FISH BIODIVERSITY AND HABITAT PARAMETERS OF RIVERS AND WETLANDS IN NORTH-EAST INDIA

Devashish Kar

Division of Wetlands, Fisheries Science and Aquaculture
Department of Life Science
Assam (Central) University
Silchar-788 011, Assam.

And

President, Conservation Forum, Silchar - 788 005, Assam
Mobile: 09435070518
E-mail: devashishkar@yahoo.com
www.dkar.000freehosting.com/home.htm

Wetland Panorama

Wetlands

. According to IUCN (1970),..Wetlands are areas of marsh, fen, etc., temporary of permanent; natural or artificial mass of water, the depth of which generally **does not exceed 6 m**

Diversity of Wetlands in South Assam

1.In Assam, and in adjoining Tripura and Bangladesh, three kinds of wetlands are generally found.

2.They are locally called as follows (Kar, 2007):

(a)‘**Beel’**

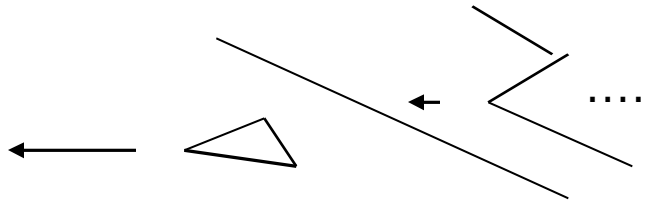
Perennial wetlands which contain water throughout the year

.(b)`**’Haor’**

Seasonal wetlands which contain water for some period of the year only, particularly, during the rainy season. As such, they are also called `floodplain wetlands’.

(c**)‘Anua’**

Peculiar river-formed perennial oxbow-type wetlands which are generally formed due to change in river course and which may or may not retain connection with the original river.



Dolu Lake

This is the Dolu wetland situated along Silchar-Hflong highway. It has a maxmum length and breadth of 2 km and 0.7 km respectively approx. The wetland has the following physico-chemical features of water: (average values):Temp: 12-35 C, pH 6.5-7.4, Turbidity: 20-35 NTU, DO:4.2-5.6 mg/l, FCO2 1.2-3.4 mg/l, TA 72-94 mg/l, Conductivity 110 µmhos/cm. There is not much rich density of AM. However, there is abundant population of *Microcystis* sp and *Closteium* sp. The fishes include mostly the small trash varieties like *Puntius* sp, *Danio* sp, *Macrognathus* sp, etc. This wetland suffers from being not having any big continuous inlet and outlet . Hence, there is not much natural oxygenation of water which often becomes foul.

Rata Beel

This oxbow wetland is situated in the Karimganj district in Assam. It is said to have been formed due to change of the course of the River Barak. Its water properties are pH 6.52., DO 5.5 mg/l, FCO 32 mg/l, TA 50 mg/l, Conductivity 35 micro-mhos/cm, Phosphate 1.25mg/l. Nitrate 0.056 mg/l.

Sagar Beel

This oxbow wetland is situated in the Karimganj district in Assam. It is said to have been formed due to change of the course of the River Barak. Its water properties are pH 5.62, Turbidity 0.5 NTU, DO 4.9 mg/l, FCO 47 mg/l, TA 80 mg/l, Conductivity 22 micro-mhos/cm, Phosphate 0.174 mg/l. Nitrate 0.05 mg/l.

Rani-Meghna Beel

This river-formed oxbow wetland is situated in the Sonai Circle of Cachar district in Assam. It lies in N 24º45' 0.9" E 92º25' 10.9" and has an altitude of 56 ft MSL Its water characteristics are Temp 27 C, Turbidity 17.0 NTU, pH 5.3, DO 5.0 mg/l, FCO 39.0 mg/l, TA 49.0 mg/l and conductivity 23 micromhos/cm, Phosphate 0.522 mg/l, Nitrate 0.12. Now, this wetland is very much choked with *Eichhornia crassipes* and could be said to be in the final stage of succesional series of conversion of wetland into land. It could be an ideal habitat for air breathing fishes.

Dubria Beel

This river-formed oxbow wetland is situated in the Katigarah Circle of Cachar district in Assam. It lies in N 24º49’ 9.9” E 92º41’ 7.7” and has an altitude of 81 ft MSL Its water characteristics are Temp 27C, Turbidity 9.0 NTU, pH 5.1, DO 6.3 mg/l, FCO 59.0 mg/l, TA 34.0 mg/l and conductivity 158 micromhos/cm, Phosphate 0.29 mg/l, Nitrate 0.36.

Angang Beel

This river-formed oxbow wetland is situated in the Cachar district of Assam. It lies in N 24º51’ 3.3” E 92º30’ 0.7” and has an altitude of 85 ft MSL Its water characteristics are Temp 28C, Turbidity 1.0 NTU, pH 5.15, DO 3.95 mg/l, FCO 52.0 mg/l, TA 41.0 mg/l and conductivity 39.0 micromhos/cm, Phosphate 0.28 mg/l, Nitrate 0.192.

Deocherra Beel

This river-formed oxbow wetland is situated in the Cachar district of Assam. It lies in N 24°50’ 52.3” E 92°33’ 44.8” and has an altitude of 34 ft MSL Its water characteristics are Temp 27C, Turbidity 2.0 NTU, pH 5.7, DO 5.2 mg/l, FCO 42.0 mg/l, TA 81.0 mg/l and conductivity 77.0 micromhos/cm, Phosphate 0.232 mg/l, Nitrate 0.15.

Asihali Beel

This wetland is situated in the Hailakandi district of Assam. It lies in N 24º41’5.7” E 92º31’ 17.7” and has an altitude of 30m MSL. Its water characteristics are Temp 29C, Turbidity 308.0 NTU, pH 6.3, DO 7.8 mg/l, FCO 8.0 mg/l, TA 36.0 mg/l and conductivity 63.0 micromhos/cm, Phosphate 0.12 mg/l, Nitrate 0.06.

Korkori Beel

This wetland is situated in the Katigarah Circle of Cachar district of Assam. It lies in N 24º58’ 32.4” E 92º35’ 5.6” and has an altitude of 7 m MSL. Its water characteristics are Temp 27C, Turbidity 41.0 NTU, pH 5.69, DO 6.6mg/l, FCO 8.0 mg/l, TA 16.0 mg/l and conductivity37.0 micromhos/cm, Phosphate 0. 14 mg/l, Nitrate 0.06.

Auti bauti Beel

This wetland is situated in the Katigarah circle of Cachar district of Assam. It lies in N 24º53’ 4 9” E 92º33’ 3.2” and has an altitude of 7m MSL. Its water characteristics are Temp 28C, Turbidity 408.0 NTU, pH 6.44, DO 3.35 mg/l, FCO 11.5 mg/l, TA 26.0 mg/l and conductivity 80.0 micromhos/cm, Phosphate 2.4 mg/l, Nitrate 0.108.

Kuria Beel

This wetland is situated in the Cachar district of Assam. It lies in N 24º55’ 16.8” E 92º36’6.3” and has an altitude of 51m MSL. Its water characteristics are Temp 32C, Turbidity 2.5 NTU, pH 5.72, DO 5.4 mg/l, FCO 7.0 mg/l, TA 30.0 mg/l and conductivity 43.0 micromhos/cm, Phosphate 0.099 mg/l, Nitrate 0.024.

Suska charua Beel

This wetland is situated in the Cachar district of Assam. It lies in N 24º55’ 17.7” E 92º36’17.1” and has an altitude of 11m MSL. Its water characteristics are Temp 32C, Turbidity 34.0 NTU, pH 5.86, DO 5.8 mg/l, FCO 7.0 mg/l, TA 29.0 mg/l and conductivity 45.0 micromhos/cm, Phosphate 0.165 mg/l, Nitrate 0.012.

Talkar Beel

This wetland is situated in the Cachar district of Assam. It lies in N 24º59’ 6.3” E 92º28’23.9” and has an altitude of -1±10m MSL. Its water characteristics are Turbidity 190.5 NTU, pH 4.72, DO 5.6 mg/l, FCO 6.0 mg/l, TA 24.0 mg/l and conductivity 60.0 micromhos/cm, Phosphate 0.165 mg/l, Nitrate 0.06.

Andura Beel

This wetland is situated in the Katigarah circle of Cachar district of Assam. It lies in N 24º56’ 10.5” E 92º35’8.7” and has an altitude of 10±10m MSL. Its water characteristics are Temperature 25 Turbidity 183.0 NTU, pH 4.99, DO 4.6 mg/l, FCO 11.5 mg/l, TA 18.0 mg/l and conductivity 51.0 micromhos/cm, Phosphate 0.165 mg/l, Nitrate 0.036.

Lora Beel

This wetland is situated in the Katigarah circle of Cachar district of Assam. It lies in N 24º55’ 1” E 92º30’37.8” and has an altitude of 6m MSL. Its water characteristics are Temperature 21 Turbidity 90.0 NTU, pH 5.73, DO 4.2mg/l, FCO 9.5 mg/l, TA 45.0 mg/l and conductivity 68.0 micromhos/cm, Phosphate 0.314 mg/l, Nitrate 0.084.

Narapati Beel

This wetland is situated in the Katigarah circle of Cachar district of Assam. It lies in N 24º55’ 39.9” E 92º30’37.1” and has an altitude of 5±10m MSL. Its water characteristics are Temperature 22 Turbidity 33.0 NTU, pH 6.02, DO 2.0 mg/l, FCO 14 mg/l, TA 92.0 mg/l and conductivity 220.0 micromhos/cm, Phosphate 0.594 mg/l, Nitrate 0.06.

Dholi Beel

This wetland is situated in the Katigarah circle of Cachar district of Assam. It lies in N 24º56’ 10.5” E 92º35’8.7” and has an altitude of 10±10m MSL. Its water characteristics are Turbidity 246.0 NTU, pH 6.09, DO 2.45 mg/l, FCO 7.5 mg/l, TA 28.0 mg/l and conductivity 50.0 micromhos/cm, Phosphate 0.15 mg/l, Nitrate 0.06.

Jabda Beel

This wetland is situated in the Katigarah circle of Cachar district of Assam. It lies in N 24º55’ 13.3” E 92º31’56.6” and has an altitude of 5±18m MSL. Its water characteristics are Temperature 25 Turbidity 168.0 NTU, pH 5.24, DO 5.2 mg/l, FCO 8.0 mg/l, TA 31.0 mg/l and conductivity 53.0 micromhos/cm, Phosphate 0.858 mg/l, Nitrate 0.036.

Mohisatal-sundarkuri Beel

This wetland is situated in the Katigarah circle of Cachar district of Assam. It lies in N 24º56’ 0.9” E 92º33’29.1” and has an altitude of 7m MSL. Its water characteristics are Temperature 26 Turbidity 384.0 NTU, pH 4.82, DO 7.0 mg/l, FCO 10.5 mg/l, TA 22.5 mg/l and conductivity 33.0 micromhos/cm, Phosphate 0.99 mg/l, Nitrate 0.036.

Developmental Measures for Beel Fisheries Development in Assam

Assam Govt has recently taken up an ambitious plan and project under the World Bank-aided Assam Agricultural Competitive Project (AACP) for the overall development of the Beels and the fisheries in them. This is a continuation of the earlier similar ARIASP Project. Under AACP, Development of Beel fisheries is one of the Major components. It begins with the following flowchart wise strategies└a) Selection of Beels based on Biodiversity assessment, physico-chemcial characteristics, primary productivity and stock assessment; b) strategies for sustainable management; c) involvement of community; d)deweeding; e)desiltation; f)artificial stocking. These activities would be done following standard guidelines. Before development of a particular Beel, the social, technical and environmental aspects are screened. The legal aspects are also taken care of..The Assam Private Fisheries Protection Act, 1935 is consulted. Generaly closed Beels with strong peripheral embankments and good communication, with 15-20% weeds is considered for development. AACP usually allows provision of construction of Rearing tanks @ Rs 2.10 Lakh/ha (civil work), Rs.0.10 Lakh for fishing nets. Provision of water retaining structure @Rs.0.9-1.54 Lakh/ha is allowed. AACP forms a social group called Beel Development Committee (BDC) under the guidance of Fishery Dept. and the NGOs. Under the BDC, there are: General Bodies (GB), Executive Body (EB) with President, Secretary and Treasurer. BDC's main objectives are: to initiate collective action for better livelihood through sustainable management of the existing beel fisheries resources; also, to increase fish production. AACP will assess: whether the following profit sharing is acceptable to the community people:(a)Fisherment:40%, (b)operating cost for the next year: 25 %, © Community and capital saving : 20%, (d)Maintenance cost: 5 %, (e) Lease value : 10 % These are generally reviewed in community participatory meetings

Chatla Haor

It lies between 93º 15' E and 24º10'N in the Cachar district of Assam. It is one of the biggest floodplain wetland Haors in Assam having an area of 1600 ha at FSL It is major inlet is called River Salganga and its major outlet is called River Ghagra. Its water properties are: Temp.33 C, pH 6.09; Turbidity: 83.27 NTU; FCO_2 7.59 mg/l, TA: 83.39 mg/l; Conductivity: 142.91 micromhos/cm. 57 spp have reported from Chatla. Presence of advanced fry of Hilsa is a remarkable feature indicating possible breeding ground.Cyprinids formed 32% of total fish population.

