ISSN 0019 - 4824

The Indian Geographical Journal

Volume 82 June & December 2007 No. 1 & 2

Editor : S. Subbiah

THE INDIAN GEOGRAPHICAL JOURNAL

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Printed in June 2008

Cover Photo

Development encroaching Nature:

Let us give space for the Ocean and the Waves for their Destined Activities

A Photograph taken South of Colombo in July 2006, well after Tsunami 2004.

by

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Composed and Printed at

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The Indian Geographical Journal

Volume 82 June 2007 No.1

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River Shifts in the Lower Ponnaiyar and Gadilam Basins in the Historic Past

B. Arunachalam
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The Ponnaiyar or the Pinakini rises to the north of the Kaveri in the northeastern slopes of Mysore Plateau near Nandidurg and tumbles down the slopes to the floor across the Barah Mahal Plateau at a lower level. Over Barah Mahal, the river has a winding course and sharp turns before it escapes through the Chengam gap between Javvadu hills to its north and the Chitteri-Kalrayan hills to its south into the East coast plains. Emerging from the Chengam gap above Thirukoilur, the river has evolved a eastward running valley, that enters the Bay of Bengal just on the northern limits of Cuddalore.

A lesser stream of shorter length, the Gadilam rises in the lower heights of the Kalrayan hills, and flows due east just south of the Ponniyar at a distance of 5 to 15 km, till it reaches the Caper hills of the Cuddalore sansdstone series about 6 to 8 km from the sea. Here the river turns north to flow about 10 km before it once again turns east to enter the sea, about 3 km south of Ponnaiyar. In the northward flow, the Gadilam is known as `Uttara-vahini'.

The Ponnaiyar valley, downstream of Tirukoilur is in a plain tract, opening out fan-like to develop flood-cum meandering belt that is almost 25 km wide in the mouth section between Puduchery and Cuddalore in the south. This wide plain contains a variety of fascinating micro-landform details that deserve a deeper insight.

□ Published in June 2008

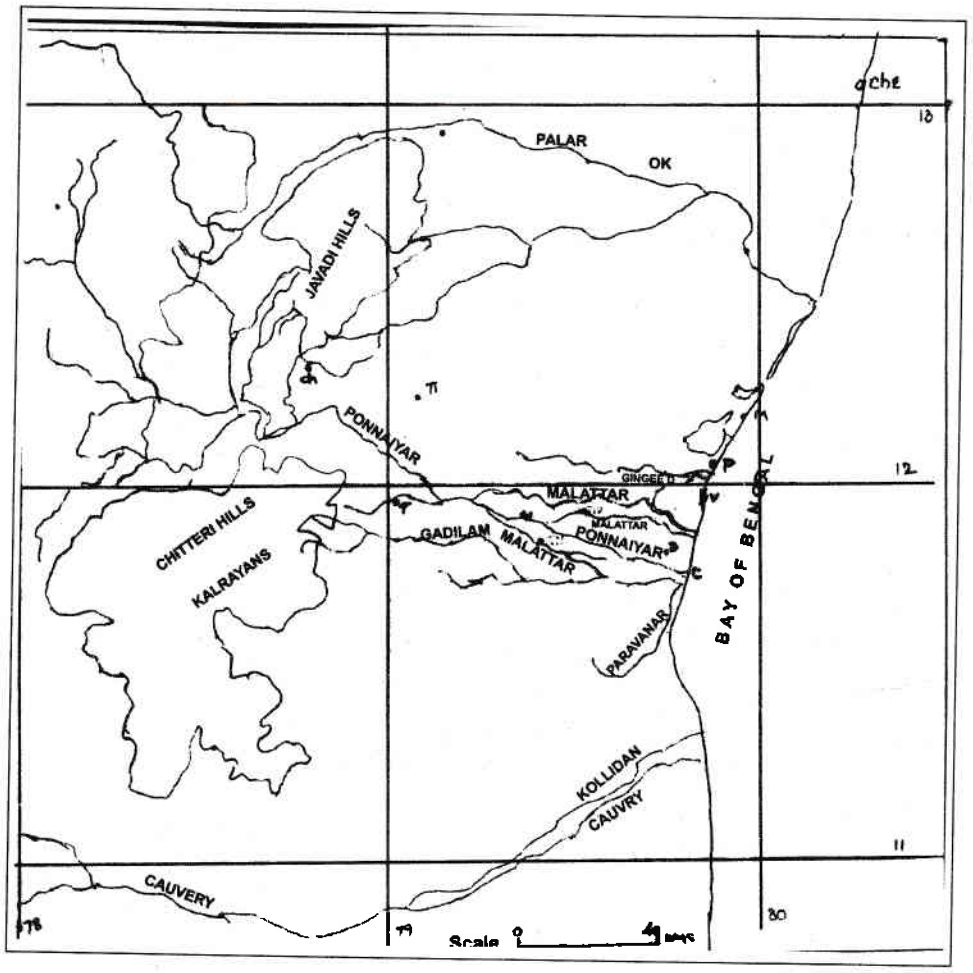

Fig. 1
Ponnaiyar Basin between Palar and Cauvery Basins
Ch-Chengam; T-Tirukoilur; Tn-Tiruvennainallur; Che-Chennai; M-Marakanam; P-Pondicherry; V-Veejai; C-Cuddalore; B-Bahur; Ti- Thiruvannamalai

A number of geologists and geomorphologists (2,3,6) have highlighted the anomalous nature of the course of the Kaveri in its middle section below the Mysore Plateau, after it tumbles over the Hogenkal falls. It has been argued based on the study of air photos and topo-sheets that the Kaveri initially had a northward flow (and not south) and entered the sea north of the Palar and Chennai. In this northward flow, the Kaveri could have flowed through the lower Palar valley and the Ponnaiyar valley in different stages of progressive shift southward to occupy the present valley that has the apex of the delta at Tiruchirapalli and one of its distributaries enters the sea near Poompuhar. Antecedence, river piracy and headward erosion apart from up-warping have been evoked as possible underlying causal factors. These changes of river courses of Kaveri, Ponnaiyar and Palar are believed to

have developed during the Teritiary period.

In a more recent study, Ramaswamy (4) *et al.* have studied based on IRS-IA satellite imageries, the lower sections of the three river systems and the changes in the river courses after 700 BC (2700 BP), and have indicated their possible significance to the finds of archeological remains. While these studies are valuable in the context of historical period, it would be worth while to look into literary references of the last 2000 years in relation to the courses the Ponnaiyar flowed in at different centuries.

A study of the 1:50000 scale topographical maps of the Ponnaiyar basin after it escapes from the Chengam gap into the plain tract, reveals that the plain is too wide to explain in relation to the size of the Catchment area, its limited width higher up, and the low rainfall of 100 cm concentrated into three to four months of the year. In that sense, the river valley appears to be a misfit to an under-fit river flow. Within this region, the river appears to have swung, over a considerable stretch, from around Puduchery on the north, to the Caper hills in the south, which would have blocked a

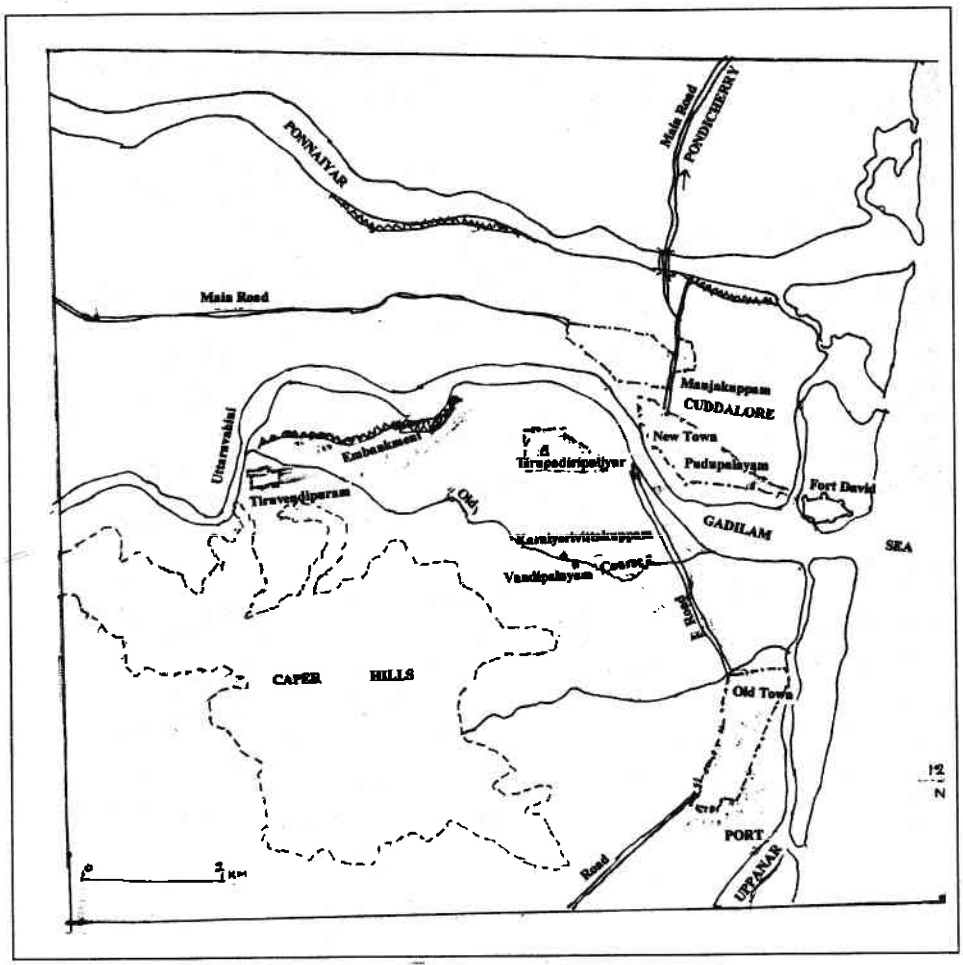

Fig. 2

further southward swing. A careful scrutiny of the satellite imageries exhibit the existence of a large number of channels, more or less sub-parallel to the present flow course of the Ponnaiyar. While the imprints on the ground are traceable even today, in the large scale topographical maps and in the field, some however, have left faint imprints, obviously because they are of an earlier date and have been partially defaced on the ground. However collaboration is provided by literary and historic evidences of the previous courses of the river flow through different paleo-channels.

A temple at Tirukoilur indicates that the brahmin poet, *Kapila*, left the two daughters of King Pari of Parambu Nadu, left in his custody, on the banks of the river Ponnaiyar near Tirukoilur ground 2300BP (300BC) before he breathed his last. Downstream of Tirukoilur about 6 km downstream a channel takes off on the left bank, flows north of Villipuram and enters the sea (south of Puduchery). This channel seen in faint traces only is recognised as the Ariankuppam river in the lower valley at present. The mouth of the Ariankuppam river is around Veerai, a port talked about in early Tamil literary traditions. Wheeler and later Vimla Bagley have done extensive archaeological excavations on the right bank of the river, and identified Podouke or Arikamedu as a Roman mart. On the basis of the archeological artifacts, found here, the mart is dated as possibly belonging to the first or second century A.D. The present river on whose bank the place lies is a tidal inlet of little consequence and historians have been unable to explain the siting of the major Roman port at the present river site. The Ponnaiyar in its swing right and left could have evolved a large river channel, on which the trade mart was located. If so, the course of the Ponnaiyar in the left most swing in the palaeo-channel, can very well explain the site of Arikamedu.

The topo-sheets as well as the imageries covering the Ponnaiyar basin reveal quiet a few `Malattar' channels, some of which are not continuous, and traced in parts, and some end abruptly in the alluvial sands. Further downstream, around Sittalingamadam, a channel takes off on the right bank, and runs south-east to join the Gadilam river on its north bank near Tiruvamur. This Malattar river bed is as wide as the main Ponnaiyar, and though most of the year has a dry sandy bed, at present during floods, it carries some water flow. This Malattar has a left bank branch which runs in the doab between the Ponniayar and the Gadilam for some distance before it is lost in the sands. Tiruvennainallur, that lies on the southern, right bank of this Malattar, almost midway, according to the Thevaram hymn of the saiva saint, Sundarar, and according to the later (11^{th} century) written Periya Puranam was on the right bank of the Ponnaiyar in the eighth century. This indicates that the main Ponnaiyar was flowing through the Malattar into the Gadilam, around the eighth century. Further it would explain the broader valley of the Gadilam below Tiruvamur (near Panruti) due to the combined flow. At what later date the Ponnaiyar lower down the take-off site of the Malattar took to the present valley is not distinct, but it may be around tenth century.

Tiruvatigai and Virattanam lower down Tiruvamur have also Tevaram references in the hymns of Appar and Sambandar of the sixth century i.e during the rule of Mahendra Varma Pallava. Dharmasena, a Jain leader, under the

influence of his sister Tilakavathi converted to Saivism, and promoted the Savite *bhakti* cult. The Jain Pallava king getting upset with this action, threw him into the floods of the Gadilam, tied to a raft. The raft shored at Karaiyerivittakuppam, close to Vandi-palayam, a settlement of Cuddalore city between the old and the new towns. The Tevaram reference of the sixth century clearly mentions that the place where the raft shored aground was to the south of the Siva temple town of Tirupadiripuliyar (an old part of Cuddalore), while the river at present is flowing to the north of the place. Other Tamil works like Thirumangai Alwar Pasuram and Tirupadiripuliyar Puranam also substantiate these facts.

Records since 1680 A.D show that both Ponnaiyar and Gadilam are liable to heavy floods periodically, and the floods in one river often leads to flooding in the other soon after because just west of Cuddalore, the two rivers flow almost side by side, with only a road separating them. Flooding in these rivers last for days, causing heavy damage to Cuddalore, where on occasions the river flows almost a metre above the level of the flood plain. This happens because Cuddalore and Ponnaiyar mouth lie right on a path of severe tropical storms generating in the Bay of Bengal during October – November and hitting the shores with heavy rains, violent winds of high speed and high surge waves, all of which not only break the sand bars on the mouths but hinder the free and quick flow of the flood waters into the sea. Further, the rainfall declines up the river valleys so much so the floods from above have to wait for the flood-water lower down to recede. On these occasions, the rivers breach their banks and flood the township from all sides. It was during one such flood the Gadilam shifted from its old course skirting the Caper Hills to a new channel, the Uttaravahini, to flow north of the old Siva temple town of Tirupadiripuliyar dividing Cuddalore into two parts. After one such flood following a severe storm in the nineteenth century, the government built high embankments on the east bank of the Gadilam and the south bank of Ponnaiyar. Though these embankments have stopped the breaches to an extent, vulnerability of Cuddalore to floods have not been effectively controlled.

Like the Malattars, on the right or south bank of the Ponnaiyar, there are a few Malattars also on the left bank in the river plain between Ponnaiyar and the Gingee river, (upper part of the Ariankuppam river) south of Puduchery. One of them, taking off about 16 km west of the town on the left of the river, has its channel running through Bahur (and feeding a lake) and joining the sea almost midway between Ponnaiyar mouth and Ariankuppam river mouth near a place called Pannitittu. Yet another Malattar, in segments, can be traced, north of the Bahur Mallattar channel; it is in parts called the Kuduvaiyar odai entering the Gingee river, close to the mouth on the southern side.

Corraborative evidence is available in the submarine floor of the shore, at a depth of 30m. The National Institute of Oceonogrpahy has located two submarine canyon valleys, one on the Gingee river mouth close to Puducherry and another double canyon off the sea off Gadilam. The heads of both the sets of canyons commence at a depth of about 30 m, and reach a depth of about 600 m. The floor gradients of the near-shore zone between Puduchery and Cuddalore Port is gentle.

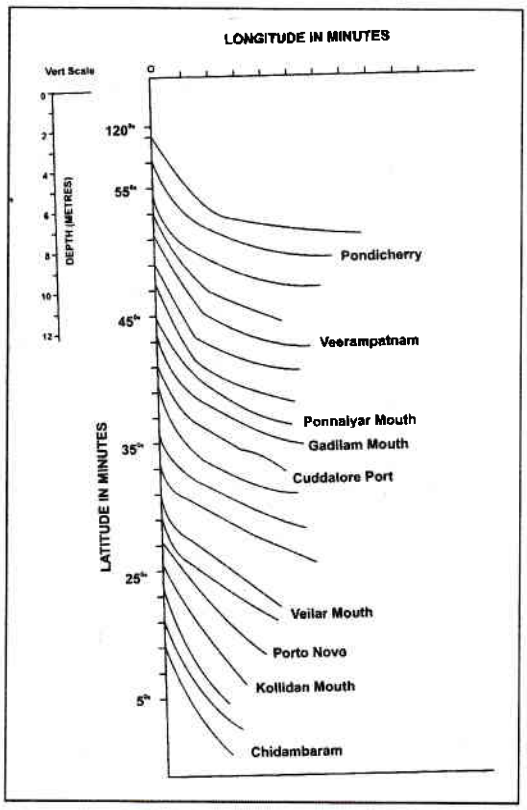

Fig. 3

South of Parankipettai, the floor dips through the steeper slopes right up to the Kaveri valley. This indicates that the sea section between Puduchery and Cuddalore Port and beyond, north of Parainkipettai are relatively gentle, while further south of Parainkipettai the floor dips through steeper slopes right upto the Kaveri Valley. This indicates that the sea-section between Puduchery and Cuddlaore has been subjected to sedimentation of the sub-aerial deposits and alluvium, brought down by floods, and spread on the floor-profiles (Fig. 3). It also indicates that the Ponnaiyar has swung to the right and left over a stretch of about 25 km, occupying different positions of river mouths during the historic past and even before. The migratory behaviour of the lower Ponnaiyar and Gadilam, even during the recent past, is substantiated by literary and historic evidences.

References

1. Baliga D.S (ed.) (1962). *Gazatteer of South Arcot*. Chennai : Government of Tamil Nadu.
2. Radhakrishnan B.P (1952). `The Antecedent Course of the River Cauveri', *Bulletin of Mysore Government Association*, 3.
3. Raivarman V (1969). `River Capture in Cauvery', *Science and Culture*, 35 (1).
4. Ramaswamy V *et al.* (1972). `The Phenomenon of River Migration in Northern Tamil Nadu', *Man and the Environment*, 17 (1).
5. Sundara Shanmugham (1982). *Wealth of Gadilam* (in Tamil).
6. Vaidaynathan R (1971). `Evolution of the Drainage of the Cauvery in South India', *Journal of Government Society of India*, 12 (1).
7. Varadachari V.V.R *et al.* (1965). `Submarine Canyons off the Coromandal Coast', *Bulletin of WIO*.

Emerging of An Indian Community in Tokyo:
A Case Study of Nishikasai

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Indian Diaspora has a long history and with the recent globalization, they are found settling down in many parts of the world including Japan. The present paper looks into how the Indian residents create the living space as 'own space', taking a case study of one of the well-known areas for dominant presence of Indians, Nishikasai, in Tokyo. Now about 17000 Indians reside in Japan, and in Tokyo alone about 6400 Indians live. With families joining the single engineers of 1990s, social network outside the work place started strengthening in 2000s, leading to formation of an Indian community. The global network of internet seems to shape ethnic identity and 'own place', more quickly and strongly. A number of social organizations and religious facilities got developed for Indians. Indian festivals like New Year, Holy, Diwali and Dusserah are organized. Indian schools with English medium have been set up. It appears that besides religion and mother tongue, idea of nationality seems to have provided more-needed threshold for getting together and feeling themselves as community.

(Received: October 2007; Revised: January 2008; Accepted: March 2008)

About 25 million people constitute Indian Diaspora now, as per the report from the Ministry of Overseas Indian Affairs, Government of India. With the current economic globalization and accelerated flow of capital across the world, human mobility and migration have been increasing quite rapidly, resulting in a marked progress of spatial reorganization of Indian Diaspora. Diaspora is the result of the interaction between the external managerial force such as global economic and political demands and the domestic pushes of the economics and politics of the countries from where emigration takes place. In the case of India, the economic liberalization started to progress from the 1980's. However, if we exclude the Indians working in the oil-producing countries of the Middle East, the sphere and scope available then for the Diaspora as compared to present were limited. On the eve of the collapse of cold war, Gulf War etc., the foreign investment reserve in India reached to an abyssal low, and the country faced a deep economic crisis; at this juncture, the Indian Government took an abrupt change in its economic policy and the new economic policy thereby slated had a tilt towards capital as a basic principle of economy. Thereafter, India has been witnessing a rapid economic growth based on

☐ The Indian Geographical Journal 82 (1) June 2007; published in June 2008

foreign investments from developed countries. With this flow of investments, highly-qualified computer and IT engineers and management graduates from Bangalore and other cities started to constitute the Indian Diaspora in the western countries and Japan. Such internal changes correspond with the waves of globalization of world economy, and in the midst of spatial reorganization based on economic globalization, India moved to a promising position among the developing countries, and this helped her to strengthen the trades and transactions with the developed world.

Globalization

Globalization is viewed by Sassen (14) as a global city, for instance New York, London and Tokyo, where capital thrives and multiplies; global city moves from a production function to specialize in a core of managerial function, and transforms itself from a national economic centre into a world economic centre. It is a place where multinational organizations establish their pivotal administrative offices and elite persons with high salaries are found directing these offices. Sassen further observed that there are still unemployed population who are not ready to work in factories or in construction for lower wages; immigrant workers are increasing in number; women immigrants working as nurses and house maids are also increasing; immigrant women are found to get engaged in male-dominated fields too. Thus, the global system is found incorporated into the working of the developed countries so much that even the local labour market of big cities of developed countries cannot be understood without a reference to global trends and interactions.

'Own Place'

The living space, 'own place', of the Diaspora may progress into a settlement. This paper investigates the Indian Diaspora focusing on how the immigrants (Indian residents in Japan) have created and maintained their 'own place' while recognized by the host community as its own ethnic identities, incompatibly different ones. The 'place' in this paper is not exactly expressed in numerical values, like population and population change, proportion of production structure etc. The concreteness and individuality are certainly emphasized on the 'place' because it is necessary for capital accumulation (3) and Topophilia, the emotional and sentimental links of individuals or groups (21). Further, 'the place', conceived by people in a physical and emotional sense, amounts to a social construction, and a locale for the human thoughts and activities, and as such it acts for enlarging the possibilities and regulations. This paper thus tries to indicate the spatial expansion of a location as their 'own place' where there is a provision for reorganizing the identity of the Diaspora, its attachment to it and desire to continue to live there.

This paper discusses the following two points resulting from a survey on the living of Indian Diaspora in the context of globalization, and looking into their 'own place'. The first question is: how the Diaspora crossing over the national border into the developed countries did create their 'own place'; and the second one: what sort of change did this crossing over the border bring on their social identity. Indian society in Tokyo belongs to the category of recent Diaspora, and it is interesting to see how the Internet plays a role in establishing their 'own place' in a new land.

Indian Diaspora: Past and the Present

There have been a number of studies on the history of Indian Diaspora, and Japanese scholars too have contributed significantly in this search (4,5,6,7,8,10,12,16,18,19,20). Indian migration has a very long history, about 2000 years old. Indians engaged themselves on maritime trade and the evidences of their activities are extensively recorded from the shores of South East Asia, Arabia, and East Africa. However, the scale of immigration in the historical past was obviously small, and it is only in the era after the colonization by European Countries that the scale became significant (5). Koga and Nakamura (5) have mentioned the following three waves of historical Indian Diaspora:

1. Thanks to the abolition of slavery in the European countries, the immigration as indentured labourers and labourers of *Kangani* system was encouraged from India into the Atlantic and Pacific islands and other regions of the colonial rule in the middle of 19th century.
2. Post war (World War II) recovery accelerated immigration into developed countries during 1950's to early 1970's.
3. Labour immigration was welcome into the oil-producing countries of the Middle East after 1973 oil crisis.

As against 80 ~ 90% of the Chinese Diaspora concentrating in South East Asia, the Indian Diaspora is rather extensively distributed throughout the world. This is due to the 1st wave factor and closely related to the historical fact that India had been a British colony (5). Further, as shown in Table 1, the 2nd, 3rd and the 4th waves which are to be

Table 1

The Cause of Indian Diaspora and the Countries of Immigration

	Cause of Diaspora	Period	Place of Immigration
1.	Abolition of slavery and indentured labourers System and Introduction of *Kangani* System	From Middle of 19th Century to 1940's	Tanzania, Kenya, Uganda, Mauritius, S.Africa Surinam, Trinidad Tobago, Guyana, Fiji, Burma (Myanmar), Ceylon, (Sri Lanka), the Malay Peninsula (Malaysia), Singapore etc.
2.	Emmigration to developed countries owing to economic recovery of post-war (II World War)	From 1950's to 1970's	UK. USA, Canada etc.,
3.	Labour Emmigration to Middle East oil-producing countries	After oil shock (1973)	Saudi Arabia, UAE, Oman, Kuwait, Quatar, Baharain, Yemen etc.
4.	IT Engineers along with economic globalisation	1990's after	Global cities in developed countries i.e USA, Japan etc.,

Source : Prepared from the reference of Naito (1996). Koga and Nakamura (2000).

mentioned later, extensively expanded the distribution of the Indian Diaspora.

Further, as shown in Fig. 1, the sprawl of the Indian Diaspora got extended with the 2nd, 3rd and the 4th waves of migration. Statistics on Indian Diaspora are available from the following two sources of the Indian Government; i) Discussion Paper submitted to the Parliament in 1980 (hereafter referred to as the 1980 Report[1]; and ii) the report submitted in January, 2002 by the High Level Committee on the Indian Diaspora (since the time of investigation of the data is December 2001, it is referred to as the 2001 Report). Between 1980 and 2001, Indian Diaspora increased from 10.9 million to 17 million, an increase of about 50 per cent[2]. However, one has to be very cautious with these numbers for any conclusion, because of certain discrepancies; for instance, no data for South Africa and Reunion are available for 1980, and for Nepal and Sri Lanka for 2001. The 1980 Report gives the number of persons who have accepted the foreign citizenship as well. The 1980 Report designates the Indian emigrants as Indian Diaspora[3], and conceptually it includes both PIO (Person of Indian Origin), NRI (Non-resident Indians), and the stateless persons. PIO refers to those who were Indian

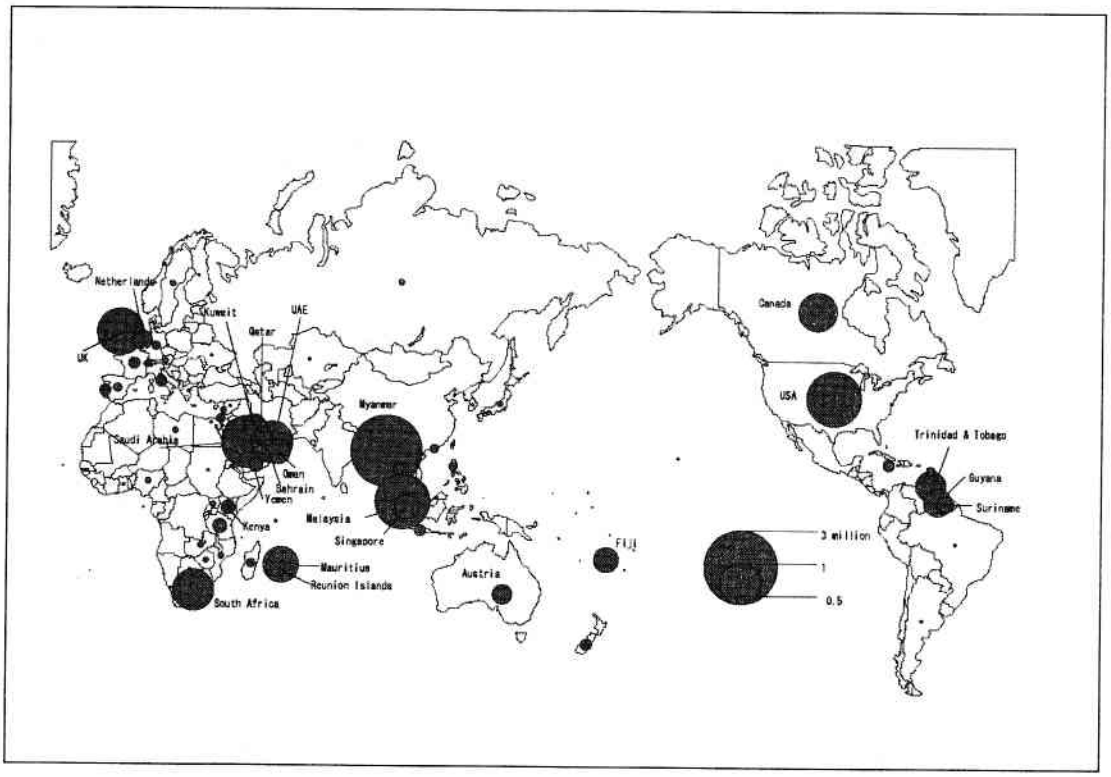

Fig. 1
Distribution of Indian Diaspora (2001)

Remarks: Indicating the countries which have above 100,000 India Diaspora (Excluded Sri Lanka and Nepal)
Source : The 2001 Report (Report of the High Level Committee on the Indian Diaspora)

residents four generations ago, and have already acquired the foreign citizenship (persons from Pakistan, Bangladesh and certain other countries as specified by the Indian Government are not eligible for this status). NRI are those who are Indian nationals but reside abroad. This paper treats both the residents possessing foreign citizenship shown in the 1980 Report and those PIO shown in the 2001 Report as the same (hereafter stated as holders of foreign citizenship).

Table 2 describes the spread and growth of the Indian Diaspora as noted in the 1980 Report and the 2001Report. Indian Diaspora increased by about 100000 persons in 13 countries, and declined by about 40000 persons in five countries.

Major countries that recorded the increase in Indian Diaspora are Saudi Arabia, UAE, Oman, Kuwait, and Qatar. The 3rd wave of the Indian Diaspora seems to continue even after 1980. The number of emigrants to the oil-producing countries of the Middle East decreased at the time of Gulf War, and however, Indian migration to these countries got revived as usual after the war. The Indian Diaspora in the Middle East consists of non-skilled or semi-skilled labourers, mainly engaged in the construction activities (1). Middle East countries enforce strict rules, restrictions and regulations on permanent residence or family visa, and therefore, the percentage of the Indian Diaspora not possessing foreign citizenship (in other words, Indian citizens) is rather high. All the other countries excluding the oil-producing countries of the Middle East have quite a large number of those persons possessing foreign citizenship during 1980. Because of that, there was natural increase in the population, and in Canada and Australia besides the natural increase, there was a marked increase in the immigration of Indian Diaspora and its permanent settlement. The decline in some countries may be due to political instability of those countries.

It is the USA which accounts for the large increase in the Indian Diaspora from 1980 to 2001. Though the movement of Indian Diaspora to the USA started from the end of 19th century to the beginning of 20th century, there was a decrease when flow of Asian Diaspora was discouraged politically. As soon as the implementation of the Act on the Diaspora abolishing the Racial Discrimination Clause was passed in the year 1965, the number of Indian Diaspora started increasing (17). As Table 2 shows, the number was 300,000 in 1980 (inclusive of 35,000 possessing the citizenship of the USA); it increased to 820,000 in 1991; and in the next ten years, it got doubled, i.e. 1,680,000 in 2001(2001 Report). Thus in two decades, Indian Diaspora got increased by five times, numbering next to Chinese and Philippines among the Asians in the USA(2001 Report). Again, if we exclude Nepal, Sri Lanka and Myanmar which are located in the vicinity of Indian main land, the USA is the largest residential country of the Indian Diaspora. The Indian Diaspora in the USA comprises a wide range of specialists such as doctors, lawyers etc, in addition to taxi drivers, and motel or restaurant owners. As regards post -1990, the special feature is the increase in IT engineers. In 2001 there were more than 300,000 IT engineers employed in the Silicon Valley, and at present it is stated that the number has doubled (4).

The demand for IT engineers is not limited to

Table 2

Trend of Indian Diaspora (1980 and 2001) - Persons

	Country	1980			2001			Change		
		Possesing foreign Nation-ality +3 (1)	Others +4 (2)	Total (3)	Possesing foreign Nation-ality +5 (4)	Others +6 (5)	Total (6)	(4) - (1)	(5) - (2)	(6) - (3)
A +1	Myanmar	7,200	342,800	350,000	2,500,000	402,000	2,902,000	2,492,800	-340,800	2,552,000
	Saudi Arabia	2,000	118,000	120,000	0	1,500,000	1,500,000	-2000	1,382,000	1,380,000
	USA	35,000	265,000	300,000	+7 n.a	+7 n.a	1,678,765	n.a	n.a	1,375,765
	UAE	2,000	150,000	152,000	50,000	900,000	950,000	48,000	750,000	798,000
	UK	250,000	250,000	500,000	+7 n.a	+7 n.a	1,200,000	n.a	n.a	700,000
	Canada	95,000	80,000	175,000	700,000	151,000	851,000	605,000	70,000	676,000
	Malaysia	1,009,500	199,000	1,208,500	1,600,000	65,000	1,665,000	590,505	-184,000	456,000
	Oman	5	59,995	60,000	1,000	311,000	312,000	995	251,000	252,000
	Kuwait	100	64,900	65,000	1,000	294,000	295,000	900	229,100	230,000
	Australia	15,985	2,614	18,599	160,000	30,000	190,000	144,015	27,386	171,401
	Singapore	1,22,000	37,500	159,500	217,000	90,000	307,000	95,000	52,500	147,500
	The Nether-lands	100,000	1,500	101,500	200,000	17,000	217,000	100,000	13,500	115,500
	Quatar	125	29,875	30,000	1,000	130,000	131,000	875	100,125	101,000
B -2	Japan	110	1,748	1,858	1,000	9,000	10,000	890	7,252	8,142
	Bhutan	20	39,980	40,000	0	1,500	1,500	-20	-38,480	-38,500
	Afghanistan	25,000	5,000	30,000	500	0	500	-24,500	-5000	-29,500
	Guyana	424,100	300	424,000	395,250	100	395,350	-28,850	-900	-29,050
	Iraq	10,000	10,250	20,250	50	60	110	-9950	-10,150	-20,140
	Iran	920	19,880	20,800	0	800	800	-920	-19,080	-20,000

Remarks :

1. Addition : Top 13 countries
2. Reduction : Top 5 countries
3. Number of those who have accepted foreign citizenship as given in The 1980 Report.
4. Number after deducting those who have accepted foreign citizenship from the total number of Indian diaspora as given in The 1980 Report
5. Number of PIO given in The 2001 Report
6. Number after deducting PIO from the total number
7. In The 2001 Report, the numerical values of PIO, NRI, the Stateless are not given separtely for the United States of America, Britain, South Africa. Moreover, besides these countries, where the columns for PIO, Stateless are empty, it is taken as zero.

Source : Prepared from The 1980 report and The 2001 report

Table 3

Foreign Residents in Japan : Number, Gender and Residential Status 2005

Nationality	Total Persons	Gender Ratio	Residential Status			
			1	2	3	4
Korea	598,687	86.6	Special Permanent Resident (74.8%)	Permanent Resident (7.5%)	Spouse or child of Japanese National (3.6%)	Dependent (2.8%)
China	519,561	70.1	Permanent Resident (20.5%)	Student (17.2%)	Designated Activities (11.6%)	Spouse or child of Japanese National (10.5%)
Brazil	302,080	122.4	Long Trem Resident (50.7%)	Spouse or child of Japanese National (26.1%)	Permanent Resident (21.1%)	Not eligible (0.8%)
Phillipines	187,261	25.7	Permanent Resident (28.5%)	Spouse or child of Japanese National (24.1%)	Long Trem Resident (14.3%)	Entertainer (12.6%)
Peru	57,728	115.3	Permanent Resident (39.2%)	Long Trem Resident (37.1%)	Spouse or child of Japanese National (12.0%)	Temporory Visitor (4.4%)
USA	49,390	183.9	Permanent Resident (19.6%)	Spouse or child of Japanese National (17.9%)	Humaities International Services (15.9%)	Dependent (11.9%)
India	16,988	252.7	Dependent (24.2%)	Engineer (16.6%)	Permanent Resident (11.3%)	Skilled Labour (9.9%)
All foreigners	2,011,555	86.2	Special Permanent Resident (22.5%)	Permanent Resident (17.4%)	Long Term Resident (13.2%)	Spouse or child of Japanese National (12.9%)

* Remarks : Gender Ratio means the number of women per 1000 men
* Source : Prepared form the Annual Report of Heisei 18 (2006) of the Japan Immigration Association. ``Statistics on the Foreigners Registered in Japan''.

the USA, but it is highly growing in the global city of all the developed countries which specialize in pivotal administrative function. The number of Indian Diaspora in Japan has increased from 1,858 (in 1980) to 10,000 (in 2001) (Table 2). In Japan, IT engineers of Indian Diaspora were found more concentrated in the global city, Tokyo. In the USA, Japan and many other such developed countries the Governments have taken steps to simplify the immigration procedure and relax the approval of visa etc., in order to admit the more Indian IT engineers more quickly.

Indian Society in Japan

The number of foreign residents in Japan is found increasing more rapidly in recent years, and it has reached 2,010,000, i.e.1.6% of Japanese population in 2005. And the 70% of foreign residents in Japan comes from three countries viz. Korea, China and Brazil (Table 3). The number of Indians is 16,988 which is just 0.8% of the total foreign residents (Table 3). The increase in Indian population in Japan was rapid between 1990 and 2005, and this may be because of the increased demand for IT professionals.

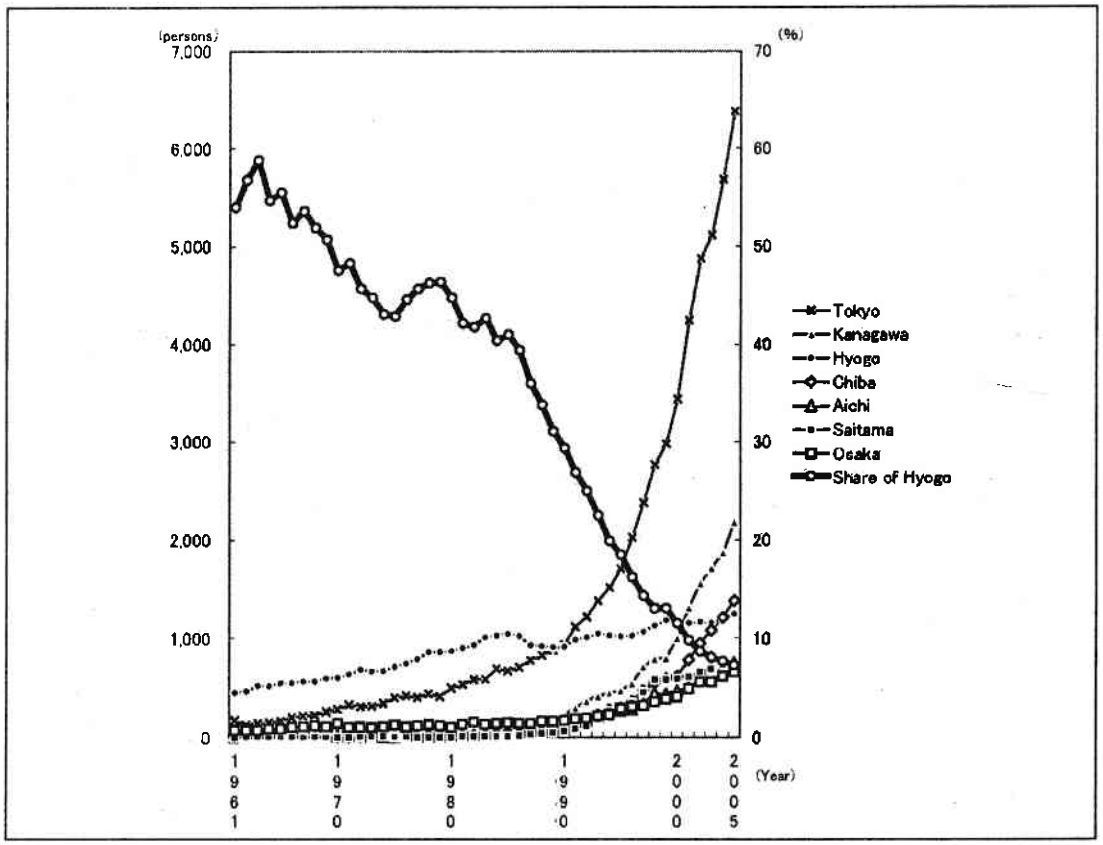

Fig. 2
A Trend of Indian Residents in 7 Perfectures in Japan

Source : Prepared from The annual report of the Japan Immigration Association, ``Statistics on the Foreigners Registered in Japan''

In 2005 Indian migrants were significantly present in seven prefectures, and in Hyogo prefecture alone, forty per cent of Indian migrants lived till 1980's (Fig.2). After the opening of Japan, the Indian traders started to reside in the port town of Kobe in Hyogo prefecture and Yokohama in Kanagawa prefecture. After the destruction of Yokohama in the Great Kanto Earthquake in 1923 the Indian traders moved to Kobe and since then continuously Kobe remained the settlement of the largest number of Indians (9,11,16). The Indian society residing in Kobe became deep-rooted as Indian traders in Kobe which was the largest port towards the direction of Asia, and established religion-wise places of worship[4]; and they maintained compact local network through face to face contact among people of the same religion and caste and thus shaped their 'own place'. The ceremonies at the religious facilities and ethnic landscapes turned out to be the facilities for locating and reviving their identity; and their ethnic identity and interactions with fellow Indians, religious and caste groups help to revive their fond memories of their native places, thereby developing their 'own place' in a foreign soil. This togetherness also promotes the relation among Indians in Kobe. With the current global network of instantaneous information

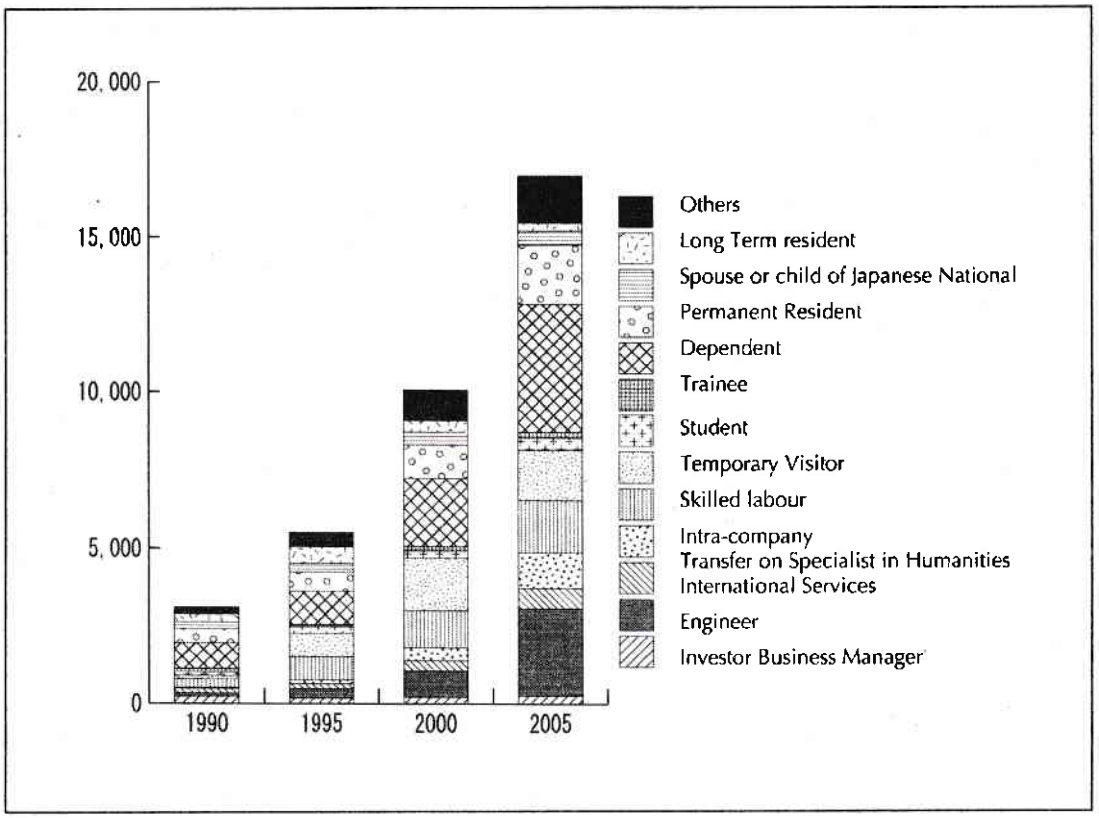

Fig. 3
Indian Residents by their Qualification in Japan

Source : Prepared from The Annual Report of the Japan Immigration Association
"Statistics on the Foreigners Registered in Japan"

exchange, the ethnic identity and development of 'own place' further get strengthened, connecting the global and local network at the same time (11,15).

From the middle of 1980 there was a sudden increase in the Indian population in Tokyo and in 1990 Tokyo took the Number One position in prefecture-wise which was so far held by Hyogo. Thereafter, even though there was small increase in Hyogo, when we keep 1990 as base, Tokyo has a remarkable increase of 3.7 times in 2000 and 6.9 times increase in 2005 (Fig.2). Moreover, the increase in Kanagawa and Chiba prefectures which are in the vicinity of Tokyo is also remarkable. If we consider the prefecture-wise resident Indians, the four locations in the descending order are Tokyo – 6,380, Kanagawa – 2,182, Chiba – 1,381, and Hyogo – 1,241. Indian population now consists obviously more of engineers, intra-company transferees, and dependent family members (Fig.3).

New migrants are dominant in the Indian community in Tokyo. It is no wonder, Tokyo being a global city, attracts more of IT engineers. Under the present circumstances of rapid development of economic globalization, Tokyo plays the important pivotal role of decision making in the case of multinational businesses. The development of IT industry is indispensable for the acceleration of it. In this situation, under these circumstances, the Indian society around Tokyo gets sudden increase with IT engineers along with elite community of business men employed in multinational corporations, the managers of Indian restaurants, cooks, and unskilled labour in sub-contract factories. Thus, the Indian society in Tokyo is currently characterized by different classes. It may be pointed out till 2000 the relation among the different strata of people was weak and fragmented because differences between different social and religious groups of Indian migrants were large enough that they did not really feel the need for information exchange[5].

Indian population is distributed unevenly in Tokyo. Tokyo Prefecture, alias Tokyo Metropolitan government, is constituted of 23 municipal wards and 39 local governments. According to the statistics of 2005 on Tokyo, 23 municipal wards accommodate 91 per cent of Indian population. Among the 23 wards, Indians mainly reside in the wards of Minato and Setagaya, in the western parts of the city in 1990. In Minato Ward, it is mostly the employees of the Indian Embassy, and those employed in the financial organizations of the Government. Setagaya ward attracts more Indian households because of the availability of international school where English is the medium of instruction. Indian traders (mostly of Gujaratis and Jains) especially involved in diamond business are found living since 1970s in Okachimachi (Taito Ward) that specializes in the whole-sale trade of jewelries. Indian population is found increasing in all the 23 wards since 1990s. Along with Minato ward in the northwest, Nerima and Nakano wards too (also in the northwest) attracted more Indians for living. The maximum increase is seen in Edogawa and Koto wards in the east. Transport accessibility and locations of IT companies may be the reasons for this sort of differences in increase.

The IT engineers so far were different from the Indian traders of Kobe in the sense that IT engineers did not form the settlement keeping the regional face to face contact as the

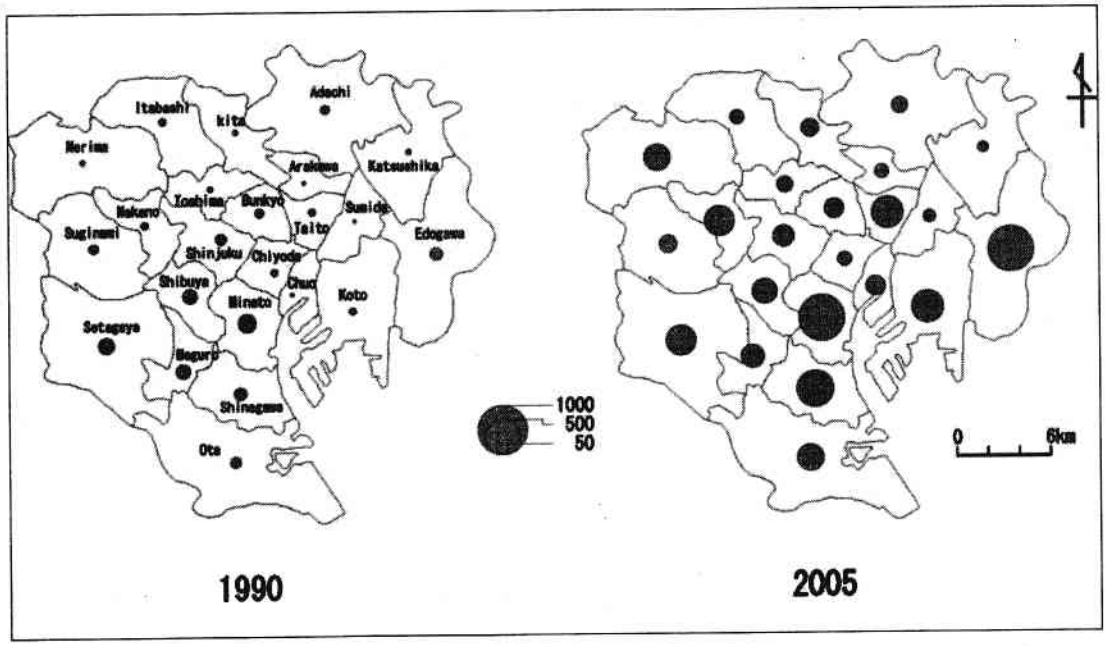

Fig. 4
Distribution of Indian Residents in 23 Wards of Tokyo

Source : Prepared from the data on Tokyo Metropolitan Government: "Identity Cards of Foreigners registered - Country-wise")

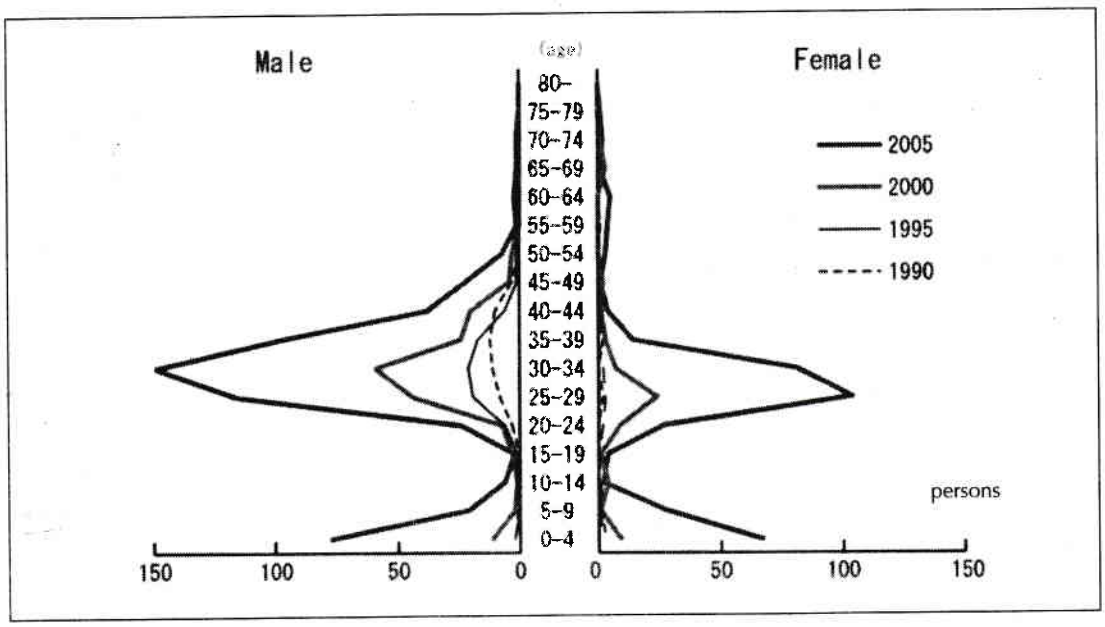

Fig. 5
Population Pyramid of Indian Residents at Edogawa Ward, Tokyo

Source : Prepared from the data of the Muncipal Office of Edogawa Ward.

premise, and most of them accepted to reside temporarily in the accommodation provided by the employers. However, since 2000 the society of new immigrants has undergone great change, and now they seem to conceive and feel for 'own place'.

