Journal of Geography and Environment

Volume 1: 1996

VIDYASAGAR UNIVERSITY, MEDINIPUR
WEST BENGAL, INDIA

Instructions to Authors

Theme **:** Journal of Geography and Environment is published once a year containing original research papers on scientific and cultural aspects of geography, environment and related matters. Papers may be uni- or multidisciplinary but should have interdisciplinary appeal.

Acceptance *:* The publication of papers in subject to the approval of referees. Two complete copies of text and figures should be submitted. Photographic prints and/or line drawings, reduced to the approximate final printing size (maximum 17cm×15cm), should be included. Originals will be requested when the paper is accepted.

Manuscript **:** Manuscripts, written in English, clearly typed (double spaced) with 5 cm left margin on one side of the A4 size paper, are to be sent to : Editor-in-Chief, Journal of Geography and Environment, Vidyasagar University, Midnapore 721 102, West Bengal, India.

A complete manuscript is required to consist of the following items :
1) Title, 2) Author's complete name, designation and office address, 3) Abstract (not exceeding 250 words), 4) Main text (not exceeding 5000 words) with sub-headings, 5) Conclusions and/or summary, 6) Acknowledgements, if any, 7) List of references (for details see below), 8) Tables and illustrations with captions.

Reference List : The reference list should be constructed as shown in the following examples :

Boyce, R. and Clark, W. (1964) : The concept of shape in Geography. *The Geographical Review,* 54 : 561-72.

Chattopadhyay, G.P. (1987) : Landslide phenomena in the Darjeeling Himalaya : some observations and analyses. In Dateye, V.S., Diddee, J., Jog, S.R. and Patil, C. (eds.) : *Explorations in the Tropics*, Prof, K.R. Dikshit Felicitation Com., Pune : 198-205.

Ives, J.D. and Barry, R.G. (1974) : *Artic and Alpine Environments.* Methun, London : 999p.

Published by Dr. Kanak Kanti Das, Registrar, Vidyasagar University, Medinipur 721 102 and Printed by Unique Phototype, 49, Guru Prosad Chowdhury Lane, Calcutta 700 006.

Volume Price : Rs. 50 (In India) and $ 50 (outside India)

EDITORIAL

With growing awareness about the changing environmental systems the need of publishing a regular journal has been felt, and the foundation of the Department of Geography and Environment Management in this university has brought this feeling to reality. This new department has not only extended the scope of systematic study of environment in the university but also opened a new horizon for research works upon the wide range of environmental problems under the discipline of geography. Hence the objective of our journal is to publish original research papers on scientific and cultural aspects of geography, environment and the related matters with interdisciplinary appeal. For this first issue we were particularly selective about the topics, and the articles have been invited from the scientists who have been working in the field for quite sometime and whose research reports were readily available.

It can never be claimed that this first issue is completely flawless, but we believe that this will at least approximate the required standard of scholarship. We extend our sincere thanks to the geographers and environmentalists who have contributed immensely through discussions and comments to organise this journal.

CONTENTS

REMARKS ON PALEOENVIRONMENT FROM THE TRACE FOSSILS FROM SUBSURFACE AND OUTCROP TERTIARY—QUATERNARY SEDIMENTS OF THE WESTERN PART OF BENGAL BASIN, INDIA

Subir Bera
Department of Botany, Presidency College, Calcutta-700 073

Abstract

Systematic study of trace fossils has been made for the first time from the Teritary-Quaternary sediments of Bengal basin. Eleven species under eight genera of trace fossils are identified. Four trace fossil assemblage zones, viz., TAZ I-IV are established. TAZ I-III are recovered from bore cores at Panagarh-Durgapur sector whereas TAZ IV is recognised on the basis of the outcrop samples from Garbeta, Midnapore. TAZ I (Rhizoliths *Planolites* sp. cf. *P. montanus*) is assignable to Late Eocene (Kopili Formation) age; Early Miocene and Late Early Miocene— Pleistocene age are suggested for TAZ II (*Thalassinoides callianassae- Bergaueria hemispherica*) and TAZ III (*Oniscoidichnus communis* - Loop trails) respectively. TAZ IV (*Ophiomorpha nodosa* - *Cylindricum* sp.- *Thalassinoides* sp.) is assignable to Lower Pleistocene - Holocene age. A brackish water mixed fresh water to shallow marine condition of deposition is suggested for the trace fossil bearing sediments.

Introduction

Trace fossils are recognised as one of the most reliable environment indicators of the geological succession ranging from Pre-Cambrian to Quaternary age. In India, environment analyses through tracefossil studies have been made mostly from pre-Tertiary rocks (Verma, 1970; Chiplonkar and Badve, 1970, 1972, 1976; Chiplonkar and Tapaswi, 1972, 1975; Chiplonkar and Ghare, 1975a-b, 1976; Chiplonkar, 1980; Sarkar, 1974; Tandon and Bhatia, 1975; Kumar *et al.*, 1975; Laskar, 1976; Acharya *et al.*, 1976; Acharya and Ray, 1977; Kumar & Tandon, 1977, 1978, 1979; Ghare & Badve, 1977; Badve and Ghare, 1978, 1979, 1980; Kumar, 1978; Shivarudrappa, 1979; Shah *et al.*, 1979; Shah and Sudan, 1980; Kumar, A., 1979; Singh and Dayal, 1979; Singh, 1982; Shringarpore, 1986, 1989; Kumar and Srivastava, 1989) and only a few records are from Tertiary and Quanternary sediments (Patel and Shringarpore, 1989).

In this paper a large number of trace fossils assigned to eight genera and eleven species have been described from Tertiary-Quaternary strata in the western part of Bengal basin, India. The specimens are recorded from subsurface bore core samples and out crop sediments. A preliminary report on the occurrences of the trace fossils was communicated earliter (Bera and Banerjee, 1991).

Location and lithology of Bore Core and Outcrop Samples

The trace fossils have been recovered from sediments of three G.S.I. bore cores viz., PGD-4, PGD-6 and PGD-8 located at the western margin of Bengal basin. Outcrop sediments exposed at Garbeta along Silai river section are also crowded with trace fossils (Fig. 1).

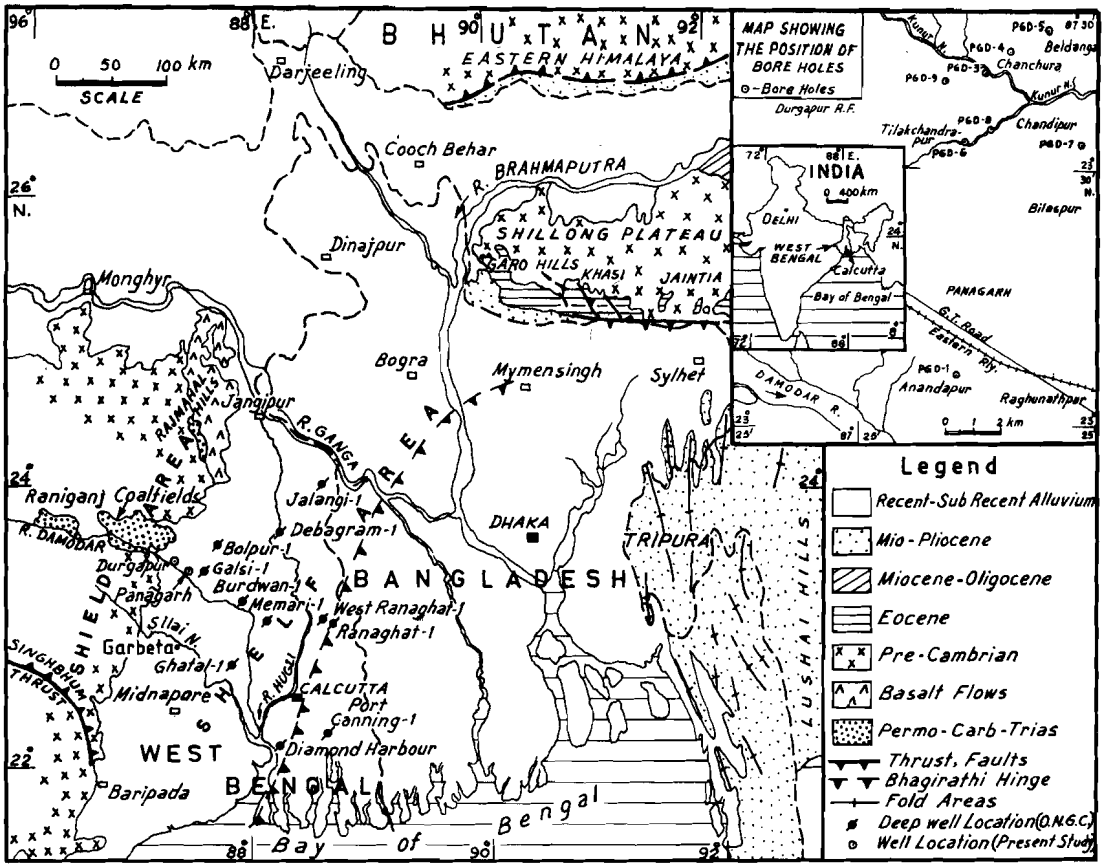


Fig. 1 Map showing the area of present investigation.

Table 1. Sample position, specimen number and lithology of the sediments

Name of the bore cores	Depth (m.)	Lithology	Specimen no.
PGD-6	95.80	Silver grey mudstone	PGD-6/TF 15, 17
	103.00	"	PGD-6/TF 15-16
	113.20	"	PGD-6/TF 14
	126.50	"	PGD-6/TF 13
	226.50	Marcasite	PGD-6/TF 1-12
PGD-4	92.60	Silver grey mudstone	PGD-4/TF 23
	101.00	"	PGD-4/TF 22
	115.00	"	PGD-4/TF 20, 21
	121.00	"	PGD-4/TF 19
	155.22	White to dull clayey sandstone	PGD-4/TF 18
PGD-8	113.80	Silver grey Mudstone	PGD-8/TF 26
	115.00	"	PGD-8/TF 25
	119.00	"	PGD-8/TF 24
Silver river section, Garbeta		Lateritised conglomerate	GTF/1-23
		Sandy loam	GTF/38-53

GENERALISED LITHOSTRATIGRAPHIC COLUMN OF WEST BENGAL

(After Roy Barman 1992)

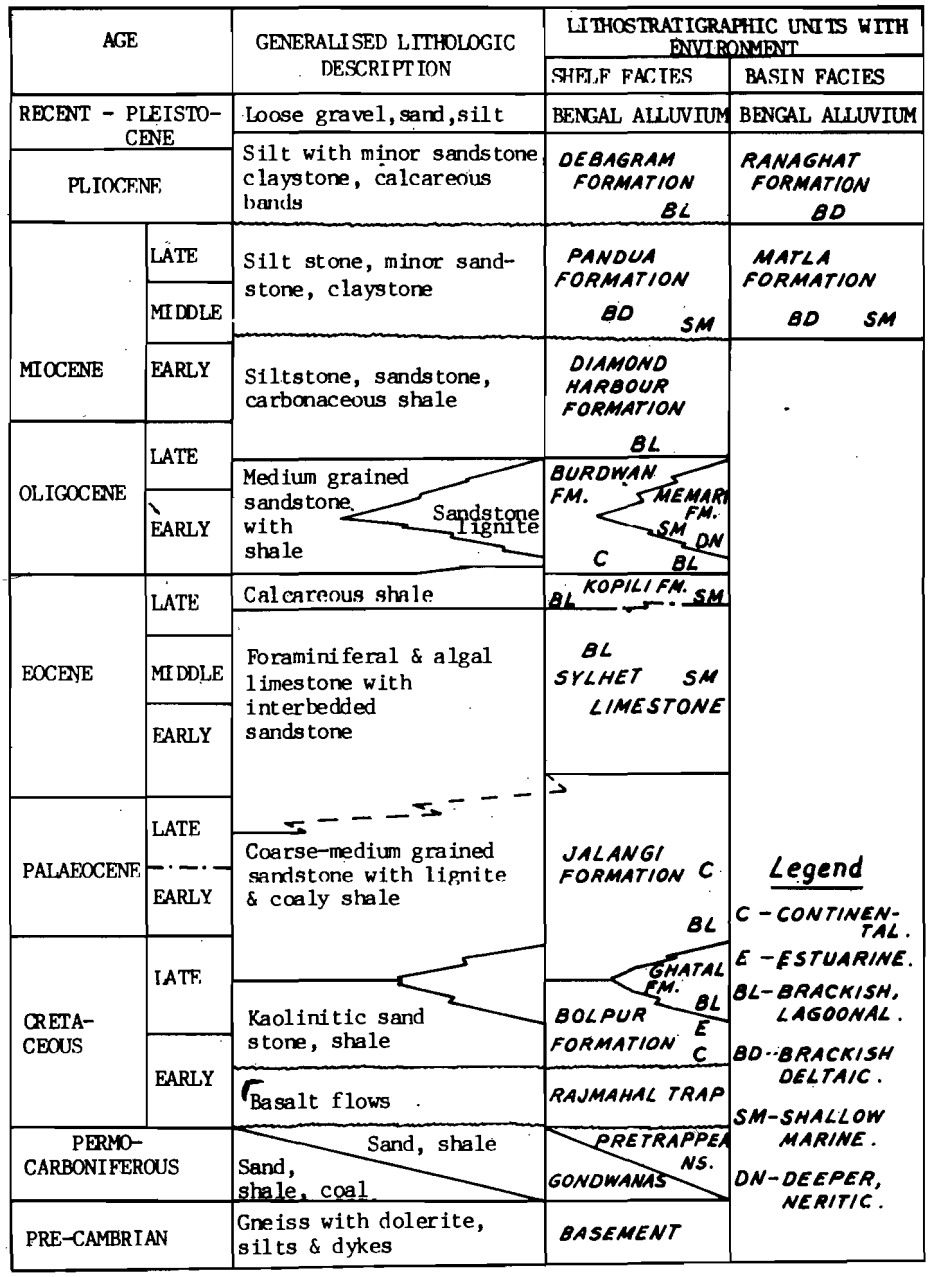


Fig. 2 Generalised lithostratigraphic column of West Bengal (After Roybarman, 1992).

Here the trace fossils are recovered from two separate lithostratigraphic units. The larger specimens are recovered from Lower Lalgarh Formation while the narrower ones are from Sijua Formation (Table-2). The lithology of the sediments bearing trace fossils is given in Table-1 and a generalised geological succession of West Bengal part of Bengal basin with corresponding environment of deposition as compiled by Roybarman (1992) are given in Table-1 and Fig. 2 respectively.

Table- 2 : Stratigraphic sequence of Kasai basin (After Ghosh, R & Majumdar, 1981)

Age	Lithostratigraphy	
Upper Holocene		Kasai Formation Bamandiha Formation Daintikri Formation
	Unconformity	
Lower Holocene	Sijua Formation	Sandy loam with burrows
	Unconformity	
Upper to Middle Pleistocene	Upper Lalgarh : Formation	Secondary laterite with pebbles and Vertebrate fossils
Lower Pleistocene (?)	Lower Lalgarh : Formation	Lateritised boulder conglomerate with petrified wood
	Unconformity	
Mio-Pliocene (?)	Upper Bhairob- : Banki Formation	Gritty Sandstone, clay-stone with leaf impressions, grit, local conglomerate. Bedded white shale and brownish white sandstone.
	Unconformity	
Pre-Tertiary to Early Tertiary (?)	Phulkusuma Formation	
	Unconformity	
Pre Cambrian	Archean Basement complex.	

Methodology

The distribution pattern of body and trace fossils along the lithosuccessions from Silai river section, Garbeta and bore core samples of Panagarh area is thoroughly investigated (Fig.3). The fragile trace fossils preserved in the calcareous marl and mudstone sediments are stored in plastic boxes with cotton. The detail morphography and characteristic burrow, trail patterns are critically investigated with hand lens and wild sterescopic microscopes; measurements, contour pattern of the trails have been noted in detail for identification of the individual species. Frequency distribution of the ichnofossils at various stratigraphic levels are recorded in Table-3.

Observation

Eleven species under eight ichno-genera are enlisted alphabetically (Table-4) along with ethological categories, environmental consideration, possible affinities, geological and geographical distribution of the respective taxa. In additiion to the eight genera two trace fossils viz., rhizoliths and loop trails could not be assigned to generic epithets and thus are left unnamed.

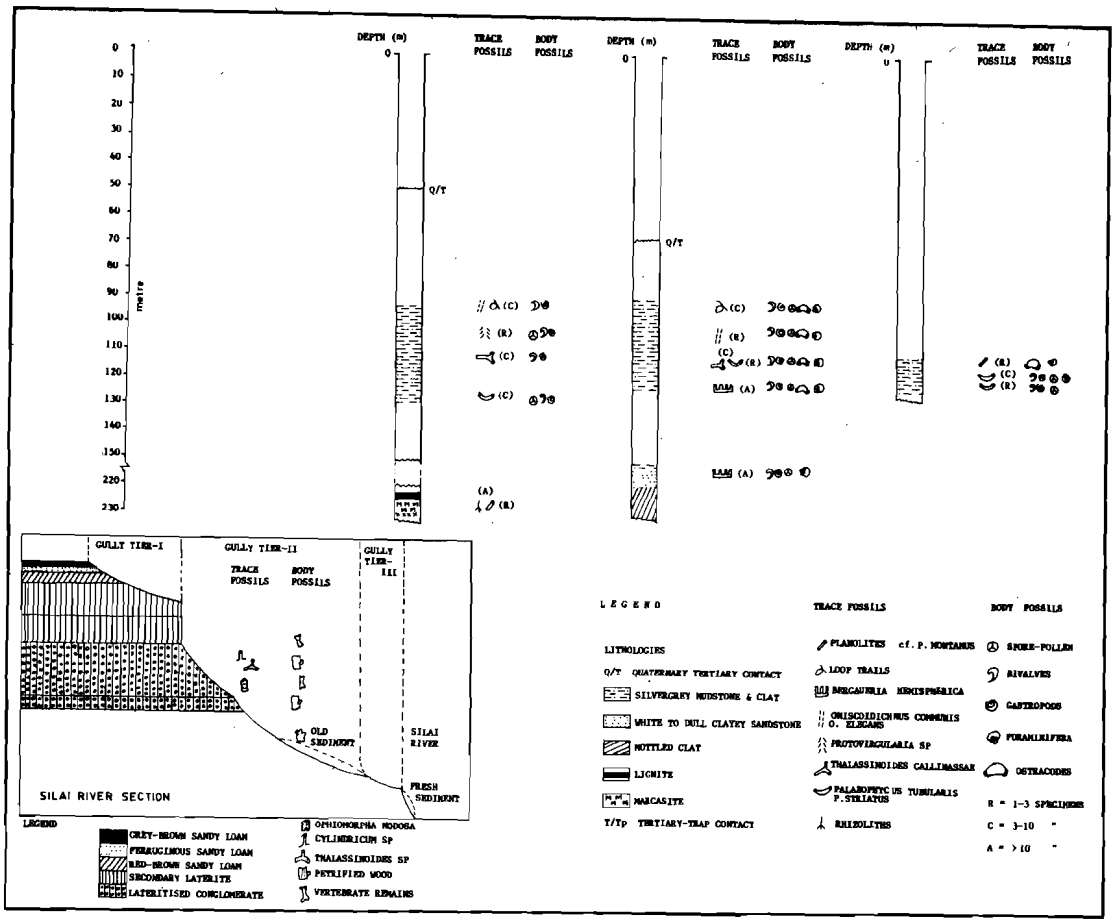


Fig. 3 Lithosuccession in fossiliferous bore cores at Durgapur and in Silai river section, Garbeta, West Bengal showing distribution of trace and body fossils.

Trace Fossils Assemblage Zonations :

Trace fossil assemblages are distinguished on the basis of frequency distribution as well as significant occurrence of taxa in stratigraphic sequence (Table-3, Fig.3). Four Trace fossil Assemblage Zones (TAZ I-IV) are recognised through correlation of the assemblages identified in the lithosuccession of the individual bore cores (Fig.4). The oldest assemblage zone TAZ I is represented by rhizoliths and *Planolites* sp.cf. *P. montanus* associated with marcasite deposits. TAZ-II is represented by consistent occurrence of *Thalassinoides callianassae, Bergaueria hemispherica, Palaeophycus tubularis, P. striatus* and *Planolites* sp. cf. *P. montanus*. TAZ-III is represented by the dominance of crawling traces viz., *Oniscoidichnus communis, O. elegans, Protovirgularia* sp. and loop trails. The youngest assemblage zone TAZ-IV, *Ophiomorpha nodosa - Cylindricum* sp. assemblage zone recovered from the Silai river Section, Garbeta, West Bengal is characterised by the dominance and significant presence of *Ophiomorpha nodosa, Cylindricum* sp. and *Thalassinoides* sp.

Table 3. Occurrence and relative frequency of trace fossils in the bore core and outcrop samples
In bore core samples the number of trace fossils per 113 cm^2 area (diameter of the bore core =12 cm) and in out crop samples per m^2 area are consideres as Rare (R) = 1-3 specimens; Common (C) = 3-10 specimens; Abundant (A) = >10 specimens

Trace fossils	PGD-6	PGD-4	PGD-8	Silai river section, Garbeta
Bergaueria hemispherica		A		
Cylindricum sp.				A
Oniscoidichnus communis	C			
Oniscoidichnus elegans		R		
Ophiomorpha nodosa				R
Palaeophycus tubularis	C	R	C	
Plaeophycus striatus		R	R	
Planolites sp. cf. *P. montanus*	R		R	
Protovirgularila sp.	R			
Thalassinoides callianassae	C	C		
Thalassinoides sp.				A
Loop trails	C	C		
Rhizoliths	A			

Age of the Sediments

Age of the sediments recovering trace fossils of long ranging geological occurrence is suggested through the data base recovered by palynological and planktonic microforminiferal studies of the sediments (Bera, 1995; Bera *et al.*, 1995).

The sediments recovering TAZ-I occur immediately below the lignite deposit yielding palynoassemblage BCPAZ-I of Late Eocene age (Bera and Banerjee, 1995). TAZ-II occurs in the associated sediments that have recovered palynological zone BCPAZ-III and planktonic microforaminiferal zone PFZ-I both dated as Early Miocene (Bera, 1995; Bera *et al.*, 1995). The planktonic microforaminifera dated as Late Early Miocene to Pleistocene (PFZ-II) have been recovered from the sediments associated with the ichnofossils of TAZ III and thus the same age is suggested for TAZ III. The youngest trace fossil zone (TAZ-IV) of Bengal basin is recovered from outcrop sample located near Silai river, Garbeta.*Ophiomorpha nodosa, Cylindricum* sp. and larger forms of *Thalassinoides* are recovered from lateritised conglomerate bed of Lower Lalgarh Formation. Ghosh & Majumdar (1981) have assigned the age of the sediment provisionally as Lower Pleistocene. Comparatively smaller and narrower forms of *Thalassinoides* are found in the overlying sandy loam of Holocene Sijua Formation (Ghosh and Majumdar, 1981) (Fig.5).