Bakri Haor

This wetland is situated in the Hailakandi district of Assam. It lies in N 24º48’41.4” E 92º35’ 58.8” and has an altitude of 5m MSL. Its water characteristics are Temp 30C, Turbidity 46.0 NTU, pH 6.5, DO 6.1 mg/l, FCO 6.0 mg/l, TA 48.0 mg/l and conductivity 74.0 micromhos/cm, Phosphate 0.42 mg/l, Nitrate 0.11.

Punir Haor

This wetland is situated in the Cachar district of Assam. It lies in N 24º38’ 33.9” E 92º52’6.3” and has an altitude of -6±13m MSL. Its water characteristics are Temp 28C, Turbidity 588.0 NTU, pH 5.66, DO 2.8 mg/l, FCO 27.0 mg/l, TA 20.0 mg/l and conductivity 250.0 micromhos/cm, Phosphate 0.3 mg/l, Nitrate 0.06.

Other Wetland types: Anuas

1.River-formed oxbow wetland formed by meandering.

2.Plenty of such `Anuas', 10 prominent along Barak

3.Being small and mamageable, many functions:

A.Pisciculure

B.Flood management

C.Tourism

4 **Problem:** Chronic patients of Eutrophication (weeds).

5.**Remedy:** Eradication not very difficult because of small size.

Plate : Satkarakandi Anua at DSL showing infestation with weeds

Satkarakandi Anua

This Anua lies between 92^{o} 52’ 41.6” E and 24^{o}45’ 8.9”N in the Sonai Revenue Circle in the Cachar district of Assam. The wetland has a max L,B and D of *c* 1.75 km, 0.3 km and 3.0 m respectively.The characteristics of its water are temp.26C, pH 5.7, DO 4.95 mg/l, FCO_2 45 mg/l, TA 101 mg/l, Conductivity 49 micro mhos/cm. This wetland is also severely infested with *Eichhornia crassipes* mainly due to eutrophication

Dungripar Anua

This oxbow wetland lies between 24°44’40.9”N and 92° 54’ 53.0”E in the Sonai Revenue Circle of Cachar district in Assam. It is said to be formed only during 1988 due to the change in the course of River Barak around Kaptanpur in Sonai Circle.The characteristics of its water are temp 26 C, turbidity <1.0, pH 7.02, DO 4.55 mg/l, FCO_2 52 mg/l, TA 171 mg/l, Conductivity 102 micro mhos/cm

Rupairbala Anua

This river-formed oxbow wetland is situated in the Sonai Circle of Cachar district in Assam. It lies in N 24º47' 7.9" E 92º55' 23.5" and has an altitude of 158 ft MSL Its water characteristics are Temp 26 C, Turbidity 74.5 NTU, pH 6.4, DO 5.05 mg/l, FCO_2 46.0 mg/l, TA 41.0 mg/l and conductivity 74 micromhos/cm. Now, this wetland is very much choked with *Eichhornia crassipes* and coud be said to be in the final stage of succesional series of conversion of wetland into land. It could be an ideal habitat for air breathing fishes

Algapur Anua

This oxbow wetland lies between 24^{o}46’37.8” N and 92^{o}53’31.0 “ E in the Lakhipur Sub-division in Cachar district of Assam. Its water characteristics are temp 26C, pH 6.1, DO 4.4 mg/l, FCO_2 54 mg/l, TA 187 mg/l and conductivity 96 micromhos/cm

Role of Wetlands

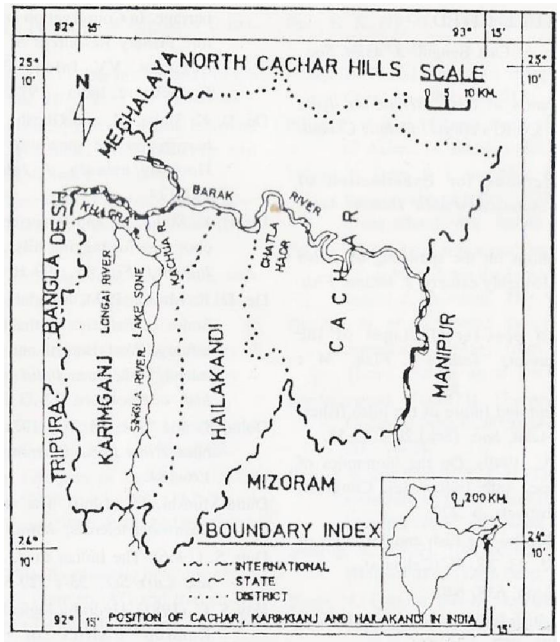
1.Wetlands for **Pisciculture**

2.Wetlands in **Flood Management**

3.Wetlands for **re-habilitation of fishermen**

Sone Beel, the biggest Wetland in Assam

It is situated between 92 o 24’ 50” – 92o 28’ 25 “ E and 24o 36’ 40” – 24o 44’ 30” N within Karimganj district of Assam and falls in a valley geologically called **syncline**, **Miopliocene**



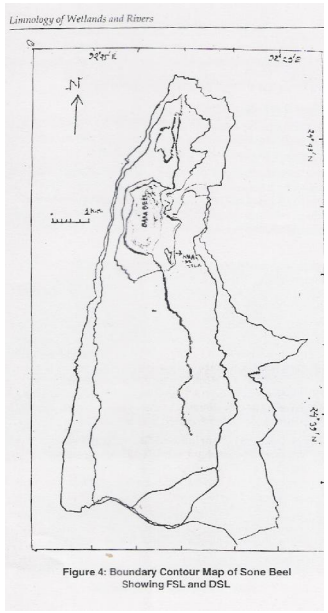


Figure 4: Boundary Contour Map of Sone Beel Showing FSL and DSL

Dimensions of Sone Beel

FSL

1.Maximum length (L)=12.5 km
2.Maximum Breadth (B)=3.9 km of the wetland at Live
3.Area=3458.12 ha
DSL

1.Max L = 4.07 km
2.Max B= 2.22 km
3.Area=409.37 ha

L of Shoreline= 35.4 km

Shore Development= 1.69
Volume Development= 0.15
Mean Depth= 0.29 m
Gross Volume= 101.54 106

Map of Barak valley region of Assam showing distribution of Wetlands

(1= Chatla Haor, 2= Baskandi Anua, 3= Salchapra Anua, 4= Hathichhara Beel, 5= Dolu Beel, 6= Puneer Haor, 7= Rupairbala Anua, 8= Fulbari Anua, 9= Sib Narayanpur Anua, 10= Bakri Haor, 11 Sone Beel, 12= Rata Beel, 13= Sagar Beel. 14= Angang Beel, 15= Tapang Beel, 16= Dubria Beel)

A Vivid example of Wetland shrinkage: Change detection of Sone Beel: 1880-1980-2006

1.Worked on GIS Platform

2.Compared Ground map at FSL of Kar, 1980 with Geo-referenced SOI topomap.

3.Superimposed 2006 LISS IV Satellite imageries.

4.Orange colored region depicts FSL 1880, 6774 ha

5.Blue colour indicates FSL 1980, 3234.4 ha

6.Red colour region portrays DSL2006, 392.4 ha

7.**Hence, within a span of 100 years, there is shrinkage of 3539.6 ha of water area in Sone Beel.**

8.Deforestation, coupled with soil erosion led to very large-scale siltation causing this shrinkage.

9.One can expect further diminution of water area, if siltation continues.

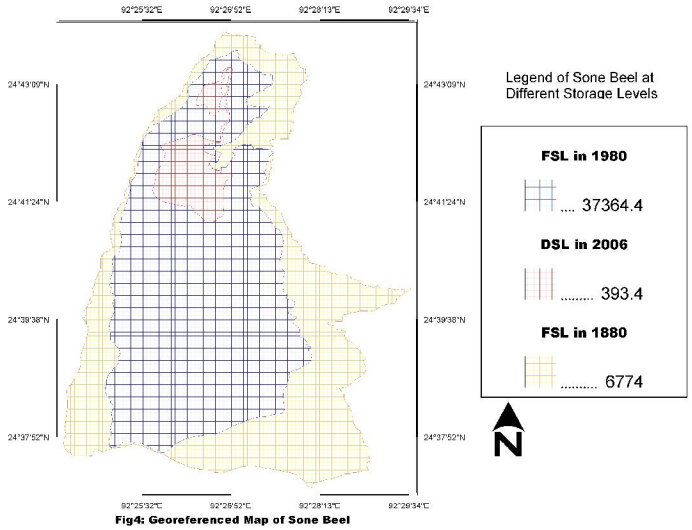


Fig4: Georeferenced Map of Sone Beel
Showing Change Detection of the Wetland from 1880, 1980 to 2006

Hydrodynamics of Sone Beel

1.Major Inlet `Singla' , or `Thing Tlawng Lui', from Mizoram, 72 km., draining catchment 46105 ha; inflow 33.91 m3/sec

2.Major outlet `Kachua' from Sone Beel. 19 km, outflow 87.03 m3/sec

3.`Kachua' was blocked by Assam Govt. with `blind dam' in 1951; then, replaced by a `lockgate' in 1964, which is functional in a nominal way now.

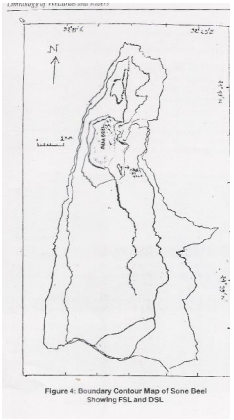


Figure 4: Boundary Contour Map of Sone Beel Showing FSL and DSL

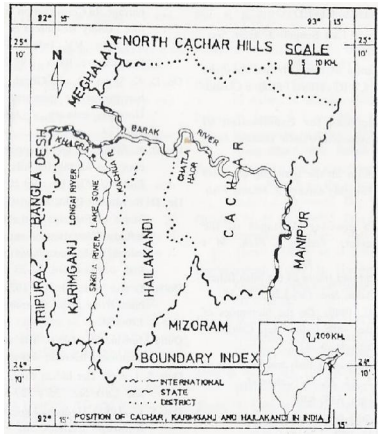


Plate : Blockade of Sone Beel Outlet

Potentialities of Sone Beel

1.Very Big size

2.Continuous inlet, outlet

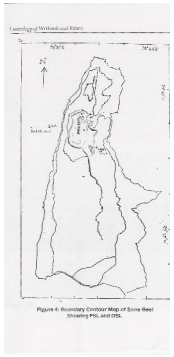
3. High Fish yield, IMC Naturally growing,

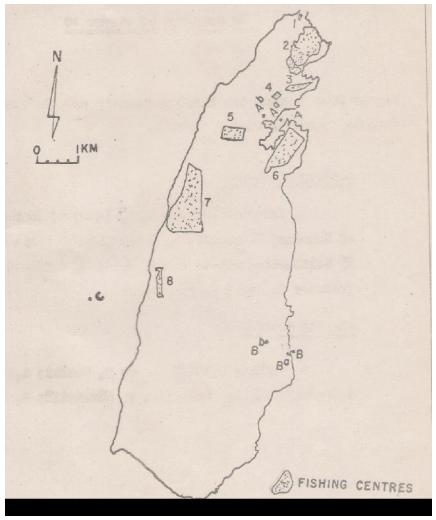
also could be cultured

4.Occurrence of Hilsa

5.Ideal site for rehabilitation

of Fishermen





Major Problems in Sone Beel Wetland

1.Inlet diversification

2.Outlet diversification

3.Outlet blockade

4.Siltation

5.Mahajal operation

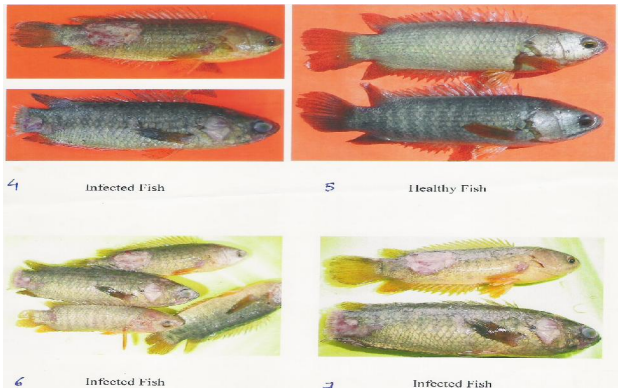
6.Paddy cultivation

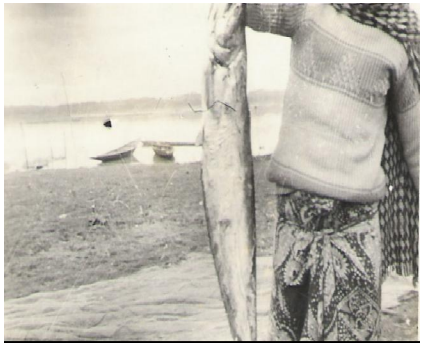
7.Big size carnivorous fishes

8.Availability of Exotic fishes

9.Day-in and day-out fishing operation

10.Fish Disease, particularly EUS





Siltation problem in Sone Beel

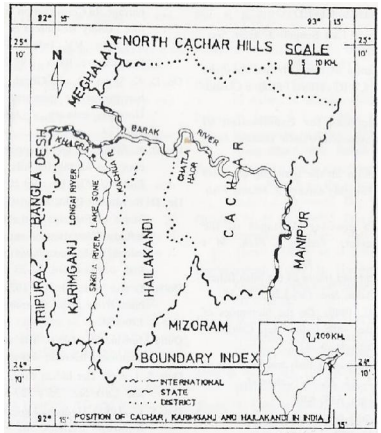
1.Max. silt load of inlet is 350 mg/lit

2.Max silt load of **outlet is 88.1 mg/lit**

3.Thus, more amount of silt is retained and deposited in

Sone Beel. Hence, decreasing depth and water area o

Sone Beel (Dey & Kar, 1987).