Emerging of an Indian Settlement in Tokyo

New Indian Settlement at Nishikasai, Edogawa Ward

In Edogawa Ward (Fig. 4) in which most of the Indians reside, male population in the age group of 20-39 was more among the Indian residents in 1990 (Fig.5). In 2005 in addition to the male population in the age group of 20-39, women in the age group of 20-34 and children of 0~9 also increased significantly. So it may be observed that the family structure that centered around single men IT engineers in 1990, got changed to the family structure consisting of couples of young IT engineers and their children in 2005. Indian households are more concentrated in Kasai area of this ward. Kasai area was developed in the second half of 1960s as residential area from agricultural land, and several condominiums were built for 6000 households on the reclaimed land. Most of the Indians in the Kasai area particularly reside in the neighbourhood of Nishikasai station on the Tokyo Metro Tozai Line. It is now one of the well-marked areas of Indian community in Tokyo, the Global City.

IT engineers come to Japan on project-based employment and most of their stay is restricted to a visa period of three years, which is extended upto five years very recently. The daily routine of an ordinary IT engineer, who is single, is as follows: He gets up between 7 ~ 7.30 in the morning and takes shower; prepares lunch to be carried; takes up breakfast and leaves to the office at about 8.00 a.m., taking a train in a nearby station like Nishikasai station on Tokyo Metro Tozai Line, or Matsudo station on JR Joban Line, Nakano station on JR Chuo Line; reaches office before 9.00 a.m.; works till 8.00 p.m. with a lunch break; reaches home around 9.00 p.m.; takes dinner; watches TV for sometime or browsing the Internet for sometime; and goes to sleep around mid-night. Thus the working day for him goes like a machine, and leisure activities and shopping wait for holidays.

Thus a person who has such a routine daily pattern of commuting from the residence to working place chooses the residence, based on convenience for commutation and cheaper rent too. He may not look into other factors which any normal resident care for like shops dealing with ethnic food, restaurants, and presence of his community people. Therefore, most of the single IT engineers who visit Tokyo for the first time reside along the railway lines at a place from where the commutation time to the city centre will be within an hour. Since most of the work place of IT engineers is located at the centre of Tokyo, the condition of accessibility to the railway line is fulfilled by Tokyo Metro Tozai Line, JR Joban Line and JR Chuo Line. Further, Nishikasai Station and Kasai Station in Edogawa Ward are along the Tozai Line; two more distant stations, Gyotoku and Myoden located on Ichikawa city, Chiba Prefecture are also convenient boarding points. In real estate market, it is noticed that Asians may find more difficulties to get houses for rent. In the case of Indian IT engineers, the employing companies enter into contract with the residential rental corporate administration, and thus problems of hesitation for ethnic

reasons get solved. Moreover, Nishikasai, being a new residential area, enjoys a cosmopolitan outlook and as such, foreign residents may get accepted with greater ease. Since 2000, it is seen that the single IT engineers soon get married or bring their wife and children, and thus Nishikasai now witnesses more Indian families settling down. When the single IT engineers settle down with family, the existence of a mutually helpful Indian family and community becomes very important for them.

Formation of the Community and Indian School

With the families joining the single engineers and others, social network outside the work places too get developed. Several Indian social organizations got established based on native States and/or language groups[6]. The religion-wise facilities for Indian immigrants are less in Tokyo as opposed to Kobe, and the State-wise religious ceremonies are organized a few times every year in community halls taken on rent. Those who reside with their families joyfully participate, and enjoy the native fun and food, thereby trying to revive and maintain identity of their region and culture. Sikhs (most of them from Punjab and working around Tokyo as unskilled labourers, sub- contract factory workers or construction workers) built Gurudwara Sahib Tokyo in 1999 in the basement of a building owned by Indians in Bunkyo Ward. Guajarati Jains have built a temple in 2000 in the Jewelry office town, Okachimachi in Taito Ward.

As mentioned earlier, the period of stay of most of the IT engineers in Japan is less than three years, and thus many of the immigrants leave Japan after a stay of three years or so; thus there is a constant flow of new migrants; and as such, the existing social groups are at loss, and word of mouth is not easily feasible for social networking. So now internet provides an effective medium to Indians for information exchange in creating and strengthening their social network. Web pages and e-mails seem to be quite popular for exchanging information on festivals, functions and any other social activities. For instance, information on Indian restaurants, Indian schools and hospitals where interactions through English are possible is frequently exchanged via web pages and e-mails. Also orders for spices and foodstuff and their home delivery are being processed through internet, and Indian traders maintain their own web sites for this purpose(16).

Thus, the households which do not have root in the 'place' get evolved as a community through promoting interactions and managing a cultural continuity by using the Internet; and by these interests and interactions, those families who live in Edogawa Ward create a virtual base that plants and propagates their 'own place' of immigrants, thereby giving a shape for a new community in the global city of Tokyo. Edogawa Ward is conveniently located with transportation facilities to the centres of activities in the city, and is endowed with housing on cheaper rent, (monthly rent of about 120,000 Yen for 2 DK: double rooms with dining kitchen and bath room), super market and convenient stores operating during nights even, Indian restaurants and hospitals especially for children. Besides these physical infrastructural advantages, the important factor, that this Ward has, in facilitating the Indian migrants to be called as a community with their 'own place', is the existence of an

Indian society. An organization by name, Indian Community of Edogawa (ICE), was established in 2000. In ICE, the event planning, approval, cooperation, guidance etc. are carried out by e-mails. It helps the Indian residents by exchanging the information on education, schools and queries from the individuals on the issues of day-to-day life. Corresponding through e-mails, celebrations of the festivals like New Year, Holy, Dusserah and Diwali, which are Indian seasonal festivals, and dance parties watching Indian films, picnics etc., are arranged every year. Traders along with restaurant owners who live in this Ward for more than 20 years, take interest to organize these meetings and events. Before the formation of ICE, information exchange among Indians residing in Tokyo was facilitated by a News Letter; and the death of the organizer of this News Letter brought a change in the ownership and also weakened this method of communication. Further, it was not easy to circulate the printed materials and it requires more time and cost for printing and dispatch; the printed materials may not be reaching to the desired extend and to all who spread over to the length and breadth of the city. With these difficulties in continuing the print medium, increasing migration of IT engineers among Indians, and the Internet being the cheaper or free medium, Internet has been chosen for promoting a social network among the Indians. It is interesting to note that the ideology of mutual help based on the nationality forms the firm foundation of this social network, and the identity of religion or native State (and/or language group) that is the most important factor of identity in the native country, is not the promoting factor for this community formation. The Indians residing in Edogawa Ward for more than 10 years belonged to different religions and different native States; and even before the establishment of ICE there existed a network based on nationality. Another factor may be mentioned here that for the restaurant owners it is not an advantageous policy to differentiate their clients on the basis of religion or native State, and thus this factor also must have played a role in helping the Indians to form as a community based on nationality. As the immigration of IT professionals has been rapidly increasing, the media like Internet becomes an indispensable tool for communication and network in the Indian society. ICE keeps a mailing list to keep the Indians informed; traders maintain their web pages for their business transactions with Indians. Blogs are circulated over Internet for exchanging events and promoting discussions. There are blogs for putting up the notices of events at Sikh Gurudwara. President of ICE and director of the Indian School very often appear in TV programmes of Japan and in the columns of English newspapers and journals; and this kind of media presentations effectively informs the presence of Indians as community to the new-comers, and also helps to enlist new and more members for the Indian society.

As already mentioned, when the Indian IT engineers came to Japan as single men they resided in the rental houses allotted to them by the employers who entered into contract with the corporate housing, and so the pattern was the dispersion of their dwellings around Tokyo along the surface and subway rail lines. Then with the increase in the married people settling down, child birth, kindergarten admission, primary school admission, and other family needs, the mutual help from the Indian community and Indian School has become

indispensable for the wives and children. Tokyo Metro Tozai Line including Edogawa Ward (especially Nishikasai) satisfies utmost the needs of the Indian community. Earlier, this residential area was introduced to the new-comers by their co-workers or through Internet. Now, the mass media like TV and newspapers propagates the sketch of Nishikasai as an Indian town, and this influences the Indian new-comers to choose this area for their living. More and more Indians move over here, thereby increasing the concentration of Indians in this locality of Tokyo; and as a result, there comes the formation of Indian community.

In the network formation, the gender difference may be noticed. Men take up the initiative to form a network, and they organize the set-up of the association. The association then advertises for the Indians to join; those who are not members may not be encouraged to participate fully and the border of the association from others is thus clearly defined; and at this stage, it becomes more an official agency for Indians to interact, and with this, Indian identity and 'place' get established. In the case of women (13), network gets enlarged in the form of a friend of a friend. Mostly, the acquaintance is realized through the children of Indian School or the same administrative office of the rental housing. In such cases, the conditions pertaining to the affiliation of the members are not strictly followed, and what is more important is mutual concerns and help in the activities like child-care education and method of obtaining food materials, which are day-to-day issues, and hobby and leisure-time activities etc. During noon of the working days while the IT engineers are at their work, the wives mostly gather in a room of the rental condominium of a nearby friend and spend their time by discussing the issues of needs and interests, either through their mother tongue or English, or teaching the cuisine of their native place. Since they do not understand Japanese at all there is no communication or interaction with the local Japanese at all. Thus, the Japanese who do not understand English as well as Indian languages become different and they consciously feel the identity of Indian nationality.

The most important issue put forth by this community is the establishment of Indian School. They require an English-medium school. The Government Schools of Japan do not provide this facility; though there exists an International School in Koto Ward, the annual school fee of about 1,000,000 Yen is quite prohibitive. Therefore, most of the Indians residing in Japan either left their children with their grandparents in their native place or send their children to the Boarding Schools in India. Under these circumstances, mainly the Indian traders in Tokyo and Yokohama city who were the old time settlers established an Indian School for the first time in Koto Ward in 2004. After that in 2006 with a view to cater to the requirements of increasing Indian children the second Indian School was established in Edogawa Ward and the third Indian School is planned to come up in Yokohama city in 2008. The latter two schools were established by Singapore Indian Corporate which is already running Indian Schools in Malaysia and New Zealand in addition to Singapore. Keeping in mind the children of highly qualified IT engineers in Tokyo, the aim is to provide an education with relevant curriculum, with a focus on Science and Mathematics. These schools follow the regulations and the

standard of the Secondary School Education of the Central Government of India (CBSE-Central Board of Secondary Education). This standard guarantees the global flow of Indian IT engineers. All of these schools are similar to Indian Private Schools in providing education through the medium of English and they do not teach through other mother tongues, although some Hindi classes are available. Thus, the ICE and Indian Schools have the commonality of not leaning on religion or specific mother tongues, and this promotes the formation of national identity as Indian citizens away from their nation.

Formation of Identity

In India the basic factors for the formation of identity of Indians are religion, caste and mother tongue. Names and food habits too may be the factors for identity formation. The daily activities and contacts with others who may belong to different religion, caste, region and the like may allow one to recognize as others, and in this process too, identity gets formed. For instance, Kobe is the place of living for many Indians since long, and here it is not their Indian nationality but the compact local network wherein face to face contacts taking place in their 'own place' within the same religion and caste, has formed the basis for identity formation.

On an overview, it may be said that there are three factors constructing the identity in Tokyo. First of all it is the religion. The Sikhs (Punjabi) and the Jains (Gujarati) who have built their own place of worship in Tokyo come under this category. By building their place of worship in Tokyo, the followers of these two religions reached the position of making the religion as the basis for formation of their identity. Secondly it is the mother tongue (native State). In Tokyo these people while prepared the mailing list of native language speakers (native States) attempt to reconfirm their identity based on same mother tongue or the nativity of the same State by holding a few parties (religious festivals, lunch and dinner, games pertaining to their native States) annually in rental community halls and other places. The third one is the nationality. Immigrant Indians in Tokyo gathered around in a cluster to form a community and found their 'own place' afresh in Nishikasai. Later, in the vicinity of this area, an Indian School was established. All this development in Nishikasai has made 'others' to say that this 'place' is of Indians. This kind of 'togetherness' of Indians in this 'place' has resulted neither from the basis of mother tongue nor of religion, but based on nationality; the idea of nationality provides a needed threshold to gather Indians overcoming their differences.

Conclusion

Indian Diaspora is now found in so many countries of the world. There has been a long history of Indian migration. Producing of oil and the consequent economic development in the Middle East saw a migration of Indian population on a historical proposition. The next accelerated wave of migration happened on the advent of economic globalization after 1990s, and during this wave, USA and other developed countries including Japan recorded a greater flow of Indian immigrants. The IT industry supplies the basic infrastructure for the economic globalization, and the Indians with their engineering education and English emerged as the skilled force for this industry,

thereby initiated a new flow of Indian Diaspora. In the case of Japan, Indian Diaspora belonged to the 4th Wave of Indian Migration.

In Tokyo, the recent immigrants are mainly of IT professionals and there exists now a few clusters of Indian residents. They assemble and hold festivals, fairs, and functions periodically, and these meetings provide fresh opportunities to reconfirm their identity. Earlier contacts among the Indians were made through the word of mouth. With the current larger flow of IT professionals who come for different companies and from different regions and religious and caste groups in India, Internet has become the main line of communication among Indians and their social organizations. In the course of time, the single men dwellings got graded into the family dwellings together with their wives and children, and with this up-gradation, the Indian Diaspora is able to conceive its 'own place'. The identity of Indians in Tokyo is formed not only on the basis of religion and mother tongue (native State), which were the factors in India or in Kobe, but also on the basis of nationality which is emphasized upon here.

The location of the offices of IT software industry is controlled by the acceptable rent and accessibility to the clients. Very often employees are sent to client sites for the job. Client sites for an IT company may not be the same all the time, and as such IT professionals may be asked to go to different locations during their work period. Normally working hours are long in the case of IT professionals and may not be for fixed duration like what is available in offices. Both working hours and duration may not be the same all through the year or all through a project on which they are employed. IT companies accept the work orders on the consideration of location, period and volume. Thus flexibility seems to be one of the basic characters of IT industry. Indian software engineers working in Japan are also experiencing this flexibility. In brief, the Indian residential distribution in Tokyo and the special features of Indian society, which are investigated in this paper, are based on this flexibility of IT industry and the globalized economy. Internet is the current medium for social communication too that helps connecting the far and wide and known and unknown almost instantaneously and at insignificant cost. E-mail, chat, video chat, TV, telephone, Internet telephony and Internet camera help the Indian engineers to keep in contact with their homeland, other parts of the world and fellow Indians around in Tokyo and Japan. Thus Internet has become an indispensable medium for the new Diaspora for communication. Internet is the backbone for the business in these days of global world and economy and at the same time, it is certainly a medium for social network developing a community and 'own place'.

Acknowledgement

The authors record their thanks to the Grants-in-aid for Scientific Research (2005-07) of the Ministry of Education, Government of Japan. Minamino is the author for the section on Indian Diaspora: Past and the Present, Indian Society in Japan, and Sawa for the other sections. The authors wish to record their deep appreciation and thanks for the help rendered by Prof. Balamabal, Retired Professor of Japanese Studies, Delhi University in translating our Japanese script of the paper.

Notes

1. The 1980 report is recorded in Lok Sabha Debates Seventh Series, Vol. vii, No. 35. pp. 125-136. This is from the materials presented for the answer by P.V. Narasimha Rao, Minister of External Affairs to the question by Mr. Mohd. Asrar Ahmad, on the proceedings of 24th July, 1980. The title of the material is given as [State of Indian residing in various Countries, (as available upto 15.7.1980)]. The five columns in the material are: No., Name of country, No. of persons of Indian origin residing abroad, No. of those who have accepted foreign citizenship, and Remark.
2. In the 1980 report there are countries showing not the number of persons but the number of house-holds. In such cases a house-hold is calculated as a unit having 5 members. Besides, there are countries such as Burma (present day Myanmar) shown in the range of 300,000-400,000 persons. In such cases the intermediate value is applied. In the 1980 Report and the 2001 Report there are certain columns showing the number of persons having foreign citizenship as empty. Those values are treated as zero. Though the data in the 1980 Report and the 2001 Report are of Government of India statistics, almost all are in round figures. Therefore, the data analysis in this paper is just to present the trend.
3. Diaspora had the meaning, particularly with reference to the Jews, of collective sentimental extemal wounds of those spending their life abroad dreaming about their homeland. In recent years that meaning has expanded to indicate the concept of foreign migrants, foreign exiles, foreign residents, ethnic racial minorities (2).
4. In Kobe there are Hindu temple, Bhagwan Mahavir Swami Jain Temple, and Sikh Gurudwara, Guru Nanak Darbar. All these temples are concentrated on Chuo Ward in Kobe City.
5. Among Indian societies it is customary to marry within the same religion, caste.
6. There are Tokyo Bengali community activities of Bengali language group (natives of West Bengal State), Tokyo Marathi Mandal of Marathi language group (natives of Maharashtra State) Kannada Balaga of Kannada language group (natives of Karnataka State) etc.

Appendix I

Distribution of Indian Residents (1961 - 2005)

Prefecture	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Tokyo	176	128	145	152	167	205	216	226	259	285	329	308
Saitama	3	1	0	0	0	2	0	3	1	7	7	8
Chiba	0	1	1	2	3	1	3	3	3	4	0	1
Kanagawa	52	50	51	56	61	59	67	63	81	69	69	85
Aichi	2	5	1	6	9	5	7	9	12	23	16	12
Osaka	77	77	75	91	89	108	115	121	114	145	106	108
Hyogo	452	467	523	519	549	552	566	566	596	602	637	683
% of Hyogo	54	56.8	58.8	54.7	55.5	52.4	53.6	51.9	50.7	47.6	48.3	45.7
Japan	837	822	890	949	990	1054	1056	1091	1176	1266	1319	1496

Source : Prepared from The Annual Report of the Japan Immigration Association
``Statistics on the Foreigners registered in Japan''

Appendix I (Contd.)

Prefecture	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Tokyo	318	344	402	421	405	440	413	497	534	585	586	692
Saitama	9	11	8	9	6	4	7	6	11	10	12	15
Chiba	15	17	15	22	27	26	36	26	21	28	28	42
Kanagawa	60	66	73	73	82	93	92	120	138	146	149	160
Aichi	17	18	9	16	19	15	15	23	27	27	40	41
Osaka	101	113	128	109	121	131	122	107	134	160	136	142
Hyogo	665	670	715	747	791	861	862	871	901	933	1011	1026
% of Hyogo	44.8	43.1	42.9	44.6	45.7	46.3	46.4	44.8	42.2	41.8	42.7	40.4
Japan	1483	1554	1668	1676	1730	1860	1858	1944	2137	2232	2368	2540

Prefecture	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Tokyo	670	707	778	828	880	934	1117	1217	1379	1511	1703	2025
Saitama	10	21	34	42	53	63	92	123	189	265	297	348
Chiba	47	46	55	64	100	108	140	191	228	283	297	363
Kanagawa	159	153	142	147	176	224	296	369	417	449	473	544
Aichi	37	59	66	66	95	118	151	168	205	270	278	285
Osaka	152	145	143	169	165	175	191	199	222	231	294	309
Hyogo	1044	1024	931	922	910	914	984	1009	1046	1027	1017	1025
% of Hyogo	41.0	39.4	36.0	33.8	31.1	29.4	26.9	25.0	22.5	19.9	18.5	16.2
Japan	2546	2601	2585	2730	2926	3107	3653	4035	4642	5169	5508	6343

Prefecture	1997	1998	1999	2000	2001	2002	2003	2004	2005
Tokyo	2382	2768	2980	3436	4247	4875	5112	5682	6380
Saitama	455	583	581	591	612	657	691	734	703
Chiba	474	552	594	617	782	948	1080	1208	1381
Kanagawa	714	792	801	1003	1308	1557	1712	1870	2182
Aichi	338	445	438	471	503	581	705	741	755
Osaka	319	361	387	410	491	560	561	617	662
Hyogo	1066	1127	1180	1156	1153	1166	1154	1195	1244
% of Hyogo	14.3	13.0	13.0	11.5	9.8	8.7	8.1	7.7	7.3
Japan	7478	8657	9067	10064	11719	13340	14234	15480	16988

References

1. Awaya T (2000). 'Indian Migrant Labourer in the Gulf States', in M.Koga, M. Naito and T.Hamaguchi (eds.). *From Migrants to Citizen: Studies on South Asian Communities Overseas.* Tokyo: University of Tokyo Press, pp.235-246(in Japanese).
2. Cohen R(1997). *Global Diasporas.* London: UCL Press
3. Harvey D (1989). *The Condition of*

Postmodernity: An Enquiry into the Origins of Cultural Change. New York: Wiley-Blackwell.

4. Hirose T (2007). 'Energetic Indians Network Abroad', in T.Hirose, M.Kondo, K.Inoue and T.Minamino (eds.). *60 Chapters to understand Modern India. Tokyo: Akashi Shoten, pp.325-330 (in Japanese).*
5. Koga M & H. Nakamura (2000). 'Trends of International Migrants and Indian Migrants', in M. Koga, M.Naito and T.Hamaguchi (eds.). *From Migrants to Citizen: Studies on South Asian Communities Overseas.* Tokyo: University of Tokyo Press, pp.1-23(in Japanese).
6. Koga M (2006). 'Indian migrants', in M.Naito & H.Nakamura (eds.). *A History of South Asia: Plural Culture and Society.* Tokyo: Yuhikaku, pp. 303 - 324 (in Japanese).
7. Minamino T (2002). 'An Analysis of Overseas Indians' Statistics', *Hyogo University of Teacher Education Journal,* 22, pp.69-80 (in Japanese).
8. Minamino T(2008). 'Present Situation and Trend of Indian Diaspora analyzing from Indian Government Statistics of 1980 and 2001', *Immigration Studies,* 4, pp.30-49(in Japanese).
9. Minamino T, M. Kudo and M.Sawa (eds.)(1999). *'History and Trends of South Asian Migrants in Japan',* (Publication of Scientific Research Results, 2, Research Project, 'Institutions, Networks and Forces of Change in Contemporary South Aisa', Tokyo) (in Japanese).
10. Minamino T, M.Sekiguchi and M.Sawa (eds.)(2001).*'South Asian Migrants crossing Boaders:Relation to the Host Community'* (Publication of Scientific Research Results, 13, Research Project, 'Institutions, Networks and Forces of Change in Contemporary South Asia, Tokyo) (in Japanese).
11. Minamino T and M. Sawa (2005). 'History of Indian Community in Kobe: Its Identities and Network', *Hyogo Geographical Journal,* 50, pp.4-15 (in Japanese).
12. Naito M(1996).'Typology of Indian/South Asian Migrants', in M.Naito (eds.). *Studies on South Asian Communities Abroad with Special Reference to Commonwealth Countries.* Tokyo: Institute for the Study of Languages and Culture of Asia and Africa, Tokyo University of Foreign Studies (in Japanese).
13. Oyamada M (2007). 'The Indian Community in Nishi-kasai with a Central Focus on the Interview Investigation of an IT Engineer's Family', *Bulletin of Sociological Studies,* Rikkyo University 14, pp.59-68 (in Japanese).
14. Sassen S(2001). *The Global City: New York, London, Tokyo.* Princeton :Princeton University Press.
15. Sawa M & T.Minamino (2003). 'Indian Community in Japan involved in Globalization: Reflectivity between Ethnic Group and Place', in S.Akita & T.Mizushima (eds.). *Contemporary South Asia. Vol.6. Networks and World System.* Tokyo,: University of Tokyo Press. pp. 347-367 (In Japanese).
16. Sawa M & T.Minamino (2008). 'Spatial Reorganization of Indian community in Japan involved in Globalization: Focusing on De-territorialisation and Re-territorialisation' in A.Takahara, K.Tamura and Y.Sato (eds.). *Contemporary Asian Studies. Vol.1. Crossing Border.* Tokyo: Keio University Press.(in Japanese).
17. Sekiguchi M (2000). 'Indians in U.S.A,' in M.Koga, M. Naito and T.Hamaguchi (eds.). *From Migrants to Citizen: Studies on South Asian Communities Overseas. Tokyo:* University of Tokyo Press, pp.196-207 (in Japanese).
18. Shigemastu S(1995). 'Overseas South Asians and Indians: Research Topics and Trends', *Forum of International Development Studies,* 3, pp.70-100 (in Japanese).
19. Shigematsu S (2003). 'New Indian Migrants,' in S.Shigemastu & M. Mita (eds.). *50 Chapters for understanding India.* Tokyo: Akashi Shoten, pp. 78-81 (in Japanese).
20. Tominaga C (1995). 'Roads of Indian Migrants: History', in M. Konishi & H.Miyamoto (eds.). *The Cultural History of Roads in India.* Tokyo: Shunju Sha, pp.289-295 (in Japanese).
21. Tuan Yi-Fu (1974). Topophilia: *A Study of Environmental Perception, Attitudes, and Values.* Englewood Cliff, NJ: Prentice-Hall.

Evaluation of an Environmentally-based Spatial Population Model

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A previously developed habitability model is evaluated at two different scales—a crude scale (California) and a more refined scale (California counties). Using the Mean Absolute Deviation and Relative Variance, the model's estimated populations show an improvement over coarse values observed for large polygons. A corollary evaluation shows that urban populations are underestimated and rural populations are overestimated. The model evaluation results indicate that environmentally based population modeling can be employed to improve upon coarse existing data.

(Received: November 2007; Accepted: April 2008)

Population concentrations do not occur randomly across the globe. Simply examining population densities across the globe shows that people tend live in proximity to the coast (2, 9). Access to water and soils capable of supporting agriculture is necessary for many populations. These factors permit groups of humans to remain in a fixed spatial location. The physical environment, then, plays a role in where people choose to settle, a role that has received little quantitative attention. To examine this relationship, a quantitative model was developed that incorporates the concept of habitability (a location's propensity to support fixed human settlement) as an influence on actual human populations (14). This model introduced the somewhat controversial concept that quantitative expressions can be utilized to contribute to the explanation of human population distributions. Zimmermann demonstrated the conceptualization of the model (14). In this paper, the model's performance and utility are evaluated and discussed.

Environmental determinism, with its sorry history in geography, rightly deserves the criticisms lobbed at it. For example, Ellsworth Huntington's work, which incredulously linked morality to climate, deserves its condemnation (4). Indeed, adverse reactions to environmental determinism are understandable and healthy. The notion that the environment "makes" a person completely (and offensively) disregards human possibilism. However, the idea that the physical environment lacks influence on human lives is equally ridiculous. Livi Bacci notes the need for humans to acquire space and attendant resources, stating

> *"though seemingly a commonplace, this connection is virtually ignored in studies of population history, apparently because it smacks of biological or natural determinism." (5, p.18).*

Stern even called for the creation of a new branch of environmental science addressing the relationships between humans and their

☐ The Indian Geographical Journal 82 (1) June 2007; published in June 2008

ambient environments (10). It is out of these understandings and beliefs that the habitability model was developed.

An extensive explanation of the model, its philosophy, and the method of population apportionment can be found in Zimmermann's work, in which the explanation of the model's concept and development is elaborated upon (14). However, the validity and potential use of a model rests on its performance after it has been evaluated. For this model to contribute to a more nuanced understanding of human population settlements and the ambient physical environment, it needs to achieve a spatial population estimate that surpasses that of coarse, unrefined data.

This paper, then, presents the results of an appraisal of the model, in the context of scale. The model is evaluated at two scales, a coarse scale employing the 1990 population of the entire state of California (United States), and a more refined scale utilizing the 1990 populations of counties (sub-units of California). An intuitive assumption would be that using the more spatially-refined county-level data should yield better results. Two statistics—mean absolute deviation (MAD) and relative variance—are used to assess the model's performance. A separate examination investigates the spatial dimensions of overprediction and underprediction by the model. Following an analysis of this model's performance, the future of environmentally-based population modeling is discussed.

The Issues of Data Availability and Scale

The spatial scale at which data are examined and questions are investigated is of great importance. A scale that is too large may mask vital information about spatial variations. The subtle topographic and physiographic nuances that render a place advantageous to the formation of permanent human communities would be missed if the available data were too coarsely refined. Similarly, a too-small scale may introduce unnecessary noise. Understanding this is particularly critical to avoid interpreting information as being more spatially refined or "better" than it actually is. Additionally, a scale that is too small may be difficult to replicate.

As Gutmann notes, population data for historical time periods are coarse at best. In the United States, these are likely unrefined beyond the county level (3). Human settlements, however, are found at scales considerably smaller than that of a county and contain numerous established settlements, such as cities, towns and villages. Indeed, the average county size in the United States ranges from 629 sq. km (Rhode Island) to 63624 sq. km (Alaska) (11). Therefore, the lack of adequately spatially refined coverage hampers research, including historical research. The ability to be able to move from a crude spatial scale to a more refined one is vital.

Evaluating Human Population Distributions at Different Scales

Low-resolution, polygon-based representations of human population distributions imply constant population densities, often across reasonably large areas. Clearly, this does not represent the true, spatially varied densities of those areas. Determining the effectiveness of the habitability model in refining such spatially coarse population data is accomplished by comparing both the model's population

density estimates and those of the coarse data to the highly spatially resolved observed block-group data; block groups represent very small units that are predicated on the number of housing units (variable, but averaging approximately 400 in 1990) (11). Block groups are spatially irregular polygons, which are not well suited to many types of research. Therefore, the block group data were gridded into 30 arc-second grid cells for the purposes of evaluating the model. The efficacy of the model is thus tested by determining whether—and to which degree—the model-estimated populations are closer to the actual population (from block-group data) than those generated from coarse population densities.

The habitability model developed was used to estimate populations for dissimilarly - sized polygons—the entire state of California and sub-units of the state, specifically the 58 counties of California. Initially, the model apportioned the population of California as a whole. This approach yielded a spatial approximation of the population that mirrored the general pattern of the observed census data (14). A similar run of the model, this time utilizing and apportioning the populations of the individual counties, yielded a more enhanced estimate of the population field (Fig. 1). This improvement was due to the fact that the county data are themselves more refined. However, Zimmermann did not report quantitative results of the model's performance evaluation in the early write-up, and instead, only its conceptualization and a visual appraisal (14).

Starting with California's total population (28,858,477), the average population density is approximately 73 people per sq. km at each 30-arc second grid cell; implicit in this is a geographically and topographically homogeneous polygon. By applying certain habitability "rules" based on elevation, topographic accessibility, and river proximity, the densities at the grid cells vary from 0 to 250 people per sq. km, since a heterogeneous landscape is incorporated into the model. The coarse pre-model densities and the refined modeled densities are compared to the observed grid cell densities based on the observed census data.

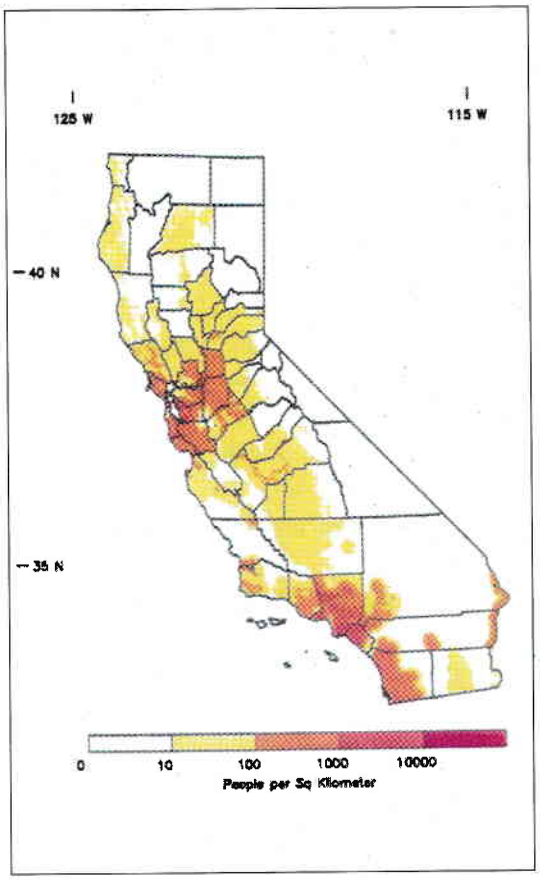

Fig. 1.
Estimated Human Population Density when forced by the Populations of the State's Counties

Clearly, the more finely resolved the initial data are, the closer to "truth" the estimated data should be. Distributing habitability-based populations across California using the census counts of the individual counties rather than the entire state should, then, result in a refinement of the estimated population values. Such data are already observed at higher spatial resolutions. Because county data (in the United States) are often the most spatially refined data available (3), at least for historical time periods, validating the model at both the larger (state) and smaller (county) levels is necessary. The question is whether these higher-resolution data will improve the habitability-based population-density estimates across California.

Model Performance based on Mean Absolute Deviation

How well or poorly a model estimates "truth" (the observed block-group data) can be summarized by the Mean Absolute Deviation (*MAD*). For a region *R*, the *MAD* can be evaluated discretely according to:

$$MAD = \frac{\sum_{i=1}^{n_i} \sum_{j=1}^{n_j} \left| \hat{P}_{i,j} - P_{i,j} \right|}{n_i n_j} \qquad (1)$$

where i is the latitude, j is the longitude, $n_i n_j$ is the number of grid nodes in R, $\hat{P}_{i,j}$ is the population estimate at a given grid node, $\bar{P}_{i,j}$ and is the census block-group population evaluated at the grid node (at a 30 arc-second resolution).

Equation (1) is subsequently evaluated with $P_{i,j}$ replacing and (the product of the mean population density of the region [either state or county] and the area of the grid cell) replacing $P_{i,j}$. This results in the *MAD* expressing the average error in the absence of the model.

The initial evaluation of the model using *MAD* utilizes the habitability-estimated populations forced by California's population as a whole. In the "no-model" scenario, the error is 84.60 people per grid cell. The *MAD* for California utilizing a model aggregating elevation, topographic accessibility, and river proximity, is 81.43 people per grid cell. Applying a physically based model to coarse data, then, does improve upon the rough population densities. Even though the improvement may appear slight, it does lend credence to the notion that the physical environment does influence where people choose to settle.

Errors are considerably lower when the model is constrained by the populations of the individual counties. The "no-model" *MAD* is 70.01 people per grid cell. Application of the model results in a reduced error of 63.61 people per grid cell. The improvement using county-level data is entirely expected, since the data are more refined. This is over six people per grid cell, representing a nine-percent refinement.

Model Performance based on Relative Variance

A second statistic, relative variance (*V*) is used to evaluate the habitability model. This describes the spatial variance exhibited by the model's population estimates relative to the variance associated with the high-resolution

block-group data. Thus, it is useful in diagnosing model performance.

The average population density is first calculated for a region R of interest (e.g. a state or a county), which results in a constant density over R. This is then multiplied by the area of each grid cell to obtain the mean grid cell population. Using these, relative variance is thus computed as:

$$V = \frac{\sum_{i=1}^{n_i} \sum_{j=1}^{n_j} \left| \hat{P}_{i,j} - \overline{P}_{i,j}(R) \right|}{\sum_{i=1}^{n_i} n_j \sum_{j=1} \left| P_{i,j} - \overline{P}_{i,j}(R) \right|} \qquad (2)$$

V will be 1.0 when the spatial variance created by the model equals the spatial variance associated with the block-group observations. V will be greater than 1.0 when the habitability model generates more variability and less than 1.0 when the habitability-estimated variance is less than that of the finely resolved and observed block-group data. Relative variance, then, indicates the similarity of variability of the model-estimated population field to the observed population field.

For the model forced by the total population of the state, V is 0.50, indicating that the habitability model underestimates the spatial variability of the observed data. However, this is entirely expected and is a pattern typical of models, which oversimplify processes. For a model with only three initial variables, an overestimation would be highly unlikely.

Constraining the model to the county-level populations surprisingly does not improve upon the relative variance. Indeed, the results are nearly identical. While state-forced population estimation yielded a V of 0.50, the county-forced model estimates returned a relative variance of 0.49.

Graphically Evaluating the Model's Performance

The model performance statistics (*MAD* and *V*) show only part of the model's performance. Equally important are the geographic areas of over- and under-estimation. Model-estimated fields also are evaluated graphically, by mapping (model-estimated population compared to block-group based population). This ratio reflects not only the difference between the two grid-cell populations, but also whether the model-estimated population is over or under the block-group observation. If < 1.0, the model predicts that fewer people reside within the grid cell (a lower density) than indicated by the block-group observation; conversely, a value greater than 1.0 shows that the model overestimates the number of people in the grid cell (a higher density). A perfect relationship, of course, would return a value of 1.0. This ratio is mapped, allowing one to discern the spatial differentiation of error.

Firstly, these ratios are applied to the habitability model using the entire population of California. The ratio of model-estimated to block-group population shows areas of overestimation and underestimation (Fig. 2). Urban areas (e.g. San Francisco, Los Angeles, San Diego) tend to be underestimated. Sparsely populated regions are typically overestimated.

Fig.3 shows the refinement after the ratios are plotted following the constrainment by the

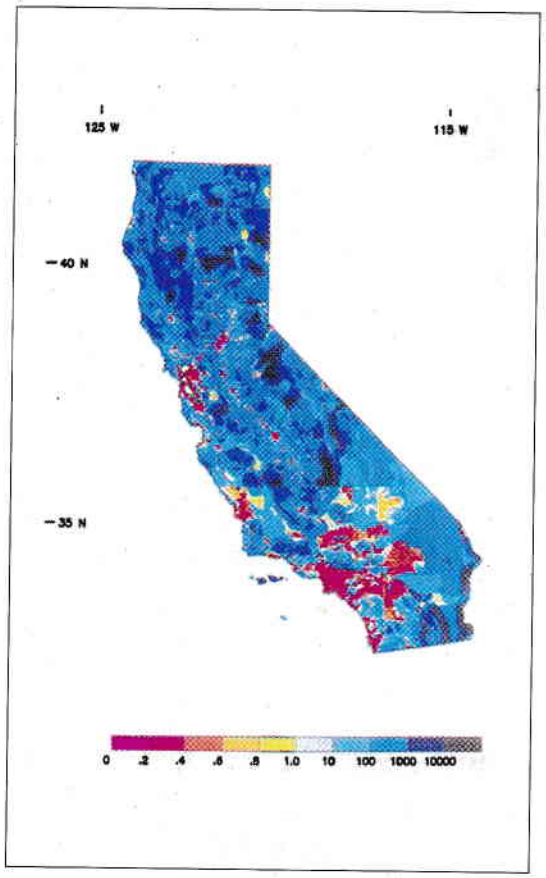

Fig. 2.
Over- and Under-estimations of Population Density based on California's Total Population.

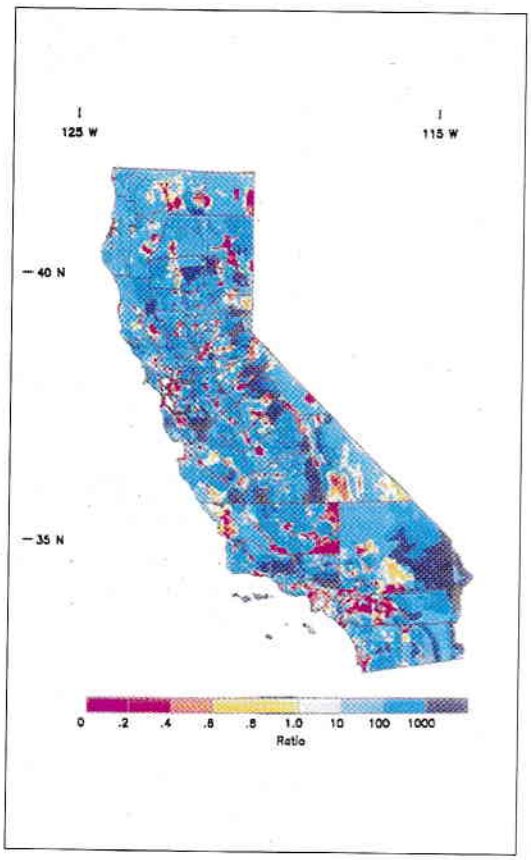

Fig. 3.
Over- and Under-estimates of Population Density-based on the Populations of California's Individual Counties

county populations. There appears to be substantial improvement compared to Fig.2. The urban areas (San Francisco, Los Angeles, and San Diego) are better estimated and the very large underestimates have been reduced. Northern California, which had been an area of large overestimates, is now resolved more realistically. This is not surprising. Utilization of county population data yields a more varied and, hence, realistic, distribution of people. Still, these mapped ratios show that the model can be used with more coarse population observations.

Discussion of the Habitability Model's Performance

In the absence of high quality data, an understanding of a place's physical geography can indeed enhance an interpretation of the spatial distribution of human population settlements. The model clearly improves upon the environmentally homogeneous landscapes of coarse data, even when constrained by the population values of the whole state; utilizing the county-level values improved the estimates even more.

One expected criticism is that the model didn't improve upon the coarse data *enough*. However, several factors refute this. Firstly, there is no established assessment of what constitutes a significant improvement. Quantitative work on human settlement and environment is sparse. Any development represents an improvement, because it establishes a clearer understanding of the relationship between humans and their ambient environments. This model, then, establishes a foundation or baseline from which further progressions can be advanced. Its improvement upon the coarse population densities demonstrates its viability, even though further refinements would render the model even more effective.

Secondly, the selection of California as the test case to evaluate the model may have introduced error that may not have been found had the model been investigated at a different location. Contemporary California is wealthy and technologically advanced. Therefore, California represents one location that is better able to overcome any obstacles presented by the environment. For example, water is diverted to more arid regions, enabling them to support populations without the need to be proximate to a water source. Los Angeles is a prime example of this, as much water from the Sierra Nevada mountains eventually makes it way into the homes and businesses of Los Angelenos. An extensive road network connects Californians, rendering the need to remain in a geographically advantageous place less important. Mountains no longer are the impediment that they had been in earlier times. Employing this model in lesser developed and technology-poor regions would likely result in less error, since such societies may not have the means to surmount physical barriers and environmental difficulties. Similarly, utilizing this model for historical time periods, where spatial population data may be of poor quality or nonexistent should also produce stronger results.

This, of course, begs the question "why California?", which has been previously addressed (14). Certainly, contemporary and wealthy societies would not find a habitability model necessary or useful, since these populations already have the means to generate high-quality spatial population data. However, that data are required to test the model and appraise its effectiveness. It would likely perform more superiorly outside the wealthy world.

Thirdly, only three variables were included in this version of the model: elevation, topographic accessibility, and river proximity. Certainly, additional factors would further refine the model and likely affect results in a more positive direction. For example, coastal proximity could be incorporated; Small and Cohen already noted that population densities decrease with distance from a sea coast (8). Climate variables could also be added to a more sophisticated habitability model. The annual temperature range might be added, since many locations with extreme variations in temperatures also have low population densities (e.g. Siberia, northern Canada). Natural vegetation, although it is strongly coupled with climate, could also be included and perhaps establish a relationship between human and food production.

Fourthly, the habitability model does not integrate socioeconomic variables into its

"rules". These factors obviously play a major role in influencing where people live. Jobs, family, conflicts, inertia—all of these affect population movements and settlements. This is, however, beyond the purview of this research.

Analysis of the Overestimates and Underestimates of Population

When population was distributed according to the model's rules, the pattern of spatial population distribution was clearly replicated (Fig. 1 ; see also Fig. 2 in Zimmermann (14)). Notably, the model correctly depicted the coastal urban areas (e.g. San Francisco, Los Angeles, San Diego), as well as the somewhat higher densities in the Central Valley. Similarly, the mountain and desert regions were allotted fewer people and reduced densities. This is impressive and promising. However, while the pattern of population was reproduced, the magnitudes of population were not. The model tended to underestimate urban areas and overestimate rural regions.

Under-estimation of urban populations is driven by the numerous factors that are not addressed by the model — employment possibilities, access to technology, cultural amenities and other lifestyle features—as well as additional pull factors. Because the model neglects social, economic, and cultural influences, focusing instead solely on ambient environmental characteristics, one would not expect it to perfectly replicate the observed population. Given the myriad non-environmental reasons that attract (or keep) urban dwellers, the estimated populations would be too small, relative to the observed.

Similarly, the model overestimated the number of people in rural regions. Indeed, the magnitudes of the error ratios are rather large. It is, however, important to note that the magnitudes are inflated because of the sparse populations in those rural areas. The small observed populations can quickly generate a seemingly substantial proportional difference, even though the actual values of estimated and observed data suggest smaller absolute differences. Beyond the issue of the small numbers of people in rural areas, there exist additional explanations for the overestimations. Lack of economic opportunities may drive some people away. This would not be accounted for in the environmentally-based model. Additionally, rural populations have been growing older; typically, rural areas contain proportionately higher populations than urbanized locations (7). Younger people are likelier to gravitate toward urban areas, leaving the elderly behind, especially in technologically advanced societies. Younger people, then, start families, leading not only to lower median ages in the urban centers, but also a greater *total* population. Since the model has no way of incorporating these demographic shifts, overestimations would, by extension, would arise in the rural environs.

The Utility of a Physically-based Model for understanding Population Distributions

Although using actual observed population data is far preferable to modeled data, unfortunately, that is not always possible. For example, climate change researchers encounter obstacles because population values are often unavailable at the spatial resolutions required for research into anthropogenic causes of climate change (12). The quality of such data are often

questionable, even in contemporary times (1, 3,13). Historical population data fare even worse, being subject to a variety of biases and inaccuracies (5, 13); they may also be erroneously interpreted by historians and anthropologists (5, 6). Gutmann, too, decried the regrettable lack of population data for small areas (3). Clearly, some other methods of assessing the spatial distribution of people is warranted, even necessary, for a proper understanding of human population dynamics and the impacts those dynamics have on the earth. Therefore, using a physically based habitability model to estimate spatial population distributions contributes not only to a better understanding of the relationships between human population settlements and the surrounding environment; it also permits one to more accurately estimate human populations in the absence of higher quality spatial data.

The results of the model evaluation have clearly demonstrated its efficacy. As the results from both analyses—utilizing the coarse population distribution of the state of California as a whole and the more spatially-refined county-level data—indicate, even spatial population data at low resolutions can be improved by incorporating an understanding of the ambient physical environment. Clearly, starting with better resolved data yields superior results. However, poor quality data need not be an insurmountable obstacle. People do tend to live near water. People do, generally, live at lower elevations. People do typically live in places where the topography is smoother. This model permits one to use this knowledge and spatially apportion human populations in the absence of better quality population data.

The Future of Quantitative Modeling of the Physical Environment and Human Population Distributions

The results of the model evaluation have shown that it is possible to apportion a coarse population value into a more realistic spatial distribution. This underscores the importance of the physical environment with respect to human population settlements. A simple model incorporating a few environmental variables improved upon coarse data, generating a population field that more closely approximated the observed data values. While the use of more finely resolved county-level data delivered better results than the coarser state-level data, model evaluation results indicate that higher quality data are not necessary to enhance the spatial expression of human population distribution. This alone suggests that population modeling using this habitability model can be quite useful, particularly for research investigations where poor quality population data exist.

A valid criticism of this particular habitability model might be its less-than-perfect duplication of the observed data. However, as discussed earlier, the model includes only three environmental variables, so the addition of more would likely improve the results. This should not be an argument against using physical variables to distribute population; rather, the model's initial success should point to a promising future using this approach to interpret population in a more realistic spatial allocation of people. An additional advantage of this particular model is that the data necessary to construct it are relatively easy to acquire. Therefore, this would represent an inexpensive method of population data enhancement.

On obvious place for environmentally-based population modeling would be using it in conjunction with known social, economic, and cultural information. That is, this habitability model could be used in tandem with an economically forced one or it could be modified to incorporate non-environmental factors. By merging the two approaches, more accurate population distributions would be likelier to be estimated from coarse observed data. Indeed, the blending of known environmental and sociocultural methods could potentially usher in a new way of examining population and environment, by providing a new investigative tool in the research arsenal.

Conclusion

A model developed by Zimmermann was tested and evaluated to determine its viability for improving the spatial distribution of coarse human population data (14). Results of this assessment show much promise for this method, which could potentially benefit research focused on an understanding of the spatial distribution of human populations, including investigations examining the anthropogenic contributions to local and global climate change. Similarly, this type of modeling could serve to improve existing, but flawed and controversial, census counts. Future work would include refining the model (while still utilizing easily acquirable data), as well as testing it in tandem with socio-cultural and economic models of population.

References

1. Clark J and D. Rhind (1992). *Population Data and Global Environmental Change.* International Social Science Council Programme on Human Dimensions of Global Environmental Change, Paris: UNESCO.
2. *Goode's World Atlas.* Rand McNally. 21st edition (2006).
3. Gutmann M (2000). 'Scaling and Demographic Issues in Global Change Research: The Great Plains, 1880-1990', *Climatic Change*, 44, pp. 377-391.
4. Huntington E (1951). *Principles of Human Geography.* New York: Wiley.
5. Livi Bacci M (1997). *A Concise History of World Population.* Oxford: Blackwell.
6. Livi Bacci M (2000). *The Population of Europe.* Oxford: Blackwell.
7. Rodgers C (2002). 'The Older Population in 21st Century Rural America', *Rural America*, 17(3), pp. 2-10.
8. Small C and J. Cohen (1999). 'Continental Physiography, Climate and the Global Distribution of Human Population', *Proceedings of the International Symposium on Digital Earth*, Beijing, China.
9. Small C, V. Gornitz and J. Cohen (2000). 'Coastal Hazards and the Global Distribution of Population', *Environmental Geosciences*, 7, pp. 3-12.
10. Stern P (1993). 'A Second Environmental Science: Human-Environment Interactions', *Science*, 260, pp.1897-1899.
11. United States Census Bureau. *Census 2000 Summary File 1 (SF 1) 100-Percent Data.*
12. Vörösmarty C, P. Green, J. Salisbury and R. Lammers (2000). 'Global Water Resources: Vulnerability from Climate Change and Population Growth', *Science*, 289, pp. 284-288.
13. Willigan J and K. Lynch (1982). *Sources and Methods of Historical Demography.* New York: Academic Press.
14. Zimmermann P (2006). 'On the Use of Environmental Variables to Help Estimate Human Population Distributions', *The Indian Geographical Journal*, 81(2), pp. 61-70.

Coastal Land Use/ Land Cover Mapping of Puri to Konark Coastal Stretch of Orissa

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The present study maps the landform features of the coastal region from Puri to Konark, and remote sensing and GIS are effectively used for this exercise. Survey of India (SOI) toposheets (1978) was used to prepare the base map. IRS 1D LISS III 1999 and IRS P6 LISS III 2005 satellite imageries were used to prepare land use/land cover maps for the study area. Through visualization process, different categories such as agricultural land, fallow land, plantation, reserved forest, protected forest, degraded forest, scrub land, sandy beach, sand dunes, mudflat, settlement with vegetation, water- logged area and water bodies were identified, and mapped; and their areas were estimated.

(Received: November 2007; Revised: January 2008; Accepted: March 2008)

Land use/land cover is continuously changing, both under the influence of humans and nature, bringing about a greater impact on the ecosystem (9). For sustainable utilization of the land ecosystem and for an equitable economic development, a rational land use is very much essential. Data on the present and past situations of land use and land cover are required for devising ways for rational land use (2). The conventional methods of detecting land use/ land cover changes are expensive and time-consuming, and also may not meet the current requirements of accuracy. With these methods, covering larger areas for mapping can not be done quickly. Here comes the remote sensing techniques for rescue. It helps to get synoptic viewing and repetitive coverage; and it is faster and less expensive (6). Remote sensing technology in recent years has proved to be of great help in acquiring data for effective resources management and monitoring (7,8).

