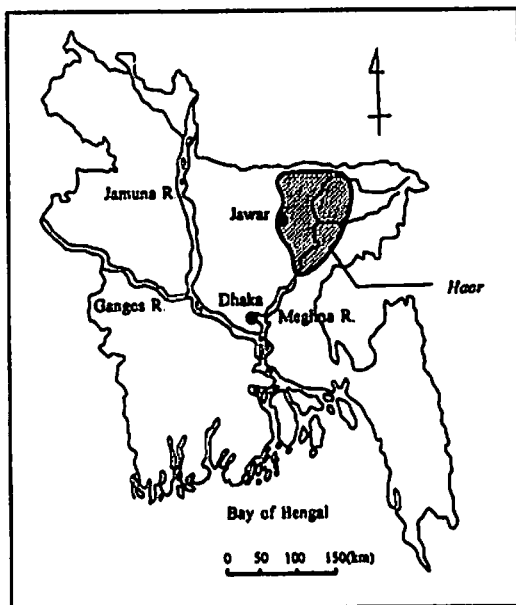


Fig1: Location of Jawar village

Characteristics of 1987 flood

Fig. 2 shows the precipitation and water level in the drain of *bil* in the village and Fig.3 describes the change of water depth along a cross-section of the village. Two peaks are observed in the beginning of August and late September after localized torrential downpour amounting to more than 140mm. Specially the first flood was so big that many houses were inundated up to

the floor (Fig.3). All cultivated lands were flooded (95% of total area) and even high-fields on *kanda*, the highest farmland which does not get inundated in normal years, were also flooded at the maximum water level which was 1.5 to 2m higher than that of the level of the normal years. Then water level decreased to just near normal maximum height (Sept 25) and increased again 50 to 60cm because of rainfall in late September.

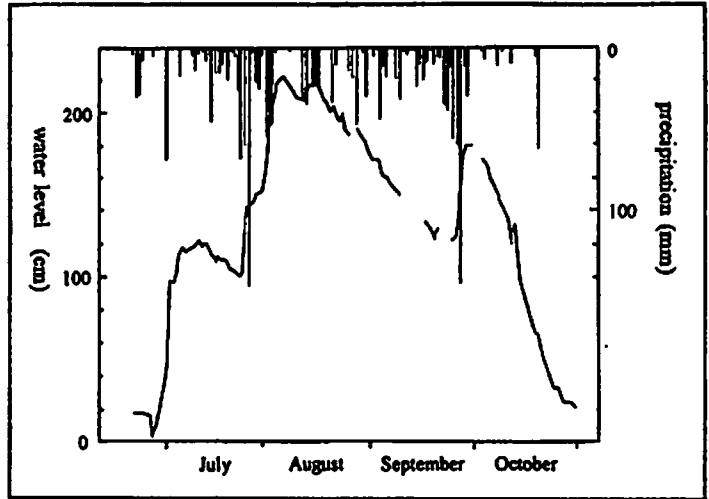


Fig 2: Precipitation and water in the drain of *bil* (Jawar village 1987)

This time water level in the high-field did not reach the first flooding level, while it was upto 1m in the medium-fields where in normal years water rises upto only 50 cm. These two high floods not only inundated many houses but also damaged *aman* rice cultivation seriously.

Damage of *Aman* Rice Cultivation by 1987 Flood

Aman area concentrates in *kanda* or highest farmland which is classified into three types: high, medium and low-field (Fig.3).

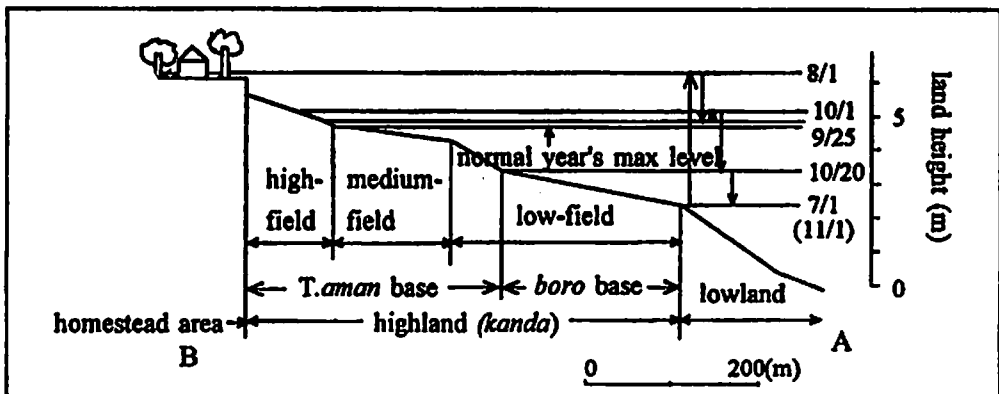


Fig 3: Change of water level in 1987 flood (Jawar village)

The first flood damaged not only *aman* plants transplanted in the field but also seedlings in the nurseries. The damaged nursery was 0.04 ha in size, i.e. more than two-third of the total. As water receded, farmers sold their paddy seed, jute and cattle to purchase seedlings, mainly *pajam*, and transplanted in high and medium-fields from mid- to the end of August. The second flood damaged the transplanted *aman* plants again. Normally, the medium-field does not get inundated but at the second flood even the high-field was inundated. There was no direct damage in the high-field because of low inundation. But in the medium fields transplanted seedlings were damaged second time. In the medium-fields, farmers usually transplant *aman* rice at the end of August. In the case of *pajam*, *rabi* crops are cultivated in December. They broadcast mustard or wheat in November in the medium-fields where seedlings could not be transplanted.

In a few low-fields, tall seedlings of LV were transplanted in the middle of September but in most of the other fields, seedlings could not be even transplanted because of deep water. And consequently, transplanted LV seedlings were almost damaged by the second flood. After the second flood receded, LV seedlings of *mongir* were transplanted again in these fields from the middle of October although the local variety of rice is transplanted from the beginning of September to the beginning of October in the normal years. The normal yield is 2.8 t/ha but in 1987 it decreased to 1.4-1.6 t/ha because of late transplantation.

Forty hectares, which is equivalent to only one-third of the normal year's 120ha could be transplanted. Cultivation of 67 percent of total *aman* rice area covering mainly medium- and low-field and other 8 hectares damaged by the two waves of flood after transplanting had to be given up.

Countermeasure to Stabilize Rice Cultivation in the Rainy Season

1. Controversial points regarding *aman* rice cultivation

Harvesting of T.*aman* rice in the medium- and low-field sometimes becomes late by one month than that in the high-field because transplanting in the former two types of fields, which depends on water recession, tends to be late. Moreover, in these fields, irrigation is required in October and November when surface water drains naturally from gently-sloping *kanda* in October. Such water shortage at the growing period is also a serious problem in addition to direct damages caused by inundation. Besides uncertain transplantation depending on water recession, transplanting is made difficult by the presence of a lot of water hyacinth brought by flood. Decrease of *aman* rice area resulting from such kind of problems deprives the daily labour farmers who have little chance to work in the rainy season. And if transplantation is delayed, many farmers may have a poor harvest even in the case of LV rice as stated above.

2. Stabilization of rice cultivation by *jangal* and *B.aman*

The authors propose to take up the following measures to resolve the problems of rice cultivation in the rainy season:

- (1) Storing surface water by constructing *jangal* or embankment to solve the problem of water shortage for the late growing rice in the low- and medium fields on *kanda* (Fig.4).

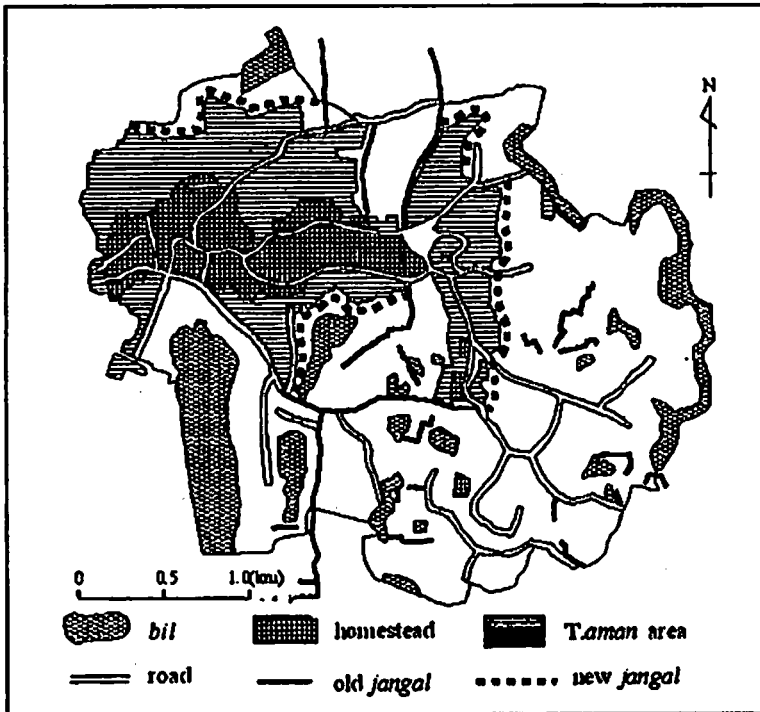


Fig 4: New *jangal* for *T.aman* cultivation (Jawar village)

- (2) Planting annual legume *dhanca* (*Sesbania aculeata*) on the top of *jangal* in order to stop the invasion of water hyacinth and waves into rice fields (Fig.5).
- (3) Transplanting deep water *aman* (*B.aman*) rice at the beginning of the rainy season which is well adapted to flood in the low-field.
- (4) Seeding deep water *aman* rice to transplant quickly again, if flood occurs at the latter half of the rainy season.

B. aman rice is photosensitive and can be harvested in November or December even if transplanted a few months later or earlier. Young plants can remain in the nursery for a few months and farmers can transplant tall seedlings even in deep inundated fields.

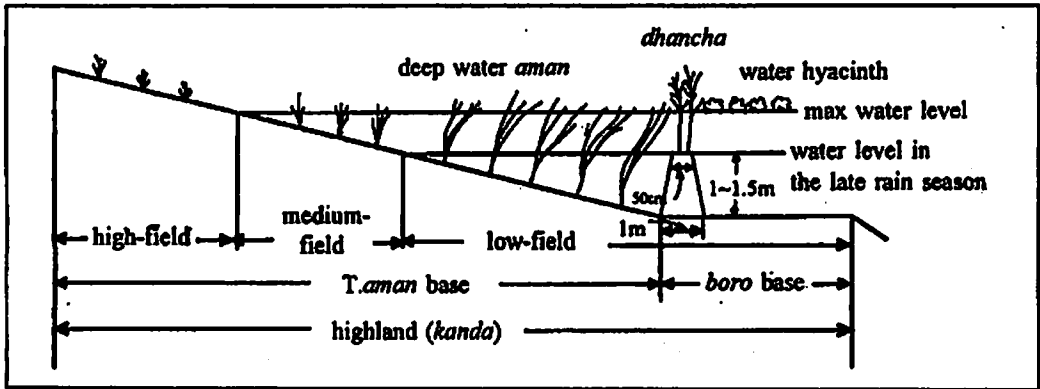


Fig 5: Transplanting cultivation of deep water rice by *jangal*

For the second transplantation it is necessary to sow again on the nursery of the first transplantation. The *aman* rice nurseries in the village are located on the flood-free higher lands. Deep water *aman* rice which grows quickly in flood environment can be cultivated even in the low-fields as normal water is 1 to 2m deep at most and flood water tends to increase slowly.

Thus, transplanted *aman* rice cultivation can be made stable and the deep water *aman* rice cultivation may be improved by planting *dhancha* and storing water at the end of the rainy season by *jangal*. This new trial is expected to be a workable plan not only to recover the abandoned 80 hectares of land in 1987 as deep *aman* transplanting fields but also solve the water shortage problem that occur at the end of the rainy season.

Conclusion

Stabilization of *aman* rice cultivation by introducing *jangal* and by transplanting deep water *aman* rice may become an equally profitable countermeasure for many farmers than that of *boro* rice cultivation. For this countermeasure, group works for construction and maintenance of *jangals* are required and it is expected that the experience of water management in the dry season developed historically by the villagers could be helpful.

Structure and Functions of Periodic Markets in the Floodplain Agro-ecosystem of Rural Kamrup, Assam The Case of Kaskata *Hat*

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Introduction

Periodic markets, locally called *hats*, reflect the socio-economic conditions of the concerned areas and play significant role in the process of rural development. Like many other river valleys of the country, the Brahmaputra valley in Assam also supports a huge population who are dependent primarily on the traditional grain farming and household horticultural practices. Till recently, the economy of the rural areas continued to be subsistence agro-based with little exposure to organized market economy. Commodity flow particularly with respect to the food crops and other perishable goods was more or less confined to the local trade areas of the central places including the *hats*. The *hats* are thus the epitomes of local economy and tradition. However, under the changing global as well as national context, even in the remote areas, there have been noticeable changes in the morphology and functions of the markets, commodity flow, sellers' and consumers' behaviour, market cycle and external relations.

Objectives

The present study is an attempt to understand the distribution pattern of the periodic markets in Rangia Sub-division of Kamrup (rural) District in the north bank plain of the Brahmaputra valley with particular reference to a *hat* called Kaskata. The study explores the morphological characteristics and functions of the market, spatial pattern and channels of commodity flow, participation of sellers and buyers, relation with neighbouring markets and seasonal variation in market functions.