Management aspects of Sone Beel: a Case Study and Suggested Remedies

1.At DSL (Nov-Apr), Sone Beel has 8 deep **`Fishing Centres' (`Bundhs'),** 5 to 200 ha, 1 to 1.75 m depth.

2.**Now**, only **`capture' fishing** goes-on in bundhs.

3.**Pisciculture** would enhance **FY**, generate **jobs** & **income**, check **exodus** and **conserve** `Fishermen' as `Fishermen'.

4.Part of cultured fish be sold as **earning**, rest be released into Beel to **replenish** stock.

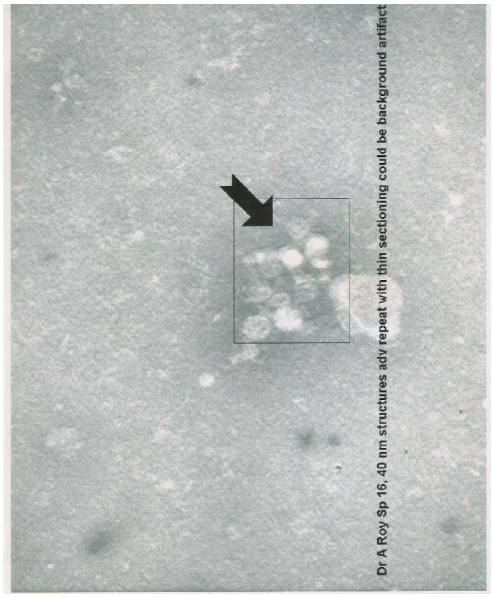
5.Only thing is that the Sone Beel has to be leased-out to the **SB Co-op Soc** which can further earn through **tolls** @:

(a)Rs 1.00/kg caught by per fisherman

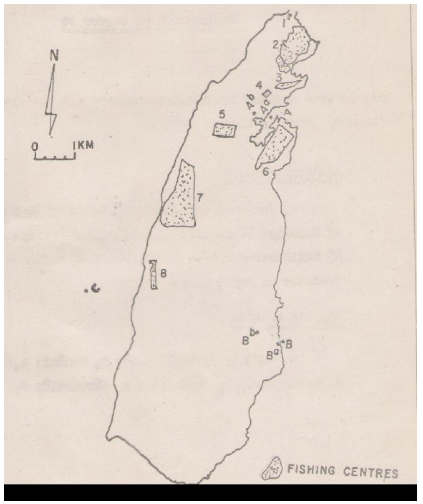
(b)Rs 2.00/kg bought by per fish trader

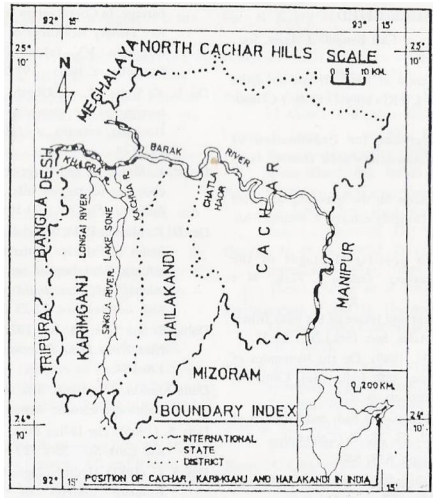
This **regulated** fish catch and purchase will **stop** over-exploitation

6.**Siltation** control by check dams, **encroachment** control by `Patta' and **`EUS'** be controlled



EUS fish virus under E/M





EPIZOOTIC ULCERATIVE SYNDROME

Aetiological studies

Bacteria

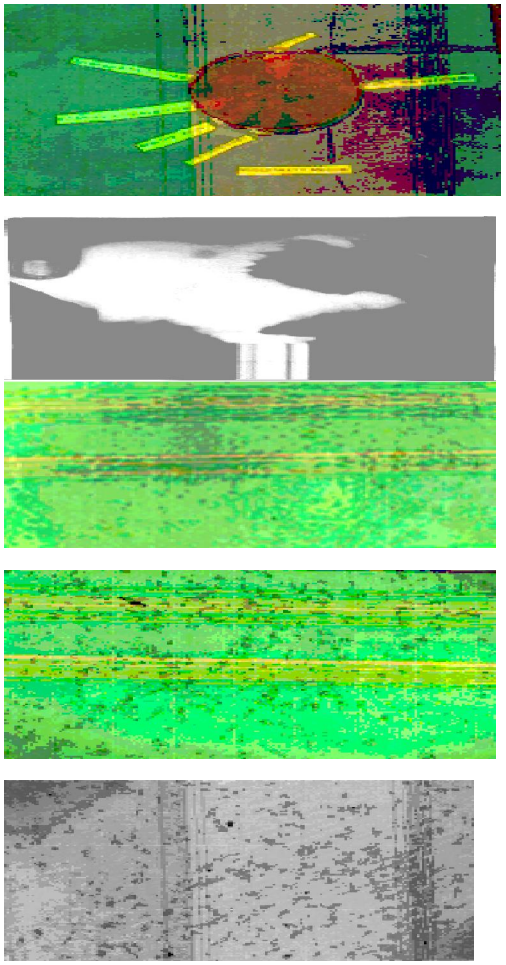
Regular isolation of bacterial flora from the surface lesion of EUS-affected fishes, as well as, from their muscles, gut, liver,gills, heart, kidney and gonads revealed the occurrence of haemolytic strains *Escherichia coli, Aeromonas hydrophila, Pseudomonas aeruginosa, Staphylococcus epidermitis* and *Klebsiella* sp. All these bacteria have been found to be sensitive to Chloramphenicol,Septran, Streptomycin, Gentamycin, Norfloxacin and so on (Kar et al., 1999 a).Guineapig showed no infection

after inoculation of microbes.

Virus

Absence of haemorrhagic septicaimia (which is so characteristic of *Aeroomonas* infection) in all but most of the ulcerated fish (Roberts et al., 1989); non-occurrence of these pathogens in the early part of the disease (lilley et al., 1992); as well as, close association of these bacteria with the fishes in water since time immemorial (Kar and Dey, 1990 b); suggests that, *A. hydrohila* is unlikely to have any primary infective role in the pathogenesis of EUS. And, a primary `viral' (?) aetiology has always been suspected to be associated with the initiation of EUS (FAO, 1986; Kar et al., 1990 a).

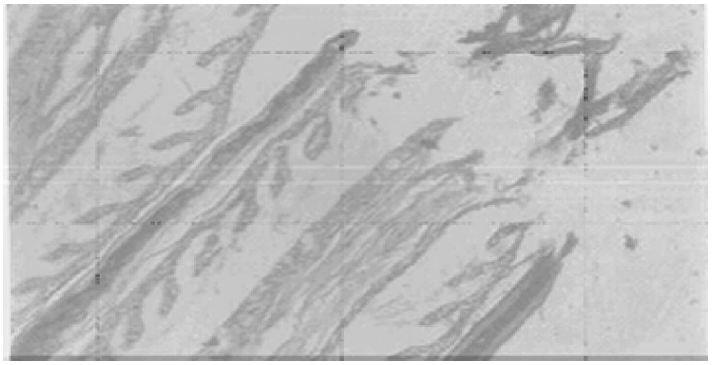
As a cinfirmation for the presence of virus in the EUS-affected tissues, in our studies, using BF2 fish cell line in tissue culture and infecting the growing cells with filtrate from homogenised tissue of ulcerated *Clarias batrachus,* a progressive CPE was noticed even at a dilution of 10 of a 10 % tissue homogenate. The infection was passable in the subsequent cultures

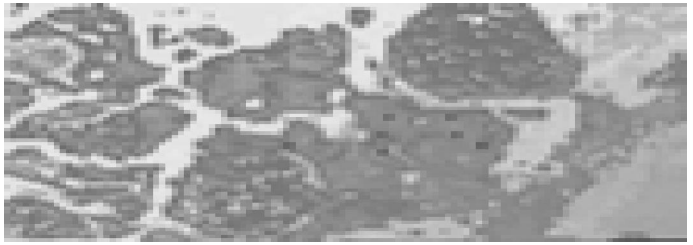


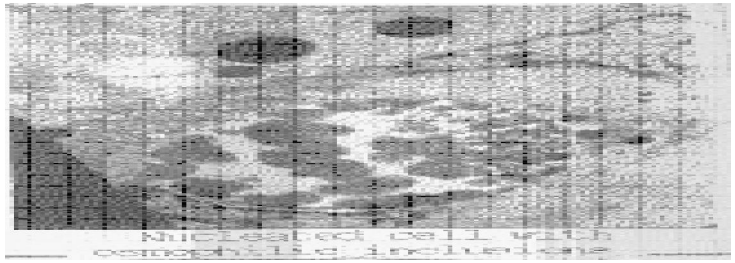
EPIZOOTIC ULCERATIVE SYNDROME

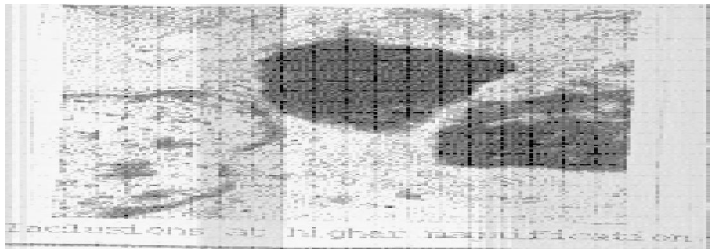
Electron Microscopic studies

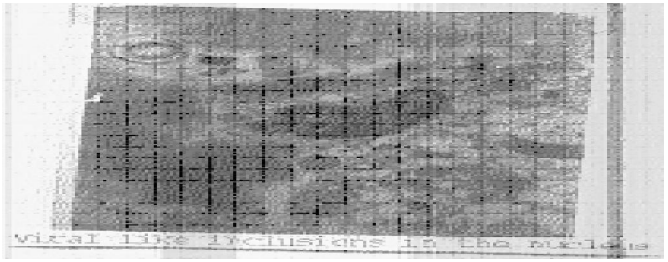
Detailed EM studies done with the ultrathin sections of EUS-affected fish tissues revealed membrane-bound and granular abnormal structures; hepatocytes with vacuolations; and, virus-like inclusion bodies in the nucleus. Further works in this direction are being conducted.











Fungi

Kar et al (1999 b) isolated *Aspergillus* sp from diseased fishes in Assam. Subsequently, Kar et al (2000 a) also isolated *Aphanomyces* sp. From the EUS-affected fish tissues. However., Fungi may not be considered as the primary aetiology in view of the fact that they have always been associated with fishes in water without generally causing any harm.

EPIZOOTIC ULCERATIVE SYNDROME

Cntrol of EUS

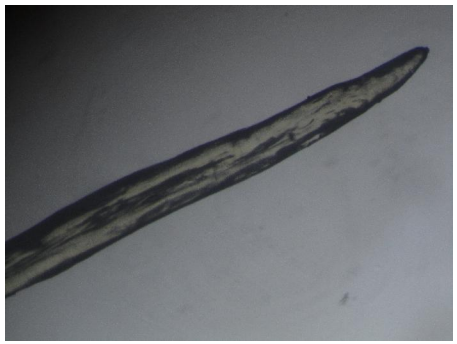
Effctive control and treatment of EUS is a major problem today because the primary pathogen has not yet been identified.