Study Area

The present study looks into the coastal land use/land cover features of the stretch from Puri to Konark in the state of Orissa (85° 45' 00" E to 86°15'00" E and 19° 45' 00" N to 20° 00' 00" N). An area extending landward for a distance of 10 km from the high tide line has been taken up for the study. The shore length is 54 km and hence the total area which has been considered for the study is about 540 sq. km. The Puri coast, extending form Kadua river mouth to Puri city, is interrupted by the Kushabhadra and Nuanai rivers. The beach between Kadua and Chandrabhaga is backed

by 10-15 m high sand dunes on which casuarina trees are planted. South of Chandrabhaga, the Puri-Konark marine drive runs parallel to the coast, for a distance of 7 km. Two of the largest fishing settlements along the Orissa coast are located in this sector, at Chandrabhaga and Puri. The shore is largely occupied by sandy beach zones frequently marked by casuarina trees growing on sandy ridges in the backshore zone, beach terrace in the off-shore zone, mostly a cliff-less gently sloping land-sea margin with coastal alluvium and a remarkably wall-like straight shore line (1).

Material and Methods

Puri to Konark coastal stretch with a buffer of 10 km from the high tide line was clipped for interpretation and identification of land use/ land cover classes. Multi-dated imageries, IRS ID LISS III imagery for the year 1999 and IRS P6 LISS III imagery for the year 2005 on a 1:50,000 scale, were interpreted by on-screen digitization. After identification and delineation, an accuracy test was made for 150 sample points. Random sampling by means of a GPS survey was carried out for validation of classified satellite data by ground truth checking. The GPS points recorded were used for validating the maps. Over the ground, out of the 150 sample points, 29 points were found to be incorrectly interpreted giving an accuracy of about 81%. The geo-referenced land use maps of 1999 and 2005 were

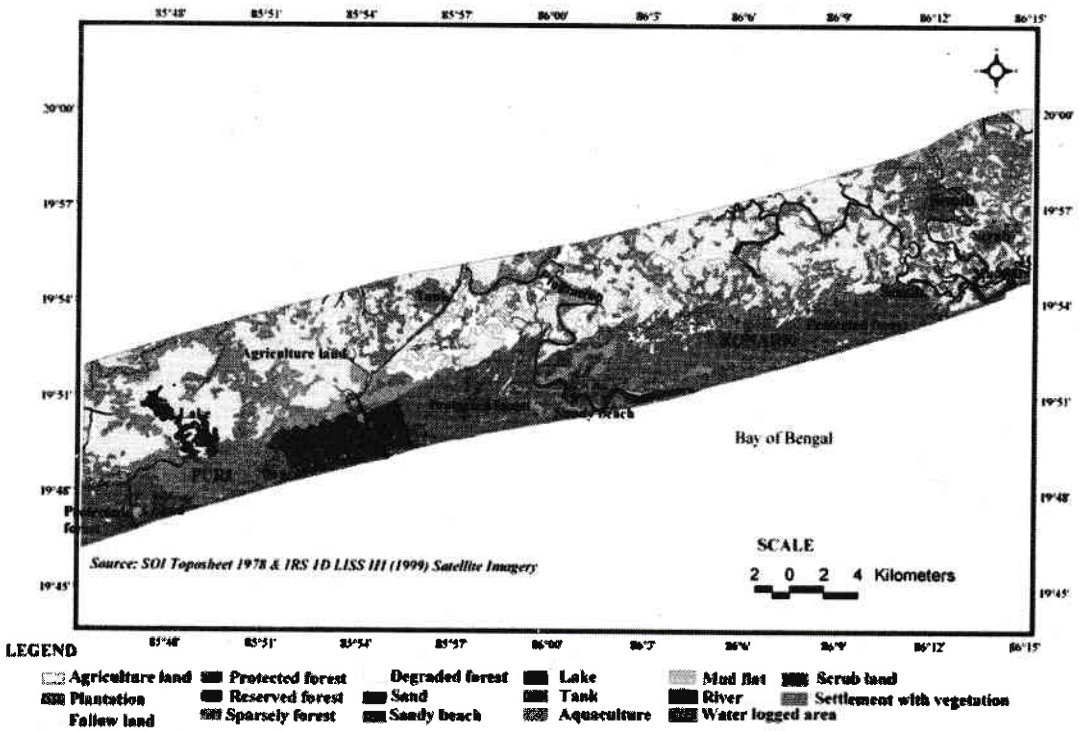

Fig. 1
Land Use/ Land Cover of Puri to Konark Coastal Stretch (1999)

digitized using the Arc Info. The digitized maps were edited, labelled and projected. Polyconic projection was adopted for area calculation. The maps thus prepared are shown in Figs.1 & 2.

Results and Discussion

The results include the land use/land cover maps for the year 1999 (Fig.1) and the year 2005 (Fig.1). The classification procedure for preparing landuse and land cover mapping based on satellite imageries as followed by Nayak (5) was adopted here. The land use and land cover categories identified for the study area are agricultural land, fallow land, plantation, reserved forest, protected forest, degraded forest, scrub land, sandy beach, sand dunes, mudflat, settlement with vegetation, water logged area and water bodies. The area covered by the various land use/land cover categories and their percentage change are given in Table 1.

Agricultural land is defined as the land primarily used for farming and production of food, fiber and other commercial and horticultural crops. It is indicated by the tonal variations from bright red to red on the satellite imagery; it covered an area of 20525.29 ha in 1999 and 17547.44 ha in 2005. ***Fallow land*** is defined as agricultural land which will be taken up for cultivation but is temporarily

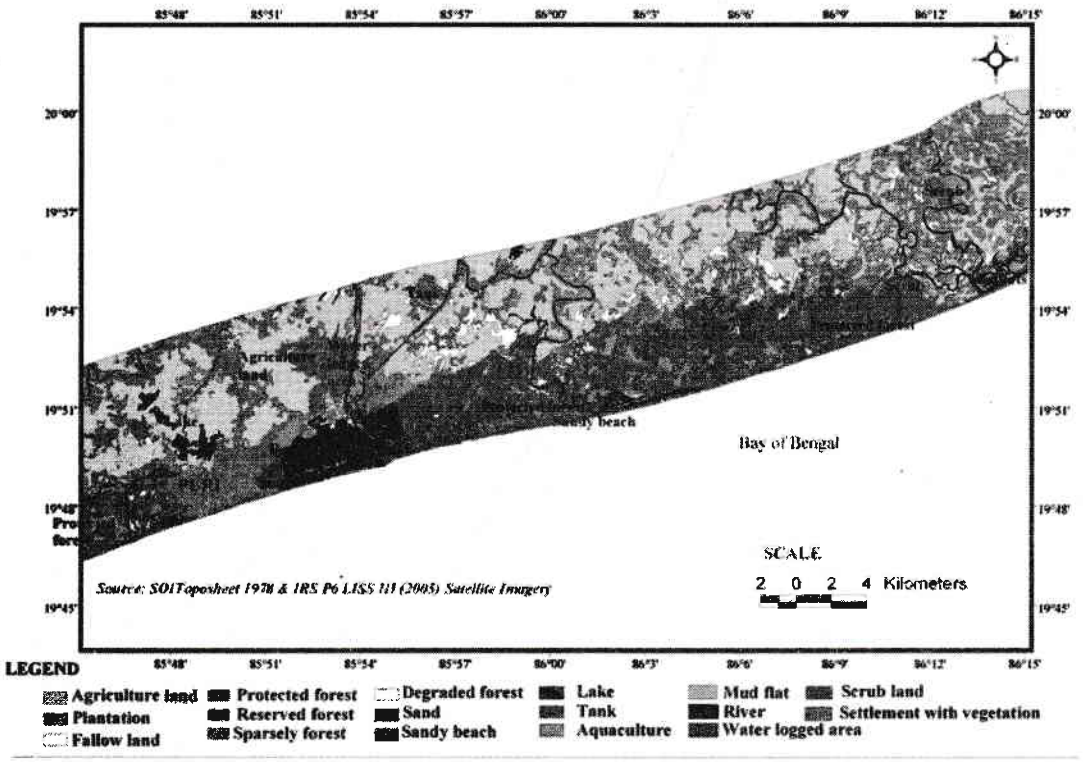

Fig. 2
Land Use/ Land Cover of Puri to Konark Coastal Stretch (2005)

Table 1

Land Use/ Land Cover Categories in the Study Area

Land Use category	Area in ha (1999)	Area in ha (2005)	Change in area (1999 - 2005)	Percentage of change
Agricultural Land	20525.29	17547.44	-2977.85	-14.50
Fallow Land	2565.03	2886.17	+321.14	+12.51
Plantation	3665.73	4036.39	+370.66	+10.11
Reserve Forest	1652.11	1562.24	-89.87	-5.43
Protected Forest	8211.54	8038.00	-173.54	-2.11
Sparsely Forested	2376.47	2640.59	+264.12	+11.11
Degraded Forest	457.10	469.67	+12.57	+2.74
Water-logged Area	965.26	2086.08	+1120.82	+116.11
Mud Flat	215.32	218.47	+3.15	+1.46
Srub Land	686.56	477.27	-209.29	-30.48
Sandy Beach	835.66	751.42	-84.24	-10.08
Sand	1052.92	1383.29	+330.37	+31.37
Settlement with Vegetation	8523.69	9580.65	+1056.96	+12.40
Acquaculture	18.82	38.24	+19.42	+103.18
River	1322.51	1208.40	-114.11	-8.62
Tank	295.57	470.53	+174.96	+59.19
Lake	444.02	312.93	-131.09	-29.52

allowed to rest. It appears yellow to greenish blue in tone depending on the topography, nature of soil, and moisture content of the ground, and appears light in tone in sandy and coastal soils. ***Plantations*** include coconut, casuarina and cashew plantations in the study area and appear as dark red to red in tone when compared to crop land in the satellite imagery. This area was found in about 3665.73 ha in 1999, and 4036.39 ha in 2005. ***Reserved Forest*** is an area so constituted under the provisions of the Indian Forest Act or other State forest Acts, having full degree of protection, and all activities are prohibited unless permitted (4). It appears as bright red to dark red in tone on the satellite imagery and noticed in an area of 1652.11 ha in 1999 and 1562.24 ha in 2005 in the study area. ***Protected Forest*** is an area notified under the provisions of the Indian Forest Act or other state forest acts, having limited degree of protection (4). It appears as bright red to dark red in tone on the satellite imagery with medium to smooth texture. ***Degraded forest*** area was located at some places both in the 1999 and 2005 imageries. It was identified by

its light whitish grey colour and irregular shape in the imagery and showed the presence of cut stumps of trees in the field (which could be due to natural causes). It covers an area of 457.10 ha in 1999 and 469.67 ha in 2005. ***Water-logged land*** is an area where the water is at/ or near the surface and stands for most part of the year. ***Mudflat*** is a wide expanse of deposits of clay, silt, ooze, etc (3), and it is identified by its dark grey tone with smooth and irregular texture and shape from the imagery. All lands generally in and around forest areas, having bushes and/ or poor tree growth consisting chiefly of small or stunted trees with canopy density less than 10%, come under the category ***scrub land*** (4). This was identified in the satellite imagery with slight red tinge and in patches. ***Sandy Beach*** area appears as bright white to yellow with bluish tone in the satellite imagery. In the study area, the entire shore has extensive sandy beaches. The total area covered by this category was 835.66 ha in 1999 and 751.42 ha in 2005. In the study area the shore and backshore regions are occupied by extensive ***sand dune*** complexes. These regions were identified as bright white areas on the imagery and were also identified in the field. Large areas of sand deposits are also present to the left and right of Puri town. Some sandy patches were also located close to the Kushabhadra and Nuanai rivers. This category occupied an area of 1052.92 ha in 1999 and 1383.29 ha in 2005. ***Settlement with vegetation*** is defined as an area of human habitation developed due to non-agricultural use, and that which has a cover of buildings, transport and communication, utilities in association with water, vegetation, and vacant land. It was identified by bluish green to bluish tone in the satellite imagery. It is surrounded by a reddish patch to specify the vegetation associated with the settlement. Puri town is the main urban area in the study area. Various villages/rural areas are found scattered through out the study area. ***Aquaculture ponds*** are found near Prachi and Kadua rivers in the study area, and covered an area of 18.82 ha in 1999 and 38.24 ha in 2005. A large number of ***water bodies*** is present in the study area. The total area covered by tanks was 295.57 ha in 1999 and 470.53 ha in 2005; river area was 1322.51 ha in 1999 and 1208.40 ha in 2005; and the area occupied by the Samang lake was 444.02 ha in 1999 and 312.93 ha in 2005.

The spread of farming land declined by about 15 per cent between 1999 and 2005, and correspondingly fallow lands got increased. In certain locations farm lands were encroached for plantation and housing. In certain areas agricultural land has also been converted into plantation and settlement with vegetation. A decrease of 5.43% was observed in the **reserved forest** area from 1999 to 2005. The protected forests are also found declining (2.1 per cent), and it may be because of increasing degraded forests and plantations encroaching upon the forest areas. Scrub lands due to expanding housing landuse are seen declining (30 per cent). There has been an increasing trend in the **settlement with vegetation** category (12.40%). Increased urbanization and commercial activities led to the development of the settlement area. The areas in the study area that got converted into this category are the agricultural land and the scrub land. Increasing population in Puri town results in the increase of the settlement with vegetation category. The **Samang lake** has

shown a decreasing trend of 29.52 % for the period from 1999 to 2005. The lake area has been converted into agricultural land and settlement with vegetation. There is a decrease in area in the **sandy beach** category from 1999 to 2005. This is because of the erosion in beach area and may also be due to sand mining.

Conclusion

Land use/ land cover change study was carried out in order to understand the status of the environment in the Puri to Konark stretch of Orissa. There has been a decreasing trend in the area covered by reserved forest, protected forest, agricultural land, scrub land, sandy beach and Samang lake in the study area. The reserved forest area has decreased due to conversion into agricultural plantation and degraded forest categories due to anthropogenic as well as natural activities. Agricultural land, scrub land and the Samang lake areas have certain portions converted into settlement with vegetation category. These changes in land use / land cover are due to the growth of population, increased tourism in the area and other coastal and marine resources exploitation activities. On the other hand, the study area shows an increasing trend of settlement with vegetation, water-logged area, mud flat and sandy area.

Acknowledgement

The authors are grateful to the Ministry of Environment and Forests, Government of India for facilitating this study and to Shri B.K Patnaik, Director, Forest .& Environment Department, Government of Orissa, Bhubaneshwar for his kind help.

References

1. Ahmad E (ed.) (1972). *Coastal Geomorphology of India*. New Delhi: Orient Longman.
2. Chaurasia R, D.C. Closhali, SS. Dhaliwal, Minakshi Sharma, P.K.Kudrat and A.K.Tiwari (1996). 'Landuse Change Analysis for Agricultural Management – A Case Study of Tehsil Talwandi Sabo, Punjab', *Journal of Indian Society of Remote Sensing*, 24 (2), pp.115-123.
3. Davies J.E (ed.)(1972). *Geomorphological Variations in Coastal Development*. Edinburg:Oliver and Boyd.
4. FSI (2003). *State of Forest Report*. Dehradun: Ministry of Forest and Environment.
5. Nayak S.R(1991). 'Manual for Mapping of Coastal Wetlands / Landforms and Shoreline Changes using Satellite Data'. Ahmedabad: Space Application Centre. (Technincal Note IRS-UP/SAC/MCE.TN/32/91).
6. Patel A.N & S. Singh (1999). *Principles of Remote Sensing*. Jodhpur:Scientific Publishers (India).
7. Ramachandran S (1993). 'Coastal Zone Information System - Pilot Project for Rameswaram Area'. (Report submitted to Department of Ocean Development, Government of India).
8. Ramachandran S, Krishnamoorthy R, S. Sundaramoorthy, Z.F.Parviz, A. Kalyanamuthiah and K. Dharanirajan (1997). 'Management of Coastal Environment of Tamil Nadu and Andaman and Nicobar Islands based on Remote Sensing and GIS Approach', *MAEER'S MIT, Pune, Journal*, IV (15 & 16), pp.129-140.
9. Rajan K.S and R.Shibasaki (1997). 'Estimation of Agricultural Productivity and Its Application to Modelling the Expansion of Agricultural Land in Thailand', *Journal of Agricultural Meteorology*, 52(5), pp. 815-818.

Delineation of Land Complexes and Agricultural Development:

A Study for Khanapur Area, Maharashtra

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The land, landforms and their potentiality can be assessed by using remote sensing and GIS techniques. The present study aims to map the landforms for assessing the agricultural potential areas by employing land complex approach in the Khanapur Plateau of Maharashtra, India. The analysis reveals that more than 71 per cent of the area is covered by pediments, followed by flood plains of rivers Krishna and Yerala. The piedmont zones are under seasonal crops, grazing land, scrub and scanty vegetation. Accordingly it is the potential land for the development of agriculture in the region with application of modern techniques of land improvement, cultivation and irrigation practices.

[November 2007; Revised: February 2008; Accepted: April 2008]

The agricultural practices in a region depend on natural as well as socio-economic factors. The geomorphic processes play an influencing role in defining soil systems, cropping systems, crop production, land utilization and hydrological potentials. Existing landuse pattern is a result of a continuous interplay of physical elements like topography, climate, soil and human efforts (4). The depth of soil is minimum where erosion is active and is deep in areas with lesser gradient. Slope limits cultivation (1). Soil, climate and vegetation are the basic factors towards analyzing the land in the context of its potentials for farming.

Land suitability is the fitness of a given tract of a land for a definite use. It is better to mention in this context that there is deference between land potentiality and land suitability. A potential land however may not be suitable due to adverse environmental relations but a suitable land may have the potentials. Suitability analysis is essential for landuse decisions which should be economically viable and environmental-friendly. The new tools of earth sciences, remote-sensing and GIS are quite handy in measuring land potentials and suitability (7). The present study aims to assess land potentials for agricultural practices, based on geomorphic and

□ The Indian Geographical Journal 82 (1) June 2007; published in June 2008

pedo-geomorphic realms, and using remote sensing and GIS.

Data and Methodology

The base map was prepared for the study area, consulting Survey of India topo-sheets of 47 K/7, 8, 11, 12, 15 and 16 on a scale of 1:50000 and 29 black and white vertical aerial photographs in four strips on a scale of 1: 50000 (Job no. 1228 A Run no. 9,10,11, and 12).

Visual interpretation with mirror stereoscope has been carried out using various photo elements such as tone, texture, shape, size, location patterns and association. Ground truth verification with selective field checks was also made to make the interpretation more reliable. The mapping of the landforms and pedo-geomorphic regions was done under GIS environment, using Map Maker (Ver.3.0).

Study Area

Khanapur taluk of Sangli district in Maharashtra State is selected for the present exercise. Lying between 17^0 20′ N to 17^0 25′ N latitudes and 74^0 20′ .E to 74^0 50′ E longitudes, it is part of Khanapur plateau (Fig.1), situated on the ranges of Shambho Mahadev hills. As a Sahyadriyan off-shoot, it exhibits different geomorphic features. Yerala and Krishna rivers flowing in the study area are responsible for fluvial features. The study area experiences hot and dry climate with scanty and erratic rainfall less than 600 mm. Dry spell is well-pronounced during the monsoon. Soils here are derived from the basic igneous rocks, commonly known as Deccan Trap. They are seen in a definite topo-sequence of very shallow soil on the ridge, medium deep soil on the slope and deep soil at the lower reaches of the streams.

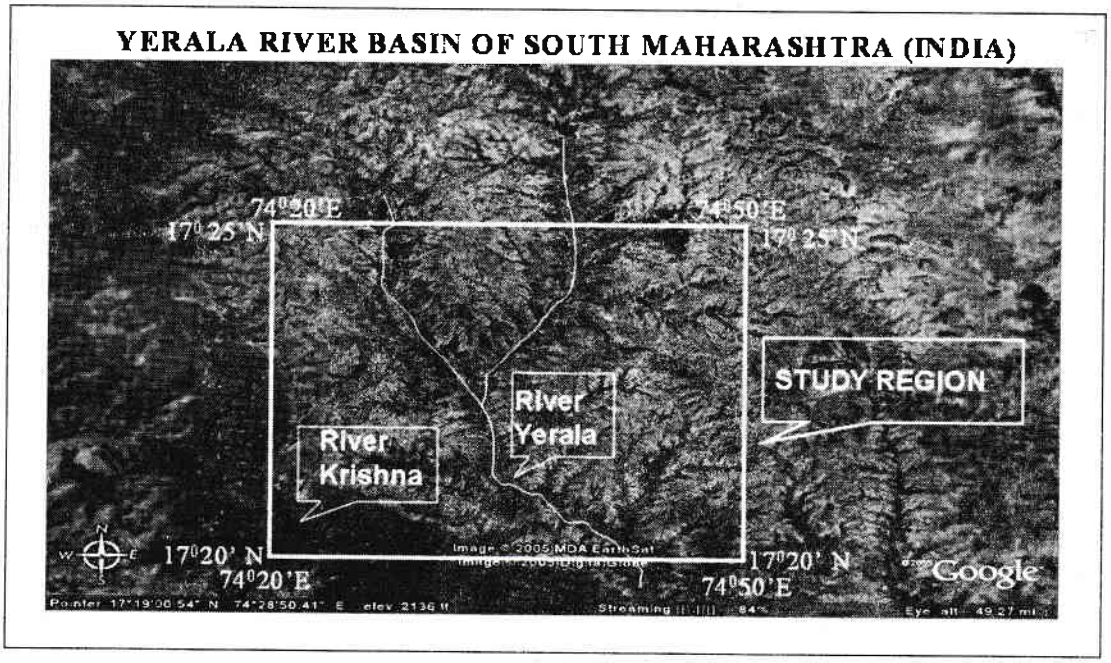


Fig. 1

The Analysis

Mechanical weathering has been dominant in the study area which is known for its drought. Seasonal rains encourage sheet erosion that removes the weathered products quickly. Weathered products thus reach the streams where they act as grinding tools for the running water, thereby accelerating fluvial erosion in the valleys.

Geomorphic Features

With the help of remote sensing techniques, 'land systems' of the study area are identified (2). The land-units are arranged spatially. The erosive agents define the distribution of landforms. The Yerala and the Krishna rivers with their tributaries are working as agents for mechanical weathering in the study region. Piedmont, pediment, and shallow and deep buried pediments are the features created by the erosion and deposition. The vast area of the region is covered by shallow buried pediment (35.22 per cent) (Table 1; Fig.2). It is followed by the deep buried pediment (21.09 per cent). The region primarily is a part of the Deccan Trap, and has been dissected by Shambhoo Mahadev hills, an off-shoot of the Sahyadris. The shallow and deep buried pediments exist as plains on the flat-topped mesa, which covers 15.26 per cent of the study area. Inter-mountain valley fill and butte occupy a small proportion of the area, and so also highland, escarpment, piedmont and rolling plains. The finer materials are carried by the river and deposited at their flood plains, and its spread is also small.

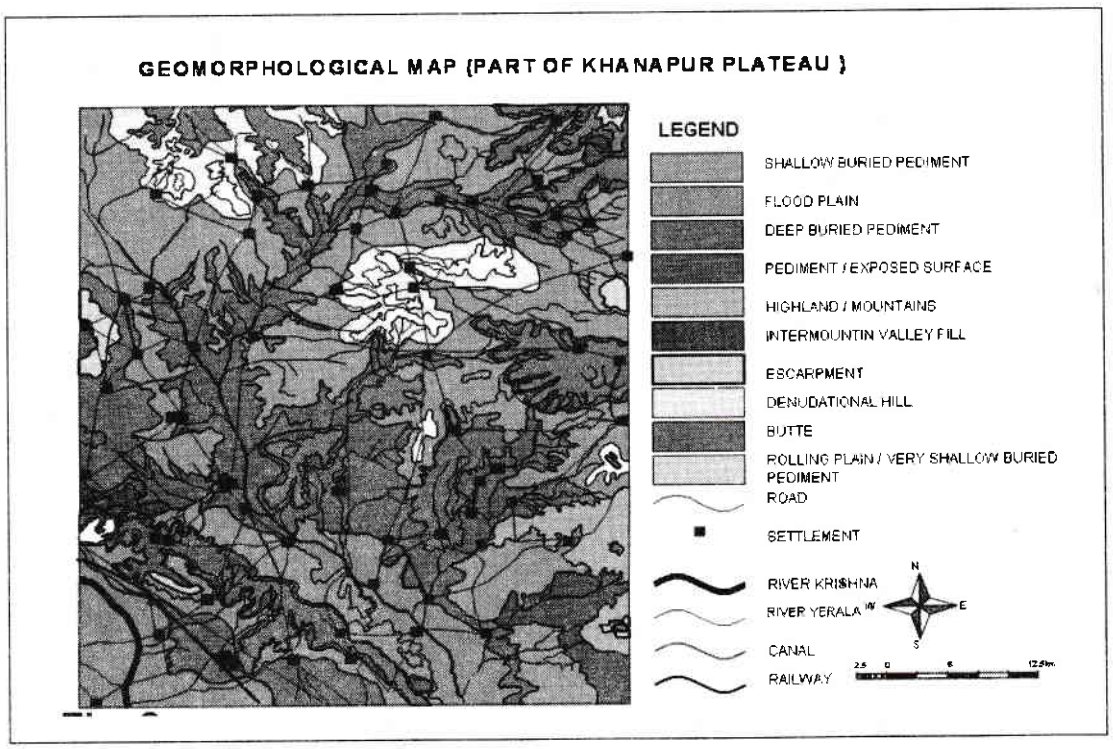


Fig. 2

Table 1

Geomorphic Features, Soil, Land Cover, Present and Suggested Land Use in a Part of Khanapur Plateau

Geomorphic unit	Area in %	Nature of surface/ Soil/ land cover	Problems / constraints	Present land use	Suggested land use
Shallow buried pediment	35.22	Shallow with moderately steep slope, gullied, extremely stony and very rocky	Severe soil erosion and sheet wash, very deep ground water table	Grazing land, seasonally under Kharif crop, shrubs and scanty vegetation	Cultivation with precaution, need soil and water conservation, plantation of Tamarind, Mango, and other fruit crops
Deep Buried Pediment	21.09	Moderate to deep smooth to rough texture soil, pockets of sandy loam, ranging from black to dark brown colour, gentle sloping	Moderate to deep water table, soil erosion	Intensively under sugar cane, grapevine, *jowar* and other *kharif* and *rabi* crops, scanty vegetation	Inter crop cultivation crop rotation needed to maintain soil fertility
Mesa	15.26	Tops are covered by black fertile soil with *Kankar* (weathered rock material), gentle to moderate slope, good soil moisture holding capacity	Gully erosion, sheet erosion, cracking during the dry spell	Cultivation of Cotton, *Jowar*, Sugarcane, Grapevine, scanty vegetation	Soil and water conservation, drought resistant fruit crops may be added to increase the output level
Flood Plain	8.17	Alluvium, clay loam, very deep soil with relatively flat to gentle slope	Very high water table, water logging, acute drainage problem, saline soils	Intensive sugarcane cultivation	Crop rotation by Maize, *Bajara*, Wheat ; addition of gypsum, flushing out the salts; pisciculture is recommended in the water logged fields
Pediment	1.24	Gravelly loam to very thick soil cover pockets, very steep, extremely stony and rocky, exposed bedrocks.	Very high rate of erosion, very deep water table, very poor moisture holding capacity	Very scanty and small grass	Need soil and water conservation; Suggested trenching, bunding and pitch cultivation method for plantation
Rolling plain	5.81	Gentle to moderate sloping with shallow *murum* soil (rough texture)	Soil erosion, gully erosion predominate	Under seasonal crops like *Jowar*, pulses etc, grazing land, scanty vegetation	Need soil and water conservation; Suggested trenching, bunding along the slope

Table 1 (Contd.)

Geomorphic unit	Area in %	Nature of surface/ Soil/ land cover	Problems / constraints	Present land use	Suggested land use
Low lying denudational hills	2.90	Exposed, very steep slope, very hard rock	Finger gully erosion is predominant	Not in practice	Unsuitable for any use
Highland/ mountain	2.55	Exposed surface, very steep slope, very hard rock	Extreme erosion	Not in practice	Unsuitable for any use
Escarpment	1.27	Vertically exposed surface	Rock fall, debris fall, land slides	Not suitable	Remove the talus or construct protection wall structure
Intermountain valley fill	0.61	Deep colluvial material, granular textured soil with lime content, good water table	Acute soil erosion, excess lime deposition	Under seasonal crops, moderately dense vegetation	Soil and water conservation needed, plantation of cactus on the bunds
Butt		Very thick soil on the top, sides are exposed	Block disintegration predominates	Not practicable	Hard to protect
Unclassified		---	--	--	--

The human activities like settlement, agriculture and transport are highly influenced by the landforms. Shallow buried pediments are under seasonal *kharif* and *rabi* crops, whereas deep buried pediment are under intensive sugarcane and orchard cultivation. The flood plains occur along the banks of the rivers, and they are fertile with irrigation facilities, and the cash crops like sugarcane, grape-vine and turmeric etc. The pediments, both rolling plains and inter-mountain valley fill are the zones of ground water recharging

Land Complexities and Potentials

The concept of land complex is to visualize a method by which detailed information of the large area can be collected as quickly as possible to prepare a soil map, to assess soil potentialities and to make recommendations for the development of land use system (3). The topography and soils are dependent on the nature of underlined rocks. The erosional and depositional processes have given rise to the present day landscape. The land surface has been shaped to its existing land units each with its own hydrological features, soil mantle, vegetation community, animal population and range of micro environment. Thus the concept of land complex may be used for scientific classification of terrain based on topography, soil and vegetation associated with geology, geomorphology and climate. The simplest criterion for distinguishing one land complex from the other is the surface relief. Next, the

interpretation of geology, soil, and erosional and depositional processes through landform analysis may be used to delineate. The concept of mapping of land complex visualizes that each part of land surface is the end product of evolution governed by the parent geological material, geomorphological processes- past and present, climate and time. Thus each unit gradually develops its own morphological character through time. Hence the application of the concept of land complex may be satisfactorily applied in assessing the land potentiality (5). Based on the spectrum of land complex approach, the Khanapur plateau of Sangli district is divided into three pedo-geomorhic environmental complex (Fig.3) i.e. 'A' complex, 'B' Complex and 'C' Complex.

Broadly speaking, the study area as a whole is the combination of flat top surface of plateau, plains, low lying hills, piedmont and moderate to gentle slope of the flood plains from the pedogeomorphic environmental point of view. In general slope of the area is from northeast to south at an altitude from 350 m to 550 m. These physiographic variations affect the soil development.

Complex 'A' (covering 11 per cent area of the study region) consists of the low lying flood plain area of river Krishna and relatively flat and flood plains of the tributaries of river Yerala (Plate 1.A). It is followed by the area of B complex characterized by the geomorphic units like rolling plains and deep to shallow buried pediments; this complex covers 34.62

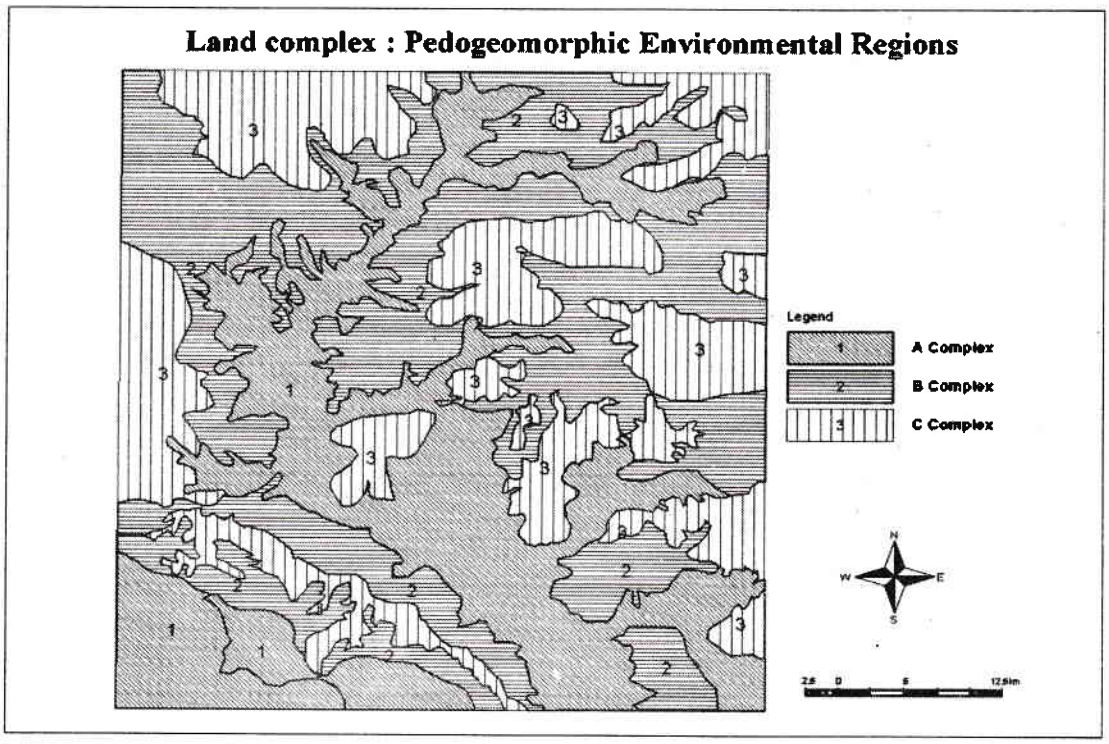
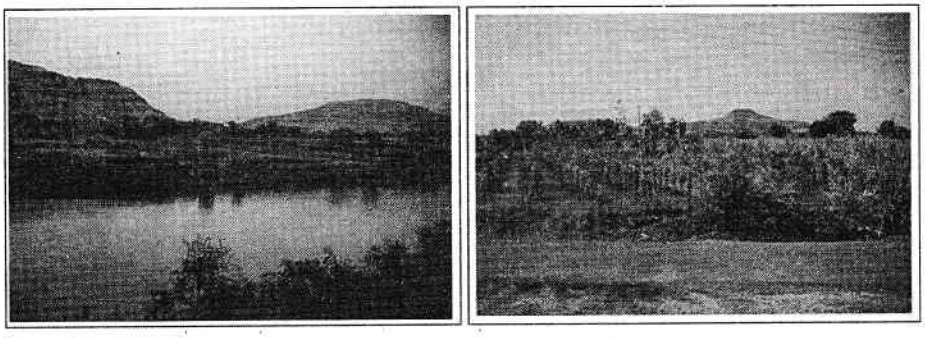
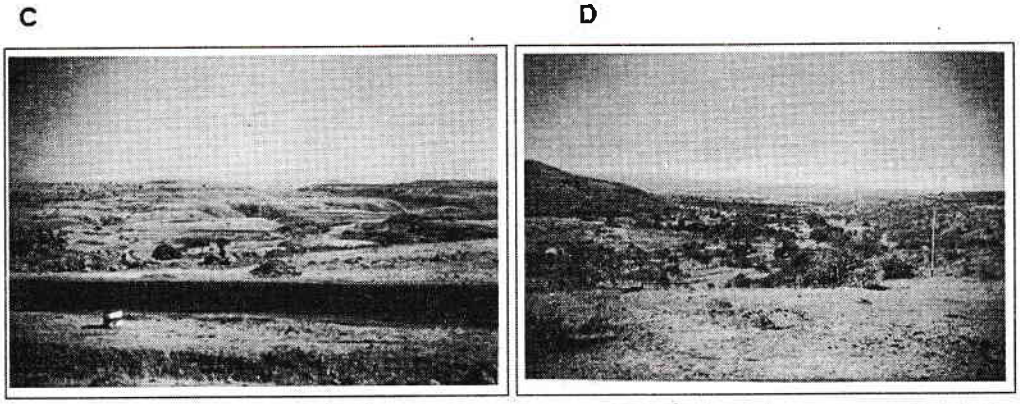


Fig. 3



An example of complex 'A' and 'B'
A: Flood plain of river Krishna, under intensive cultivation.
B: Grapevine and sugar cane cultivation in the deep soils of buried pediment

Plate 1



An example of complex 'C'
C: Flat tops of the plateau.
D: Intermountain valley fill (snapshot from the study region)

Plate 2

per cent of the study area (Plate 1.B). The highland areas, inter-mountain valley fill, flat top surface of plateau, and pediments are grouped in 'C' complex. Complex 'C' covers an area of 53.85 per cent of the study region. The details of the soil, vegetation, land cover and hydrological conditions of the regions according to the morphological unit are explained in Table 1. Accordingly the undulating and relatively flat top of plateau, pediments and inter-mountain valley fill areas are under seasonal *kharif* and *rabi* crops (Plate 2 C & D). In certain areas, the modern irrigation techniques promoted an intensive cultivation of grapevine orchards.

On the basis of land categories (Table 2), strategies for future development are prescribed as follows:

Table 2
Status of Land in the Study Area

Land Complex	Land Quality	Category	Area in %
A Complex	Good	I	11.00
B Complex	Good - Medium	II	34.62
C Complex	Medium - Poor	III	53.85

Source: Compiled by authors

A Complex: Flushing out the salt from the field and cultivation of salt-tolerant crops with proper drainage and rotation of crops is suggested to maintain soil quality and fertility. Pisciculture may also be well adopted in such lands (6).

B Complex: Emphasis may be laid on the double and multiple cropping. Social forestry may be encouraged as an alternative. Commercial crops like grapevine, fruits and vegetable crops may be cultivated.

Proper bunding is suggested for both the complexes to conserve the soil and water resources.

C Complex: Orchard cultivation and social forestry may be the better choice here. The micro level planning for watershed development and proper utilization of available water resources may be drawn for optimum utilization of land. Provisions like electrification and credit facilities are important measures for a balanced regional development.

Conclusion

The study area is an agrarian one, and due to physiographic heterogeneity, it faces the problems of water scarcity in highlands and problem of water logging in flood plains. The tools of remote sensing and GIS have helped to delineate regions for the choice of development processes. The study area with its post-harvesting facilities, has developed overseas markets for its farm products, and high demands for fruits and vegetables abroad may be a good opportunity for this region to take advantage and progress further.

References

1. Datye V.S *et al.* (1979). 'Slope and Agricultural Land Use – an Analytical Study with Reference to Poona District (Maharashtra)', *Transaction, IIG*, 1 (1), pp. 65-68.
2. De N. K and P. Ghosh (1995). 'Application of Remote Sensing in Geomorphological Studies, Indian Geomorphology', in S. R. Jog (ed.). *Geomorphology and Resource Management.* Jaipur: Rawat Publications, pp. 177-192.
3. De N. K and H.K. Sarkar (1993). *Soil Geography.* Calcutta: Sribhumi Publishing Company, pp.113-15.
4. Dankar R.P *et al.* (1985). 'Landscape Soil Relationship in Ghazipur District', *Geographical Review of India*, 47, (2), pp. 41-46.
5. Jana N. C (1995). 'Measuring Land Potentials in the South Western Midanpore, West Bengal', *Transactions, IIG*, 17 (1), pp.35-46.
6. Pawar C. T (2005). 'Reclamation of Degraded Soils: A Study on Economics of Fish Farming', *The Indian Geographical Journal*, 80 (1), pp. 39-44.
7. Raghavaswamy V and R. Vidyanathan (1980). 'Landuse Studies from Aerial Photographs: A Case Study of Visakhapatnam and its Environs', *Geographical Review of India*, 42 (1), pp. 1-15.

Short Communications

Land Use/Land Cover Description of a Sub-watershed of Doon Valley, Uttarakhand, India

The overall growth and development of a region depends on effective management system, which makes use of land and water resources. Land use map is a general-purpose map of such nature that the elements of land use distribution can further be correlated with other elements of the land units with varying land capability. Besides, this can also be used to adjust the present types of land use to land capability, and to check undesirable trends of the irrational use of land. The question whether it is possible to increase the carrying capacity of land with specific objective of feeding the increasing population is of greater importance (1).

The term, land use, relates to human activities associated with a specific piece of land, whereas the term land cover refers to the type of features, present on the surface of the earth. Land use is the way in which, and the purposes for which, human beings employ the land and its resources, for example, farming, mining, or lumbering. Thus, 'land use has to be seen in the context of the interface of "Earth and Man". It is a 'relational space' or 'contextual space', referring not only to the visible elements of geographic space i.e. physical features, landforms and natural resource elements, but also to the relatively non-visible human values i.e. social relations, culture, hopes and aspirations of the local community. Land cover describes the physical state of the land surface as in cropland, mountains, or forests. The term, land cover, originally referred to the kind and state of vegetation (such as forest or grass cover), but it has broadened in subsequent usage to include human structures such as buildings or pavement and other aspects of the natural environment, such as soil type, biodiversity, and surface and groundwater. Land use/land cover pattern of a region marks a true interface of physical and human (socio-economic and cultural) aspects of the local/regional geography, and as well reflects the cumulative effects of its historical development or sequence occupancy.

With the present economic development and the changing demographic profiles, there has now been a greater pressure on land in India. Decline in forest cover, adding more and more areas for cultivation, and excessive grazing upset the ecological balance, which in turn

☐ The Indian Geographical Journal 82 (1) June 2007; published in June 2008

degrades the soil productivity. As such, land and water management seems to be emerging an urgent issue for the current process of planned development. In land resource development, watershed management is the foremost one and it refers to a wide range of activities including soil and water conservation, restoration of eroded lands, afforestations, water harvesting with special reference to rain-fed agriculture, and the generation of employment for rural poor people. In the long run, it preserves the ecosystem, restores the environmental degradation, and stabilizes and sustains the overall productivity of an area (2). In this context, gathering, assessing and analyzing the information on land use/land cover may be essential for an optimum land use for sustainable development. Sustainable development is a positive concept which aims to seek good partnership by man with nature, and explore ways and means for economic development without adverse impact on the capacity of natural resources to regenerate (3). The search for a middle ground, which could combine environmentalism and development, was expressed as the paradigm of sustainable development. At least two basic objectives of any watershed development project are to be addressed: (i) To promote the economic development of the village community; (ii) To encourage restoration of the ecological balance in the village (4). As such, information on existing land use/land cover pattern, and its spatial distribution and changes provide better understanding of land utilization aspects but also play vital role in development planning (5). More recently the study of forest as vital land cover has become very significant since the overall changes in vegetation have resulted to undesirable impact on our environment and overall global climate change. The Indian National Forest Policy, 1998 envisages to realize one-third of the geographic area of the country under forest/tree cover to maintain ecological balance and environmental stability, but the estimate shows that the forest cover of the country is less than the goal laid down in the policy. In view of this, it is necessary to examine the present land use of the country so as to explore the possibility of finding out land, which can be brought under forest cover to achieve the stipulated objective (6). According to one of the estimates, 'in India, out of 329 million hectares of our total geographical area, nearly 50 per cent of the land is waste or degraded. While at one end, 50 per cent of our lands are degraded, at the other end, nearly 50 per cent of our people are poor or below poverty line (BPL). With proper planning, scientific approach and efficient management, it is possible to make these lands and people more productive, generating huge assets, and employment opportunities (7).

The present study carries out an assessment of human-induced changes to land use/land cover aspects using remote sensing (RS) technique at a sub-watershed level in Doon Valley of the Himalayan region. Land is becoming a scarce commodity due to immense agricultural and demographic pressures. Man-land ratio has been declining, as arable land gets occupied for economic and residential purposes. In this context, efficient land use seems to be a dependable alternative for optimum utilization of resources, and it is to be immediately accepted and adopted. Along with land management, water management is also required to achieve an

integrated efficiency of basic resources of human beings.

In the present study, the main causes of land and forest degradation in the Doon Valley are discussed. Morphometric parameters such as elevation, slope and shape are associated with relative forest and land degradation particularly in the upper reaches of the study area. These parameters are also closely related with cultivation intensity. However, the analysis reveals that there are certain anomalies in the observed pattern of relationship. It seems that the man-made factors have introduced these anomalies, which means that humans are responsible for forest degradation especially in the central areas of the study area.

Study Area

The Sitlarao Sub-watershed is in the western part of the Dehradun district, Uttarakhand. The sub-watershed belongs to the Asan river system sub-catchment, which is a tributary of Yamuna River (8). The study area lies approximately between latitudes of 30^0 24′ 43″ N to 30^0 29′ 04″ N and longitudes of 77^0 45′ 35″ E to 77^0 57′ 40″ E covering 57.48 sq.km (Fig. 1). It falls in the Meso Mountains of the Indian Himalayas, marked by a chain of erosional hills, extensive piedmont and river valleys. The altitude of the area ranges from 440 m to 2200 m. The study area is characterized with the general slope from northeast to southwest direction. The climate here is characterized by hot summers and cold winters; the main rainy season is from June to August,: and the mean annual rainfall ranges from 1600 mm to 2200 mm, depending on altitude. Elevation and anual rainfall are found significantly correlated (0.743)(9). Main crops are rice, wheat, maize and sugarcane.

Materials and Methods

During the last three decades, remote sensing data have been increasingly used with better resolution, enabling reliable mapping as well as monitoring of resources in general and land resource in particular at micro level. Remote sensing data products offer an objective way-out for this, and GIS provides an appreciable capability for analyzing these data products in spatial context. Digital Elevation Model (DEM) is useful for displaying thematic information in the background of relief data. The present study is based on IRS 1D LISS-III data (Path: 149; Row: 39; Date: April 21, 2001) along with the Survey of India topographic-sheet No. 53 F/15 (Surveyed in 1965-66: scale 1:50,000), and the responses gathered from the farmers of selected villages/localities during field traverse for field checks. Land use/land cover classes were delineated on screen by digitizing using the Integrated Land and Water Information System (ILWIS Academic 3.2) software, using topo-sheet and visual interpretation keys. Sufficient ground truth verification was carried out using *Garmin* GPS and collecting ground data from selected localities along a rectangular traverse in the study area. With this supervised classification, a final land/land cover map was obtained for the study area and the relevant quantitative information was also derived (Fig. 2). Digital Elevation Model (DEM) of Sitlarao Sub-watershed was prepared by digitizing contour lines from the 1:50,000 toposheet using the ILWIS. Elevation data has been used in the same software to generate slope as well as shape classes for the study area.