Methodology

The study has been carried out on Kaskata *hat* located at Jajikona village under the broad frame of reference of the Rangia Sub-division in Kamrup district, Assam (Fig 1). The market is

situated just on the right bank of the Checha river, a sub-tributary to the Brahmaputra. This *hat* is at a distance of about 31 km from Guwahati city and about 700 meters from a local central place called Belkona *chowk*. It is a bi-weekly *hat* held on every Tuesday and Saturday. The total area occupied by the *hat* is 4295.696 sq.mt. The trade in this *hat* has been mainly confined to crops and agriculture related products, and the people belonging to the local peasant community, government employees and petty businessmen. During the year 2007-2008, a random sampling survey with a purposively designed questionnaire was conducted to interview around 100 vendors who are in agricultural business and the same number of customers in every month of the year in order to know about their residential localities, land holding size, visiting frequency and the sources of goods supplied. The data thus obtained are then processed to depict the sources of supply, marketing channel, itinerary of vendors and customers etc. Usually, the seasonal peak season of this *hat* begins from the month of January and continues to April, while the lean season spreads from the month of June to July. To represent the seasonal variation in market

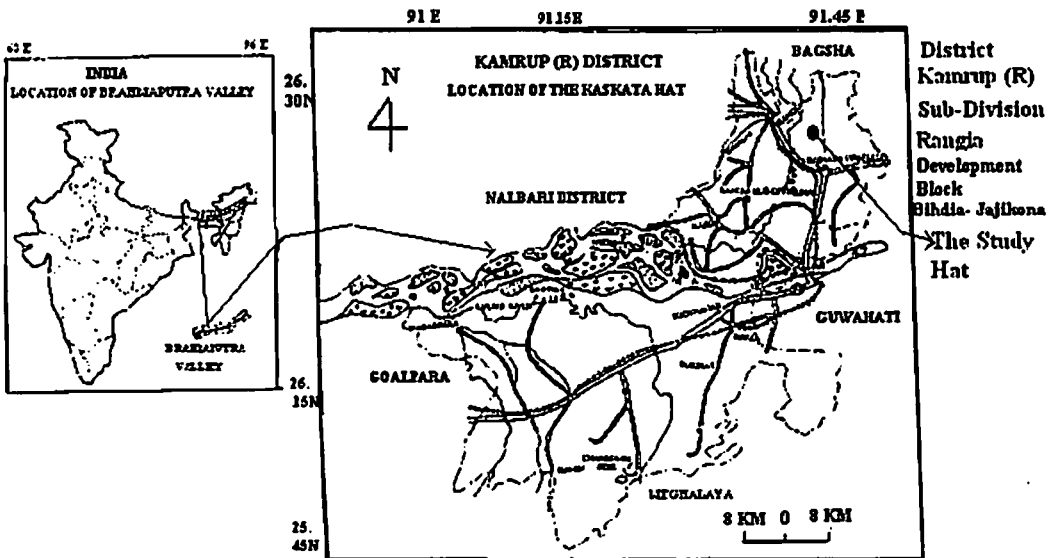


Fig 1: Location of the Kaskata hat

function all the vendors and customers were interviewed with the same questionnaire on 15th April and 17th July, 2008.

The internal structure of the *hat* was studied by plotting the location and spatial arrangement of shops on a sketch along the small interior routes. The shops are then classified into several types based on their structure and kind of goods sold. Information related to the historical

development of the *hat* was obtained by interviewing some elderly people of the villages located around the *hat*. Data on tax structure, management etc. were collected by interviewing some personnels of the *hat* management committee and some vendors of the *hat* having different infrastructural facilities.

Distributional Pattern of Hats in Rangia Sub-division

With an area of 790.129 sq.km. and a population of 4,52,855 as per 2001 census, the Rangia Subdivision contains 48 periodic markets. Out of these, 26 markets are in Goreswar circle, while Rangia and Kamalpur circles have respectively 10 and 12 markets. The Rn statistics calculated for the periodic markets in the Subdivision reveals a random pattern of distribution. This indicates that the periodic markets are developed to meet the demands of the respective localities. However, the market days are generally decided on the basis of the market days of the neighbouring *hats* so that the vendors and consumers can have the opportunity of visiting more than one market in a week. The Chi-square (χ^2) test on the other hand reveals that the markets are distributed fairly uniformly for each day of the week in the Subdivision (Table 1).

Table 1: Number of markets in different market days in Rangia Sub-Division

Market day	Number of markets
Monday	10
Tuesday	11
Wednesday	10
Thursday	7
Friday	11
Saturday	11
Sunday	6
Total market days	66
Chi square (χ^2)	2.72
Market frequency (weekly)	9.43

Growth and Management

The Kaskata *hat* was initiated by the people of the neighbouring villages in the year 1961. At the beginning, it was a weekly *hat* held on every Tuesday. In 1975, it was promoted to a bi-weekly *hat* with Tuesday and Saturday as market days. The *hat* occupied an area of 22700 sq.mt. Currently a large number of vendors (315) operate their trade activities from 38 concrete

stall, 165 open sheds and large number of small open spaces (112). The total number of consumers as enumerated in the winter peak season (15th April, 2008) stands at around 2000.

Morphology

The morphology of the periodic markets in a particular socio-spatial context bears certain common characteristics. The periodic markets of the Brahmaputra plain exhibit certain commonality with respect to geographical location, layout, market cycle and commodity flow. A generalized model of the internal structure of the markets distributed in the Rangia Sub-division is presented here (Fig 2). The structure of the present market (Kaskata) may be viewed within the broad framework of the model (Fig 3).

Vendors and Consumers

These are the two major components that keep a periodic market vibrant. Their numbers indicate the dimension of the market in terms of size and functions. In the rural context, participation rates of both these components are found to vary seasonally as there have been significant seasonal variations in the agro-ecosystem and livelihood pattern in the complementary areas.

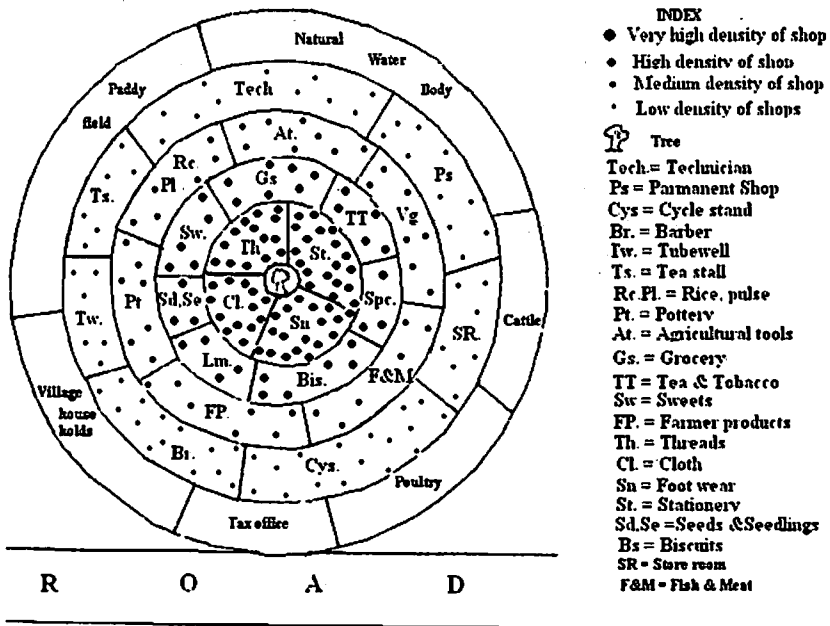


Fig 2: Generalised Morphology of Periodic Markets under Rangia Sub-Division

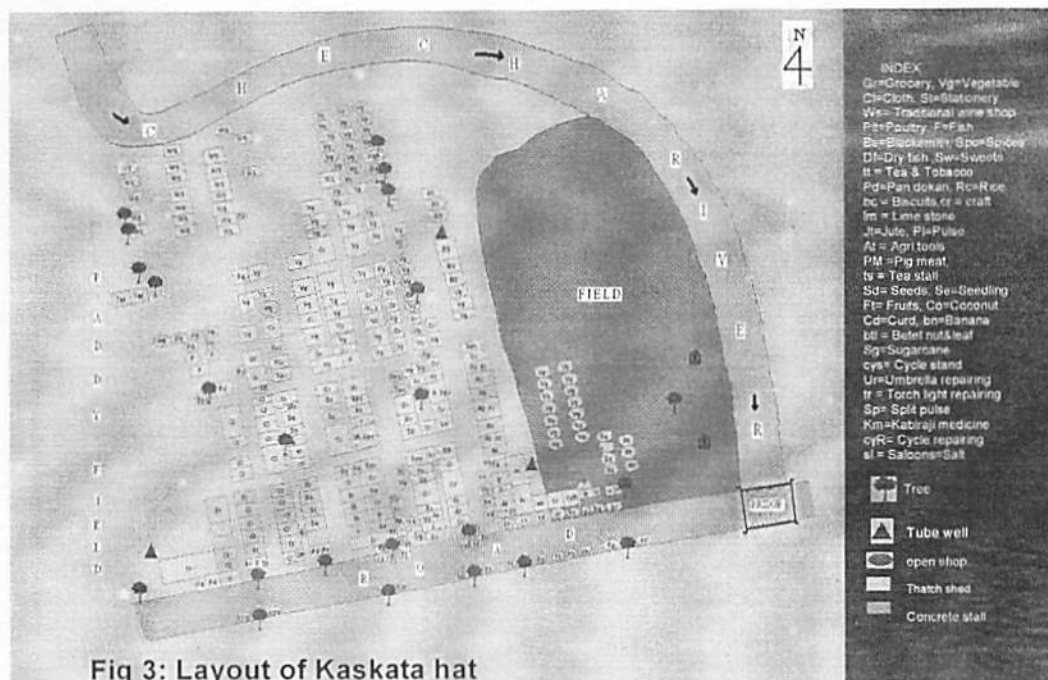


Fig 3: Layout of Kaskata hat

Variations are observed between the vendors and consumers in terms of their source areas and distances covered (Fig 4). The spatial range of vendors visiting the *hat* is notably more than that of the consumers.

The longest distance covered by vendors in the case of Kaskata is about 60 km, while it is only 12 km in the case of the consumers. However, 84.42 % of the vendors come from within a distance of 5 km from the market. In the case of consumers, on the other hand, 96.42% visit the market from a distance of 5 km (Table 2 and Table 3).

Table 2: Distance of the source areas of the vendors visiting Kaskata *hat*

Distance	Number of vendors		
	Summer	Winter	Yearly
0 – 5 km	514 (85.67 %)	499 (83.17 5)	1013 (84.42 %)
5 – 10 km	38 (6.33 %)	33 (5.5 %)	71 (5.92 %)
10 – 15 km	38 (6.33 5)	54 (9 %)	92 (7.67 %)
> 15 km	10 (1.67 5)	14 (2.33%)	24 (2 %)

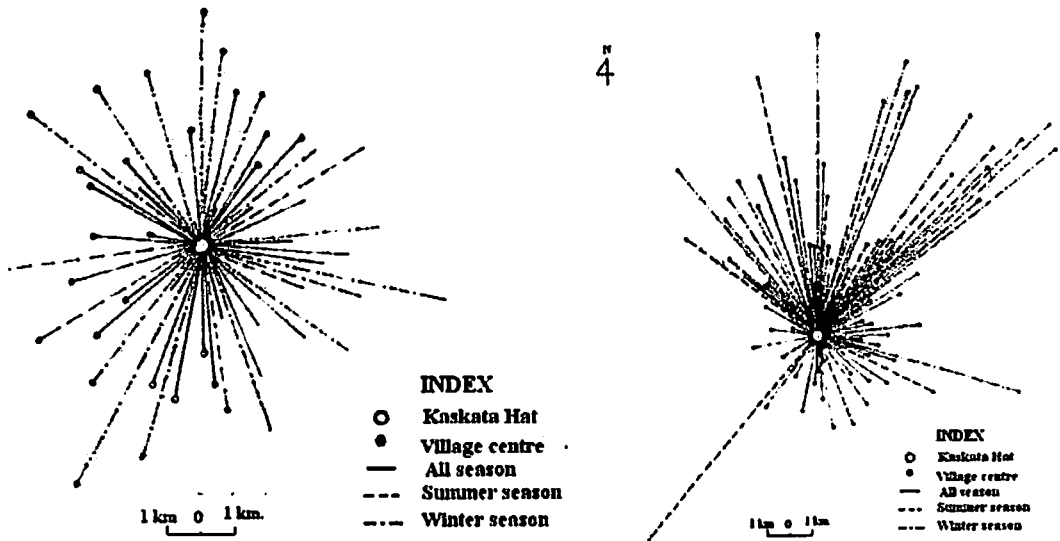


Fig 4: Source areas of vendors and customers visiting Kaskata hat

Table 3: Distance of the source areas of the consumers visiting Kaskata Hat

Distance km	Number of vendors		
	Summer	Winter	Yearly
0 -5	584 (97.33 %)	573 (95.5 %)	1157 (96.42 %)
5 - 10	16 (2.67 %)	25 (4.17 %)	41 (3.42 %)
10 - 15	Nil	2 (0.33)	2 (0.33 %)
> 15	Nil	Nil	Nil

Source: Field survey, 2007-2008

When looked from seasonal perspective, there exists considerable variation in the participation of vendors and consumers. In the winter peak (15th April), the number of vendors and consumers was recorded to be 315 and 2500 respectively, while in summer (17th July), the numbers stood at 250 and 1500 respectively.