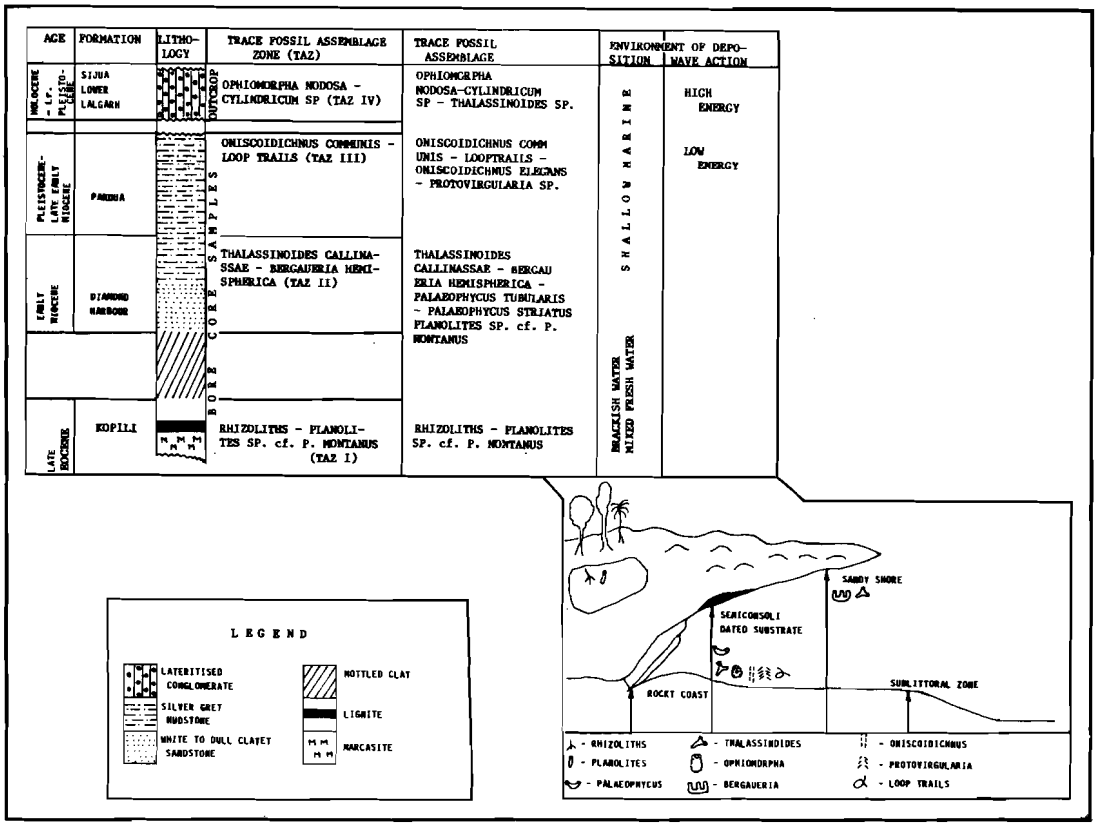


Fig. 4 Trace fossil assemblages from different cores and outcrop samples & their correlation.

Environment of Deposition

The trace fossil assemplages TAZ-I-IV indicate distinct environmental facies ranging from brackish water mixed fresh water to nearshore shallow water environment of deposition (Table-4; Fig. 5). The record of marcasite in the sediments of TAZ-I indicates a brackish water mixed fresh water condition of deposition in marshy environment. TAZ-II to TAZ-IV indicate shallow marine environment of deposition. *Bergaueria hemispherica* and *Thalassinoides callianassae*, the dominant taxa of TAZ-II are inhabitants of sandy shores (Table-4). Loop trails and *Oniscoidichnus* spp. of TAZ-III indicate a quiet shallow marine environment. A comparatively more high energy conditioin occurred in TAZ-IV dominanted by *Cylindricum* sp. and *Ophiomorpha nodosa.*

The trace fossil sequence in the present study clearly brings out the population strategies as adopted by the extant trace making endobenthic organisms. TAZ-I and lower part of TAZ-II is occupied by specialised feeders like *Planolites, Palaeophycus* whose individual species abundance and population distribution are rather low. Such species in palaeoecological terms are called the equilibrium or 'k' selected species (Pianka, 1970). These organisms are slow to colonize, generally with lower reproductive and growth rates and narrow range of tolerance. In contrast to the equilibrium species

Table 4 : List of ichnogenera recovered showing ethology, possible affinities, distribution and possible

Ichnotaxa	Ethology	Possible affinity
Genus : *Bergaueria* Prantl : *B. hemispherica* Crimes, Legg, Marcos &Arboleya (Pl. 1, Fig.5)	Cubichnia (Resting trace)	Actinarians (anemone) (Hantzschel, 1962; Seilacher, 1964; Alpert, 1973)
Genus : *Cylindricum* Linck : *Cylindricum* sp (Pl. 1, Fig. 8)	Domichnia (Dwelling burrow)	Annelid/Fish plankton, wolf spiders (Ratcliffe & Fagerstrom. 1980) Tiger beetles (Frey, 1975)
Genus : *Oniscoidichnus* Brady : *O. communis* Chiplonkar & Badve (Pl. -1, Fig. 3) : *O elegans* Chiplonkar & Badve	Repichnia (Crawling trace)	*Oniscus* (Isopod) (Hantzschel, 1962)
Genus : *Ophiomorpha* Lundgren : *O. nodosa* Lundgren (Pl. 1, Figs. 2 & 4)	Fodnichnia (Feeding burrow)	*Callianassa major* (Frey, Howard & pryor, 1978)
Genus : *Palaeophycus* Hall : *P. tubularis* Hall : *P. Striatus* Hall		Predaceous polychaetes (Osgood, 1970) or suspension feeder
Genus : *Planolites* Nicholson : *Planolites* sp. cf. *P. montanus*	Pascichnia (Grazing trace)	Sediment ingesting animal, Gryllotalpidae (mole crickets), Saldidae (Shore bugs) (Ratcliffe & Fagerstrom, 1980)
Genus : *Protovirgularia* M'coy : *Protovirgularia* sp.	Repichnia (Crawling trace)	Chordophyceae (Hantzschel, 1962)
Genus : *Thalassinoides* Ehrenberg : *T. callianassae* (Pl. 1 Fig. 6) : *Thalassinoides* sp. (pl. 1, Fig. 4)	Domichnia (dwelling burrow, sometimes considered as combined dwelling feeding structure)	Decapod crustaceans
Loop trails	Repichnia (Crawling trace)	Arthropods
Rhizoiths (pl.1, Fig. 7)	Root penetration	Root casts of vascular plants (Bracken & Picard, 1984)

environment of deposition.

Distribution	Environment of deposition
Upper Cretaceous of West coast, India (Singh, 1982)	Shallow marine sand-mud interface (Seilacher, 1964; Crimes *et al.*, 1977; Pemberton & Magwood, 1990; Pemberton *et al* .. 1988)
Cretaceous of Bagh beds, India (Chiplonkar & Ghare, 1975a-b)	Flood plain (Ratcliffe & Fagerstrom, 1980)
Cretaceous of Bagh beds, India (Chiplonkar & Badve, 1970, 1972)	Near shore (Chiplonkar & Badve, 1969)
Upper Cretaceous of Lameta beds (Kumar & Tandon 1977, 1978, 1979), Bagh beds (Chiplonkar & Ghare, 1975 a-b), Lower Miocene of Gujarat (Patel & Shringarpore, 1989)	Beaches or well agitated littoral to shallow sublittoral sands (Frey, Howard & Pryor, 1978), beach/intertidal sand flat sequences (Hoyt & Weimer, 1963; Frey & Mayou, 1971; Howard, 1978), shallow subtidal sediment (Howard, 1972) Curan, 1984; Kamola, 1984; Pemberton & Frey, 1984), fluvial (Stewart, 1978; Bown, 1982; Merrill, 1984). Produced under high energy conditions.
Middle Jurassic of eastern Kutch, Lower Miocene of Gujarat (Patel and Shringarpore, 1989)	Offshore or lower shoreface environment (Patel & Shringarpore, 1989)
Jurassic of Kutch (Badve & Ghare, 1978), South Indian Cretaceous (Chiplonkar & Ghare, 1976)	Flood plain (Ratcliffe & Fagerstrom, 1980)
Upper Cretaceous of Bagh beds. (Chiplonkar & Badve, 1970)	—
Upper Cretaceous Lameta beds (Kumar & Tandon, 1977, 1978, 1979), Upper Cretaceous of Bagh beds (Singh & Dayal, 1979), Middle Jurassic of eastern Kutch (Shringarpore, 1989)	Sandy shore, represents a stable substrate (Ekdale, 1988; Crimes, 1975; Frey & Seilacher, 1980)
	Possibly occurs in marine mud layers during quiet (non storm) intervals.

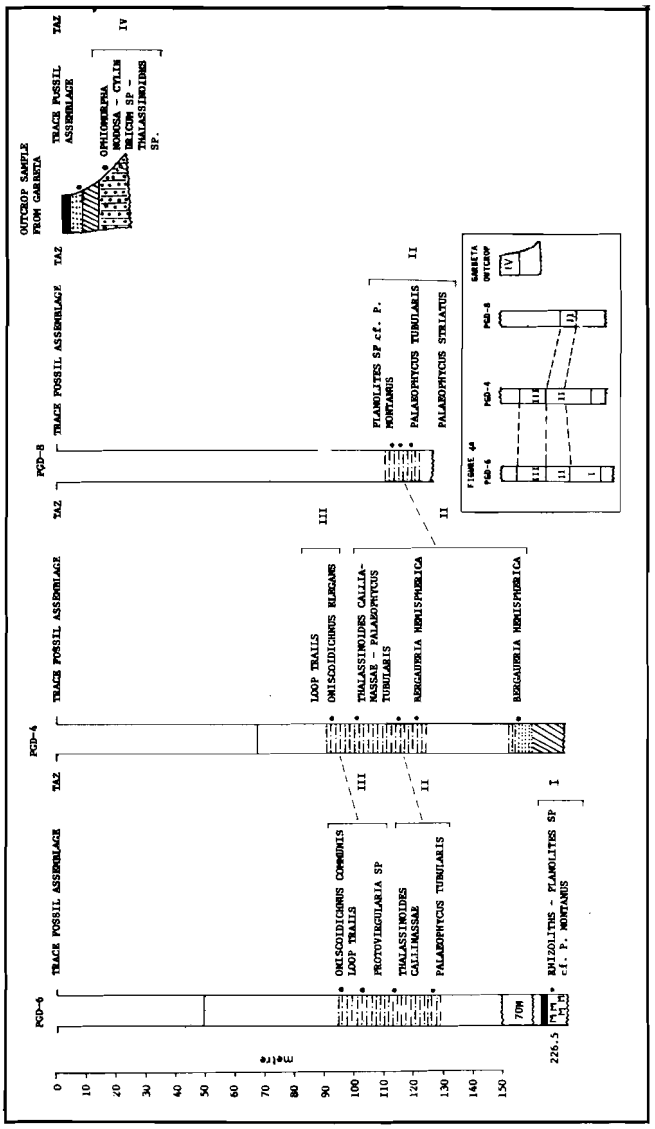
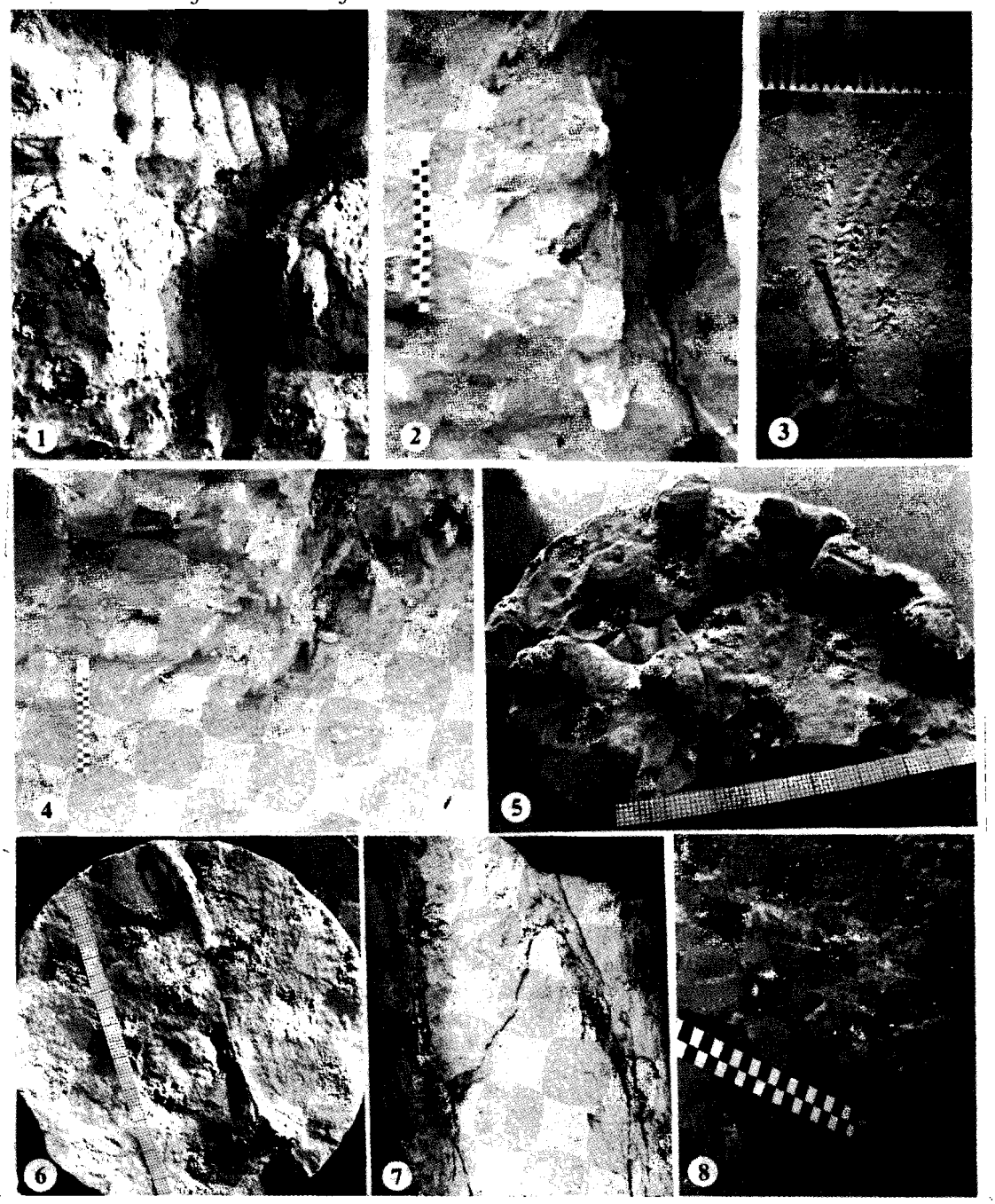


Fig. 5 Comprehensive trace fossie assemblage zones (TAZ I-IV) in the Tertiary-Quaternary sediments of Western part of Bengal Basin with presumed environmental facies and palaeogeographic consideration.



Description of Plates : (1) Silai river section at Garbeta showing the position of trace fossils. **(2)** *Ophiomorpha modosa* feeding burrows in sandy loam at Garbeta. **(3)** *Oniscoidichnus communis* crawling trace from subsurface sediments at Paranarh area. **(4)** Dwelling burrows of *Thalassinoides* sp. and feeding burrows of *Ophiomorpha nodosa* in sandy loam at Garbeta. **(5)** Resting trace of *Bergauereia hemispherica* from subsurface sediments at Paranarh area. **(6)** Dwelling burrwo of *Thalassinoides callianassae* from subsurface sediments at Paranarh area (note the 'Y' branching). **(7)** Rhizoliths (root casts of vascular plants) from subsurface sediments. **(8)** Dwelling burrwo of *Cylindricum* sp. in lateritised sediments at Garbeta.

of the previous phase of deposition, striking changes occur in the trace fossil population at the upper part of TAZ-II and TAZ-IV. This includes abundant and densely populated domichnial burrows of benthos viz., *Thalassinoides* and *Ophiomorpha.* The organisms characterise high reproduction rate, rapid growth and broad environmental tolerance. Such species are called 'r' selected species or opportunistic species (Pianka, 1970). Population strategic consideration of TAZ-III has not been attempted due to insufficient information about the species of the zone.

Acknowledgements

The author is grateful to Prof. Manju Banerjee, Department of Botany, University of Calcutta for her constant help and guidance during the present work. Sincere thanks are due to Sri S.K. Bandyopadhyay, Ex-Director, Geological Survey of India for providing the core samples.

References

Acharya, S. K., Ghosh, S. C. and Ghosh, R. N. (1976) : Geological framework of the Kamong-Subansiri-Siang districts Arunachal Pradesh (NEFA) Eastern Himalayas. *Symposiumn on Geology and Mineral resources of North Eastern Himalayas, Shillong (Geol. Surv. Ind.).* Abstract : 39-40.

Acharya, S. K. and Ray, K. K. (1977) : Geology of the Darjeeling-Sikkim, Himalayas, A guide to Excursion; *4th International Gondwana Symposium, Calcutta, India* : 25.

Alpert, S. (1973) : *Bergaueria* Prantl (Cambrian and Ordovician), a probable actinian trace fossil. *Journal of Palaeontology,* 47 : 919-924.

Badve, R. M. and Ghare, M. A. (1979) : The Holocene trace fossils from Beach rock of velas coast, Kolaba district, Maharashtra, Proceeding, National Seminar on Quaternary environments with special reference to Western India. (Geol. Dept., M. A. Univ. of Baroda; Baroda-2; India). 67-73.

Badve, R. M. Ghare, M. A. (1980) : Ichnofauna of the Bagh Beds from Devaganga river valley, south of Narmada. *Biovigyanam,* 6(2) : 137-140.

Bera, Subir (1995) : Palaeoenvironment of Bengal basin through study of biological remains. Ph. D. thesis. University of Calcutta, 281 p.

Bera, Subir and Banerjee, M. (1991) : Occurrence of ichnofossils from the lateritic sediment of Silai rever section, Midnapore, West Bengal. Indian Journal of Earth Science, 18(2) : 146-147.

Bera, Subir and Banerjee,. M. (1995) : Eocence palynoassemblage from lignite deposits of West Bengal, India with remarks on environment of deposition. *Indian Journal of Earth Science* , 22(4) : 149-152.

Bera, Subir, Sen. M. K. and Banerjee, M. (1995) : Foraminiferal biozonation in the western margin of the Bengal basin. *Indian Journal of Earth Science,* 22(3) : 110-118.

Bown, T. M. (1982) : Ichnofossils and rhizoliths of the nearshore Egypt. *Palaeogeography, Palaeoclimatology, Palaeoecology,* 40 : 255-309.

Bracken, B. and Picard, M. D (1984) : Trace fossils from Cretaceous/Tertiary North Horn Formation in Central Utah. *Journal of Palaeonotology,* 58 : 477-487.

Chiplonkar, G. W. (1980) : First twelve years of palichnology in India. Proceeding, 3rd Indian Gelogical Congress, Poona : 1-38.

Chiplonkar, G. W and Badve, R. M. (1969) : Trace fossils from the Bagh Beds. *Journal of the Palaeontological Society of India,* 14 : 1-10.

Chiplonkar, G.W and Badve, R. M. (1970) : Trace fossils from the Bagh Beds . pt. II, *Journal, Geological Society of India.* 13 (1) : 92-95.

Chiplonkar. G. W and Badve, R.M. (1976) : Occurence of the trace fossil *Hirmeria* Fucini 1936, in the Inter-Trappean Bed of Ninama, Surendranagar district, Gujarat. *Current Science*, 45 (6) : 221.

Chiplonkar G. W. and Ghare, M. A. (1975a) : Some additional trace fossils from the Bagh Beds. *Bulletin Indian Gelogical Association*, 8(1) : 71-84.

Chiplonmar, G. W. and Ghare, M. A. (1975b) : Trace fossils from the Upper Cretaceous rocks of Trichinopoly district. *Colloquium on palaeontological Studies in South India. Geol. Surv. Ind. Southern Region, Hyderabad)* : 101-109.

Chiplonkar, G. W. and Tapaswi, P.M. (1972) : A new trace fossil from the Upper Cretaceous of South Indla. *Current Science*, 41 (20) : 747.

Chiplonkar, G. W. and Tapaswi, P.M. (1975) : *Chondrites* Sternberg, a trace fossil from the Dalmiapuram Formation of Trichinopoly district, S. India. *Current Science*, 44(4) : 144-145.

Crimes, T. P. (1975) : The stratigraphical significance of trace fossils. In R. W. Frey (Ed.), *The study of trace fossils*, Springer-verlag, New York : 109-130.

Crimes, T. P. Legg, I. Marcos, A and Arboleya. M. (1977) : Late Precambrian-low Lower Cambrian trace fossils from Spain. In Crimes.T.P. & Harper. J.C (Eds) : *Trace fossils 2. Geological Journal, Special*, 9 : 139-162.

Curran, H. A. (1988) : Pitfalls of palaeobathymetric interpretations based on trace fossils assemblages. *Palaios*, 3 : 464-472.

Frey, R. W (1975) : The realm of ichnology, its strengths and limitations. In Frey, R.W (Ed). *The sutdy of trace fossils.* Springer-Verlag, New york : 13-38.

Frey., R.W and Mayou, T. V. (1971) : Decapod burrows in Holocene barrier island beaches and washover fans, Georagia.*Senckenbergia Maritima.*, 3 : 53-77.

Frey. R.W., Howard, J. D. and Pryor, W. A (1978) : *Ophiomorpha* : its morphologic, taxonomic and environmental significance. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 23 : 199-229.

Frey, R. W. and Seilacher. A. (1980) : Uniformity in marine invertebrate ichnology. *Lethaia*, 13 : 183-207.

Ghare. M. A. and Badve, R.M. (1977) : Trace fossils from the Vindhyans of Chambal valley, *Biovigyanam*, 3(2) : 205-214.

Ghosh, R. N. and Majumdar, S. (1981) : Neogene-Quaternary sequence of Kasai basin, West Bengal, India. *Neogene/Quaternary Boundary Field Conference, India, proceedings* : 63-73.

Hantzschel, W. (1962) : Trace fossils and problematica. In *Treatise on Ivertebrate paleontology*, pt. W. Miscellenea, (Moore, R.C. ed.) University of Kansas press and Geol. Soc. Amer., Boulder, Colorado, U.S.A.: W177-W245.

Howard, J.D. (1978) : Sedimentology and trace fossils. In : Basan, Palaeontologists and Minerologists short course, 5 : 13-47.

Hoyt, J. H. and Weimer. R. J (1963) : Comparison of modern and ancient beaches, central Georgia coast. *American Association of petroleum Geologists' Bulletin*, 47 : 529-531.

Kamola, D.L. (1984) : Trace fossils from marginal marine facies of the Spring Canyon Member, Blackhawk Formation (Upper Cretaceous east central Utah.*Journal of palaeontology*, 58 : 529-541.

Kumar, A. (1979) : Report on the occurrence of Gyrochorte and other bilobed trace fossils in the Jaisalmir Formation, Rajasthan. *Current Science*, 48(18) : 817.

Kumar, S. (1978) : The Kheinjua formation of the Semri Group (Lowr Vindhyan) of Newari area, Mirzapur district, U. P. *Proceedings Indian National Sceince Academy*, 44A(3) : 144-154.