Control of EUS in large natural water bodies is, perhaps, impossble. However, in view of the fact that, TA of water acts as a predisposing `stress' factor, application of lime in low alkaline water bodies, helps to control the spread of EUS .

Definition of EUS

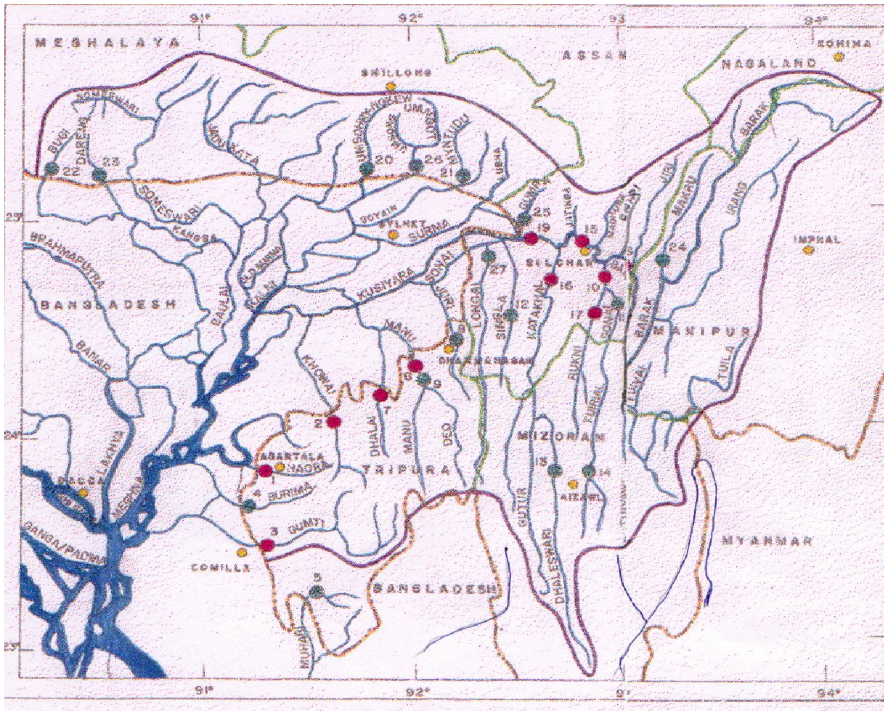
EUS today is a semi-global problem among the freshwater fishes. Unfortunately, in view of its complex infectious aetiology, it is yet to be accurately defined (OIE, 1997).

Fish Parasites of Awangsoi Lake in Manipur

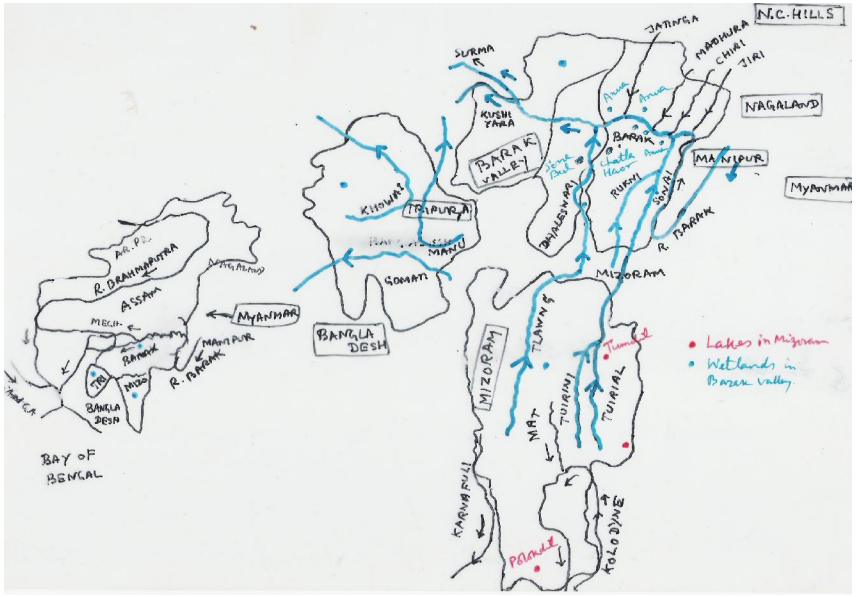


Fish Parasites of Utra Lake in Manipur

River Network of North-East India



River Network of North-East India (Diagrammatic)



Principal Rivers in North-East India studied by Kar *et al.*: 48 rivers

Assam : Brahmaputra drainage: Brahmaputra, Kopili, Dhansiri, Puthimari,Manas,Beki : 6

Barak drainage: Barak, Jiri,Chiri,Madhura,Jatinga, Ghagra,Sonai,Rukni,Dhaleswari,Baleswar,Surma, Kushiara,Singla,Longai:14

Mizoram: Tuirial, Tlwang, Tuirini, Tuivai, Mat, Kolodyne, Tuichong, Karnafuli, Serlui: 9

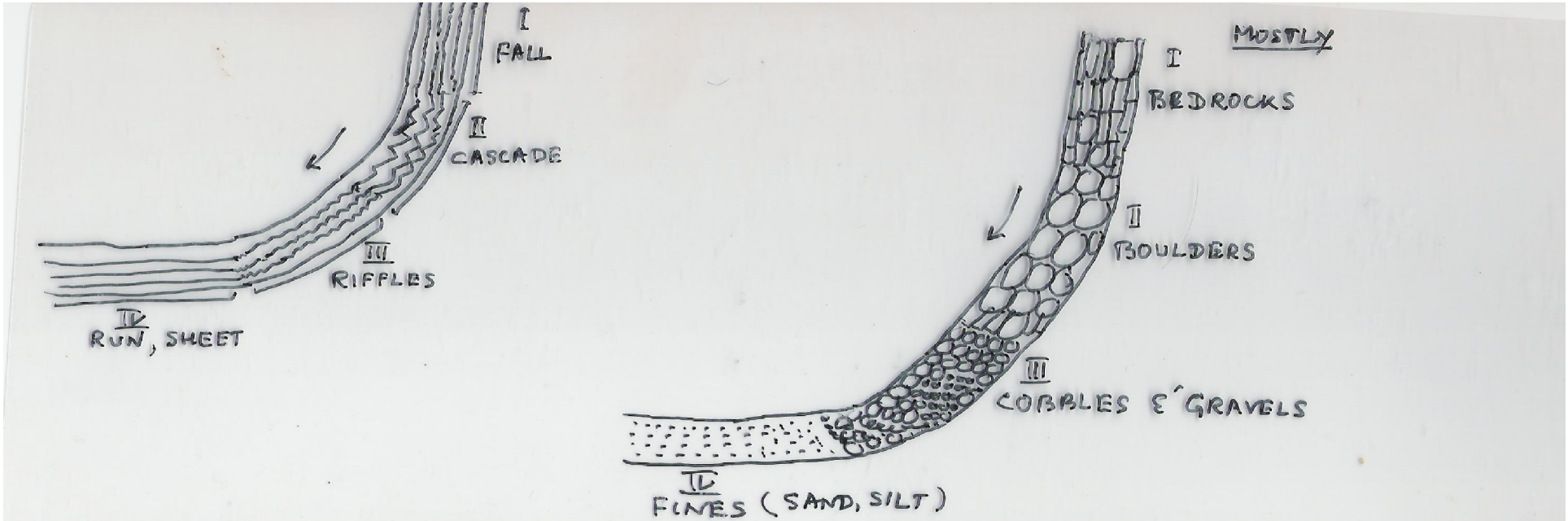
Tripura: Deo, Monu, Dholai. Khowai, Haora, Gomati, Muhuri, Feni: 8

Manipur: Barak, Nambul, Imphal, Irang, Thaobal, Iril, Leitang (Ukhrul), Lokchao, Khujailok: 9

Nagaland: Chate: 1

Arunachal Pradesh: Subansiri : 1

Diagram of Micro-Habitat, Substratum & Fish Diversity of N.E. Rivers



PRINCIPAL FISH SPECIES (GENERALLY OCCURRING)

I. FALL
MAINLY:
1. BALITORA SP.
2. SCHISTURA SPP.
3. ERETHISTES SP
4. GLYPTOTHORAX SPP.
5. GARRA SPP.

II. CASCADE
MAINLY:
1. BARILIUS SPP.
2. GARRA SPP.
3. TOR SPP
4. NEOLISSOCHILUS SP.
5. CROSSOCHEILUS SPP.
6. PSILORHYNCHUS SPP.
7. GLYPTOTHORAX SPP.
8. LABEO PANGUSIA
9. OLYRA SP.

III. RIFFLES (& POOLS)
MAINLY:
1. BARILIUS SPP.
2. DANIO AEQUIPINNATUS
3. DANIO NAGANENSIS
4. TOR SPP.
5. CROSSOCHEILUS SPP.
6. NEOLISSOCHILUS SP.
7. GARRA SPP.
8. BOTIA SPP
9. NOEMACHEILUS SPP.
10. ACANTHOCOBITIS SPP.
11. GAGATA SPP.
12. NANGRA SPP.

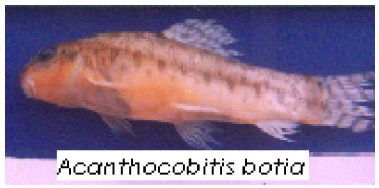
IV. RUN, SHEE
ALL OTHE
SPECIES

Habitat and Fishes of River Barak in Assam

Erethestes pussilus

Osteobrama cotio

Chacca chacca



Acanthocobitis botia

Botia dario

Chela laubuca

1. Valley segment :	Alluvial
2. Stream order :	Fourth
3. Reach type :	Regime
4. Geographical possition :	N 24 43 34 E 93 4 21 Alt.32 m
5. CGU microhabitat type	Run, Backwater pool
6. Channel bankful width	200 m(in average)
7. Bankful depth :	20m (in average)
8. Wetted width :	130m (in average)
9. Wetted depth :	14m (in average)
10. Fish cover type :	Depth cover,Turbulence cover.
11.Substrate type :	Fines and bedrock
12.Riparian type :	Mesoriparian
13. Riparian vegetation type :	Grass, Shurbs and Tea garden
14. Riparian land use pattern :	Human habitation
15. Signs of erosion :	Visible

Habitat and Fishes of River Jatinga in Assam

1. Valley segment :	Alluvial
2. Stream order :	Fourth
3. Reach type :	Pool- Riffle
4. Geographical possition :	N 24 57 55 E 92 45 42 Alt. 86 m
5. CGU microhabitat type	Riffle, Run, Trench pool
6. Channel bankful width	130m (in average)
7. Bankful depth :	10 m (in average)
8. Wetted width :	55m (in average)
9. Wetted depth :	1.2m (in average)
10. Fish cover type :	Undercut bedrock,Bottom free big boulder
11.Substrate type :	Gravels, Cobbles,Bedrocks
12.Riparian type :	Mesoriparian
13. Riparian vegetation type :	Deciduous trees, Shrubs and grasses
14. Riparian land use pattem :	Highway, Human habitation
15. Signs of erosion :	Visible

Habitat and Fishes of River Sonai in Assam

1. Valley segment :	Alluvial
2. Stream order :	Third order
3. Reach type :	Regime
4. Geographical possition :	N 24 34 39 E 92 57 24 Alt.37 m
5. CGU microhabitat type	Run, Trench pool
6. Channel bankful width	130 m (in average)
7. Bankful depth :	8m (in average)
8. Wetted width :	50m (in average)
9. Wetted depth :	2.9m 9in average)
10. Fish cover type :	Overhanging vegetation, Turbulence and depth
11. Substrate type :	Fines and silt
12. Riparian type :	Mesoriparian
13. Riparian vegetation type :	Grass, Shurbs, Coniferous tree
14. Riparian land use pattem :	Human habitation and Agriculture
15. Signs of erosion :	Visible

Habitat and Fishes of River Dhaleswari in Assam

1. Valley segment :	Alluvial
2. Stream order :	Third order
3. Reach type :	Braided
4. Geographical position :	N 23 48 36 E 92 39 10 Alt. 66 m
5. CGU microhabitat type	Riffle, Run
6. Channel bankful width	150 m(in average)
7. Bankful depth :	15 m (in average)
8. Wetted width :	80 m (in average)
9. Wetted depth :	2m (in average)
10. Fish cover type :	Undercut bank, Turbulence and Depth cover
11. Substrate type :	Gravels and cobbles
12. Riparian type :	Mesoriparian
13. Riparian vegetation type :	Grass abd Shurbs
14. Riparian land use pattern :	Agriculture and Human habitation
15. Signs of erosion :	Visible

Water chemistry and Fishes of River Jiri in Assam

This river is originated in the Province of Assam. The study site lies in N 24º47' 45.5" E 92º54' 27.1" and has an altitude of 46 ft MSL Its water characteristics are Temp 24C, Turbidity 44.0 NTU, pH 6.83, DO 6.1 mg/l, FCO 9.0 mg/l, TA 54.5 mg/l and conductivity 88 micromhos/cm, Phosphate 0.462 mg/l, Nitrate 0.072.