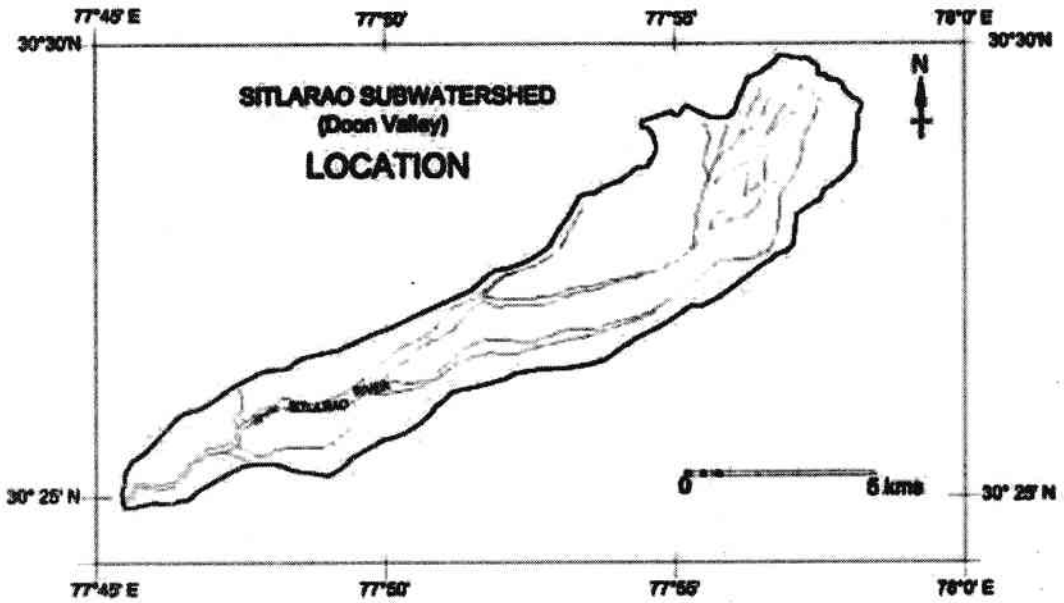

77°45' E
77°50'
77°55'
78°0' E
30°30'N
30°30'N
SITLARAO SUBWATERSHED
(Doon Valley)
LOCATION
N
30° 25' N
0
6 kms
30° 25' N
77°45' E
77°50'
77°55'
78°0' E

Fig. 1

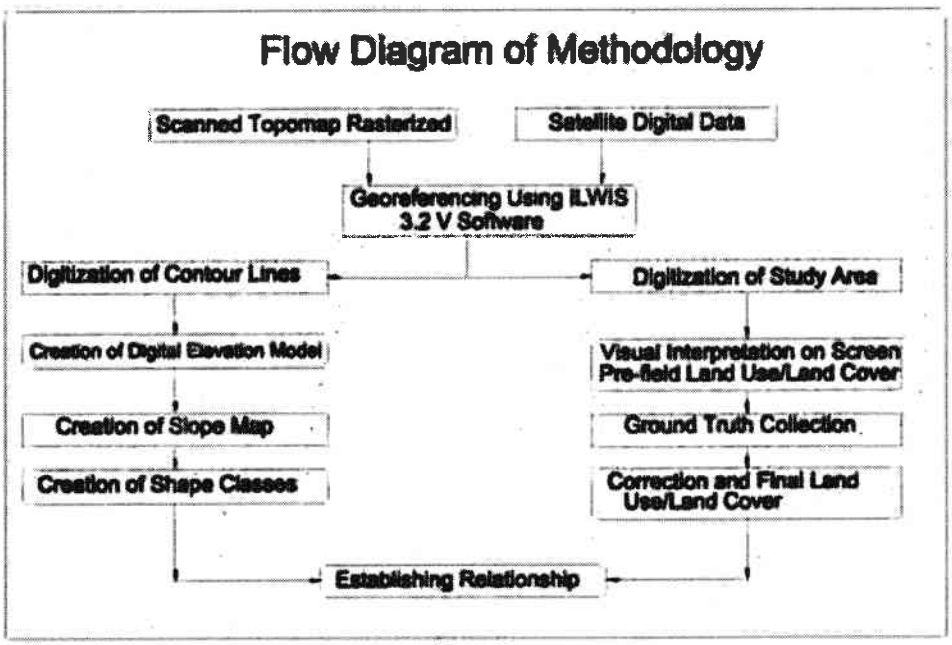

Flow Diagram of Methodology
Scanned Topomap Rasterized
Satellite Digital Data
Georeferencing Using ILWIS 3.2 V Software
Digitization of Contour Lines
Digitization of Study Area
Creation of Digital Elevation Model
Visual Interpretation on Screen Pre-field Land Use/Land Cover
Creation of Slope Map
Ground Truth Collection
Creation of Shape Classes
Correction and Final Land Use/Land Cover
Establishing Relationship

Fig. 2

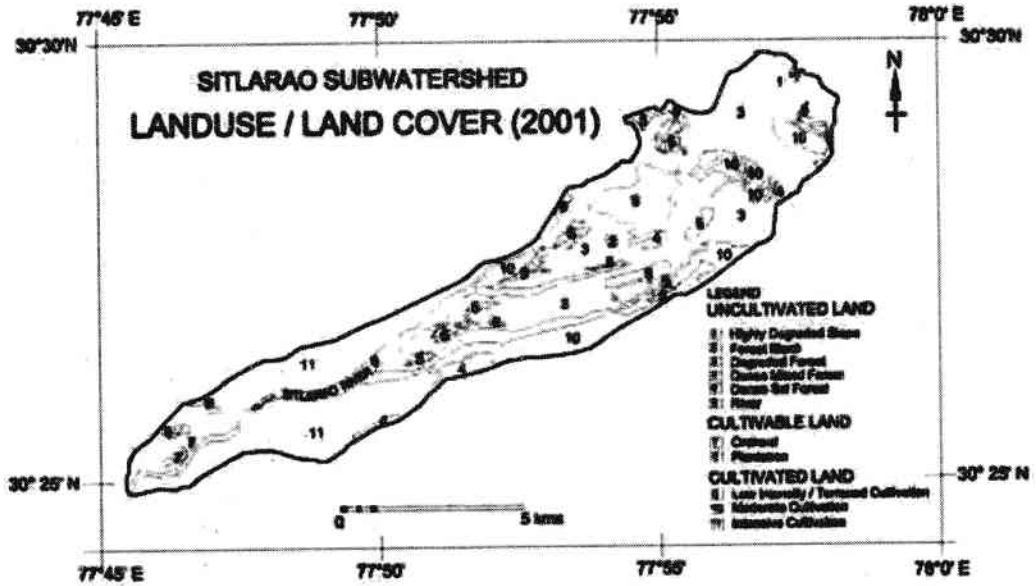

77°45' E
77°50'
77°55'
78°0' E
30°30'N
30° 25' N
SITLARAO SUBWATERSHED
LANDUSE / LAND COVER (2001)
N
LEGEND
UNCULTIVATED LAND
CULTIVABLE LAND
CULTIVATED LAND
0
5 kms

Fig. 3

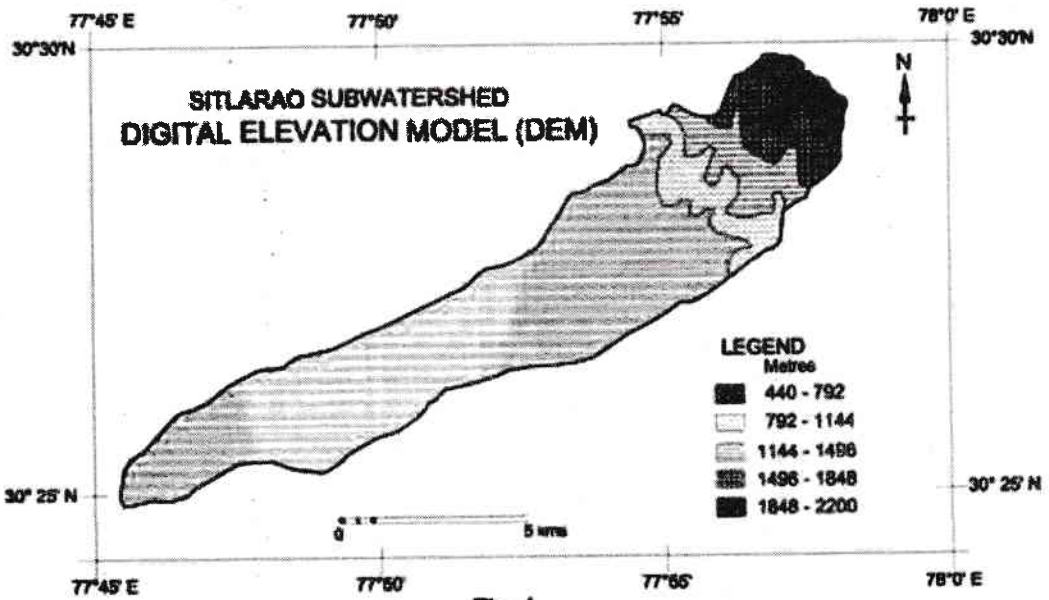

77°45' E
77°50'
77°55'
78°0' E
30°30'N
30° 25' N
SITLARAO SUBWATERSHED
DIGITAL ELEVATION MODEL (DEM)
N
LEGEND
Metres
440 - 792
792 - 1144
1144 - 1496
1496 - 1848
1848 - 2200
0
5 kms

Fig. 4

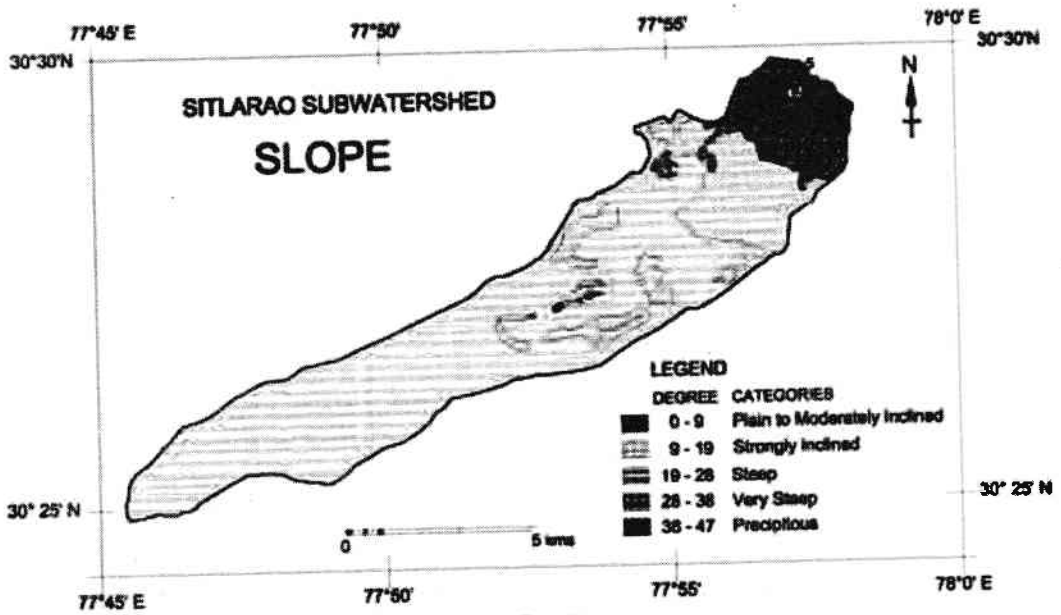

77°45' E
77°50'
77°55'
78°0' E
30°30'N
SITLARAO SUBWATERSHED
SLOPE
N
LEGEND
DEGREE CATEGORIES
0 - 9 Plain to Moderately Inclined
9 - 19 Strongly Inclined
19 - 28 Steep
28 - 38 Very Steep
38 - 47 Precipitous
30° 25' N
0
5 kms

Fig. 5

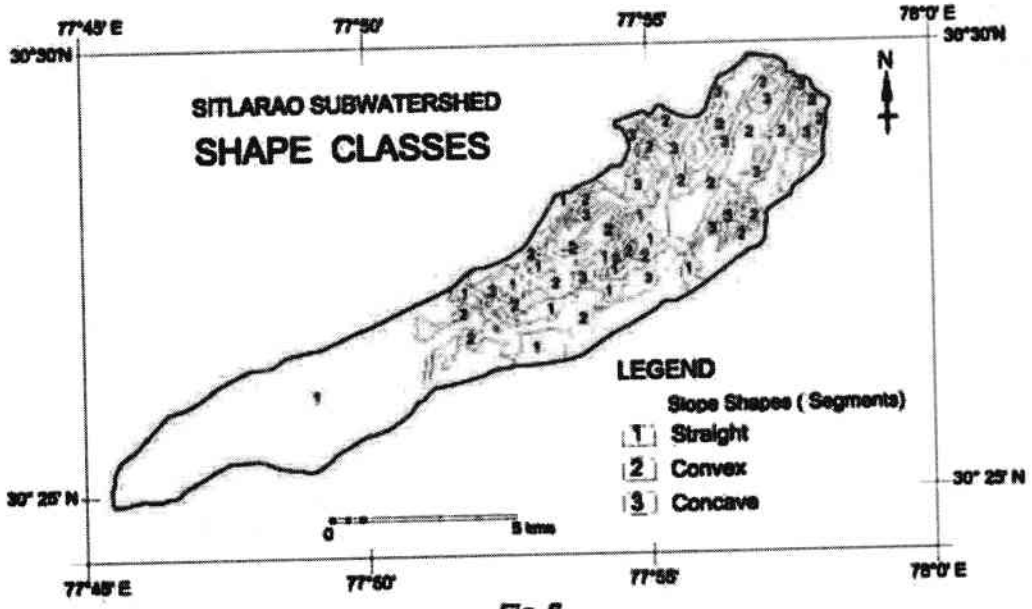

77°45' E
77°50'
77°55'
78°0' E
30°30'N
SITLARAO SUBWATERSHED
SHAPE CLASSES
N
LEGEND
Slope Shapes (Segments)
1 Straight
2 Convex
3 Concave
30° 25' N
0
5 kms

Fig. 6

Results and Discussion

Land Use / Land Cover Classification

There are three main groups of land use/land cover delineated in the study area: uncultivated, cultivable and cultivated lands (Table 1). These main types were further divided into sub classes. Uncultivated land occupies 57 per cent of the study area. It consists of six types of land: highly degraded steep slope, forest blank, degraded forest, dense mixed forest, dense *sal* forest and drainage line. Out of these types, degraded forestland, covering about 44 per cent of the area, dominates. The vegetal cover is found altered drastically in the middle parts of the study area with increasing population pressure, agricultural activities and industrial wood/raw material extraction activities. As indicated by locals, a substantial area of dense forests has been converted to open or degraded forests as a result of human encroachments, especially during the current decade. In the lower elevation, forest with *sal* trees is dominant, while in the higher elevations forest is of mixed type. Dense forest

Table 1
Land Use/Land Cover in Sitlarao Sub-watershed (2001)

Main Land Use/ Land Cover Classes	Sub Classes	Area (sq.km)	% to the Total Geographical Area
Uncultivated Land	Highly degraded /Sloppy land	0.30	0.50
	Forest blank	0.06	0.10
	Degraded forest	25.30	44.10
	Dense mixed forest	0.95	1.70
	Dense *sal* forest	2.76	4.80
	River (main channel)	3.57	6.20
Cultivable Land	Orchard	0.08	0.10
	Plantation	0.18	0.30
Cultivated Land	Low intensity/ terraced cultivation	2.80	4.90
	Moderate intensity cultivation	5.60	9.70
	High intensity cultivation	15.40	27.60
Total		57.48	100.0

cover is only 6.50 per cent of the total geographical area of the Sitlarao sub-watershed. Cultivable land is negligible in the study area, and it is sparsely covered with orchards and plantation.

About 42 per cent of the area is under cultivation. Cultivated land is further divided into low intensity/terraced cultivation, moderate intensity cultivation and high intensity cultivation. The high intensity cultivation is widespread covering about 27 per cent of the study area, which is found only in the southwestern part of the study area in a continuous stretch (Fig. 3). The central, northern and eastern parts of the study area are associated with the moderate intensity cultivation, which is generally scattered. The low intensity is mainly terraced, which is found scattered in northern parts of the study area. The sub-classes of high, moderate and low intensities of cultivation cover about 63 per cent, 23 per cent and 11 per cent respectively of the total cultivated land in the Sitlarao sub-watershed.

There are five classes of elevation as depicted ranging from 440-2200 m in the study area. The northern part of the study area faces the maximum degradation in forest cover due to high elevations and steep slopes as indicated in the Digital Elevation Model (DEM) (Fig. 4). Similarly, five classes of slope ranging from degrees 0-47 (Fig. 5) are comparable with the five classes of elevation. There are five main algorithms for calculating slope from Digital Elevation Models (DEMs) on varying scales, and different methods produce different results, but the most significant outcome is that slope varies inversely with the DEM grid size (10). In general, the slope degrees are grouped into three categories: (i) 0–4 degrees (Flat slope) (ii) 5-14 degrees (Gentle slope) and (iii) Above 14 degrees (Steep slope). It is found that the maximum slope range of 25 to 47 degrees (very steep) is also associated with the maximum intensity of forest degradation in the upper reaches of the study area. Moderate cultivation practices are occurring in the middle part the study area due to the constraints of moderate to steep slopes between 9 to 19 degrees.

The constraint of non-availability of favourable terrain for cultivation has also accelerated the land degradation processes in this part of the Sitlarao sub-watershed. The shape of a slope is a definite sign of how stable it is. Straight slopes tend to be more stable than the concave and convex slopes. Concave slope terrain is responsible for poor land cover which is dominant in the upper reaches of the study area, and the straight slope (Fig. 6) is quite favourable for the intense cultivation (Fig. 3). As a matter of fact, concave slopes will concentrate the run off; convex, tend to speed up and diffuse the run off; and straight one, to intermediate situation (11).

There was neither a programme of need-based development intervention implemented through any agency nor any type of organized group was found working in the study area. Soil erosion was not an acute problem in the areas of intensive cultivation in the lower reaches, but it matters in the middle and the upper reaches of the study area.

Conclusion

Remote sensing data provides an objective and quick mapping of land use /land cover attributes and identification of land

degradation in spatial context. GPS helps in specifying the sites for field checks. Uncultivated land dominates with about 57 per cent of the total area under this category. More than 63 per of the total cultivated area is under intensive cultivation.

In the upper reaches, lands with steep slopes are found devoid of forest cover. Steep slopes are more vulnerable for soil loss due to high elevation and high degree of slope in the northern part of the study area. Human intervention has been main factor in middle portion of the study area, and the local people too have similar views. Deforestation is thus taking place due to both physical and human-induced factors.

Digital Elevation Model (DEM), and slope and shape class maps are helpful to give effective visualization for broad associations. These morphometric parameters are closely related to each other indicating high degree of resemblance, and they affect directly land use/land cover pattern of the Sitlarao sub-watershed. Terrace cultivation is followed with poor cultivation practices due to terrain constraints. Small sized-terraced-field plots are not viable units in the upper middle portion of the sub-watershed. Corporate farming may be a viable solution to take maximum returns from the marginal lands of the study area. Nearly 45 percent of the total study area is as degraded *sal* forest. Agro and social forestry measures have to be adopted to ensure sustainability of agrarian society at local community level by generating employment opportunities in the study area.

Moderate to intensive cultivation mainly characterizes the low elevations. Farmers are able to take double crops with the available good rains in an agricultural year. Nevertheless, the lack of suitable water storage structures and poor maintenance of available canal network seem to be a handicap to have better crops from the areas of moderate intensity cultivation. Government and NGOs should come forward to build water-harvesting structures to ensure the livelihood of the agrarian community of this area.

Acknowledgement

I record my appreciation and thanks to NNRMS, ISRO for sponsoring me for an eight weeks training-cum workshop at IIRS, Dehradun in 2006.

References

1. Kurli A. V (2006). 'Spatial Pattern of Carrying Capacity of Land in Hirekerur Taluk, Karnataka – A Macro Level Analysis,' in Rath *et al.* (ed.). Proceedings of Second International Geography Conference, Goa, 27-29 January 2005, pp. 69-75.
2. Chakraborty D and J. Mukherjee (2001). 'Watershed Management,' *Employment News*, 25(51). pp. 1-2.
3. Braganza C (2006). 'Environmental Education for Sustainable Development,' in Rath *et al.* (ed.). `Proceedings of Second International Geography Conference, Goa, 27-29 January 2005, pp. 107-107.
4. Government of India (1994). *Guidelines for Watershed Development*. New Delhi: Ministry of Rural Development.
5. Dhinwa P. S, S.K. Pathan, S.V.C. Sastri, M. Rao, K.L.Majumdar, M.L. Choti, P.J. Singh and R.L.P. Sinha (1992). 'Land Use Change Analysis of Bharatpur Distrct Using GIS,' *Journal of Remote Sensing*, 20(4), pp. 237-250.
6. The Hindu (2001). 'Document on State of

Forests- Forest Resources in India,' *Survey of the Environment*, pp. 199-204.

7. Government of India (1995). 'Report of the High Level Committee on Wastelands', New Delhi: Ministry of Rural Areas & Employment.
8. Government of India (1990). *Watershed Atlas of India*. New Delhi:All India Soil and Land Use Survey.
9. Shrestha D. P (1997). *The Integrated Land and Water Information System* (ILWIS). Enschede, The Netherlands: ITC
10. Zhang X, N.A. Drake, J. Wainwright and M. Mulligan (1999). 'Comparison of Slope Estimates from Low Resolution DEM: Scaling Issuses and A Fractal Method for their Solution,' *Earth Surface Processes and Landforms*, 24(9), pp. 763-779.
11. Strahler H (1978). 'Response of Woody Species to Site Factors of Slope Angle, Rock Type, and Topographic Position in Maryland as Evaluated by Binary Discriminant Analysis,' *Journal of Biogeography*, 5(5), pp. 403-423.

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(Received : November 2007; Revised: February 2008; Accepted : April 2008)

Landuse/Land Cover Changes in Nellore District

Land use / land cover information is the basic pre-requisite for managing land, water and vegetation resources. The information on land use / land cover available today in the form of thematic maps, and published statistical figures in records and publications are inadequate, inconsistent, and do not provide updated information on the changing land use patterns, processes and their spatial distribution. Remote sensing and Geographic Information Systems (GIS) offer synoptic and repetitive coverages of large areas in a quick and in near real time which help in resources mapping, monitoring and measurement with a high degree of accuracy and reliability.

Materials and Methods

The study is made for the coastal area of Nellore district in Andhra Pradesh. Topographic maps and satellite imageries were the prime data source for this study. Arc GIS software was used to organize the data. Study area covers the *mandals* of Vidavalur, Kodavalur, Buchiredipalem, Nellore, Kovur, Indukurpet, Thotapalligudur, Muthukur and Venkatachalam. Survey of India toposheets for the year 1972 (57N/14, 66B/2, 57 N/15, 66B/3, 57N/16 and 66B/4) and IRS 1D LISS III multi spectral image for the year 2006 with 102 row and 62 column were used. Fig.1 shows the methodology adopted for the present study.

Erdas Image 8.5 was used for the raster analysis. Survey of India topographic maps (1972) were rectified by assigning the latitudinal and longitudinal values using the datum WGS 84. IRS 1D data (2006) were geometrically corrected using these rectified toposheets by consulting the ground control points. UTM WGS 84 with datum WGS 84 was the projections in these exercises.

Base map and land use map for the year 1972 and 2006 were visually interpreted, using Arc GIS 9.2. Different landuse classes were identified using the interpretation keys. Landuse map was prepared using level three classification technique. Doubtful areas were identified and verified using the GS5+ Global Positioning Systems (GPS). Ground truth data were updated on the map using Arc Pad 7 GPS software. Accuracy Assessment was made using field verification for overall accuracy of the results.

The IRS 1D LISS III imagery for the year 2006 was classified using the classification levels as noted in Table 1. General features in the study area are water bodies, wetland classes, reserve forest and existing economic activities.

Accuracy Assessment

Ground truth refers to measurements made at or near the surface of the earth in support of an air or space-based remote sensing survey for defining accuracy. It may also be referred to as ancillary data or reference data to improve the accuracy of the map. Accuracy assessments

Table 1
Classification Level

Level 1	Level 2	Level 3
Water Bodies	Rivers	River- water spread area River-dry
	Tanks	Tank - water spread area Tank -dry
	Canals	Canal
Wetland	Coastal Plantation	Mud
		Mangroves
		Sand
		Saltpan
		Coastal plantation Degraded plantation
Activities	Agriculture	Agriculture Current fallow
	Aquaculture	Aquaculture
	Settlement	Village
		Town
	Wasteland	Scrub
		Waste land
Forest	Reserved Forest	Reserved Forest
		Degraded Forest

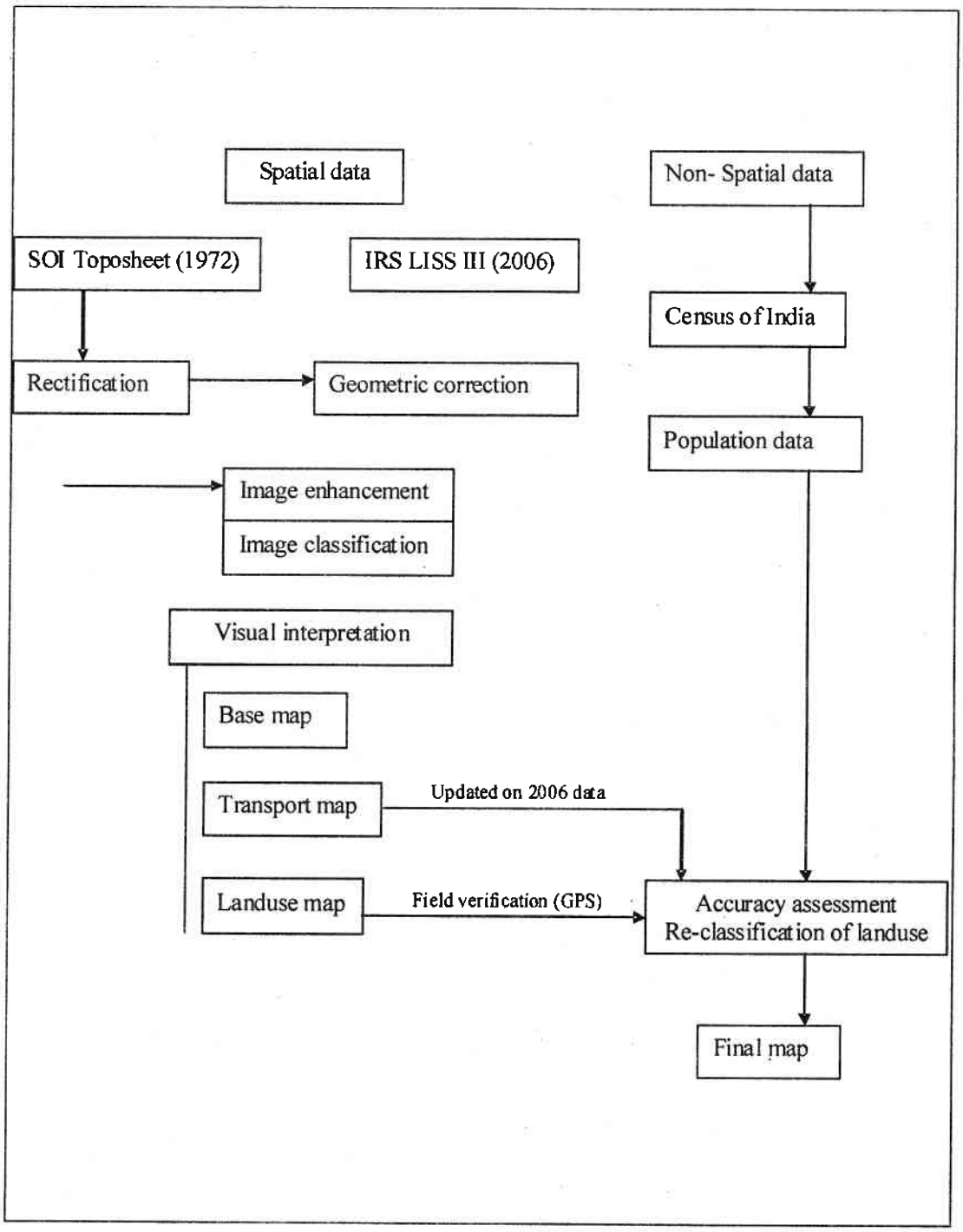

Fig. 1
Methodology

determine the quality of the information derived from remotely sensed data. Totally 150 points were taken and it was verified in the field; out of this 19 points were of different classes; all the verified points were imported using Arc Pad 7 and updated on the landuse map. Over all accuracy of the landuse map for the year 2006 data was 87%. Final layout was prepared using Arc Map (Fig. 2).

Results and Discussion

Nellore district is one of the fertile and

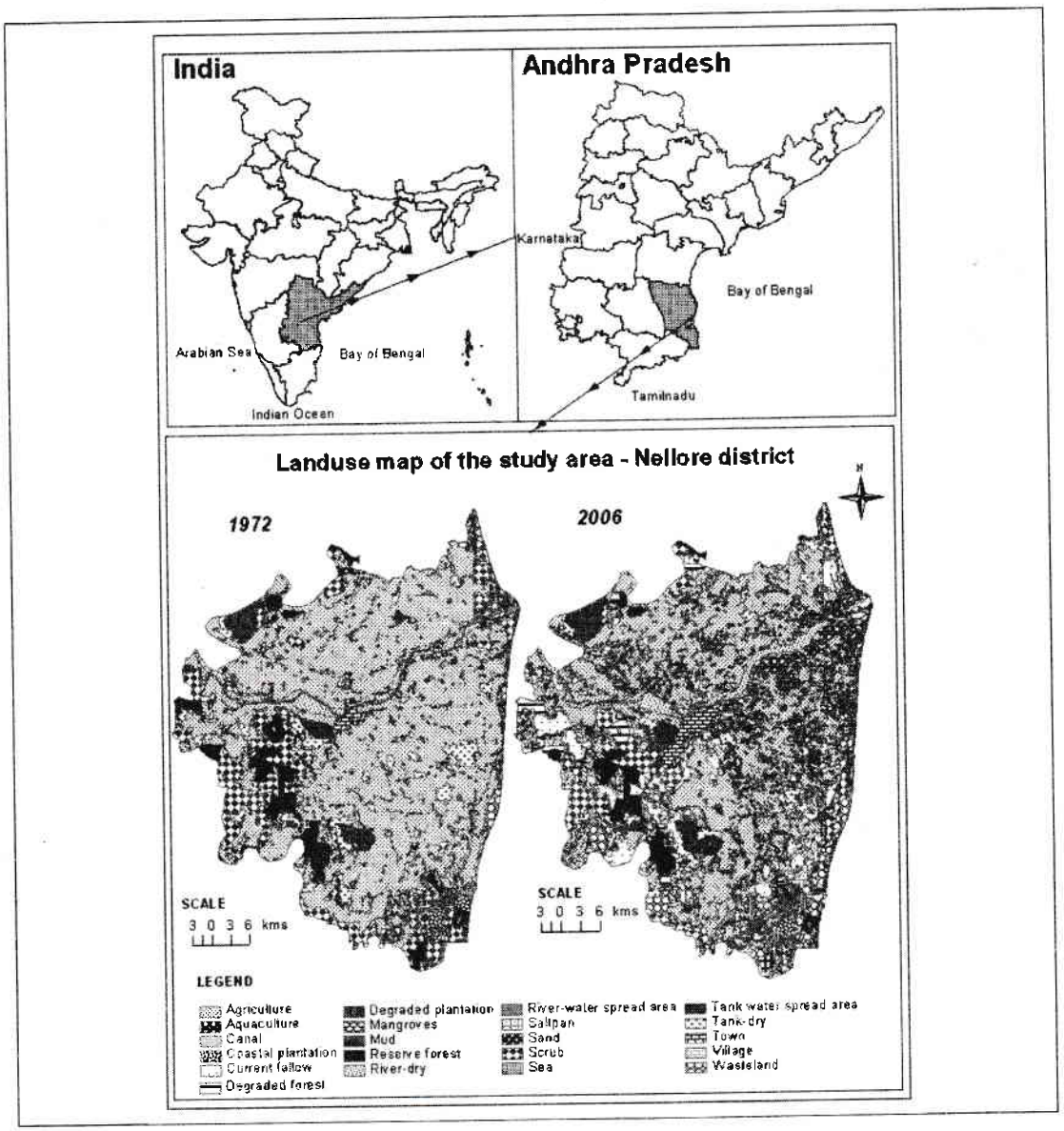

Fig. 2
Landuse Map (1972 and 2006)

agriculturally rich districts of Andhra Pradesh, and is located in the southern part of the State, along the coast of Bay of Bengal. It lies between 13°N and 15°'N and 70 5'. Coastline in the district runs for about 170 km. The district spreads over an area of 13,076 sq.km and supports a population of 2,668,564 of which 22.45% is urban (Census 2001). Table 2 shows the change detection analysis for the study area between the years of 1972 and 2006 and Fig. 2 represents the change detection analysis for the study area.

Water Bodies

The normal rainfall of the district is 1080 mm. During the year 2006-07 the actual rainfall received was 852.1 mm. The Pennar and Swarnamukhi are the principal rivers, besides

Table 2
Changes between 1972- 2006

Class	Area in ha		Per Cent to Total		Difference in per cent
	1972	2006	1972	2006	
Agriculture	105568.26	70510.06	62.44	41.71	-20.74
Aquaculture	16.63	16748.03	0.01	9.91	9.90
Canal	229.80	229.80	0.14	0.14	0.00
Coastal Plantation	1427.78	860.13	0.84	0.51	-0.34
Current Fallow	*	19875.47	*	11.76	11.76
Degraded Forest	74.42	2886.67	0.04	1.71	1.66
Degraded Plantation	*	223.95	*	0.13	0.13
Mangroves	*	476.47	*	0.28	0.28
Mud	326.41	320.88	0.19	0.19	0.00
Reserve Forest	8139.39	5327.15	4.81	3.15	-1.66
River-dry	4439.28	4507.47	2.63	2.67	0.04
River-water Spread Area	1994.76	1926.57	1.18	1.14	0.04
Saltpan	246.11	362.84	0.15	0.21	0.07
Sand	894.49	914.51	0.53	0.54	0.01
Scrub	23714.49	11951.99	14.03	7.07	-6.96
Sea	884.77	653.77	0.52	0.39	-0.14
Tank Water Spread Area	4548.31	7822.19	2.69	4.63	1.94
Tank-dry	9498.90	6225.02	5.62	3.68	-1.94
Town	722.03	2093.14	0.43	1.24	0.81
Village	4144.33	4615.41	2.45	2.73	0.28
Wasteland	2189.75	10528.14	1.30	6.23	4.93
Total	**169059.91**	**169059.91**			

* Data not available

Table 3 - Accuracy Assesment

Class	Agri-cult-ure	Aqua-cul-ture	Canal	Coastal Planta--tion	Current Fallow	Deg. Plant ation	Man gro-ves	Mud	Res-erve Forest	River	Salt pan	Sand	Scrub	Tank	Settle ment	Was te land	Total
Agricultrue	**10**	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	**12**
Aquaculture	0	**10**	0	0	0	0	0	0	0	0	2	0	0	0	0	0	**12**
Canal	0	0	**5**	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**
Coastal Plantation	0	0	0	**10**	0	2	1	0	0	0	0	0	0	0	0	1	**14**
Current Fallow	0	0	0	0	**10**	0	0	0	0	0	0	0	0	0	0	1	**11**
Degraded Plantation	0	0	0	0	0	**6**	0	0	0	0	0	0	**0**	0	0	1	**7**
Mangroves	0	0	0	0	0	0	**10**	0	0	0	0	0	1	0	0	0	**11**
Mud	0	0	0	0	0	0	0	**10**	0	0	0	0	1	0	0	1	**12**
Reserve Forest	0	0	0	0	0	0	0	0	**5**	0	0	0	0	0	0	0	**5**
River	0	0	0	0	0	0	1	0	0	**5**	0	0	0	0	0	0	**6**
Saltpan	0	1	0	0	0	0	0	0	0	0	**5**	0	0	0	0	0	**6**
Sand	0	0	0	0	0	0	0	0	0	0	0	**5**	0	0	0	1	**6**
Scrub	0	0	0	0	0	0	0	0	0	0	0	1	**10**	0	0	1	**12**
Tank	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	**10**
Settlement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**	0	**10**
Wasteland	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**10**	**11**
Total	**10**	**11**	**5**	**11**	**11**	**8**	**12**	**10**	**5**	**5**	**7**	**6**	**13**	**10**	**10**	**16**	**150**

the streams like Kandaleru and Boggeru. Pennar flows for about 112 km in the district and serves as a boon to the eastern half of the district. There are two anicuts at Sangam and Nellore. River water spreads decreased from 1994 ha to 1926 ha. River-dry area increased from 4439 ha to 4507 ha. Tank water spread area increased from 4548 ha to 7822 ha and also tank – dry area decreased from 9498 ha to 6225 ha (-1.94%). Canal spread remains the same.

Wetland

Area under coastal plantation declined from 1427 ha to 860 ha. There are areas of degraded plantation too, and this may be due to tidal fluctuations and salt water intrusions. Mangroves cover an area of 476 ha (2006). Some in coastal *mandals* of Nellore cut mangroves for constructing houses and other purposes. Saltpan increased from 246 ha to 362 ha. Sand area increased from 894 ha to 914 ha. Land under scrub vegetation got reduced from 23174 ha to 11951 ha.

Economic Activities

The total area under irrigation in the district is 306517 ha, Pennar delta system of irrigation covers 101,300 ha and the remaining covered by other sources like rain-fed tanks. Cropping in the study area declined from 105568 ha to 70510 ha in 2006, nearly about 20 per cent. Current fallow increased by about 11 per cent. Aquaculture goes on in about 10 per cent of the area and with its foreign exchange, it has become an important economic activity along the Coastal Nellore district. From mere 16 ha in 1972, its area dramatically increased to 16748 ha. The major agriculture crops in the study area are rice, sugarcane, groundnut, cotton, *bajra* and tobacco. Shrimp culture was more near the Kandaleru Creek area, which is located on the south of the study area. Area under settlement increased from 4866 ha to 6708 ha. Wasteland increased from 2189 ha to 10528 ha, nearly 5% decline.

Reserve Forest

Reserve forest decreased from 8139 ha to 5327 ha (2006); thus it got reduced at an annual rate of nearly 2%. expanding economic activities may be responsible for this alarming rate of decline of forest area.

Conclusion

The study using remote sensing products on GIS frame has clearly brought out landuse/land cover changes in Nellore district between 1972 and 2006. The accuracy assessment carried out for the data drawn from the imageries indicates an appreciable level of dependability (87 per cent). Area under farming, coastal plantation, reserve forests, scrub vegetation, and tank-dry spread is found decling. Decrease in farm land area and increase in current fallow are quite significant.

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(Received: November 2007; Revised: February 2008; Accepted: April 2008)

Morphometric Analysis of Kaveri River Basin in Khandwa District, Madhya Pradesh, India

The Kaveri river, a left bank tributary of the Narmada river has a length of about 78 km. It rises in the Western part of Satpura Hills in Khandwa district, Madhya Pradesh at 353 m above sea level. It flows in a North-West direction until it joins the Narmada river. The Kaveri basin has a drainage area of 901.23 sq.km. The study area is located between 21°55'N to 22°20'N latitudes and 76°8'E to 76°28'E longitudes and is represented in the Survey of India topographic sheets of 55B/4, 55B/7, 55B/8, 55C/1 and 55C/5. The area mainly comprises of recent alluvium which covers the Deccan Traps (Fig.1). Along the river course, boulders, cobbles, pebbles and gravels are deposited as elongated strips especially in the lower reaches.

Drainage

The Kaveri river and some of her tributary streams have their source in the Western Satpura upland. After receiving numerous first to sixth order streams, Kaveri confluences with the Narmada river. The general slope of the basin in southern and central courses is from south to north, and the northern part of the basin has slope towards south to northwest direction. The river Kaveri receives water from many tributaries. Some of the tributaries of the Kaveri river are Negi, Kalichauri, Kalda, Basaniya, Amak, Purwahi, Bodul, Chipjira, Garbadia, Ajnal, etc. (Fig.2). All these streams are ephemeral in nature and most of them dry in summer. The surface runoff in most of the streams is restricted to a few weeks after heavy rain, while in a very few streams the flow lasts for a few weeks to a few months. Though there are many tributaries (sub-basins), only four have been selected for study (Table 1). The main drainage is dendritic in nature (Fig.2).

Morphometric

Morphometry may be defined as the measurement and mathematical analysis of the configuration of the earth's surface and of the shape and dimensions of its landforms (1). The morphometric analysis includes stream order, stream number, stream length, bifurcation ratio, drainage density, stream frequency, shape of the basin, relief ratio, elongation ratio and drainage texture of the basin. The analysis of drainage frequency,

Table 1
Drainage Area and Stream Orders of Sub-Basins of Kaveri Basin

S. No.	Name of the Basin	Area (sq.km)	Stream Order
1.	Kaveri	901.23	Seventh
2.	Ajnal	312.24	Sixth
3.	Purwahi	86.83	Fifth
4.	Negi	78.41	Fifth
5.	Amak	75.15	Fifth

☐ The Indian Geographical Journal 82 (1) June 2007; published in June 2008

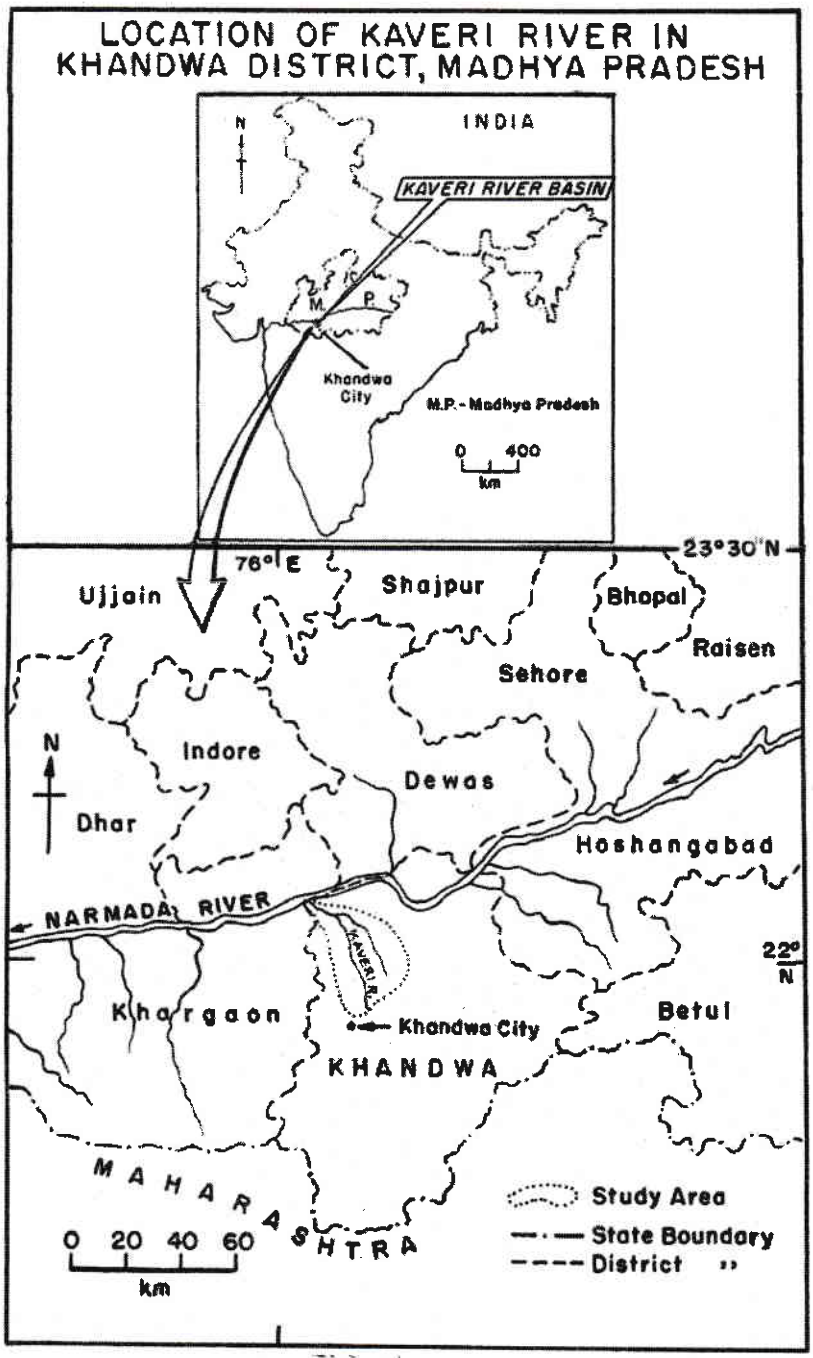
LOCATION OF KAVERI RIVER IN KHANDWA DISTRICT, MADHYA PRADESH
INDIA
KAVERI RIVER BASIN
M. P.
Khandwa City
M.P. - Madhya Pradesh
0 400 km
76° E
23°30' N
Ujjain
Shajpur
Bhopal
Raisen
Sehore
N
Indore
Dewas
Dhar
Hoshangabad
NARMADA RIVER
KAVERI R.
22° N
Khargaon
Khandwa City
Betul
KHANDWA
MAHARASHTRA
0 20 40 60 km
Study Area
State Boundary
District ,,

Fig. 1


KAVERI BASIN: DRAINAGE NETWORK
PURNAH R.
AJNAL R.
KAVERI R.
AMAK R.
N
0 2 4 6 8
km

Fig. 2

Table 2

Stream Characteristics of Kaveri Basin

S. No.	Basins	Stream Order	No. of Streams	Length of Streams (Km)	Average stream length (Km)
1.	Kaveri	I	2428	1512	0.62
		II	736	721	0.98
		III	118	330	2.80
		IV	129	130	4.48
		V	7	74	10.57
		VI	2	42	21.00
		Vii	1	7	7.00
2.	Ajnal	I	622	439	0.71
		II	115	96	0.80
		III	39	74	1.90
		IV	9	28	3.11
		V	3	26	8.70
		VI	1	34	34.00
3.	Purwahi	I	255	160	0.63
		II	54	48	0.89
		III	15	41	2.73
		IV	5	29	5.80
		V	1	7	7.00
4.	Negi	I	332	263	0.79
		II	67	83	1.24
		III	12	39	3.25
		IV	3	16	5.33
		V	1	9	9.00
5.	Amak	I	236	148	0.63
		II	85	82	0.96
		III	10	26	2.6
		IV	3	13	4.23
		V	1	4	4.00

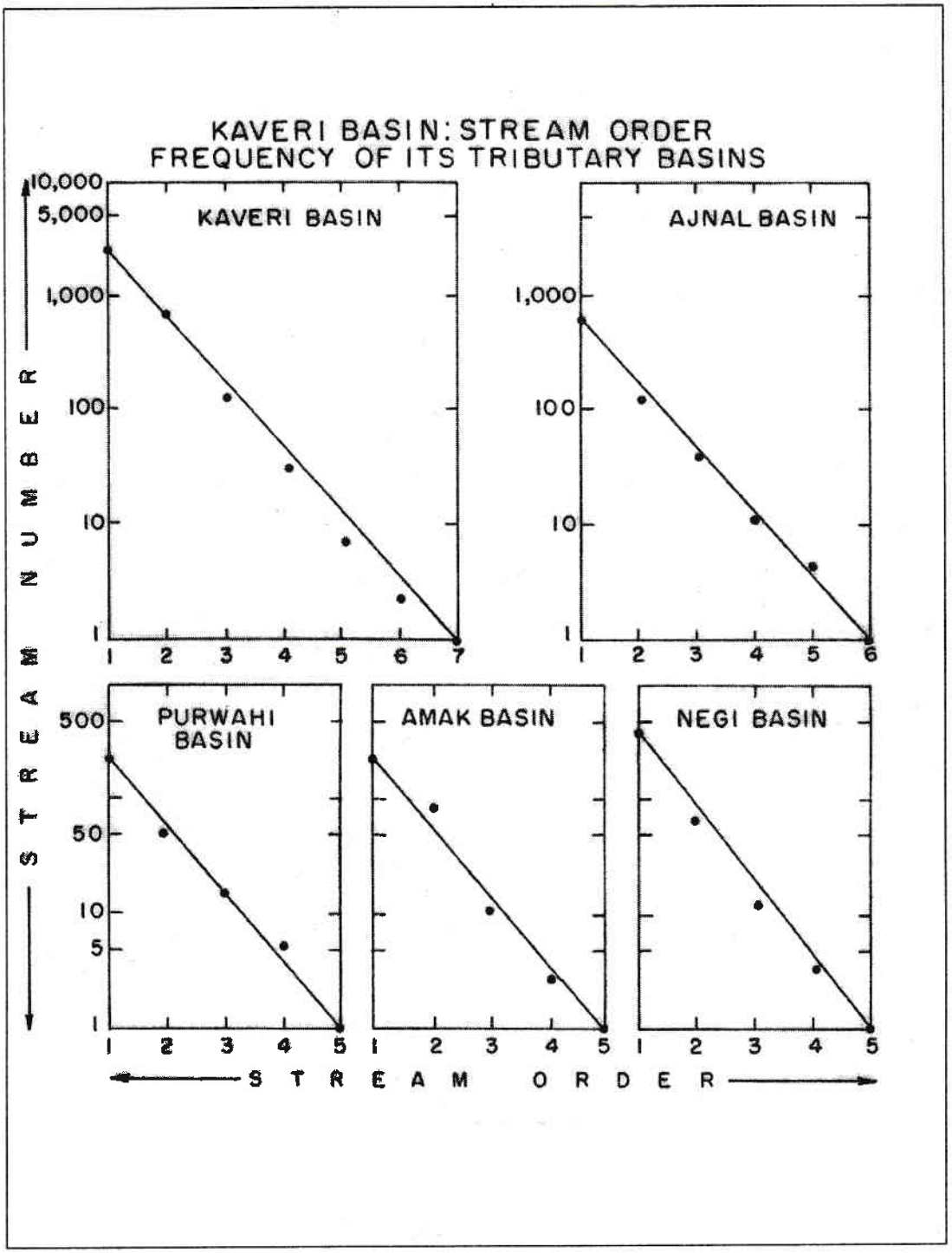
KAVERI BASIN: STREAM ORDER
FREQUENCY OF ITS TRIBUTARY BASINS
KAVERI BASIN
AJNAL BASIN
PURWAHI BASIN
AMAK BASIN
NEGI BASIN
STREAM NUMBER
STREAM ORDER
10,000
5,000
1,000
100
10
1
500
50
5
1 2 3 4 5 6 7

Fig. 3

bifurcation ratio and length of streams has been done on the basis of drainage order (3). For analysis of stream order, Strahler's scheme was followed which is popularly known as 'Stream segment method'(4). Stream lengths are measured with rotameter . Table 2 shows stream characteristics of Kaveri Basin which conforms to 'Laws of Stream Numbers' of Horton which states that the number of streams of different orders to make a geometric

Table 3
Bifurcation Ratio between Streams of Various Orders of Kaveri Basin

S. N0.	Basins	i - II	II - III	III - IV	IV - V	V - VI	VI - VII	Average
1.	Kaveri	3.30	6.24	4.07	3.14	3.50	2	3.88
2.	Ajnal	5.40	2.95	4.33	3.00	3.30	--	3.74
3.	Purwahi	4.72	3.60	3.00	5.00	--	--	4.08
4.	Negi	4.96	5.58	4.00	3.00	--	--	4.39
5.	Amak	2.78	8.50	3.30	3.00	--	--	4.39

Table 4
Relief and Elongation Ratio of Streams

S.No.	Basins	Relief (m)	Relief Ratio	Elongation Ratio
1,	Kaveri	353	0.36	0.24
2.	Ajnal	320	0.35	0.43
3.	Purwahi	260	0.43	0.48
4.	Negi	340	0.18	0.81
5.	Amak	300	0.22	0.68

Table 5
Stream Frequency and Drainage Density of the Stream

S.No.	Basins	Stream Frequency	Density Frequency	Nature of Drainage
1.	Kaveri	3.68	3.12	Course Drained
2.	Ajnal	2.53	2.23	Course Drained
3.	Purwahi	3.80	3.28	Course Drained
4.	Neg	5.29	5.23	Very Course Drained
5.	Amak	4.42	3.63	Course Drained

series (Fig.3). The analysis of stream frequency of the Kaveri basin reflects a perfect inter-relation between stream order and drainage texture. In area of first order texture of drainage, the frequency tends to decrease gradually with the increase in basin order. Low frequency with high order of basin area indicates a progressive advance in basin maturity.

The lower number of streams in II, III, IV and V order shows the occurrence of mature topography in basins of Ajnal, Purwahi, Negi and Amak. The total length of streams is maximum in case of I order streams and it decreases as the order increases up to V order. But a sudden increase in VI order stream of Anjal depicts a very interesting picture. It is due to less variation in relief for a long distance. The other reason is the presence of narrow elongated divides between the main streams Kaveri and Anjal which makes the Anjal stream to travel a long distance (Fig.4).

Bifurcation Ratio

It is a ratio between the total number of streams of an order to that of the next higher order in the drainage basin. The bifurcation ratio varies

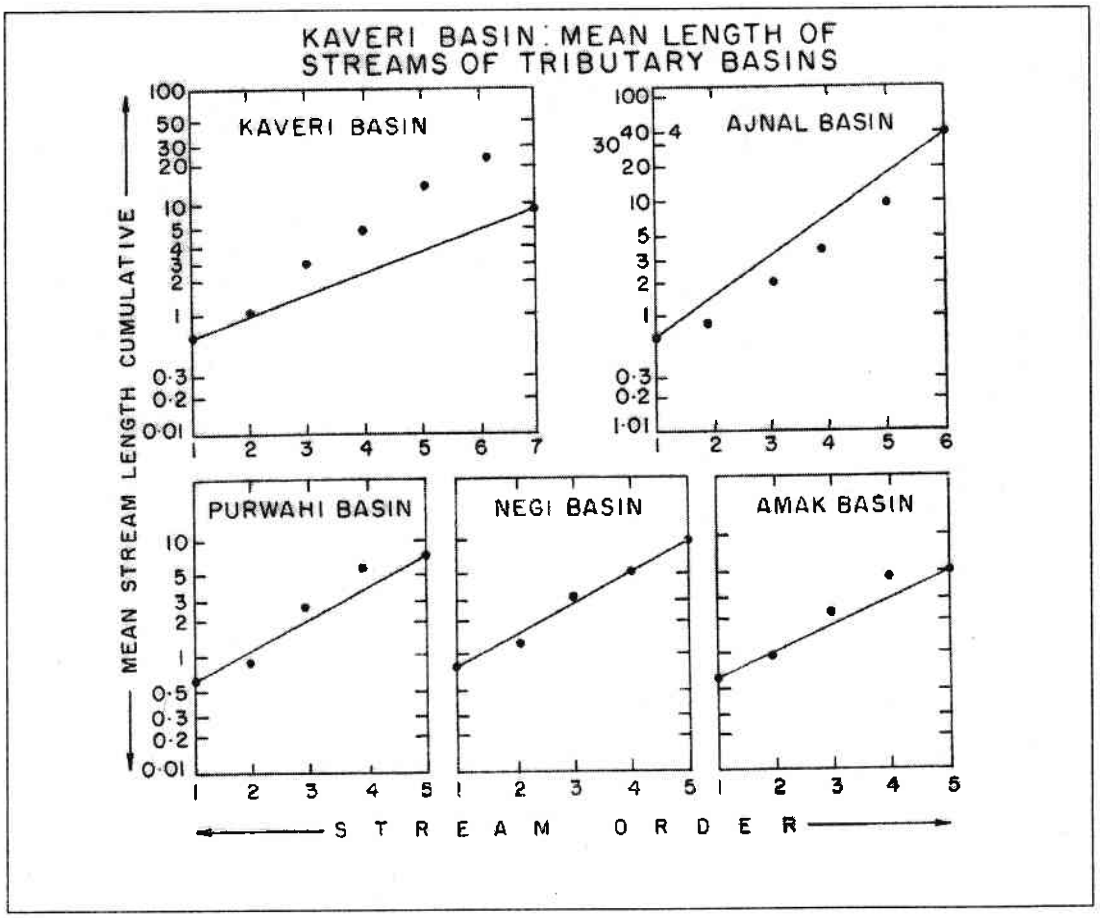

Fig. 4

Table 6
Stream Length Ratio of the Kaveri Basin

S. N0.	Basins	I - II	II - III	III - IV	IV - V	V - VI	VI - VII	Average
1.	Kaveri	2.10	2.18	2.54	1.76	3.50	1.76	6
2.	Ajnal	4.17	1.30	2.64	1.08	3.30	0.76	--
3.	Purwahi	3.33	1.17	1.41	4.14	--	--	--
4.	Negi	3.17	2.13	2.44	1.78	--	--	--
5.	Amak	1.74	3.15	2.00	3.25	--	--	--

from 2 to 5.58 with two exceptions of main basin and fifth order stream, Amak (Table 3). The higher ratio indicates lower degree of stream integration which is the special feature of basal granite and gneiss rock formation. The high bifurcation ratio of II and III order streams are noted due to presence of highly dissected terrain. The basin as a whole has bifurcation ratios ranging between 2 and 5.58, whereas the mean bifurcation ratio for the entire basin is 3.88 indicating that the drainage pattern is not much distorted by geologic formations. The bifurcation ratio between V and VI order stream and VI and VII is found only in two larger sub-basins; the ratio ranges from 3 to 3.5 and 2.0 respectively. It is due to less variation in the surface relief. The bifurcation ratio between VI and VII order stream, which is only 2, suggests that this part of the basin has minimum irregularities.