Kumar, S., Singh, I. B. and Singh, S. K. (1975) : Lithostratigraphy, structure, depositional environoment, palaeocurrents and trace fossils of the Tethys sediments of the Malla Johar area, Pithoragarh and Chamoli districts, Uttar Pradesh, India. *Journal of the Palaeontological Society of India, (A. J. Orlov Memorial Number)*, 20 : 396-435.

Kumar, S. and Tandon, K. K. (1977) : A note on bioturbation in the Lameta Beds, Jabalpur area, M. P.*Geophytology, 7(2) : 135-138.*

Kumar, S. and Tandon, K. K. (1978) : *Thalassinoides* in the Mottled Nodular bed. Jabalpur area, M.P. *Current Science*, 47(2) : 52-53.

Kumar, S. andTandon, S. K. (1979) : Trace fossils and environment of deposition of sedimentary succession of Jabalpur, Madhya Pradesh, *Journal Geological Society of India*, 20 (3) : 103-106.

Kumar, S. andSrivastava, A. K. (1989) : Trace fossils from the Cretaceous rocks of Malla Johar area, Tethys Himalaya, UttarPradesh. *Journal of the Palaeontological Society of India*, 34 : 115-128.

Laskar, B.(1976) : Coal Measures and resources in Arunachala Pradesh-A Review. *Symposium on Geological and Mining Resources of North-Eastern Himalaya (Geol. Surv. Ind.; Shillong).*

Merrill, R. D. (1984) : *Ophiomorpha* and other nonmarine trace fossils from the Eocene Iocene Formation, California. *Journal of Palaeontology*, 58 : 542-549.

Osgood, R.G. (1970) : Trace fossils of the Cincinnati area. *Palaeontologia Americana*, 6 (44) : 281-444.

Patel, S. J. and Shringarpore. D.M. (1989) : Note on the trace fossils in carbonate rocks of Ramwada Mandir, Western Kutch, Gujrat State. *proc. XIII. Ind. Colloqium Micropalaeontology & Startigraphy* ; 175-179.

Pemberton, S.G. and Frey, R.W. (1984) : Ichnolgoy of storm influenced shallow marine sequence : Cardium Formation (Upper Cretaceous) at Seebe. Alberta. *In* Scott. D. F. and Glass, D. J. (Eds.). The Mesozoic of Middle North America. *Canadian Society of petroleum Geologists.* Memoir no. 9 : 281-304.

Pemberton, S.G., Frey, R.W and Bromley, R. G. (1988) : The ichnotaxonomy of *Conostichus* and other plug shaped ichnofossils. *Canadian Journal of Earth Sciences*, 25 : 866-892.

Pemberton. S.G. and Magwood. J.P.A. (1980) : A unique occurrence of *Bergaueria* in the Lower Cambrian Gog group near lake Louise, Alberta. *Journal of Palaeontology*, 64(3) : 436-440.

Pianka, E. R. (1970) : On r and k selection. *American Nature*, 104 : 592-597.

Ratcliffe, B. C. and Fagerstrom. J. A. (1980) : Invertebrate lebensspuren of Holocene floodplains : their morphology, origin and palaeoecological significance. *Journal of palaeontology*, 54 : 614-630.

Roybarman, A. (1992) : Geological history and hydrocarbon exploration in Bengal. *Indian Journal of Geology*, 64 (3) : 235-258.

Sarkar, Bhagawati (1974) : Biogenic sedimentary structures and microfossils of the Bhander Limestone (Proterozoice), India. *Quartenly Journal of Geological Mining and Metallurgical Society of India* (Golden Jubilee Volume), 46 : 143-156.

Seilacher, A. (1964) : Biogenic sedimentary structures-in *Approaches to palaeoecology.* (Imbre, J. and Newell, N.D..eds.) John Wiley and sons : 296-316.

Shah, S.K. , Sharma, T.R. and Gupta, S. K. (1979) : Trilobite trace fossils from Baftiaz Formation, western Pir Panjal and their significance. *Journal Geologicl Society of India*, 19(6) : 273-276.

Shah, S.K. and Sudan, C.S. (1980) : Trace fossil from the Cambrian of Kashmir and Jammu. *Prceedings 8th Indian Colloqium on Micropalaeontology and Stratigraphy* , Geol. Dept., M.S. Univ. of Baroda; Baroda-2; India; 143.

Shivarudrappa, T.V. (1979) : A note on the occcurrence of ichnofissils in quartzite from Dodgani, Tamkur district, Karnataka state. *Proceeding 7th Indian Colloqium on Micropalaeontology and Stratigraphy.* Geol. Dept., Madras Univ., Madras, India : 114.

Shringarpore, D.M. (1989) : Record of endobenthic trace fossils in the Middle Jurassic rocks of Chitrod, Eastern Kutch *Proceedings XII Indian colloqium on Micropalaeontology & Statigraphy* : 70-74.

Singh, S. K. (1982) : *Bergaueria* prantl from Upper Cretaceous rocks of Madhya Pradesh, India.

Journal of the palaeontological Society of India, 27 : 62-62.

Singh, S.K. and Dayal, R.M. (1979) : Trace fossils and environment of deposition of Nimar Sandstone, Bagh Beds. *Journal Geological Society India* , 30(5) : 234-239.

Stewart, D.J. (1978) : *Ophiomorpha* : a marine indicator? *Proceedings of the Geologists' Association*, 89 : 33-41.

Tandon, S.K. and Bhatia, S.B. (1975) : Ichnocoenoses of the Tethyan zone of Kumaun Himalaya with special reference to the Precambrian-Cambrian boundary. *Recent Researches in Geology* (Verma. V.K. et al., eds.), 2, Hindustan publishing corp. (india), Delhi-7 : 378-398.

Verma, K.K. (1970) : On the occurrence of trace fossils in the Bagh Beds of Amba Dongar area, Gujarat State, *Journal of Indian Geoscience Association*, 12 : 37-40.

DESERTIFICATION : THE SCENARIO FOR ARID WESTERN INDIA

Amal Kar
Central Arid Zone Research Institute, Jodhpur-342 003

Abstract

Desertification is a major environmental problem in the drylands of India, but it is little understood. Many assessments are made on the basis of opinions and perceptions rather than on scientific data, which lead to confusions and controversies. Some studies have been made in the arid zone of the country to understand the processes and to map the phenomena. The results are summarised and evaluated. The scientific database needs to be refined and updated, and integrated with the socio-economic factors for a holistic view of the phenomenon. Similar studies are also necessary for other areas of the country.

Introduction

Continuously increasing human and livestock population in the fragile hot arid, semi-arid and dry subhumid lands of the world are now creating immense pressure on the relatively scarce natural resources of these lands. Scramble for resources and unscientific ways of resource exploitation are leading to land degradation at a rate which is believed to be much faster than before. In other words, it is leading to 'desertification' which is defined in the Agenda 21, Article 12.2 of the United Nations as "land degradation in the arid, semi-arid and dry subhumid areas resulting from various factors, including climatic variations and human activities" (Cardy, 1994). Although there is still no common consensus among scientists and technocrats as to the precise understanding and definition of the term desertification, many former views on the symptoms of desertification, methods of assessment and causative factors have seen seriously commented upon (Ahlocrona, 1988; Warren and Khogali, 1992; Olsson, 1993; Hellden, 1994; Thomas, 1993). According to one estimate 69.5 percent area of the world's dryland is affected by different land degradation processes. The continent of Asia, which has one of the world's largest area under drylands (32% of the world's total drylands; 1949 million hectares), is considered to have 1881.43 million hectares under agricultural land, including irrigated croplands, rainfed croplands and rangelands. Out of this total 69.7 per cent area is now believed to be affected by land degradation processes (Dregne *et al.*, 1991).

In India the drylands, comprising the hot arid, semi-arid and the dry sub-humid climatic zones, account for 203 million hectares or 61.9 percent of the total geographical area (Fig. 1). Each region has its own desertification problem. For example, gully erosion and badland formation are very serious problems in parts of the Chambal and the Sabarmati river valleys, but wind erosion is a major problem in the arid western part of Rajasthan, containing the Thar desert. According to a recent estimate by Government of India, 32.7 per cent of the country's land area has been affected by different land

degradation processes (Anon., 1994) but the figures are not absolute. Individual perceptions, methods of assessment and attempts to exaggerate the effects of local droughts have often influenced the estimation process. Some studies have been carried out at the Central Arid Zone Research Institute (CAZRI), Jodhpur, to understand desertification processes and their manifestations in the arid western part of the country, especially in the western part of Rajasthan state which contains more than 60 per cent of the Thar desert. It will be discussed here how an understanding of the

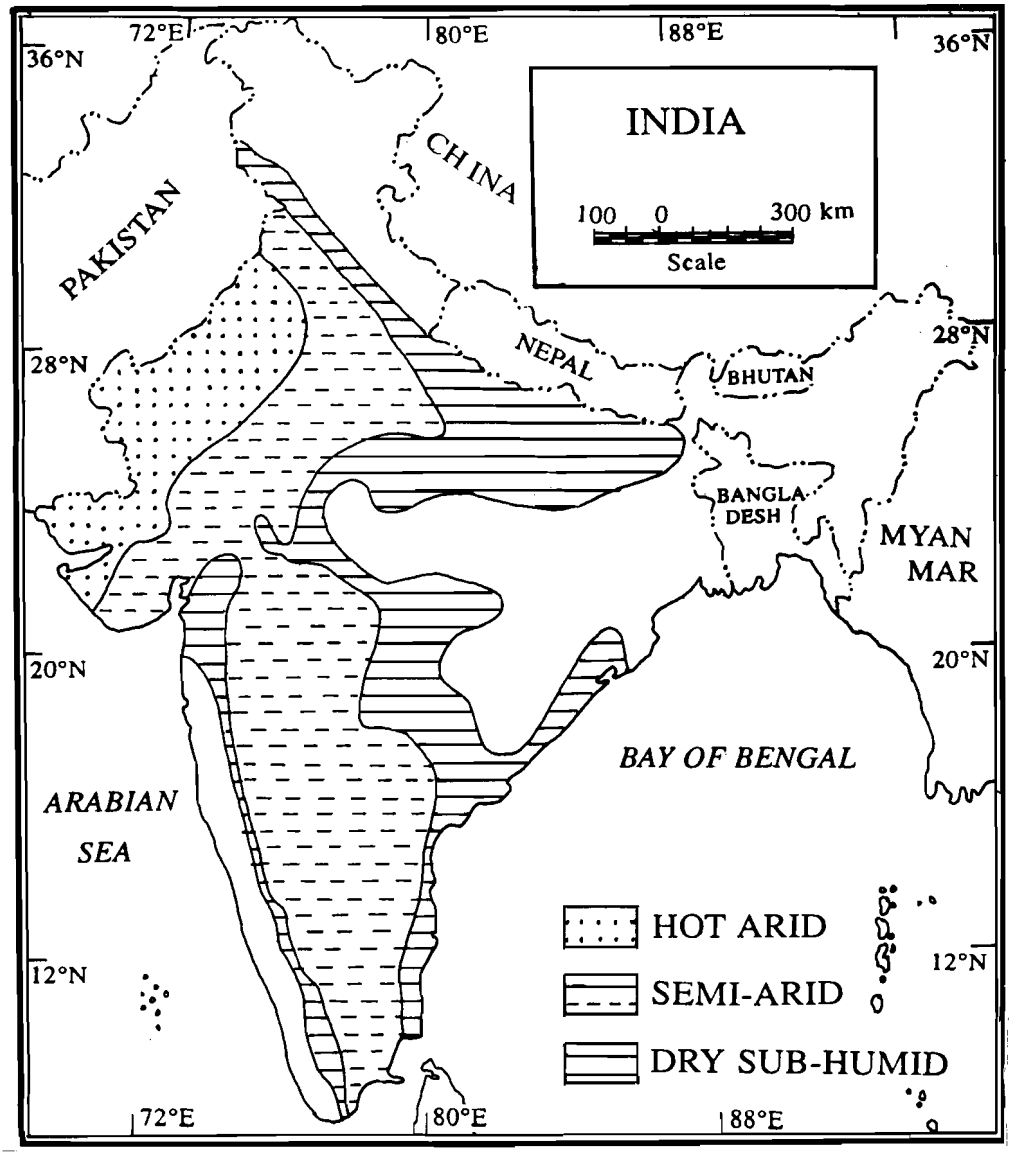


Fig. 1 Distribution of different climatic zones in India

geomorphic processes and acceleration of the processes due to human interventions helped us to understand the physical basis of the problem, and how this understanding can be linked to the information on socio-economic compulsions of the inhabitants for a holistic approach to the problem.

Present-day Processes

Indian arid zone is dominated by two exogenic processes : fluvial and aeolian; although a few other processes, like the fluvio-marine along the coasts and weathering elsewhere in some favoured inland locations, have also played significant roles in the evolution of the landforms. These processes have been operating throughout the Quaternary period and consist of a nested pattern of processes which operate for both short and long durations. The long drawn processes have produced mega-landforms like the hills, pediments, pavements, other rocky planation surfaces, vast alluvial plains, alluvial fans, high sand dunes, etc. Imprints of the short duration processes remain for a few days to a few tens of years and include the low transient features like barchans, shrub-coppice dunes (nebkhas), fence line sandy hummocks, other sand streaks, rills and gullies, new flood plain deposits, scalding, etc. Such short duration features provide excellent clues to present-day land degradation. Net result of these processes at different time scales is the formation of a number of landforms with hierarchical arrangement. The endogenic processes are rare and episodic, but these can drastically change in a very short span of time the landforms created by the long-term exogenic processes. The major example is the "Allah Bund" in the Great Rann of Kachchh, which was elevated during the 1819 earthquake and caused many drainage reversals. Similar Quaternary earth movements took place elsewhere in Kachchh, parts of Saurashtra and west Rajasthan, and disturbed the delicate base level of streams, creating river terraces, intrenched valleys and gully networks.

Erosion Potentials

It is possible to estimate broadly the potentials of major exogenic processes in the drylands. There are many models to quantify the water and sediment discharge in drainage basins and attendant erosion/deposition problems. Distributed process models like the Areal Nonpoint Source Watershed Environment Response Simulation (ANSWERS), or the Systeme Hydrologique European (SHE) have been used under many situations, but can sometime provide estimations which may be difficult to interpret physically. In an arid region like ours, where the actual data base is very poor and stream flows are intermittent, the problems may be compounded, unless all the parameters are understood and recorded properly, although some success was made in predicting flood-related soil loss from watersheds, using ANSWERS (Faroda and Singh, 1997). A detailed discussion on the different terrain and hydrological modelling software is provided in Beven and Moore (1992). Field estimation of soil erosion in decadal scale have been made through measurement of caesium-137 depletion in soil after the radionuclide fallout from atmospheric nuclear tests (Olive *et al.*, 1994). The technique is yet to be tested under Indian situations. Pending the application of these and similar researches to our situations, the pattern of soil erosion through fluvial processes can be

deciphered from the pattern of sheet, rill and gully erosion features. These features are numerous in the Saurashtra and Kachchh uplands, and along the eastern margin of the Thar desert where the average annual rainfall varies between 350 and 500 mm, but are very few to the west of the 250 mm isohyet in the Thar (Kar, 1988 & 1995). Although increased ploughing and destruction of vegetation cover must have accelerated the erosion, it is difficult to find out how much of the gullying activity is due to human activities alone and how much due to the natural processes.

Modelling the wind erosion/deposition is still more difficult, because of the complexities of the parameters involved. Musick *et al.* (1996) studied the influence of vegetation structure on saltation threshold, using non-erodible roughness elements over sand bed in a wind tunnel. Modelling of wind erosion from agricultural fields has been carried out by the US Department of Agriculture (USDA), the most recent model being the Wind Erosion Prediction System (WEPS), which has been field-tested (Larney *et al.*, 1995). However, the input parameters are so detailed that it is difficult to apply it widely in the drylands where instrumental records are very limited. The various modelling efforts have been reviewed by Buckley (1996). By far the best and the easiest method of predicting wind erosion from a natural, sparsely vegetated sandy terrain, is that by Buckley (1987), which is based on Bagnold's formulae, and was obtained from wind tunnel studies. This author found good concordance between the data predicted from this model and that derived from a *Lasiurus sindicus* grassland during sandstorms. Laboratory simulation of sand transport on dunes is, however, difficult due to the limitations of wind tunnels in properly scaling all the parameters involved (White, 1996).

The most vulnerable landforms to wind erosion/deposition are the deep sandy plains in the western part of the Thar. In order to calculate the potential wind erosion index under a natural system for the Thar desert, Kar (1992, 1993) used the mean wind speed and P/E values of meteorological stations. Excellent relationship was found between the mobile crescentic dunefields and the index contours > 120. The satellite image pattern of sand reactivation and the index contours also matched broadly. The results demonstrate that this index, rather than isohyet, determines the spatial distribution of recently-formed aeolian bedforms under natural conditions. Areas of high sand reactivation in the low-index zones could be explained through a knowledge on the history of aeolian bedform development and wind erodibility pattern (Kar, 1996). For example, the sandy landforms in the eastern part of the desert, including the high sand dunes, are largely inherited from a past major dry climatic phase, as is the case with the high dunes elsewhere in the desert (Singhvi and Kar, 1992). Consequently, the susceptibility of this terrain to wind erosion is almost as high as that in the west (Kar and Joshi, 1992). This is why some parts of eastern Thar (e.g. Churu-Sikar belt) with high cultivation and grazing pressures suffer from high sand reactivation in spite of higher rainfall and better vegetation status of the sandy terrain there. The sand mobility is restricted only to the areas of high human interventions. It is now possible to identify the major areas vulnerable to wind erosion from the spatial distribution of landform types, wind erosion index and wind erodibility pattern (Kar, 1996).

Human Influences

Isolation of the signatures of human influences on the terrain (through process acceleration) from that of the natural geomorphic processes is still a difficult proposition over major part of the region. This is especially true for some of the notable water eroded areas, both along the eastern part of the Thar desert and in the arid tracts of Kachchh and Saurashtra. Estimation of areas affected by sheet-wash is difficult and debated. Human activities must have accelerated the processes through cultivation on marginal lands, deep ploughing, etc.; but no realistic estimate is available as to how much erosion is attributable to nature and how much to man. Another dimension to the problem is provided by the stake-holders, the farmers. According to them the column of shallow, 'marginal' soil-which they used to cultivate earlier, is almost the same today. Even if there is some soil loss it hardly makes any difference to them. The soil column, for them, is still adequate to continue with, although some soil amendment practices are carried out to improve the crop productivity. Perhaps, much of the upland erosion is through periodic rill and gully erosion, rather than overland flow. In the areas of low relief, 'sinks' appear to be large and repetitive enough to trap much of the sediments loosened by deep ploughing, and regulate the delivery to the trunk streams through overland flow over small channel systems during high monsoon floods. Unfortunately, quantified data are not available.

Gully erosion is a serious problem along the eastern margin of the Thar. It is believed that the rate of gully erosion has increased due to increased of cultivation on the land. Yet, there are very little supportive data. Observations suggest that the progression of gully head is more related to a few, very high, rainfall events. The farmers are aware of the headward progress of the gullies, but do not believe that their agricultural activities create this problem. Many farmers believe that their age-old practice of keeping crop residues in the fields bind the soil effectively; whatever soil is lost to gullies is due to a slow natural process (related to decadal floods).

The continuous use of the land for cultivation, without leaving it fallow for a certain period, is often a key factor of cropland degradation and diminishing return from the land. In a study on the effects of continuous cultivation in sandy soils of variable depths, having nodular soft calcrete horizon below the effective soil depth, it has been found that the soil nutrients, especially available P plays a crucial role. The available P has a higher concentration in the near-surface layer than in the lower horizons as because it is absorbed by plant roots and then replenished through root litter. In the shallow soils (>45 cm) the total available P is exhausted rapidly by continuous cultivation, and leaving the land fallow thereafter for some time hardly helps as the soil column is not thick enough to hold and supply the required quantity through root litter. Since root litter concentration can be more in a deeper soil (>120 cm), such soil can supply the required quantity of available P to the crops and, thus sustain crop productivity over a longer period of time (Tsunekawa *et al.*, in press). This finding has implications for desertification research, as we are now able to isolate the factors of land degradation at the level of soil-plant interactions.

The major problem in the Thar desert is undoubtedly the wind erosion. The western limit of dryland cultivation is almost coterminous with the 240 contour of wind erosion

index. Over the last two decades, tractor ploughing has gradually covered almost the whole of the sandy area to the east of this contour. Cultivation has encroached upon the traditional common grazing lands (orans and gochars) and shallow uplands. Even the lower and the middle slopes of sand dunes, which were earlier left for long and short fallow, and were occasionally tilled using country ploughs, are now under the disc ploughing by tractor. Studies in a small village near Jodhpur in Central Thar revealed that even fifteen years back the tractor ploughing was limited largely to the footslope of old sand dunes and in the interdune corridors. It then advanced fast to the higher dune slopes, as feeding the draught animals became gradually more difficult (especially during and after the major drought of 1984-87). The compulsion to utilize the soil moisture in quickest possible time and the availability of the cash (through loan), replaced draught animals by tractor-driven ploughs in almost all croplands. Now it is fast encroaching upon the more sloping and vulnerable lands. The result is the loosening of sand to a greater depth and over a larger area, followed by increased sand movement. The villagers are aware of these threats of land degradation but economic compulsions dominantly influence their decision making process. The story is almost the same over most parts of the croplands in the Thar.

In spite of the recent sand reactivation to a larger spatial extent in the Thar, the problem does not always spill over to the eastern part of Rajasthan beyond the Aravalli ranges. This is because of the very low wind erosion index in that part. Whatever be the state of land degradation faced by the inhabitants, it is largely due to the local landuse practices. The sandy landforms in those areas, including the sand dunes, were inherited from past dry climatic episodes. The last major episode of large-scale dune formation was about 13-15 thousand years ago, when much of Rajasthan, upto the border with Delhi, experienced a very severe aridity (Ghose *et al.*, 1977). This phase was followed by an extended period of higher rainfall and landscape stability in the Thar and its margins (~10000-40000 years B.P.) during which pre-Harappan and Harappan civilizations flourished. Although periodic sand accumulation continued thereafter, the severity was much less. The depositions were episodic in nature, mostly related to small-scale climatic fluctuations. Along the foothills of the Aravallis and further east, the last phase of sand reactivation terminated in about 1300 A.D (Singhvi *et al.*, 1994), while in the extreme west, to the north of Pokaran, this phase terminated around 1400 A.D (Kar *et al.*, in press). In the east, the dunes and sandy plains attained a greater natural stability due to higher rainfall and thicker natural vegetation cover. The environment became more favourable for cultivation and grazing, and hence, the region became more densely populated. Yet, the land is vulnerable due to the sandy nature of the terrain, and there is a limit to the capacity of the sandy bedforms to maintain a balance with the exploitative enterprises. Wanton destruction of the vegetation on the stable dunes and sandy plains by the local inhabitants, as well as very intense pressure of cultivation and grazing on those terrains, without caring for erosion control measures, have now caused serious problems of sand reactivation at a few places around Pushkar, Jaipur, etc. (Kar, 1986, 1992). Such localized sand reactivations are not related to any 'desert spread' but are the results of desertification due to neglecting the local land resources, as apprehended by some workers.