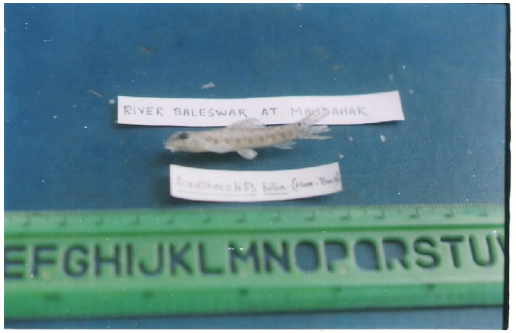
Habitat and Fishes of River Chiri in Assam

Micro-habitat type: Mainly Runs

Substrate types: Mostly sand, silt

Cover type: Mainly pools in some regions

Habitat and Fishes of River Baleswar in Assam



Microhabitat: Riffles, run

Substrate : Boulders, fines

Cover type: Bottom-free boulders, turbidity

Habitat and Fishes of River Rukni in Assam

Micro-habitat: Maily run

Substrate: Mainly fines

Cover type: Mainly turbidity

Water chemistry and Fishes of River Singla in Assam

This river is originated in the Province of Assam. The study site lies in N 24°47' 45.5" E 92°54' 27.1" and has an altitude of 46 ft MSL Its water characteristics are Temp 24C, Turbidity 17.0 NTU, pH 6.43, DO 6.43 mg/l, FCO 10.0 mg/l, TA 52 mg/l and conductivity 183 micromhos/cm, Phosphate 0.35 mg/l, Nitrate 0.112.

Water chemistry and Fishes of River Longai in Assam

This river is originated in the Province of Assam. The study site lies in N 24°47’ 45.5” E 92°54’ 27.1” and has an altitude of 46 ft MSL Its water characteristics are Temp 24C, Turbidity 472.0 NTU, pH 7.16, DO 7.3 mg/l, FCO 9.0 mg/l, TA 69.0 mg/l and conductivity 114 micromhos/cm, Phosphate 0.24 mg/l, Nitrate 0.06.

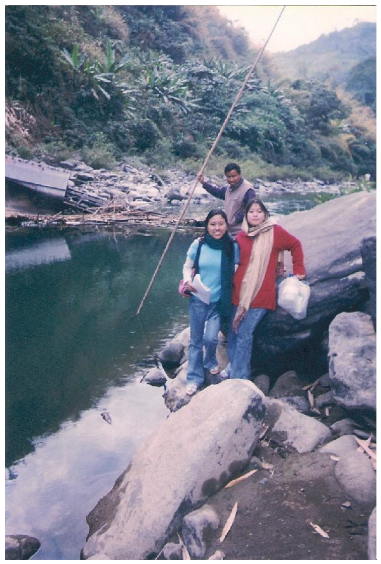
Water chemistry and Fishes of River Brahmaputra in Assam

This river is originated in the Province of Assam. The study site lies in N 24°47’ 45.5” E 92°54’ 27.1” and has an altitude of 46 ft MSL Its water characteristics are Temp 24C, Turbidity 397 NTU, pH 7.33, DO 7.1 mg/l, FCO 12.0 mg/l, TA 113.0 mg/l and conductivity 200 micromhos/cm, Phosphate 0.3 mg/l, Nitrate 0.07.

Water chemistry and Fishes of River Kopili in Assam

This river is originated in the Province of Assam. The study site is near to Panimur, lies in N 25º43' 24.2" E 92º49' 25.8" and has an altitude of 193 m MSL Its water characteristics are Temp 16C, Turbidity 59.5 NTU, pH 6.33, DO 3.0 mg/l, FCO 10.0 mg/l, TA 100.5 mg/l and conductivity 220 micromhos/cm, Phosphate 0.35 mg/l, Nitrate 0.192.

Water chemistry and Fishes of River Irang in Manipur



This river is originated in the Province of Manipur. The study site lies in N 24^{o}47’ 45.5” E 92^{o}54’ 27.1” and has an altitude of 46 ft MSL Its water characteristics are Temp 24C, Turbidity 4.5 NTU, pH 7.59, DO 6.6 mg/l, FCO 7.0 mg/l, TA 80.5 mg/l and conductivity 143 micromhos/cm, Phosphate 0.30 mg/l, Nitrate 0.084.

Water chemistry and Fishes of River Luva in Meghalaya

This river is originated in the Province of Meghalaya. The study site is near Sonapur bridge that lies in N 24°47’ 45.5” E 92°54’ 27.1” and has an altitude of 46 ft MSL Its water characteristics are Temp 28C, Turbidity 4.0 NTU, pH 6.19, DO 8.55 mg/l, FCO 35.0 mg/l, TA 99.0 mg/l and conductivity 280 micromhos/cm, Phosphate 0.30 mg/l, Nitrate 0.09.

Habitat and Fishes of River Tuirial in Mizoram

1. Valley segment :	Alluvial
2. Stream order :	Third order
3. Reach type :	Pool-Riffle
4. Geographical possition :	N 23 42 57 E 92 48 9 Alt. 275 m
5. CGU microhabitat type	Riffle, Dammed pool and Run
6. Channel bankful width	110 m (in average)
7. Bankful depth :	20 m (in average)
8. Wetted width :	50 m (in average)
9. Wetted depth :	1.5 m (in average)
10. Fish cover type :	Overhanging vegetation, Bottom free big boulders and Undercut bank
11. Substrate type :	Gravels, Cobbles and Boulders
12. Riparian type :	Mesoriparian
13. Riparian vegetation type :	Teak plantation and Shurbs
14. Riparian land use pattern :	Agriculture and Human habitation
15. Signs of erosion :	Visible

Habitat and Fishes of River Tuirini in Mizoram

Micro-habitat type: Rifflem run

Substrate types: Some boulders, fines

Cover type: Mainly depth

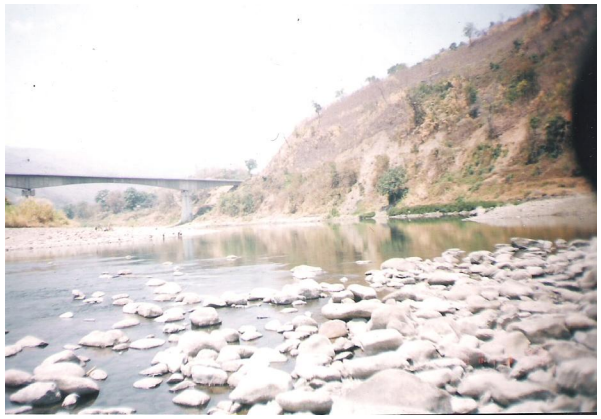
Habitat and Fishes of River Mat in Mizoram

Micro-habitat: Mainly Cascade, riffles, pools

Substrate: Bedrocks, Boulders,cobbles

Cover type: Overhanging vegetation, bottom-free boulders

Habitat and Fishes of River Kolodyne in Mizoram



Micro-habitat: Riffle-pools, run

Substrate: Bedrocks, boulders, cobbles, gravels

Cover type: Depth. Undercut banks, bottom-free big boulders

Habitat and Fishes of River Karnafuli in Mizoram

Micro-habitat: Riffles, pools mainly

Substrate type: Bedrocks, boulders, fines

Cover type: Depth, turbidity

Water chemistry and Fishes of River Tuivai in Mizoram

This river is originated in the Province of Mizoram. The study site is near Mat bridge that lies in N 24°47' 45.5" E 92°54' 27.1" and has an altitude of 46 ft MSL Its water characteristics are Temp 24C, Turbidity 83 NTU, pH 5.85, DO 6.1 mg/l, FCO 46.0 mg/l, TA 190 mg/l and conductivity 155 micromhos/cm, Phosphate 0.30 mg/l, Nitrate 0.07.

Habitat and Fishes of River Gomati in Tripura

1. Valley segment :	Alluvial
2. Stream order :	Third order
3. Reach type :	Regime
4. Geographical possition :	N 23 30 59 E 91 39 48 Alt. 42m
5. CGU microhabitat type	Dammed pool, Eddy pool, Run
6. Char >ankful width	180m (in average)
7. Bankful depth :	14m (in average)
8. Wetted width :	80 m (in average)
9. Wetted depth :	6 m (in average)
10. Fish cover type :	Floating vegetation 20%, Small woody debris 3%, Overhanging egetation 2%, Depth 25%.
11.Substrate type :	Fines.
12.Riparian type :	Mesoriparian
13. Riparian vegetation type :	Grass, Shurbs, Trees.
14. Riparian land use pattern :	Huma habitation, Protect ed forest, Agriculture.
15. Signs of erosion :	Visible

Habitat and Fishes of River Manu in Tripura

Micro-habitat type: Mainly run, sometimes riffle, pools

Substrate: Mainly fines; sometimes boulders and cobbles, gravels

Cover type: Mainly overhanging vegetation

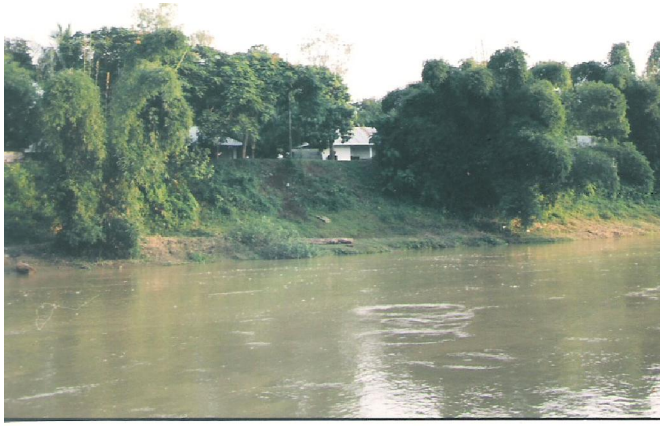
Habitat and Fishes of River Khowai in Tripura

Micro-habitat type: run, sometimes riffles

Substrate type: Mainly fines; sometimes boulders and cobbles

Cover type: Overhanging vegetation and depth

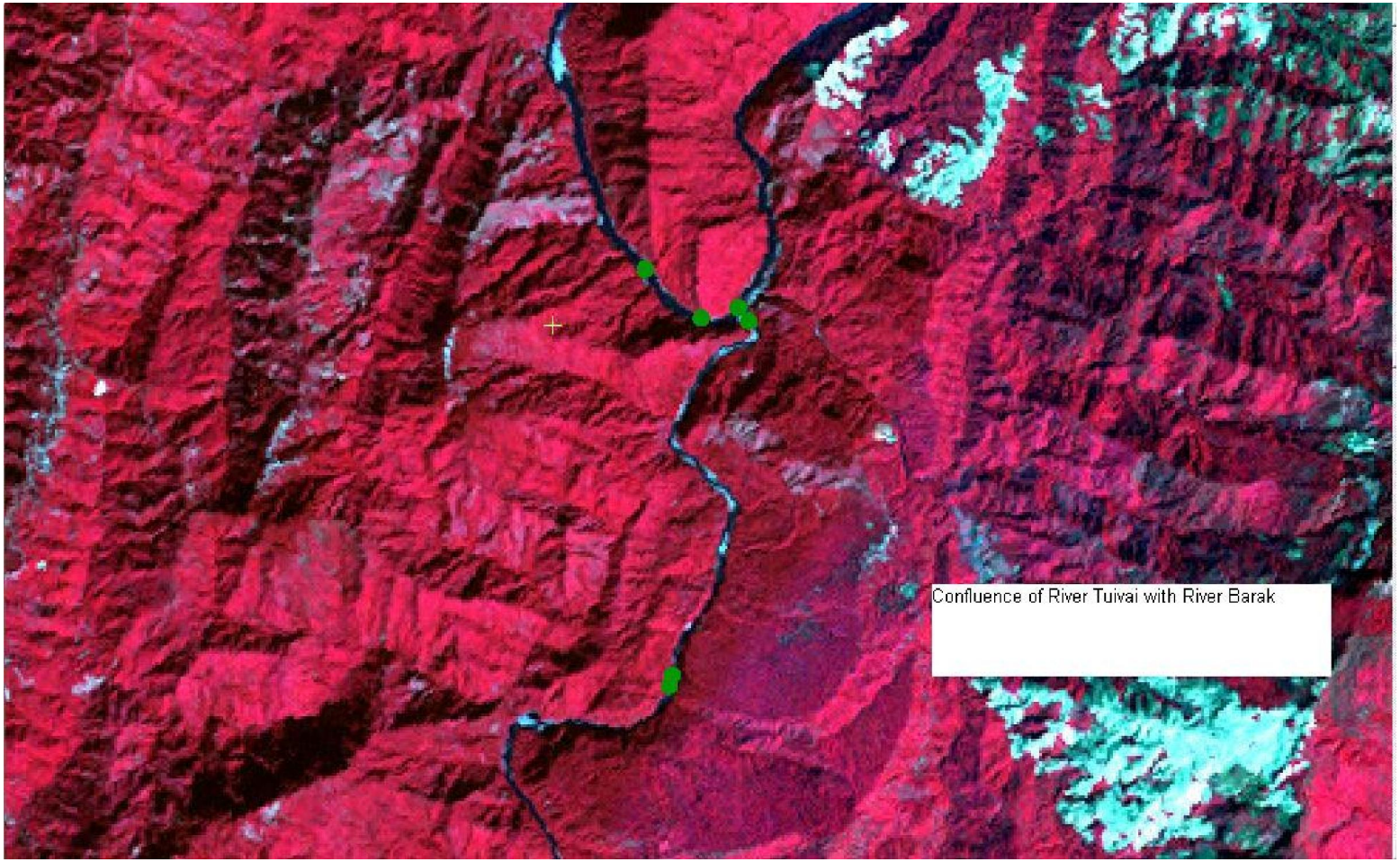
Habitat and Fishes of River Feni in Tripura