Commodity and Flow Channels

In the rural periodic markets, most of the commodities are supplied by the neighbouring productive territories. The perishable products like vegetables, milk items and local fish come

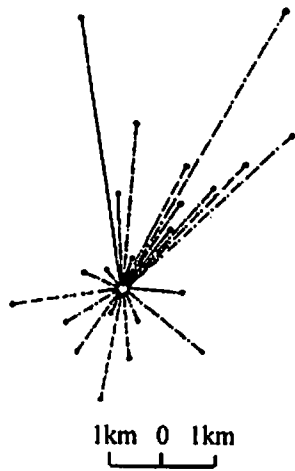


Fig : Source areas of betel leaf

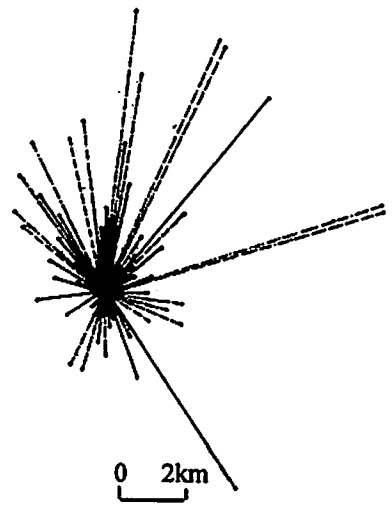


Fig : Source areas of vegetable

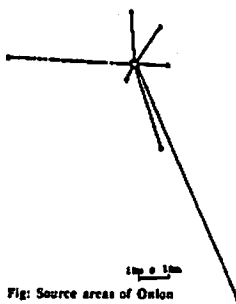


Fig: Source areas of Onion

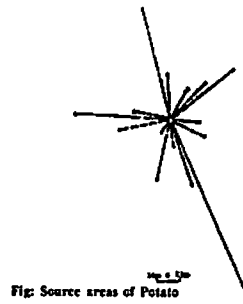


Fig: Source areas of Potato

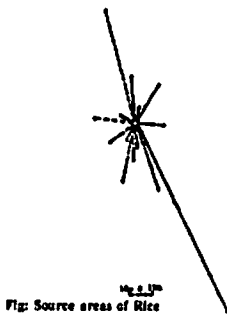


Fig: Source areas of Rice

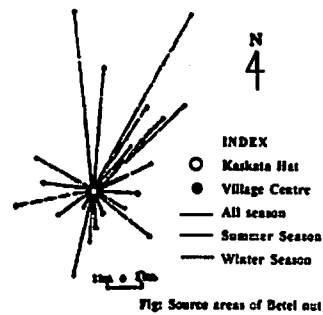


Fig: Source areas of Betel nut

Fig 5: Source areas of selected commodities

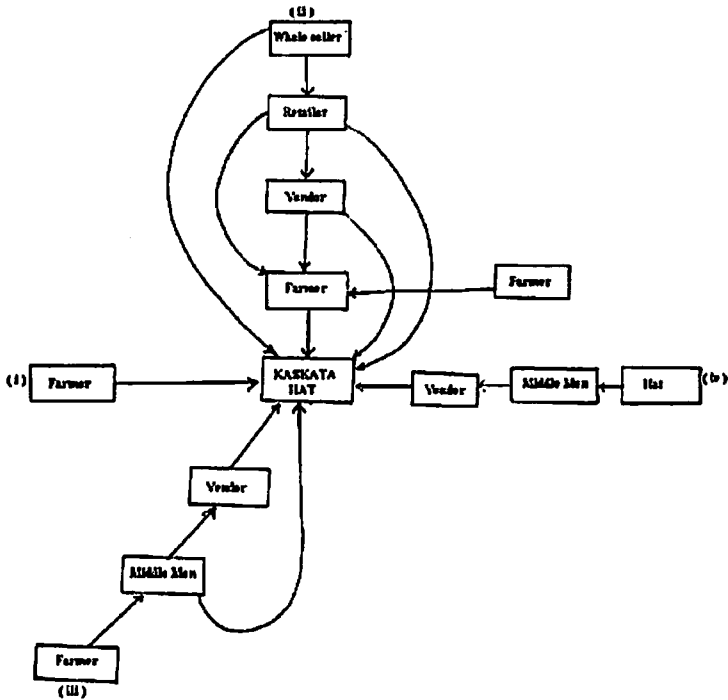


Fig 6: Flow channels of market goods from various sources

from the closely located areas, while the stationeries, foot wears and clothes are obtained from distant sources. Earthen utensils, bamboo products, agricultural tools are generally supplied by the neighbouring villages. However, the spatial pattern and channels of commodity flow are interesting to observe (Fig 5).

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Buried Humus Soil Layers and Land Development in Central and Eastern Himalayas

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Introduction

Environmental changes caused by human impact in the Himalayas have attracted the attention of conservationist, scientist, and administrators during the last 30 years. Particularly in Nepal, it has often been stated that deforestation (forest destruction by human impact) has been accelerated during the latter half of the 20th century because of population growth. However, recent studies do not support the above idea of deforestation and they claim that the area under forest has not changed significantly during the past few decades (Ives and Messerli, 1989). Deforestation in Eastern Himalayan area is poorly understood except for that happened in the recent years, which is documented in historical records.

Soil studies are important ways for identifying the past environmental changes. Palaeosols such as buried soil, and charcoal fragments and fossil pollen in soil provide clear information on local palaeoenvironments. In the western and central Himalayas and Tibet, soil studies have been conducted to try to reconstruct the past environment. Caine *et al.* (1982) reported a podzonic paleosol near Namche Bazar (Nauje), eastern Nepal, which indicates mid-Holocene environmental changes. Saijo (1993) indicated evidence of forest fire in historical times in the Middle mountains, near Katmandu, central Nepal. Iwata (1994) observed many buried soil layers containing charcoal fragments in the south-eastern part of Tibet and eastern Nepal, and concluded that expansion of Tibet and immigration of Sherpa people caused this palaeosol formation. Saijo (1993) and Iwata (1994) emphasized that charcoal fragments in soil and buried humus layers are evidences of human factors contributing to forest destruction. Iwata *et al.* (1996) , Miyamoto (1998) reported deforestation since the 3 ka yrs BP around the central Himalayas in Nepal.

In this paper, previous studies around the Tibet and Nepal (Assam Himalayas and Sikkim Himalayas) areas are reviewed and datable charcoal and humus material in soil in Eastern Himalaya (Arunachal Pradesh) are reported at preliminary level.

Study Area

The observation and sampling sites are situated in Ziro (Old Ziro) in Lower Subansiri district of Arunachal Pradesh, northeastern India (Fig.1) which is surrounded by mountains. The plain area of the valley is utilized for wet rice cultivation. The slopes of adjacent hills in the vicinity of the wet rice-fields are used for rain fed agriculture which includes cultivation of maize, millet and variety of vegetables. This area is characterized by the cultivation of *Eleusine colacana* on the paddy field edge.

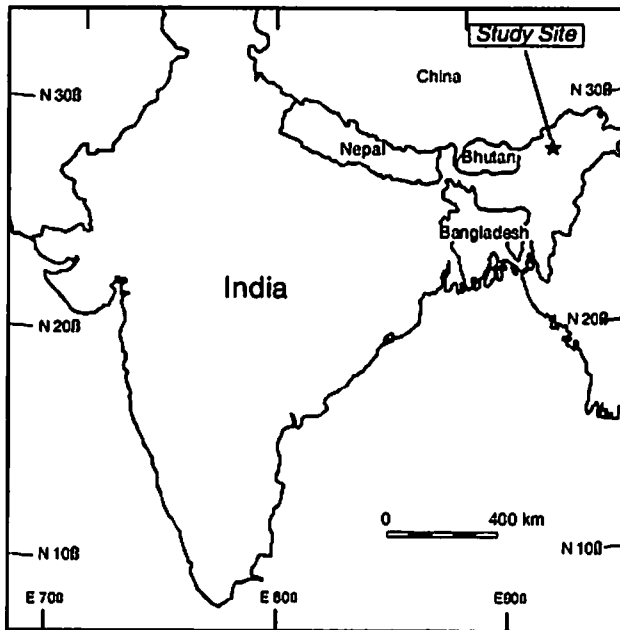


Fig 1: The study site

Method

Soil profiles were observed at various exposures along paths and risers of the terraced fields and ridge of the paddy fields. Charcoal fragments and organic rich parts of soil were collected for radiocarbon (^{14}C) dating at the exposed localities. Radiocarbon ages were obtained from charcoal fragments and humus soils taken from soil layers. From bulk humus soil, acid-insoluble humus mainly composed of humus acid and humin were extracted with the following physical and chemical analysis: samples from which rootlets, worms, and gravels were removed,

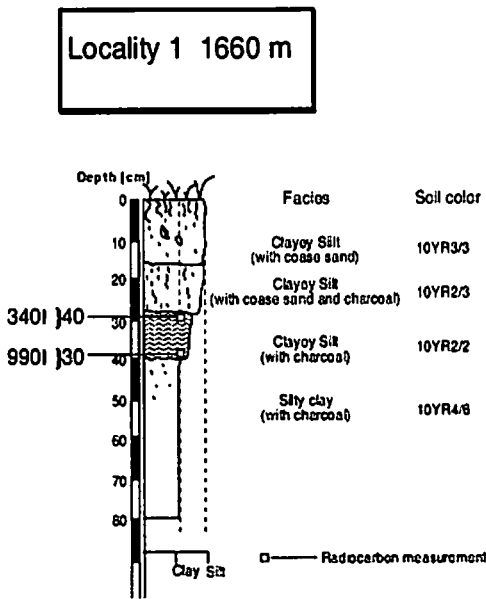


Fig 2: Burried Humic Soil Layer around Ziro,

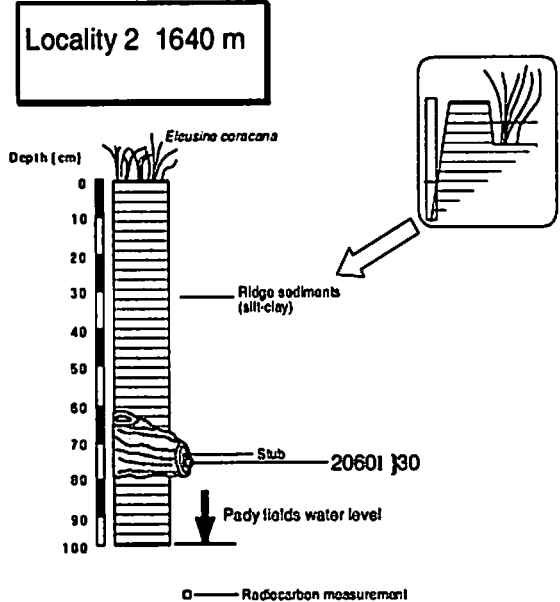


Fig 3: Burried Stamp around Ziro,

were boiled with 1N or 6N HCL for one hour in order to remove fresh organic materials. After the top clear solution was poured away, the residue (acid insoluble humus) was washed with distilled water. Measured ^{14}C ages calibrated using the calibration program OxCal ver. 3.10 (Bronk Ramsey, 2001).

Results and Discussion

Buried humus soil layers, charcoal fragments and stump of paddy fields ridge (Fig. 2) show the columnar sections from which samples for radiocarbon dating were taken. This soil section represents typical site around Ziro area. In this area, relatively thin exposed layers (about less than 20 cm) were observed. Buried stump in paddy fields are distributed in many sites not only in Ziro area but in the surrounding areas also. Ridge of paddy fields built by human and buried stumps are detected under carbonized surface condition (Fig. 4). Stumps are suggesting not secondary sedimentation, because ridges are repaired every year in dry season. However, the layer of detected stumps is not disturbed. The soil organics and buried stumps taken from buried humus soil layer and ridge of paddy field were dated: 340 ± 40 (upper), 990 ± 30 (lower), 2060 ± 30 (stump).

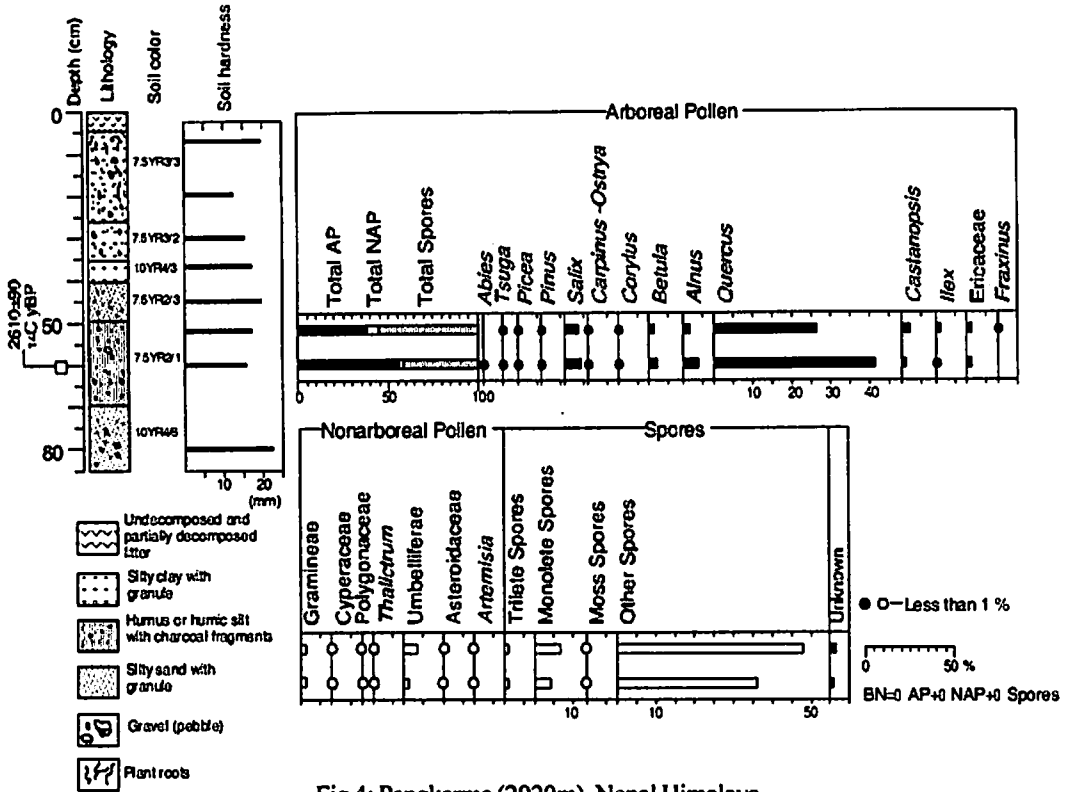


Fig 4: Pangkarma (2920m), Nepal Himalaya

It is reported that a fire appeared on many places from charcoal fragments being detected not only in buried humus layer but in the various horizons of the comparatively short dark-brown soil layer under the surface in Junbesi valley of the Sikkim Himalayas (Iwata and Miyamoto, 1997). Moreover, the concentrating layer of the charcoal fragments is recognized even in the Assam Himalayas except for the buried humus layer which indicates that a forest fire appeared in many places. The development by the bush fire of the forest aimed for pasturage was recognized after ca. 3700 y BP in the Sikkim Himalayas (Miyamoto, 1998), but the buried humus layer of the Assam Himalayas indicates ca. 990 and ca. 340 y BP.

As for the eastern Himalayan (Assam Himalaya) area as well, this can be estimated that a similar development took place here also. As pointed out in the case of Sikkim Himalayas, there is a possibility that a forest fire appeared in each age and area intermittently. There were a few forest fires which appeared naturally. But the possibility of the cause of the forest fire may be the human impact. So far the environment of Junbesi valley is concerned, it remains cloudy during monsoon (Tsuchiya, 1996). Equally, in the area which adjoins Assam has a

On the other hand, buried stump under the rice field indicates that it occurred at ca. 2000 yrs BP, which is older than the buried humus layer. The oldest value of the buried humus layer was ca. 3700 yrs BP, and it was confirmed in a development period in Sikkim Himalayas (Fig. 6). However, in Assam Himalayan area, where cereal cultivation is done, it can not be same as that of the Sikkim area. As forest or bush fire was done in many areas, it can be estimated that some developmental activities in the early days were undertaken since ca. 2000 yrs BP in the present shifting cultivation field. We can estimate that the full-scale development concentrated at ca. 1000-340 years BP, the formation time of the buried humus soil layer. The migration of tribes may be a probable cause (Miyamoto, 1998) which is, however, not yet clear.