Another form of land degradation is the accelerated salinity-alkalinity in soil, especially due to irrigation with saline-sodic ground water. The problem is dominant in areas of medium to heavy textured alluvial soils. In the seaward margin of the coastal alluvial plains very high pumping of potable ground water has led to intrusion of saline sea water into the aquifer. Since the farmers have no other choice as regards watering the crops, they continue to use the ground water, even though its quality has been adversely affected by sea water intrusion. In the Indira Gandhi Canal Command (IGNP) area in the Thar desert the problems of waterlogging and salinity-alkalinity are increasing at a faster rate. In the Stage I area of IGNP, the affected areas for waterlogging increased from 742 sq km. in 1981 to 1980 sq. km in 1990, especially because the soil is followed at a shallow depth by a barrier of gypsum or calcium-rich formation. Salinity build up has also been noticed in the command areas of small irrigation tanks in the south central part of the desert and where the canals have crossed some salt-rich palaeochannels.

The Future

The pressure on the land is likely to increase continuously as the human and livestock populations increase. About 75 percent of the population growth is expected to be in the rural sector, putting tremendous pressure on the existing agricultural land and the less suitable marginal lands, or the so-called wastelands. It is estimated that 32 percent of area in the western Rajasthan is slightly affected by desertification, while 40 percent is moderately affected and 21 percent severely (Singh *et al.*, 1994).

Inspite of some awareness of the problem among the scientific communities, there are still wide gaps in research programmes to understand and combat it. A more integrated approach towards identification, formulation, implementation and monitoring of the research activities on desertification is needed. The first requisite is proper monitoring of the problem and identification of the vulnerable areas. A map on the desertification status has been prepared for western Rajasthan, using some simple and easy to follow field indicators (Singh *et al.*, 1992). Similar maps are also needed for other areas of the country. These will form the basis for evaluating the problems in greater details and for financial allocations to control them. The key indicators of desertification need to be evaluated and tested for each region. A common and easy to follow methodology is also to be adopted for the establishment of a reliable database on desertification.

Another aspect is the need for adequate dialogue with the people living in the rural areas, who suffer the most by desertification. These tradition-bound people have their own perceptions of drought and desertification, which should have received attention from the scientists and the planners. It is also to be noted that degradation of land, if it is not too alarming, usually receives a low priority in the list of the problems prepared by the villagers. According to them some loss of soil is tolerable, so long as the return from the land is adequate. Interest for the economic return from the land is not always in agreement with the interest of scientists and technocrats who find the degradation of land as a cause for more concern. The traditional land management practices by the villagers had some elaborate degradation control measures in-built within the system.

Unfortunately many of these measures have disappeared as pressures on land have increased and new methods have been introduced. Faced with such hazards, the planning for desertification control becomes a truly difficult job. Environment awareness programmes are necessary for the inhabitants, but not without respecting their knowledge-base and aspirations. The control techniques and the alternatives should be placed before the stake-holders and discussed with them before implementation (Venkateswarlu and Kar, 1996). Now as the country has signed the UN Desertification Convention, it is expected that the programmes on assessment and control of the phenomena will be taken up on a much clear understanding.

Acknowledgement

The author is grateful to the Director and the Head of Resource Survey and Monitoring Division, CAZRI, Jodhpur, for providing facilities to carry out the research.

References

Ahlcrona, E (1988) : *The Impact of Climate and Man on Land Transformation in Central Sudan.* Meddleanden Fran Lunds Universitats Geografiska Institutioner, No. 103 : 140p.

Anonymous (1994) : *Draft Report on Status of Land Degradation in India.* Department of Agriculture & Cooperation, Ministry of Agriculture, Govt of India, New Delhi: 102p.

Beven, K.J. and Moore, I.D., Eds. (1992) : *Terrain Analysis and Distributed Modelling in Hydrology.* John Wiley & Sons, Chichester. 149p.

Buckley, R.C. (1987) : The effect of sparse vegetation on the transport of dune sand by wind. *Nature,* 325 : 426-428

Buckley, R.C. (1996) : Effects of vegetation on the Transport of dune sand. *Annals of Arid Zone,* 35:215-223.

Cardy, F (1994) : Desertification. *Our Planet,* 6(5): 4.

Dregne, H., Kassas, M. and Rozanov, B. (1991) : A new assessment of the world status of desertification. *Desertification Control Bulletin.* 20-6-18.

Faroda, A.S. and Singh, S. (1997) : Desertification—causes, impact and future trends in Indian arid zone. In Singh, S. and Kar. A (eds) : *Desertification Control in the Arid Ecosystem of India for Sustainable Development.* Agra Botanic Publishers. Bikaner, 1-18.

Ghose, B., Singh, S. and Kar, A. (1977) : Desertification around the Thar—a geomorphological interpretation. *Annals of Arid Zone,* 16 : 290-301.

Hellden, U. (1994) : Desertification— fact or fiction? *Our Planet,* 6(5) : 33p.

Kar, A (1986) : Physical environment, human influences and desertification in Pushkar- Buddha Pushkar lake region, India. *The Environmentalist,* 6 : 227-232.

Kar, A. (1988) : Evaluation of present-day geomorphic processes in the Indian desert for assessing land degradation and natural hazards. In Singh, S. and Tewari, R.C. (eds.): *Geommorphology and Environment.* Allahabad Geographical Society, Allahabad : 643-654.

Kar, A. (1992) : Morphological processes, human influences and land degradation in the Indian desert. In, Mohammad, N (ed.) : *New Dimensions in Agricultural Geography,* vol. 2 Concept. New Delhi : 123-150.

Kar, A (1993) : Aeolian processes and bedforms in the Thar desert. *Journal of Arid Environments,* 25: 83-96.

Kar, A. (1995) : Geomorphology of arid Western India. In, Wadia, S., Korisettar, R. and Kale, V.

(eds.) *Quaternary Environment and Geoarchaeology in India.* Memoir 32. Geological Society of India, Bangalore : 168-190.

Kar, A. (1996) : Desertification processes in arid western India. In, Miyazaki, T. and Tsunekawa, A (eds.) : *Towards Solving the Global Desertification Problem.* 4. National Institute for Environmental Studies, Tsukuba : 20-29.

Kar, A. and Joshi, D.C. (1992) : Prediction of land degradation hazards and risk assessment : the experience from Indian arid zone. *Proceedings, World Congress on Natural Hazard Reduction.* vol. 2. New Delhi : 11-23.

Kar, A., Felix, C., Rajaguru, S.N. and Singhvi, A.K. (1997) : Late Holocene growth and mobility of a transverse dune in the Thar desert. *Journal of Arid Environments* (in press).

Larney, F.J., Bullock, M.S., McGinn, S.M. and Fryrear, D.W. (1995) : Quantifying wind erosion on summer fallow in southern Alberta. *Journal of Soil and Water Conservation.* 50 : 91-94.

Musick, H.B., Trujillo, S.M. and Truman, C.R. (1996) : Wind tunnel modelling of the influence of vegetation structure on saltation threshold. *Earth Surface Processes and Landform.* 21 : 589-605.

Olive, L.J., Loughran, R.J. and Kesby, J.A., Eds (1994) : *Variability in Stream Erosion and Sediment Transport.* IAHS Publication 224, Institute of Hydrology. Wallingford : 498p.

Olsson, L. (1993) : Desertification in Africa— a critique and an alternative approach. *Geo Journal.* 31 : 23-31.

Singh, S., Kar, A., Joshi, D.C., Kumar, S. and Sharma, K.D. (1994) : Desertification problem in western Rajasthan. *Annals of Arid Zone.* 33 : 191-202.

Singh, S., Kar, A., Joshi, D.C., Ram, B., Kumar, S., Vats, P.C., Singh, N., Raina, P., Kolakar, A.S. and Dhir, R.P. (1992) : Desertification mapping in western Rajasthan. *Annals of Arid Zone.* 31 : 237-246.

Singhvi, A.K., Banerjee, D., Rajaguru S.N. and Kishan Kumar, V.S. (1994) : Luminenscence chronology of a fossil dune at Budha Pushkar, Thar desert : palaeoenvironmental and archaeological implications. *Current Science.* 66 : 770-773.

Singhvi, A.K. and Kar, A., Eds. (1992) : *Thar Desert in Rajasthan.* Geological Society of India, Bangalore : 191p.

Thomas, D.S.G. (1993) : Sandstorm over a tea cup? Understanding desertification. *The Geographical Journal.* 159 : 318-331.

Tsukenawaka, A., Kar, A., Yanni, J., Tanaka, U. and Miyazaki, T. (1997) : Influence of continuous cultivation on the soil properties affecting crop productivity in the Thar desert, India. *Journal of Arid Environments* (in press).

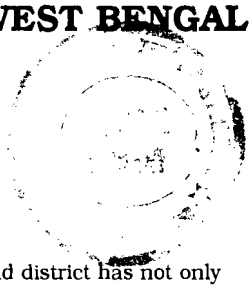
Venkateswarlu, J. and Kar, A. (1996) : Wind erosion and its control in arid north-west India. *Annals of Arid Zone.* 35 : 85-99.

Waren, A. and Khogali, M. (1992) : *Assessment of Desertification and Drought in the Sudano-Sahelian Region, 1985-1991.* UNSO/UNDP. New York : 102p.

White, B.R. (1996) : Laboratory simulation of aeolian sand transport and physical modelling of flow around dunes. *Annals of Arid Zone.* 35 : 187-213.

PROBLEMS OF RIVER BANK EROSION ALONG THE GANGA IN MURSHIDABAD DISTRICT OF WEST BENGAL

Kalyan Rudra
Habra Sri Chaitanya College of Commerce
Habra-743 263



Abstract

The alarming condition of bank erosion along the river-front of Murshidabad district has not only caused land reallocation, population displacement and disruption of communication links but also caused problems for the Farakka Barrage Project. The greatest socio-economic impact of erosion has been the creation of a class of neo-refugees who now live on the newly emerged *chars* under the shadow of poverty and insecurity. According to official sources about 206.56km^2 of fertile land has been eroded from the right bank of the Ganga (or Padma) since 1988 and at least 79,720 persons were rendered homeless. The strategy to combat erosion should be proactive, not reactive. The low-level technological adjustment seems to be one of the causes of the distress of the afflicted community. Scientific preparedness to combat erosion may reduce the distress of erosion-victims to a certain extent.

Introduction

The course of the Ganga along the northern river-front of West Bengal has been fast changing due to unabated bank erosion, especially over the last few decades. The rotational bank failures between the Farakka Barrage and Jalangi, a stretch of about 100 km., has become a matter of serious concern. The physical processes, associated with instability along this stretch of the Ganga has already been discussed (Rudra, 1993). However, the overall impact of erosion and the human response to this menace have hardly been taken into account in any geographical studies. Recently Das and Dasgupta (1992) reported on threat to land resources from erosion by the Bhagirathi and the Ganga. But their work now seems back dated as the Ganga has remarkably changed its course since they submitted report in 1992. The Ganga was chosen as the international boundary in this stretch of land in 1947, at the time of partition of India. Since then, rapid growth of population, large scale human migration from the then East Pakistan (subsequently also from Bangladesh), and unplanned expansion of habitation as far as the bank of the Ganga, wrong alignment of roads and railways within the meander-belt of the river, and above all the layout of the Farakka Barrage Project have drastically changed the landscape of the area. The recurrent bank failure and encroachment of the Ganga upon the Indian territory has often taken a disastrous magnitude and threatened the possible benefit of Farakka Barrage Project (Banerjee and Chakraborty 1983.) and the possibility of delinking of the North and South Bengal can not be ruled out. At present the Ganga has approached very close to the National Highway No. 34 and the railway track. The erosion has created a class of neo-refugees. The erosion has not only uprooted them but has also compelled them to indulge in

smuggling activities which has now become an organised business along the Indo-Bangladesh border. Thus agrarian economy has been seriously affected by the loss of fertile land. The Government has invested millions of rupees in erosion control works, but many such ventures have proved futile against the impinging fury of the Padma and, truly so, the river has been known as *Kirtinasha* or the destroyer of creative works.

Geomorphic Processes of Bank Failure

Though erosion along the bank of the Ganga remains restricted during the monsoon months (June-September), it has two distinct phases : the pre-flood and post-flood erosion. The fluctuation of discharge and stratigraphy of the bank are two major factors contributing to the bank erosion. The discharges of the river reaches nearly 1,800,000 cusecs during the month of August. The fast flowing water current during the rising stage of discharge removes unconsolidated sediment from the base of the shelving bank which ultimately collapses. The stratigraphic condition of the bank, being composed of micaceous material at the bottom and silt-clay upon it, appears to be responsible for this process. The post-flood erosion is related to the effluent flow of the ground water into the river. This occurs during the falling stage of the discharge. The flow of the ground water toward the river leads to liquefaction and flowage of basal sediments of the bank. However, in both cases a linear crack, often 100 metres in length, develops along the bank and the edge of the bank collapse into the river along this line.

Land Reclamation and Population Displacement

It seems to be a matter of conjecture that human life in an area, which is geomorphologically marked as depositional, has been threatened by erosion. While about one million people are displaced every year by the flood and erosion in Bangladesh (Elahi and Rogge, 1990); it is no less than 10,000 people who are evicted every year from their homelands by erosion in Murshidabad district alone. The erosion and land reallocation is an age-old problem along the bank of the Ganga. The erosion of vast stretches of land and subsequent emergence of *Chars*[1] have been in progress for last 200 years or so. Major Colebrooke, in his paper 'On the courses of the Ganges through Bengal' (1801), described the devastation caused by the Ganga in the Murshidabad district. He noted : "The quantity of land, which has been destroyed by the river in course of a few years, will amount, upon most moderate calculation, to 40 square miles, or 25,600 acres; but this is counter-balanced, in a great measure, by alluviation which has taken place on the opposite shore." In the late 19th century, Hunter (1876) observed that an acre of land was engulfed by the gnawing Padma within half an hour. Captain Sherwill (1858) witnessed the emergence of *Charlands* which became inhabited, cleared and cultivated, the population increased, large village started up, land revenue was collected for ten or twelve years, and then the whole fabric disappeared within one rainy season'.

It has been observed that since the beginning of construction of the Farakka Barrage in 1962 the intensity of erosion has increased. Dhulian and its adjoining areas were severely affected in mid 1970s when about 50,000 people became homeless. The present site of Dhulian is reportedly the fourth site (Bhattacharya, 1978). The

encroaching river wiped out 50 mouzas and engulfed about 10,000 hectares of fertile land. A large part of the interfluve, lying between the Bhagirathi and Padma with an area of about 77 km^2 between Nayansukh and Giria, desappeared for ever between 1925 and 1974 (Rudra, 1992). Thus the map of this area has been changed beyond recognition, which is ostensible by comparing the older topo-sheet published by Survey of India in 1925 and the recent satellite images.

The erosion is a seasonal phenomenon experienced during the monsoon months (June to September) every year. The erosion has been the cause of major distress of the people living along the river-front of Murshidabad for the last two centuries, and the ravages caused by the mighty Padma at Akheriganj in 1989 and 1990 surpassed all previous records. Akheriganj, which literally means the last settlement, virtually

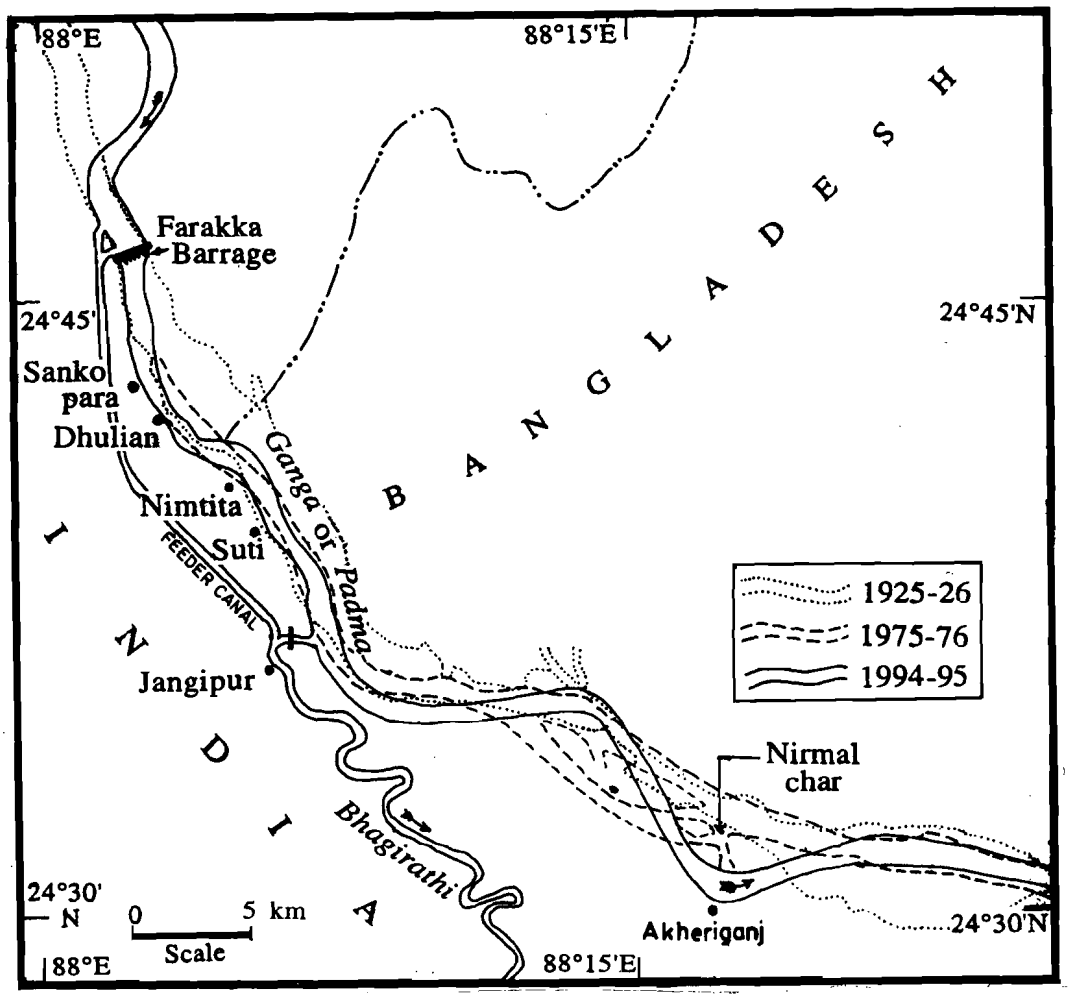


Fig. 1 Changing course of the Ganga

disappeared from the map. The nostalgic people still describe a retreated cluster of settlement as Akheriganj. The disastrous erosion engulfed 2,766 houses and left 23,394 persons homeless. Many survivers migrated to the newly emerged Nirmal *Char* along the opposite bank. The changing course of Ganga-Padma have been displayed in Figure 1.

As the intensity of erosion subsided at Akheriganj, the Padma, attacked human settlements at Jalangi in September 1994 with immense power. In 1990 when this author first visited Jalangi, there was an extensive *Charland* in front of the town and the river was about a kilometre away from the market area. Subsequently, the mighty river changed its course southwards and engulfed high school, police station, panchayet office, market area and as many as 450 houses were submerged (The Statesman, 1994). Even the Berhampur-Karimpur road was delinked and at least 12,000 people became homeless (GoWB Report, 1995) The erosion is nothing new at Jalangi. Rennell (1788) in his 'Memoir of a Map of Hindustan' noted : "During eleven years of my residence in Bengal, the outlet or head of the Jalangi river was gradually removed three quaters of a mile further down and by two surveys of a part of adjacent bank of the Ganges, taken about the distance of nine years from each other, it happeared that the breadth of an english mile and a half has been taken away."

The following table (Table 1) presents a comprehensive picture of the land loss and population displacement during 1988-1994 in Murshidabad District.

Table 1 : Land Loss and Population displacement during 1988-1994

Year	Area Eroded in Km^2	Families affected	No. of Population Displaced (Projected)
1988	4.35	872	4,360
1989	107.00	8,875	44,475
1990	7.50	612	3,060
1991	8.90	763	3,815
1992	34.00	1,197	5,985
1993	19.00	1,099	5,495
1994	25.85	818	12,000
Total	206.60	14,236	79,190

Source : GoWB, 1995

The Changing Course of Ganga-Padma vs. Border Dispute

In recent years possession of *Charlands* has became an issue of controversy in Indo-Bangladesh relationship (Rudra and Rudra, 1990). When India was liberated in 1947, the course of the Ganga was accepted as the international boundary between Rajshahi District of East Pakistan (Now Bangladesh) and Murshidabad District of West Bengal (India). Subsequently, more than 35,000 hectares of land has been wiped out from Murshidabad and *Charlands* of an almost equal areal extent emerged along the opposite bank. These *Charlands*, being attached with the mainland of Bangladesh, are difficult to approach from India. The erosion wiped away boundary posts at many places, where the

1. 'Chars' are the riverine mud banks or sandbanks, as they are locally called.

border is now merely an imagination. The matter was raised in the Parliament and the members expressed their serious concern over the issue. The Minister concerned assured the house that the boundary was fixed on the map and the erosion of Ganga would hardly affect it. (The Hindustan Times, 1986)

Whatever be the assurance from the ministry the infiltration and illegal occupance on *Charlands* by Bangladeshi nationals have very often been experienced. The *Charlands* of opposite, Jalangi, has been cultivated by the Bangladeshi nationals in spite of strong protest by our Government. In April 1993, a joint survey was conducted to ascertain the boundary on the *Charlands*, but Bangladesh subsequently declined to accept this newly identified boundary. Certainly, Bangladesh has a better access to the *Charlands*, and also it is often difficult for the district authorities of Murshidabad to provide proper security to the new settlers there.

Endangered Communication Lines

The encroaching river very often engulfed important roads and railways, as had happened in mid-1950s when the railway track near Dhulian station collapsed into the advancing river and train services remained delinked for about a decade. It was realigned to the further west and normal services were resumed not before 1965. The alarming rate of encroachment continues near Sankopara halt station where river is now only 165 metres away from the railway track. The National Highway No. 34, the only road to connect North and South Bengal was also realigned in 1966 in view of the threat of erosion. In June 1990, this author observed the collapse of about 20 metres of metal road into the Padma at Akheriganj and in 1994 the road to Karimpur was delinked at Jalangi. The following table presents the diminishing distance between the railway and the Padma at some important stations, as measured from older maps of Survey of India and a map recently prepared by the Public Works Department of West Bengal.

Table 2 : Decrease in distance between the railway track and the Ganga river from 1925 to 1995.

Location	1925	1974	1995	Decrease of distance from 1925 to 1975
1. Nayansukh	5.12 km.	2.50 km.	1.30 km.	75%
2. Sankopara	4.00 km.	0.50 km.	1.65 km.	96%
3. Dhulian	7.52 km.	2.50 km.	2.40 km.	62%
4. Nimtita	4.80 km.	3.00 km.	1.84 km.	62%
5. Suti	4.48 km.	2.90 km.	1.73 km.	61%
6. Sajanipara	6.72 km.	4.00 km.	2.88 km.	57%
7. Ahiran	5.60 km.	4.80 km.	3.34 km.	40%

Both the National Highway and the railway track extend through a narrow stretch of land before approaching the Farakka Barrage and the river is not too far away from this stretch. The Padma in between Farakka and Dhulian flows through a narrow channel, and with highly concentrated hydraulic energy, it attacks the right bank with immense force especially during the monsoon months. So the possibility of

disconnecting the communication links between the North and South Bengal in near future cannot be ruled out.