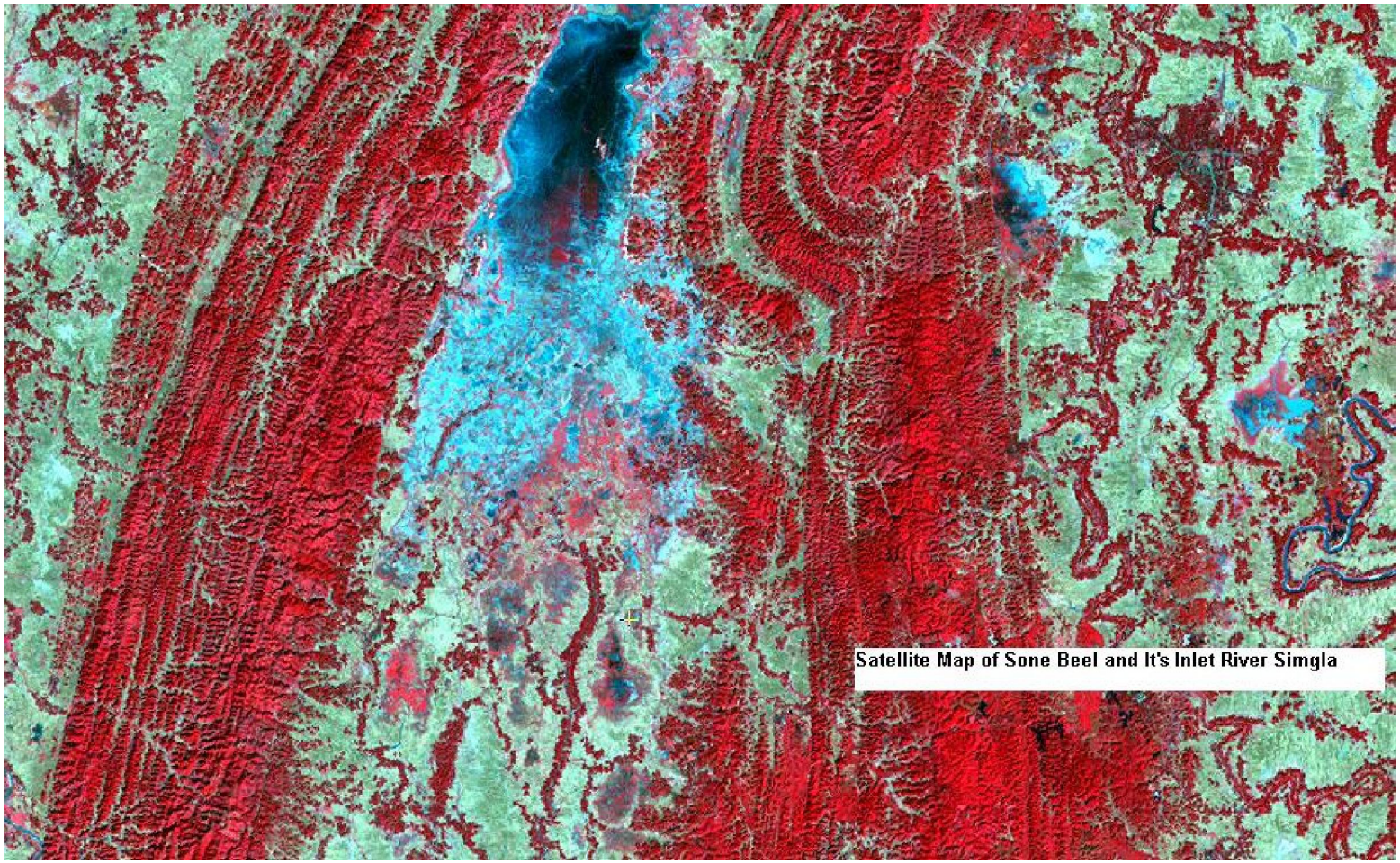


Micro-habitat type: Mainly run

Substrate type: Mainly runs

Cover type: Mainly turbidity


Confluence of River Tuivai with River Barak


Satellite Map of Sone Beel and It's Inlet River Simgla

At first, the topographic maps (1970-71)of the study sites, i.e., the upstream region of river Barak are georeferenced using Geomatica software versopm 10.1. The maps have then been mosaiced to create the base map and clipped to the required size (Fig.1).

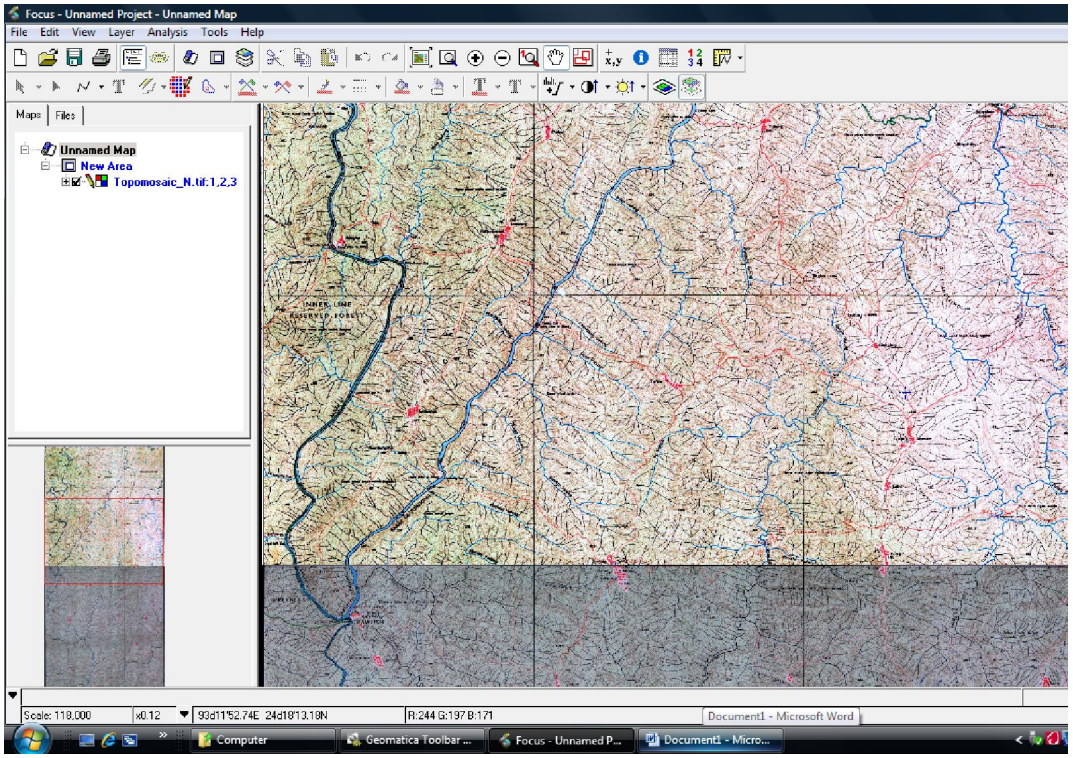


Fig. 1: Georeferenced and mosaiced topographic map of the study site.

The vector layers of the course of River Barak have been digitised from both the topographic map (blue line) and satellite imagery (red line) separately in order to display the change detection (Fig. 3).

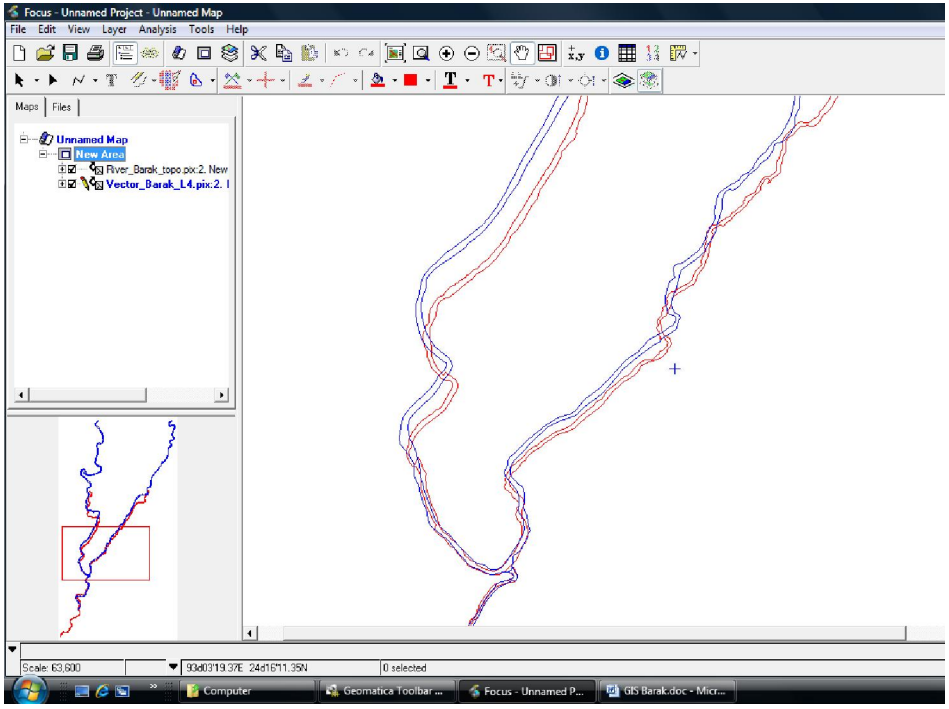


Fig. 3: Digitized vector layers of river Barak from topographic map (blue line) & satellite imagery (red line) to display`change detection'

Table Ichthyospecies assemblage and distribution in Barak, Mizoram and Tripura drainages

Ichthyospecies	Ba	Ji	Ma	Ja	So	Ru	Dh	Bl	Tu	Se	Tl	Tv	Mt	Ko	Ka	Mn	Kh	Go	Fe
1. *Notoptenus notoptenus*(Pallas)	+	+	+			+	+				+	+			+				
2. *Chitala chitala*(Ham-Buch)	+																	+	
3. *Pisodonophis boro*(Ham-Buch)	+																		
4. *Hilsa(Tenualosa)ilisa*(Ham_Buch)	+			+			+											+	
5. *Gudusia chapra* (Ham-Buch)	+			+			+								+				
6. *Securicula gora* (Ham-Buch)	+			+	+		+			+	+	+			+		+	+	
7. *Salmostoma bacaila* (Ham-Buch	+			+	+		+	+			+	+			+		+	+	
8. *Salmostoma phulo* (Ham-Buch)												+							
9. *Salmostoma sardinella* (Val.)													+						
10. *Aspidoparia morar*(Ham-Buch)	+			+	+		+			+				+		+	+	+	
12. *Barilius barila* (Ham-Buch)	+			+	+											+			
13. *Barilius barna* (Ham-Buch)	+		+	+					+		+							+	
14. *Barilius barnoides* (Vinciguerra)					+				+			+	+				+		
15. *Barilius bendelisis*(Ham-Buch)				+	+				+		+						+		
16. *Barilius dogarsinghi* Hora	+			+	+														
17. *Barilius dimorphicus* Tilak & Hussain																		+	
18. *Barilius shacra* (Ham-Buch)					+			+	+	+		+		+		+		+	
19. *Barilius tileo*(Ham-Buch)				+	+		+	+	+	+		+							
20. *Barilius vagra vagra*(Ham-Buch)				+	+		+	+	+		+		+		+			+	
21. *Chela laubuca* (Ham-Buch)	+	+			+		+			+				+				+	
22. *Esomus danricus* (Ham-Buch)	+						+				+		+					+	
23. *Danio aequipinnatus* (McClelland)	+			+	+			+	+				+						
24. *Danio annandalei*(Choudhuri)																	+		
25. *Danio devario*(Ham-Buch)				+															
26. *Danio naganensis* Choudhuri				+	+				+				+	+	+	+	+		
27. *Amblypharyngodon mola* (Ham-Buch)	+			+	+		+											+	
28. *Tor masal* (Ham-Buch)					+							+		+					