Relief and Elongation Ratio

'Relief Ratio' is dimensionless height-length ratio equal to the tangent of the angle formed by two planes intersecting at the mouth of the basin, one representing the horizontal, and the other passing through the highest point of the basin (2). Table 4 shows relief and elongation ratios of the Kaveri Basin and its four main tributaries. The value of relief ratios vary from 0.18 to 0.43 for Negi and Purwahi basins respectively. Relief ratios for other basins are: Kaveri – 0.36, Ajnal – 0.35 and Amak – 0.22.

Elongation ratio is the ratio between the diameter of a circle of the same area as the basin and the maximum basin length. Table 4 shows the elongation ratio of the Kaveri basin and its tributaries. This ratio varies from 0.24 to 0.81. Negi basin has maximum elongation ratio. The movement of surface run-off is maximum in Negi basin, and this may be due to association with strong relief and steep slopes. According to Strahler (5) elongation ratio noted between 0.6 and 1.0 over a wide variety of climate and geological types. Values close to 1.0 are examples of regions of very low relief whereas values ranging from 0.2 to 0.4 are commonly associated with strong and steep slopes. Out of five basins of the study area, two basins Kaveri and Anjal are the regions of strong relief with steep slopes whereas other three basins indicate very low relief.

Stream Frequency and Drainage Density

The stream frequency of a basin may be defined as the ratio between the total

cumulative numbers of channels for all orders within a basin area. Similarly, the drainage density of a basin may be defined as the ratio between total cumulative channel lengths of all orders within a basin area. Table 5 shows spacing of stream channels of the study area. Higher frequency of first order streams in Kaveri and Ajnal is due to steeper scraps formed by Western Satpuras. There first order streams are mainly found along the north-eastern and southern boundaries of the Kaveri basin perimeter. These two areas receive higher rainfall than other areas, and another reason is the presence of Western Satpuras in the south. By analysing above factors, it is concluded that most of the tributaries of Kaveri flow over coarse topography.

Stream Length Ratio

Stream length ratio is the ratio of the mean length of streams of one order to that of the next lower order. Computed values of all stream length ratios of different basins of the study area are given in Table 6

It is noticed that the stream length ratios between successive stream orders of the basins vary due to differences in slope and other topographic conditions. Stream length ratio varies from 0.76 to 6 for the whole study area. Kaveri has minimum at 1.76, and maximum 6 is found for VI – VII order. In Ajnal basin it ranges from 0.76 to 4.57 which indicates large variations in topography of the basin. The Purwahi basin has minimum stream length ratio of 1.17 and maximum 4.14. The Negi basin ranges from 1.78 to 3.17 and Amak basin ratio varies from 1.74 to 3.25.

Conclusion

Basic elements of fluvial morphometry have been computed for Kaveri basin which is a left bank tributary of the Narmada river. The linear and areal properties of the basin have been examined and analysed. The higher bifurcation ratio indicates lower degree of stream integration which is a characteristic feature of shale, sandstone and static terrain. The average bifurcation ratio of Kaveri basin, 2.72, indicates that drainage pattern is not much distorted by the geological structure of the study area. The elongation ratio of the basins under study, for example Negi and Amak, indicates that the region has very low relief. Whereas the other two basins Ajnal and Purwahi have regions of strong relief and main basin.

References

1. Clarke J.L (1967). 'Morphometry from Maps', in G.H.Dury (ed.). *Essays in Geomorphology. London:*Heinemann, London.
2. Chow V. T (1964) (ed.). *Handbook of Applied Hydrology*. New York: McGraw-Hill.
3. Horton R.E (1945). 'Erosional Development of Streams and their Drainage Basins: Hydro-physical Approach to Quantitative Morphology', *Geological Society of America Bulletin*, 56, pp.275 – 370.
4. Strahler A.N (1952). 'Hypsometric Analysis of Erosional Topography', *Geological Society America Bulletin*, 63, pp.1117 – 1142.
5. Strahler A.N (1964). 'Quantitative Geomorphology of Drainage Basin and Channel Networks', in V.T. Chow (ed.). *Handbook of Applied Hydrology*. New York: McGraw-Hill. Pp. 439 – 476.

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(Received: November 2007; Revised: February 2008; Accepted: April 2008)

The Indian Geographical Journal

Volume 82 December 2007 No.2

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The Indian Geographical Journal

Volume 82 December 2007 No.2

Cuddalore through Two Millennia

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Unlike an American city conceived in full on the architect's board as a plan drawing, later executed, the oriental city has its deep roots well implanted in the history of the past. Initiated in the form of settlements crystallizing within a farm production area, their subsequent growth is according to dictates of time and demands. Thus in an Indian city, the initial nuclei of habitation continues to survive in the core in a dormant or fossilized form, and further growth has taken place unevenly in different directions as necessitated by the transport routes converging and diverse urban functions adding on during different periods of time. They lack the plan structure of a planned city. Though spatially haphazard in growth, they reveal a distinct oriental flavour and charm.

Cuddalore is a coastal city of Tamil Nadu, that is the administrative capital of a district by the same name. With a population of 1.59 lakhs in 2001, it has more than doubled in the last 50 years, but had remained a slow-growing stagnant city for well over a century. The city owes its name to its sea-side location and possibly the confluence of three rivers with the sea within a distance of 3 km. Bound by the mouth of the Ponnaiyar in the north, the old course and mouth of the Gadilam in the south, the city is constricted in its pattern of growth and is extremely vulnerable to a repeated destruction by a number of natural forces: river floods, cyclones and huge sea-surges like the tsunami of 2004 AD. The new course of the lower Gadilam, post - 8th century AD, runs through the centre of the urban settlement to join the old course just above the mouth. A third tidal river, the Paravanar-Uppanar runs into its mouth from the south, separated from

□ Published in June 2008

Book Review

Geography of Maharashtra edited by Ms.Jayamala Diddee, S.R.Jog, V.S.Kale and V.S.Datye (Jaipur: Rawat Publications, 2002; 347 pages; 70 tables; 76 figures; appendices; Rs.750).

The book is an edited volume intended to explain in detail the physical, cultural and social landscapes of Maharashtra. It contains 17 research papers by scholars drawn from the various departments of Geography in Maharashtra. The chapters are organized in three sections namely Physical Environment, Economic and Cultural Landscapes and Maharashtra's regions.

The first section on Physical Environment has eight papers describing the geology, physiography, climate, soils, forests and wildlife. V.S. Kale describes in detail the geochemical, geochronological and paleomagnetic studies of Tertiary and Quaternary periods of the Deccan Traps. S.R. Jog *et al.* gives a perspective on the physical landscape of Maharashtra with landforms, morphometric characteristics and lithological characteristics, weathering, and morpho-genetic region. Karlekar details geomorphology of the Konkan coast and recounts the impact of tides, sediments and climate on the formation of coastal landforms on the Konkan coast. V. S. Kale *et al.* explains the fluvial regimes of the rivers of Maharashtra and examined the hydrological characteristics of sediments in relation to the flow of rivers. Gadgil looks into the detail on rainfall characteristics, annual, seasonal, storms patterns etc. for Maharashtra in relation to droughts and floods on one hand, and on the other, agricultural situations as found by the National Commission on agriculture. Mrs. Dikshit outlines different factors and processes that have contributed to soil formation in Maharashtra. She further accounts for the determinants of forest growth of Maharashtra and assesses the present status of wildlife. Also she brings out the efforts and problems of wildlife conservation, ecological disasters and future prospects in relation to declining numbers.

The second section provides an overview of economic and cultural landscape with seven chapters on agriculture, industry, population growth, urbanization and transport. Datye *et al.* broadly describes cropping patterns and productivity in spatio-temporal terms for two time periods to bring out agricultural regions. Deosthalli identifies dry farming regions of Maharashtra through soils, climatic patterns and cropping patterns to identify crop sub zones, and suggests alternate strategies for dry farming. Paprikar gives an overall industrial scenario of the state, its major industries, its regions, the changing trends and industrial policy. Diddee *et al.* in detail elaborates the

population situation in Maharashtra with several variables and explains issues and concerns for demographic stabilization. Kewalramani brings out the overall trends of urbanization. Lewis *et al.* looks into the process of urbanization with strategies for planning and policy. Vaidya has highlighted the surface transport network of the state.

The third section of the book with two papers by Prof. Dikshit devotes itself to the Regions of Maharashtra. Based on location, human activities and past history, Dikshit identifies five regions-Konkan, Desh, Marathawada, Khandesh and Vidharbha. These are further sub- divided basin-wise and described in detail. Dikshit in the last paper elaborately describes the demography of Mumbai City and its metropolitan region.

The scholarly text on the "Geography of Maharashtra" may be more helpful to the researchers and planners, and teachers at higher education. Further all the chapters of the book are not written in equal depth. For instance, the chapter by Kale on Deccan Traps is a lenghy and well-researched one. Climatic elements of temperature, wind and relative humidity, river systems, population distribution, air transportation, pollution, tourism, and planning and development could have been included for description so as to have a full treatment of the subject taken up for the book. Maps, diagrams, graphs, and tables are neatly done and they remarkably supplement the text. Each chapter is presented with a long bibliography which is useful for cross references. Finally the appendix on the administrative details is well brought out. On the whole the book is an appreciable attempt by the authors and the Department of Geography, Pune University.

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Colonial and Post-Colonial Geographies of India edited by Saraswati Raju, M.Satish Kumar and Stuart Corbridge (2006); New Delhi: Sage Publications; 16 Chapters; 368 pages; price: Indian Rs. 695.

The volume under review is a collection of fifteen essays written by practising geographers, sociologists, gender-interest groups and NGOs, admirably arguing on a variety of contemporary themes on Indian (and if colonial, then of course, necessarily South Asian) discourses. The volume has been well compiled and contains eminently readable essays. Arguably, the volume is one of the best on contemporary Indian geography, at least in last two decades. Indeed, the volume opens dialog on a number of issues within the broader rubric of discourses on social science in India.

Broadly, the *tenor* of the essays is post-modernist, and *genre*, contemporary. Two of the essays, "Idioms, Symbolisms and Divisions.." by M. Satish Kumar and "Teritoriality, Kashmir and Evolving Geopolitics of India..." by Robert W. Bradnock, in some sense, are essays connected to the colonial India, especially, the former that portrays caste relations and

"divided spaces" in colonial Madras (1652-1850); the latter draws upon the past more in an effort to understand the present. A sizeable number of essays (5) are gender-related or on women in struggle in the rural and in the urban milieu in India—in narratives of struggles of a myriad kind. Post-colonial would in some sense mean the linkages of the two periods, which to some extent is justified in essays of Alison Blunt and Bradnock; rest, no doubt, are about contemporary issues, geographical (perhaps) but in political and sociological discourses, in essence. So, whereas one has no arguments about the contents of the essays and their selections and quality, they do not justify the title of the collection (unless, such titles are as fashionable, as they were in mid-seventies in University cafeterias in India).

What the volume achieves, in a broader sense, is also opening a social theory debate from the Indian perspective to a larger global audience—as rightly pointed in the Introduction to the volume, Indian geography lived and prospered in isolation from international human geographies (also, barring exceptions, from rest of social sciences in India itself).

The opening essay of M. Satish Kumar and "Teritoriality, Kashmir and Evolving Geopolitics of India..." is an application of Lefebvre's "reproduction of social space" to an eminently historical theme of urban residential segregation in 17^{th}-18^{th} century Chennai (formerly, Madras) on caste cleaves and its opportunistic perpetuation by the Colonial British is no doubt, an interesting exposition of an area, in which India is rich (history) and Indian geography has been poor. Alison Blunt's essay "Home, Community and Nationality..." exposes the crisis of identity and self-image of the "Anglo-Indian" community that was at one stage large, caught between its allegiances to its home-land that is India and a "culture" that was essentially drawn from the west and in the manner in which other local communities often looked at them with suspicion.

Robert Bradnock's essay on Kashmir depicts the concerns and geopolitics of the past that impinges on its present and future—the global geopolitics and power plays that keep the fire burning on the border, though conception of territoriality is reduced to irrelevance by processes of global economy and globalisation. In Chapter 5 Corbridge and Simpson write on "Militant Cartographies..." of contemporary Indian politics of the *Sangh Parivar* in constructing an *Akhand Bharat* (*Hindustan,* through *Hindutva)* by creating a geography without territory and maps and the significance of "place-making" to contemporary politics. Whereas the essay is passionate about the *Hindutva* politics, it does not much reflect on the failures of the *Hindutva,* because the unifying icon, Rama, has never been in common Hindu perspective, as never more than a God-figure than God himself (except, in NW India)—more than religious plurality, the cultural plurality (different beliefs and religious practices) of India has been a greater unifying force than the *Hindutva* business.

Saraswati Raju in her essay "From Global to Local..." passionately argues about the influence of global economic processes on urban (women) labour market in India with her comparisons of Tamil Nadu and Delhi, in what

she calls, "...how the global intersects with local, and how the local itself is not homogeneous...". Some of the issues she highlights, like the perception in the North India, the pervasive patriarchy and reduction of women to the domestic sphere even in work and employment as against in the South India, where education and a job creates a better marriage prospect for the girl, are well-known, but never the less suffer from the same perspective. Vandana Desai (Chapter 7) and A. Shaw (Chapter 13) argue women's issues from the perspective of two other metropolises, Mumbai (formerly, Bombay) and Kolkata (formerly, Calcutta), the former a powerful theorising on the contemporary global impacts on poor women in metro-India and evaluation of NGOs on empowerment. Shaw devotes her discussion to the local level politics and women in Kolkata particularly in relation to a number of central schemes like UBSP and later, SJSRY.

Chapter 10 by Stephen Legg and Chapter 11 by Banerjee-Guha are broadly under Lefebvrean constructs "produced urban spaces", the former on Delhi and the latter on Mumbai. Whereas Banerjee-Guha may wonder at the "polyanrchy" of Mumbai, what about the "lived-experience" of the *Mumbaikar* (residents of Bombay) that could be matter of fact, rewarding experience, and to the recent migrants to the city, even better—a wonderland of limitless riches and possibilities!

The study by the Jeffreys (Chapter 13) explores the social mobility of the lower castes achieved through education as influenced by globalising forces though they might not have produced significant employment opportunities as yet (in the Western Uttar Pradesh)—no doubt a positive outcome. Essays by Williams and Mawdsley (Chapter 14) and Paul Robbins (Chapter 15) explore other contemporary dimensions like the environment dimension, and the last essay by Richa Singh and Richa Nagar on globalisation and knowledge production.

As stated earlier, the volume is refreshingly different collection of essays both in tenor and contents than those routinely churned out. However, the essays are too diverse and do not provide a coherent focus, other than they use contemporary genre of human geography writing and therefore, in a sense showcase, the possibilities of new explorations in geographic research and writing in India—which is, no doubt, a praiseworthy effort.

However, the contemporary *genre* of "post-modernist" human geographies have their pit-falls in particularising understanding, which clearly is against the very idea of "rational progress" (of science). So, even if we reject grand theories, laws and theories that are hinged on to the universalities (and not the particularities) cannot be whole-sale dumped (along with the baby). Geography remains and will remain a profoundly fact-based empirical science and a balance necessarily be achieved between hermeneutical and empirical dimensions of the spatial perspective, whichever way one may look at.

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Geographical Perspectives in Environmental Issues edited by A.Kamalakara Reddy and (Ms.).Vijay Bhole (Hyderabad: Department of Publications and Press, Osmania University, 2006; 156 pages).

The book under reference focuses on various environmental issues that affect the present and future generations. It deals with emerging human environmental relationships and most of the articles reflect environmental problems such as landuse/land cover changes, pollution, health, comfort, climate along with the tools such as Remote Sensing and GIS.

Landuse/ land cover dynamics and environmental development is the subject matter of the introductory article authored by Kamalakara Reddy & Akther Ali. The second article reveals the adverse effect of the land cover changes in Western Ghats Region of Kanyakumari District (Gopalakrishnan and Sakthivel). The study on climate and agriculture in drought prone Anantapur District (Madhuri and Ramanaiah) indicates that climatic and edaphic factors combined with scanty irrigation facilities, and a poor adoption of agricultural technologies have a negative bearing on the crop productivity. The case studies on air pollution and its implications on health (Venugopala Rao and Kamalakara Reddy), ground water pollution in Bolaram Industrial Development Area (Gurunadha Rao), urban environmental pollution taking a case study of noise levels in Hyderabad city (Kamalakara Reddy and Narayana Reddy), and level of air pollution in Hyderabad city (Venugopala Rao) present sensible approaches and methodologies to monitor pollution problems, and may be useful for students and scholars. Article on disease environment in Kurnool District of Andhra Pradesh (Nagaveni and Krishna Kumari) describes the spatial patterns of 16 different diseases and may be useful for the administration in planning preventive and control measures/programmes. The articles on urban environment and human thermal comfort (Suneetha and Sachi Devi), and urban ecology of Thirupathi city (Krishnaiah, Eswaramma and Ramanaiah) elucidate different physical and socio economic issues of urban environment. Study on environment and development of Adilabad district by Narasaiah and Padmanabha Rao assessed the sustainability of various developmental schemes of Integrated Tribal Development Agency (ITDA). This study provides a feed back to policy makers/administrators, NGOs, and the environmentalists for designing future developmental plans/schemes/programmes. The two articles on EIA authored by Padmaja,Harishankar Reddy, Vijaya Bhole, Padmanabha Rao, Kamalakar Reddy and Rajendra Kumar bring out the need for EIA to estimate the environmental compatibility of developmental projects. They are highly useful for GIS practitioners as well as decision makers. The last two articles authored by Venkata Krishna, Hari Krishna, Mohanm Kumar, Jayaraju, Lingeswara Rao and Harinath elaborate the approaches and applications of Remote Sensing and Geographic Information Systems in Environmental Studies.

Environmental challenges we face today result from unplanned developmental activities and unwise use of natural resources. These problems are difficult to tackle without social awareness and public consciousness, and editors put in an appreciable effort to create it to the possible extent.

Readings in Resource Management and Geoinformatics edited by C.V.Venugopala Rao and A.Kamalakara Reddy (Hyderabad: Geo Tech Publishers, 2005; 166 pages).

The book here addresses modern methods and approaches of resource management, and may be of greater use to academicians, administrators and planners. The book consists of eighteen papers mainly concerned with water, land and forest resources, and their evaluation based on GIS techniques. The first paper authored by Padmanabha Rao and Kamalakara Reddy analysed the problems and potentialities of soil and water resource development in drought prone district of Anantapur. The studies on human resource development of Jalgaon District, Maharastra by A.S.Bhole & S.D.Bhangale, and on Karnataka region by S.I.Biradar and M.B.Bhiradi effectively used statistical methods to measure the levels of human resource development. Sudhakar, Srinivas and Venugopala Rao analysed the temporal changes in land use/land cover in Adilabad district of Andhra Pradesh, and Sambhasiva Rao discussed the land degradation and eco-development in Nallamalai and Erraamalai hilly region of Andhra Pradesh. Udayalaxmi, Himabindhu and Ramdass evaluated land use of Osmania University campus, Hyderabad using merged data of PAN and LISS-III, and described the campus as environmentally-well balanced micro region. Sreedhara Naidu and Ramanaiah assessed the development and dynamics of food resource system in Andhra Pradesh.

Articles on water resource management such as water resources for irrigation in Mandya district, Karnataka by Chandra Sekhar and Sivalingappa, water resource management and agriculture development in A.P by Venugopla Rao and Shashikala, surface water resources in Chitravathi basin of Rayalaseema by Ravindra Reddy, Krishna Kumari and Ramanaiah, informatic systems for water resource development in urban areas by Venkata Krishna, Hari Krishna and Kumar, under ground water level fluctuations in Hyderabad by Anand Gopagani and Vijaya Bhole provide valuable insights and suggestions for effective utilization of water resources and conservation of water bodies. Sudhakar, Kamalakara Reddy and Satyanarayana classified the forests and evaluated the impact of Joint Forest Management on forest cover in Kamareddy division of A.P, and observed an increase in forest cover in recent years. Anuja Tigga and Hemamalini evaluated the forest resources of Jharkhand State. Depletion of forest is observed due to agriculture, mining and forest-based industrial activities. Udayalaxmi, Ramadas, Sangeetha and Trupthi explained sub-surface structure of the gold-bearing Gadwal Schist belt and identified two gravity profiles across the belt. Venugopala Rao evaluated the performance and spatial aspects of sugar industry. Akther Ali and Kamalakara Reddy identified the sources of land and water contamination and quantified the extent of affected area in and around Hyderabad. Mekvan and Ansari in the concluding article elaborated the effect of globalization on resource utilization. Various geo-political issues from international oil market and drug trafficking to agriculture in third world countries are discussed at length, adequately supported with references and research finding.

Many of the articles are quite descriptive, and lack theoretical and analytical perspectives of the issues under discussion. Chapters could have been meaningfully integrated so as to have more justification for the titles of the books. However, the case studies quoted in the books are certainly useful for the researchers, administrators, and policy-makers who are concerned for balanced environmental development.

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Report on
Seminars and Conferences

NAGI's Second International Indian Geography Congress on *Unified Planet Earth and Diversified World : Changing Environment and Space Technology*

The Second International Indian Geography Congress of the National Association of Geographers, India, was held at the Department of Geography and Natural Resource Management of Janardan Rai Nagar Rajasthan Vidyapeeth, Udaipur, Rajasthan during February 29-March 2, 2008. Started in 1937, JRNR Vidyapeeth is one of the oldest and reputed educational institutions in Rajasthan. About 600 delegates from India and abroad took part in this great and memorable event. Foreign participants have come from USA, Romania, Egypt, Ethiopia, Yemen, Iran and Bangla Desh. There were participants from national institutions like Space Application Centre, Indian Space Research Organization, Survey of India, Census of India, CSIR, ICSSR, INSA and the like.

The Congress was inaugurated in a grand function with Prof.Lokesh Bhatt, the Vice-Chancellor of the JRNR Vidyapeeth, in chair, and with Prof.J.S.Ranawat, Chair Person of the Organizing Committee of the Congress, welcoming the participants and the guests. Prof.L.Dashora, former Professor of Geography of JRNR Vidyapeeth, gave the inaugural address, and Prof. Vasile Surd from Romania presented the key note address. Professor Girija Vyas, Chairperson of National Women Commission, New Delhi, Prof.H.S.Sharma, President of NAGI and Prof.R.B.Singh, the Secretary General of NAGI were also present at the Inauguration.

The focus of the deliberations in the Congress is on technology and environment in the diversified world. Totally 42 sessions were laid out under five sub-themes, Earth System and Environment, Regional Development, Ecological Sustainability, Urban Environment, and Geoinformatics. A panel discussion on the main theme of the Congress was also conducted and five subject experts led the discussions.

Senior professors like Prof.L.S.Bhat, Prof.P.S.Tiwari, Prof.Sudesh Nangia, Prof.M.H.Qureshi, Prof.R.K.Sharma, Prof.Ali Mohammad, Prof.Rashid, Prof.H.L.Yadav, Prof.Tara Singh, Prof.Anuradha Sahay and Prof. Anjana Vyas took active participation in

leading discussions in various technical sessions. On the whole, 316 papers were presented. Besides technical sessions, two memorial lectures were also organized on the second day of the Congress. Prof.P.S.Tiwari of Chennai gave the Arthur Geddis Memorial Lecture, and Dr.Vinit Kumar Choudhary Memorial Lecture was given by Mr.Mumtaz Khan of New Delhi. Also a Panel Discussion on Climate Change was organized with Prof.M.H.Qureshi in chair, and Prof.M.K Bandhopadhyay, Prof.Abd-Alla Gad of Egypt, Prof.Gurfan Beig of Pune and Prof.R.B.Singh of Delhi were the main speakers in this panel.

Shri Gulab Chand Kataria , Minister of Home Affairs , State Government of Rajasthan was the chief guest for the Valedictory Session of Congress. With Prof.L.S.Bhat in chair and Shri Prafull Ji Nagar, the Secretary of the JRNR as special guest, Prof. Sudesh Nangia of Jawaharlal Nehru University, New Delhi delivered the valedictory address. Prof.P.R.Vyas, the Organizing Secretary, read the report of the deliberations of the Congress. Prof. H. S. Sharma, President of NAGI and Prof. R. B. Singh also addressed the delegates.

The following recommendations were made from the deliberations aired in different sessions of the Congress:

1. Changing earth system must be conceptualized at global, national, regional and local level.
2. Global warming must be controlled through joint efforts at global level.
3. Proper coordination has to be defined for managing the natural hazards and disasters.
4. Population growth has to be controlled particularly in the third world countries.
5. Environmental impacts should be properly monitored and environmental planning should be suggested at every level.
6. Regional imbalances should be reduced and priority has to be given for infrastructural development.
7. Economic activities should be organized on proper planning and on the rational needs of the Society
8. Urban growth should be monitored and a sustainable planning for urban centres should be promoted.
9. Growth of mega cities should be controlled and it should not destroy the ecosystem of the area where it takes place.
10. Changing environment must be monitored through space technology.
11. Environmentalists of the world are to be addressed for protecting the Mother Planet Earth for a sustainable human existence.

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Arthur Geddes Memorial Lecture, 2nd International Indian Geography Congress, Janardan Rai Nagar Rajasthan Vidyapeeth University, Udaipur (Rajasthan) INDIA, March 1, 2008

by
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Development of Urban Centres in India

Indian cities and towns have witnessed tremendous population growth in recent years. In 1951, at the dawn of the Independence, a total of 62 million people, making 17.3 percent of the country's population, lived in 2,843 urban centres. By 2001, the urban population swelled to 286 million and the number of urban centers to 5,545. Their share in the total population went up to 27.8 percent. In just a span of five decades, the urban population has grown almost five times. The rate of urban growth, 26.4 percent in the fifties, progressively peaked to 46.0 percent in the seventies and slowed down to 31.5 percent in the nineties. At the present rate of growth, the urban population of India will surpass one billion mark by 2050. Recent estimates place India's urban population at 348 million (mid 2007), second only to that of China (580 million) and greater than the total population of the United States of America and Canada combined.

This massive accretion to India's urban population is basically the result of large scale migration of people from rural areas to urban dwellers in search of greener pastures. Though the constitution of the country provides for equal opportunities of development to all the people, irrespective of the place of their residence, urban dwellers have received much greater attention than the rural ones. This bias in the development process is best reflected in the changing composition of the GDP. The share of the primary sector, the mainstay of the rural folk, has shrunk from 55 percent in 1950-51 to 23 percent in 2004-05, and that of the secondary and tertiary sectors has grown from 45 to 77 percent during the same period.

The perennial flow of rural migrants puts great strain on the urban civic amenities which are already inadequate for the existing population. It leads to prolific growth of slums or squatter settlements which are home to about one-third to one- half of urban population in India. These slums present pathetic living conditions, totally unacceptable in a civilized society. They represent pockets of extreme poverty in the midst of urban affluence.

The efforts to tackle urban problems of crowding and congestion, proliferation of slums, traffic jams, pollution, water supply, sewage, sanitation and solid waste disposal over the last six decades after the Independence, have met with little success. This is so, mainly because of two reasons: one, our cities are growing too fast and the demand for civic amenities is always outpacing the supply; and two, the traditional planning process, rooted in the twentieth century urban situation in the U.K., is never equal to the task

at hand. Added to that, the efforts to cope with the urban problems have been only half-hearted, at the best. Rampant corruption, total lack of law enforcement and lack of coordination among the various organizations involved in managing urban affairs is another important factor responsible for the sorry state of affairs.

A New Strategy for Urban Development

A new two-pronged strategy should be adopted to improve the living conditions in Indian cities: discourage and slow down the mass exodus of people from rural areas heading to the cities; and improve urban civic amenities at war footing.

Arresting Rural – Urban Migration

Arresting rural – urban migration is, no doubt, a daunting task, but it has to be taken up sooner than later and it can be accomplished. By nature, human beings are attached to their roots, and leave their homes only due to some compelling reasons. The most important push factor is the lack of employment opportunities in the home territory. Though over 70 percent Indians live in villages, and most of them depend on agriculture for their sustenance, agriculture remains a neglected subject in our development plans in the last two decades or so. Over the years, farming has become less and less remunerative, leading to farmers' suicides in extreme cases. Therefore, farming has to be made remunerative by arranging farm inputs at reasonable prices and marketing of outputs at reasonable profits through village cooperatives. Cooperative movement should be strengthened in the country by curbing rampant corruption and by Government recognition and support.

Employment opportunities in rural areas can be augmented substantially by promoting agro-processing and value addition, agro-industries, and allied agricultural activities like livestock rearing, bee-keeping, seri-culture, fisheries, forestry etc. The great potential of livestock rearing has been amply demonstrated by the white revolution of Gujarat. Similarly, tertiary activities can be profitably encouraged in rural areas by developing infra-structure, particularly, electricity, transport and communication.

Along with making farming remunerative and augmenting employment opportunities in rural areas, it is equally important to make rural living comfortable by providing basic amenities of life. It is indeed a pity that our villages lack basic amenities even after six decades of planned development. 'PURA' (Provision of Urban amenities in Rural Areas), made popular by our ex-President, APJ Abdul Kalam, is quite relevant in this regard. Electricity, water supply, transport, education and health care are the prime areas which require our immediate attention.

Improving Civic Amenities in Urban Areas

In order to make our urban life comfortable, it is imperative that civic amenities in urban centers are improved expediously. The basic amenities, required for comfortable and happy living in urban centers, include hygiene and sanitation, solid waste disposal, water supply and sewage, electricity, public transport, smooth and obstacle–free pavements for cycling and pedestrian movement, education, health care, law and order, recreation and cultural facilities.

'Shuchita' or cleanliness has been an important trait of Indian culture and Indians have been known for high standards of personal hygiene. Yet, when it comes to social hygiene, the situation is pathetic. Indian cities are still persisting with back-breathing manual cleaning of roads and there is little mechanization. Efficient methods of sanitation and waste disposal have yet to come in place. Some cities have introduced source segregation of solid waste but the progress is very slow. Considering the rapid urbanization and ever increasing volume and diversity of solid waste, it is absolutely necessary that scientific system of solid waste disposal is evolved and put in place at the earliest. Segregated waste should be profitably recycled, wherever possible. It is particularly important to manage the hazardous waste, including hospital waste, with great care. Similarly, treatment and recycling of sewage should be taken up with urgency.

The growing urban population and ever-expanding demand for protected water supply pose great challenge to municipal managers in the country. In most Indian cities, the existing sources of water supply, planned for much smaller population, fall too short of the requirements. The growing water pollution, both surface and underground, necessitates strict enforcement of pollution control laws. Many urban centers in the country have yet to provide for proper drainage system.

Efficient public transport is the foremost requirement in our cities. In this vast country, there is hardly any city, where public transport is adequate and efficient. Mumbai is often quoted as having the best organized public transport, yet crowding of sub-urban trains there is frightening. The metro-rail of Delhi is, of course, a fine example of efficient public transport. Such metro-rails should be available in all cities of the country. Similarly, road transport should be developed primarily as subsidiary / feeder to the sub-urban /metro-rail system. It should aim at reducing the private vehicles on urban roads. Roads should be of uniform width and free of obstructions. Clean and air-conditioned buses with wide coverage and good frequency, especially tailored for office hours, should be introduced. The bus service should be punctual and cheap.

Water transport should be developed wherever possible. Chennai, for example, has two large streams, Adyar and Coovum, cutting across the city and joining the sea, and Buckingham Canal running parallel to the coast. About half-a-century ago, these rivers were perennial streams; today they are reduced to foul smelling drains. Similar is the fate of Buckingham Canal which was used for bulk transport till about 50 years back. In addition to these three waterways, there are a large number of lakes and ponds in the city and its periphery, which remain mostly dry and uncared, and are getting encroached with tacit support of politicians and government officials. All these water bodies could be profitably developed for transport and tourism, and could make the city beautiful, like the Danube and the Danube canal in Vienna and the Spree in Berlin.

It is equally necessary to facilitate and encourage cycling by allocating dedicated lanes on the pavements. That will go a long way to reduce pollution in the cities. The pavements should be smooth, without ups and

downs, and obstacle-free to facilitate pedestrian movement. Unfortunately, in most Indian cities, cycle tracks are totally missing. Pavements, wherever available, are uneven and full of obstacles. In Chennai, for example, it is difficult to walk on the pavements even for 10 meters without stepping up and down and encountering obstacles like garbage dumps, electric poles, trees, telephone boxes, post boxes, kiosks and cut-outs of political big wigs. All these obstacles and ups and downs render the pavements unusable.

Public transport being the domain of too many agencies, it is very important that there is good coordination and understanding among the agencies. Such coordination is generally missing in most Indian cities. Some times, even within the same agency / department, two different sections are found unaware of the activities of the other section on the ground.

For efficient management of public transport, it is essential to adopt an integrated approach. A common / unified ticket for different modes of transport helps a lot. In most European cities, one can have a common ticket / pass to use different modes – surface trains, underground trains, and buses – for a specified period. Monthly passes are very popular there, making commuting so easy. Many cities provide for dedicated train services from the airport to the city centre. In Vienna, for example, city airport train (CAT) takes you non-stop from the city to the airport and vice-versa in16 minutes, every 30 minutes from early morning to mid night, 365 days a year. Such examples could be profitably replicated in Indian cities without much difficulty.

Traffic management requires efficient planning and strict enforcement. It has to be based on systematic study of the traffic flows in the city. Traffic bottle-necks should be identified and removed speedily. Many a time traffic bottle-necks are avoided by diverting traffic to a longer route or making the road one-way. That in fact results in wastage of time and fuel, and in much greater pollution. All intersections should be completely clean and no parking should be allowed for upto 30 m in each direction. The pavements should be clear and no vendors should be allowed to set up shops. Intersections in almost all Indian cities witness the maximum traffic jams. Enforcement of traffic rules is quite lax in most Indian cities. Even in a very cultured city like Pune, jumping traffic signal is not uncommon, not only by youngsters but also by elderly commuters. Enforcement of traffic rules requires strict and efficient policing.

Education and health care facilities too fall short of the demands, both in quality and quantity, in most urban centers in the country and require immediate attention of municipal managers. Young children in our schools should be taught proper traffic rules so that when they grow up, they can discriminate between 'do's and don'ts' of traffic rules. Law and order, the most important pre-requisite for economic development and prosperity, should receive the top priority in management of civic affairs.

Massive inflow of migrants from different socio-cultural realms has led to social tensions in many Indian cities. Such tensions arise whenever the local people feel threatened to lose their jobs and cultural identity and be reduced to minority status in their own land. It is, therefore, necessary to maintain the delicate balance and never allow outsiders to

out-number the local populace. Balanced regional development and decentralization of industries and enterprises through fiscal incentives and disincentives are the only remedies of the problem.

Success of urban development plan depends, to large extent, on the coordination among the different agencies involved in the planning and development process. Empirical evidences suggest that coordination is best achieved when the team works under one command and the roles and responsibilities of the participants are well defined. Let us take an example of Tiruchirapalli in Tamil Nadu. The city showcases the manifold problems of unplanned urban sprawl and the confusion and chaos associated with such development. It is a city undergoing transformation from an ancient town of narrow and congested lanes and mixed functional character to a modern planned and modified city. The centripetal forces of the past are giving way to centrifugal forces of today. The arterial roads pass through densely populated areas. The physical constraints imposed by the two rivers and the railway lines on three sides of the old city result in traffic bottle-necks.

The Directorate of Town and Country Planning, a department of the Government of Tamil Nadu, is charged to take care of the city planning. But the Directorate has neither the necessary resources nor the authority to do the job. That is why, the development plan prepared in 1965 has largely been ineffective. The Government constituted the Tiruchirappalli Local Planning Authority in 1980 to prepare a fresh development plan. It took 25 years for the Authority to prepare the plan which became obsolete even before it was finalized. A substantial part of the city, including five large settlements (Bharat Heavy Electricals Ltd, two Ordnance Factories, National Institute of Technology, and Bharatidasan University), was outside the jurisdiction of the planning authority. These settlements form integral part of the city but lie beyond the boundary of the Municipal Corporation. Naturally, any development plan, prepared by such authority, will be incomplete and ineffective to meet the challenge of urban growth.

To be effective, the Tiruchirappalli Metropolitan Development Authority should have jurisdiction over the entire urban area, irrespective of the municipal boundary, and should involve all the stake holders – the people, the Government and the corporate business. It should be headed by a senior Minister of the Government, hailing from the city / district who should have the authority and stature to coordinate the work. The Authority should be responsible for formulation, implementation and monitoring the development plan which should be prepared with the support of subject experts and cover all aspects of urban development.

Finally, let us understand that urban development in India suffers not so much due to lack of resources as due to paucity of ideas and intent and lack of law enforcement. Indian cities should, therefore, evolve mechanism to involve well-meaning people with ideas and expertise in management of urban affairs.

Mid-Term Workshop on Health Vulnerability in Chennai : Towards a Better Understanding of Urban Health

Human health in any social system is a reflection of the specific state of its social and ecological environment. To probe this, geography departments in Bonn University, Germany and Madras University joined with French Institute of Pondicherry took a research project in 2007 focusing on threats to human health posed by water-related stressors in Metropolitan Chennai, India. The main objective of this joint research was to explore different dimensions of health vulnerability in Chennai and the aspects of sensitivity and adaptive capacity of urban poor. The sensitivity to ill-health was monitored through self-reported syndromes surveillance from the sample households.

A mid-term workshop was held on March 15th 2008 at the French Institute of Pondicherry to discuss the preliminary results of the project for getting a feed-back from the experts and stake-holders. It was organized with the scope that the debate and discussion of the workshop would help in evaluating the project design in the first phase, and in locating the areas of short-comings that can be corrected in the next phase of the research.

The Workshop began its sessions with a warm welcome address by Dr.Muller, Director, French Institute of Pondicherry, followed by a key-note address by Mr.Danraj of the Municipal Corporation of Chennai. Mr.Patrick Sakdapolrak, a geographer from Bonn University participating in this project, who stayed in the field for long-term observations, gave the introductory remarks to indicate the conceptual framework and the objectives of the project, methodology followed for field observations and data generation, and finally the analytical frame within which interpretations are made. Further he went on to talk on health vulnerability of poor in Chennai, by looking into the impact of illness on livelihood sensitivity.

From his questionnaire survey in select slums, Mr. Patrick analyzed the health problems and the multiple risks due to income loss on account of poor health of the active work force in the slums. With regard to coping mechanisms adopted by the households, he estimated that 48% of the surveyed households use self-medication with allopathic medicines, and about 68% consult the private medical practitioners. On an average, 59% of the households spend about Rs.60 (about US $1.5) for medical treatment, and 43 per cent of the expenditure is derived from the current income. Fifty per cent of the sample households reported that their daily earning gets affected when they fell sick. Finally he extended his analysis to describe the relationship between water-related stressors and the health of the people.

Ms.Nandhini from Madras University described the site and situation and the socio economic characteristic features of slum communities in Chennai, and she further brought out clearly the deteriorating environmental conditions and the possible health risks in the slums.

Thomas Seylor from French Institute of Pondicherry accounted for the syndromes surveillance in an inner city slum. He

explained the health vulnerability in relation to exposure, sensitivity and adaptive capacity. The vector-borne diseases such as malaria, dengue, chikungunia and filariasis, during 2000 and 2007 were described with neatly-drawn diagrams. The major objective of his presentation was on the incidence of symptoms and their combination for ill-health among the slum dwellers. With the data collected through a primary survey during wet and dry seasons, using cluster sampling method, the risk factors of the health of slum dwellers were identified and narrated. It was found out that the incidence of fever was 3.8 persons per 000's per day in the dry season and 5.8 persons per 000's per day in the wet season. The incidence of rashes and other skin-related diseases was 2.4 persons per 000's per day in dry season and 0.24 persons per 000's per day in the wet season. The joint pain is also high in summer with an incidence rate of 4.4 persons per 000's per day and 3.1 persons per 000's per day during the rainy season. The water-related risk factors were examined with illustrations. The vectors responsible for vector-borne diseases were identified, based on the collection of Culux, Aedes and Anaphelus mosquitoes using BG traps. The breeding of mosquitoes was found related to rainfall, temperature and breeding-source areas during wet and dry seasons. From the questionnaire survey, the breeding sources in the residences were identified, and measures to destroy these sources were further suggested in the presentation.

Hutin from WHO talked on urban water-borne outbreaks in India, citing the water supply and treatment in the cities. An environmental investigation on urban water-borne outbreaks and diagnosis was undertaken, using the epidemiological analytical methods. The corroded pipelines of water distribution seem-to be the major source of the outbreaks. He drew examples from the outbreaks in Garulia of West Bengal, and the large scale epidemic of acute Hepatitis B in Baripada of Orissa and Hyderabad in Andhra Pradesh. Damaged drinking-water pipelines crossing over sewerage pipelines or storm water drainage lines are found to be another source responsible for outbreaks. In the end, he briefly mentioned about the issues relating to an effective environmental investigations on the incidences and spread of disease outbreaks.

Prof.T.Vasanthakumaran from the University of Madras presented a talk on 'human health in Chennai slums', taking up an adaptive eco-system approach, and emphasizing the Participatory Action Research (PRAXIS). He suggested the use of health indicators for health care analysis among the urban poor and also presented a socio-ecological description with a rich picture of problem situation. He concluded stressing the need for self-organizing towards community development.

Mr.Danraj, an entomologist from the Municipal Corporation of Chennai, in his lively talk listed the interesting methods for the control of vector-borne and zoonotic diseases. He pointed out that water, if not stored properly and disposed properly, can cause morbidity and mortality, sometimes acute diarrhea, cholera, typhoid and jaundice. The mosquito breeding sites are accounted as 10% on domestic water, 40% on storm water drains and 50% on waterways. He quoted that there are about 40000 malaria cases each year, and it results in an economic loss of Rs 50 million,

and expenditure of Rs.100 million to the Corporation of Chennai. Nearly 30% of overhead tanks of the city residences are inaccessible for weekly larviciding and most of the tanks are built in violation the health principles. To control the mosquito breeding, regular spraying of drainage lines of the city, and keeping the river mouths opened to tidal waves to maintain flow of water may be very much needed. At present, in Chennai city there are 390 sprayers, 200 portable foggers and fogging machines being used to control the mosquito breeding, and of course, these machineries may not be sufficient enough for the sprawling city of Chennai.

The day-long workshop came to an end with the valedictory address by Prof. Hans Bohle of Bonn University, Germany. He summarized the proceedings with his expert comments. On the whole, there were a good amount of analytical interactions among the participants. Different dimensions of health issues were identified and analyzed in the workshop. The papers provided a good framework for understanding the health of the marginalized community. The organizers deserve all appreciation for the meticulous arrangement for a fruitful discussion on the health of urban poor. Certainly the discussion in the workshop paved the right direction in which further field investigation and research can proceed to unravel the puzzle of urban health of the marginalized households.

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International Conference on *Studying, Modeling & Sense Making of Planet Earth* University of the Aegean in Lesvos, Greece June 1-6, 2008

On the occasion of the celebration of the International Year of Planet Earth in 2008, the Department of Geography of the University of the Aegean in Lesvos, Greece, organized an international conference on "Studying, Modeling and Sense Making of Planet Earth" during June 1-6, 2008, with a support from the UNESCO Natural Sciences Sector. About 300 scholars from different disciplines coming from different parts of the world participated in this great event.

Contemporary spatial and social problems require a basic understanding of human-environmental interactions that characterize the Planet Earth so as to go for rational and relevant decision-making at all levels. This International Event in Greece attempted to promote a dialogue among the experts to cross over the disciplinary boundaries towards developing theoretical and analytical perspectives about making a sense of Planet Earth.

The Conference focused on the following three major streams: i) studying the earth

Geography Island and the venue of the Conference

A view of the Lesves Island

system – devoted to the natural sciences, the links within their fields and subfields as well as their links to the social sciences; ii). modeling the earth system – devoted on models integrating spatial and temporal levels; iii). sense making of the earth system – aimed to discuss on the social and policy sciences that try to make sense of the ways people perceive, function, modify and, in general, interact with the earth system while simultaneously being a part of it.

Each theme had several sessions and thematic workshops, dedicated to cutting-edge topics in contemporary Geography. Special emphasis has been placed on interdisciplinary studies, within and across the streams. First day sessions discussed topics like Geomorphology and Geo-conservation, managing the Earth's Hydrological Systems, natural hazards, environmental modeling for methods and techniques and resource use. Second day sessions deliberated more specifically on Sense Making of the Earth System and Studying the Earth System; papers were presented on policy frameworks of spatial development of environ- ment, environmental modeling of soil, farming and the like, managing the earth system, urban development, human migration and political dimensions of spatial changes.

On the third day, papers presented discussing the problems of managing the Earth's Coastal Systems, the identification of ecological risks, land use changes, economy and ecology, global changes, and sustainability. The role of education and public awareness were emphasized on the questions of sustainability.

Welcome Party in Progress

The final sessions had been dedicated to address the issues on trans-disciplinary thinking on the natural, social, and geographical studies in the context of making a sense of earth system.

Totally there were eighty six research papers presented in the sessions and poster sessions too had been organized. Well-known subject experts were invited to offer keynote speeches on the topics of each stream. There were three plenary speeches of 60 minutes duration during the sessions on the topics of 'Making Sense of Europe's Territory: Spatial Planning in the EU, Modeling the Earth System...but where are the People?', 'Material Matters and the Search for Resilience, Insights into Environmental Aspects of Bio-energy via a Systems Perspective', and 'Land Change Modeling: the Issue of Cover and Multiple Use and My Home: Planet Earth'.

The participants of the Conference were received officially on June 1, 2008 with a welcome dinner at the University of Aegean with a musical feat by the traditional Agiasos Music Troupe playing local songs of Lesvos and Asia Minor, and an ethnic feast hosted by the Mesotopos Women Cooperative at the University Hill Top. To provide an holistic experience and spirit of unity of the Earth System, flowing from the UN agenda for the Year of Planet Earth, during the Conference days, several events such as performances, film/video presentations, exhibitions, games/athletic events, and gastronomic tours were organized. Morning hours were devoted to conference sessions, while evening hours were devoted to cultural events on earth system-related themes. The events took place in selected places on the island of Lesvos with the assistance of several services such as the Archaeological Service, the Museum of the Petrified Forest of Lesvos, and others. The post-conference excursion included places of natural, cultural and historic interest on Lesvos and the neighboring islands, as well as on the Asia Minor coast across Lesvos.

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The Indian Geographical Journal

Volume 82 December 2007 No.2

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The Indian Geographical Journal

Volume 82 December 2007 No.2

Cuddalore through Two Millennia

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Unlike an American city conceived in full on the architect's board as a plan drawing, later executed, the oriental city has its deep roots well implanted in the history of the past. Initiated in the form of settlements crystallizing within a farm production area, their subsequent growth is according to dictates of time and demands. Thus in an Indian city, the initial nuclei of habitation continues to survive in the core in a dormant or fossilized form, and further growth has taken place unevenly in different directions as necessitated by the transport routes converging and diverse urban functions adding on during different periods of time. They lack the plan structure of a planned city. Though spatially haphazard in growth, they reveal a distinct oriental flavour and charm.

Cuddalore is a coastal city of Tamil Nadu, that is the administrative capital of a district by the same name. With a population of 1.59 lakhs in 2001, it has more than doubled in the last 50 years, but had remained a slow-growing stagnant city for well over a century. The city owes its name to its sea-side location and possibly the confluence of three rivers with the sea within a distance of 3 km. Bound by the mouth of the Ponnaiyar in the north, the old course and mouth of the Gadilam in the south, the city is constricted in its pattern of growth and is extremely vulnerable to a repeated destruction by a number of natural forces: river floods, cyclones and huge sea-surges like the tsunami of 2004 AD. The new course of the lower Gadilam, post - 8th century AD, runs through the centre of the urban settlement to join the old course just above the mouth. A third tidal river, the Paravanar-Uppanar runs into its mouth from the south, separated from

□ Published in June 2008

the sea by a north- running sand spit, a product of the northward long-shore drift over most months of the year.

The earliest references to the place indicate that the settlement north of the old Gadilam was a Jain settlement. The place seems to have gone under the name Padalipuram, being a grove of 'padiri' trees. Ptolemy in his Geographia of the 2nd century AD makes mention of Sabouras, a port just south of Podouke, a roman mart, now known as Puducheri (Pondicherry). Sabouras appeals to have developed at the south-end at the confluence of the Paravanar, a tidal inlet and the Gadilam at the joint entrance into the sea. The find of a roman gold coin, red conical jars and shreds of amphorae at a coastal site by name Karaikadu, just south of the old port site seems to support the case. A settlement sited on the spit at the north centre of the spit, named Sonagarkuppam (meaning a site of yavana settlers) and the presence of a *toni-turai*, even today a boat building site also point in this direction. Sabouras is classed as an emporium on the east coast; the word 'emporium' in classical Greek is referred to 'that port or sector of a coastal town' which was devoted to foreign commerce.

Early sites of habitations appear to have been isolated places spread in the midst of rice fields, on relatively high grounds like low mounds: these were built around temple complexes, however tiny, such as the old temple town close to the present railway junction, (around which the port centre developed), Tirupapuliyar, away from the sea, on the banks of Gadilam, around initially a Jain temple and subsequently a Siva temple, and Vilvaiayanattam, again around a Siva temple, apart from sea-side fishing kuppams like Devanampartnam, Sonagarkuppam, Singara-toppu and Sembadakuppam adjoining Toni-Turai.

The next reference to Tirupapuliyar is during the rule of the Pallava king Mahendravarman in the 7th century AD when the Jain preacher living in the local *'palli'* turned to saivism under the moral guidance of his elder sister. This appears to have angered the Pallava king who ordered the preacher to be thrown in the Gadilam which was in the floods (possibly October-November, the flooding season) and he was washed ashore on the north bank of the river close to a hamlet, known as Karaiyerivittakuppam. This place is about 2 km south of the main settlement, Tirupapuliyur. The saint renamed as Appar and other Siva saints who lived in the next two to three centuries all refer to the main habitation as being located on the north banks of the Gadilam. Vaishnavite literature also refers to this north bank location. The Gadilam flowing east, turns east, skirting the hills around the vaishnavite temple complex, Hayagriva Kshetra (more popularly, Tiruvendipuram) about 4 km west of Tirupapuliyur. Just north of the hill, the river turned abruptly east to run directly to the sea, south of Tirupapuliyur. This old course of the river seems to have continued till as late as early eighteenth century, when a number of Tamil works specifically on Tirupapuliyar still talk of the river to the south of the temple complex.