Problem of Bank Protection

After the commissioning of the Farakka Barrage, Pritam Singh Committee was entrusted with the task of finding a remedial measure to erosion and the committee submitted its report in 1980. Considering the possible huge expenditure, the committee reported that erosion-control work would not be cost-effective, unless it was absolutely essential to protect any national assets like highways, railways or urban centres. The experts recommended erosion-control measures at eight vulnerable stretches and the cost was estimated to have been Rs. 2.94 billion.

The bank protection work is so expensive that it often involves Rs. 30 thousand to protect one metre stretch but it offers no guarantee against erosion. The Government spent sixty million rupees to protect two kilometres long river bank at Akheriganj in 1991 but the newly constructed embankment was washed away in the very next rainy season. Yet bank protection is a popular demand. In some stretches bank restoration and monitoring are important. In Fazilpur, where the encroaching Padma threatens to unite with the Bhagirathi and may jeopardise the main purpose of the Farakka Barrage Project, the preventive measure is of real necessity. But in many areas bank protection works proved futile .

Human Life on Charlands

There is hardly any official records regarding the number of people living on the *Charlands* at present. But even at a very modest estimate it is no less than 50,000 and the number is increasing every year. The erosion-victims migrate to *Chars* loosing everything into the river. The skill and experience of the displaced population in agriculture help force to start a new struggle for existence. Evidently, the neo-refugees lead their life under the shadow of poverty and insecurity. The erosion and resultant homelessness cause an oversupply of agricultural labour. The labourers are often engaged at a wage lower than the minimum fixed by the Government.

Unfortunately, when the country is going celebrate its fifty years of independence, there has been no master plan to reduce the distress of the afflicted community living far away from the main crowd of the city of Calcutta. The neo-refugees survive on the *Chars* with their improvised strategies. When the *chars* first emerge above the water level of the Padma, it is sandy, and not habitable. With the passage of time, the finer sediments lof silt and clay are deposited and make the land fertile and cultivable. The conflict over the possession of land is a common feature in the social life on *Chars.* Paddy, pulses, vegetables water melons etc. are the main agricultural products. The natural pastures help to rear cattle and goats.

The displaced persons rebuild their huts with corrugated tin sheets, bamboos and mud, and thatch the roof with straw. These materials, being light and not very costly, are brought from the mainland. The country boats are the main mode of conveyance, while on land bicycles and bullock-carts are used.

The human life on *chars* lacks facilities of sanitation, education, medical, market,

and even drinking water. The residents prefer to go to Bangladesh for treatment or marketing to avoid the trouble of crossing the Padma. Thus they virtually enjoy dual citizenship.

Preparedness to Combat Problems of Erosion

The erosion has taken an alarming magnitude because of low level of technological adjustment and ill-directed planing, especially during post independence period. Commercialisation of agriculture started in this subcontinent with the introduction of permanent settlement shceme in 1793 and the Bengal Tenancy Act of 1885 under the British rule. Since then an exploited and marginalised class, who have had very limited control over the means of production has been created. Since 1947 the demographic transition, resulting from high birth rate, comparatively low mortality rate and large scale human migration from East Pakistan, brought about a changed socio-economic scene in deltaic West Bengal. In the river-front of Murshidabad erosion acted as an added force for marginalisation.

When the roads and railways were aligned through the meander belt of the Padma during the first half of this century, the engineers failed to foresee that the gnawing river would encroach upon that limits. Dhulian, Suti, Akheriganj and Jalangi; all developed as important trading centres after the partition of India. No one took into account that the process of delta building involves oscillation of distributaries within a wide limit. In this age of the application of remote sensing techniques and quantitative geomorphology, identification of the meander belt which is prone to rotational bank failure and annual flood, has became easy.

While the total river taming is hardly possible considering a tremendous eroding force of the Padma, the local people have to learn to live upon continuous adjustment with erosion. The response of the Government should be proactive. The low-cost house buildin, with easily detachable and movable materials, like corrugated sheets, bamboos, wood etc. may be provided on the *chars*. The futile ventures of bank restoration spending a large sum of money every year should also be avoided. The Government pays more attention to protect non-displaced, and the relief generally provided for the displaced persons seem to be meagre.

The minimum facilities for living, like drinking water, sanitation, school, medical centre, market etc. should be provided to the erosion-victims on the *Charlands*. Establishment of police outpost or B.S.F. camp may also develop a sense of security among the settlers. As the extensive areas of the *Chars* remain submerged during the rainy season, arrangement for elevated flood shelter is of absolute necessity. The school buildings may be so constructed that it can serve the dual role. As land is the most important life-supporting resource the displaced persons may be granted their rights (*Pattas*) without any delay, so that the conflict over the possession of land may be reduced.

The engineering measures, which involve huge capital investment, can partly or temporarily protect the non-displaced persons. But better preparedness and scientific resettlement strategies may improve the socio-economic status of the thousands of erosion-victims living a hazardous life on the *Charlands*.

Acknowledgement

The author is grateful to Mrs. Debjani Sinha of INTACH, Murshidabad Regional Chapter and to the Border Security Force for assistance during the fieldwork.

References

Banerjee, S.N. and Chakraborty, P. (1983) : Some observations on recent trends of shifting pattern of the Ganga between Rajmahal and Ahiron. *Journal of the Geological Society of India.* 24: 318-321.

Bhattacharya, N.D. (1978) : Changing course of the Padma and human settlements. *National Geographical Journal of India.* 24(1&2) : 62-76.

Colebrook, R.H. (1801) : On the course of the Ganges through Bengal. *Asiatic Researches.* 7: 1-31.

Das, S.C.and Dasgupta, R.K. (1992) : *Study on Combating Threat to Land Resources from Erosion and Bank Failure of the Rivers Bhagirathi-Hooghly and Ganga in West Bengal.* Eastern Regional Centre for Wasteland Development, Jadavpur University, Calcutta. Report 22 : 10-17.

Elahi, K.M. and Rogge, J.R. (1990) : *Riverbank Erosion, Flood and Population Displacement in Bangladesh.* Jahangirnagar University, Dhaka : 11-66.

Government of West Bengal (GoWB) (1995) : *Status Report on Erosion in Murshidabad.* 23p.

Hunter, W.W. (1876) : *A Statistical Account of Bengal, 9* (Districts of Murshidabad and Pabna). Trubner and Co. London : 91-97.

Rennell, J. (1788) : *Memoir of a Map of Hindoostan or the Mogul Empire.* M. Brown, London : 263.

Rudra, K.(1992) : In Search of the Source of the Bhagirthi (in Bengali). *Biswa Biksha.* 2(1) : 27-34.

Rudra, K. (1993) : Encroaching Ganga in West Bengal. *Indian Journal of Landscape System and Ecological Studies,* 16(2) : 82-88.

Rudra, K. and Rudra, G. (1990) : The delineation of the Indo-Bangladesh river border—some problems. *National Atlas and Thematic Mapping Organisation Monograph.* 10(1) : 94-95.

Sherwill, W.S. (1858) : *Report on the Rivers of the Bengal, 29.* G.A. Savielle Printing and Publishing Co. Ltd. Calcutta : 1-18.

The Hindustan Times (1986) : The erosion won't affect boundary. Issue dated 25 July, 1986 : 5p.

The Statesman (1994) : Helpless Jalangi residents turn violent. Issue dated 22 September, 1994 : 1p.

THEORETICAL FRAMEWORK FOR UNDERSTANDING THE NECESSITY FOR ECONOMIC AND SOCIAL EMPOWERMENT OF WOMEN

Arabinda Biswas & Manishree Mondal
Department of Geography, University of Burdwan
Barddhaman 713104

Abstract

Economic and social empowerment of women is a much needed step in our efforts at creating the basis for sustainable development. Female participation in gainful work is disproportionately lower than male participation rate particularly in the developing countries. In India, not more than 35 per cent of the able-bodied women belonging to the working age-group of 15-64 years are able to participate in outdoor wage-earning occupations. The rest 65 per cent of the working age-group females, however, manage most of the household work particularly collection of domestic water, fuel, fodder and also food apart from looking after the children. Yet, their contribution to resource conversion is highly under-assessed. An in-depth survey in the district of Medinipur, West Bengal, shows that women's perception of natural resources is much keener and more accurate than men's. Therefore, an appropriate management of natural resources and their use should take into account women's environmental perception and should aim at giving moral, material and organisational support to women's active participation in gainful work through economic rewards.

Introduction

Any meaningful policy aiming at desirable changes in the global and regional population-resource relationships should address the question of women's position vis-a-vis the society and the environment. The reasons may be found to lie in a number of very pedantic facts like the child-bearing capacity of women who can upset the demographic calculations any moment, the collection and primary use of a large number of natural resources like water, wood, wild food and fodder, the management and headship of poor households in particular, the discriminitions against women in many countries in terms of access to social services, credit and property ownership, the significant impact of women's education on birth rate, health and family size and the like (Tolba & El-Kholy, 1993). But all such facts, very important and significant though they are, do not explicitly tell us about the placement of women in the global, regional or local human ecosystems. The global human ecosystem in essence refers to the sum of all relationships between the global natural environment and human resource utilisation processes with all their consequences.

Labour Process in Human Ecosystem

These relationships for all theoretical and practical purposes may follow either deterministic or non-deterministic lines of development in terms of the qualities of and

resistance offered by natural environment. In other words, choice of product-mix and technology-mix either exist or not, the debate between environmental determinism, possibilism and probabilism may continue but the finiteness of the global environmental possibilities cannot be scientifically ignored. Choice or no choice, limiting conditions will continue to reappear as climacterics at different junctures and different levels depending on the quality of the environment and the modes of human intervention upon it (Bourne, 1976).

The environmental impact on society shapes itself by the interactions of mainly four processes. These are :

(a) spatial differentiation of the global environment into habitats of different dimensions;
(b) horizontal differentiation of the global society into culture groups ;
(c) vertical differentiation of the society into economic classes (with or without conscious recognition of the process by the classes themselves) ; and finally,
(d) redefinition of the habitat on the basis of its perceived qualities, as the intrinsic attributes of the phenomenal environment rarely determine the social or community modes of intervention upon the natural environment (Biswas, 1981).

Community perception of habitat leads to choice of the resource spectrum, choice of the technology-mix and also of the product-mix which, to a great extent, determine the level of social development of the community. Perceptions differ according to the whole range of historical, political and cultural conditioning of the community concerned, and have either fuller or constrained behavioural expressions depending on the economic capacity of the group concerned and the market relations prevailing in the global and regional societies. Regional and local economies are the results of such constrained expressions of environmental perceptions. Since no groups have unlimited economic freedom, it is only the constrained environmental perceptions which determine the mode of resource use, the spectrum of realisable resources and the quantum of resource utilisation at any given point of time and within any habitat of a given dimension, given resource abundance and given complexities of inter-group relationships.

Perceptions, resource spectrum, mode, quantity and rate of resource utilisation change over time due to the specific property of human ecosystemic mechanism as distinct from animal ecosystems. In animal ecosystems, behaviour is a result of instinctive or reptilineal response to any signal or stimulus produced from the surrounding conditions. In a human ecosystem, behaviour is the result of cerebral cognition (O'Riordan, 1976) of signals and stimuli, filtered through social norms, social purpose and social mode of reaction to favourable and unfavourable circumstances, all of which change over time due to bilateral transfer and exchange of naive resident perception of the insiders and the sophisticated scientific perception of outsiders about a given habitat (Biswas, 1982).

This conscious interaction of perceptive realities between naive and articulate perceptions of the qualities of matter and energy, between science and society and between the common mass and the leaders of the society, forms the essential property of human ecosystems whose efficiency depends upon its capacity to bridge the gap

between the potential and the realised resources of the environment. This relationship can be visualised in Figure 1.

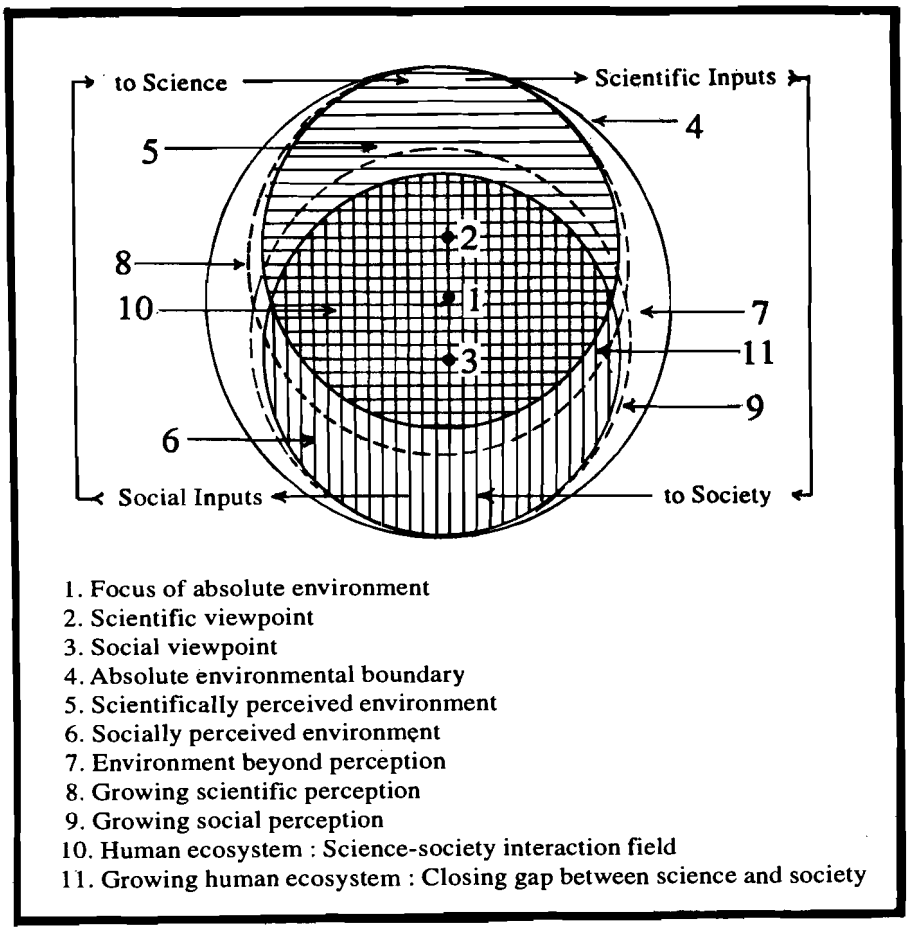


Fig. 1 Relationship between Science & Society and Phenomental & Perceived Environment

Within the constraints of the economy, there are privileged groups having a greater say in matters of choice of products and techniques, greater economic freedom and greater share of the benefits coming out of the product-and technology-mix, as much as there are under-privileged groups having lesser choice, lesser economic freedom and lesser share of the benefits.

Within each group again, the privileged and the under-privileged exist, creating wide differences in choice, capacity and benefits, the combined effects of which only

perpetuate and even accentuate the disparities. In animal ecosystems. the trunsduction of energy depends upon the size and diversity of theautotroph level. In human ecosystems, conversion of natural elements into raw materials and of raw materials into commodities depends on the size and composition of the social labour force (Biswas, 1985).

At any given level of perception, whatever the choice might be, both the spectrum and quantity of resource utilisation will depend on the proportion of the potential labour force actually engaged in the labour process, and the status of development will depend upon how efficiently the productive capacities of the different sections of the potential labour force for different types of socially productive activities are identified and deployed in appropriate spheres of work.

The Global Situation

The potential human labour force of the world are divided equally between the two gender groups and constitutes nearly two thirds of the total world population of about 6000 millions at present. The male labour participation rate has been found to be invariably higher irrespective of the status of development. But the proportion is significantly higher in the developing countries compared to the same in developed market economies, the erstwhile communist countries of Europe, China and other planned economies of Asia (Tolba & El-Kholy, 1993).

Female participation in gainful labour is about 62 per cent of the total female working-age population in China and only about 30 per cent in the developing countries. While the comparison itself is significant, much more has to be read from the fact that this labour force includes female children of the age group of 10-15, an age when they are expected to invest their time and energy for acquiring education, skill and orientation (Tolba & El-Kholy, 1993).

In 1970, there were about 77 persons under age 15 per 100 persons in the working-age group of 15-64 in the developing countries compared to 44 in developed regions (Tolba & El-Kholy, 1993). These proportions are not much different for male and female populations. The high child dependency ratio forces the under-privileged communities of the developing world to push their under-age future female labour force into immediate and premature wage earning, thus making women distinctly more under-privileged than their male counterparts, simply because they look after household affairs, earn their wages and at the same time consume the benefits in a disproportionately lower rate compared to the male members of the family.

The Indian Scenario

The Indian situation as of 1981 was not much different from the average conditions prevailing in the developing countries as a whole. The decisively under-privileged status of Indian women can easily be gauged from a number of simple statistical statements. As shown in Fig 2, while the average female male ratio (FMR) for all ages was 933, there were two critical ages, one between 10 and 14 and another between 50 and 54 at which the FMR dropped strikingly to 910 and 872 respectively (NATMO, 1985). The reasons, though not obvious, in all probability lie in the following facts. 10 to 14 is that critical

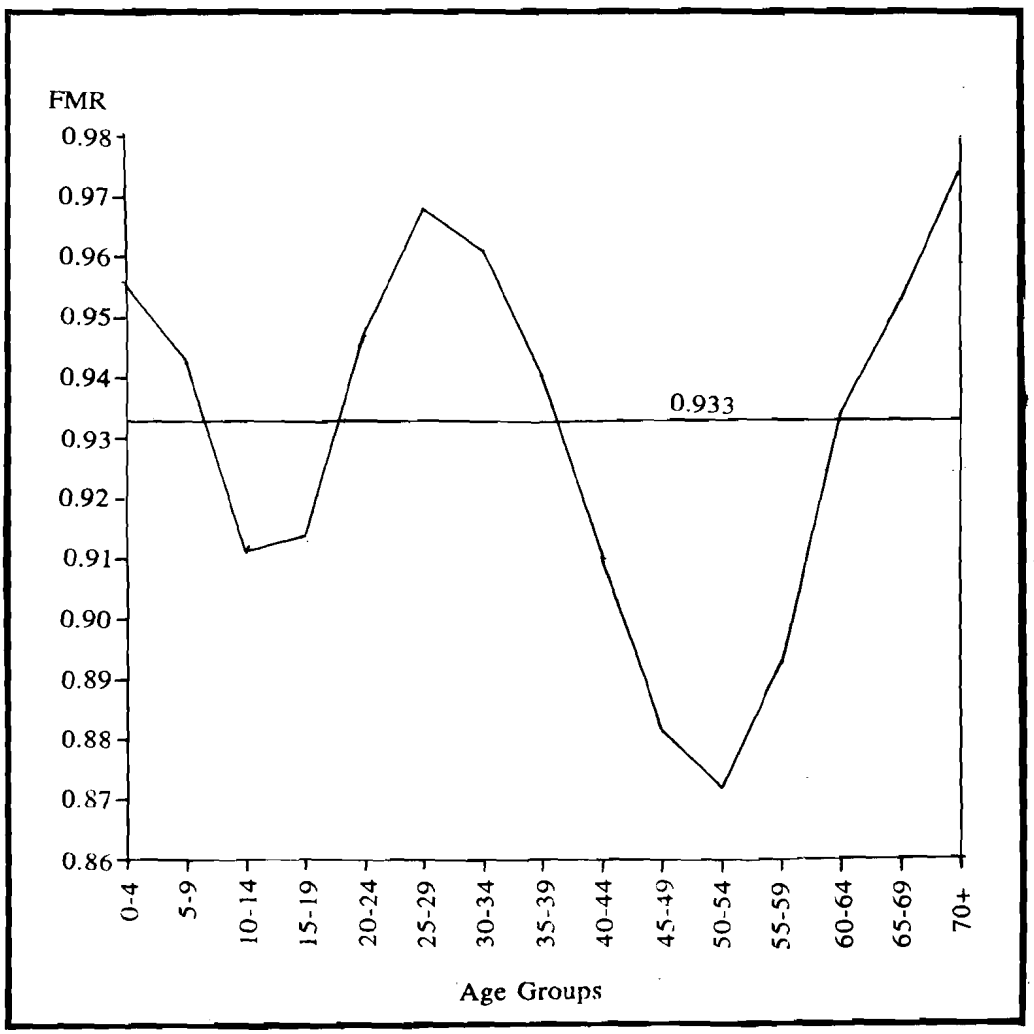


Fig. 2 FMR at Different Age-Groups in India (1981)

age at which female children experience their puberty when the advent of physiological capability of reproduction is associated with a sudden increase in the want for food and nutrition which in many cases remains unfulfilled partly due to economic conditions but largely due to the male dominance in the apportionment of the family diet. 50 to 54 is another critical age at which most mothers become incapable of child-bearing and start suffering from ill-treatment through the most materialistically effective means of tortures that is deprivation from their rightful share of food and healthcare. It is understandable therefore, why a large number of female children cease to live beyond the age of 12 and a still greater number of adult women die at the ages of 40 to 54 soon after crossing the

limits of their reproductive capability.