Conclusions

Dated charcoal and humus materials present in soil are the evidences of forest fire, while vegetation changes indicate deforestation in the past and land development (paddy field) in Eastern Himalaya. Around Ziro, Arunachal Pradesh, North Eastern India, human factors such as population growth and cultural changes may have triggered an environmental and agricultural changes after ca. 2 ka BP. Relatively intense deforestation and land development since the ca. 1 ka BP was due to the human impact.

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An Observational Plan about Raindrop-size Distribution at Cherrapunjee, Meghalaya

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Introduction

Raindrop has the size range between 100 μm and 7 mm in diameter. The minimum size depends on gravity. For example, a drop of diameter 10 μm takes around 5 days during its free falling per 100 m. Such small drops are regarded as cloud droplets. A drop of diameter 1 mm has a falling speed of around 4 min/100m (Gunn and Kinzer, 1949). If the drop is too large, it becomes unstable and break up into several smaller drops. The raindrops of diameter more than 8 mm have not been observed. The raindrop-size distribution (later referred as DSD) depends on the environment in which raindrops are formed, and also the atmospheric condition during their falling. It is known that DSDs vary across places, seasons, and even in a precipitating system. The most famous form of DSD is the exponential form [$N(D) = N_0 \exp(-\Lambda D)$] proposed by Marshall and Palmer (1948), where Λ is a function of rain intensity. This form includes only two unknown parameters. However, in general, how many parameters are needed to represent all DSDs over the world is still an unresolved problem.

Observation Methods

The observation methods of DSDs have been developed since the end of the 19th century (Mason, 1971). One of the well-known manual methods uses an absorbent paper which is dusted with a water soluble dye (e.g., methylene blue). When a raindrop hits the paper, the color gets changed and the colored stains which vary with the drop sizes can be measured. Figure 1 shows the result of another method which is conducted at Cherrapunjee in the summer of 2005. This method uses flour. It is placed in a shallow dish and raindrops which fall into the four layers, make balls and the size of the balls varies with drop sizes. Recently the automated methods are also available. Some of the methods observe falling speed of droplets and derive DSDs as the fall speed depends on the drop-size.

Present Importance of DSD

Recently, understanding of the DSDs has become more important because of the application of remote sensing technique. The most popular technique to measure the horizontal distribution of rain is the rain radar. Since 1997, the TRMM satellite has been observing the rainfall over the world from space, which is the first satellite of rain radar on board. In deriving rain intensity from the rain radar we need to assume DSDs. If we do not use appropriate DSDs, the estimation of rain intensity from rain radar may have error to the extent of double.

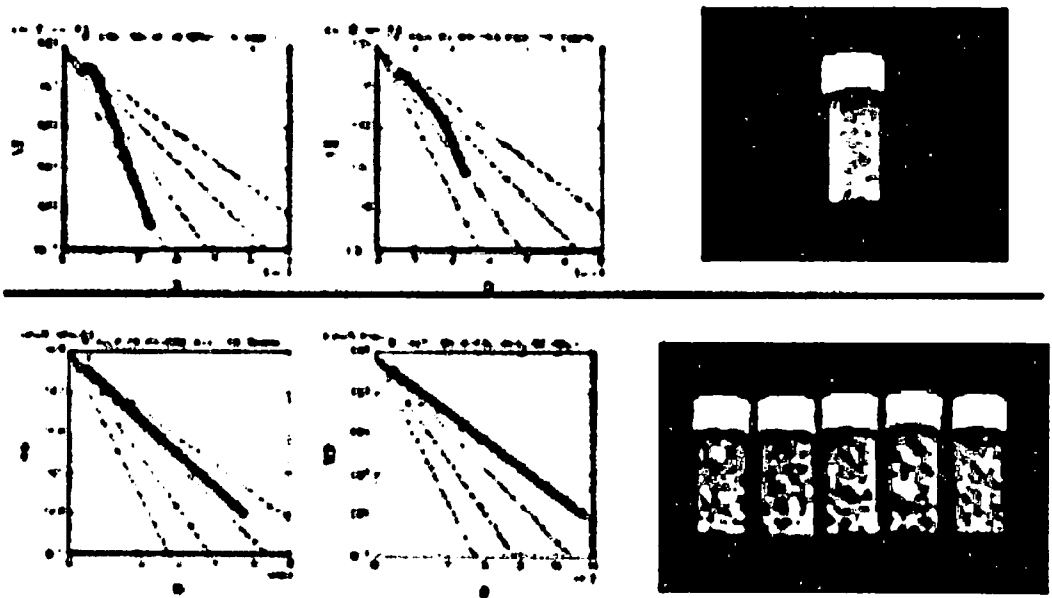


Figure 1 : Left figures show DSDs observed at Cherrapunjee in July 2005. The four thin blacklines are the DSD forms proposed by Marshall and Palmer for 1, 5, 25, and 100 mmh⁻¹. The upper DSDs are not fitting on the black lines, but the lower DSDs are having good correspondence with the black lines. The right photos are typical flour balls of the corresponding DSD types.

Observational Plan

Most parts of North-East India are floodprone areas, and the main cause of this is the upstream heavy rainfall. As many as 20 raingauges have been installed in north-eastern India. But rain gauges provide point information, and the local heavy rainfall in the mountainous region sometimes becomes difficult to detect. Rain radar is a useful instrument to provide the horizontal

distribution of rainfall even over the complex terrain. DSD measurement must be important for conversion from output of radar to rain intensity. We are planning to conduct DSD observation at Cherrapunjee, Meghalaya. Because it is an interesting place with the heaviest rainfall in the world, and it can be evaluated by using a rain radar from Bangladesh which will be installed in the next year.

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Flood Hazards and Human Responses in the Lower Brahmaputra Floodplain in Assam

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Extended Abstract

Floods are considered as one of the most significant natural hazards causing large-scale human sufferings and damage to economy on regular basis all over the world. These high-magnitude episodic events are capable of causing gigantic geomorphic activities and they bring about dramatic consequence in the landscape (Gupta, 1988). Rivers causing high floods are the extremely dynamic features of the natural environment, especially in humid tropics. Floods are primarily responsible for modification of landscape leading to changes in natural environment, agro-ecosystem, socio-economic situations and so on. Periodic flooding controls a variety of functional and structural aspects of large river floodplain ecosystem (Bayley, 1995). For example, flooding regulates rates of nutrient cycling and productivity, creates habitats for some riparian flora and fauna, recharges hydrologic and fluvial conditions of the floodplain wetlands (Saharia and Bora, 2008). However, such potentially significant hydrologic connections and linkages have been disrupted through modifications of river flow and channel morphology due to both natural and human-induced factors, which have resulted in extensive changes in riparian ecosystem. The floodplain dwellers, besides being major contributors of flood-intensifying activities in some cases, require to adopt certain modes of adjustment with the hazardous floods (Bora, 2003a).

Flood is a common phenomenon in the Brahmaputra Valley of Assam which is monsoon synchronized in nature (Bora, 2003b, 2004). Because of its peculiar geographic location and other natural and human-induced factors, the valley experiences severe floods annually. The floods of characteristically high frequencies and magnitudes heavily affect the agricultural lands, crops, cattles etc., of the Brahmaputra floodplain (Goswami, 1989). The most dominant impact of flood is on the agricultural sector, and thus the agrarian economy of the valley is greatly impaired by recurring flood losses (Bhattacharyya and Bora, 1997; Bora, 2003b).

The present study is confined to the lower Brahmaputra floodplain of Assam comprising parts of the districts of Kamrup, Nalbari, Barpeta, Goalpara, Bongaigaon, Kokrajhar and Dhubri. During flood time normally more than 60 percent area of the lower Brahmaputra floodplain gets

inundated. Almost every year the area receives 2 to 4 waves of floods triggered by heavy monsoonal rain with departure from the normal by more than 60 percent. The area records about 40 to 50 percent of flood damages out of the total damages in the Brahmaputra valley. Besides analyzing the general pattern of floodings and nature of associated hazards, six villages are considered for field studies, selecting four from the active bed of the Brahmaputra (active floodplain) and two from the chronically affected floodplain of the river. Based on the field studies, the nature and extent of flood hazards and the modes of human responses to and adjustments with floods in the study area have been analysed.

The study reveals that the flood management measures so far taken are inadequate in proportion to the dimension of the Brahmaputra flood problem in the study area. The occurrence of flood in the study area is quite natural and certain and the poor people living in the floodplain suffer severely. The poor people thus have no alternative but to cultivate the land and accept the risk of flood. In such a situation, there is an urgent need to pursue the approach of 'Living with Floods'. The cropping system in the floodplain has to be scientifically adapted to the rhythm of regular flooding and so a suitable and appropriate crop calendar has been evolved, keeping in mind that the possible flood period may be avoided so as to reduce crop damage substantially. It is further observed that the study area with much potential for development and diversification of agriculture may attain flourishing economy if a suitable crop calendar matched with the possible flood period is adopted.

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Livelihoods in Muktapur Village, Assam: Tasks towards Sustainable Rural Development

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Introduction

In the context of rural development, the "Integrated Rural Development" approach continues to be dominant. However, in the recent years "Sustainable Livelihoods" approach has drawn much attention. One of the reasons for this can be explained by such key words as sustainability, capital / asset, access and vulnerability as shown in Figure 1. According to Ellis (2000), a livelihood comprises the assets, the activities and the access to these that together determine the living gained by the individual or households. It is said that the sustainable livelihood

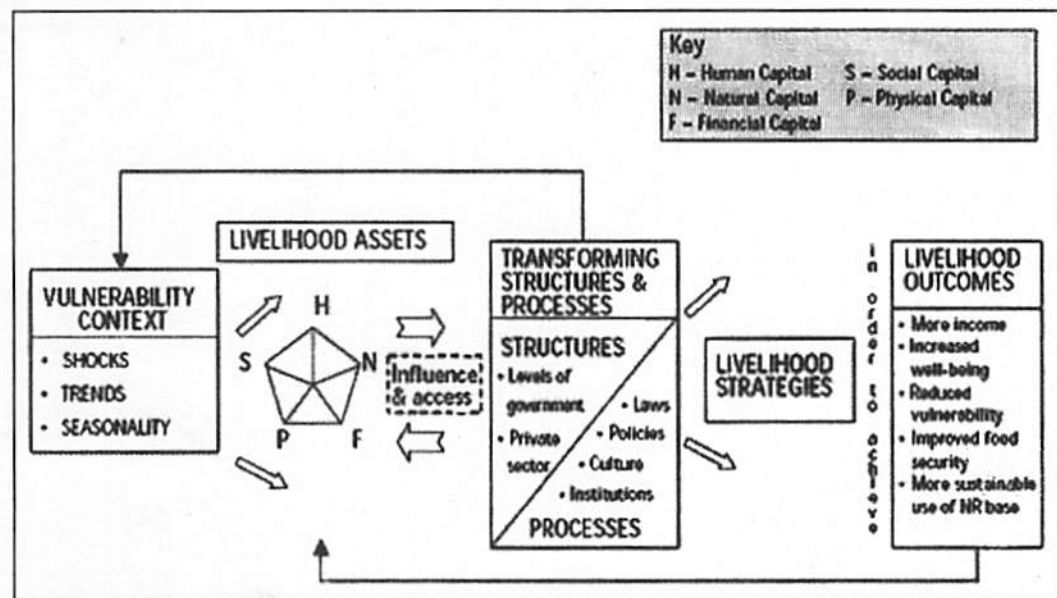


Fig 1 : Sustainable livelihoods framework

framework is helpful for understanding the structural factors behind the poverty of individuals and households.

The paper aims at (i) examining diversification of livelihoods in a village in the said framework and (ii) clarifying tasks ahead towards sustainable development.

Study Area and Methodology

As a case study, Muktapur village with 11 *chuba* (hamlet), a total households of 408 and a population of 2,080 was selected. The village is located in Muktapur *Gaon Panchayat* (comprising of 6 villages) in the Kamrup district of Assam (Fig 2). A complete survey was conducted in 2006 (Aug.-Nov.) to grasp the capital status (especially possession and utilization) with reference to (a) occupation, (b) landholding, (c) cropping pattern, (d) livestock, (e) agro-forestry, (f) assets, (g) income and credit, (h) food consumption, (i) social organization, etc.