During the late Chola period (11th to 13th century), Manjakuppam, a name in corruption of Meychal Kuppam (grazing field) of the earlier days is mentioned under the name of Vanavanmahadevipuram and is classified as a *nagaram,* coastal trade centre with itinerant trade guild. Cuddalore, also called Pallavanpattinam as well as Tiruvendipuram

in thirteenth century were coastal trade centres. They all individually appear to have attained the status of a *taniyur*, with a temple core, a concentration of population and an independent local administration. For a short period in 17th century during the Nawab rule, the place was known as Islamabad, a name quickly forgotten. The Governor of Madras obtained from Harsi Raja, the Governor of Ginjee (a Maratha fort), a cowle to permit the English East India Company to settle at Cuddalore, Porto Novo and Kunimedu. The first English settlement was thus at Cuddalore in AD 1681. Six years later, land was purchased, and Fort Saint David, located at the south end of the insular territory of Devanampattinam, was acquired in 1687. The fort was thus a pre-European Maratha

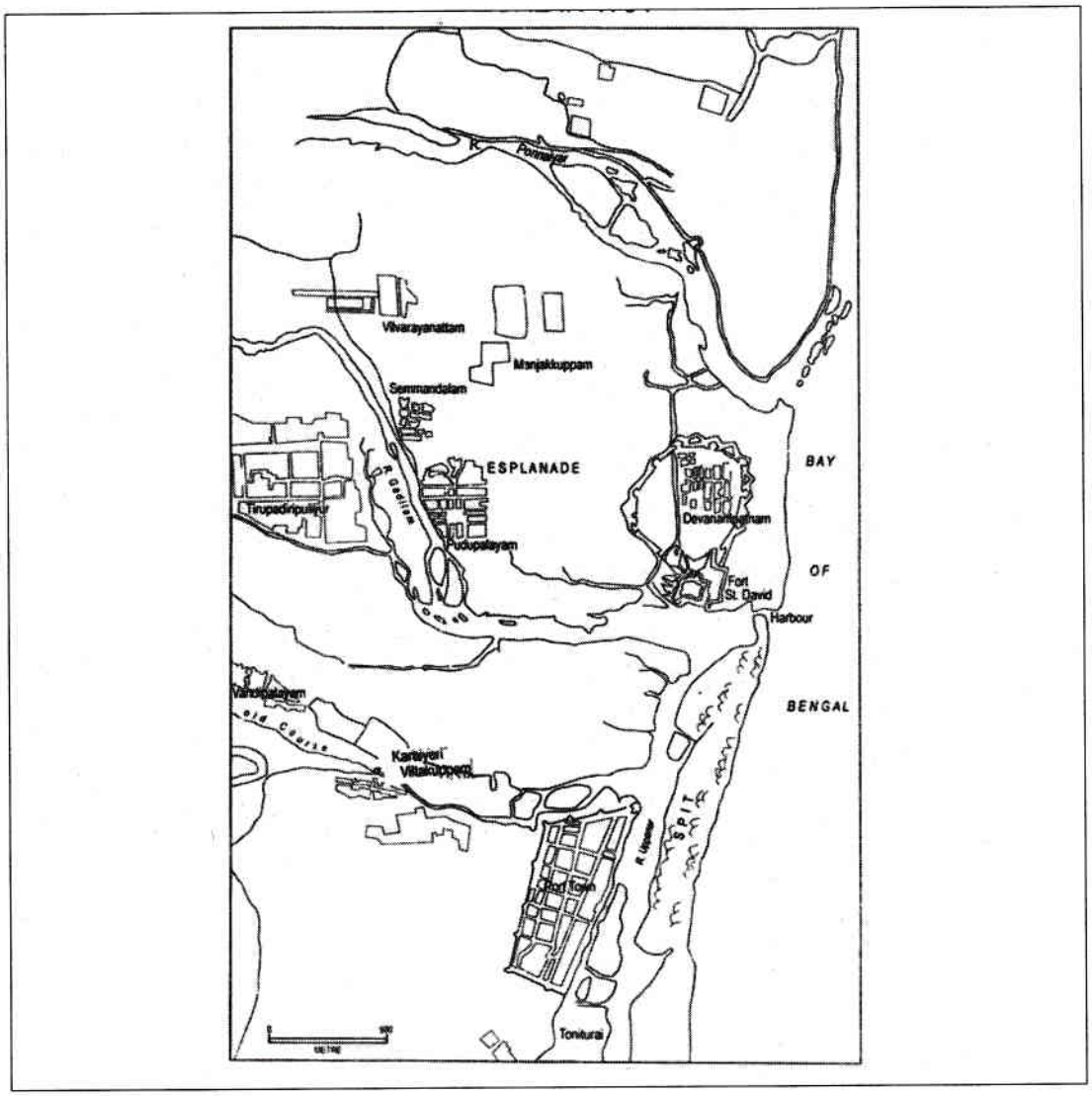

Fig. 1 Cuddalore - 1754

construction. In September 1690, a pact was signed with Rama Raja of Gingee for transfer of the fort of Devanampattinam with all its guns, buildings and the grounds as well as the woods and rivers around the said fort, all within a set of random shots of a great gunner using a brass gun. The purchase money was 30000 pagodas. The villages and settlements that fall within the gunshot are known as *gundu gramam,* "cannon ball villages". These villages that now fall within Cuddalore urban centre extend from Tiruvendipuram in the west to the sea in the east and the Caper Hills in the south beyond Toni Turai to the Ponnaiyar in the north; Semmandalam along the highway leading to Panruti was on the border

Once possession was ensured, the English company proceeded to introduce law and order. A mint was established but it started coinage in silver and gold only from 1747, the year in which Madras was lost to the French and Fort St. David became the capital and

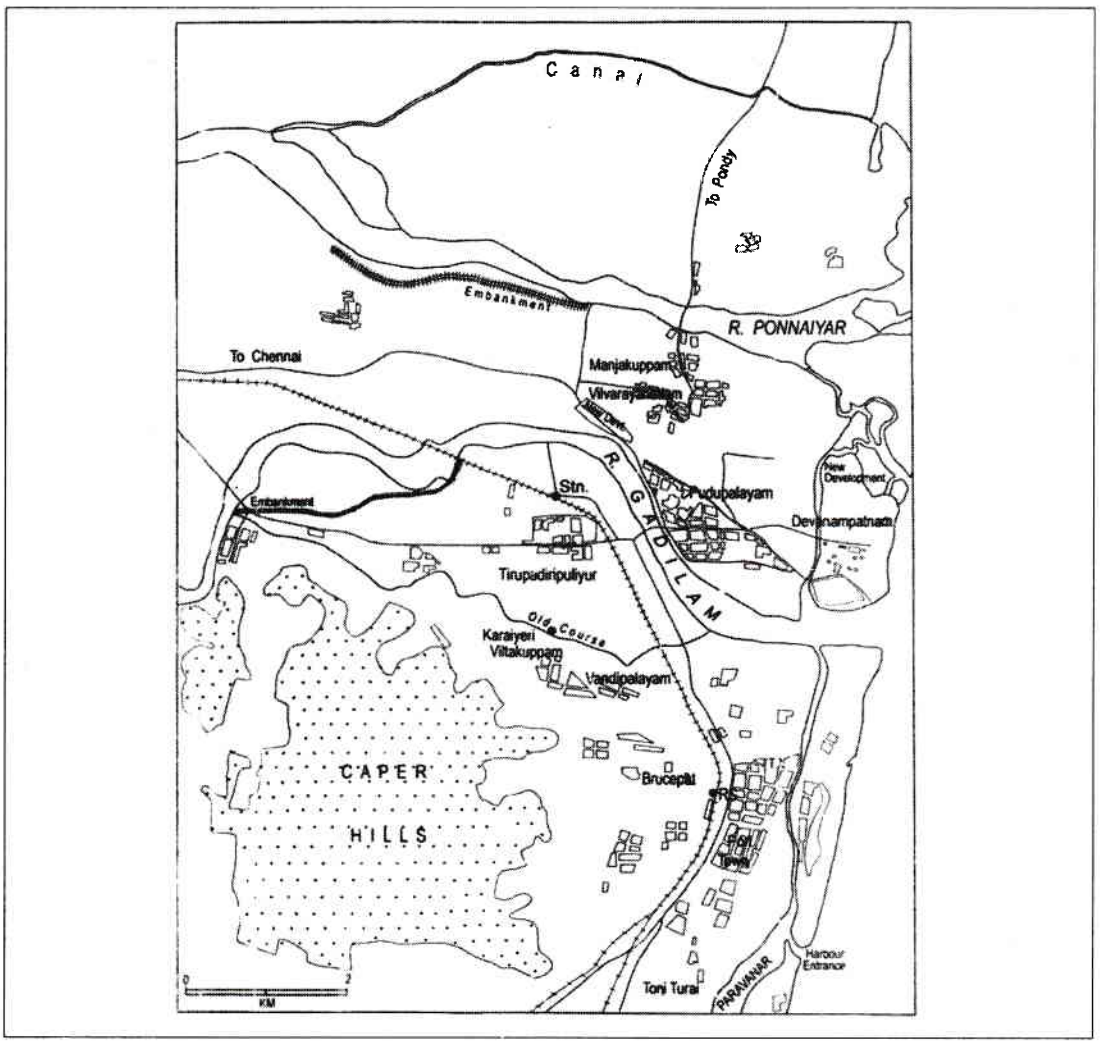

Fig. 2 Cuddalore - 1970

chief settlement of the Company on the Cholamandalam Coast. In 1757, Robert Clive became the first Governor, but left shortly to Madras. He lived in a bungalow about 3 km west of the fort, and a plaque just at the entrance door of the house of the Collector even today proudly announces this fact.

In the 18th century, the urban landscape of Cuddalore started taking shape. The town had four distinct parts, that are separate from each other, across extensive fields, rivers and canals. The old town, the commercial quarters, at the confluence of the Galidam and the Uppanar just before they empty into the sea had also the port-entrance that is free of bars throughout the year, unlike the bar-ridden sea-mouths of Ponnaiyar and the north branch of the Galidam. With the steam ship arrival, Cuddalore Port became a road-stead, with anchor site, three to five km away in the open sea. Earlier, the sail boats would enter the Port through this entrance to anchor at Toni Turai on the west bank of Uppanar.

The old town was built around a temple core, with a rectangular grid pattern and straight narrow streets. The second segment of the town was Tirupapuliyur, a jain settlement at the beginning of the Christian era, but transformed to a Siva temple nucleus, that is made of three components: the east facing Pataleeswara temple within a walled compound, adjoined on its left by the Amman Koil, also within a compound and a north-facing Pidari Amman Koil, just outside the entrance to the Amman Koil, now also within a smaller built structure. The town has a square grid pattern, with the temple at the centre; the inner streets are the deity procession routes and the outer, wider roads, the route of the temple car processions. The town-ship is a typical example of a temple town similar to Chidambaram, in its layout and social structure. The third component is Fort St. David, the original factory, and Company "factory" town within fort walls. The south side bastions face the north branch of Gadilam, close to the bar-ridden mouth. It is separate from other areas through a small navigable channel connecting the two rivers. The Fort was razed to the ground by Count de Lally of the French-army during an attack in 1758; after its destruction, it never became a military outpost. The ruins of the old fort have today only two bastions overlooking the river. No structures exist, except a house, now the residence of the Port Officer.

The last segment is the Company's official and administrative headquarters, Manjakuppam. Clive's residence continues till today as the District Collector's residence, adjoining which on its east is the Collectorate. Just behind, over a wide land area, extending almost upto the sea was a garden, known as the `Colonel Thottam' now forming the extensive fenced grounds of a major educational complex of a foreign mission known as the St. Joseph's; in front of the Collectorate is an open expanse of land known in early company days as the Esplanade, later renamed the Maidan. A Jesuit church and the law courts are aligned on its east and north sides, and the roads to the Fort and the beaches run on its south side. Built behind the administrative kernel is the residential area of the service staff, developed in a somewhat haphazard cluster, with narrow cross-cutting streets.

Apart from the four segments, and the fringe settlements along the limits of the urban area, the English Company created near 'suburbs' or *'pettahs'* for the weavers brought from Andhra or Interior Tamil Nadu to settle down. These were 'Brookspet, Lawsempet, Cumiengpet

and Kinchantpet sited in the open space between the Port Town and Tirupapuliyur in and around Vandipalayam, along the old course of the Gadilam. The last of these, Cumingspet, was destroyed by Tippu Sultan in 1783 and Kinchantpet reverted to fields. The Fort and the administrative township of Manjakuppam are separated from the Port Town and Tirupapuliyur by the new course of the Gadilam, flowing north of the old course since the eighteenth century.

Three mainroads run through the town: towards the south, along the south bank of Gadilam to Chidambaram and Neyveli, towards north through Manjakuppam to Puducherry and to the west on the north bank of Gadilam towards Panruti and beyond. The railway from Madras to Thanjavur came into being early in twentieth century and two stations serve the township. Cuddalore New Town serves Tirupapuliyur through a station at the north end of the Sannadhi Street as well as Manjakuppam. The Port Town is served by an independent station, which is a junction.

Cuddalore Town in the last century, grew by infilling as well as peripheral accretionary growth, especially along the trunk roads which served as the main public bus routes, though the Fort St. David area remained aloof with few people visiting the beaches. With no major industry to boast of, the prominent urban function of Cuddalore was as a social, cultural service centre, general education and teacher training apart from a craft centre, as well as a government hospital on the Panruti Road, on the outskirts. Along the north banks of the Gadilam there emerged a new town area, north of the Maidan, known as Pudupalayam. This linear residential area mainly housed people engaged in legal services.

In the last four decades, residential *'nagars'* have come up to the east of the Maidan behind the Court houses in an area formerly known as Anaikuppam. So too, housing development makes the road running west from the Collectorate, infilling all open spaces. A boat building industry of large boats has developed in the Toni Thurai area, after the decline of the Beypore industry. An industrial area has also emerged south of the Port Town at the foot of Caper Hills which also houses the Central Jail. Peripheral growth, though slow, is also taking place to the west of Tirupapuliyur on the road to Tiruvendipuram. Retail marketing is mainly around the stations and main roads.

In spite of all this growth and substantial increase in population to 1.6 lakh (2001), Cuddalore presents an amorphous structure, not yet fully coherent. The sleepy decadent air of the city half a century back is slowly changing to become more active, but is not yet fully bubbling with newly-found energetic forward thrusts.

Note: The author is a third generation resident of Cuddalore and lived in Manjakuppain during the school days and after till 1953 AD.

References

1. Baliga D S (ed.) (196). *South Arcot District Gazatteer.*
2. Champakalakshmi R (1996). *Trade, Ideology and Urbanisation.*
3. Forrest G.W (1999). *Cities of India : Past and Present.*
4. Francis W (1882). *South Arcot District Gazatteer.*
5. Love H D (1913). *Vestiges of Old Madras.*
6. Nilakanta Sastri K (1975). *The Cholas.*
7. Subbarayalu Y (1973). *Political Geography of the Chola Country*
8. Sundarashanmugham (1987). *Wealth of Gadilam. (in Tamil).*

Land Use Modelling through GIS and Remote Sensing

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Land use modelling is a comprehensive action programme aimed at optimal utilisation of resource potential. It entails harmonious development of land, water, vegetation and other resources of an area. An attempt has been made in the present study to develop an optimal land use model for Bobbili Mandal in Vizianagaram District of Andhra Pradesh. GIS and Remote Sensing techniques have been effectively used to analyse and map the resource potential. Thematic maps of hydrogeomorphology, slope, soil and land use/land cover have been derived and vectorised from multi dated multi spectral imagery of IRS-P6 LISS III and topographic map. Integration of these vector layers evolved a composite map from which 68 composite map units (CMUs) have been delineated. The Optimal land use model derived from manipulation/analysis of the CMUs suggests nine alternative land use practices such as intensive agriculture, irrigated dry crops, horticulture, silvipasture, social forestry etc. Appropriate land and water resources conservation measures have also been recommended for each optimal land use class.

(Received: September 2006; Accepted: January 2007)

Over exploitation of land, vegetation and water resources has resulted in serious problems like land degradation, denudation, soil erosion, land slides, floods, droughts etc. This alarming situation calls upon the scientific appraisal of all available resources for their optimal and sustainable utilization. Managing and developing the land resources without endangering the environment is a crucial issue the world is facing today (4,5,9). This is essential for the developing countries like India with a large rural population base. Developmental planning in this context is a complex process of decision making and optimal utilisation of resource potential, and for this, remote sensing data products seem to be potential enough for resource inventory and monitoring. Along with the remote sensing data, Geographic Information Systems provides an useful technology for multi dimensional data integration and also for generating suitable and economically feasible models for holistic development. Krishna Murthy *et al.* (6), Bhagavan *et al* (2), Sando & Leimbach (8), and Singh & Gajbhiye (10) have demonstrated the role of remote sensing in conjunction with Geographic Information Systems for developing several viable methodologies for integrating spatial and non-spatial data bases and for developing pragmatic development plans consistent with resource potential and problems. The objective of the present study is to develop an optimal land use model suitable for microlevel developmental planning using GIS and Remote Sensing techniques. Bobbili Mandal in Vizianagaram district of Andhra Pradesh has been selected.

☐ The Indian Geographical Journal 82 (2) December 2007; published in June 2008

Study Area

Bobbili *Mandal* lies in the central part of Vizianagaram district between 18° 30′ - 18° 40′ N latitudes and 83° 15′ - 83° 30′ E longitudes (Fig.1). The *Mandal* may be broadly divided into two physiographic divisions, namely, the hilly region and the plain region. The hilly region covers the west and northwestern part of the Mandal. The rest of the area is an open flat plain broken with a few hills. According to Census 2001, the total

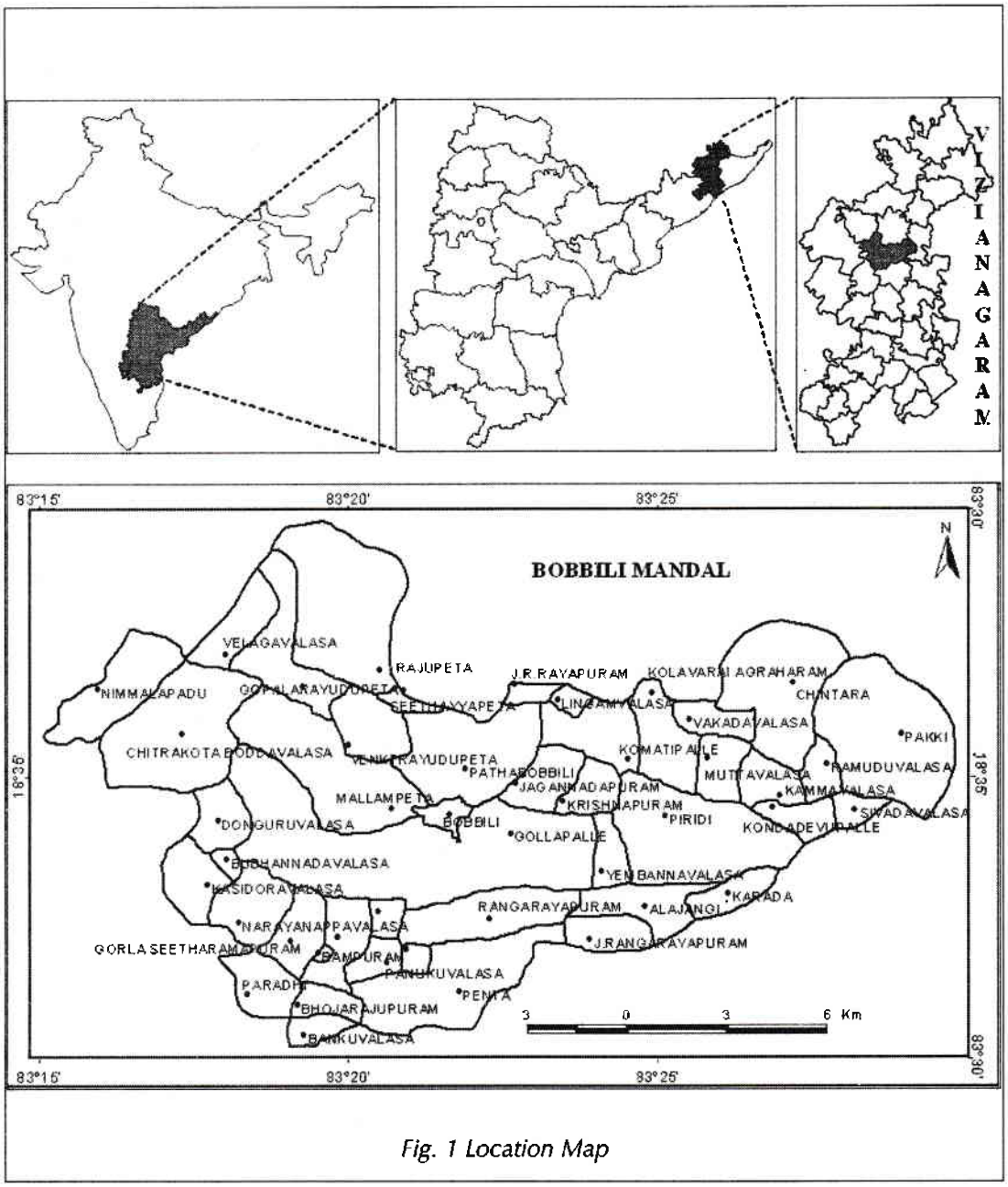

Fig. 1 Location Map

population of the *Mandal* was 1,16,213 with a high population growth during 1991-2001. The economy of Bobbili *Mandal* is predominantly agricultural, and rain-fed farming is the characteristic of agriculture. It is true that irrigated crops too depend on rains.

Data and Methodology

The IRS-P6 LISS III image of November 2004, February 2005 and Survey of India topographic map (No.65N/6 on 1: 50,000 scale) are the primary input for classification and mapping the resources. ERDAS Imagine has been used for image processing operations. Techniques like stratification, directional filtering, layered approach, composition, aggregation and refinements are applied wherever necessary to improve the quality of mapping. Thematic maps of geomorphology, geology, lineaments, soils, land use/land cover, forest/vegetation, drainage and slope on 1:50,000 scale have been extracted from satellite image and topographic map as well. The integration of spatial data, manipulation and analysis are carried out using Arc GIS software. The vectorised thematic maps from the corresponding map files have been integrated to derive the composite map. Based on the analysis of this multilayered information and field observations, the optimal land use model has been generated.

Data Analysis and Discussion

The elements of slope, hydrogeomorphology, soils and land use/land cover are mapped and integrated for generating an optimal land use model for the study area.

Hydrogeomorphology

Location, geology, climate and geomorphic processes generally define the landforms of any region. Since the groundwater prospects of an area depend on its lithology, structure, and geomorphology, mapping the hydrogeomorphic features of an area is essential to appreciate and manage this precious resource. The geological, geomorphological and lineament maps derived form the satellite images have been integrated with drainage layer digitized from the Survey of India topographical maps to delineate potential zones of groundwater,and field verification for these maps was also carried out. Fig.2 shows the hydrogeomorphic features of the study area. About nine hydrogeomorphic units have been derived based on landform, genesis, geology, soils etc. They are flood plain (fp), moderately weathered pediplain (ppm), shallow weathered pediplain (pps), residual hill (rh), denudational hill (dh), structural hill (sh), inselberg (i), pediment (pd) and bajada. In general most of the study area from centre towards east has good ground water potential zones. But the western parts and a small pocket in the north western part are graded as poor from the view point of ground water essentially due to the structure. So they are not prospective zones for ground water exploration.

Slope

For land use planning, slope of the land surface is a major controlling factor and its aspect and altitude are very important from the land utilization point of view. Slope map (Fig.3) has been derived from the topographical map following the guidelines of Soil Survey Manual (3), and the following slope categories have been demarcated.

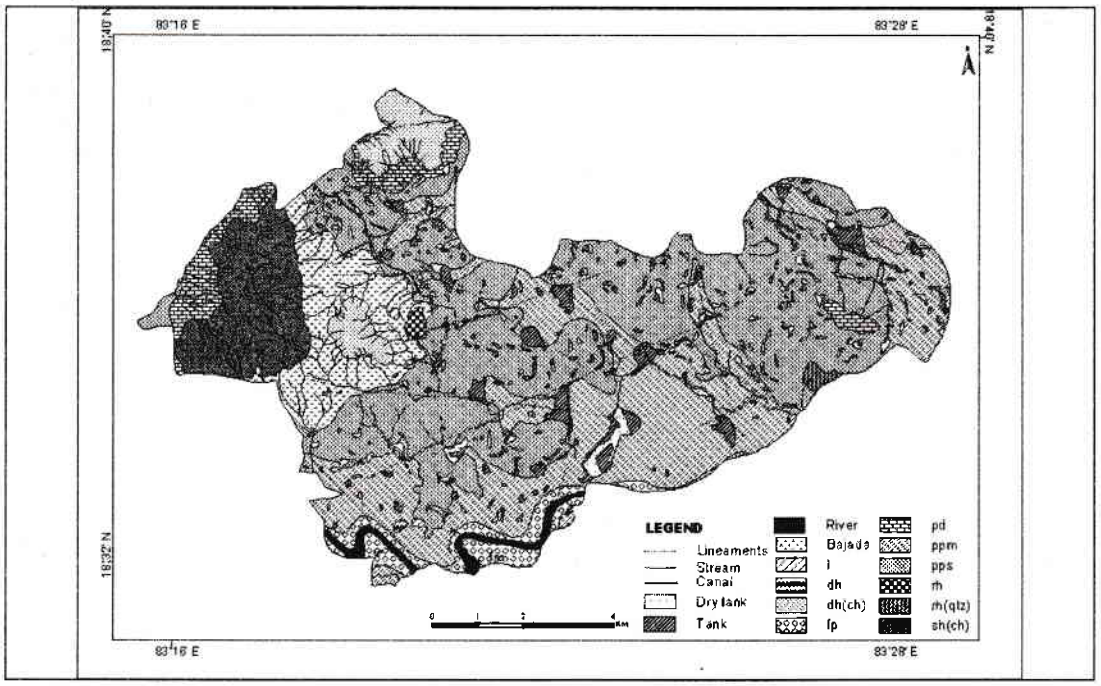

Fig.2 Hydrogeomorphology

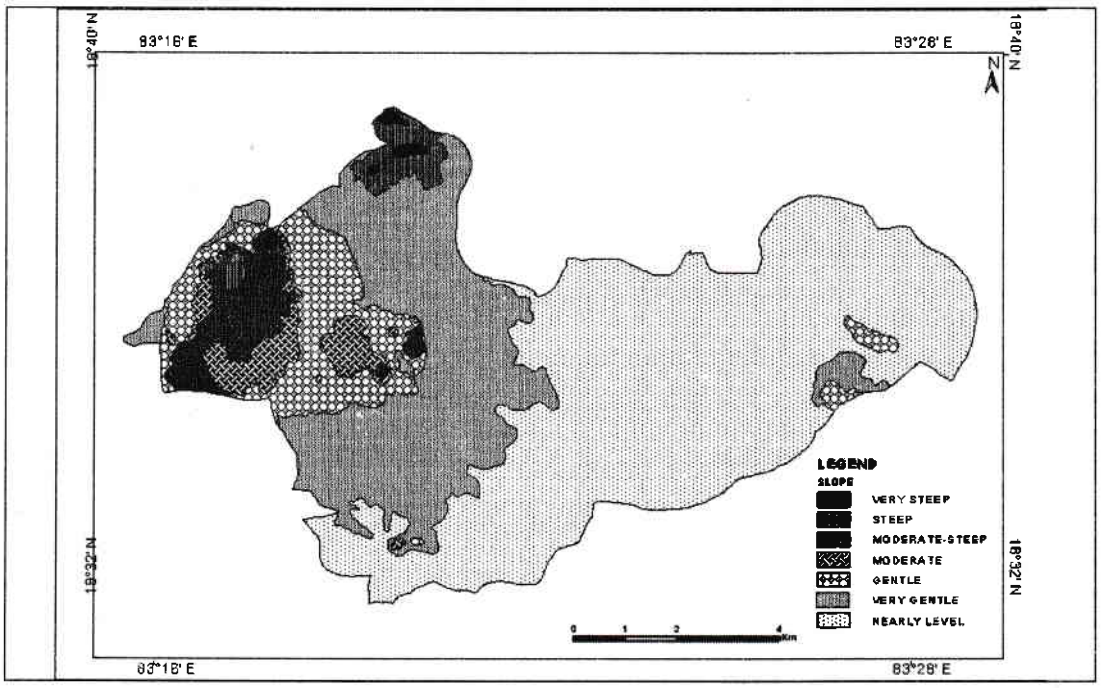

Fig.3 Slope Map

Slope Category	slope (°)
Nearly level	0 - 1
Very gentle slope	1 - 3
Gentle slope	3 - 5
Moderate slope	5 - 10
Moderately steep slope	10 - 15
Steep slope	15 - 35
Very steep slope	> 35

Most of the study area has nearly level and very gentle slope categories. The east, northeast and southeastern parts are dominantly covered by nearly level slopes. Steeper slopes are observed in the west and northwestern parts which are covered by Donguruvalasa and Narasimhunipeta villages of the study area. The slope in northwestern part of Narasimhunipeta village falls under the very steep slope category. General aspect is dominantly inclined to south.

Soils

Soils differ greatly in their morphological, physico-chemical and mineralogical properties. These differences affect the response of the soils to inputs. For appraising the productivity of the soils, for the preparation of perspective plan for land use and soil conservation, and for sustainable development, a thorough knowledge of the

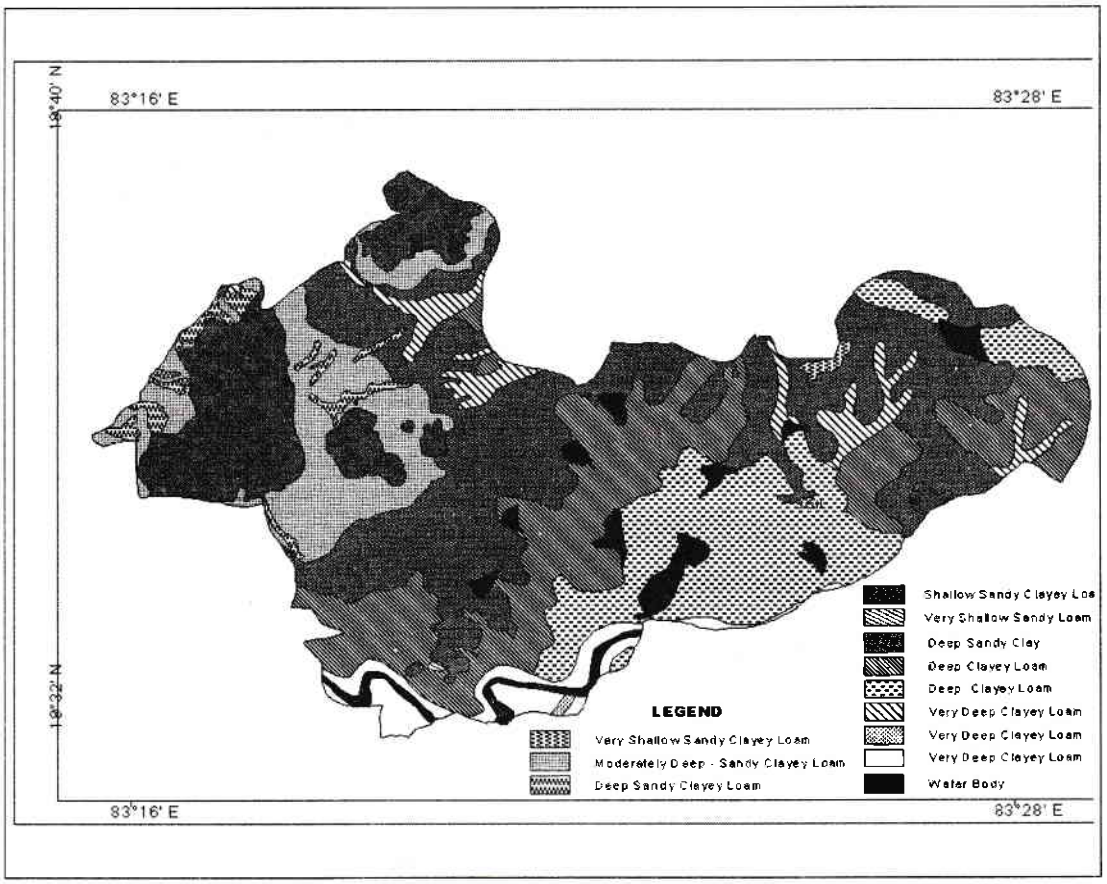

Fig.4 Soil Map

Table 1
Legend of the Soil Map

Mapping Unit	*Phsiography*	*Association of soil series*	*Description*	Soil taxonomy	
	Hill	Rocky		Fine loamy, Mixed, Iso-Hyperth ermic, Typic Ustorthents	
		Dongaravalasa	Brown, Shallow, Sandy clayey loams, Severe erosion, over 20°slopes		
	Inselberg	Rocky		Loamy Skeletal, Mixed Iso-Hyper thermic, Lithic Ustorthents	
		Mettavalasa	Brown, Very shallow, Sandy loam to Sandy clayey loam, Severe erosion, over 10° slopes		
	Pediment Inselberg Complex	Rocky		Loamy Skeletal, Mixed Iso-Hyper thermic, Lithic Ustorthent	
		Mettavalasa	Brown, Very shallow, Sandy loam to Sandy clayey loam, Severe erosion, over 10° slopes.		
	Undulating Pediplain	Velagavalasa	Yellowish brown, Moderately deep, Sandy clayey loam, Moderate erosion, 1-3° slopes.	Fine loamy, Mixed, Iso-Hyperth ermic, Typic Ustropepts	
		Dongaravalasa	Dark brown, Moderately deep, Sandy clayey loam, Moderate erosion, 3-5° slopes.	Fine loamy, Mixed, Iso-Hyperth ermic, Typic Ustorthents	
	Gullied land	Venkatarajupea	Brown, Shallow, Sandy clayey loams, Severe erosion, over 5-10° slopes.	Fine loamy, Mixed, Iso-Hyperth ermic, Typic Ustropept	
	Upper Pediplain	Bobbili	Yellowish brown, Moderately deep, Sandy clayey loam, Moderate erosion, 1-3° slopes.	Fine loamy, Mixed, Iso-Hyperth ermic, Typic Ustochrepts	
		Narasimhuni-pea	Light brown, moderately deep, Sandy clayey loam, very severe erosion, 5-8° slopes.	Fine, Mixed, Iso-Hyperth ermic, Typic Ustochrepts	
	Middle Pediplain	Gollapalli	Yellowish brown, Moderately deep, Sandy clayey loam, Moderate erosion, 1-3° slopes	Fine, Mixed, Iso-Hyperth ermic, Typic Haplustalfs	
		Narasimhuni-peta	Dark Yellowish Brown, Deep, Sandy clay, Moderate erosion, 1-3° slopes.	Fine, Mixed, Iso-Hyperth ermic, Typic Ustropepts	

distribution of different types of soils is essential. False Colour Composite has been visually interpreted with the help of topographical map to extract the soil map (Fig.4). Soil series information and field information were also incorporated to establish the soil taxonomy. Totally 11 map units have been identified in the study area. Table 1 Shows the legend of soil map where soil taxonomy and characteristics are mentioned. Soil series viz. Velagavalasa, Bobbili, Gollapalli and Pakki comprise more than 60 per cent of the study area. These are red soils and yellowish brown to dark brown in colour with sandy loamy clay composition. Depth of the soils is moderately deep to very deep, falls in 0-5° slope category, and are subjected to moderate erosion. Red soils are found in pediplains, valleys, paleo channels and flood plain which are good for cultivation of crops.

Land Use and Land Cover

Multi dated IRS P6 LISS III imagery of Nov. 2004 & Feb. 2005 representing *kharif* and *rabi* seasons respectively were used to analyse the spatial and temporal variability in land cover classes. Change detection and overlay

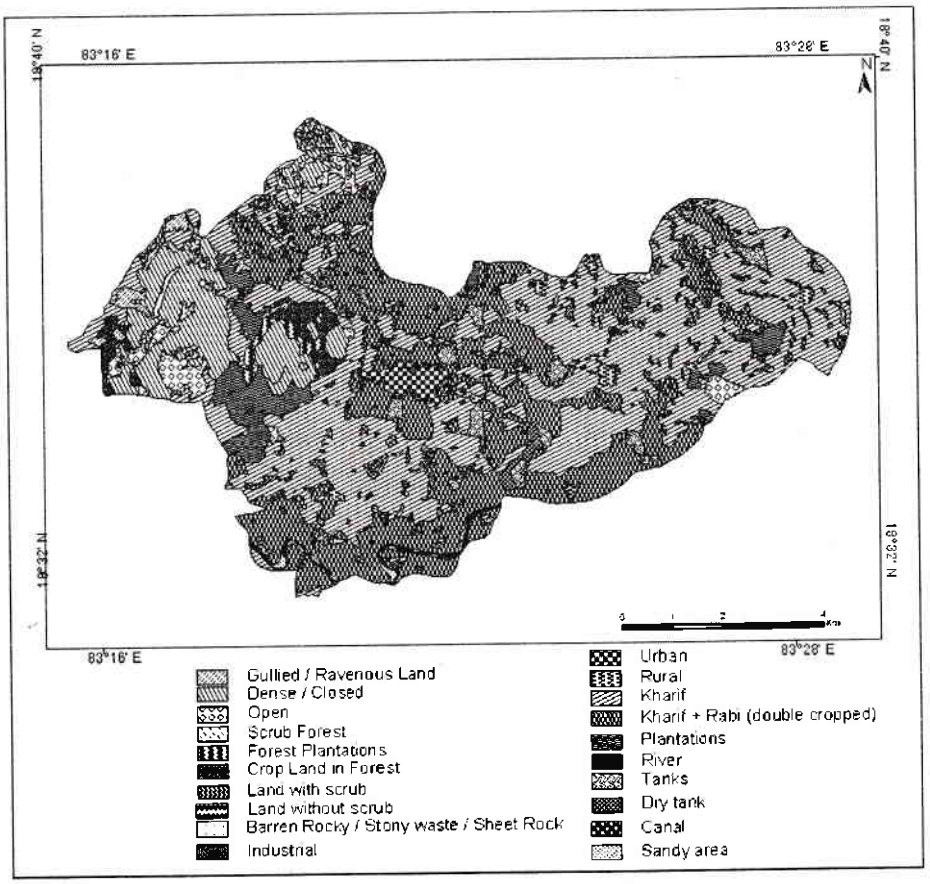

Fig.5 Land Use / Land Cover Map

techniques were applied to derive the details. Standard classification system and the interpretation key developed by the National Remote Sensing Agency (6) were used for interpretation. The interpretation was made in conjunction with the topographic map and adequately supported with field information. Land use/ land cover polygons have been delineated and presented in Fig. 5. Settlements, major roads, railway, built up land, agricultural land, forest, wasteland, water bodies etc., comprise the land use/land cover categories. Table 2 explains the land use/ land cover classes and subclasses also. It is evident that most of the geographic area is covered by agricultural land use (15,852 ha) followed by forest cover (3,093 ha) and water bodies (1,577 ha). 9,088 ha of land is cultivated during *kharif* season which is synonymous with the summer monsoon. This season is associated with rainfed crops with limited or no irrigation facilities, and areas of paddy and other crops with irrigation as well. The estimated area under double crop is 5,857 ha. These are the areas where crops are grown during both *kharif* and *rabi* seasons. Most of this area is located in command areas of tanks and canals. Though there are many small and a few large tanks spread throughout the plains, only a very few of them hold sufficient amount of water for a full crop season.

Land Use Modelling

The integrated approach developed by Andhra Pradesh State Remote Sensing Application Centre (1) has been adopted to suggest an optimal land use model for the study area. The vectorised thematic maps of hydrogeomorphology, slope, soil and land use/land cover from the corresponding map files have been integrated using overlay technique to derive the composite map which comprises 68 unique composite map units (CMUs). A CMU is a three dimensional landscape unit homogeneous in respect of characteristics and qualities of land, water and vegetation and separated from other dissimilar units by distinct boundaries. Table 3 shows the broad scheme of CMU manipulation/ analysis for developing alternative land utilization types and practices. An optimal land use model (Fig.6) has been generated based on the analysis of multilayered information which reveals the potential or limitations of the study area with respect to the present day land use/land cover utilization status of the natural resources. It suggests nine alternative land use practices (query) such as intensive agriculture, irrigated dry crops, dry crops, horticulture, silvipasture, social forestry, afforestation, conservation measures of existing forests and quarrying. Table 4 depicts the characteristics of each optimal land use. The conservation measures for each query in the study area are listed in Table 5. The following heads briefly explain the nine optimal land uses suggested for the study area.

Query - 1: Intensive agriculture has been suggested for an area of 700.47 hectares. These are the areas with excellent ground water availability, gently sloping terrain, and soils with good land capability. Presently these areas are under double crops. Crops during kharif are cultivated with irrigation facilities. A linear stretch along the river Vegavathi through Bhojapuram, Bankuruvalasa, Paridhi, and Penta villages, Bobbili in the central part and Chintada in the east fall under this category. Strategically-placed check dams, and de-silting of the tanks would sustain the ground water levels in these areas.

Table 2
Land Use / Land Cover Classes

Land Use Class	*Land Use Sub-class*	*Area in Hectares*
Agriculture	*Kharif* (KI, KU)	9088
Agriculture	*Kharif* + *Rabi* (double cropped) (DC)	5857
Agriculture	Plantations	906
Built up land	Towns/cities (Urban)	233
Built up land	Villages (Rural)	340
Forest	Crop Land in Forest	356
Forest	Dense / Closed	1878
Forest	Open	716
Forest	Forest Plantations	136
Forest	Scrub Forest	7
Wastelands	Barren Rocky / Stony waste / Sheet Rock (BSA)	69
Wastelands	Gullied / Ravenous Land	187
Wastelands	Land with scrub (LS)	34
Wastelands	Land without scrub (LWS)	15
Wastelands	Canal	15
Wastelands	Dry tank	678
Wastelands	Water channel area in river	89
Wastelands	Sandy area	76
Wastelands	Tanks	720
Total		21400

Table 3

Characteristics of Composite Map Unit (CMU)

I	II	III	IV	V	VI
1.	fp	11	1	*Kharif*	1
2.	fp	11	1	*Kharif + Rabi* (double cropped)	1
3.	ppm	8	1	*Kharif*	2
4.	ppm	8	1	*Kharif + Rabi* (double cropped)	2
5.	pps	6	1	*Kharif*	3
6.	pps	6	1	*Kharif + Rabi* (double cropped)	3
7.	pps	6	2	*Kharif*	3
8.	pps	6	2	*Kharif + Rabi* (double cropped)	3
9.	pps	6	1	*Kharif*	3
10.	bajada	4	1	Plantations	4
11.	pps	8	1	Land with scrub	4
12.	pps	8	1	Land without scrub	4
13.	pps	6	1	Plantations	4
14.	pps	6	2	Plantations	4
15.	pd	4	2	Plantations	4
16.	bajada	5	2	Plantations	4
17.	dh(ch)	1	3	Plantations	4
18.	sh(ch)	1	3	Plantations	4
19.	bajada	6	3	Plantations	4
20.	bajada	5	1	Gullied / Ravenous Land	5
21.	pd	5	1	Gullied / Ravenous Land	5
22.	bajada	6	1	*Kharif*	5
23.	pd	4	1	*Kharif*	5
24.	pps	5	1	Gullied / Ravenous Land	5
25.	pps	6	2	Land without scrub	5
26.	pd	5	2	Gullied / Ravenous Land	5
27.	pd	1	2	*Kharif*	5
28.	bajada	5	2	Gullied / Ravenous Land	5
29.	bajada	6	2	*Kharif*	5
30.	I	2	2	Land with scrub	5
31.	pd	4	1	Land without scrub	5
32.	dh(ch)	1	3	Gullied / Ravenous Land	5
33.	sh(ch)	1	3	Gullied / Ravenous Land	6
34.	dh(ch)	1	3	*Kharif*	6
35.	sh(ch)	1	3	*Kharif*	6
36.	dh	7	3	Land with scrub	6

I – Composite Map Unit II – Hydrogeomorphology III – Soil
IV– Slope V – Land use / land cover VI – Optimal Land Use

Table 3 (Contd.)

Characteristics of Composite Map Unit (CMU)

I	II	III	IV	V	VI
37.	sh(ch)	3	1	*Kharif*	6
38.	Bajada	6	1	Crop Land in Forest	7
39.	pd	4	1	Open	7
40.	pps	4	1	Crop Land in Forest	7
41.	pps	3	1	Open	7
42.	pd	4	2	Crop Land in Forest	7
43.	rh(qtz)	1	2	Open	7
44.	Bajada	5	2	Crop Land in Forest	7
45.	Bajada	4	2	Open	7
46.	dh(ch)	1	3	Open	7
47.	sh(ch)	1	3	Open	7
48.	dh(ch)	1	3	Scrub Forest	7
49.	dh(ch)	1	3	Crop Land in Forest	7
50.	sh(ch)	1	3	Crop Land in Forest	7
51.	pd	1	3	Crop Land in Forest	7
52.	Bajada	4	1	Dense / Closed	8
53	pps	6	1	Dense / Closed	8
54.	pd	4	1	Dense / Closed	8
55.	pd	5	2	Dense / Closed	8
56.	Bajada	5	2	Dense / Closed	8
57.	Bajada	5	2	Forest Plantations	8
58.	Rh	1	3	Dense / Closed	8
59.	sh(dh)	1	3	Dense / Closed	8
60.	dh(ch)	1	3	Forest Plantations	8
61.	Bajada	4	3	Forest Plantations	8
62.	dh(ch)	1	3	Dense / Closed	8
63.	I	1	3	Dense / Closed	8
64.	dh(ch)	1	3	Barren Rocky / Stony waste / Sheet Rock	9
65.	sh(ch)	1	3	Barren Rocky / Stony waste / Sheet Rock	9
66.	River	River	River	River	10
67.	Tank	Tank	Tank	Tank	11
68.	Settlements	Settlements	Settlements	Settlements	12

I – Composite Map Unit II – Hydrogeomorphology III – Soil
IV– Slope V – Land use / land cover VI – Optimal Land Use

Query - 2: An area of 5,405.66 ha has been suggested for irrigated dry crops. Presently these areas are under double crop, with irrigation facilities during *kharif*. Terrain is very gently sloping with good soils and ground water conditions. These areas are widely spread throughout the *mandal* sparing the north western hilly region. The limiting factor for intensive agriculture is availability of water and traditional methods of irrigation. Modernizing irrigation with sprinklers or drip systems would conserve and sustain water utility.

Query - 3: Very large extent of 7,298.51 ha has been suggested for dry crops. Red soils with medium capability on gently sloping terrain are common. Several villages spanning the entire *mandal* fall under this category. Ground water prospects which vary between good to poor is the limiting factor in this area. The existing land use is cultivation of rain fed crops during kharif.

Query - 4: Red soils on gentle to moderately sloping pediplain spread over an area of 908.05 ha. Pediplains in Donguruvalasa, Bhubabadavalasa and Kasidoravalasa villages and small patches in the east are covered by this category. Ground water prospects vary from good to poor. The existing land use is plantation. Water and lack of soil management are the limiting factors in these areas, and hence horticultural use may be suggested here.

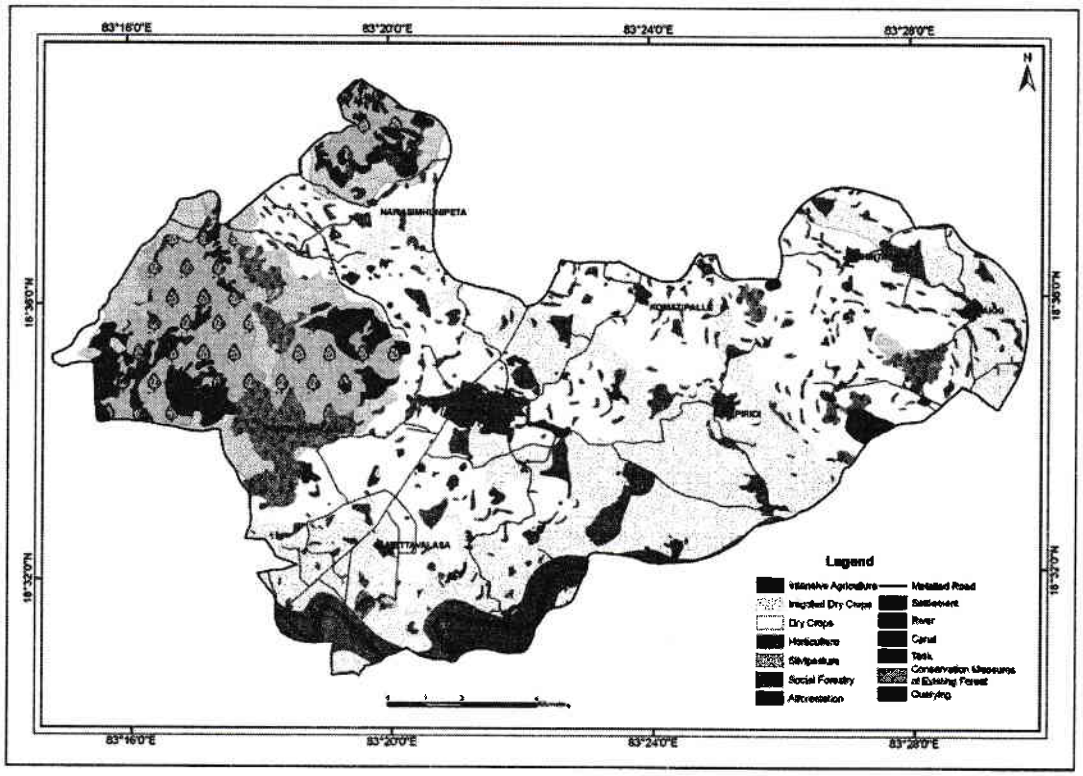

Fig.6 Optimal Land Use Map

Table 4

Characteristics of Composite Map Unit (CMU)

QUERY – 1: INTENSIVE AGRICULTURE: (([geoname] = "FP") and ([soil_id] ="11") and ([slope_id] = 1) and ([landuse] = "KI", "DC"))

QUERY – 2: IRRIGATED DRY CROPS: (([geoname] = "PPM") and ([soil_id] ="8") and ([slope_id] = 1) and ([landuse] = "KI", "DC"))

QUERY – 3: DRY CROPS: (([geoname] = "PPS") and ([soil_id] ="6") and ([slope_id] <=2) and ([landuse] = "KU"))

QUERY – 4: HORTICULTURE: ((([geoname] = "PPS") and ([soil_id] ="8"))) and ([slope_id] <=2) and ([landuse] = "LS", "LWS"))) or ((([geoname] ="PPS") and ([soil_id] ="6"))) and ([slope_id] <=2) and ([landuse] = "PLANTATION"))) or ((([geoname] ="BAJ") or ([geoname] = "PD") or ([geoname] = "SH") or ([geoname] = "DH") and ([soil_id] ="4") or ([soil_id] ="5") or ([soil_id] ="1") and ([slope_id] <=3) and
([landuse] = "PLANTATION")))

QUERY – 5: SILVIPASTURE: ((([geoname] = "PPS") and ([soil_id] ="6") or ([soil_id] ="5"))) and ([slope_id] <=2) and ([landuse] = "GULLIES", "LWS"))) or ((([geoname] ="BAJ") or ([geoname] = "PD") or ([geoname] = "I") and ([soil_id] ="6") or ([soil_id] ="4") or ([soil_id] ="2") and ([slope_id] <=2) or ([slope_id] =3) and ([landuse] ="LS","LWS") or ([landuse] ="GULLIES")))

QUERY – 6: SOCIAL FORESTRY: (([geoname] = "DH") or ([geoname] = "SH") and ([soil_id] ="1") and ([slope_id] > 2) and ([landuse] = "KU", "GULLIES"))

QUERRY – 7: AFFORESTATION: ((([geoname] = "PPS") and ([soil_id] ="4") or ([soil_id] ="3"))) and ([slope_id] <=2) and ([landuse] = "Crop Land in Forest" or ([landuse] = "Open Forest")) or ((([geoname] ="BAJ") or ([geoname] = "PD") or ([geoname] = "SH") or ([geoname] = "DH") or ([geoname] = "RH") and ([soil_id] ="5") or ([soil_id] ="4") or ([soil_id] ="1") and ([slope_id] <=2) or ([slope_id] =3) and ([landuse] ="Open Forest") or ([landuse] ="Crop Land in Forest")))

QUERY – 8: CONSERVATION MEASURES OF EXISTING FOREST: ((([geoname] = "PPS") and ([soil_id] = "6"))) and ([slope_id] <=2) ([landuse] = "Dense/Closed Forest")) or ((([geoname] = "BAJ") or ([geoname] = "PD") or ([geoname] = "SH") or ([geoname] = "DH") or ([geoname] = "RH") or ([geoname] = "I") and ([soil_id] ="5") or ([soil_id] ="4") or ([soil_id] = "1") and ([slope_id] <=2) or ([slope_id] =3) and ([landuse] =" Forest Plantation") or ([landuse] ="Dense/Closed Forest")))

QUERY – 9; QUARRYING: (([geoname] ="DH" "SH") and ([soil_id] ="1") and ([slope_id] >=3) and ([landuse] = "BSA"))

Table 5
Soil and Water Conservation Measures

Query	Optimal Land Use	Soil and Water Conservation Measures	Area (Hectares)	Villages	
1.	Intensive agriculture	Irrigation and water management-check dams, rock fill dams, de-siltation of tanks	700.47	Bobbili, Bhojapuram, Bankuruvalasa, Penta, Paradhi, Alajangi, Chintada	
2.	Irrigated dry crops	Irrigation and water management- check dams, rock fill dams, sprinklers, drip irrigation.	5405.66	Rajupeta, Paradhi, Penta, Bhojapuram, Pata Bibbili Rangarayapuram, Pakki J.Rangarayapuram, Alajangi, Yembanavalasa, Karada, Piridi, Krishnapuram, , Chintada	
3.	Dry crops in red soils	Soil erosion control measures- contour trenching, bunding and gully plugging etc.	7298.51	Gollapalle, Mettavalasa, Mallampeta, Velagavalasa Venkatarayudupeta, Gopalarayudupeta, Komatipalle,Vakadavalasa, Lingamvalasa, Pakki, J.R.Rayapuram, Chintada, Kammavalasa, Piridi, Ramuduvalasa, Kondadevupalle, Sivadavalasa, Nimmalapadu	
4.	Horticulture	Irrigation water management-sprinklers, drip irrigation	908.05	Donguruvalasa, Pakki, Bhubanadavalasa, Kasidoravalasa, Velagavalasa, Ramuduvalasa, vakadavalasa, Gopalarayudupeta	

Query - 5: Red soils with low capability prevail on gentle to moderately steep slopes in an area of 1,196 ha. A few villages like Nimmalapadu, Velagavalasa, Rajupeta, Gopalarayudupeta etc. fall under this type. Water and soil erosion due to steep slope are the limiting factors. The existing land cover is gullies and this area is suggested for silvipasture to control erosion.