Considering that the proper working age for gainful occupations stretches from 15 to 64, India had 386 million persons in the working-age group in 1981, equivalent to about 56 per cent of the total population. The total number of main-workers on the other hand was only little above 32 per cent of the total population, meaning that nearly 24 per cent of persons belonging to the working age group had no work of any dignified category. Another 3 per cent of the total population was engaged as marginal workers. These average figures appear to be highly biased in favour of the male population in the sense that as much as 79 per cent of the male working-age group had some gainful work to do while the corresponding figure for females was only 46 per cent. The comparison is itself enough to bring out the stark inadequacy of economic empowerment of women in India. The reality of the situation becomes even more explicit when we see that about 8 per cent of the working-age males and 3 percent of the working-age females were identified as marginal workers in 1981 bringing down the shares of the male workers to

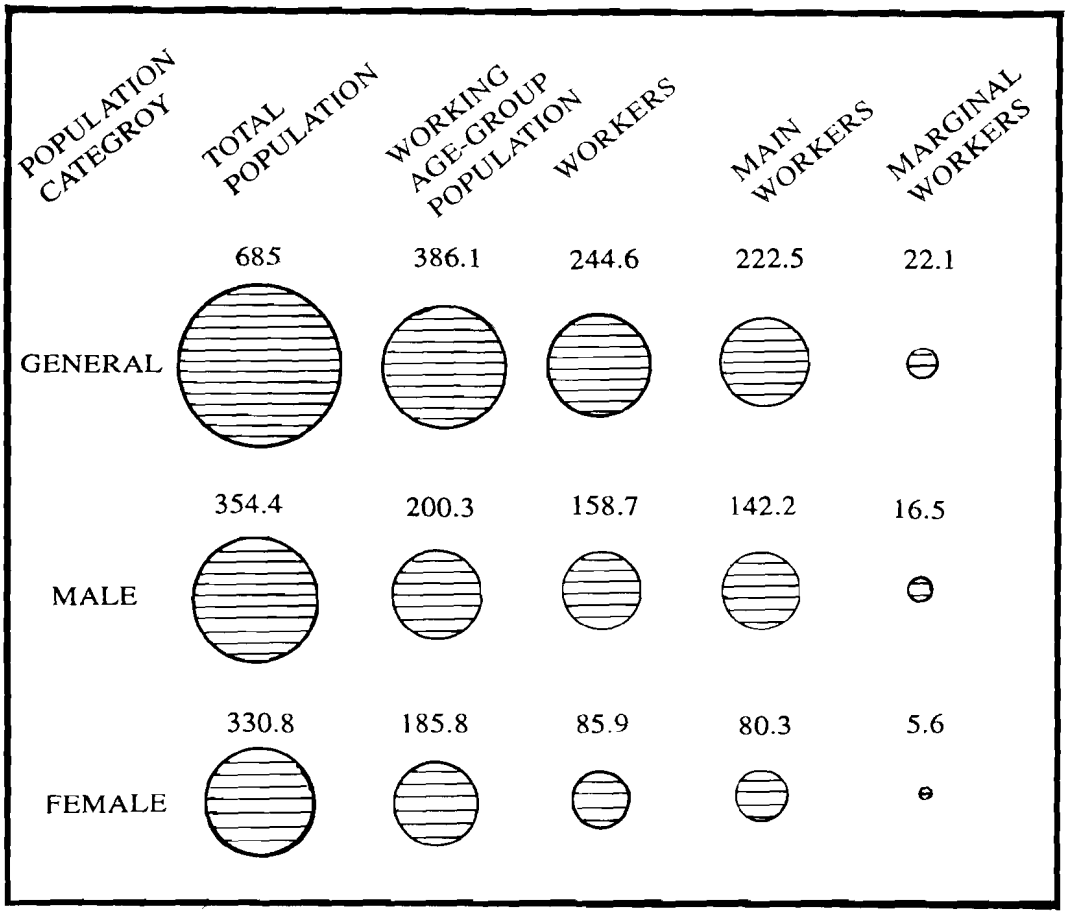


Fig. 3 Some Facts on Indian Population (1981)

71 per cent and female workers 43 percent of the respective working age populations. This utterly low 43 per cent was not free from the intrusion of female children of under 15 and old women of over 64 age groups. Thus, one can make a reasonably safe conjecture that not more than 35 per cent able-bodied women of our nation have scope of acquiring some economic freedom by means of participating in outdoor wage-earning occupations. The experience, on the other hand, shows that the rest 65 per cent of the working-age women are as busy in their indoor activities, particularly management of household affairs, as male outdoor wage-earners. Fig. 3.

While the question of economic empowerment of women is one facet of the totality of the problem, the other more important issue that should be taken up with due earnest is the under-evaluation of the quantum of work done by women in most of the rural families of India.

A Micro-level Experience from Rural West Bengal

In rural West Bengal for example, or for that matter in any other parts of rural India, the essential tasks which women must fulfil to run the family are cooking, washing, preservation of grains and other food materials and also the upkeep of domestic animals. Therefore, collection of water, fuel and fodder constitutes the principal sphere of interaction between women and their habitat.

As long as the neighbuorhood environment is friendly, the gender specific interactions may not be very conspicuously different from the general pattern. But as soon as the natural ecosystem in the vicinity of the neighbourhood becomes degraded, unstable or fragile, the differences become not only prominent, but also tell upon the healthy survival of the womenfolk of the society and the future generations.

Experience from a micro-level survey in rural West Bengal (Mondal, 1994) may help us have a deeper insight into the issues mentioned above particularly with reference to the natural resources of water and forests. Three villages, Pairaura, Dwarigeria and Khandibandh from the vicinity of Garhbeta in the district of Medinipur were studied at some depth through observations of visual facts relating to the phenomenal environment and human practices, group discussions and canvassing open-ended and closed questionnaire schedules among a sample of one hundred women respondents differentiated along age, income and ethnic lines, in terms of some fortynine questions related to physical environment, surplus income, shelter, nutrition, health, security, education, social stability and leisure—the basic components of social well-being, level of living, quality of life, social satisfaction, social welfare, standard of living and a desirable holistic environment (Drewnowski & Scot, 1968, Drenowski, 1970, 1972, 1974 Coates et al, 1977, Smith, 1977). Thirtyeight of these questions finally turned out to be important to the respondents.

It may be worth discussing some of the responses to questions which are relevant to what has been said in the earlier parts of this essay. Awareness about the need for afforestation was one of the issues in the questionnaire to which all women irrespective of ethnicity, income and age had a positive response to the effect that they realised its importance. But when they were further asked whether they were aware about any afforestation scheme being undertaken in the neighbourhood, it was only women from

the lower income group who invariably answered in the positive while a sizeable 28 per cent of the higher income group were unaware of such developments. Again, Scheduled Caste, Scheduled Tribe and Muslim women were more conscious about forests while others were less concerned. Thus while those belonging to the better-off middle caste peasantry were found to be trying to keep on with the style of the day by publicising their awareness about forests, the greater concern among the poorer and socially ostracised women was a result of their actual participation in the labour process that made the forests materially meaningful to them. This becomes even more evident when we find that all families belonging to the lower income group used only fuelwood for the purpose of cooking while only 31 per cent of the respondents from the higher income group used fuelwood and the rest depended on coal, gas, electricity and kerosene. All poorer families derived their fuelwood directly from forests but the middle and higher income groups purchased their fuelwood requirements from the market.

The responses to three questions related to drinking water were equally significant. To the first question "Where do you get drinking water from?", not even 10 per cent of the poorer families were found to be using water from tubewells and wells. Nearly 50 per cent of the middle income and more than 86 per cent of the higher income families derived their drinking water from tubewells and wells. Obviously 90 per cent of the poorer families had to depend on water from sources of questionable quality.To the query "Who fetches the water?", every respondent irrespective of income, ethnicity and age made it clear that procurement of domestic water was entirely the responsibility of women in rural areas. To another question "Do you use the same water for drinking and other purposes?", 90 per cent of the poorer, 60 per cent of the middle income and 35 per cent of the higher income families were found to be using different sources for different purposes. The Scheduled Tribes and Castes had to tap different sources for different purposes almost invariably, but the general castes or slightly better-off sections of the respondents had the privilege of using (wasting?) drinking water for other purposes as well.

The Task Ahead

Thus, water and fuelwood are the two most important natural resources whose identification, collection and utilisation heavily depend on the perceptive capacities, skill and concern of the women in rural West Bengal—the more marginal they are economically and socially, the more crucial is their involvement in the processes of utilisation of these resources.

There is a growing awareness that economic crisis, population growth and environmental degradation have a far better possibility of being solved through economic empowerment of women in formal and informal sectors of gainful work. The rate of participation of women in unpaid family labour is under-assessed in the rural sector. In the urban sector too, their actual participation in small scale home-based production or services cannot be overlooked. Yet, their wage rates are markedly lower compared to those of men. Thus there has been a 'feminization of poverty' (WHO, 1990) in which environmental degradation and pollution have a severe deleterious effect particularly in rural areas where a receding source of water or fuel has to be countered only with greater

doses of unpaid labour by the women of the community.

Women are as much converters of natural elements into raw materials and commodities as are men. To neglect their role in resource generation and utilisation tantamounts neglecting fifty per cent of the prospective resource conversion process and, therefore, fifty per cent of the chance of sustainable development. In order to harness this fifty percent of the resource horizon, the proper place of women in the human ecosystem has to be identified and proper material and organisational supports have to be extended to them (Eckholm, 1982) so that their labour powers are honed and realised at appropriate ages in appropriate spheres of productive activities.

While finding out the modalities through which effective supports could be extended to the prospective women labour force in the economy, women's perceptions of their environment and of resources contained in the environment have to be given premium over examining the intrinsic properties of the phenomenal environment from a narrow so-called scientific viewpoint. Women's perceptions of natural resources which enter the day to day household management in rural areas are apt to be keener and more accurate than men's. These perceptions should constitute important items of scientific enquiry in order to verify the elements of truth contained in them. At the same time there should be efforts to help women come out of their constrained behavioural expressions so that they can interact with the scientific world, contribute their knowledge and experience to the field of science and also absorb the inputs of science in their own spheres of activities.

References

Biswas, A. (1981) : The Concept & Ecosystem & the Position of Geographers. *Transactions of the Institute of Indian Geographers.* 3(1), Pune. pp 9-10.

Biswas, A. (1982) : Environmental Perception and Vulnerability of the Farm Sector. *Value Orientation and Environmental Education.* ed. Chakraborty S.C. Vivekananda Nidhi. Calcutta. 37-45.

Biswas, A. (1985) : Role of Labour in Man-Nature Interaction. 225-231 *The Concepts and Methods in Geography.* Institute of Geography, Burdwan University, Bardhaman.

Bourne, A.G. (1976) : Ecological Basis of Human Settlements, The Oxford Uviv. Press, 2-8 *Environment of Human Settlements.* In Laconte, P. (ed) Human Well-being in Cities. Proc. Conf. Brussels, Belgium Ministry of Pub- health, Brussels : 2-8.

Coates, B.E. Johnston, R.J. and Knox P.L. (1977) : *Geography and Inequality,* London : 8-22

Drewnowski, J. and Scot, W. (1968) : The Level of Living Index, *Ekistics.* 25 : 226-275.

Drewnowski, J. (1970) : *Studies in the Measurement of Levels of Living and Welfare,* UN Research Institute for Social Development, Geneva : 37-41.

Drewnowski, J. (1972) Social Indicators and Welfare Measurement : Remarks on Methodology, Ed., Baster N. *Measuring Development* Cases, London : 77-90.

Drewnowski, J. (1974) : *On Measuring and Planning the Quality of Life.* Mouten, The Hague : 15-16.

Eckholm, E.P. (1982) : *Down to Earth Environment and Human Needs* International Institute for Environment and Development, New Delhi : 146-147, 171-172.

Mondal, M. (1994) : *Women's Perception of Environment.* Unpublished M.A. dissertation Department of Geography, Burdwan University, Barddhaman : 1-86.

NATMO (National Atlas and Thematic Napping Organisation) (1985) *Glimpses of India,* Monograph-2, Calcutta : Table 2-4.

O'Riordan, T. (1976) : *Environmentalism* London : 50-70.

Smith, D.M. (1977) : *Human Geography : A Welfare Approach, Edward Arnold.* London : 12-35

Tolba, M.K. & El-Kholy, O (ed) (1993) *The World Environment 1972-1992—Two Decades of Challenge.* Chapman & Hall. London : 495-496.

WHO (World Health Organisation) (1990) : *Women, Health and Development, Progress Report.* Executive Board 87th Session, Provisional Agenda (EB 87/22). Geneva : 137.

URBANISATION IN THE DEVELOPING AND DEVELOPED COUNTRIES OF THE WORLD

Sachinandan Sau
Department of Economics with Rural Development, Vidyasagar University, Medinipur 721 102

Abstract

Level, pace and pattern of urbanisation vary widely across the low-income and middle-income (developing) countries and high-income (developed) countries of the world. In the developing countries (including India) the rate of growth of urban population has been comparatively high, though their level of urbanisation is low. On the other hand, in the developed countries this rate of urban population growth has been comparatively low, though their level of urbanisation has been high. In both the developing and the developed countries deceleration in the level of urbanisation as well as the rate of growth of urban population has set in; though this deceleration has been comparatively rapid in the developed countries. There is high concentration of urban population in the metropolitan cities in both the developed and developing countries (including India). Per capita income, percentage share of industry in GDP and that of industry, and services in total labour force can significantly explain the differential level of urbanisation across the countries of the world.

Introduction

The term 'urbanisation' is frequently used as an index of socio-cultural and economic development of a country. There is spatial variation in respect of different aspects of urbanisation across not only the countries of the world but also the different regions within a country. Some of the questions that are raised in this context are : in what ways does urbanisation vary over the space? And what factors account for this variation? This paper makes an attempt to analyse these and other related aspects with reference to the developing and developed countries of the world.

The importance of such a study arises out of the inadequacy of the existing literature to give answers to the questions stated above. Though a lot of literature has recently been developed on world urbanisation (Breese, 1966: Chandna, 1986) very few focus on the variation of the level, pace and pattern of urbanisation in the developing and the developed countries of the world.

Objectives of the study : The present study sets the following objectives for itself :

(i) to discuss the level and pace of urbanisation in the developing and the developed countries of the world;
(ii) to examine the pattern of urbanisation in these economies; and
(iii) to analyse the factors that explain the differential urbanisation in these economies.

Hypothesis : It is hypothesised in this work that the level as well as pace and pattern of urbanisation vary significantly in the developing and the developed countries of the

world. It is argued here that this differential urbanisation is explained mainly by the economic factors.

Data base and methodology : This work is based on secondary data. World Development Report, Human Development Report and World Resources provide the major data sources.

Almost all the countries of the world for which the relevant data of the world are available constitute our samples under study. These sample countries have been grouped as per their per capita income.

The collected secondary data have been analysed using various statistical and econometric techniques including coefficient of variation, regression analysis, etc.

Graphical representation of the data relating to the level and pace as well as pattern of urbanisation is made by bar and line diagrams to show their trends, and pattern of distribution among the different income groups of the countries of the world.

Multiple regression technique has been used in an attempt to capture the explanatory power of the various factors, such as per capita income, percentage of labour force engaged in industry and services in explaining the variation in urbanisation level. By employing this technique, an attempt has been made to capture the role of per capita income, industry, etc. in raising the urbanisation level in the sample countries. For this purpose, urban population as percentage of total population of the sample countries has been used as the dependant variable and per capita income, share of industry in labour force and GDP, etc. as independent variables.

Concepts Used

For the sake of clarity of analyses an attempt has been made to define different concepts used in this work. Urbanisation itself is a comprehensive concept. It bears different meanings and implications to persons belonging to different disciplines. Urbanisation is a process of spatial change of population and sociological and economic transformation of people and regions. Geographers view urbanisation as a process of concentration of population in larger human settlements. Urban centres are grouped into classes on the basis of size of population or functional characteristics (Gilbert & Gugler, 1987). Sociologists treat urbanisation as a process of diffusion of certain modernizing traits or characteristics in a population (Gold thrope, 1984). Economists treat urbanisation as a process whereby primary production functions are replaced by secondary and tertiary functions (Misra, 1978).

Level of urbanisation of a country or a region is defined as the proportion of urban population (Up) in its total population (Tp). Kingsley Davis (1955) defines the level of urbanisation as the ratio of urban to total population at a given time, Ut/Pt or as a rise in that ratio, Δ Ut/ Δ Pt.

Rate of pace of urbanisation is defined as the percentage change in the level of urbanisation. Symbolically this can be presented as :

$$Ru = \frac{\Delta(Up / Tp)}{Up / Tp} \times 100$$

where, *Ru* stands for rate of urbanisation, and Δ stands for change.

Rate of growth of urban population is defined as the increase in Up as a percentage of the initial Up. Symbolically,

$$RGUP = \frac{\Delta Up}{Up} \times 100$$

where, RGUp stands for rate of growth of urban population. ***Acceleration*** in the rate of growth of Up is defined as the increase in this rate of growth over years, while ***deceleration*** implies the reverse.

Pattern of urbanisation indicates the particular type of urbanisation. Two patterns of urbanisation are generally considered : (i) structural pattern, and (ii) functional pattern. Both these types may show (i) balanced pattern, (ii) unbalanced pattern. The balanced structural pattern and implies spatial balancing of the level of urbanisation within a country. In other words, it indicates the intra-country structural balancing. On the other hand, the functional pattern of urbanisation may show three characteristics and types—(i) primary activity-based urbanisation, (ii) secondary activity-based urbanisation, and (iii) tertiary sctivity-based urbanisation. These occur while functional pattern of urbanisation is unbalanced. The balanced functional pattern implies more or less equal importance of sectoral economic activities.

World Development Report include all low-and middle-income countries of the world under the title "Developing economies". Low-income countries have been defined in World Development Report 1996 as ones whose GNPs per capita do not exceed 750 dollars, and the middle-income countries are those whose GNPs per capita do not exceed 9,000 dollars. Developd economies are high-income economies which have advanced industrially as well as in services.

Level of Urbanisation

As per World Development Report 1987 urban population, as percentage of total population in 1985 in the developing economies, was 31, while in the industrial market economies it was 75. In 1994, as per World Development Report 1996, the respective figures were 39 and 77. In the low-income economies (of the developing countries) the level of urbanisation was still lower, 22 per cent in 1995 and 28 per cent in 1994. In the middle-income economies, however, the level of urbanisation was relatively high, 48 percent in 1985 and 61 per cent in 1994. These clearly suggest that the level of urbanisation varies significantly across the developing economy group and the developed economy group and within the former group itself it varies significantly across the low-income and the middle-income economy groups.

In 1980, the coefficient of variation was 54.76 percent. It declined marginally to 53.05% in 1985 and further to 45.51% in 1994. The data indicate that variation in level of urbanisation across the sample countries of the world is still substantial.

Another interesting feature is that though the level of urbanisation in the developing countries is relatively low, the absolute number of urban population in these economies together constitutes more than two times higher than that in the developed economies as a whole.

Table 1 : Level of Urbanisation and its change in the Developing and Developed Countries of the world, 1985 and 1994.

Country Groups	Urban Population (Up) (Million)		Total population (TP) Million)		Up as percen tage of Tp		Absolute Change in (Up./ Tp)	percentage Change
	1985	1994	1985	1994	1985	1994	1985-1994	1985-1994
A. Developing countries	1141.3 (100)	1853.4 (162)	3681.5 (100)	4752.2 (129)	31	39	8	25.80
i) Low-income countries	536.7 (100)	891.0 (166)	2439.4 (100)	3182.2 (130)	22	28	6	27.27
ii) High-income countries	596.2 (100)	957.6 (161)	1242.1 (100)	1569.9 (126)	48	61	13	27.08
B. Developed countries	553.0 (100)	654.4 (118)	737.3 (100)	849.9 (115)	75	77	2	2.66
Total	1694.3	2507.8		5602.1	38	45	7	18.42

Source : World Develpment Report 1987, 1996.
Note : Figures within ( ) indicate respective index number..

Besides, the developing countries are experiencing the rapid rise in the level of urbanisation compared to that in the developed economies. While the developing countries recorded about 26 percent increase in the level of urbanisation, the developed countries recorded only about 3 percent rise (Table 1). The level of urbanisation in the countries in 1985 and 1995 is shown in Figure 1.

Another interesting feature which is revealed from the above table is that the developing countries experienced higher rate of growth of urban population (68%) during the period 1985-1994 than that of total population (29%). The developed economies also experienced the same though their urban population growth rate has been somewhat lower (18%),

The frequency distribution of the developing and the developed countries shows that more than 70 percent of the low-income countries are concentrated in the urbanisation level classes having below 40 percent urban population, while in the middle-income countries more that 60 percent of the countries are concentrated in the classes where level of urbanisation ranges between 40 percent and 79 percent. On the other hand among the developed countries more than 80 percent are concentrated in the urbanisation level classes ranging between 60 percent and 100 percent (See Table 2).

Table 2 Frequency Distribution of Developing and Developed Countries by their level of Urbanisaton, 1985 and 1994

Level of Urbanisation	Number of Countries					
	1985			1994		
	L. i.e.	M. i.e.	H. i.e.	L. i.e.	M. i.e.	H. i.e
2-19	13 (38)	5 (9)	-	7 (14)	2 (14)	1 (4)
20-39	19 (56)	10 (17)	2 (6)	29 (56)	6 (11)	1 (4)
40-59	2 (6)	26 (45)	3 (10)	12 (24)	23 (40)	2 (8)
60-79	-	10 (7)	18 (56)	3 (6)	20 (34)	9 (36)
80-100	-	7 (12)	9 (28)	-	6 (1)	12 (48)
Total	34 (100)	58 (100)	32A (100)	51 (100)	57 (100)	25 (100)

Source : Same as in Table 1.
Notes : L. ie, indicates low-income economies.
M.i,e. indicates middle-inom economies.
H.i,e indicates high-income economies.
Figures within ( ) indicate percentage share to total.

Average annual growth rate of urban population in the developing economies, particularly in the low-income economies, has been spectacularly high, more than four times the growth rate in the developed economies during 1980-1990 and 1990-1994. Another important feature is that in all the countries the growth rate has very recently declined. But this deceleration in the urban population growth rate has been substantial in the developed countries, while it has been marginal in the low-income countries (See Table 3).

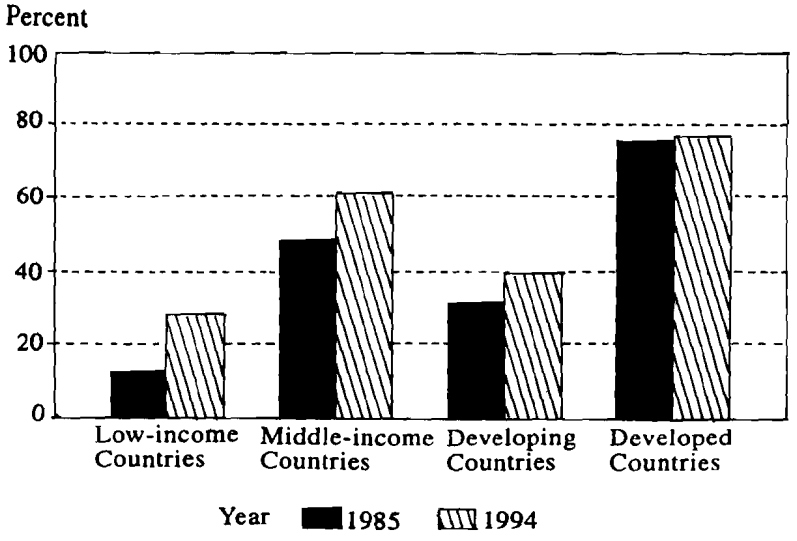


Fig. 1 Percentage of urban population to total population

Table 3 Average annual growth rate of urban population in the Developing and Developed countries

Country Groups	Average annual growth rate (Percent)		
	1965-80	1980-90	1990-94
i) Low-income countries	3.6	4.2	3.8
ii) Middle-income countries	4.4	3.0	2.4
A. Developing countries	3.9	3.6	3.1
B. Developed countries	1.4	0.8	0.3

Source : Same as in Table 1

Differential growth rates of these countries are shown in Figure 2

Pattern of Urbanisation in the Developing and Developed countries

In the developed countries urbanisation has traditionally been based on industrialisation. In recent years, the share of industry in GDP has been higher in these countries than in the developing ones. Service sector has also advanced in all the economies playing a very important role in the urbanisation process (Table 4).