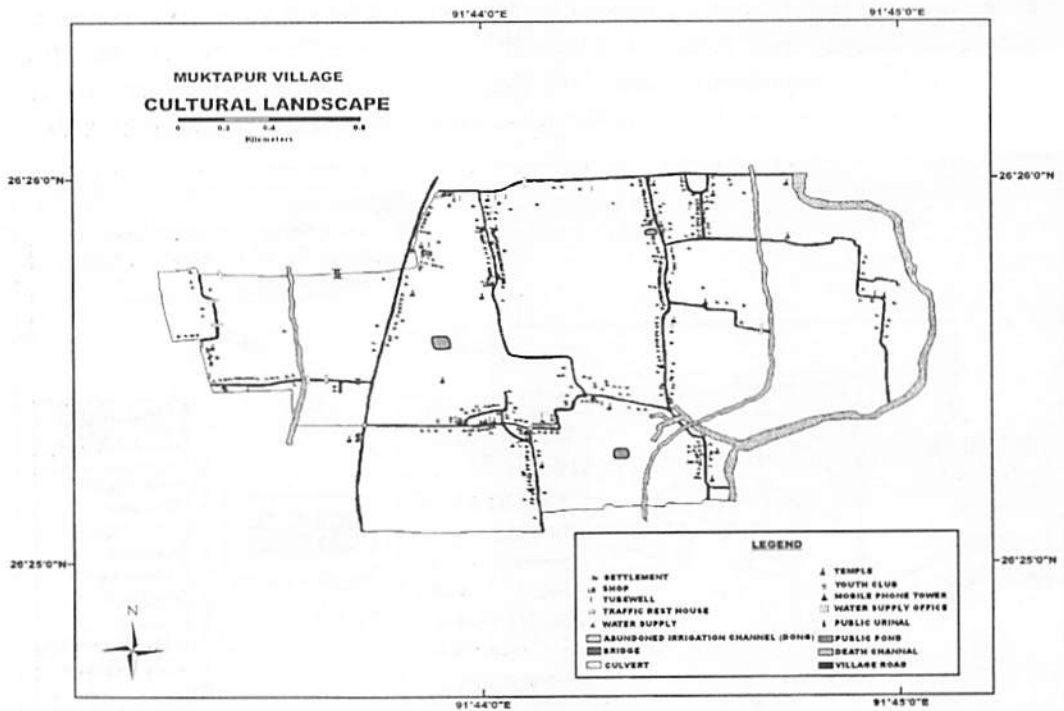


Figure 2: Cultural landscape of Muktapur village

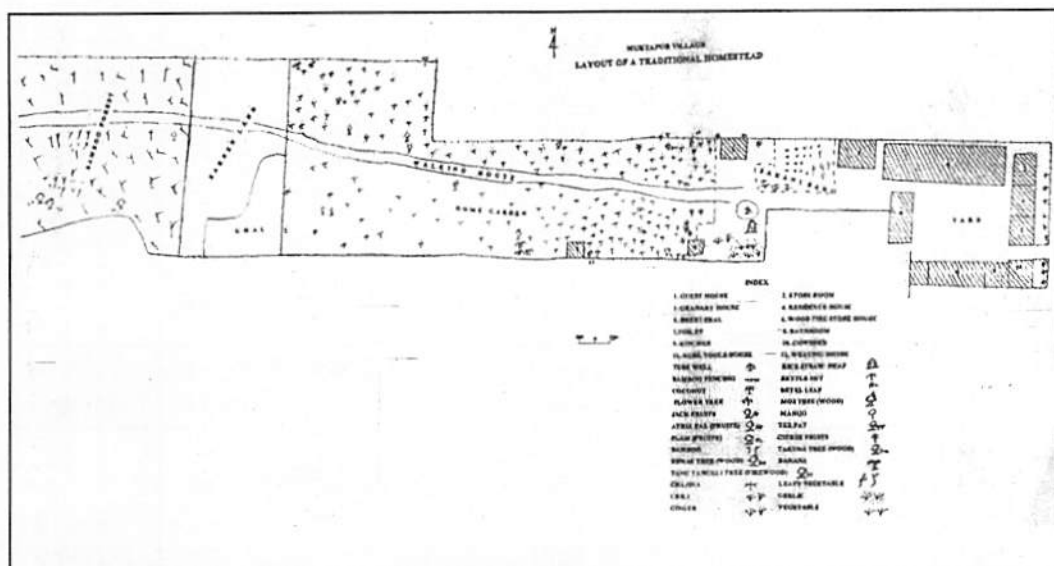


Figure 3 (1): Layout of traditional homestead

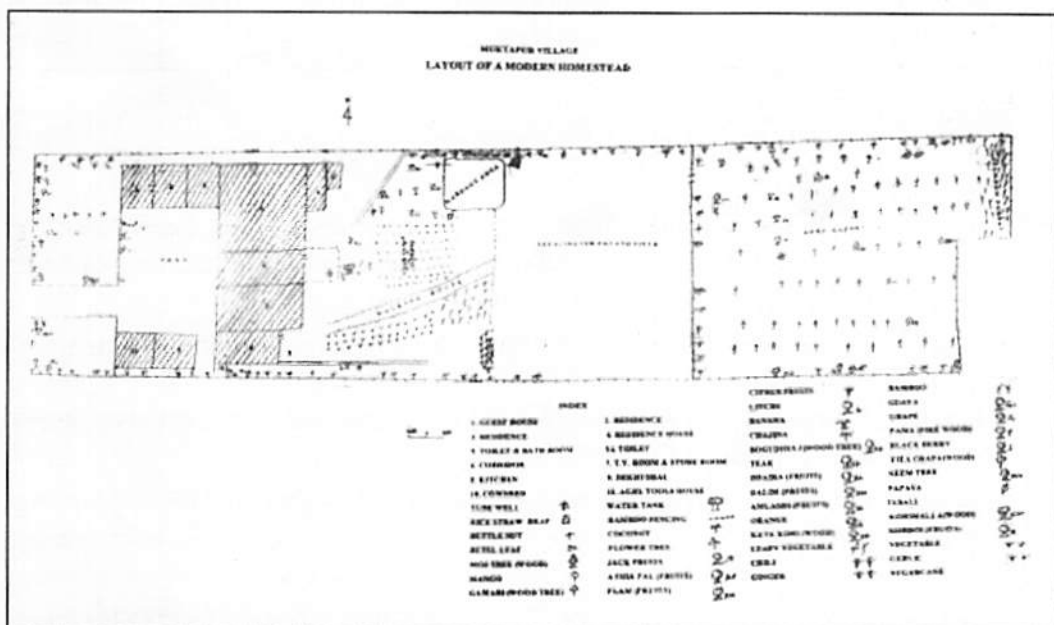


Figure 3 (2): Layout of modern homestead

Results and Discussion

Though not directly related to capitals (natural, social, human, financial, and physical), several features concerning livelihoods could be found out:

- The livelihoods (= a means of earning money to live) of the village are diversified (Table 1), as there is scope for higher percentage of non-farm employment provided by the linkages with Guwahati city.

Table 1: Number of households in difficult Income sources in Muktapur village

Income source	No.of HH	Income (in Rs.)	Income source	No.of HH	Income (in Rs.)
Landholding arrangement Sale	165	859,575	Wage agricultural labor	106	475,010
1) agricultural products	321	662,392	non-agricultural labor	86	804,195
2) land	7	143,000	Business	99	2,859,500
3) large livestock	159	268,845	Service	218	15,625,072
4) cottage products	11	28,212	Remittance	8	109,300
5) furniture	1	1,800	Dividend and others	17	501,300
6) others	2	1,400			

Source: Field survey, 2006-07.

- Farmland market and agricultural labor market are developed to some extent, although farming is not so much intensive due mainly to lack of irrigation. Farmland is mobilized by sharecropping (*adhia*) and mortgage (*bandhaki*) systems.
- Rice consumption per household is 4.24 kg per day. Of the total 289 farm households, 119 households (41%) can provide rice for themselves. The agro-forestry which is practiced around the homesteads (Figure 3.1 and 3.2) also contribute to food stock and earnings for the villagers in different seasons.
- Resource market and institutions (formal / informal) in the village and its neighbouring settlements can work to supply credit in order to cope with and recover from stresses and shocks, for example, medical treatment, ceremonial occasions and so on.
- Social organizations have been indigenously and externally established (Figure 4). However, their activities and rate of participation differ from *chuba* to *chuba*.

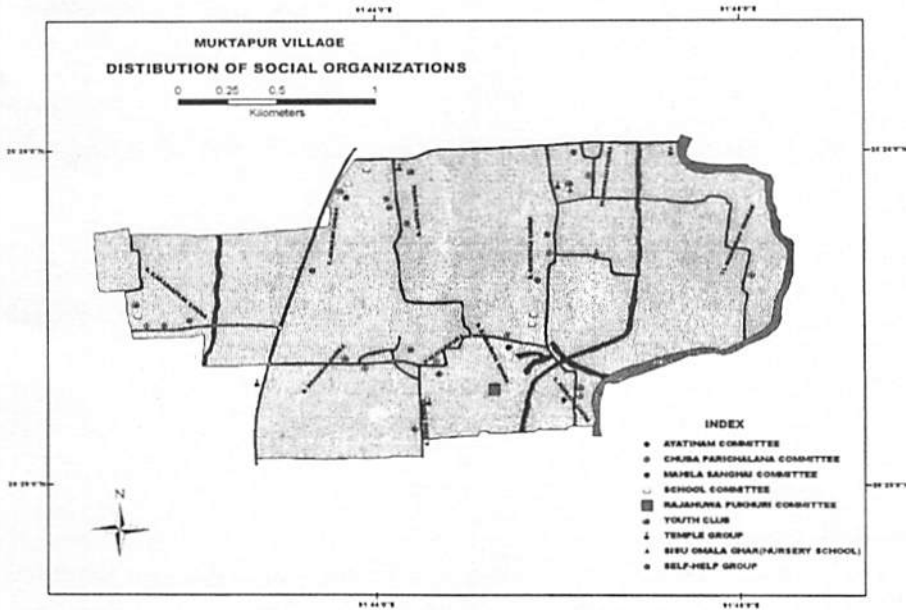


Figure 4: Location of social organizations

Conclusion

Thus, the livelihoods of the villagers seem to be sustainable as they are living on diversified resource bases. However, there should be a good integration among the resources (such as natural, social, human, financial and physical) in order to maintain a sustainable livelihood pattern and a balanced utilization of resources. There is doubt that further outward diversification as strategies might result in undermining of the local natural resource base. In that sense, agricultural development in Muktapur village would face difficulty in maintaining the existing agro-ecosystem. There is an urgent need to improve the rural agricultural labor market in the context of Muktapur and its neighboring villages where farming is in the process of intensification.

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An Experimental and Modeling Investigation of Macropore Dominated Subsurface Stormflow in Vegetated Hillslopes of Northeast India

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Abstract

Macropores, commonly referred as the preferential pathways of soil, are known as one of the most significant parameters to control rapid subsurface water movement in hillslopes. In Northeast India, where the hillslopes are characterized by high degree of macroporosity and the area receives extreme rainfall events frequently during the monsoon season, rapid lateral preferential flow is the major source of storm runoff. Such rapid movement of storm water from the adjacent hilly areas either in the form of old water or fresh water, often triggers devastating flash floods in the river. However, due to lack of experimental data or reliable empirical models for these watersheds, very little seems to be known about infiltration behavior, macropore connectivity, subsurface flow pattern through soil macropores, and the resulting runoff response of the watersheds. Therefore, as a prerequisite to developing any rainfall-runoff model it is essential to characterize both surface and subsurface flow behavior with good understanding of the critical hydrological processes prevailing in the region.

In forested hilly watersheds, the spatial and temporal variation of active macropore flow network primarily governs both surface and subsurface runoff generation processes. In order to understand this variability of macropore flow network and their connectivity, infiltration experiments were conducted with color dye tracer for undisturbed soil columns collected from various sites of the region like undisturbed forested hillslopes, paddy fields in the floodplains, *jhum* cultivated forested hillslopes, and paddy fields under *jhuming*. The analysis of the resulting dye patterns using digital image processing techniques clearly showed the effects of different management practices on the macroporosity of the soil. The obtained dye patterns were used as a physical basis of developing a subsurface flow model for the region. For developing the subsurface flow model about 15 runoff experiments were conducted with a sheet flow generation system on a uniform hillslope with clear evidence of well connected macropore network in its

subsoil. The plot was instrumented with profile probe soil moisture meter and 25 piezometers installed along five transects of the plot to keep track of subsurface moisture conditions and temporary water table build up above the impermeable layer.

The modeling concept considers that the soil mantle consists of soil matrix and a population of lateral macropores. Total subsurface storm flow is due to saturated Darcian flow through the soil matrix and kinematic preferential flow through the macropores. The hydraulically effective soil macropores, which get connectivity throughout the entire length of the slope, are assumed to be distributed in different layers of the soil profile. These lateral macropores are considered as circular pipes of small uniform diameter. Due to high preferential infiltration during extreme rainfall events a temporary water table is formed over the impermeable layer and starts contributing to lateral subsurface storm flow. Apart from the saturated matrix flow, the lateral macropores present below the temporary water table actively contributes to quick interflow mechanism from the hillslope. These macropores are termed as 'hydrologically active macropores'. The amount of water which seeps into the macropores is assumed to be discharged laterally with very high velocity without much interaction with the surrounding soil matrix. Thus, the temporary water table build up and its recession are controlled by recharge as well as the number and diameter of hydrologically active macropores present within the saturated soil strata.

The model was successfully used to simulate the observed temporal variations of water table build up and recession in the experimental plot under various recharge conditions. All the experiments showed the common trend of increasing the number of hydraulically effective and hydrologically active macropores in soil with increasing rate of recharge. The field observations clearly showed very fast build up and recession of saturated zone above the impermeable layer indicating the occurrence of rapid subsurface storm flow in the hillslope. In most of the cases, within 2-3 hours from the cessation of recharge, major portion of subsurface runoff had occurred. With a very slow matrix flow rate such quick response is not possible and thus it is clear that the lateral preferential flow dominated the storm hydrograph. This typical runoff pattern seems to be captured properly in the model simulations. The peaks of both matrix and macropore flow hydrographs occurred immediately after the cessation of recharge. All the experiments clearly showed that matrix flow was almost negligible compared to the amount and rate of lateral preferential flow. Preferential flow contributed more than 99% of prompt interflow occurring immediately after the storm events and with the increasing rate of recharge, contribution of macropore flow also increased as a polynomial function. Analysis of the computed subsurface flow hydrographs clearly showed that the peak rate of macropore flow has a good linear correlation with recharge. However, the peak matrix flow rate has a power relationship with recharge with comparatively poor correlation. This may be due to the significant domination of preferential flow over matrix flow prevailing in the hillslope. The present investigation provides an insight of the dominating hydrologic processes and their extremities in the hillslopes of Northeast India by coupling mathematical modeling with field investigation. The hydraulically effective or hydrologically active lateral macroporosity, and peak rates of matrix and macropore flow are found to be controlled primarily by the rate of recharge.

Rainfall Characteristics in Northeastern India during Pre-Monsoon and Mature Monsoon Seasons

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Introduction

The Northeastern India including Meghalaya plateau, Assam Basin and Bangladesh is one of the most prominent heavy rainfall areas in the world. This area, before the onset of summer monsoon associated with the commencement of south-westerly monsoon wind over the Indian Ocean, receives strong pre-monsoon convective rainfall.

Tipping bucket type automatic rain gauges have been installed to gather rainfall data with high temporal and spatial resolutions. Six rain gauges were installed in Bangladesh in 2004. After 2006, 20 gauges were set up in Assam and Meghalaya states, and 10 more gauges were added in Sylhet area in North-eastern Bangladesh.

In this report, new findings on rainfall intensity and its diurnal variation in North-eastern Indian subcontinent have been incorporated. Although it is well known that the midnight to early morning rainfall peak is dominant in this area, those of pre-monsoon season was not studied adequately. Since dataset with high temporal resolution is required, quantitative analysis of rainfall intensity is very few.

Diurnal Variation of Rainfall

In this analysis, the pre-monsoon and mature monsoon seasons are defined as the periods from March to May, and July to September respectively. Figures 1 and 2 show the average diurnal rainfall variation in Bangladesh for pre-monsoon (Fig. 1) and mature monsoon season (Fig. 2). These variations are shown for three sub-regions: north-eastern part (Sylhet), central and western part (Dhaka, Mymensingh, Dinajpur and Rajshahi), and south-eastern part (Chittagong). Those for Meghalaya and Assam states are shown in Figs. 3 and 4 respectively.