Abbrvs.: Ba=Barak, Ji=Jiri, Ma=Madhura, Jn=Jatinga, So=Sonai, Ru=Rukni, Dh=Dhaleswari, Bl= Baleswar; Tu=Tuirial, Se=Serlui, Tl=Tlawng, Tv=Tuivai, Mt=Mat, Ko=Kolodyne, Ka=Karnafuli; Mn=Manu, Kh=Khowai Go=Gomati, Fe=Feni

29. *Tor progenius* (McClelland)				+															
30. *Tor tor* (Ham-Buch)													+						
31. *Neolissochilus hexagonolepis* (McClelland)	+			+	+		+	+	+	+			+	+		+		+	
32. *Neolissochilus blythi* (Day)													+						
33. *Osteobrama cotio cotio* (Ham-Buch)	+	+					+	+						+	+				
34. *Chagunius chagunio* (Ham-Buch)												+							
35. *Puntius chola* (Ham-Buch)	+			+						+						+	+	+	
36. *Puntius clavatus clavatus* (McClelland)												+							
37. *Puntius conchonius* (Ham-Buch)	+	+		+	+		+		+		+	+	+	+	+	+	+	+	
38. *Puntius sarana orphoides* (Valenciennes).									+										
39. *Puntius sarana sarana (Ham-Buch)*				+															
40. *Puntius sarana spilurus* (Gunther)									+				+						
41. *Puntius sophore* (Ham-Buch)	+				+											+		+	
42. *Puntius ticto* (Ham-Buch)	+				+		+		+										
43. *Semiplotus semiplotus* (McClelland)													+						
44. *Cirrhinus cirrhosus* (Bloch)																+			
45. *Cirrhinus mrigala* (Ham-Buch)	+	+		+	+		+			+						+		+	
46. *Cirrhinus reba* (Ham-Buch)		+		+	+		+			+						+		+	
47. *Catla catla* (Ham-Buch)	+				+														
48. *Laebo calbasu* (Ham-Buch)	+			+			+			+									
49. *Labeo gonius* (Ham-Buch)		+		+		+													
50. *Labeo boga* (Ham-Buch)																	+		
51. *Labeo pangusia* (Ham-Buch)				+															
52. *Labeo rohita* (Ham-Buch)	+					+													

53. *Crossocheilus burmanicus:* Hora			+						+					+							
54. *Crossocheilus latus latius* (Ham-Buch)				+					+				+	+		+		+			
55. *Garra annandalei* Hora									+					+							
56.*Garra gotyla gotyla* (Gray)				+	+				+			+	+	+							
57. *Garra lamta* (Ham-Buch)													+								
58.*Garra lissorhynchus* (McClelland)									+												
59. *Garra nasuta* (McClelland)				+																	
60.*Psilorhynchus balitora* (Ham-Buch)				+					+		+							+		+	
61.*Psilorhynchus gracillis* Rainboth									+												
62.*Homaloptera bilineata* Blyth								+													
63.*Balitora brucei* Gray			+						+				+					+			
64. *Acanthocobitis botia* (Ham-Buch)	+	+	+	+	+		+		+		+			+				+		+	
65. *Schistura multifasciatus* (Day)	+																	+		+	
66.*Schistura scaturigina* (McClelland)									+												
67.*Schistura vinciguerrae*(Hora)								+	+				+					+		+	
68.*Scistura nupecula*(Hora)									+												
69. *Botia dario* (Ham-Buch)	+	+	+	+	+	+	+	+			+										
70.*Botia rostrata* (Gunther)				+							+										
71. *Acantophthalmus pangia* (Ham-Buch)									+		+										
72.*Somileptus gongota* (Ham-Buch)																		+		+	
73.Lepidocephalus annandalei Chaudhuri					+						+										
74.*Lepidocephalus guntea* (Ham-Buch)	+	+			+			+										+		+	
75.*Rita rita* (Ham-Buch)	+	+					+													+	
76. *Batasio batasio* (Ham-Buch)															+						
77. *Batasio tengana* (Ham-Buch)		+																			
78.*Mystus bleekeri* (Day)		+				+	+													+	
79.*Mystus cavasius* (Ham-Buch)	+		+	+	+	+										+				+	

80.*Mystus tengara* (Ham-Buch)					+													+	
81.*Mystus vittatus* (Bloch)	+			+	+	+				+					+	+		+	
82.*Aorichthys seenghala* (Sykes)	+			+		+			+		+			+	+		+	+	
83.*Aorichthys aor* (Ham-Buch)												+		+	+				
84.*Ompok bimaculatus* (Bloch)	+		+	+	+													+	
85.*Ompok pabo* (Ham-Buch)		+																	
86.*Wallago attu* (Bloch and Schneider)	+	+																	
87.*Ailia coila* (Ham-Buch)	+	+		+	+		+		+						+		+	+	
88. *Clupisoma garua* (Ham-Buch)	+				+						+						+		
89.*Eutropiichthys murius* (Ham-Buch)	+					+	+		+			+						+	
90.*Eutropiichthys vacha* (Ham-Buch)	+	+	+	+	+	+	+		+					+	+			+	
91. *Amblyfceps mangois*(Ham-Buch)		+																	
92. *Bagarius bagarius* (Ham-Buch)	+			+															
93. *Gagata cenia* (Ham-Buch).																		+	
94.*Gagata gagata* (Ham-Buch)					+													+	
95.*Nangra nangra* (Ham-Buch)	+	+	+		+	+	+		+						+			+	
96. *Nangra robastra* Mirza & Awan																		+	
97.*Nangra viridescens* (Ham-Buch)				+			+	+	+			+							
98.*Erethistes pussilus* Muller & Troschel	+								+						+			+	
99.*Glyptothorax cavia* (HaBuch)													+						
100.*Glyptothorax striatus* (McClelland)			+	+															
101.*Glyptothorax sinensis* (Regan)												+							
102.*Glyptothorax telchitta* (Ham-Buch)	+			+	+		+		+			+	+						
103.*Glyptothorax trilineatus* Blyth												+							
104.*Exostoma berdmorei* Blyth																		+	
105.*Sisor rhabdophorus* Ham-Buch						+													
106. *Heteropneustes fossilis* (Bloch)							+		+										
107.*Chaca chaca* (Ham-	+				+														

108. *Olyra longicaudata* (McClelland)				+															
109.*Sicamugil cascasia* (Ham-Buch)					+		+	+											
110. *Rhinomugil corsula* (Ham-Buch)	+																+	+	
111. *Xenentodon cancila* (Ham-Buch)	+			+	+	+			+			+	+	+	+			+	
112.*Aplocheilus panchax* (Ham-Buch)	+				+													+	
113.*Macrognathus aral* (Bloch Schneider)	+				+														
114.*Macrognathus pancalus* (Ham-Buch)	+	+	+	+	+											+		+	
115.*Mastacembelus armatus* (Lacepede)	+	+		+	+		+		+		+	+	+	+		+		+	
116. *Chanda nama* Ham-Buch	+	+	+	+	+	+	+			+	+			+	+	+		+	
117.*Parambassis baculis* (Ham- Buch)	+																	+	
118.*Parambassis ranga* (Ham-Buch)	+	+		+	+										+			+	
119.*Parambassis tenasserimensis* Roberts											+		+						
120. *Johnius coitor* (Ham-Buch)	+				+		+								+				
121.*Badis badis* (Ham-Buch)	+	+		+	+				+		+	+			+			+	
122.*Nandus nandus* (Ham-Buch)	+																		
123. *Glossogobius giuris giuris* (Ham-Buch)	+	+	+	+	+	+	+	+		+	+			+	+	+	+	+	
124. *Anabas testudineus* (Bloch)																		+	
125.*Colisa fasciatus* (Schneider)								+											
126.*Colisa lalia* (Ham-Buch)	+																		
127.*Colisa sota* (Ham-Buch)	+																		

128. Channa barca (Ham-Buch)																			
129. *Channa marulius* (Ham-Buch)																			
130.*Channa orientalis* (Schneider)	+										+	+	+						
131.*Channa punctatus* (Bloch)	+	+	+	+	+			+								+		+	
132.*Channa striata* (Bloch)		+		+															
133. *Tetraodon cutcutia* (Ham-Buch)																			

Table No.: 8. STATUS OF SOME OF THE FISH SPECIES IN THE STUDIED RIVERS.
(Based on informations collected from **January 2000** to **March 2002**).

Sl. No.	Icthyospecies	River in which recorded	Status
1	*Chitala chitala*	Barak	Critically endangered
2	*Danio annandalei*	Khowai	Endangered
3	*Bengana elanga*	Sonai	Endangered
4	*Tor mosal*	Sonai	Vulnerable
5	*Tor progenius*	Jatinga	Endangered
6	*Puntius sarana orphoides*	Turial	Critically endangered
7	*Puntius sarana sarana*	Jatinga	Critically endangered
8	*Puntius sarana spilurus*	Turial	Vulnerable
9	*Labeo pangusia*	Jatinga	Endangered
10	*Garra nasuta*	Jatinga	Endangered
11	*Psilorhynchus gracillis*	Turial	Endangered
12	*Balitora brucei*	Turial, Mat	Endangered
13	*Schistura multifasciatus*	Barak, Gomati	Vulnerable
14	*Schistura scaturigina*	Turial	Endangered
15	*Botia rostrata*	Jatinga	Vulnerable
16	*Mystus tengara*	Sonai, Gomati	Vulnerable
17	*Bagarius bagarius*	Barak, Jatinga	Endangered
18	*Erethistes pussilus*	Barak, Gomati	Endangered
19	*Chaca chaca*	Barak, Sonai	Vulnerable
20	*Rhinomugil corsula*	Barak, Gomati.	Vulnerable
21	*Parambassis tenasserimensis*	Tlwang, Kolodyne	Vulnerable
22	*Johnius coitor*	Dhaleswari	Endangered

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In this issue

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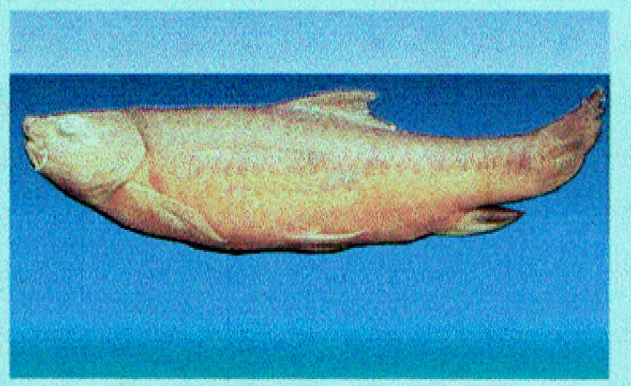
Samir Bhattecherya
N.C.Datta