Query - 6: The soils are coarse with poor water potential in an area of 77.73 ha. Small areas in Rajupeta, Bhojarajupalem and Nimmalapadu are suggested for this use. The present land use is under dry *kharif* crops with out irrigation. Slope of the terrain and erosion are the limiting

factors and this land is suitable for social forestry.

Query - 7: Soils are unproductive with gentle to moderate slopes with poor ground water potential. The existing land use is of forest or open forest. An extent of 1,066.40 ha is suggested for afforestration. Small extent in Kondadevupalle, Rajupeta, Chitrakota and Mallampeta villages in the northwestern region and a small stretch in Kondadevupalle in the east are suitable for this use.

Query - 8: The soils are low productive on gentle to moderate slopes in 2,026.45 ha of area. Forest cover (dense/closed forest and forest plantation) spread in Rajupeta, Nimmalapadu, Chitrakota and Mallampeta villages in north western hilly region are covered under this category. Conservation measures are suggested to sustain and conserve the existing forest cover.

Query – 9: This is a very small area of 9.84 ha located in Penta village in the southern region of the study area. The existing use is barren rocky area and the suggested use is quarrying essentially with conservational measures.

Conclusion

The analysis of composite map derived by integrating various basic and derived thematic layers shows 68 composite map units. The optimal land use model generated from the manipulation/analysis of this multilayered information suggests nine alternative land use practices (query) such as intensive agriculture, irrigated dry crops, dry crops unirrigated, horticulture, silvipasture, social forestry, afforestation, conservation measures of existing forests and quarrying along with conservation measures for each use. Adoption of appropriate conservation measures like modern water management techniques (sprinklers, drip irrigation, construction of check dams, desiltation of tanks, clearing of weeds etc.) and soil erosion control measures (contour trenches, bunding, gully plugging etc.,) would reasonably enhance the potential of water and land resources. Overlaying administrative layer on the optimal land use model will further help farmers in identifying problems, limitations and potential of their fields, and thus formulating an appropriate site specific action plan.

References

1. Andhra Pradesh State Remote Sensing Application Centre (1997). 'Integrated Study to combat Drought , Ananthapur District, *Project Report'*. Hyderabad: Govt. of Andhra Pradesh.
2. Bhagavan S.V.B.K, G.Mehar Baba and G.V.K.Ramakrishna (2001). 'Remote Sensing and GIS Study for Land Use Planning in Mahabubnagar District, Andhra Pradesh', *GIS India*, 10(1), pp.6-17.
3. Indian Agricultural Research Institute (1971). *Soil Survey Manual*. New Delhi: Govt. of India.
4. Kachhwaha T.S(1985). 'Temporal Monitoring of Forest Land For Change Detection and Forest Cover Mapping through Satellite Remote Sensing', *Proceedings of Sixth Asian Congress on Remote Sensing*. Hyderabad, pp 77-83.
5. Khorram S and A.B.John (1991). 'A Regional Assessement of Land Use/Land Cover Types in Sicily with Landsat TM data', *International Journal of Remote Sensing*,12 (1), pp.69-78.
6. Krishna Murthy Y.V.N, A.K.Sinha, A.Jayaram, K.M.Jagadesh, S.S.Rao, D.S.Srinivasan and K.Radha Krishnan(1994). 'Integrated Resources Developmental Planning using Remote Sensing and GIS', *Proceedings of the 15th Asian*

Conference on Remote Sensing, 2, pp. k.31-k.36.

7. National Remote Sensing Agency (2006). *'Manual of National Land Use/Land Cover Mapping using Multi Temporal Satellite Data'.* Hyderabad: Govt of India.

8. Sando R & M. Leimbach(2003). 'Modelling Agriculture and Land Use in an Integrated Assessment Framework', *Climatic Change,* 56(1-2), pp.185-210.

9. Sharma K.D and D.N.Bohra (1989). 'Satellite Remote Sensing for detecting Temporal Changes in the Grazing Lands', *Journal of Indian Society of Remote Sensing,* 17(4), pp.55-59.

10. Singh S.R. & K.S. Gajbhiye (2004). 'Strategy for the Land Resource Management for the Sub-catchment in Ramtek and Bhandara Tahsils, Maharashtra State', *The Deccan Geographer,* 42(2), pp.85-94.

Domestic Unsealed Water Sources and Malaria Incidence

A Case Study from Chennai, South India

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Malaria is a great public health challenge not only for rural but also for urban areas in India. Based on a case-control study in the megacity of Chennai, Tamil Nadu, the paper focuses on domestic unsealed water sources as a risk factor for malaria infection. The paper comes to the conclusion that the risk of getting malaria is 13 times higher for people living in a building with an unsealed sump than for people living in a building with a sealed sump or no sump at all. Furthermore the paper highlights the potentials of using Geographic Information Systems (GIS) to understand and control malaria.

(Received: November 2007; Accepted: March 2008)

Malaria is a parasitic disease transmitted by the bite of an infected female Anopheles mosquito. Infection with malaria parasites may result in a wide variety of symptoms, ranging from absent or very mild symptoms to severe disease and even death. In general, malaria is a curable disease if diagnosed and treated promptly and correctly. Four species of malaria parasites can infect humans under natural conditions: *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale* and *Plasmodium malariae. The first two species cause the most infections worldwide. Plasmodium falciparum* is the agent of severe, potentially fatal malaria, causing an estimated 700,000 - 2.7 million deaths annually, most of them in young children in Africa (1).

In India, at the time of Independence, there was an estimated 75 million malaria cases causing 0.8 million deaths per year (2). In 1953, the Indian government launched the National Malaria Control Programme in order to contain the spread of malaria. DDT spraying campaigns proved to be successful in reducing the incidence of the disease. By the mid-60s, the national figures were down to 100,000 with no deaths reported. However,

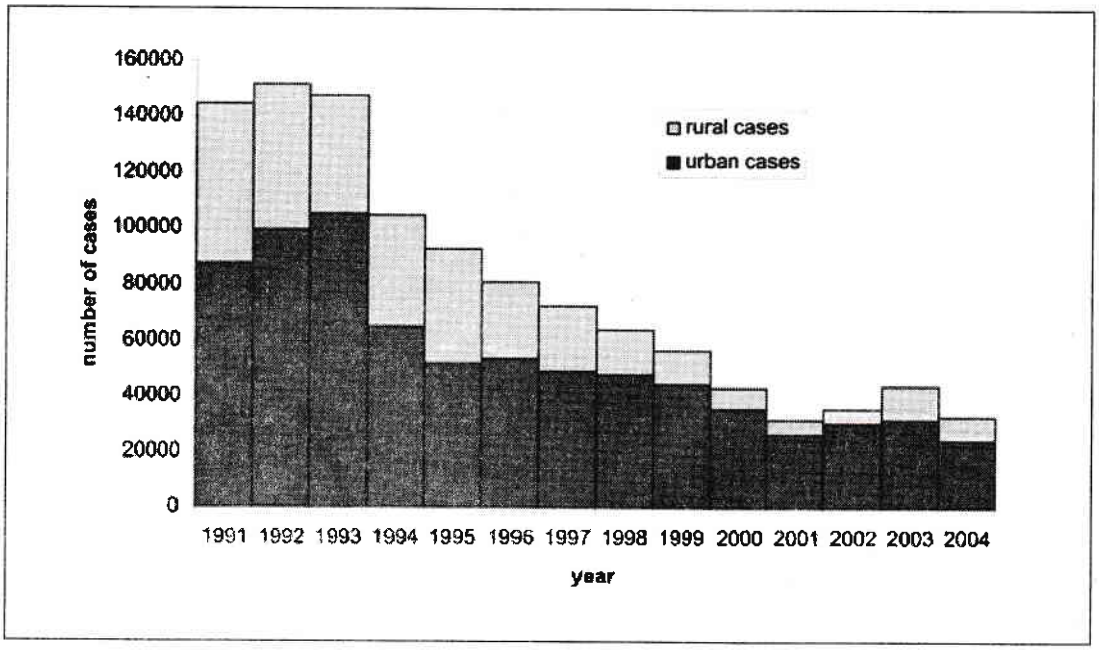


Fig. 1

Annual Urban and Rural Malaria Cases in Tamil Nadu, 1991-2004

Source: Department of Public Health and Preventive Medicine, Tamil Nadu (2005)

elimination was not achieved and malaria re-emerged as a major public health issue in the 70s (6.5 million cases reported in 1976). In 2002, the National Vector-borne Disease Control Programme reported more than 1.7 million cases nationwide, leading to an estimated 1,000 deaths (3). For the same year, the World Health Organization (WHO) estimated that the burden of malaria in India was 844,000 Disability Adjusted Life Years (DALYs)[1] (4). This was less than HIV and tuberculosis but more than any other vector-borne diseases like dengue, Japanese encephalitis or filariasis. Malaria affects most of India except the areas 1800 metres above sea level. However, intensity of transmission varies according to the local environment. Factors such as vector density (itself correlated to rainfall, temperature and water management practices), human density, mobility and immunity are all important determinants of transmission. In North-Eastern States, malaria transmission is maintained during most months of the year (endemic). In the desert ecosystem of Rajasthan, malaria transmission is epidemic (5). Intermediate level of stability of malaria transmission is maintained in the plains of India, in the forests and forest fringes (Andhra Pradesh, Jharkhand, Gujarat, Madhya Pradesh, Chhattisgarh, Maharashtra, Orissa and Rajasthan) (2).

In India Malaria is not a phenomenon that is limited to rural areas. It is a great public health concern for cities as well. Data from the department of Public Health and Preventive Medicine of Tamil Nadu (Fig. 1) indicates that in 2004, out of the 32,459 malaria cases reported in the state, 24,096 (74%) were

[1]Disability Adjusted Life Years measure the loss due to a disease and allow public health planners to compare the burden of different diseases. It takes into account morbidity, mortality, duration, age of the patients and a discount rate

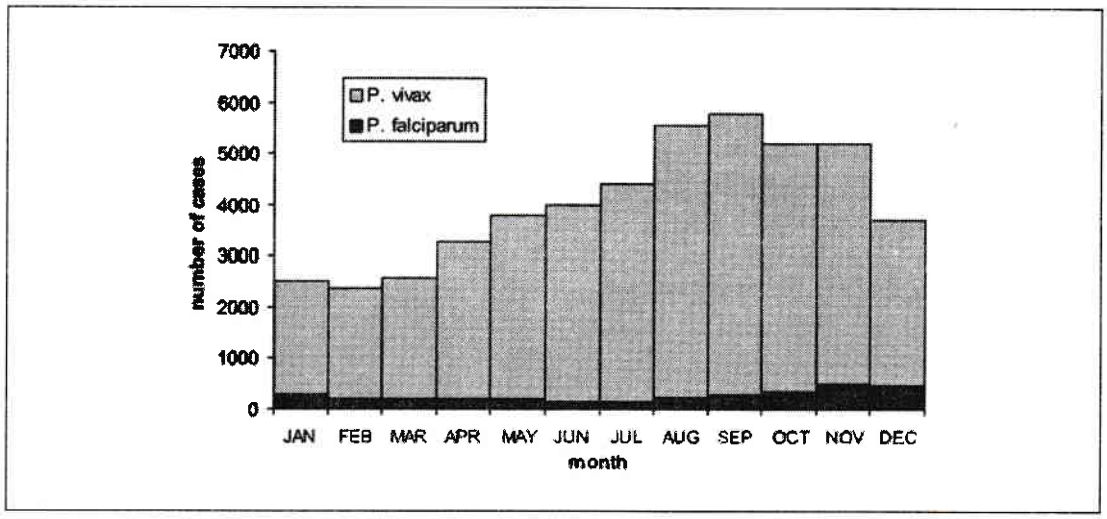


Fig. 2
Number of Malaria Cases in Chennai, 1983-98

Source: Corporation of Chennai (2005)

reported in urban areas as defined by the Census of India. Moreover, more than 70% of cases were diagnosed in patients living in the city of Chennai, the capital city of the state. The vector has successfully adapted to changing environmental conditions and large cities have become sustainable ecosystems for Anopheles populations. Anopheles stephensi was first incriminated as a malaria vector in Mumbai, in the Indian state of Maharashtra in 1911 (6). Less than 30 years later, it was also incriminated in the city of Chennai. As far as its host preferences are concerned, there is evidence of an increased tendency to feed on humans (6).

Chennai is located on the southeast coast of India (Bay of Bengal), in the state of Tamil Nadu. Its 4,260,000 inhabitants are distributed within an area of 216 sq.km. Although the literacy rate is high (80%), more than 25% of Chennai population lives below the poverty line (defined as 1$ per day). The Monsoon season lasts from June to November, with most of the heavy rainfalls being brought by the northeast monsoon (average rainfall of 925mm from September to November). Mean maximum and mean minimum temperatures range between 20-27°C and 29-39°C respectively. May is the hottest month with mean maximum temperature around 39°C. The malaria parasites present in Chennai are P. vivax and P. falciparum, with the latter accounting for less than eight per cent of annual burden of cases reported by the dispensaries of Chennai municipal corporation. In 2001, the corporation dispensaries detected a total of 16,623 cases, corresponding to an annual incidence of 378 per 100,000. No resistance to Chloroquine has been reported so far. The monthly average malaria incidence over 16 years is shown in Fig. 2. The disease is endemic with higher incidence observed during the rainy months, from August to December. However, transmission is perennial suggesting that breeding sites are active throughout the year. As far as the geographical distribution of cases is concerned, the northeastern part of the city including the commercial area of Georges

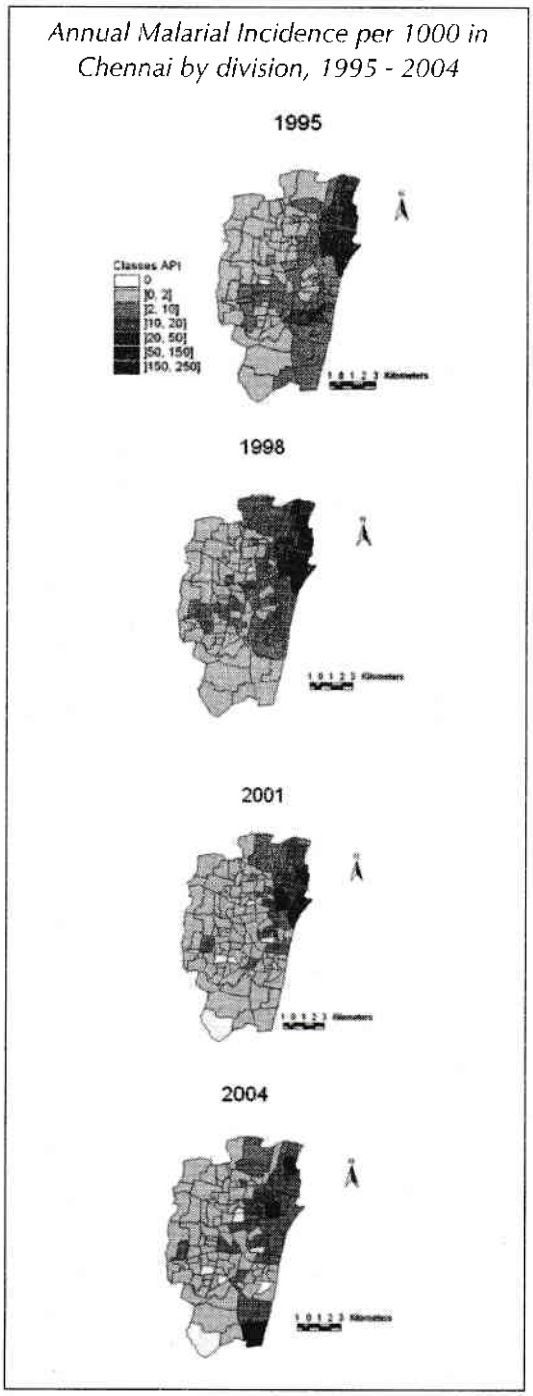


Fig. 3
Annual Malaria Incidence per 1000 (API) in the Corporation of Chennai, by Division
Source: Corporation of Chennai (2005)

Town near the harbour is reporting the highest incidence (Fig. 3.). Larvae of *An. stephensi* have been found in wells, over-head or ground-level water tanks, cisterns, sumps, tanks.

Recognising the burden of urban malaria, the Urban Malaria Scheme was implemented in 1971. It has been modified and adapted since then but the overall aim and strategies remain unchanged: reducing incidence through 1) reducing the vector population in urban areas and 2) early detection of cases and prompt treatment (EDPT). Reducing vector population in urban areas includes measures that aim at reducing the number of potential breeding sites of the mosquito. Besides the use of larvicide, covering water sources and containers (over-head tanks, sumps and wells) with a mosquito-proof structure is an effective preventive measure. In our study, we describe malaria cases in time and space in a densely-populated area of Chennai, Tamil Nadu, in 2005, and measure the risk associated with the proximity to unsealed over-head tanks, sumps and wells.

Material and Methods

Study Area

Chennai is administratively divided into 10 zones, each zone being subdivided into 15-18 divisions, comprising altogether 155 divisions. Our study focuses on Division No.48, located in the northeast of the city. It has a population of 22,615 (7). Population density is 2253 per hectare. The female to male sex ratio is 1.07, while 11% of inhabitants are below the age of 6. Literacy rate in Ward No.48 was 71% in 2001. It is a commercial area, with narrow streets, highly congested during the day. We selected this area to conduct our study as it is one of the divisions that has been reporting the highest malaria incidence in the last 10 years.

Malaria Cases

A malaria case was defined as a patient living in Division No.48 who sought treatment for fever in 2005 at one of the municipal dispensaries and who was diagnosed with malaria after blood smear examination. Diagnosis and treatment of malaria at Corporation dispensaries is free of cost. Medical officers routinely collect information on the date and the result of the diagnosis (whether positive or negative for malaria, and in the case of a positive test, whether the parasite is *P. vivax* or *P. falciparum*). They also collect information on age, gender and the address of the patient.

Survey on Potential Breeding Sites

Open over-head tanks, wells and sumps are potential breeding sites for *An. Stephensi*, the vector of malaria in Chennai. In 2004, the Corporation of Chennai organised a door-to-door survey to count the number of open wells, over-head tanks and sumps in Division No.48. For each door number, the team of surveyors collected the number of unsealed over-head tanks, wells and sumps.

Case-control Study

A case-control study is an epidemiological study that helps identifying risk factors that are associated with an event (e.g. malaria infection). It is based on a comparison of the prevalence of an exposure (e.g. presence of open well in the house) between two groups of people: those who experienced the event (cases) and those who did not (controls). Controls should be selected from the study population, i.e. they would have been selected as cases if they had suffered from the disease. In our study, cases were all malaria patients living in Division No.48 diagnosed at the Corporation dispensaries in 2005, as explained above. We randomly selected controls among the list of patients who lived in the Division and came to the dispensaries with fever and tested negative for malaria in 2005. The exposures of interest were the presence in the house - or proximity (up to 50 m) - of an unsealed overhead-tank, well or sump.

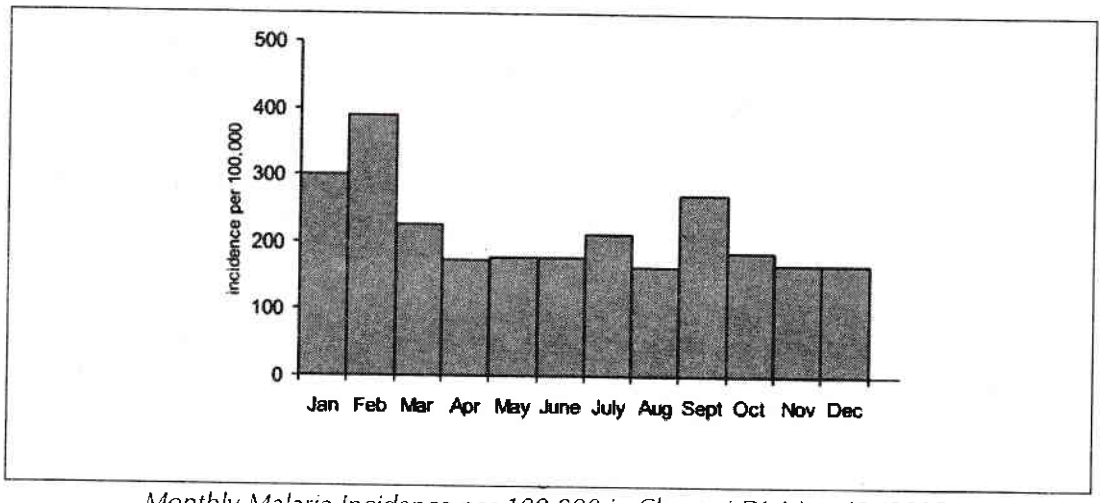
Geo-reference Database

We constructed a geo-referenced map of Division 48. We covered 36 streets with a global positioning system and located 1207 buildings. We integrated the database into a Geographical Information Systems (Arcview 3.2a). We assigned attributes to each building (represented by a polygon): presence/absence of a case, presence/absence of a control, presence/absence of an unsealed over-head tanks, presence/absence of an unsealed well, presence/absence of an unsealed sump. For each building with an unsealed potential breeding site, we applied a buffer of 10 and 50 metres and located buildings that fell into that buffer. Thus, three levels of exposure were defined: presence of unsealed potential breeding site in the house, within a radius of 10m and within a radius of 50m.

Results

Malaria Incidence

We identified a total of 590 malaria cases in Division 48 from 3 January 2005 to 31 December 2005. As shown in Fig. 4, incidence was highest in February with 389 cases per 100,000. The lowest incidence was reported in August with 163 cases per 100,000. The female to male ratio was 0.53 while the median age was 20 (22 for males, 14 for females). All parasites identified in the blood of patients were *P. vivax*, except for one *P. falciparum*. We were able to locate the door number of 216 patients (36% of all cases).



Monthly Malaria Incidence per 100,000 in Chennai Division 48 (2005)

Source: Corporation of Chennai (2005)

Fig. 5 shows the location of the houses where at least one malaria case occurred over the period. The spatial distribution of controls (273) is shown in Fig. 6. The female to male sex ratio for controls was 0.27 while median age was 23.

Potential Breeding Sites

Out of 992 over-head tanks identified in Division 48 during the 2004 survey, 344 (34%) were unsealed. Six hundred and one sumps were identified, 34 (5%) were unsealed. Out of the 346 wells identified, 194 (56%) were unsealed. The survey therefore identified a total of 572 potential breeding sites in Division 48. Figs. 7, 8 and 9 show the spatial distribution of houses where at least one over-head tank, sump and well respectively were found.

Analysis

Table 1 summarises the results of the analytical study. Out of the 216 malaria cases for which we could locate the house, 54 (25%) lived in building with at least one unsealed over-head tank, 35 (16%) lived in a building with atleast one unsealed sump, and 36 (16%) lived in building with at least one unsealed well. The proportions of exposed controls were 26% (72), 1.4% (4) and 18% (51) respectively. When we drew a radius of 10 m around each potential breeding site, the number of exposed in both groups (cases and controls) increased. One hundred and ninety four cases (89%) and 252 (91%) controls lived within 10 m of an unsealed over-head tank. Fifty cases (23%) and 64 controls (23) lived within 10 m of an unsealed sump (Table 1). When the radius was increased to 50 m, all cases and controls were equally exposed (100%).

In the univariate analysis, we find that malaria cases were 13 times more likely than controls to live in a building with an unsealed sump (OR=13.05, 95% CI= 4.53-51.19). For all other exposures of interest, we did not find an odd ratio that differed significantly from 1.

Limitations

This study suffers from 3 main limitations. First, the survey on potential breeding sites was conducted in 2004, while we collected data on malaria cases diagnosed in 2005. Some inhabitants of Division 48 might have covered some of the water sources and containers after

Table 1
Results of the Case-control study to identify the Risk Factors for Malaria Infection, Division 48, Chennai, 2005

Exposure		Case (n=216)	Control (n=274)	Crude OR	95% CI
Presence in the building of an unsealed:	Over-head tank	54	72	0.94	0.60-1.43
	Sump	35	4	13.05	4.53-51.19
	Well	36	51	0.87	0.52-1.43
Presence within 10 m of the building of an unsealed:	Over-head tank	194	252	0.77	0.39-1.50
	Sump	50	64	0.99	0.65-1.51
	Well	177	215	1.25	0.79-1.95

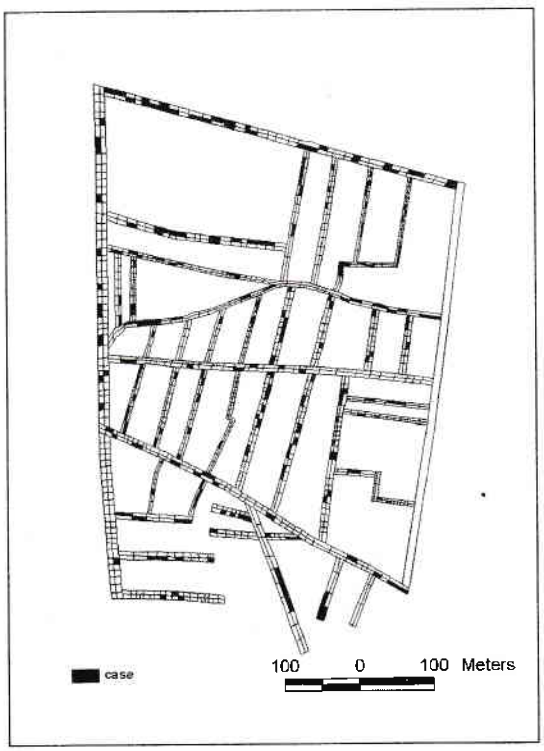


Fig. 5
Spatial Distribution of Malaria Cases (n=216) in Chennai Division 48 (2005)
Source: Corporation of Chennai (2005)

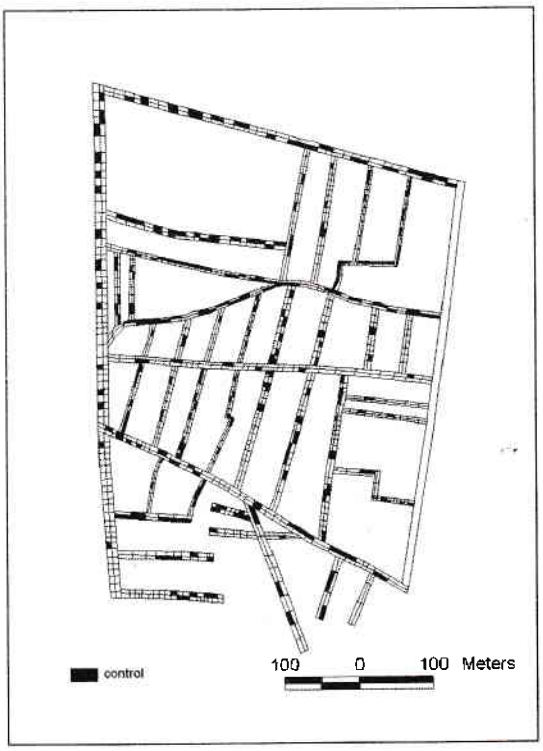


Fig. 6
Spatial Distribution of Controls (n=274) in Chennai Division 48 (2005)
Source: Corporati f Chennai (2005)

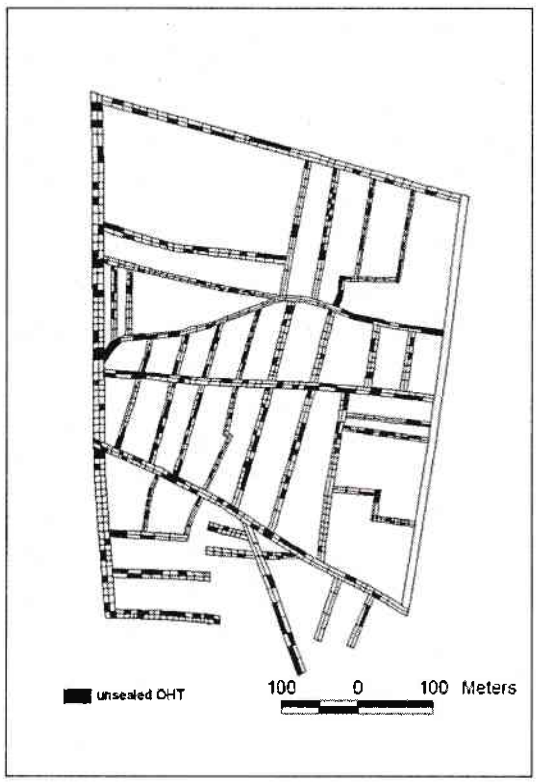


Fig. 7
Spatial Distribution of Unsealed Over-head tanks in Chennai Division 48 (2005)
Source: Corporation of Chennai (2005)

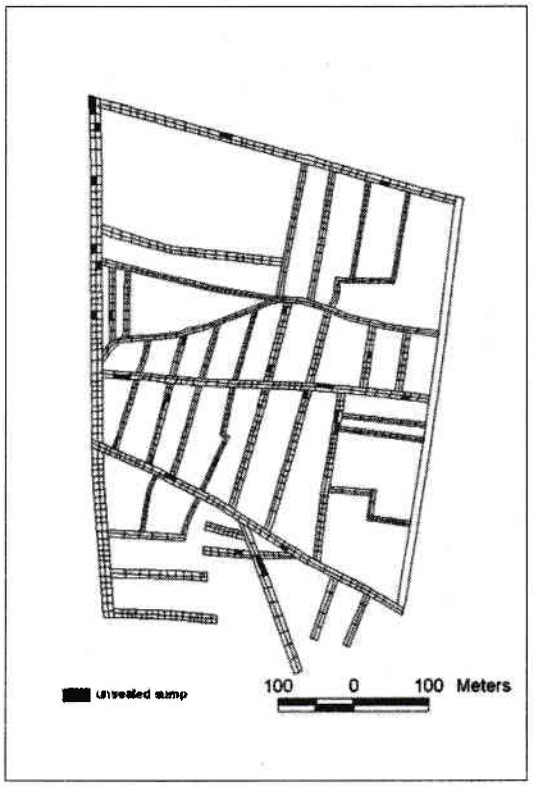


Fig. 8
Spatial Distribution of Unsealed Sumps in Chennai Division 48 (2005)
Source: Corporation of Chennai (2005)

the survey. This would have led us to overestimate real exposure. The extent to which this overestimation is affecting cases and controls differently is not known. The opposite (underestimation of exposure) might also be true if additional over-head tanks, sumps and wells were built and left unsealed between 2004 and 2005. Second, we were able to locate the address (door numbers) of 34% of all cases reported by the corporation dispensaries in 2005. It is possible that the remaining 66% of cases were more likely to live in buildings where the exposure of interest differed e.g. slum dwellers, therefore introducing bias. Third, we did not have information on other risk factors such as personal protection (use of mosquito nets, mosquito repellent) that are possible confounders. For example, it might be the case that people living in a building with an unsealed over-head tank are more likely to sleep under a mosquito net because of the mosquito nuisance resulting from the breeding site. As we know, sleeping under a mosquito net is protective from mosquito bites and therefore reduces the risk of malaria infection. Our study might therefore have under-estimated the net effect of staying in a house with an unsealed over-head tank.

Conclusion

Keeping in mind the previous limitations, we

found that in 2005 the risk of getting malaria in Division 48 of the city of Chennai was 13 times higher for people living in a building with an unsealed sump than for people living in a building with a sealed sump or no sump at all (crude OR=13.05 95% CI: 4.53-51.19). This result should encourage the Corporation of Chennai and other public agencies to intensify their prevention campaigns aiming at increasing awareness among the general population on the most efficient ways to avoid domestic breeding sites i.e. sealing with mosquito-proof nets or use of larvicide. Our result suggests that unsealed sumps are particularly productive breeding sites for *An. stephensi,* the vector of malaria in Chennai. Further studies using entomological larval indices (indicators of mosquito larvae density) are needed to confirm this. Furthermore this study also underlines the potential of using Geographical Information Systems (GIS) to understand and control Malaria. The public health application of GIS ranges from simple mapping of incidence, that gives an overview of trends and current situation, to the correlation of malaria incidence with other variables to understand the dynamics of transmission (like in this study), to more complex modelling of malaria risk. Sipe *et al.* (2003) have extensively reviewed and discussed the use of the tool in malaria research and control and have identified challenges for its successful application. Based on their assessment, it can be established that the use of GIS in malaria control within the Corporation of Chennai has a great potential for success given the availability of detailed and accurate data on malaria collected through a dense network of well-established Corporation clinics and dispensaries, which are known and utilised by a wide section of the urban population, and the availability of a human resources capable of managing such a system. A well managed GIS-based surveillance system for malaria control has the potential to increase the effectiveness of public health interventions and to reduce the malaria burden currently experienced by the population of Chennai.

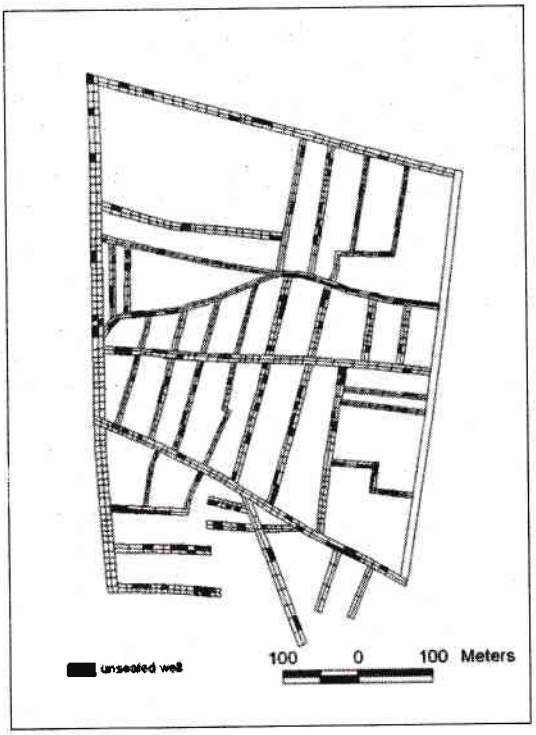


Fig. 9
Spatial distribution of unsealed wells in Chennai division 48 (2005)

Source: Corporation of Chennai (2005)

References

1. Centers for Disease Control and Prevention (2008). 'Malaria Facts'. <http://www.cdc.gov/malaria/facts.htm>, 4th May 2008.
2. WHO Country Office for India (2008). 'National Anti Malaria Programme'. http://www.whoindia.org/EN/Section3/Section128/Section235.htm, 4th May 2008.
3. National Vector-borne Disease Control Programme (2008). http://www.nvbdcp.gov.in/malaria-new.html, 4th May 2008.
4. WHO (2008). WHO Statistical Information

System (WHOSIS). <http://www.who.int/whosis/en/>, 4th May 2008.

5. Joshi V, Adha S, Singh H, Singhi M, and Dam PK. (2006) 'Introduction, transmission and aggravation of malaria in desert ecosystem of Rajasthan, India', *Journal of Vector-borne Diseases 43 (4)*, pp 179 - 85.

6. Malaria Research Centre (2002). A profile of Malaria Research Centre. Delhi: Malaria Research Centre. http://www.mrcindia.org/profile.htm, 4th May 2008.

7. Census of India (2006)

8. Sipe N. G. and P. Dale (2003). 'Challenges in using Geographic Information Systems (GIS) to understand and control Malaria in Indinesia', *Malaria Journal*, 2 (36), pp. 1-8.

Water Pollution in the Kalingarayan Command Area in Kaveri Basin

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An ecosystem and adaptive management approach herein framed to study the management of water pollution in the Kalingarayan canal, a 90 km long channel, runs between the rivers, Bhavani and Noyil. A large number of industries got developed along the right bank of the canal. Two sets of samples, one at hot weather season and another at monsoon season in 1999 were followed to collect data on water quaility. The analysis of the data clearly brought out that the canal water is highly polluted.

(Received: September 2007; Revised: December 2007; Accepted: February 2008)

Long term effects of pollution result in the accumulation of undesirable materials, which deteriorates the ecological conditions of land and water (3,10). Ecological pollution has social dimension too (2,5,6), and the present study looks into pollution and industry-irrigation relationship through stakeholder analysis. Knowledge, attitudes and perceptions of farmers, industrialists and officials have been studied to understand the nature, extent and mitigation of pollution in the Kalingarayan Channel (5, 18). The impact of industrial wastes on the biological systems of the River Kaveri has been researched by several other scientists (11,16,12).

The present study takes up an ecosystem and adaptive management approach, and develops a framework of issues and management strategies for water pollution and water quality in the Kalingarayan command. It looks into the strategy of partnership between local government, people and non-governmental/community-based organizations in managing the pollution problems. Thus the objectives of the study are to examine the levels of pollution and the consequent deterioration in water quality in the command of the Kalingarayan channel and to apply an ecosystem approach to resolve the problem of water quality and pollution.

Study Area

The study area is the area under irrigation by the Kalingarayan channel, which is 90 km long, stretching between the river Bhavani and the river Noyil. The Channel begins in Bhavani near the town of the same name, follows closely the course of the river Kaveri until it drains into the river Noyil, near the town of Kodumudi. It has a winding course and numerous industries along the right bank; these industries dump waste waters into the channel, making the waters most polluted. There are industries of all descriptions, but most important are the tanneries and textile processing units using chemicals in processing their products and dyeing for colouring the products.

The Kalingarayan channel helps to irrigate 8,460 ha of land at present. The command area in 1880 was about 3,020 ha. The lands are cultivated with paddy, sugarcane, turmeric and banana, on its left. The water from the Channel is mainly used for irrigation, and occasionally for industrial purposes. The Bhavani, the source for Kalingarayan, receives various wastes from chemical, textiles and, paper and pulp industries, distilleries and tanneries. The polluted channel water poses a serious problem for crop practices, and farmers in the study area are aware of this problem.

Planktonic population has declined in the Channel (13). Irrigating with polluted water affects the yield and quality of the crop produce. The aquatic ecosystem has been seriously damaged by the tannery effluents (4,7,14). The tannery effluent which mixes with the Kalingarayan Channel changes the physical, chemical and biological characteristics of the waters.

Methodology

For the purpose of the study, the entire Channel and its command are conceived as an ecosystem of intricate relations. The ecosystem approach is organized into three main phases:

(i) socio-ecological system description,

(ii) scenario analysis and design, and

(iii) on-going adaptive management.

The scenario analysis and design phase explores a series of scenarios representing feasible and desired socio-ecological possibilities and alternative management interventions. This is accomplished through development of a framework based on the conceptual ecosystem model and narrative descriptions of each scenario.

The framework is used to evaluate the implications of different scenarios while the narrative descriptions provide the basis for community - focused discussions, aiming at involving marginalised farmers' groups in decision-making processes. This phase concludes with a review of different scenarios and develops a community vision to be promoted in adaptive management phase (9).

The adaptive management phase focuses on governance, management and monitoring to realize the vision of the community. This phase will entail development of community action plans to address aspects of the problem that can be managed at the local community or neighbourhood level, development of monitoring plans to assess progress, and review of governance arrangements to address broader aspects of the problem that cannot be effectively managed at the local level.

This phase concludes with an adaptive management strategy, which is implemented by partnerships between the local government, the farmers and the non-governmental organizations. The study portrays a socio-economic scenario of the area, taking into account the issues of social and cultural perspectives, and then works towards resolving the problem of pollution and deterioration in water quality.

Water Quality

For assessing water quality, two sets of samples were taken from the Channel waters, to represent two different seasons: one, hot weather and the other, monsoon season. A

total of 13 samples (7 by evening and 6 by night) were taken first, in the month of April 1999, and 10 samples were taken in the month of August 1999. The preference for night-time was for the reason that the discharge into the Channel is the normal practice and it is uninterrupted during the nights than during the days.

The analysis for the April samples was done at the Metrowater Laboratory, and for the August samples, at the Tamil Nadu Water and Drainage Board, Chennai. The analysis was carried out for physical and chemical properties. The geo-hydrologists of the two laboratories were also consulted in the interpretation of the analytical results.

Highly Polluting Industries of the Kalingarayan Channel Command

Actual locations of industries (revenue villages, town panchayats and municipality), their class (small, medium, large) and nature of pollution, year of establishment, distance from the Channel (metres, adjacent), requirement of effluent treatment plant and the consequences of not having an ETP (closing, sealing and vacating of the industrial units), and the discharge of effluents in the Channel (or no effluents) are all looked into.

The industries are primarily on the right bank of the Channel, and the area of the right bank is relatively elevated compared to that of the left bank. There are eight medium and one large industrial units in the study area, and most of them contribute to the pollution of the channel. Chemical industries, textile processing and dyeing units are the important ones. Most tanneries are smaller units and still they are one of the most polluting industries in the channel command area.

The survey of 1999 reported 157 highly polluting industries, of which seven were chemical industries, 13 textile processing, 84 textile dyeing, 43 tannery, and nine leather-board industries. One textile processing industry and seven textile dyeing factories have been sealed in November 1998.

Results and Discussion

The one particular conclusion the study leads up to is that the 'buffering capacity of the Kalingarayan Channel Command and the Channel itself' has not been used up as yet. It is for this reason that the environmental impacts of industrial pollution of the Channel waters are not completely felt nor are they felt in a continuous way. Also the reason why the water samples of April 1999 (7 samples taken in the evening and 6 samples taken at night) and August 1999 (5 evening and 5 night samples) do not show up excessive levels of physical or chemical characteristics, is that the effluents are: (a) let into the Channel intermittently, and (b) where the effluents are let into the Channel continuously, they are greatly diluted to show any significantly excessive levels of physical or chemical characteristics.

The samples were collected from Karukkanpalayam, Sunnambu Odai, Kalingarayan Palayam, Veerappan Chatram, B. P. Agraharam, Karaivaikkal and Lakkapuram, and were tested for physical, chemical and organic elements. The physical test included the measurement of temperature, colour, odour, taste, turbidity, density, specific conductance (EC) and pH values. The chemical test included estimation of total dissolved solids, calcium, magnesium,

sodium, potassium, iron, chloride, sulphate, nitrate, fluoride, carbonate, bi-carbonate and total hardness. Organic tests included estimation of biochemical oxygen demand, chemical oxygen demand and coli-form bacteria.

April 1999 Samples: One of the samples was pure effluent that all parameters were above and far above the permissible limits. The effluent was blackish and opaque, whereas other samples were colourless and clear. The water, in extreme dilution, was used for bathing and irrigation but from the way the farmers report of itchiness and withered crops, the water of the channel cannot be used for these purposes. The evening and night samples showed values well above the limits set by the Indian Standards Institution in 1992. In the effluent sample, however, there was no dissolved oxygen. Except for the evening sample from Lakkapuram, all other samples showed BOD limits well below the maximum permitted for any of the five designated best uses, namely, drinking water source with conventional treatment, outdoor bathing, wildlife, fisheries, recreation, irrigation and industrial cooling (Tables 1 and 2).

While an evening sample showed a BOD level of 5.4 mg/l, one night sample showed a BOD level of only 2.3 mg/l. TDS was at its minimum, of less than 300 mg/l, in all samples except the effluent sample from Sunnambu Odai (Table 2). The parameters, below the permissible limits for any of the designated best uses, were chlorides (less than 45 mg/l), boron (all including effluent – BDL), sulphastes (< 35 mg/l), pH (all below 8.5), fluorides (all 0.1 mg/l), magnesium (< 20 mg/l) and total hardness (< 150 mg/l).

The parameters, which showed traces above permissible limits, were SAR, Free Ammonia, N, and conductivity (EC). This meant that the waters of the Kalingarayan were highly polluted.

August 1999 Samples: The physical analysis of these samples indicated that the waters were not all that colourless and clear. Six samples collected showed turbidity. The waters had odours while six of the samples showed hydrogen, sand, oil and oil smells. This meant that the waters could not be used for drinking but could however be used for irrigation. Turbidity was registered at high levels by samples S8435 and S9436 of B.P. Agraharam at 144 and 85 respectively.

The TDS was within desirable limits in eight of the ten samples, except in Sunnambu Odai (S9434) and B.P. Agraharam (S9436). Sunnambu Odai showed excessive pH at 11.37 while in all others this parameter was within limits. Alkalinity as indicated by $CaCO_3$ was very high in Sunnambu Odai with a value of 636. COD and BOD registered traces in some while 90 per cent of the samples did not show any traces of the COD even though they showed BOD (Tables 3 and 4). The one element that was disturbing in the water samples was chromium, which was found to a good measure in the waters of the Channel. This was attributable to leather tanning, in places like Sunnambu Odai and B.P. Agraharam. The sample that registered the highest levels of 613.48 mg/l was that collected from Sunnambu Odai. Some of the highest amounts of Cr were found in B.P. Agraharam (71.54 mg/l and 45.08 mg/l), Vairapalayam (61.74 mg/l) and Karai Vaikkal (120.5 mg/l).

Table 1

Results of Analysis of Water Samples (April 1999) - Evening Samples

Parameters	S001 6.30p.m	S002 4.15p.m	S003 4.30p.m	S004 5.05p.m	S005 5.30p.m	S006 5.50p.m	S007 6.05p.m
Physical Analysis							
Colour & Transparency	B & O	C & O	C & O	C & O	C & O	C & O	C & O
Odour	Obj.	Nil	Nil	Nil	Nil	Nil	Nil
Turbidity (NTU)	170	3	2	2	2	2	3
Chemical (mg/l) Analysis							
TDS at 145°C	3420	280	260	250	240	200	195
Calcium (Ca	104	23	24	24	23	20	23
Magnesium (Mg)	49	18	17	16	17	15	14
Total Hardness ($CaCO_3$	460	132	130	126	130	112	116
Chlorides (Cl)	1760	48	34	38	34	26	22
Free Ammonia (N)	1.25	0.15	0.09	0.30	0.11	0.10	0.28
Sodium (Na)	680	40	33	33	31	24	23
Potassium (K)	20	4	4	5	3	3	2
Dissolved oxygen	--	7.2	6.3	6.8	5.6	5.9	6.1
Oxygen absorbed	--	--	--	--	--	--	--
Hydrogen ion pH	9.4	7.8	7.9	8.0	7.7	7.9	8.2
Alkalinity to Phenol $CaCO_3$	10	Nil	Nil	Nil	Nil	Nil	Nil
Alkalinity to Methyl $CaCO_3$	548	145	135	138	117	125	108
Sulphates SO_4	400	28	22	24	23	20	23
Chromium Cr	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Boron B	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Flouride F	0.1	0.1	0.1	0.1	0.1	0.1	0.1
COD	650	21	10	19	14	16	13
BOD	390	1.5	0.3	5.4	0.2	1.2	0.9
Suspended soilds	450	22	13	8	20	15	8
SAR	13.72	1.51	1.25	1.27	1.19	0.98	0.93
EC (microohms/cm at 20°C)	4890	435	405	390	375	315	305

Source: Samples analysed at the Metrowater Laboratories, Chennai. Samples are: S001 Sunnambu Odai (Effluent), S002 Karukkampalayam, S003 Malayampalayam, S004 Lakkapuram, S005 Pallipalayam, S006 B.P. Agraharam and S007 Kalinga-rayanpalayam, Main Channel. B & C – Blackish and Opaque; C & C Colourless and Clear; Obj. – Objectionable; BDL – below deductable limit.

Table 2

Results of Analysis of Water Samples (April 1999) - Night Samples

Parameters	S002 10.20p.m	S003 10.35p.m	S004 11.10p.m	S005 11.40p.m	S006 11.50p.m	S007 12.10p.m
Physical Analysis						
Colour & Transparency	C & C	C & C	C & C	C & C	C & C	C & C
Odour	Nil	Nil	Nil	Nil	Nil	Nil
Turbidity (NTU)	3	2	2	2	2	3
Chemical (mg/l) Analysis						
TDS at 145°C	295	250	250	235	230	200
Calcium (Ca)	25	26	26	26	22	21
Magnesium (Mg)	19	17	14	12	15	13
Total Hardness ($CaCO_3$)	142	132	124	112	114	106
Chlorides (Cl)	52	46	38	36	36	22
Free Ammonia (N)	0.12	0.11	0.27	0.13	0.12	0.10
Sodium (Na)	42	30	31	30	29	22
Potassium (K)	5	3	4	3	3	2
Dissolved oxygen	7.5	7.0	7.5	6.9	7.0	7.5
Oxygen absorbed	--	--	--	--	--	--
Hydrogen ion pH	8.3	8.3	8.3	7.8	8.3	7.9
Alkalinity to Phenol $CaCO_3$	3	Nil	4	Nil	5	Nil
Alkalinity to Methyl $CaCO_3$	159	130	140	122	121	114
Sulphates SO_4	29	21	23	23	21	27
Chromium Cr	BDL	BDL	BDL	BDL	BDL	BDL
Boron B	BDL	BDL	BDL	BDL	BDL	BDL
Flouride F	0.1	0.1	0.1	0.1	0.1	0.1
COD	9	9	7	9	7	10
BOD	1.3	1.2	2.0	2.3	0.8	0.5
Suspended soilds	17	8	10	13	15	17
SAR	1.53	1.12	1.21	1.22	1.16	0.93
EC (microohms/cm at 20°C)	455	385	385	365	355	310

Source: Samples analysed at the Metrowater Laboratories, Chennai. Samples are: S001 Sunnambu Odai (Effluent), S002 Karukkampalayam, S003 Malayampalayam, S004 Lakkapuram, S005 Pallipalayam, S006 B.P. Agraharam and S007 Kalinga-rayanpalayam, Main Channel. B & C – Blackish and Opaque; C & C Colourless and Clear; Obj. – Objectionable; BDL – below deductable limit.

Table 3 - Results of Analysis of Water Samples (August 1999)

Parameters	Desirable Limit (A)	Permiss-ible Limit (B)	S9432	S9433	S9434	S9435	S9436
Date of collection			17/8	17/8	17/8	17/8	17/8
Location			Main	RNPu	S.odai	B.P.A	B.P.A
Turbidity (NTU)	170	3	2	2	2	2	3
Physical Analysis							
Appearance			C&C	C&C	Turb.	Turb.	Turb.
Odour	Unobj.	Unobjec	None	None	H_2 smell	Sand smell	Oil smell
Turbidity NTU	2.5	10	5.71	5.56	144	27.8	85
Total suspended solids	--	--	2	5	120	4	136
TDS	500	1500	220	216	2600	260	3410
EC (mic S/cm)	--	--	288	290	3777	350	4952
Chemical Analysis							
pH	6.5 - 9.2	6.5 - 9.2	7.75	7.75	11.37	7.86	8.28
Alkalinity $CaCO_3$	--	--	0	0	636	0	0
Alkalinity Total	--	--	116	120	872	128	604
Total Hardness	200	600	118	120	250	134	440
Ca	75	200	27	26	64	46	120
Mg	30	150	12	12	22	8	34
Na	--	--	16.2	15.9	683	21	917
K	--	--	0.99	0.78	14	12	32
Fe	0.1	1.0	0.54	0.87	2.25	2.29	2.86
Mn	0.5	0.5	Nil	Nil	Nil	Nil	Nil
Nitrogen	--	--	4.2	4.48	4.76	4.2	9.8
Free Ammonia	--	--	0.05	0.07	25.2	0.10	21.9
Nitrite	--	--	0.02	0.03	0.08	0.09	0.36
Nitrate	45	45	1	1	2	3	1
Chloride	200	435	405	390	375	315	305
Flouride	1.0	1.5	0.41	0.27	1.36	0.31	0.71
Sulphate	200	1000	16	15	579	24	1424
Phosphate	--	--	0.19	0.12	0.49	0.04	1.61
Tidy's test	--	--	1.5	1.6	33	1.7	63
COD	--	--	Nil	Nil	65	Nil	190
BOD	--	--	0.6	1.0	15	0.7	59
Chromium	--	--	6.31	17.67	613.5	71.5	45.1

Source : Samples analysed by Tamil Nadu Water and Drainage Board, Chennai
Note : A and B are CPHEEO Standards. Results of chemical anaysis expressed in mg/l.