The midnight to early morning peak of rainfall is seen in most of the regions. Both Meghalaya and Assam exhibit midnight to early morning peak not only for mature monsoon, but also for pre-monsoon season. In Meghalaya, the pre-monsoon rainfall peak time is somewhat earlier than that of the mature monsoon season.

Difference in Rainfall Intensity for Seasons and Sub-regions

Rainfall intensity is notably high for pre-monsoon Bangladesh except for south-eastern part. The contribution ratio of 10-minute rainfall stronger than 5 mm is most clearly seen in the central to western part of Bangladesh for pre-monsoon season, exceeding 60 %. The same tendency is obvious for Meghalaya plateau. For Assam area, no significant difference in rainfall intensity is seen.

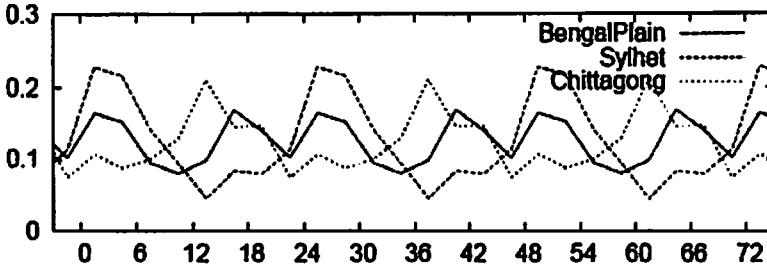


Fig. 1: Diurnal variation of rainfall in three subregions in Bangladesh for pre-monsoon season. Horizontal axis represents local time of Bangladesh (GMT+6).

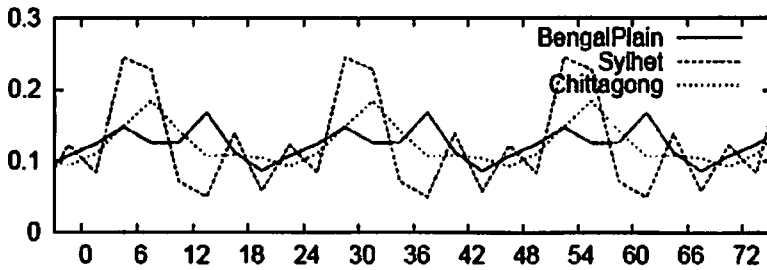


Fig. 2: Same as Fig. 1 except for mature monsoon season.

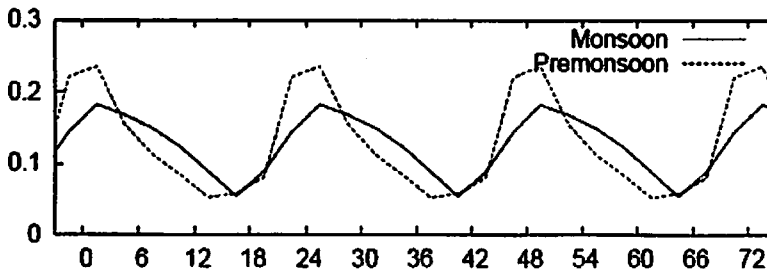


Fig. 3: Diurnal variation of rainfall in Meghalaya area. Horizontal axis represents local time of Bangladesh (GMT+6).

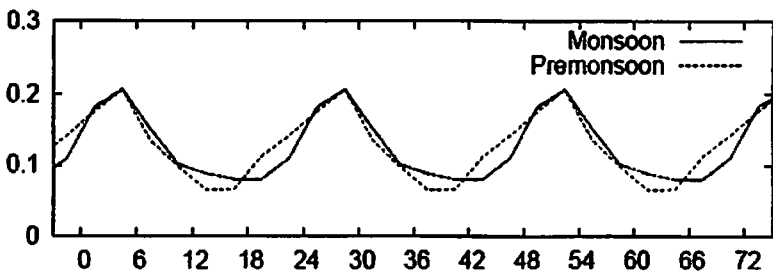


Fig. 4: Same as Fig. 3 except for Assam. Horizontal axis represents local time of Bangladesh (GMT+6).

Several Features and Future Perspect of Weather Condition in the North-Eastern Region of Indian Subcontinent

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The Asian monsoons are supplying a plenty of water as rainfall in the South and South East Asia. As shown in the schemaitc figure (Figure 1), the summer monsoon has the large temporal and spatial scales. The origin of the monsoon wind is located in the southern hemisphere. The wet and hot wind blows in the western coast of Indian subcontinent and heavy rainfall was recorded frequently in the Western Ghat montains. The air mass drys over the Deccan plateau and becomes wet again over the Bay of Bengal with the sufficient supply of water vapor. This air flows with high potential of heavy rainfall that comes to the north-eastern region of the Indian subcontinent and releases the rainfall in the southern slope of the Meghalaya Plateau.

The Meghalaya plateau is located in the north-eastern part of the Indian subcontinent and consists of relatively higher hills with the highest point of 1,965m (Figure 2). Cherrapunjee is well known as the place of the highest rainfall in the world with 26,461mm from August, 1860 to July, 1861.

In this paper, the rainfall behavior with several temporal scales of inter-annual, annual, seasonal and intra-seasonal and daily rainfall variations using daily rainfall data of Indian Meteorological Department and Bangladesh Meteorological Department are presented.

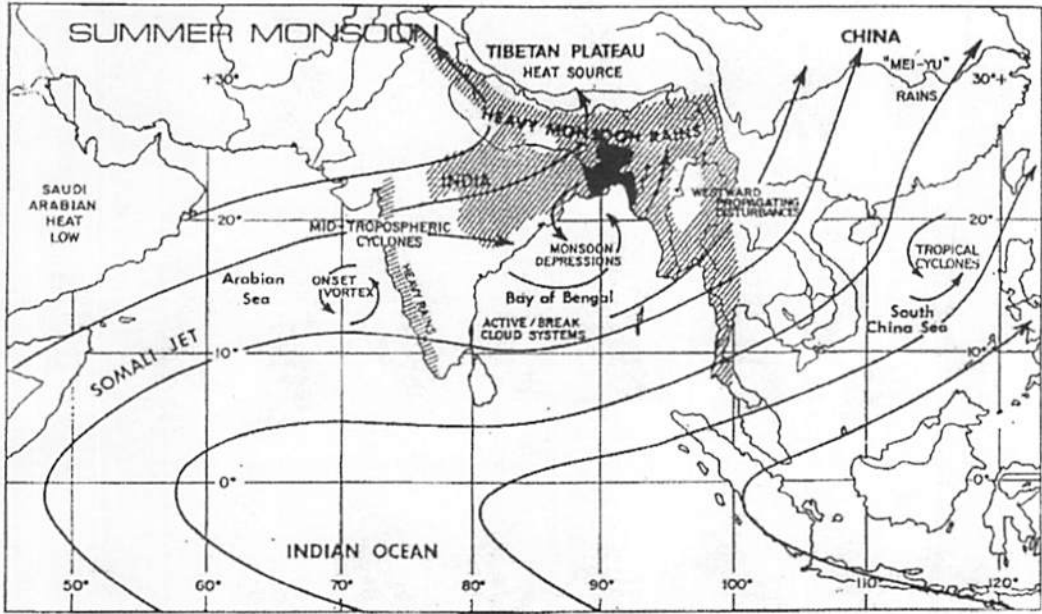


Figure 1: Schematic figure of Asian summer monsoon



Figure 2: Location of Cherrapunjee and Mawsynram in India, and Sylhet in Bangladesh

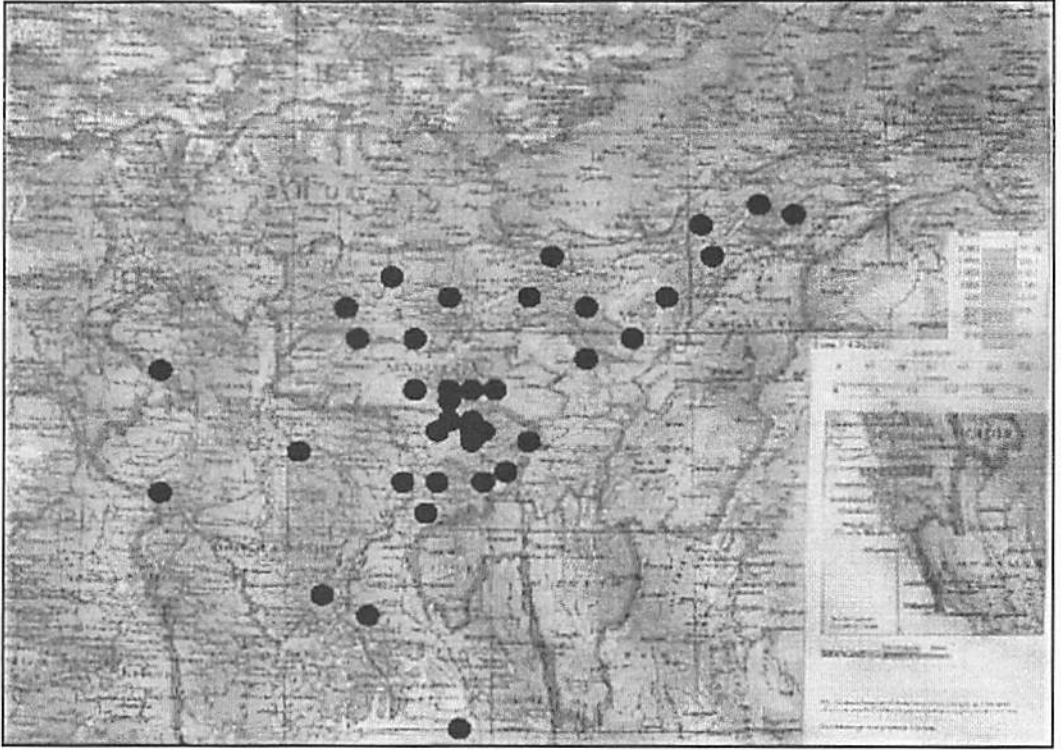


Fig.3 Rangauge distribution in the North-east Indian subcontinent

A large amount of rainfall in Meghalaya flows down direct to Bangladesh and severe floods occurred frequently in the past. At present, the field observation over Assam, Meghalaya and Bangladesh is extended for getting an integrated understanding of the rainfall behaviour in both the countries. Figure 3 shows the intensive observation network, where more than 40 raingauges are installed already. The exact rainfall with high temporal and spatial resolution has been determined and the preliminary results presented for discussion.

Comparative Study on Local Governance and Participatory Rural Development through Decentralization in Bhutan and Arunachal Pradesh, India

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Abstract

In terms of “protected area development”, Arunachal Pradesh of India and Bhutan have two points in common, viz. conservation of natural forest and participatory rural development through decentralization. I try to extend the observations published in the Journal of the Open University of Japan, November 25, 2007 (in Japanese) to a case of Arunachal Pradesh, India. Royal Government of Bhutan (RGOB) has accelerated decentralization process towards local governance and participatory rural development. The *Ninth Plan Main Document 2002-2007* focuses on the points presented below.

Decentralization and Devolution

People’s active participation in their own development has been a key policy of His Majesty the King since the Coronation in 1974. Toward this end, several institutions have been established and legislations enacted to empower people, evolving a representative system of governance. The formal organizational structure and procedures for decentralization have evolved over the last three decades, and continue to do so. The first step in the process was taken in 1981 with the introduction of the *Dzongkhag Yargye Tshogchung* (District Development Committee). And the process was consolidated in 1991 with the establishment of the *Gewog Yargye Tshogchung* (Block Development Committee).

These two institutions involve the people in political, social and economic decision making increasing thus their capacities to set their collective priorities and to initiate means for their fulfillment. Two decades of decentralization and participatory development has brought about the following changes:

1. Devolution of administrative and financial powers, and human resources from the capital to the Dzongkhag administration;

2. Increased capacity of GYT and DYT to make collective decisions regarding their development plans and its implementation; and
3. Autonomy of GYT and DYT to make regulations and legislations applicable within their jurisdictions.

Experiences over the past decades have reinforced the confidence of the Royal Government on the capacities of the communities to plan and implement development activities on their own (RGOB, *Ninth Plan Main Document 2002-2007*, 2002, p.22). Royal Government of Bhutan has almost achieved the 9th five year plan. In Bhutan's case, the establishment of autonomy of GYT and DYT to make regulations and legislations applicable within their jurisdictions follows the devolution of administrative, financial powers, and human resources from the capital to the district. It took almost three decades. The natural forest is preserved by the enactment of very strong forest acts.

In the case of Arunachal Pradesh, the Government of India protected the area as a union territory keeping it away from any outside influence in order to make the area safe from confrontation with China. Elwin thus writes: In NEFA there are no landlords, no extortionate money-lender, no liquor-vendors, anxiety and the corruption that such people have brought to other, more accessible, tribal areas (Elwin, V. A: *Philosophy for NEFA*, Govt. of AP, 1957, p.7).

It appears that the people enjoy autonomy based on their community; but the devolution process of administrative and financial powers has just started in Arunachal Pradesh. This process is to be observed carefully employing the available Government reports and secondary materials.

Impact of Climate Change on Health: Diarrhoea Diseases in Bangladesh

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We aim to investigate the relationship between inter-annual and seasonal anomalies of local and global meteorological elements and diarrhoeal diseases. Diarrhoea surveillance data used were daily diarrhoeal patient numbers from ICDDR, Dhaka Hospital for over 22 years (1980-2001). Time scales of meteorological elements used were diurnal, intra-seasonal, seasonal and inter-annual variations. Lag-correlation and time-series regression models were used to

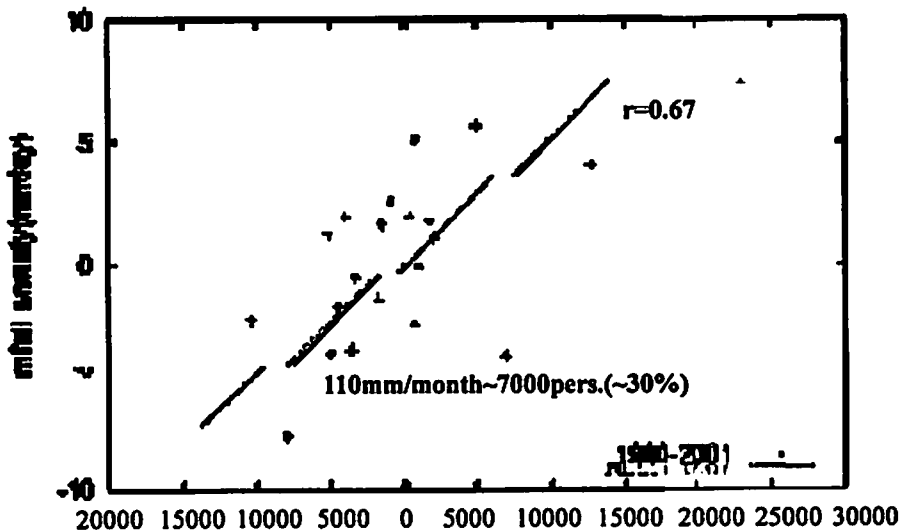


Fig 1: Number of patients in August-October and rainfall in August

assess the effect of meteorological phenomenon on the epidemiology of diarrhoea diseases. For the anomalies of diarrhoeal patients, two peaks were found: the first peak is in April-May and the second peak in August-October. Time lag correlation analysis showed the first peak lagged by about one month behind the rise in ambient temperature and was related with low temperature in preceding winter. The second peak corresponded with higher overall rainfall, especially more with the latter half of the rainy season (Figure 1). The effect of ambient temperature on the incidence of diarrhea was greatest during the winter months (January). Spatial distribution of sea surface temperature (SST) and rainfall anomalies in a global scale showed significant relationship with the increase of diarrhoeal patients.