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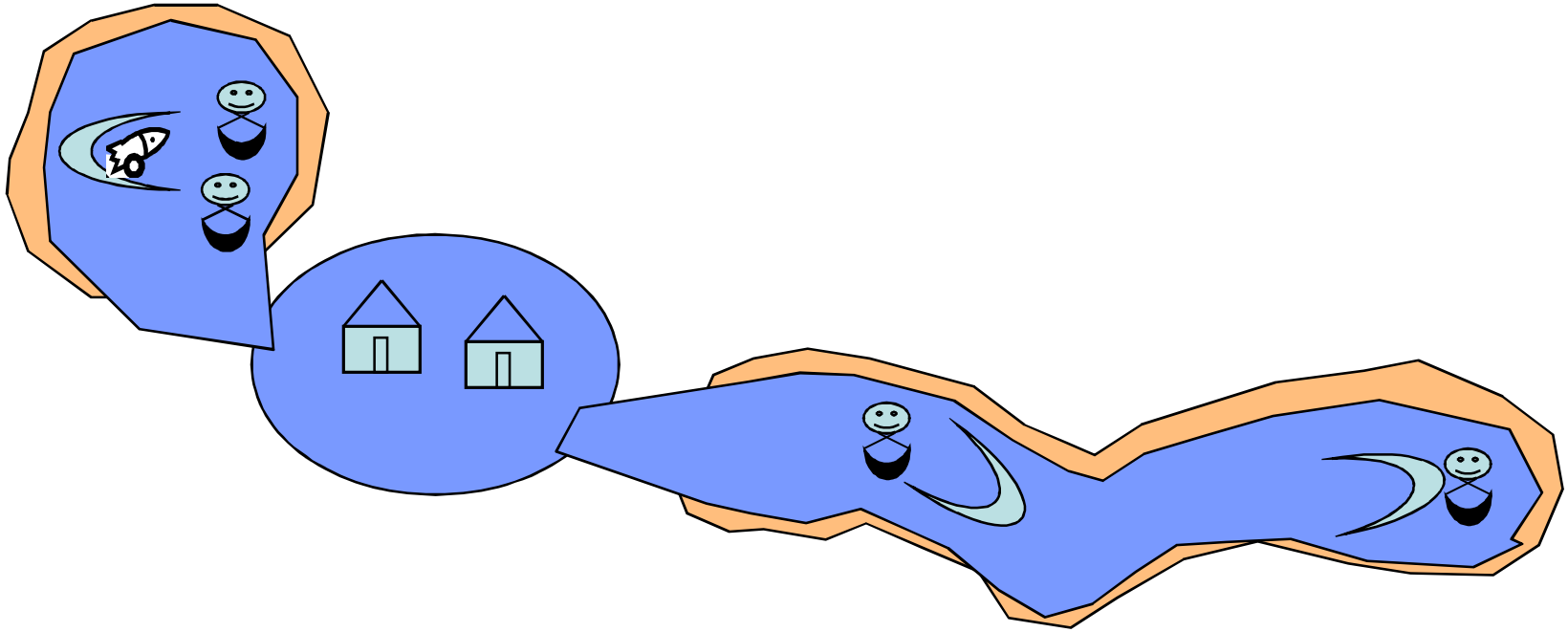
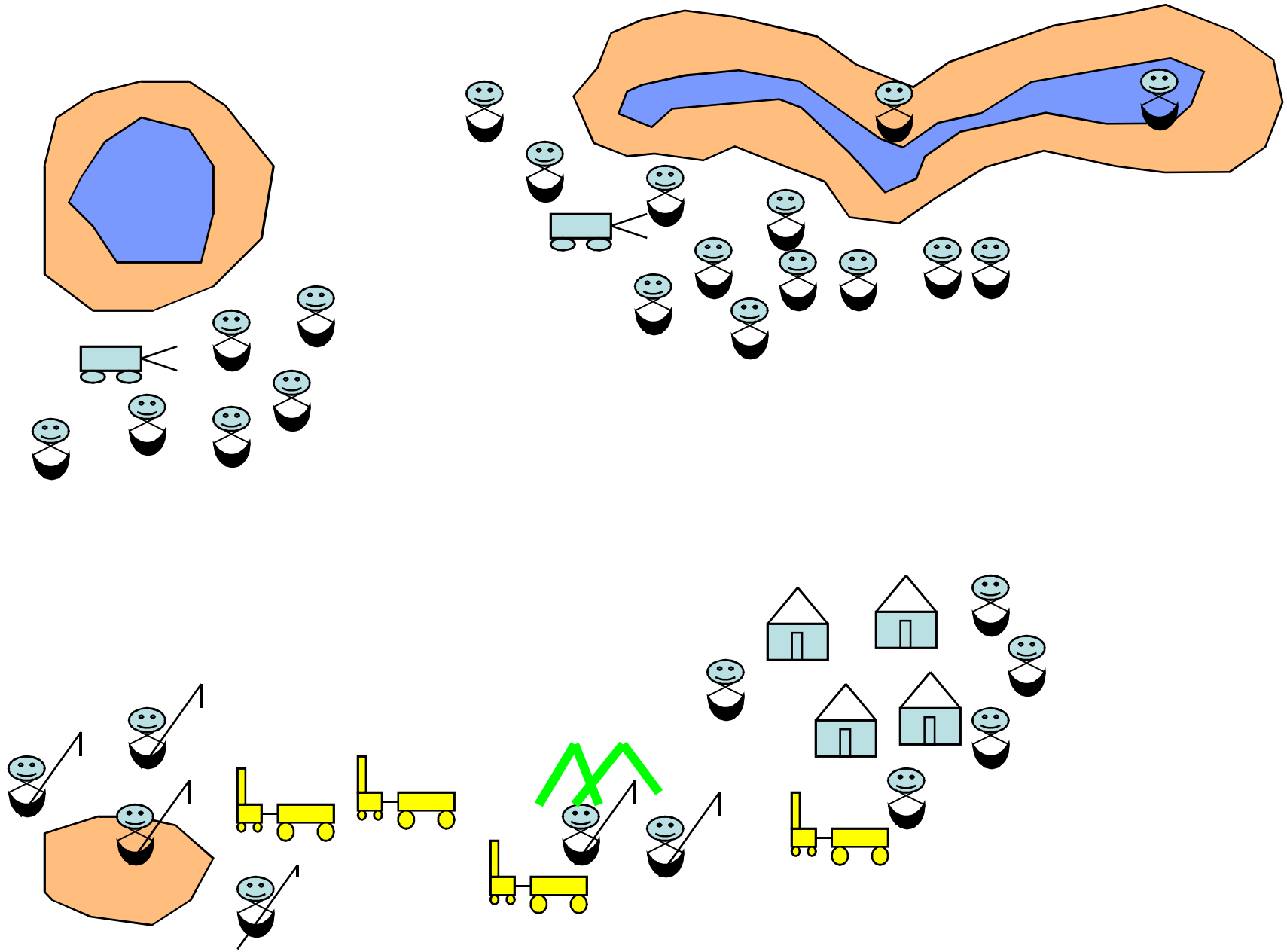
Cartoons showing a humble design for flood management using wetlands: 1



Cartoons showing a humble design for flood management using wetlands: 2



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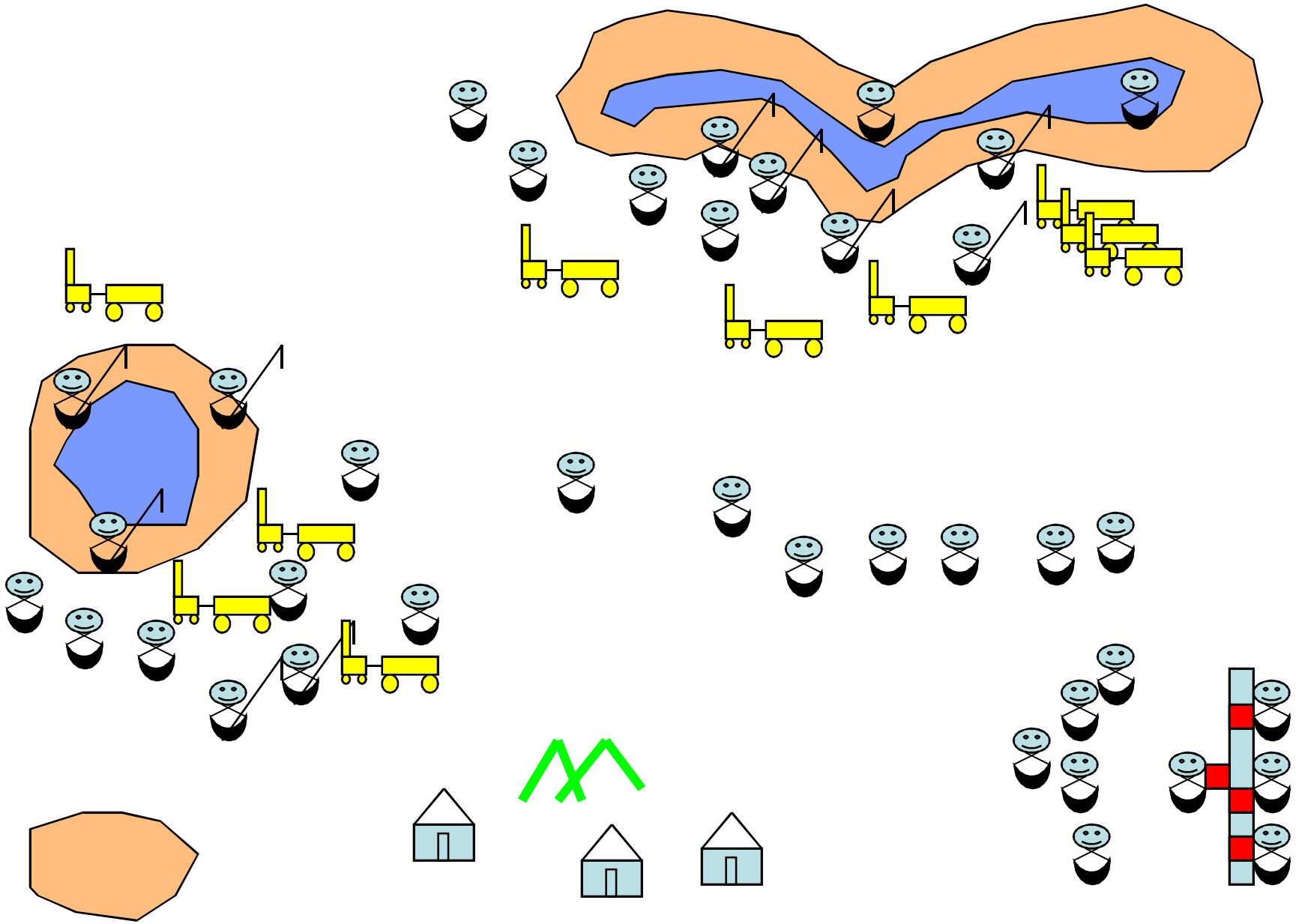
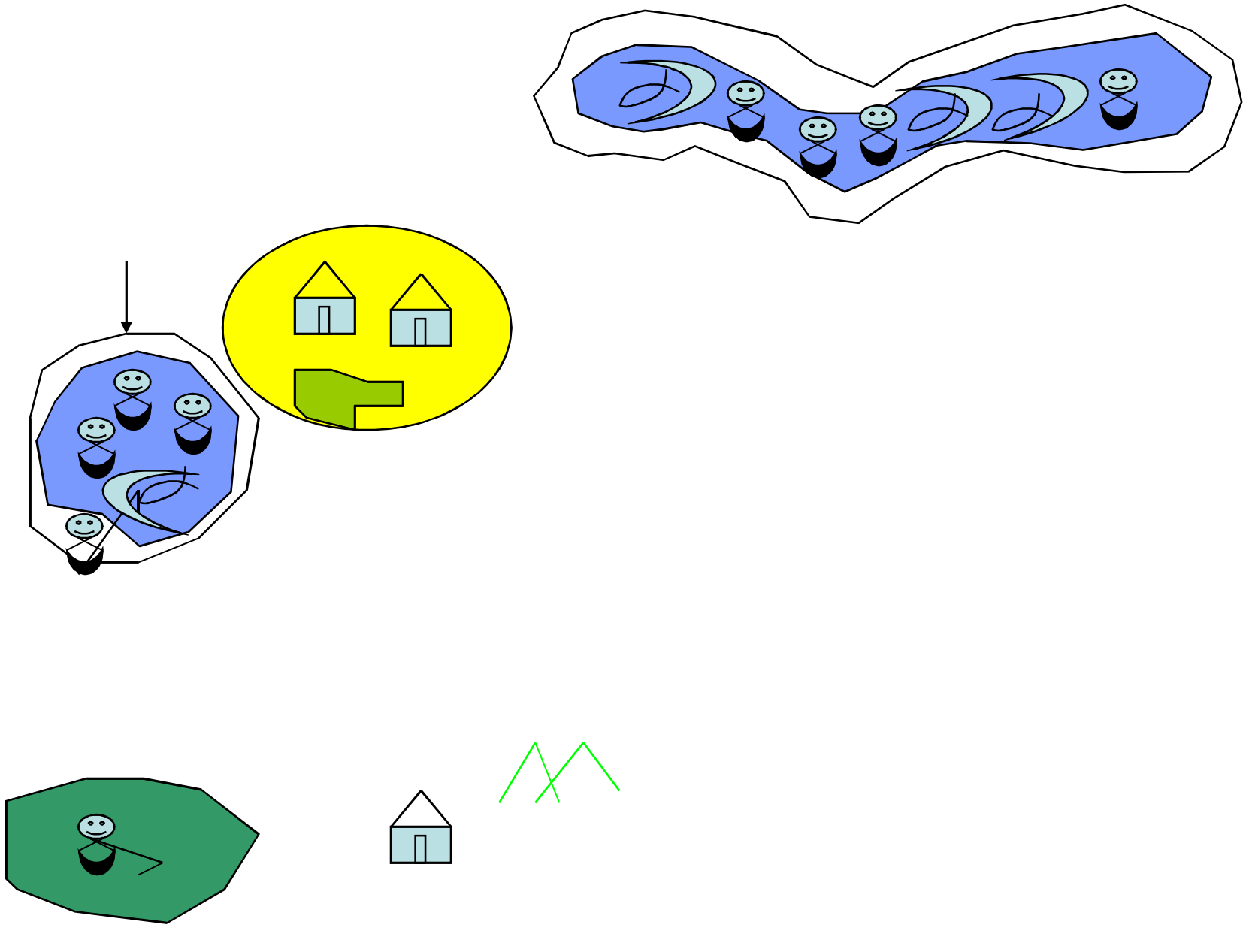


Cartoons showing a humble design for flood management using wetlands: 4



Thank You