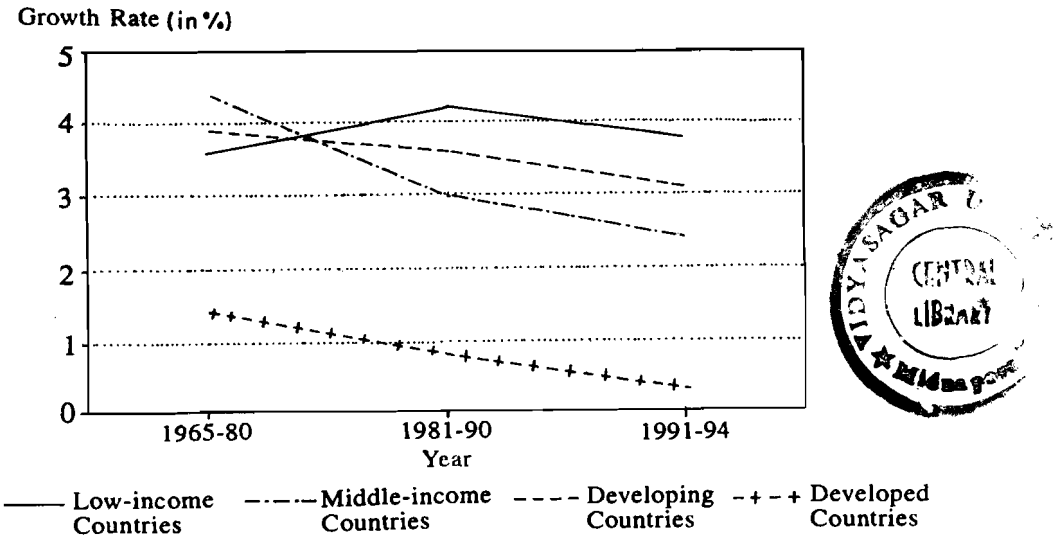


Fig. 2 : Average annual growth rate of urban population

Table 4 Percentage Share in GDP of Industry and Services in 1985 and 1994

Country Groups	Percentage share in GDP of			
	Industry		Services	
	1985	1994	1985	1994
A. Developing countries	34	36	47	48
i) Low-income countries	33	34	35	36
ii) Middle-income countries	34	36	52	52
B. Developed countries	36	-	61	-

Source : Same as Table 1

Both in the developed and in the developing countries most of the urban population are concentrated in the metropolitan cities having population over five hundred thousand. In these country groups this concentration of urban population increased over the years but apparently at a higher rate in the developed countries than in the developing ones (Table 5).

Table 5 Concentration of Urban population in Metropolitan Cities, 1960 to 1994

Country Groups	Percentage of Urban population			
	In cities of Over 5 hundred thousand persons		In cities of 1 Million or more	
	1960	1980	1980	1994
A. Developing countries	34	46	32	34
i) Low-income countries	31	55	32	34
ii) Middle-income countries	37	49	32	33
B. Developed countries	48	55	40	43

Source : Same as in Table 1.

Factors explaining the differential urbanisation level across the sample countries

There are many historical, economic and cultural reasons for the differential level of urbanisation across the countries of the world. However, only economic factors may be considered here; such as, per capital income, share of industry in GDP and percentage of labour force in the industrial and the service sector.

Simple linear regression technique has been used to explain the differential urbanisation level across the sample countries. The results are shown in Table 6.

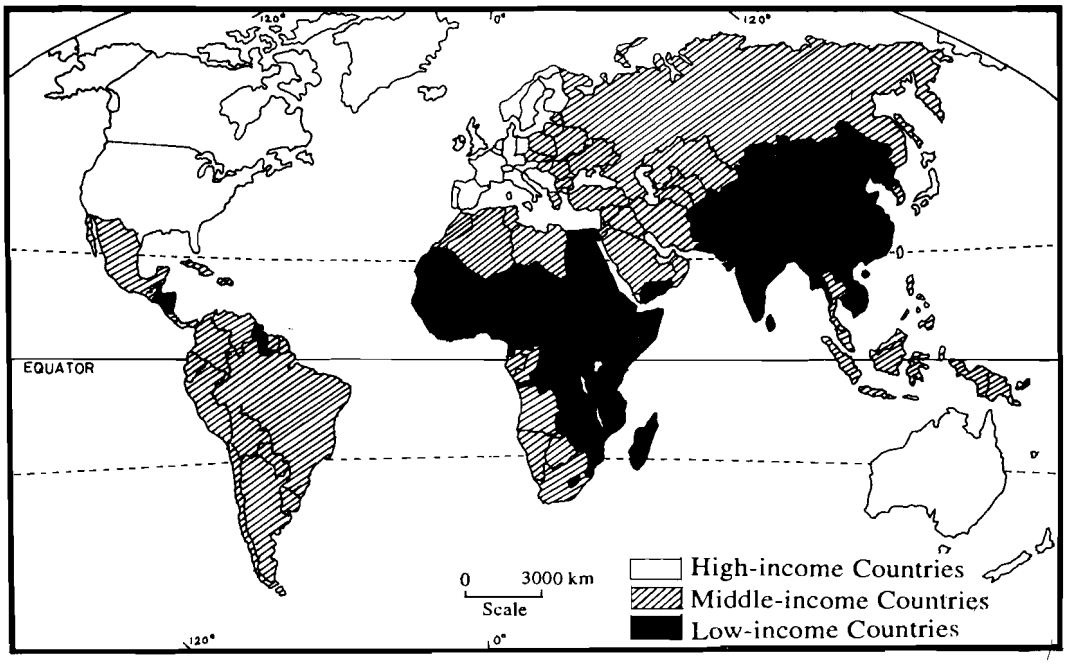


Fig. 3 : Distribution of different groups of countries in the world

Table 6 Estimated Linear Regression equations concerning level of urbanisation as the dependent variable Explanatory Variables

Model	Year	Constant	X_1	X_2	X_3	X_4	X_5	R^2	R^{-2}	F
I	1980	4.9615	0.5268*	0.8769*	-	-	-	0.714	0.709	160.78
			(4.17)	(8.81)						
II	1985	24.5178	-	-	3.4491E $^{-3*}$	0.376**	-	0.511	0.506	48.09
					(7.31)	(2.14)				
III	1985	-53.0166	-	-	-	0.9088*	1.5094*	0.639	0.632	81.56
						(6.88)	(10.26)			
IV	1994	40.2868	-	-	1.8434E^{-3*}	0.0628***	-	0.355	0.343	29.94
					(7.32)	(1.76)				
V	1994	2.7409	-	-	-	0.0619	0.9223*	0.291	0.278	28.42
						(1.65	(6.46)			

Notes : X1 = percentage of labour force in industry,
X2 = that in services
X3 = GNP per capita,
X4 = percentage share of industry in GDP,
x5 = that of services in GDP.
*indicates the coefficients are significant at 1 percent level
**indicates the coefficients are significant at 5 percent level
***indicates the coefficients are significant at 10 percent level

It is revealed that all the models are significant since F values are significant at 1 percent level. In the Model I more than 71 percent in the variation in the urbanisation is explained with the help of X_1 and X_4, whose coefficients are significant at 1 percent level. In other models 29 to 64 percent of the variation in the dependent variable is explained with the relevant explanatory variables.

Pattern of Urbanisation in India

India, being a developing country, belongs to the low-income economy group. The per capita income in India in 1994 was equal to 320 dollars. The percentage of urban population in India in 1994 was 27 as against 23 in 1980. India experienced rapid growth of urban population in recent years, though some deceleration in the level of urbanisation has been noticed (Table 7).

Another noticeable feature of India's urbanisation is that it represents the centralised pattern of urbanisation (Table 8).

Table 7 Level and pace of urbnisation in India

	1985	1994	1965-80	1980-90	1990-94
Urban population (up)	191.3	246.7	-	-	-
(in million)	(100)	(119)			
% of Up in Tp	25	27	-	-	-
Average Annual					
Growth of up (%)	-	-	3.6	3.2	2.9

Note : Figures within ( ) indicate index numbers.

It is revealed from the above Table that (i) total population (Tp) of India increased by 19 percent during 1985-1994, (ii) urban population (Up) increased by 29 percent , i.e., increase in Up has been higher than that in Tp, (iii) Average annual growth of Up was quite high during the period from mid-1960s to 1990 i.e., 3.6% during 1965-80 and 3.2% during 1980-90, (iv) there is deceleration in Up growth rate, i.e, decline in up growth rate from 3.6% during 1965-80 to 3.2% during 1980-90 and further to 2.9% during 190-94.

Table 8 Distribution of Urban population in India among different size-classes of towns

	1960	1980	1994	1931	1961	1981	1991
Percentage of Up in cities of over 5 hundred thousand persons	26	39	-	-	-	-	-
Percentage of Up in cities of 1 million or more persons	-	25	35	-	-	-	-
Percentage of Up in							
i) I class towns	-			27.4	48.4	60.4	65.2
ii) II class towns				11.9	11.9	11.6	10.9
iii) III class towns				18.8	18.5	14.4	132
iv) IV class towns				19.0	13.0	9.5	7.8
v) V class towns				17.3	7.2	3.6	2.6
vi) VI Class towns				5.6	0.9	0.6	0.3

Sources : Census of India, 1931, 1981 and 1991.

The Table reveals that i) percentage of Up in cities of over 5 ,00,000 persons increased from 26 in 1960 to 39 in 1980, ii) percentage of Up in cities of 1 million or more persons increased from 25 in 1980 to 35 in 1994, iii) percentage of Up in class I towns increased from 27.4 in 1931 to 48.4 in 1961, and further to 65.2 in 1991, iv) percentage of Up in other size classes of towns continuously declined, and v) this decline in percentage share of Up has been sharper from IV to V size classes of towns. All these indicate an increasing concentration of Up in class I towns in India.

Table 9 Spatial variation in level of urbainsation in some states and regions of India and their per capita income and share of industry in labour force.

Regions/States	Percentage of Up to Tp		Per capita Income	Percentage share of Industry in Labour force
	1991	1981	1990-91	1991
Eastern Region				
Assam	11.08 (17)	9.88	4,014 (15)	4.18 (17.5)
Bihar	13.17 (16)	12.46	2.655 (14)	4.18 (17.5)
West Bengal	27.39 (7)	26.49	4,753 (9)	15.46 (3.0)
Orissa	13..43 (15)	11.82	3.077 (18)	6.57 (14.0)
Western Region				
Goa	41.02 (1)	32.03	8,797 (1)	15.45 (4.0)
Maharastra	38.73 (2)	35.03	7,316 (4)	17.15 (2.0)
Gujarat	34.40 (3)	31.08	5,687 (5)	18.48 (1.0)
Rajasthan	22.84 (13)	20.93	4,113 (14)	9.51 (11.0)
Southern Region				
Tamil Nadu	34.20 (4)	32.98	5,047 (7)	15.32 (5.0)
Karnataka	30.91 (50	28.91	4,696 (11)	10.99 9.0)
Andhra Pradesh	26.84 (8	23.25	4,728 (10)	9.76 (10.0)
Kerala	26.44 (9)	18.78	4,207 (12)	12.23 (7.0)
Northern Region				
Punjab	29,72 (6)	27.72	8,373 (2)	12.40 (6.0)
Haryanan	24.79 (10	21.96	7,502 (3)	11.09 (8.0)
Hammu Kashmir	23.83 (11)	21.05	3,872 (16)	- -
Madhya Pradesh	23.21 (12)	20.31	4,149 (13)	7.70 (13.0)
Uttar Pradesh	19.89 (14)	18.01	3,516 (17)	7.98 (12.0)
Sikkim	9.12 (18)	16.23	5,063 (6)	4.93 (16.0)
Himachal Pradesh	8.70 (19)	7.72	4,70 (8)	6.8 (15.0)

Sources : i) Census of India, Paper 2 of 1981, 27-28.
ii) Census of India, Paper 2 of 1991, 16-18.
iii) Reserve Bank of India, Report on Currency & Finance, Vol.1, 1992-93
Note : Figures within in ( ) indicate their respective ranks

Spatially, the western part of India is more urbanised than the eastern part and the southern part is more urbanised than the northern (Table 9).

Historical, economic and cultural factors may explain the lopsided pattern of urbanisation in India. it is a certain fact that colonial rule in India was responsible for the development of infrastructures including ports like Calcutta and Bombay. These force played an important colonial role in the form of exports of relatively cheap agricultural raw materials and mineral resources, and imports of finished consumer goods. In recent years, these port-cities are playing the developmental roles.

Differential economic performances of the states in India can very well explain the differential level, pace and pattern of urbanisation. The states belonging to the western part of India have higher per capita income and higher share of industry in labour force. These factors very well explain the differential level of urbanisation across the relevant states. The states belonging to the south also advanced significantly in recent years, which are reflected in the rapid growth of per capita income (Table 9) .These factors also explain the higher urbanisaton level in the southern states, compared to those belonging to the northern part of India. Rank correlation between per capita income of Up to Tp and for capita is estimated to be 0.5944.

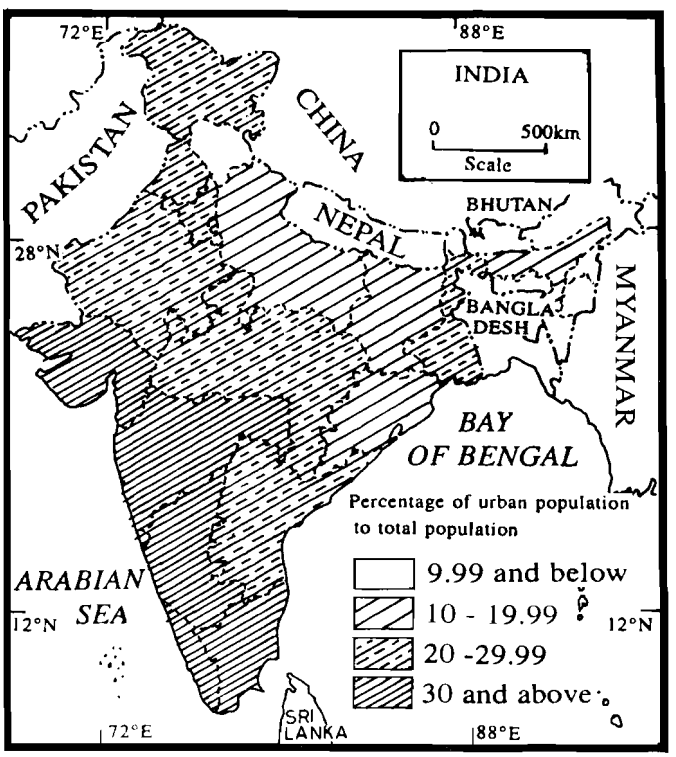


Fig. 4 : Percentage of urban population to total population in the states of India

Summary and Concluding Remarks

Level, pace and pattern of urbanisation vary widely across the developing and developed countries of the world. The coefficient of variation in the level of urbanisation across a large number of sample countries has, no doubt, declined over the years, but it has remained substantially high. The level of urbanisation in the developed economies has been higher than that in developing economies. From the frequency distribution of countries by size class or level of urbanisation it has been observed that the sample developing countries are concentrated in the size classes of 2 to 59 percent level of urbanisation, while the sample developed countries are concentrated in the 60 to 100 size classes. Though the level of urbanisation is relatively low in the developing economies it is rapidly rising. Rate (pace) of growth of urban population in the former set of countries is high compared to that in the latter. In recent years there has occurred deceleration in the rate of growth of urban population in both the economes. But this deceleration is higher in developed economies. Historically, urbanisation in the developed economies is based on industrialisation and recently it is increasingly being based on expansion of services.

An attempt has been made to explain the differential level of urbanisation across the developing and developed countries in terms of economic factors. Per capita income, percentage of labour force in industry and services, and percentage share of industry in gross domestic product can significantly explain the variation in the level of urbanisation across the sample countries.

From the analysis above the following policy recommendations may be made. First, the variation in the level of urbanisation across the countries may be reduced through economic growth. Rapid increase in per capita income and industrialisation can contribute significantly to reducing the variation in the level of urbanisation across the countries. Secondly, structural changes of these developing economies, which support increasing absorption of labour force in the industries and services, should be induced so that they can help significantly in reducing the differences in urbanisation level. Thirdly, development of urban infrastructures emerges to be necessary because of limited explanatory powers of the pairs of the above factors (R_2 being not high in most cases). In fact, the rapid overall development (i.e., economic, social and cultural developments) of the developing economies is a *sine qua non* for removing the differences in urbanisation level across the countries of the world.

References :

Breese, G. (1966) : *Urbanisation in Newly Developing Countries.* Englewood, Cliffs, N.I.

Chandua, R.C. (1986) : *A Geography of Population.* Kalyani Publishers, New Delhi. Davis, K. (1955) : The Origin and Growth of Urbanisation in the World. *American Journalof Sociology,* 60(5) : 429-437.

Gilbert, A. & Gugler, J. (1987) : *Citties, Poverty and Development of Urbanisation in the Third World.* Oxford University Press, London.

Goldthrope, J.E. (1984) : *The Sociology of the Third World : Disparity and Development.* Cambridge University Press, Cambridge.

Misra, R.P. (1978) : Million Cities in the Context of World Urbanisation. In Misra, R.P. (ed.) *Million Cities of India,* Vikash Publishing House, New Delhi.

DECENTRALISED PLANNING THOUGHTS AND METHODS : A REVIEW

Arjunan Mohan
National Informatics Centre, Planning Commission. New Delhi-100 003.

Partha Pratim Das
Department of Computer Science & Engineering, Indian Institute of Technology, Kharagpur-721 302

&

Rabindranath Chattopadhyay
Rural Development Centre, Indian Institute of Technology, Kharagpur-721 302

Abstract

An up-to-date review of the relevant literature, dealing with decentralised planning in India, has been carried out. It is organised in three parts covering the efforts made on conceptualising the notion of decentralised planning in different periods of Indian Five Year Plans; the historical perspective on the development of the statistical system in India and the application of computers in planning. It is clear from the review that several efforts have been made from the inception of planned development to decentralise the planning process, though without much success. It is due to the lack of any decentralised statistical system to support the planning functionaries. However, steps are being taken by the Government through nationwide projects to give due importance to the spatial planning at the local level. These projects are being carried out with an objective to experiment the viability of computer technology in data collection, storage and analysis. But similar attempts in academic institutions are yet to take off in a significant way.

Introduction

In Indian planning the concept of Decentralised Planning, though advocated, could not be practised till the Seventh Five Year Plan. One of the main reasons as pointed out by many planners and economists clearly revealed that unless the statistical support is assured at the decentralised spatial units, it cannot be possible to incorporate the micro-level parameters in the planning models. Even if such support is assured, the complexity of the modern society demands careful judgement based on sufficient information about the consequences of all alternative courses of actions. This necessitates further treatment of the large volume of data collected. As an outcome of the information explosion being experienced all over the world, the introduction of computers offer greater opportunity to collect, store, manipulate and analyse the large quantum of data. In this process the trade-off between the conceptual evaluation of decentralised planning, statistical system and the computer applications needs no emphasis.

In view of the above, an attempt has been made to take a stock of the efforts made to Decentralise the Planning process, the statistical system and the use of computers in planning to understand the sustainability of the concept of decentralised planning. As mentioned earlier, this review is restricted to Indian scenario, because the effective adoption of information technology in planning is a recent trend in India which may not be compared with other developed countries.

Decentralised Planning Efforts in Indian Five Year Plans

The strategy of economic development of the country has to draw support and sustenance from the studies of resources and possibilities of the states and similarly for the states from districts, districts from blocks and so on. In the pre-independent India, in the absence of such analysis covering the entire spectors and spaces, it was not possible to guide development rationally, avoid costly mistakes and forecast future contingencies wisely and constructively. Problems of this type called for serious thinking on the decentralised development plannng during the planning era.

1st Five Year Plan (1951-56) : Though the concept of Decentralised Planning emerged right at the beginning of the planning era, the approach of plan formulation and execution have remained as a centralised exercise since then. During the First Plan period the effort was contemplated at macro level, which concentrated on capital goods industries and their related sectors to get maximum returns for the investement. the main lacuna in this approach as pointed out by many economists and planners is that these capital goods industries depended on the imports on one hand and failed to generate its trickle down effects for development of sub-national or local spatial units.

In this plan document, the concept of Decentralised Planning within the framework of state plan was clearly emphasised, which was reiterated in one form or other in all the subsequet Five Year Plan documents. It was stated as : 'A democracy working for social ends has to base itself on on the willing assent of the people and not the coercive power of the state... their own views about their needs and difficulties and the correct solutions must be elicted and given the fullest weight in making the plans, in the execution of which they will be called upon to assist... means to have, therefore, to be devised to bring the people into association both at the stage of formulation of the plan and in their implementation form stage to stage' (First Five Year Plan, 1951).' Further, it was also stated that : 'no plan can have any chance of success unless million of small farmers in the country accept its objectives, share in its making and regards it as their own...?

All these remained just as statements and could not be concretised that confined the plan formulation exercise only at the state level. A pioneering attempt on decentralisation was the establishment of inter-state authorities, particularly for the river valley projects. Similarly, the constitution of Inter-State Development Authority in 1952 for the rehabilitation of refugees under the joint effort of the centre and states like Orissa, Madhya Pradesh and Andhra pradesh may be considered as a milestone in the process of decentralised path of development.

2nd Five Year Plan (1956-61) : During this plan period some thoughts on the concept of local horizontal plan emanated. Though this concept generated significant discussions, no serious effort could be given towards operationalisation of the same. However, certain sectors and activities were identified for planing and execution at the district level. Such sectors and activities were : i) Community Development and National Extension Programme, ii) Social Welfare Extension Projects, iii) Agricultural Production Programme and Allied Activities such as Animal Husbandry, Soil Conservation Etc., iv) Development of Co-operatives, v) Village and Small Industries, vi) Housing and Urban

Development, vii) Programme for the Welfare of Backward Classes, viii) Primary and Secondary Education, ix) Health Units and Sanitation, x) Land Reforms etc. (Planning Commission, 1966).

Though the sectors and activities were identified, the actual approach of planning remained same as that of the previous Five Year Plan.

3rd Five Year Plan (1961-66) : In this period only the first attempt on decentralisation to the first level, i.e. state level planning, was made. Introduction of the three tier Panchayati Raj System which was recomended by the Balwant Raj Mehta Committee was tried during this period.

It recommended constitution of statutory elective local bodies with the necessary resources, power and authority and a decentralised administrative system working under their control, which became the genesis of Panchayati Raj System introduced in the country (Rao, 1989). Thus the process of decentralisation in Indian planning was given a new direction through the promulgation of the Panchayati Raj Act.

4th Five Year Plan (1969-74) : In this plan period emphasis was shifted from the conceptual issues to the environment for decentralisation. Efforts were made to strengthen the planning machinery at different local levels. The Planning Commission issued guidelines for district planning in 1969 and launched a scheme for strengthening the planning machinery at state level during 1972. On issuing the guidelines, the Planning Commission realised the existence of wide disparities in the level of development over the regions and across sections of the population. It also felt the need for proper assessment of local problems and potentials. Further, it pointed out that lack of strong data base is also one of the main reasons for the lapses in the previous plans. Its guidelines emphasised the district as the planning unit for its data availability, of departmental manpower and convenience of coordination. These guidelines also specified the planning process to be adopted in the formulation of district plans. However, the state governments had been given freedom to adopt or modify those according to their suitabillity (Planning Commission, 1969).

The awareness on the imbalances in the levels of development which lead to the disparities among and within the regions resulted in the appointment of the Wanchoo Committee at national level for the identification of backward pockets on a district basis. But, after identification, hardly anything could be done towards reduction of the imbalances.

Several area specific programmes, like Drought Prone Area Programme (DPAP), Command Area Development Programme (CADP), Integrated Tribal Development Programme (ITDP), Desert Area Development Programme (DADP) and Hill Area Development Programme (HADP), with focus on agricultural development were introduced. Though these programmes showed some impacts on the development of some typical areas, they could not be integrated into a coordinated programme looking forward for balanced regional development.