In conclusion, ambient temperature and rainfall had effects on the incidence of diarrhoeal diseases. Distinguished characteristics in related meteorological elements were found between the first and second diarrhoeal peaks. Conceptual framework on the impact of climate change on diarrhoeal disease should further be investigated (Figure 2).

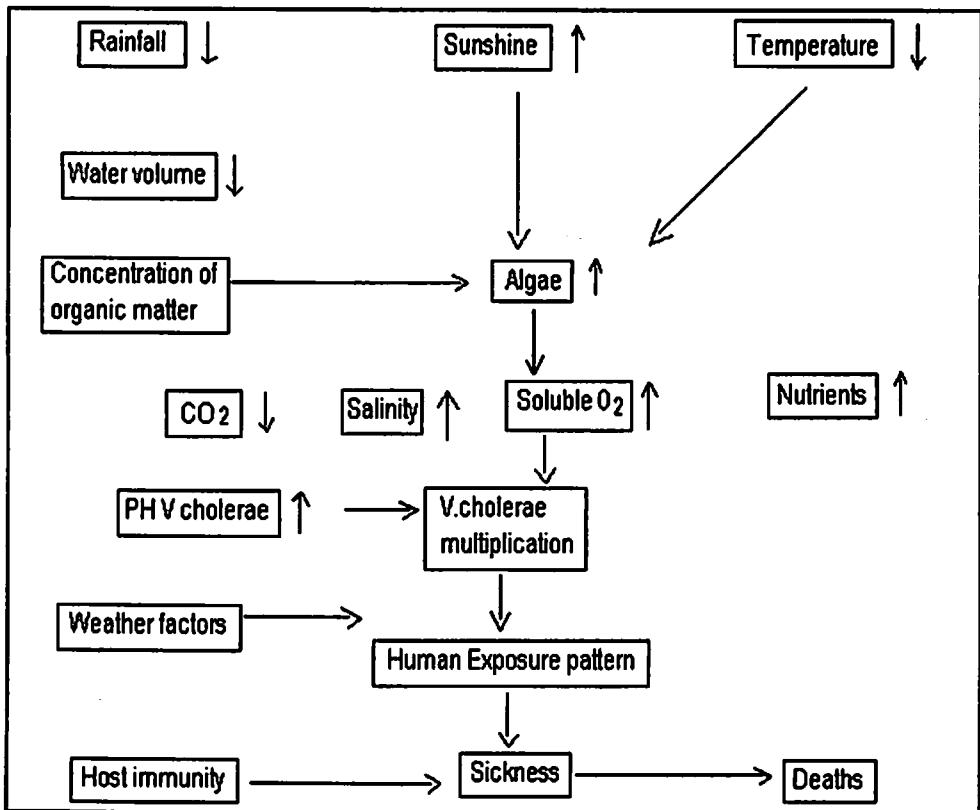


Fig 2: Conceptual model of diarrhoea disease

Impact of Geo-environmental Characteristics on Socio-economic Settings of Lower Jinari Basin, Goalpara District, Assam

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The geo-environmental characteristics of a region exert considerable influence on the nature and development of the socio-economic settings. The general flood and the flash flood and sand deposition etc. are the significant geo-environmental characteristics that highly influence the socio-economic settings of a region. The Jinari river, which is one of the important south bank tributaries of the Brahmaputra river originated in the Garo Hills of Meghalaya, has a basin

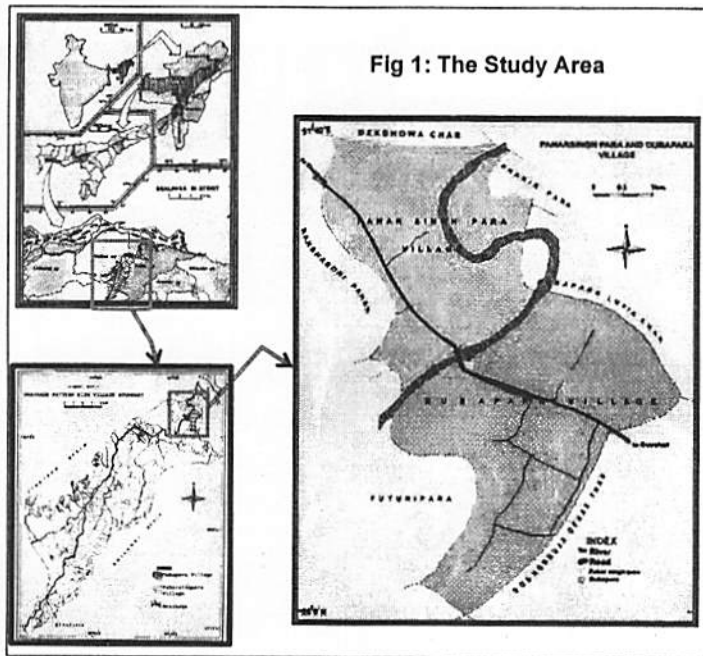


Fig.1

area of 598 km² and stretches between 25° 42' N to 26° 8' N latitudes and 90° 20' E to 90° 43' E longitudes and traverses a distance of about 94 Km. The basin receives an average annual rainfall of 2740 mm with a major concentration in the summer months. The lower Jinari basin is regularly experiencing flood during summer months and affects the socio-economic status.

The study is concerned with two aspects: (i) geo-environmental characteristics in the lower Jinari river basin as well as in the two villages and (ii) socio-economic status of the people living in two villages (Dubapara and Paharsingpara) covering an area of 672 hectares (Fig.1) with a population of 4,425 (2001). The two villages are inhabited by a particular community of people who migrated from the then East Bengal (now Bangladesh) in the last part of the nineteenth century. They practice a typical agriculture i.e. raising *Sital Pati* for their livelihood. The prevailing flood and geo-environmental settings in the area help to grow Patidoi (*Clinogyne dichotoma*) in the area. The areas where water remains less than 1.5 metre in depth even for 3 months in a year permit the growth of *Pati* plants.

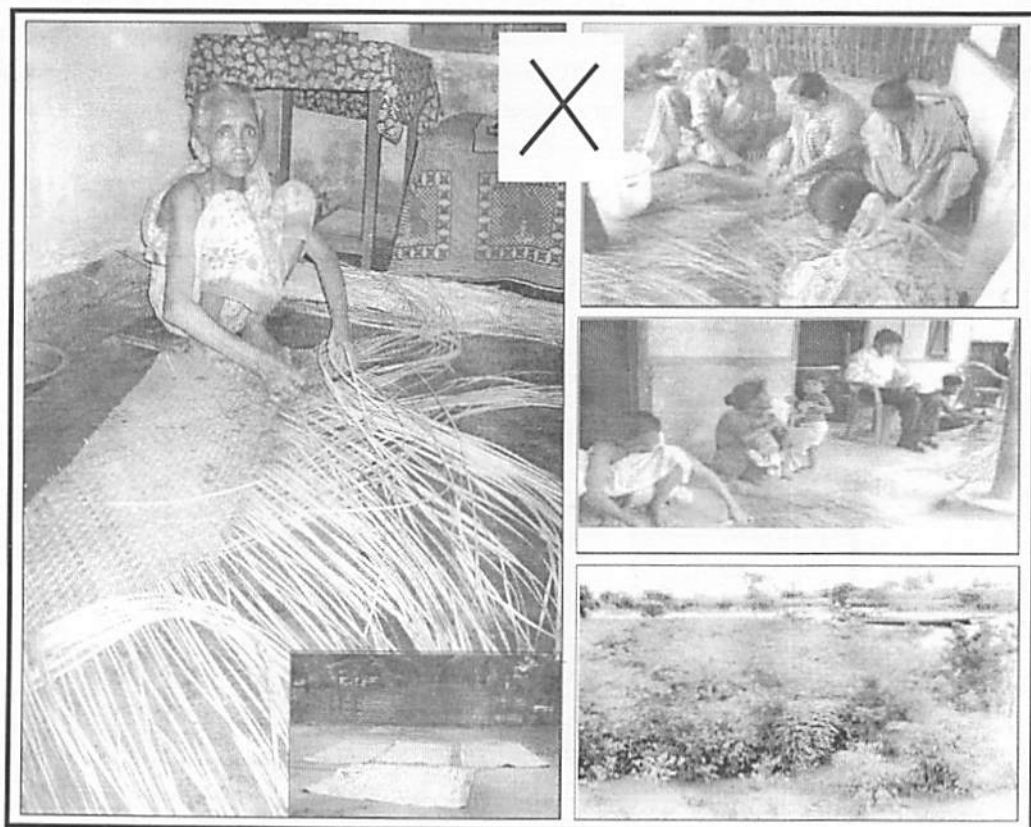


Photo : Activities relating to *Patidoi* cultivation and production.

The present paper is a modest attempt to discuss the impact of geo-environmental characteristics on rural economy in the study area. Out of the total working population, nearly 85 percent are engaged in *Pati* cultivation and related cottage industry.

Table 1: Occupational pattern (in percentage)

Occupation	2000	2008
Pati artisan	87.60	85.35
Agriculture	6.00	3.18
Agricultural labour	1.20	5.75
Service	2.75	1.27
Wage earner	2.00	1.91
Others	3.2	2.54

From the study, it is observed that low floodwater is helping to develop a peculiar socio-economic habit of the people in the study area. However, very high flood, sand deposition due to flash flood, lack of technological innovation in *Pati* cultivation and *Pati* industry and lack of government initiatives towards *Pati* industry are the major problems that affect the overall socio-economic settings of the region. The technological innovation in cultivation and in industry and the government initiative to provide basic infrastructure and to develop a suitable market network are the need of the hour.

Population Growth and Associated Demographic Character in Assam, India

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Abstract

The state of Assam, with a long history of peopling and diverse population composition, is characterised by a very high and varied growth rates of population during the last several decades. At the beginning of the twentieth century the state's population was 3.29 million and it increased to 8.03 million in 1951 and 26.65 million in 2001 by experiencing an average annual exponential growth rate of 1.80 percent during 1901-1951 and 2.43 percent during 1951-2001 as against the country's corresponding growth rates of 0.83 percent and 2.11 percent. As a consequence of such a rapid population growth, the share of state's population to the country's total increased from 1.38 percent in 1901 to 2.59 percent in 2001. Despite having almost similar birth and death rates as in the country, the considerably high growth rates of population in the state have been due to significant volume of migration from within and outside the country. Such a high growth rate of population in the state since long would have a number of serious demographic implications including the changes in the ethno-linguistic and religious composition of population in the state. For instance, although the overall growth rate of population in the state has come down significantly in the recent time, the after effect of the migrant population has still been continuing in terms of high fertility rate among them. This phenomenon is found to be quite clear in respect of population growth rate and associated demographic aspects like age composition, age at marriage and literacy rate among the major religious groups in the state with future socio-economic implications.

In the above background, an attempt is made in this paper to analyze the pattern of population growth and its inter-religion variation, and demographic issues associated with it in the state of Assam. The study is primarily based on secondary data drawn from various Census of India publications, especially for the period 1971-2001.

Tourism in North-East India: Trend of Development and Issues Associated with Sustainability

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Tourism is one of the rapidly growing industries in the present day world influencing societal, governmental and academic circles. In 2007, global tourism arrival record crossed the eight hundred million mark (WTO, 2008). Emerging trend of tourism opens door for many, especially for the countries of developing world. The tourism industry needing comparatively lesser import content can bear promise to the countries and regions of the world, which are otherwise economically backward to afford large-scale investment in other capital-intensive industrial sectors. As a service industry, tourism has a flexible character having capability of accommodating skilled, semi-skilled and unskilled work forces.

North-eastern region of India comprises seven states viz. Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura and Meghalaya. Endowed with both physical and human diversities the region may prove to be one of the most potential regions of India in respect of tourism promotion. Landscape constituents of the region viz. hilly (60%), plateau (12 %) and plain (28 %) along with five major river systems contribute substantially in enriching its natural and cultural context. As a zone of convergence of diverse ethnic stocks, the region is undoubtedly a showcase of cultural diversity. Proper campaigning of the region's wide variety of physical and cultural products (the hidden substances for developing tourism) can bring a positive change in the prevailing socio-economic condition of the region. Considering the significance of the tourism sector as a viable catalyst for regional development, an attempt has been made in this paper to understand the trend of development of tourism sector in North-eastern region of the country and analyze its strengths and weaknesses from the perspective of a much needed sustainable tourism developmental approach.

Biophysical Attributes and Prediction of Summer Rice Yield in the Brahmaputra Valley, Assam

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Abstract

Reviewing concerned literature on crop yield prediction, it is obvious that sustainable crop production systems that are based on plant- soil- environment relationship were widely analyzed to attempt the development of physiologically based crop yield modeling in order to understand the mechanism and to simulate the crop growth especially in the humid tropical environment of the Brahmaputra valley. It is evident that variations in potential yield of summer rice crop are the function of the dynamics of biophysical (soil and water) factors. Adopting integrated crop yield function that is based on the dynamics of biophysical attributes of land in terms of development of potential production index (PPI), the observed and calculated yields is compared with ecologically based potential production index, PPI, for summer rice yield as $A = m * PPI$.

Land Tenure Systems: A Study on Rice-based Farming Systems in Baghaichari Muk Village, Khagrachari District, Bangladesh

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This study was conducted in Baghaichhari muk village, 51 No Dighinala Union of Dighinala Upazila in the CHT region of Bangladesh, about 30 km from the Khagrachari District headquarters. Regular field surveys were done during the cropping seasons for two years (2003-2005). In Bangladesh, although several studies on land tenure systems have already been carried out in the plain areas, no study has appeared on CHT as yet. In order to understand the socio-economic conditions of the study village, land tenure and mortgage systems need to be focused. Such information will provide a better understanding of the existing farming systems in the CHT. The results of the farming system research will provide basic information to extension workers, policy makers, NGOs, etc. The present study was conducted to describe the existing land tenure systems in rice-based farming systems in the study village. It seems to be the only means commonly practiced by farmers for solving their economic problems.

Coexistence with National Park : A Case Study in Kaziranga National Park

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North-East India is included in Indo-Burma and Himalayan biodiversity hot-spot (<http://www.biodiversityhotspots.org>). North-East India has 119 important Bird Areas (25.6% of the total in India), 41 Wildlife Sanctuaries (21.5%), 12 National Parks (23.1%), 3 Tiger Reserves (13.0%) and 63 non-official Protected Areas (31.7%). Especially, Assam and Arunachal Pradesh are very important areas for IBAs. Assam with 46 IBAs is the richest state in India in so far as the number of IBAs is concerned. Arunachal Pradesh also has 28 IBAs. Arunachal Pradesh occupies the fourth place in the number of IBAs. These indicate that North-East India is a very rich biodiversity area in the country. However, such protected areas sometimes face a conflict with the farming population who live around them. Here, an attempt is made to report how people coexist with the wild animals and perceive the behavior of the wild animals.

Kaziranga National Park in North-East India is famous as a protected area of *Rhinoceros unicornis*. Kaziranga was declared a World Heritage Site by UNESCO in 1985. Kaziranga National Park was established as a protected area in 1905 after Mary Victoria Leiter Curzon, the wife of the Viceroy of India, Lord Curzon, who visited the area. She tried to protect *Rhinoceros unicornis* and other dwelling species. As a National Park Kaziranga has a long history.

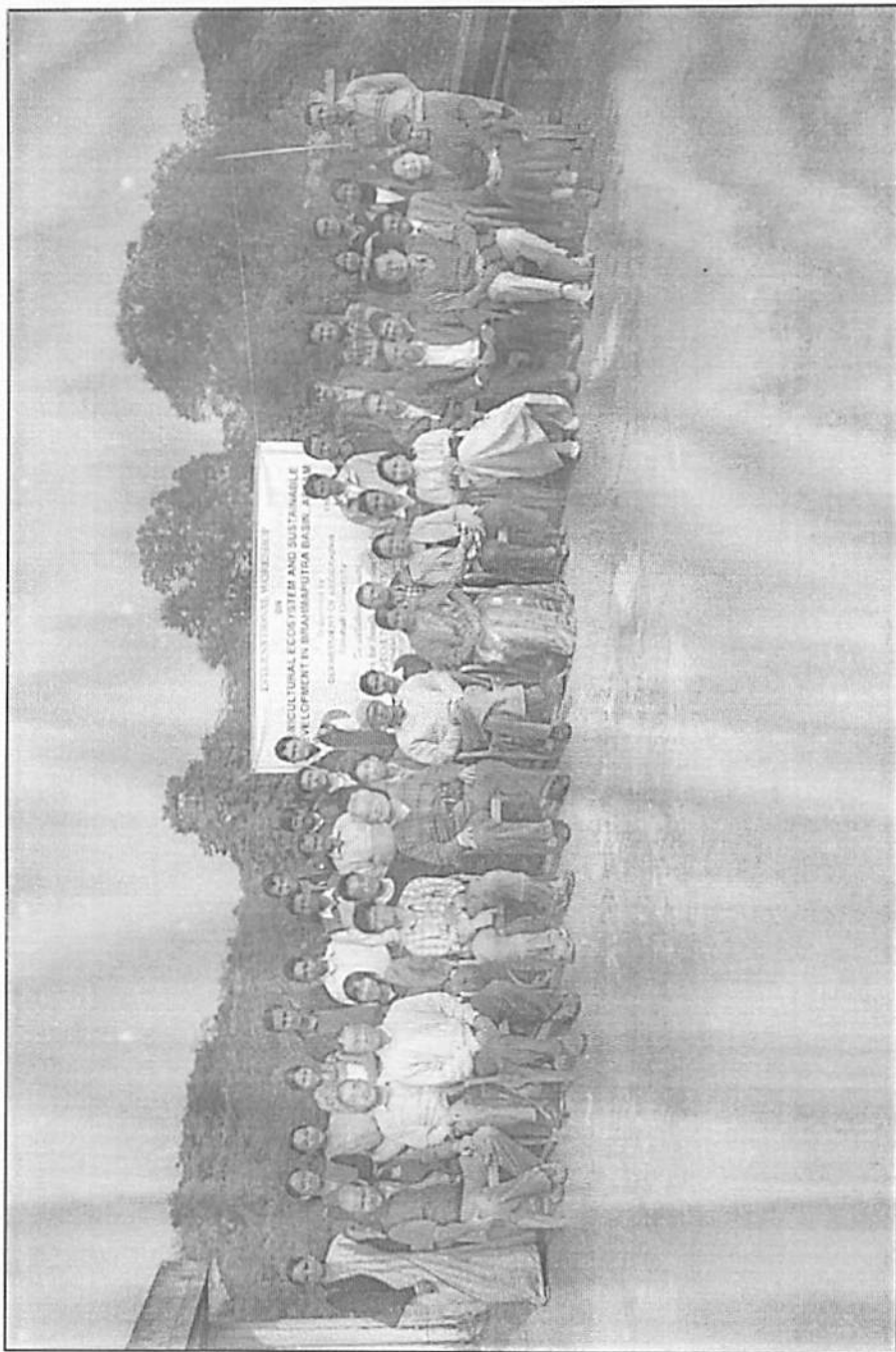
Kaziranga National Park is surrounded by small creeks but not by any fences or borders. People can find animals of the National Park in their village. I also found that the rhinos were mating near the boundary of the park. For the animals, it is easy to cross the creeks. Animals flee from the flooded park to the hill area across the villages in the rainy season. The animals also visit the villages for foraging. The elephant, rhino, wild bow, buffalo, deer and tiger create problems for the farmers around the Park. The herbivorous animals come out and eat the crops of the farmland. The tigers sometimes catch and eat the cows. The elephants and the rhinos come more frequently.

In one case, the elephants came and ate the vegetables of a garden at 2:30 a.m. At that time, an elephant pushed the wall of the house and kicked the mound of the house. They feared that the elephant may attack. They believed that the elephant will get angry if the people make noises and thus they kept silence. The farming family could not do anything against the attack and stayed in the house until the elephant left. The repairing of the house will cost about Rs. 2,000. The officer of the forest department said that they will support some of them. But, it is not sure when and how much they will be paid.

The farmers sometimes prepare watch houses in their farmland. They repelled the animals intruding the farmland. The farmers claim that they took lot of trouble in watching during the cropping season. But, they never kill any animal. Their countermeasure is only repelling the animals with fire and by throwing stones.

Farmers guarding seem to be not so serious. Farmers told about animals and their behavior as follows: It is animal's behavior that they come to eat crops and go back to the park. They do not care for animals visiting their areas. Animals do not live in the forest area. Animals do not belong only to the forest department. They also belong to the villagers. As cows and chickens are the domestic animals, wild animals are also some of their members.

In the market, some cows were walking and foraging on the grains and vegetables that were sold by retailers. When the animal ate those, retailers repelled them. But never chased out seriously. This closely resembles how farmers repel the wild animals that eat crops in the fields. People are familiar with domestic animals in their daily life. The behavior of the wild animals is similar to those of the domesticated ones. These daily experiences may be one possible reason why farmers tolerate the wild animals foraging on their crops.



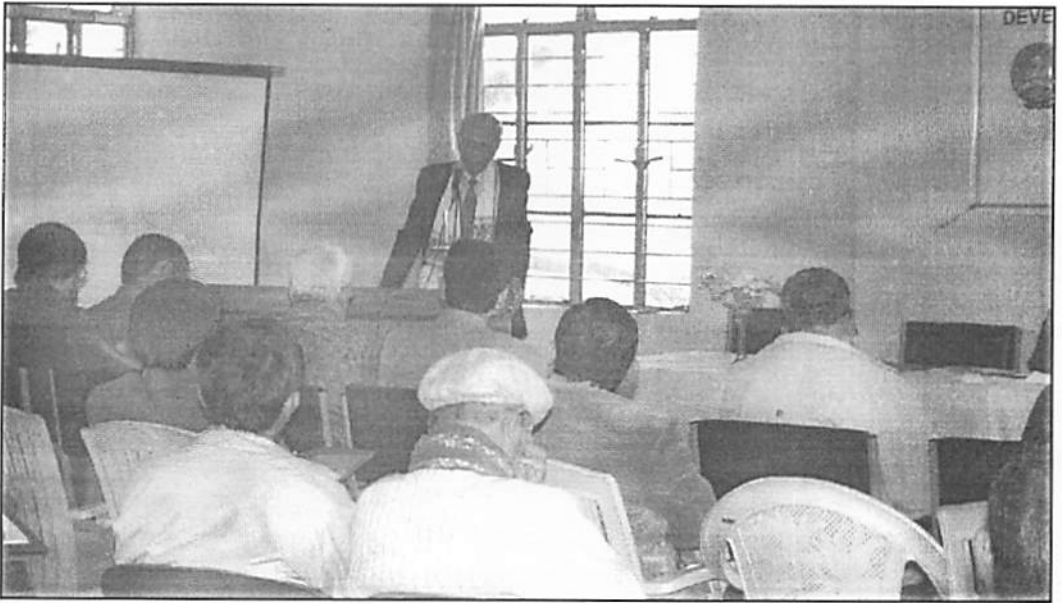
Participants of the workshop



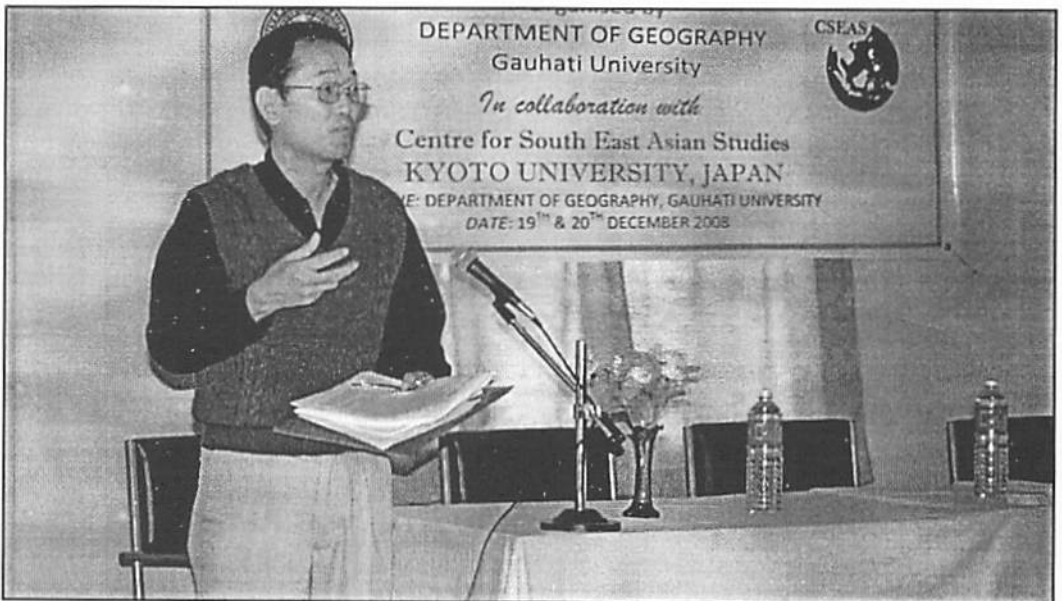
Prof. Medhi, Vice-chancellor delivering the inaugural address



Prof. L. Datta addressing in the inaugural session



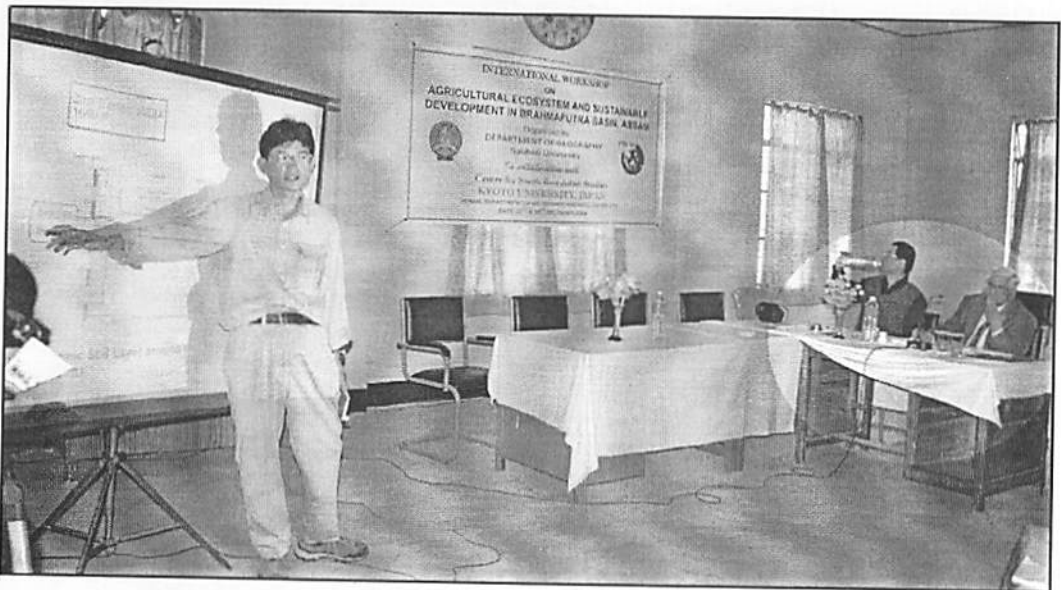
Prof. Taher– addressing as the Guest of Honour



Dr. K. Ando addressing as the co-ordinator of the workshop



A section of the audience



Dr. S. Miyamoto presenting his paper. Prof. H. N. Sharma, Chairman & Dr. K. Ando, Co-chairman are seen in the background



Valediction