5th Five Year Plan (1974-79) : During this period attempts were made on experimenting with different approaches on Decentralised Planning. These approaches

include : (i) Area Development Approach (hill area development etc.), (ii) Problem Based Approach (drought prone, flood prone area development etc.), (iii) Target Group Approach (SC & ST development, small farmers etc.), (iv) In Acentive Approac and (v) Comprehensive Area Development Aproach.

The attempts on Decentralised Planning in a district was only at conceptual level. Block instead was taken as a unit for local planning by considering the administrative and planning considerations. In 1978, Planning Commission set up a working group under the chairmanship of Prof. M.L.Dantwala to draw up guidelines for block level planning. It suggested that plan for the Block should be integrated on the one hand to the plan of the district and the state and on the other, to the plans of the sub-units comprising of clusters of villages within the Block. This gave emphasis on planning in a multi-level framework.

Simultaneously, a committee was formed under the chairmanship of Ashok Mehta (1978) on Panchayat Raj Institutions. Both these committees were appointed in 1977 and submitted their reports in 1978. The Mehta Committee was strongly in favour of the district as the unit of planning.

In addition, the block as the unit of planning was identified in relation to the three tier Panchayati Raj Institutions at district, block and village levels. However the block level planning remained as a concept, and could not be practised. Later, the states of Maharashtra and Gujarat adopted the district as the most viable planning unit and Zila parishads emerged as the planning machinery at district level. The nature of planning at district level remained similar to the block level plants.

The important landmark during this period is the formation of specialised agencies for the implementation of area development programmes. Emphasis was laid on anti-poverty programmes, minimum needs, employment opportunities and the household oriented beneficiary programmes. District industries programmes geared towards the promotion of small village and cottage industries. The programmes like, National Rural Employment Programme (NREP), Rural Landless Employment Guarantee Programme (RLEGP), and the Economic Rehabilitation of the Rural Poor (ERRP) were introduced. These programmes were further strengthned under Integrated Rural Development Programme (IRDP) in 1980, with the objective of increasing individual family income.

6th Five Year Plan (1980-84) : In 1983, the Economic Advisory Council to the prime minister, headed by Sukhamoy Chakravarty, presented its report on *Decentralisation of Development Planning and Implementation in the States.* This council considered even the district to be too small for area planning and favoured Divisional level Planning, where the division may be comprised of a few districts (Chakravarty, 1983).

Till this period, there was a confusion over the unit of Planning. Dantwala committee favoured the block as the planning unit, whereas Ashok Mehta Committee categorically favoured the district. Sukhamoy Chakravarty Committee, as mentioned above, was not in favour of either block or district and preferred a regional approach. At this point of disagreement, Planning Commission set up the Working Group on District Planning in 1982 under the chairmanship of Prof. C.H.Hanumantha Rao to examine the methodological aspects of district planning. This committee formed the basis of the seventh plan proposals on Decentralised Planning.

7th Five Year Plan (1985-90) : During this plan period the central scheme of strengthening the planning machinery continued. It was also emphasised that unless the planning process is decentralised, the balanced regional development and poverty alleviation cannot be realised.

In view of strengthening the planning machinery at the local level, the Government of India sponsored several training programmes to train the trainers in district planning who in turn were expected to impart the training to the local level planning functionaries. In addition, a task force to assess the training needs in district planning was also setup.

The Planning Commission constituted a committee in March, 1985, under the chairmanship of G.V.K.Rao to review the existing administrative arrangements for rural development and poverty alleviation programmes (CAARD) and to recommend appropriate structural mechanisms to ensure that they are planned in an integrated manner and are effectively implemented. This committee opined that economic growth should be poverty alleviating and poverty alleviation programmes should be growth oriented. It also emphasised the involvement of the people and their representatives effectively in drawing up programmes of rural development and their implementation. This Committee has also recommended several administrative reforms like strengthening the *Panchayati Raj* bodies, Participatory features in tackling the problems of Rural development, appointment of Development Commissioner at the state level and District Development Commissioner at district level budgeting etc.

8th Five Year Plan (1991-95) : The Article 40 of the Constitution which enshrines one of the Directive Principles of State Policy, lays down that the state shall take steps to organise village panchayats and endow them with such powers and authority as may be necessary to enable them to function as units of self-government. However, since 1959 several attempts were made to give an effective shape to *Panchayat Raj* Institution's (PRI). But defiance of constitutional status and lack of political will made the functioning of the PRI a futile exercise. Further, during 1989, the PRI's were given politically and constitutionally a big push which ultimately attained a new status in April 1993 through the 73rd Constitutional Amendment Act. The Act was passed by the Parliament on December 22nd, 1992, which was notified by the Central Government through Official Gazette on April 20, 1993 as it got rectification by the state legislatures and the assented by the Presidend of India. After part VII of the Constitution a separate part IX has been added to the Constitution with the addition in Article 243A to 243O and a fresh Schedule called Eleventh Schedule enumerating the powers and functions of the PRI's has been incorporated.

Development of Statistical System in India

Though the statistical system developed in India since the middle of this century, its importance was realised as early as 1862 when the Imperial Government setup the Statistical Committee for preparing model statistical forms for collection and compilation of data related to finance, agriculture, trade etc. The publication of the first Gazetteer of India in 1866 and the first Statistical Abstract of British India in 1868 heralded a new era in the statistical documentation of the country. Though the gazetteer contained

economic statistics of the provinces, the demographic information could be obtained first time in 1881 when the Population Census of India was first published. This was followed by publication of Agricultural Statistics in 1886. Though all these publications no doubt gave opportunity for building information formally by the government, no effort was spared for creating organisational machinery for assuring quality, continuity, and regularity of such information.

It was first time in 1895 that a full fledged statistical bureau was formed at the centre under the control of Director General of Statistics, who was made in-charge of collection, scrutiny and collation of statistics related to agriculture, industry, prices and wages.

In 1934, another important committee known as Bowley-Robertson Committee was set up to enquire in to the possibility of bringing out the Economic Census of India. Working on a broader perspective this committee however suggested census operation in respect of measurement of national income, prices, production, wages, profits etc. It also recommended in favour of establishing an Economic Intelligence Organisation including appointment of a number of full time economists and statisticians under an economic adviser.

The independence of the country in 1947 gave a big fillip to the statistical system of the country when the Directorate of Statistics and Economics was set up under the Ministry of Agriculture. This was given further boost when a nucleus statistical unit was set up in the cabinet secretariat.

Computer Applications in Planning in India

It is an established fact that in spite of the progressive attempts, it took a long way to build an efficient statistical system in the country. However, throughout this period of evolution various attempts were made to devise a methodology to handle information of bulk size. The vast opportunities offered by information technology in recent times could be utilised to manage huge amount of information which otherwise may not be possible. A review on the applications of computers in the context of India's recent planning experiences will uncover certain remarkable achievements in this field.

Urban and Regional Planning Information Systems (URIS) : Misra (1985) and Nair (1985) discussed about the development of URIS in India. In 1976, the recommendation derived out of the Annual Conference of Chief Town Planners of various states laid the foundation for setting up an Urban and Regional Planning Information System (URIS) in the country at different spatial levels. Subsequently in 1977, Dr. J. C. Coiner, was deputed as an expert from United Nations to prepare a feasibility report on development of URIS in India. In 1979, Town and Country Planning Organisation (TCPO), New Delhi, organised a national seminar to discuss the conceptual and developmental issues related to URIS. It recommended that the then Ministry of Works and Housing (now Ministry of Urban Development) in association with the State Governments should do the following :

i) Setup a steering group to identify among others, data needs and formats, specify guidelines for data collection and management system and give suggestions for

undertaking case studies and ii) Establish an apex body to co-ordinate development of URIS in India on a long term basis.

As an outcome of the recommendations of the seminar, a steering group was constituted in 1979. The steering grouop constituted a number of working groups to identify the data needs for Urban and Regional Planning and Development. The working groups identified 21 main categories and 250 sub variables in the Urban Information System (URBIS) and 21 main categories and 340 sub-variables in the Regional Information System (RIS). It also identified that there are 113 agencies at local, district, state and national levels in India collecting and compiling information from primary or secondary sources related to Urban and Regional Planning. This steering group also recommended in favour of taking up a pilot study. This group presented the report on URBIS in 1981 and on RIS in 1983. As an effect of the recommendation of conducting pilot studies, two such studies were completed covering the Chengalpattu town in Tamilnadu and Anand in Gujarat. The study on Chengalpattu included 29 agencies at local level and 29, 29 and 26 agencies at the district, state and national levels respectively.

District Information System of National Informatics Centre, (DISNIC) : In 1977, Govt. of India has setup National Informatics Centre (NIC), the nodal organisation of Government of India to introduce computer based Management Information System (MIS), fileless-office concept, electronic mail services and telematic services in the central, state and district Government departments through its satellite based computer network (NICNET) covering all districts, state capitals and the centre. This is facilitating the development of District Information System at district level (DISNIC) and building essential databases for state and central government departments. The major objectives of DISNIC, in short, have been :
i) to develop the necessary information system/data base in various sectors of economy for planning and decision making by the district administration, ii) to promote informatics culture at the district administration, iii) to improve the analysis capacity and the presentation of the statistics utilised for national, regional and district planing and iv) to device modelling and forecasting techniques that are required for decision making for socio-economic development.

The input parameters required under DISNIC programme both at micro and macro levels for decision support system have been identified; accordingly project decument has been prepared for each sector taking into consideration the procedure of collection, processing and dissemination of information by the administration. DISNIC has the following functional components as : i) MIS for the Revenue Administration (MISRA) at the district level, ii) MIS for the Development Administration (Sectoral databases), iii) District Planning Information System (DISPLAN), iv) Geographic Information System of NIC (GISNIC) and v) National Natural Resources Management System (NNRMS).

Under the MISRA, the sectors included are revenue recovery, land administration, implementation of housing schemes, functional literacy programme, relief works following natural calamity, law & order, vigilance cases, Pension & wlefare schemes, National savings, Public grievances monitoring system etc. Similarly the 26 sectoral

databases contained under MIS for development administration are :

Agriculture,	Animal husbandry,	Buildings & works,
Civil supplies,	Collegiate education,	District Planning,
Employment & training,	Fisheries,	Ground water,
Health,	Industry,	Irrigation,
Labour,	Panchayat,	Power,
Public instruction,	Roads and bridges,	Rural development,
SC/ST development,	Environment-Forest & Wild life,	Social welfare,
Town planning,	Transport,	Water supply,
District treasury,	Co-operative societies.	

The GISNIC software to store, manipulate and display the geo-referenced or geocoded data is capable of handling, analysing and modelling both locational and attribute data. It aims at a map based decision support system, or computer based cartographic system handling remotely sensed data and user friendly expert shells. For the attribute data the various databases developed under DISNIC will be utilised. Considering the software and hardware availability at the district, the system has been designed to work even in the absence of digitiser, plotter and/ or any other special graphic hardware. Further, for effective utilisation of remotely sensed data NICNET facilities will be extended to all the ragional remote sensing service centres of the NNRMS set up by the Department of Space, Govt. of India. This will be a major input for GISNIC in developing both the locational and attribute data base. The DISPLAN is intended to support the district administration in their district planning process by providing relevant data in time for the plan formulation, implementation and monitoring. For this purpose a five level database, comprising district, block, taluk, local body, and village, is proposed. In order to build information base at these levels, three well structured proforma had been designed.

Natural Resources Data Management System (NRDMS) : During 1982, the Department of Science & Technology (DST) Govt. of India launched NRDMS, a GIS system for developing national resources. NRDMS is a multi-disciplinary and multi-agency project aimed towards developing computer based methodologies for generating area-specific profiles of natural resources and socio-economic parameters, and decision support models for micro-level planning. Under this project, both operational (pilot scale) and R & D activities are being pursued. NRDMS, being a grid reference system, is based on latitudes and longitudes. The demarcation of the grid is based on the Survey of India (SOI) topo-graphical sheets which is of 5 minutes grid interval. Each SOI grid is subdivided into four equal grids for the purpose of the NRDMS project. While developing software and thematic maps, grids have been demarcated at 2.5 minutes intervals on the mainland and at 5 minutes intervals in off-shore areas. Further, village and block referencing is based on unique numeric codes. The file structure under this system is in consonance with the recommendation of the working group on district planning set up by the Planning Commission (1984).

Under NRDMS several pilot scale data bases operationalised are : (1) Vishakapatnam (A.P), (2) Gurgoan (Haryana), (3) Sultanpur (U.P), (4) Kheda (Gujarat), (5)

Koraput (Orissa), (6) Alwar (Rajasthan), (7) Pauri (U.P. Garhwal Himalaya), (8) Munger (Bihar), (9) Chandel (Manipur), and (10) Goa (U.T).

Computerisation of Rural Information System Project (CRISP) : In order to facilitate the District Rural Development Agencies (DRDA), the government of India has launched the project named, *Computerisation of Rural information System Project.* Under this project each unit of DRDA has been provided with mini computers for developing data base for different rural development programmes to facilitate monitoring of the physical and financial progresses of the schemes and also to maintain the flow of benefits to the target groups. In addition, the village level information, collected through report formats specially prescribed, are processed and developed for planning purposes. The basic functions of the CRISP programme are to : i) provide an easy method of report generation, ii) create record of beneficiaries and works under rural development programmes, iii) collect information about villages for planning purposes and iv) cover the activities under Integrated Rural Development Programme (IRDP), National Rural Employment Programme (NREP), Rural Landless Employment Guarantee Programme (RLEGP), Rural Drinking Water Supply etc.

This project aimed at gaining the benefits such as monitoring information of various schemes, improvement in the quality of implementation by disseminating village-wise or programme-wise information widely to the concerned persons. For each of the programme covered under CRISP, the data collected in two formats are : i) summary data input and, ii) detailed input.

The village-level information covers population details, livestock, landuse, cropping pattern, education, drinking water, natural resources infrastructural details etc.

Natural Resource information System (NRIS) : The establishment of a three tiered Natural Resources Information System (NRIS) was conceived as a major step under NNRMS. The three tiers of the NRIS are : i) Strategic level-serving the needs of strategic decision makers, mainly at the centre/ministries etc. ii) Tactical level-catering to the needs of middle level decision making -say at states regions. This will be of two types based on the hierarchy; (State level-serving 25 state nodes of the centre-state-district hierarchy. Sectoral-for regional level of planning in all sectors.) and iii) Technical level for planning at district level and for plan implementation. This will also be of two types based on the hierarchy : district-level of about 450 nodes of the centre-state-district hierarchy and Project level of about 200 nodes of the centre-region-district hierarchy.

In these, about 450 nodes of the districts form about 90 base establishment under NRIS. Further, the emphasis on Decentralized Planning is at district level in the first phase and would also be practicable, since the lowest node starts at the district and when aggregated can cater to the needs of all other higher level nodes. However, adequate care is required at this stage in identifying the data sets that should be reoriented towards the local problems in addition to the problems at the higher level nodes. This hopefully, would provide a planning/decision making base for the natural resources management in the country. The detailed framework and implementation scenario of the NIRS has been addressed as a major inter-agency effort envisaged over a time frame of the next 4-5 years.

Conclusion

In this paper, the seminal contributions towards decentralized planning, statistical system and computer applications are reviewed. From this review it becomes clear that no significant relationship exists between the efforts on the above fields. However, it is true that the decentralised planning concept has come to an exciting crossroads, and its effective adoption largely depends on relevant information and its processing.

References

Chakravary. S. (1983) : Decentralization of Development Planning and Implementing Systems in the States. *Report of the Economic Advisory Council., Govt. of India.*

Mehta, A (1978) : *Report of the Committee on Panchayat Raj Institutions.* Planning Commission, Govt. of India.

Misra, G. K. (1985) : Urban and Regional Information System in Planning , Nagarbok. *Urban Affairs Quarterly;* Spl. issue on Urban Information System. Vol. XVIII, No. 4.

Nair, P.K.S. (1985) : Urban and Regional Information System in India, Nagarlok. *Urban Affairs Quarterly,* Spl. Issue on Urban Information & System, Vol, XVII, No. 4.

Rao, C.H. H (1989) : Decentralised Planning : An Overview of Experience and Prospects. *Economic and Political Weekly,* Feb. 25.

Book Review :

Geomorphological Analysis of Drainage Basin *by* Probhat Kumar Sen, The University of Burdwan, Burdwan, West Bengal, 1993, pp. 212, Price Rs. 120.00.

The book contains eight chapters in addition to a list of 48 maps and diagrams in the beginning and a list of 49 references at the end. Moreover, a large number of useful references have been cited in the text as well. The index given at the end of the book is also of great help to the readers.

The first chapter describes the drainage basin as a geomorphic unit. The second one deals with the morphometric analysis of the drainage basin, its concept, parameters of the drainage, basin, field techniques etc. Chapter three describes the shape of the drainage basin while chapter four deals with the vertical dimension, its various ways of analysis. Chapter five discusses the linear properties like stream ordering, stream laws, drainage pattern, meander geometry etc. Chapter six is devoted to hydrological characteristics of a drainage basin covering most of the important characteritics such as surface and sub-surface run off, hydrograph, surface stream flow conditions, floods as well as velocity, discharge, erosion, depostion etc. Chapter seven is devoted exclusively to the discussion of simple methods of statistical analysis which may be used in morphological and hydrological studies.

The author has been successful in presenting apparently difficult technical themes in a very simple manner readily understood even by a beginner in the field. Citing of Indian examples has added a new dimension to the book and has satisfied long-standing demands of the students and researchers of our country. Introduction of a chapter on aerial photographs and satellite images and their usefulness in the study of drainage basin, however, would surely have increased the value of the book. Perhaps the author may consider this fact while bringing out the next edition.

A few careless errors like the conversion figure "1 cusec = 0.0283 Cu m^3/Sec. (p. 153) may be ignored by careful reader as a misprint. Editing and publishing, no doubt, is of outstanding quality and use of better quality paper will surely help capturing foreign market, conversion of figures in Table I and II (pp. 154-155) from FPS to CGS system will be in line with modern trend.

The merit of the book lies in its lucid language, excellent illustrations, and almost exhaustive references. Some confusions may arise regarding certain diagrams like Dendritic vs Pinnate (p.111) or Trellis vs Rectangular (p.112) pattern, or the classification based on structure controlled vs tectonics controlled (p.113), or, say, whether longitudinal profile (p.128) and cross-sectional profile (p.137) of a stream should come under "measures of linear properties" (chapter five, as is done by the author), or under "measures of relief" (chapter four). Also minor differences of opinion may arise regarding the explanation given for the orgin of trellis pattern (p..115). But these are surely of little significance and if may be stated that the author has made a very valuable contribution to the field of geomorphological and hydrological research and teaching in our country and that the reviewer has no hesitation in recommending the book for both post-graduate and under-graduate students of Indian universities where geography is taught as a scientific discipline.

M.K. Bandyopadhyay.

Port and Development : A Study of Calcutta Port in India *by* Sachidandan Sau : Firma KLM Private Limited (1997)

The publication of this latest addition to the not-too-sizeable literature on the Calcutta Port almost coincided with the 125th anniversary of the oldest mejor port of the country; an occasion which witnessed a crop of largely instant literature, strong on pious expectations and not so much on facts on Calcutta Port. In contrast Prof. Sau's treatise is refreshingly free from cants and preoccupations. His main concern is to examine, with reference to facts and figures, what, given some effort, the future of Calcutta Port should be.

This book is a revision of the author's dissertation on the economics of Haldia Dock complex. In the first part of the book he traces the history of Calcutta port and the stages of its development. In the second part he examines the constraints of the port, both on the demand and supply sides. Calcutta, the port which is older than Calcutta, the metropolis, started expanding only in the second half of the 19th century; thanks to a remourseless chain of events which had been set in motion by the Industrial Revolution in England. Facilities in the port were created in stages over more than five decades. For more than eight decades, the oldest port of the country remained its premier port too, inspite of the loss of a sizeable chunk of its hinterland after the partition of India. The last hurrah came in 1964-65 when Calcutta port recorded its best ever performances. Thereafter it has been a story of decline. As of now, Calcutta Port—more accurately its Calcutta component, better known as the Calcutta Dock system (CDS)—has been handling an amount of traffic averaging 4.5 to 5 million tonnes and the Haldia Dock Complex (HDC), commissioned in 1977, has been handling about 75% of the total cargo of the Calcutta Port. It is unlikely that this trend will change to the disadvantage of the Haldia Dock Complex in the coming years. At the national level Calcutta has fallen behind Mumbai, Chennai, Visakhapattanam and Kandla, and is thereatened by the other major ports. Improved performance is the need of the hour and hence, the relevance of the "constraints".

Constraints or the bottlenecks are the factors "responsible for the relative decline and the under-utilisation of Calcutta Port" (p. 98). On the demand side economic conditions of the hinterland, trade policy and transport policy are the principal constraints. The principal supply constraints have been flagged down as : deficiency in drafts, fall in productivity, labour unrest and the turnround time (detention of ships). The author has examined each constraint in depth and has drawn upon a large volume of statistical information to reach his conclusions. They are : (a) "..... neither draft nor productivity nor labour unrest, detention time and turnround time can very well explain the problem of declining trend in share of traffic of Calcutta-Haldia Port of that of excess capacity being generated in Calcutta-Haldia in recent years" (p. 124) and (b) "economic factors, namely economic conditions of hinterland of the port, the rate and pattern of its growth are seen to tbe significant in explaining the traffic problem concerning the Calcutta Port" (p. 191). There will be no dispute about the conclusions about demand, constraints : economic growth in the hinterland has been sluggish and is, "less trade-oriented or opposite to the pattern in which all-India sea-borne trade in terms of tonnage has rapidly increased" (p. 145). The conclusions about supply constraints are unconvensional and contradict popular thinking on this point. Why the trade considers supply constraints as a serious bottleneck, the author's arguments notwithstanding, is a point which should have merited attention.

Prof. Sau believes that, Calcutta Port, on the strength of its location and institutional support enjoys considerable strategic advantage, now that the economic policy of the Govt. of India is more favourable towards the eastern region of India and the "Asian tigers" have indicated their strong urge to look Indiaward. The posssibility of the reemergence of Calcutta port has been accepted by come other observers of the port too. In the concluding chapter the author has made a "commoditywise" analysis of the future scenario and on the whole, everything augurs well for Calcutta port. The analysis is exhaustive and informative. However, any bluprint of the future of Calcutta port should take into cognizance several issues. Space does not permit an elaborate discussion and hence only a few points are raised here : First, is Calcutta port (Calcutta Dock System in particular) the costliest port in the country, as a section of the trade circle believes? This raises the question about the future of Calcutta Dock Labour Board, widely regarded as the dead albatross which does not propose to relax its stranglehold. Second, given the physical limitations which rule out the arrival of last generation container vessels in Calcutta Dock System, how wise is the decision to develop CDS and the centre of container traffic? Third, the threat to nevigation in the Hooghly is looming large and some students of the situation have predicted a bleak future for Haldia Dock Complex. How real is the threat? Finally, the author must be complimented for his indepth study which bears the marks of painstaking research. Obviously it is a labour of love and should be useful to the specialist and also to the lay readers.

P. K. Mukherjee