Table 4 - Results of Analysis of Water Samples (August 1999) (all night samples)

Parameters	Desirable Limit (A)	Permiss-ible Limit (B)	S9432	S9433	S9434	S9435	S9436
Date of collection			17/8	17/8	17/8	17/8	17/8
Location			Vaira	Karun	Marav	Karai	Lakka
Turbidity (NTU)	170	3	2	2	2	2	3
Physical Analysis							
Appearance			C&C	C&C	Turb.	Turb.	Turb.
Odour	Unobj.	Unobjec	Soil Smell	None	None	Soil smell	Soil smell
Turbidity NTU	2.5	10	12.51	9.45	8.80	19.3	16.5
Total suspended solids	--	--	5	2	4	14	4
TDS	500	1500	310	275	290	295	215
EC (mic S/cm)	--	--	458	375	369	352	349
Chemical Analysis							
pH	6.5 - 9.2	6.5 - 9.2	7.89	7.77	7.71	7.74	7.59
Alkalinity $CaCO_3$	--	--	0	0	636	0	0
Alkalinity Total	--	--	116	120	872	128	604
Total Hardness	200	600	132	128	126	140	130
Ca	75	200	33	31	33	34	33
Mg	30	150	12	12	11	13	12
Na	--	--	16.2	15.9	683	21	917
K	--	--	1.5	1.5	0.99	1.4	0.89
Fe	0.1	1.0	1.48	0.82	0.98	1.95	1.85
Mn	0.5	0.5	Nil	Nil	Nil	Nil	Nil
Kjeldhal Nitrogen	--	--	4.8	3.08	4.2	4.48	3.92
Free Ammonia	--	--	0.18	0.05	0.28	0.90	0.27
Nitrite	--	--	0.13	0.15	0.14	0.20	0.18
Nitrate	45	45	3	3	3	1	3
Chloride	200	1000	38	34	32	28	27
Flouride	1.0	1.5	0.37	0.42	0.35	0.13	0.48
Sulphate	200	400	26	26	24	24	22
Phosphate	--	--	0.03	0.16	0.18	0.31	0.19
Tidy's test	--	--	1.7	1.3	1.7	2.0	1.7
COD	--	--	Nil	Nil	Nil	Nil	Nil
BOD	--	--	1.0	1.4	1.4	0.8	0.4
Chromium	--	--	61.74	23.52	2.94	120.5	0.90

Source : Samples analysed by Tamil Nadu Water and Drainage Board, Chennai
Note : A and B are CPHEEO Standards. Results of chemical anaysis expressed in mg/l.

The farmers do know when the water is most polluted, by its colour, foul smell, other quality attributes and dead fish floating in the water. On every single count, the waters of the Kalingarayan may be considered as highly polluted, as also seen from the stunted growth of banana crop, disease afflicted and withering trees and plants such as coconut and pulse crops.

And if we accept the fact that the buffering capacity of the Command and the Channel has not been used up as yet, then it is possible to accept the fact that the environmental impacts would be dramatic and sudden, in some future time. It is better not to wait for such changes to occur but take necessary measures from now on to correct the harm being done to the Channel and the Command, through participatory means rather than regulatory, government exercises alone. It appears that the significant difficulty in this regard arises from the fact that the industrialists do not heed the appeal of the agriculturists who were up against the pollution caused by the industries. Rallies, processions and protests from the organized sections of the farmers, especially owing allegiance to the Lower Bhavani Command Farmers' Association, did not yield much results.

Strategies for reducing Pollution and improving Water Quality

There are three basic options available to resolving the problems of industrial pollution of the Kalingarayan Channel waters: The Closure Option, the Effluent Treatment Plant Option and the Community- Government -Industry Co-operation Option. The Closure option is the legal one, and it is a tough decision. The Effluent Treatment Plant can be put up by the government or by the industrialists or by both jointly. The last option may be thought about, when community is brought to bear on the treatment of effluents by the industries with due assistance from the Government for the process.

A Partnership Approach focuses primarily on the ways communities can improve their ability to sustainably control and overcome pollution and improve water quality, fitting in well with the local and regional goals and objectives.

A common partnership platform is required to manage, organise and control industrial development and polluting activities, where issues arising can be discussed, analysed and resolved with consensus. The framework of setting the goals and objectives for partnerships requires collaboration and coordination with the stakeholders and the interest groups, insiders and outsiders. Their participation in the decision-making is imperative for the success of partnerships. Therefore, for the effective and efficient performance of partnerships, it is essential to:

- Identify probable stakeholders in the partnerships;
- Recognise common goals and objectives which partnerships intend to achieve;
- Identify various processes involved in partnerships such as collaboration;
- participation, integration and communication; and
- Establish structures for maximising benefits in the effective implementation of development plans.

The nature, type and intensity of partnerships is a function of multifaceted processes operating in a development system, wherein

the centripetal forces of integration, collaboration and participation among stakeholders, are focused on a common field of force (Zone of Partnerships). On the other hand, the centrifugal forces tend to disrupt the articulation process by making use of the socio-economic and institutional cleavages in the society. These forces operate in various forms and intensity based on the stakeholders' interests and socio-cultural background.

An Ecosystem Adaptive Management could be the solution. The present work has drawn on Adaptive Environment Assessment and Management (AEAM), and one of the main ideas of the AEAM is the idea of adaptation. Adaptation here involves active and intentional learning in the human management of systems as a mechanism to deal with uncertainty and change.

References

1. Anbalagan K, G. Karthikeyan and N.Narayanasamy(1997).`Assessing Pollution from Tannery Effluents in a South Indian Village', *PLA Notes, Participation and Fishing Communities*. London: International Institute for Environment and Development, pp.3-15.
2. Anabzhahan N and T.V.Kumaran (1995). `Industrial Pollution of the Kalingarayan Channel Command: A Perception Study', *The Indian Geographical Journal*, 70(1), pp. 13-22.
3. Banerjee S.M and M.P. Motwani (1960). `Some Observations on Pollution of the Suvaon Stream by the Effluents of Sugar Factory, Balrampur (UP)', *Indian Journal of Fisheries*, 7(1), pp. 107-123.
4. Baskaran G.K, K.N.Seth, Chakrabarthy and S. De (1960). `Treatment and Disposal of Tannery Wastes in Uttar Pradesh', Proceedings of the Symposium on *Utilisation of By- Products of Leather Industry*, CLRI, Chennai, pp. 70-79.
5. Jainulabdin D (1991). `Impact of Industry on Irrigated Agriculture'. Chennai: Anna University (M.E. Thesis).
6. Jayasekhar L, T.V.Kumaran and D. Jainulabdin (1993). `Industry and Irrigation: A Case of Kalingarayan Channel, Tamil Nadu, India', *Proceedings of the Stockholm Water Symposium 1992*, Stockholm, Sweden.
7. Kedarnath S (1987). Biswas A.K and Qu Geping (eds.). *Environmental Impact Assessment for Developing Countries*. London: Tycooly International.
8. Kumaran T. V (1990). `Tanneries as a Hazardous Activity: An Assessment of Water Use and Its Consequences', Paper presented at 8th Afro-Asian Meet on *Irrigation and Drainage*, at Asian Institute of Technology, Bangkok.
9. Newson M (1992). `Policy and Practice Review: Water and Sustainble Development: The 'Turn Around Decade', *Journal of Environmental Planning and Management*, 35(2), pp. 175-183.
10. Prasad B.N and M. Saxena (1980). `Ecological Study of Blue Green Algae in River Gomati', *Indian Journal of Environmental Health*, 22(2) pp. 151-168.
11. Rahman A.A (1976). `Some Aspects of Pollution in the Grand Anicut on River Cauvery', *Proceedings of the Biological Society*, 4, pp. 6-9.
12. Rajendran V, S.Babu and S.Mani (1990). `A Preliminary Study in the Distributary of River Bhavani: Physico- chemical Characteristics and Phytoplanktons', in R.K.Trivedy(ed.). *River Pollution in India*. New Delhi: Ashish, pp. 31-38.
13. Ranjithakani P (1983). `*Effects on Tannery Waste on the Phyto-plankton of a Stream at Erode*'. Chennai: University of Madras (Ph.D. Thesis).
14. Rao M. G and N.V.Nandakumar (1981). `Analysis of Irrigation Reserviour contaminated by Tannery Effluents', *Indian Journal Environmental Health*, 23 (3), pp. 239-241.
15. Rasu S (1987). *Kalingarayan Kalvai*. Madras: Maruthi.(in Tamil).
16. Sreenivasan A and S. Raj (1967). `Effects of Certain Wastes on the Water Quality and Fisheries of River Cauvery and Bhavani', *Environmental Health*, 9, pp.13-21.

Conventional Water Storage Structures:

The Sustainable Alternate for Water Management

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Artificial recharge is an important instrument for the development of the limited water resources in the semi-arid regions. Artificial recharge comprises of surface infiltration, subsurface infiltration, direct injection, aquifer storage and recovery wells, modification of natural recharge, and underground water storage. The need of the hour is to rejuvenate these structures. The present sources of pollution to groundwater must be changed into structures giving life to the nature and to mankind, which will be an environmental gain. The paper deals with the existing ancient structures of Ajmer city, which are presently in ruined condition and are the major source polluting the available resources. The existing sources identified in the study area must be used as storing the rain water, and excess amount of water should be diverted to recharge the aquifer for improving the quantity as well as quality of the groundwater.

(Received: September 2007; Revised: December 2007; Accepted: February 2008)

Throughout the history of Rajasthan, its semi-arid climate, periodic multi-year drought cycles,and the increasing needs of the growing population highlight the need for water storage and conservation. Surface water reservoirs have been the primary means of storing water to meet Rajasthan's needs, but however, building large new reservoirs is not easily possible for various reasons including the arguments from the environmental conservationist groups. An alternative means of increasing water storage capacity is to store water underground in aquifers and voids, which will act as a dual purpose- improving the quality and quantity of the groundwater.

The hydrology of arid regions has not received as much attention as other climatic regions (7). It is only recently that the hydrologic community has attempted to understand the variability in fluxes and processes that occur within arid and semi-arid basins (6) through intensive field campaigns such as HAPEX-Sahel (1) and SALSA (4,5). A recent review by Scanlon *et al.* (7) discussed some of the major issues in flow and transport within arid and unsaturated systems. A common thread in each new discovery has been the realization that hydrologic processes in an arid or semi-arid watershed are distinctly different from their humid counterparts.

Water availability in arid regions is both sporadic and highly variable in intensity. Sometimes a flash flood may occur and sometimes there is a condition of drought. The input into the system is extremely small and infrequent; possibly a thunderstorm of high intensity lasting only a few hours, causing a flood wave propagating more rapidly over a crusted surface, may be of great magnitude. In order to realize a sustainability of this water resource (*i.e.*, maintain a constant flux of water into the system), one must exert some degree

of control over the system by altering its response time and storage capacity. While the precipitation inputs are not alterable, many possibilities exist in modifying the watershed surface, aquifer properties and storage capacity.

Study Area

In the context of Rajasthan and Ajmer in particular, water resource development has been identified as one of the thrust areas due to a general shortage of this resource and a history of low rainfall and recurring droughts. As a result regular hydrological studies have been carried out by the state and central government agencies. The present study deals with the identification of existing conventional water harvesting structures for improving the quality as well as the quantity of the ground-water in the study area.

The district of Ajmer is situated in the center of the State between 25°38′ and 26°52′ north latitudes and 73°54′ and 75°22′ east longitudes. Aravalli range runs from northeast to southwest in the district and the city is surrounded by the three hills of Aravalli Ranges *i.e.* Nag hills, Madar hills & Taragarh hills at an average of 486.0 MSL.

Ajmer city, lying in between 26°27′ N latitude and 74°42′ E longitude (Fig.1), receives annual rainfall of about 50 cm, which is not encouraging primarily due to the imbalance

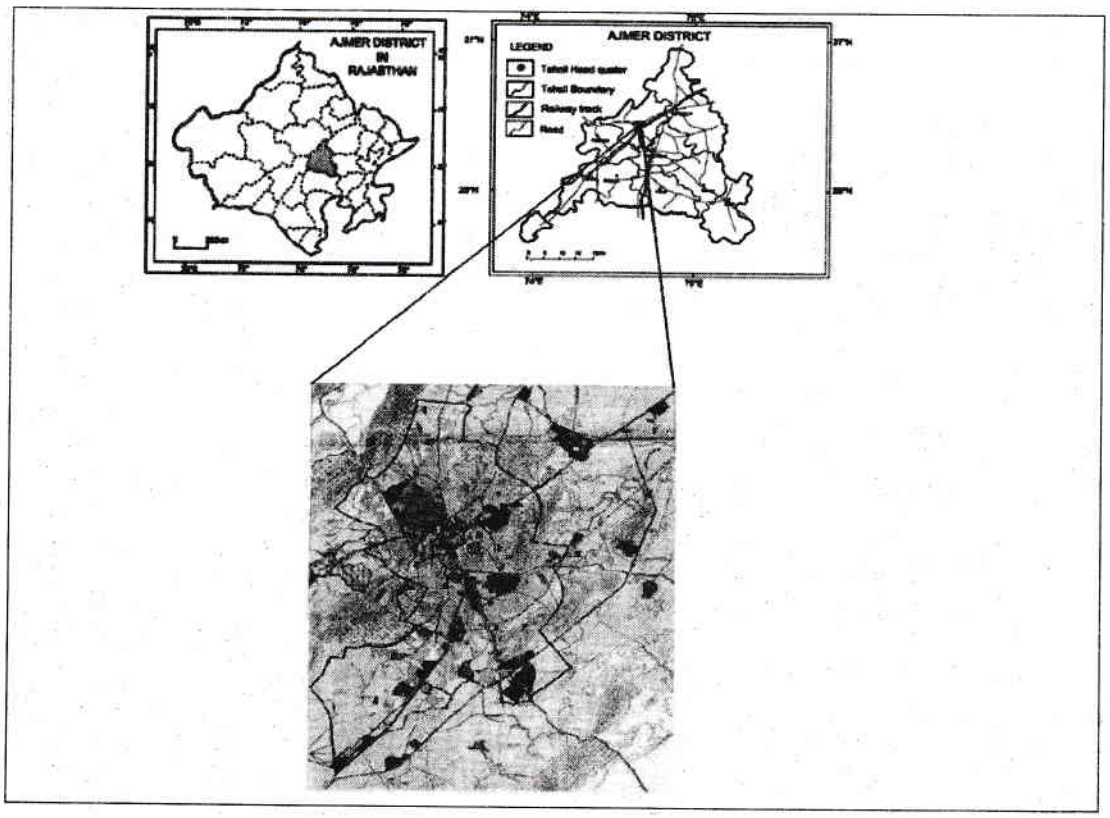


Fig 1. Location map of Ajmer city in Rajasthan

between recharge and groundwater exploitation. The city has more paved areas and hence less natural recharging.

Due to increment in the paved area, large amount of rainwater is lost through run-off; and this problem is compounded by the lack of rain water harvesting practices and misusing or demolishing the ancient structures. Over exploitation of sub-surface water from deep aquifers further empties these precious resources that took decades or centuries to get accumulated in deep layers, and on which the current annual rainfall has no immediate effect.

Water supply

The piped water supply in Ajmer started in 1884 from Anasagar reservoir to the then population of 50,000 of the town. In 1892 Foysagar Lake was constructed to cater the raised demand of increased population of the town. The continued growth in the population of the town made these two water supply sources insufficient, and therefore, Bhewanta well-field was developed on Sagarmati River in 1952, about 18 km from Ajmer city.

Subsequently the water supply to the Ajmer city was augmented from groundwater source near Banas River. Banas phase-I was taken during the year 1962-68 and subsequently second phase was taken up during the year 1978-83. In 1982 wells were drilled at Budha Pushkar to supply water to the city and Pushkar too. A few tube wells were also drilled at Leela Saori during 1990 to 1995 to supply water to Ajmer as well as Pushkar town. The water supply scheme from Foy Sagar, Budha Pushkar and Leela Saori has now got abandoned (Fig 2).

The Bisalpur-Water Supply Project (BWSP) phase-I was commissioned in year 1995 to deliver water from the existing Bisalpur dam that is 115 km away, to Ajmer city to address the city's scarcity of wate. The areas developed after Bisalpur phase-1 was meeting their demands through tapping of the water mains, passing by, hand pumps, and sometimes through water tankers. The condition goes worst in the summers, when water tractors are used to supply the water once in a week. People have to fetch water from long distances and they have to store it for a week or so.

The city is not only facing the problem of water shortage but the deteriorating quality of the water also. All the parameters measuring water quality indicate value above the accepted

Fig 2. Dilapidated Condition of Foy Sagar and Budha Pushkar

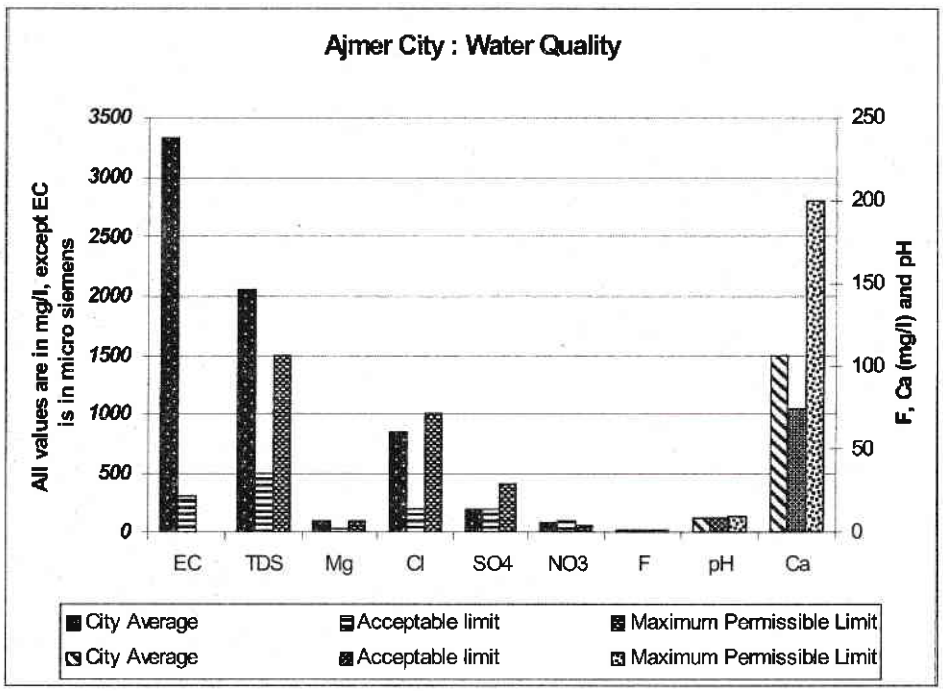


Fig 3 Water Quality Parameters for Ajmer city (2003)

level (Fig.3). Due to over drafting of groundwater, the quantity and as well as quality is deteriorating. Effluents coming from the industries, and disposing of the liter to the drainage structures, along the streets and public places have become the major source behind the pollution of the groundwater sources (Fig 4).

The amount of rain-water received is very little and that too flow as run-off because of the urbanization. The need of the hour is to store the rainwater, recharge the aquifer and to check the groundwater pollution, which can be done either by constructing new structures or by utilizing the old ones.

(a)Bihariganj Nallah (b) Bhrampuri Nallah (c) RIICO industrial area

Fig. 4 Garbage Dumping, Open Sewerage and Effluents from the Industries: Possible Groundwater Pollutants

This paper explores the possibility of enhancing the natural aquifer recharge and improving the groundwater quality by using the conventional water structures. The study area is a hard rock region with a few ephemeral rivers. The water crisis in the natural drainage area has been accelerated by urbanization and wide-spread unauthorized constructions in the towns. The natural drainages thus blocked are a potential hazard during flash floods and storm showers, and low-lying areas become stagnant pools of water. Of course, in the last four to five years, the rains have been below the mean; and however any storm showers because of urban blockages may get wasted without helping the recharges of groundwater resources.

The water resource management was given priority while planning/developing the Ajmer city in earlier times. This is evident from a number of surface water storage structures like Ana Sagar, Foy Sagar, Pushkar, Budha Pushkar and other water structures in the city, which have good storage capacity for storing rainwater but unfortunately they are losing their importance because of our ignorance towards them (Fig 5).

In addition, number of smaller water storage structures like tanks, *baories* (a local word to mean step-wells), *kunds, khadins, naddis, and talabs* were also constructed to store rain water in different types of surface structures. Although the water level was very shallow, still it helps to replenish the groundwater. During rainy season, such depressions get filled with water, which was later used for livestock round the year. Most of these storages, unfortunately, are completely neglected and they are in ruins now. They are very often now used for disposing the urban waste (Fig. 6).

Aims & objectives

The one such safe solution for improving the quality of groundwater is by applying artificial recharge techniques and optimal retrieval of our conventional water harvesting techniques. Aquifer recharge is an artificial way of collecting and storing water in the underlying layers of aquifers, and it is an engineering solution. In this context several aspects have to be considered:

- the design objectives for implementing artificial recharge;
- the various artificial recharge technologies available within the area;
- the current application of the artificial recharge in other countries;

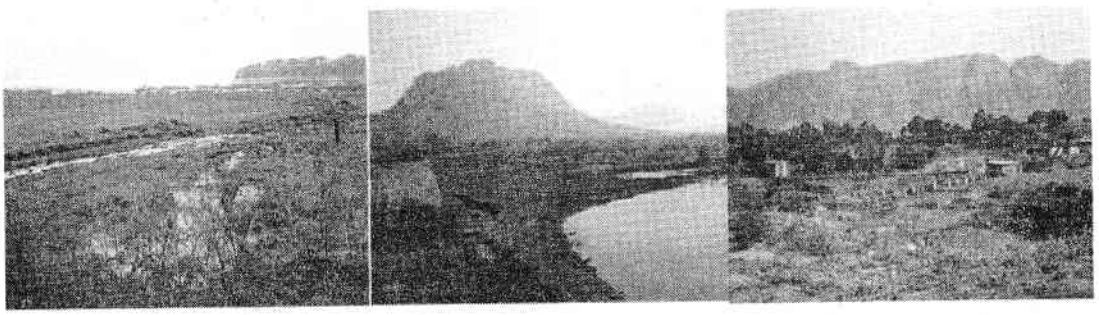
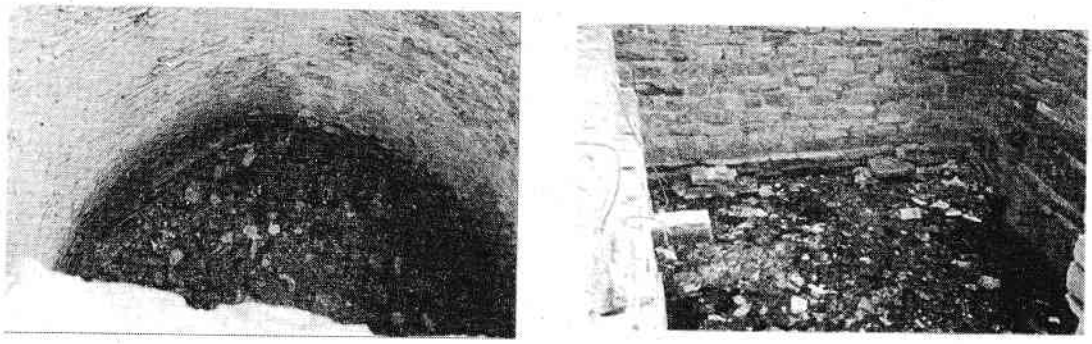


Fig. 5 Contaminated and Silted Ana Sagar, Foy Sagar and Budha Pushkar



(a) Well on Pushkar Road *(b) Tank behind Topedara School Area*

Fig. 6. Traditional Water Storing Structures used as Garbage-dumping Site Now

- the present practice of artificial recharge in semi-arid regions of Rajasthan, particularly in Ajmer district; and
- the suitability of various aquifers, abandoned step-wells, tanks, wells and other existing structures to store water in them.

Generally, the objectives of most of the artificial recharge applications fall into one, or a combination, of the following categories:

- manage water supply;
- manage/mitigate water quality through improvement of surface- or ground-water quality or
- treated waste water disposal;
- restore/protect aquifers by restoring groundwater levels;
- meet legal obligations;
- protection of the environment by maintaining wetland hydrology, controlling the migration of groundwater contamination.

Enhanced aquifer recharge is one alternative to the water crisis occurring in many arid regions. Intermittent and intense rainfall events over an arid watershed can lead to short term surface water availability. Without the proper management of this water resource, the precipitation can be quickly lost to the high evaporative environment or lost from the watershed via runoff. By ensuring that the available surface water remains within the catchment in the form of stored groundwater, a sustainable flux of water is obtained for the region (2). Sustainability, defined in this perspective, allows a water resources manager to focus on ensuring a consistent yield corresponding to the climatically variable input.

Identification of the Area

The artificial recharge projects are site specific, and the replication of the techniques for similar areas are to be based on the local hydrogeological and hydrological environments. The first step is to demarcate the area of recharge. The artificial recharge of groundwater is normally taken in the following areas-

i) Areas where groundwater levels are declining on regular basis.

ii) Areas where substantial amount of aquifer has already been de-saturated.

iii) Areas where availability of groundwater is inadequate in lean months.

Scientific Inputs

In order to plan the artificial recharge schemes the following studies are needed.

Hydrometeorological Studies

They are undertaken to decipher the climatological features, rainfall pattern, and evaporation losses of the area. Measuring the evaporation losses in post monsoon period will help in designing the storage capacity so as to have minimum evaporation losses. In semi-arid regions, evaporation losses are significant after January, and a system for more percolation of water in this period may have to be designed The data on rainfall intensity, number of rainy days, water-spread surface, depth of the storage structure and the like may be required to decide the capacity and design of the artificial recharge structures.

Hydrological Studies

The hydrological studies comprise of the following parameters:

- in situ precipitation on the watershed;
- surface (canal) supplies from large reservoirs located within the basin;
- surface supplies through trans-basin water transfer; and
- treated municipal and industrial wastewater.

In situ precipitation will be available almost at every location but may or may not be adequate to cause artificial recharge but the run-off going unutilized outside the water-shed/basin can be stored/ transmitted through simple recharge structures at appropriate locations. In a basin, more than one hydrological source may be available. To make use of these resources, the following information may be required:

- the quantity that may be diverted for artificial recharge;
- the time for which the source water will be available;
- the quality of source water and the pretreatment required; and
- conveyance system required to bring the water to the recharge site.
- hydrological studies to work out surplus monsoon run-off, which can be harnessed as source water for artificial recharge.

Soil Infiltration Studies

The suitability of a certain area either as catchment for water harvesting or as fields for cropping depends strongly on its soil characteristics: surface structure, the infiltration and percolation rate, flow of water into soil matrix, the soil depth and soil texture. Surface structure defines run-off and soil texture, the quantity of water that can be stored in the soil.

Hydrogeological Studies

The hydrogeological investigations required before implementation of an artificial recharge scheme are given below:

- *Hydrogeological Mapping*: The purpose of

hydrogeological mapping is to represent the hydrogeological characteristics in a graphical which facilitate in the analysis of the groundwater regime and its suitability to artificial recharge schemes.

- *Aquifer Geometry*: This includes the data on the sub-surface hydrogeological units, their thickness and depth of occurrence, and properties of unconfined, semi-confined and confined aquifers in the area. To work out the surface water spread, the characteristics at shallow depth are to be understood: surface rock types for its permeability and rate of infiltration during artificial recharge.

- *Geophysical Studies*: The main purpose of applying geophysical methods for the selection of appropriate site for artificial recharge studies is mostly to help and assess the unknown sub-surface hydrogeological conditions adequately and unambiguously. Generally the prime task is to compliment the exploratory programme. Mostly it is employed to narrow down the target zone, and to pinpoint the probable site for artificial recharge structure and its proper design.

- *Chemical Quality of Source Water*: Problems which arise as a result of recharge to groundwater are mainly related to the quality of raw waters that are available for recharge and which generally require some sort of treatment before being used in recharge installation. Quality is also related to the available soil composition and structure. The chemical and bacteriological analysis of source water besides that of groundwater is therefore essential.

Results and Discussion

Artificial recharge systems are not a new solution in arid regions. In fact, various hydrologic technologies were implemented hundreds of years ago in portions of Iran, Israel, Spain and India (3). Despite the lack of knowledge regarding hydrologic processes, earlier civilizations established in arid regions were able to modify the natural environment to provide a source of water for the population. Many of these systems were evolved as a result of initial empirical observation and years of trial and error. Some of these systems are still in use today, while many others were replaced by modern systems or were abandoned. The tanks, *baorie* constructed on Taragarh Fort, inverted well and check dam constructed in Happy Valley are such examples (Figs. 7 & 8).

Very few attempts have been made to study

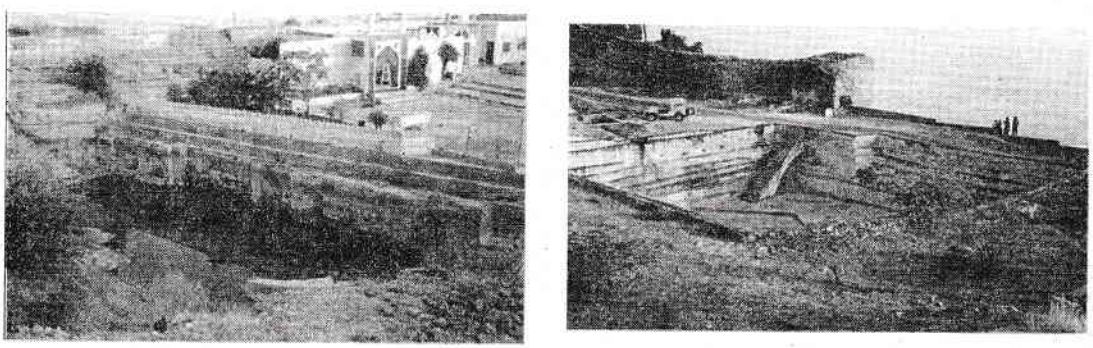


Fig. 7 Baories and Tank constructed at Tara Garh now in Dilapidated Condition.

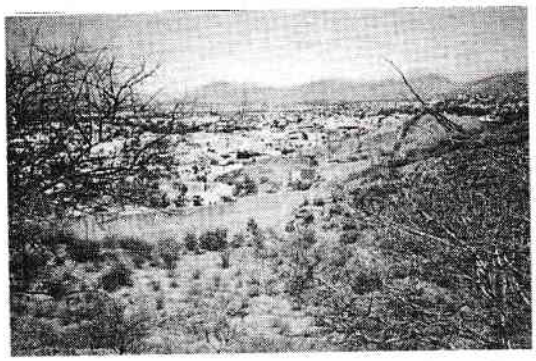


Fig. 8 (a) Inverted well on the Hill Side of Happy Valley

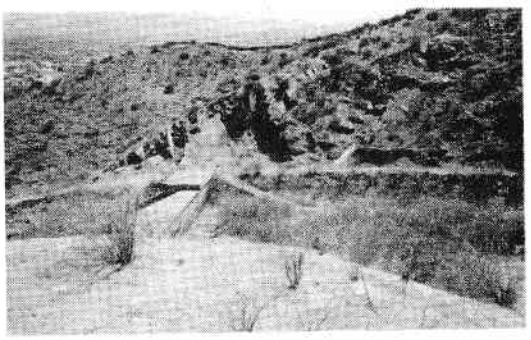


Fig. 8 (b) View Check Dam in Happy Valley

these ancient systems using our present hydrological understanding of rainfall-runoff processes, infiltration, saturated and unsaturated flow and evapotranspiration. In one of the few studies of its kind, van Wesemael *et al.* (9) describes the relationship between geomorphic location of a hydrologic engineering system and the water yield using a simplified curve number approach to surface runoff. With the advanced knowledge concerning hydrological fluxes presently available, a critical look at these ancient hydrologic engineering systems should lead to a theoretical understanding of the empirically arrived methods, and improvements to these systems based on current hydrologic understanding.

Most of the conventional structures are being in use as a dumping site, which are becoming potential source to pollution of groundwater resources. Their proper use is the need of the hour, as the construction of new structures for storing the water will cost more and also time consuming. Instead of constructing new structures old structures can be used properly to mitigate water shortage and poor quality of water. The total amount of stored groundwater will increase in a very specific and calculated fashion.

References

1. Desconnets J.C, J.D.Taupin, T.Lebel and C.Leduc(1997). 'Hydrology of the HAPEX-Sahel Central Super-Site: Surface Water Drainage and Aquifer Recharge through the Pool System,' *Journal of Hydrology*, 188-189, pp. 155-178.
2. Eltahir E.A.B (1996). *Sustainable Water Resources: Concept, Definition and Example.* Massachusetts: MIT. (Unpublished manuscript).
3. Fitzmaurice J (2000). *Ancient Hydrologic Technologies. Massachusetts* : MIT Class Project: 1.714 Surface Hydrology.
4. Giao P.H, N.Phien-Wej and Y.Honjo (1998). 'FEM quasi-3D Modeling of Responses to Artificial Recharge in the Bangkok Multiaquifer System', *Environmental Modelling and Software*, 14, pp.141-151.
5. Gore K.P, M.S.Pendke, V.V.S.Gurunadha and C.P.Gupta (1998). 'Groundwater Modeling to quantify the Effect of Water Harvesting

Structures in Wagarwadi Watershed, Parbhani District, Maharashtra, India', *Hyrological Processes*, 12, pp. 1043-1052.

6. Nash D.J (1999). 'Arid Geomorphology', *Progress in Physical Geography*, 23 (3), pp. 429-439.

7. Scanlon B.R, R.P.Langford and R.S.Goldsmith (1999). 'Relationship between Geomorphic Setting and Unsaturated Flow in an Arid Setting', *Water Resources Research*, 35(4), pp. 983-999.

8. Soil Conservation Service (1986). *Urban Hydrology for Small Watersheds*. Washingon D.C: US Department of Agriculture. (Technincal Release 55).

9. van Wesemael B, J. Poesen, A.Sole Benet, L.Cara Barrionuevo and J.Puigdefabregas (1998). 'Collection and Storage of Run-off from Hill-slopes in a Semi-arid Environment: Geomorphic and Hydrologic Aspects of the Aljibe System in Almeria Province, Spain', *Journal of Arid Environments*, 40, pp.1-14.

Socio–Economic Status of the Velips:

A Case Study from the Village of Morpilla, Goa

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Morpilla village of Quepem taluk of Goa has its 97 per cent of population belonging to Velip tribal community. The paper looks into their current socio-economic status from a sample survey of 58 households. The sex ratio in the village is low, 911. The basic occupation of the Velip households is agriculture, though now their participation in service sector has been increasing. About 40 percent lives below poverty line. Literacy level is improving fast. Most of their houses are smaller in size. With regard to household amenities, the Velips are found with low socio-economic standard of living.

(Received: January 2008; Revised: March 2008; Accepted May 2008)

Presently the state of Goa comprises of various scheduled tribes like Gawadas, Dhangars, Kunbis and Velips. The Velips stand unique in terms of their socio-economic characteristics and life style. They were denoted as scheduled tribe in December, 2002 from their original status of Other Backward Community (OBC). Velips are mainly concentrated in taluks like Canacona, Quepem and Sanguem which are considered as economically backward taluks of Goa (3). As a case study, village Morpilla of Quepem taluk, wherein 97 percent of population belongs to Velip community, has been chosen for the present study. The paper here makes a search for their current status and this is the main objective of this study.

Data and Methodology

The paper makes use of both primary and secondary sources for its data requirements. Structured questionnaires were administered for data collection from 58 households selected randomly. Collected information was tabulated, analysed and interpreted. Literacy, occupational structure, house type, household amenities, drinking water sources are some of the factors identified to assess the socio-economic status of the tribal people of the selected village. With these indicators, a composite index was developed, adopting a point-grading system. A scale of 2 to 10 points was selected and points were assigned to the factors based on the importance and status received by these factors among the households. For instance, television was given 2 points, two wheeler 4 points, telephone 6 points, gas 8 points, and 4 wheeler 10 points. Overall socio-economic status was assessed by a composite index, as low, medium and

□ The Indian Geographical Journal 82 (2) December 2007; published in June 2008

high: 0-5 points as very low; 5-10, low; 10-20, moderate; 20-25, high; and more than 25, very high.

Morpilla, the Village

Goa, one of the smallest states of the Indian Union, has eleven taluks and the village Morpilla is located in Quepem taluk (Fig. 1). It has a population of 2,511 persons of which 97 percent are Velips. Historically, the Velips in Morpilla are believed to have migrated from different parts of Goa. According to a legend, during 1365 -1370 A.D, the Turkey and Arab rulers looted the wealth of the temples of North Goa. During this conflicts, the devotees of Lord Saptakoteshwar from Narvem (Bicholim) shifted their God to one of the remote and densely-forested villages of South Goa, Morpilla (2); and then the village was occupied by groups of people, coming in streams - one after other from different parts of Goa. The first were the people from Gaondogrem (Canacona) who worshipped Lord Mallikarjun, followed by people from Cuncolim who worshipped Ramnath Sateri and Chandreshwar Bhutnath, then people from Balli and Fatorpa who were devotees of Shantadurga Ballikarin and Shantadurga Fatorpekarin, and people from Zambaulim , Adnem and Mogale . Thus Morpilla is thus a composite of people from different parts of Goa at different points of time in the historical past (4). It is believed that in the earlier time the village was the home of peacocks and gods. Morpilla derived its name from this belief. Located at the foot of the Western Ghats, the village is amidst mixed deciduous evergreen forest. Due to copious orographic rainfall,

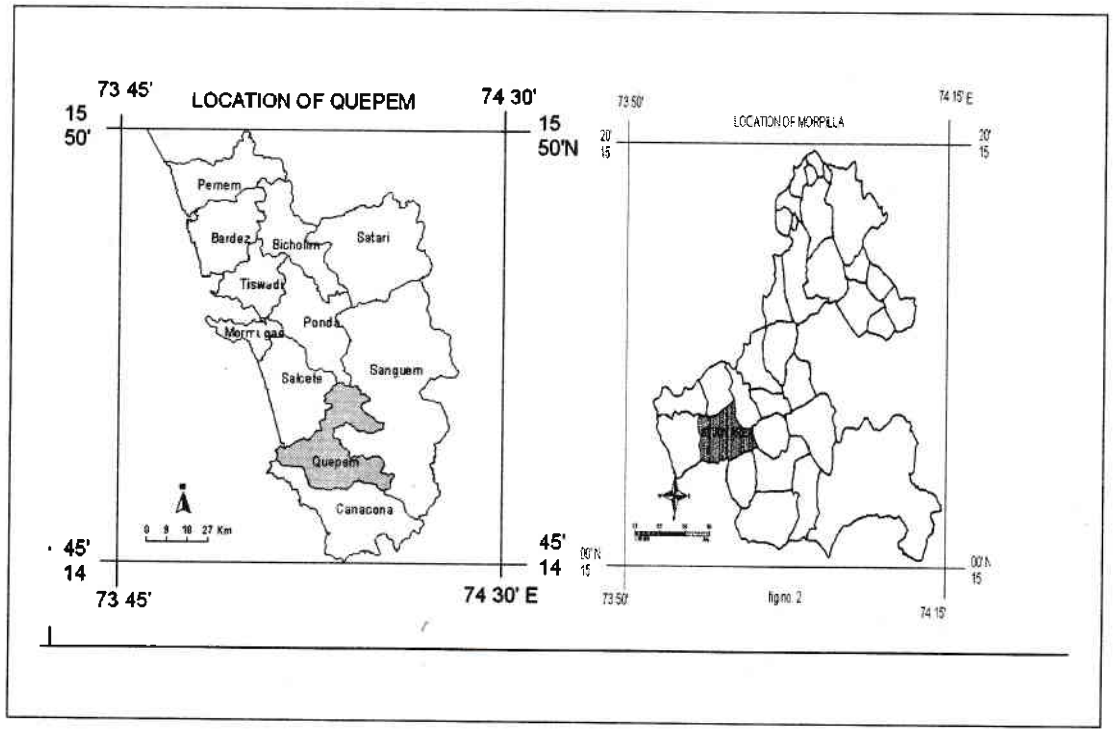

Fig. 1
Goa and Location of Quepem Taluk and Morpilla Village

many semi-perennial streams traverse the lands around.

People of Morpilla still have tribal traits and many of their activities are aligned with the environment (5). They are the worshippers of Lord Mallikarjun, Chandreshwar and Sapkoteshwar. The main festivals are the Ganesh Chaturthi, Diwali and Holi but the special festival is Gudulo, and uniqueness of the Velips lies in their folk dance i.e. Dhalo.

The village has one sub-primary health centre, a banking counter, post office, telephone service, a high school, two middle schools, five primary schools and five *balwadis* (nursery school). Balli and Cuncolim are the nearest markets and Balli is the nearest railway station (7 km) too. A well-laid road connects the village with the National Highway NH 17 between Margao and Karwar. According to the Census 2001, the total population is 2,511 with sex ratio of 911 females per thousand males. The literacy rate was 52.7 per cent (1). The decadal growth of population has been low and the people are mainly agrarian.

Discussion

The community is mainly engaged in agriculture. Some decades back, they practiced *kumeri* cultivation (shifting cultivation), but now with growing population pressure on land they till the land to grow paddy and other plantation crops. As per the available statistics for 1991, more than 60 percent of the land is now under agriculture. It is interesting to note that in the last three decades, proportion of households engaged in farming remains same. Census 2001 records that 84 percent of the workers are engaged in agriculture, of which 63 percent are cultivators and 22 percent, agricultural labourers. Over the decades, an increase in population coupled with increase in division of properties among the members of the family has resulted in the increase in the number of agricultural labourers. Further, due to reservation policy of the government , there has been substantial increase of job opportunities in other services. As per the survey, 12 percent is working in government offices. Many of the Velips work as clerks, peons and contractual labourers in the service sector. Secondary sector workers are very negligible. A few of the Velips youths are engaged in the wine-making (local drink - *feni*), bread and bakery products. With the help of government schemes, some own or hire transport vehicles and run a trade in the transport sector.

In brief, the Velips are basically farmers. During the rainy season, paddy cultivation is the main focus while during the post monsoon season cashew cultivation and cashew collection keep them engaged. They practice agriculture in a rudimentary way. Normally along the gradient of the hilly tracts, small rectangular fields are made in a terraced form. To plough the fields, a pair of bullocks is used and with the arrival of the monsoon, the agricultural operations begin. Women folk constitute the major workforce, mainly used for transplantation, weeding and harvesting. The harvest season is in the months of October – November. A casual glance on the landscape shows lowlands are devoted for paddy cultivation while the upland areas are brought under cashew and coconut cultivation.

As per the government official report, out of the total 492 households, 170 families fall

under the category of below poverty line (BPL), where the annual income is less than Rs 12,000/ per annum. This clearly signifies the economic status of the Velips.

As per Census 2001, about 52 per cent of the people in Morpilla are literate, with male literacy at 59 per cent and female literacy at 45 per cent. This level is far behind the state's mean. There has been good progress in literacy in the last three decades or so; in 1971, the literacy rate was 9 per cent and in 2001, it was 52 per cent, a remarkable achievement. The progress of female literacy is also quite appreciable.

On the eve of liberation of Goa, Morpilla had no school. Only in 1971, two primary schools were established. Now it has four primary schools, two middle schools, one high school, and five *anganwadis*. For college level education, the children have to go to the nearest town, Cuncolim. Nearly half of the Velips population is illiterate. From the study, one cannot deny the fact that the government is putting immense efforts to improve the social and economic status of the Velips through provision of education facilities. Of the literates, about 25 per cent had primary level education; about 20 per cent, high school level; and 10 per cent, higher secondary level Drop-out rate is higher in this community and importance of education is yet to be appreciated by all. The government has initiated some literacy drive through *Gurukul* scheme and educational loan.

In the case of house structure and size, the majorities of the Velips, due to their low economic status have semi pucca-houses (51.72 per cent) which comprises of two or three rooms(Table 1). Large houses are a few (i.e. 6 rooms), and this belongs to the family who still carry on their joint family system. The locally-available material forms the basis of construction. Walls are made of bricks of lateritic rocks and the roof is composed of wooden beams and country-made roofing tiles. Normally the floors are of mud plastered with cow dug.

All the houses are electrified and a limited population use toilets. Though the government provides subsidy (Rs. 7,500/-) for the construction of the toilets, not many take the advantage of the same. Only 29 per cent of the households have their personal toilets. There is a need for awareness for better sanitation amongst the people

Though the village receives annual rainfall more than 300 cm, provision for drinking water has been a matter of concern. The main sources are wells, springs, tap and water tankers. During the monsoon season, people normally drink tap water while in the post monsoon season, well water is the major source. Economically poor depend mainly on spring or well water. During the summer there is acute scarcity of water and therefore tanker services are made available(Table 1).

Sex ratio, female literacy and work participation rate play a key role in gender equality. In case of Velips of Morpilla, the sex ratio has been always been male-favoured. Over the decades, the sex ratio has dwindled from 950 females in 1971 to 911 females/1000 males presently. The decline of sex ratio requires a careful study.

The village has a primary sub-health centre and family planning centre. A field nurse daily visits the village. In case of serious casualty,

the patient is taken to the nearest primary health centre, Balli (7 km away) or to government hospital Hospicio at Margao town (25 km). Still there is a greater support among the people for the locally-available *ayurvedic* medicine and treatments. Here are some examples : In case of snake bite, people prefer local *vaidya* who gives traditional medicine, *moli udak* (medicated water made of roots of the plants); similarily, in case of kidney stone problem , the people prefer the traditional *ayurvedic* medicine.

Household amenities may also indicate the socio-economic progress of the people. In this context, possession of telephone, television, two wheeler, gas, computer and four wheeler was considered. An index value is assigned to each of these amenities based on the importance and ability to buy each of the item; for instance, value 2 was given to telephone; index values assigned are 2, 4, 6 and 10; possession of car draws a value of 10. The composite index ranged between 0-30 points. Out of the total 58 houses, 26 houses did not have any of the amenities, and here the composite point index value was zero i.e very low economic status. One fourth of the houses had a composite index of less than ten points (low economic status), and the rest had score more than ten to thirty points. This indicates that the Velips have a low socio economic living standard.

Conclusion and Suggestions

The study proves that the Velips have not reached the desired level of development. In response to this, the government has been making earnest efforts by executing various programmes and schemes for their uplifment. There is a greater need to improve the literacy level of the community that opens up many opportunities for improving the socio-economic level. As the agriculture is the main occupation of the people, and farming is largely practiced with rudimentary technology, it is essential for them to adopt modern technologies in farming to increase the productivity. For the products from the plantation crops like cashew, pineapple and vegetables, a cooperative organization in the village for marketing may be a good

Table 1
Socio – Economic Aspects of Morpilla Village

Indicator	*Percentage*
1. Family Size	
3 Members	5.17
4 Members	34.48
5 Members	32.75
6 Members	8.62
7 Members	5.17
>8 Members	13.79
2. Size of the House	
2	31.47
3	34.48
4	17.24
5	1.72
6	5.17
3. House - Type	
Kuccha	0
Semi-Pucca	51.72
Pucca	43.1
RCC	5.17
4. Source of Drinking Water	
Well Spring	15.51
Tanker and Tap	43.1
Well, Spring and Tanker	42.39
5. Aggregate Status	
Aggregate socio - economic status Points of Status	**No. of Households**
0-5 very low	0 - 26
5-10 low	14
10 - 5 Moderate	8
15 - 20 Moderate	5
20 - 25 High	1
> 25 Very high	4

Source : Navhind Times, July 10.

proposition to maximize the profit. Agro-based industries for processing, canning and packing of the products like cashew have to be promoted by the government in this village. Local governments have to take efforts to make the tribal people aware of the new technologies, government's programmes and facilities available for development. To improve the economic status of the people, the government has started with self employment scheme which enables the Velips to avail loan for starting own independent business. Very recently the government has also announced watershed management scheme with an input of three crore rupees . This programme aims at soil and water conservation. To provide proper shelter and sanitation to the people, the government has initiated Indira Awaas Yojana and Sulab Sochalaya schemes.

References

1. Census of India(2001). *District Census Handbook – South Goa*. New Delhi: Census of India.
2. Desai Shaba (2005). 'Faterpakaniche Devastan: Goikarache Shradhastan', *Sunaprant*, December, 30.
3. Karin Larsen (1998). *Faces of Goa*. New Delhi: Gyan Publication House.
4. Sakhardhande Prajal (2005). *'OF GOA' and Kunbis Entomology'*, *Navhind Times*, July 10.
5. Singh K.S (1994). *People of India: The Scheduled Tribe*. New Delhi: Oxford University Press.
6. *Economic Survey 2004-05*. Panaji: Government of Goa.

Short Communications

Major Challenges of Iranian Rural Communities for achieving Sustainable Development

Twenty years ago, Our Common Future (15) presented a new way of looking at human settlements. The new paradigm, called sustainability, got developed on the scientific evidence that indicated rapid destruction of air, water, species of flora and fauna, forests, and other ecosystems as well as overuse of natural resources (3). Thus the Brundtland Commission Report thrust the concept of "sustainable development" into the mainstream of world debate, to confront the twin problems of environmental degradation and necessary economic development. The commission's report defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (15). In the early 1990s rural development was almost a synonym for the agricultural sector. Now it is clearly understood that it also includes other industries employing the rural population, as well as social issues such as education and training, environmental protection, medical care and infrastructure (10). By incorporating the dimension of time, or future, the definition of sustainable development introduced three inter-connected, mutually inclusive themes, or spheres: the environment, society and economics (11). Numerous authors have presented the union of these spheres to graphically illustrate the concept of sustainability (4, 9)(Fig. 1).

According to the sustainability paradigm no single sphere should be allowed to dominate a development decision. In fact, each of the spheres should be taken into equal consideration prior to any economic decision (5).

In the words of Wilkerson and Baruah (14), while sustainability has local, regional, national and international dimensions, ultimately, it must be achieved at the local level where people live, work, and interact with each other and with nature. Since 1987, however, a number of different agencies has attempted to operationalize the concept of sustainable development at the community level. A community defined in terms of sustainable development means, the pursuit of modes of economic development that is not just "environmentally friendly", but which also offer the community long- term economic

□ The Indian Geographical Journal 82 (2) December 2007; published in June 2008

stability, diversity and prosperity(2). In this context a sustainable economy means building a local economy that is both stable and diversified. The social sustainability means, a community satisfies basic human needs for food, shelter, education, income, safe living and working conditions, job opportunities, equity and social well-being, participation and involvement (11).

Today the terms sustainability and sustainable development are used interchangeably. These terms define a new approach to development that requires the broad integration of economic, environment and social factors in contrast to the traditional economic growth model that advances only the economic condition at the expense of the environmental and social conditions (11). Thus the concept of sustainability introduces a new way of thinking about development, one which requires the entrenchment of environmental and social considerations into economic policy making (11).

In Iran 23 million people living in rural areas where they directly or indirectly depend on agriculture to survive, while most of them are

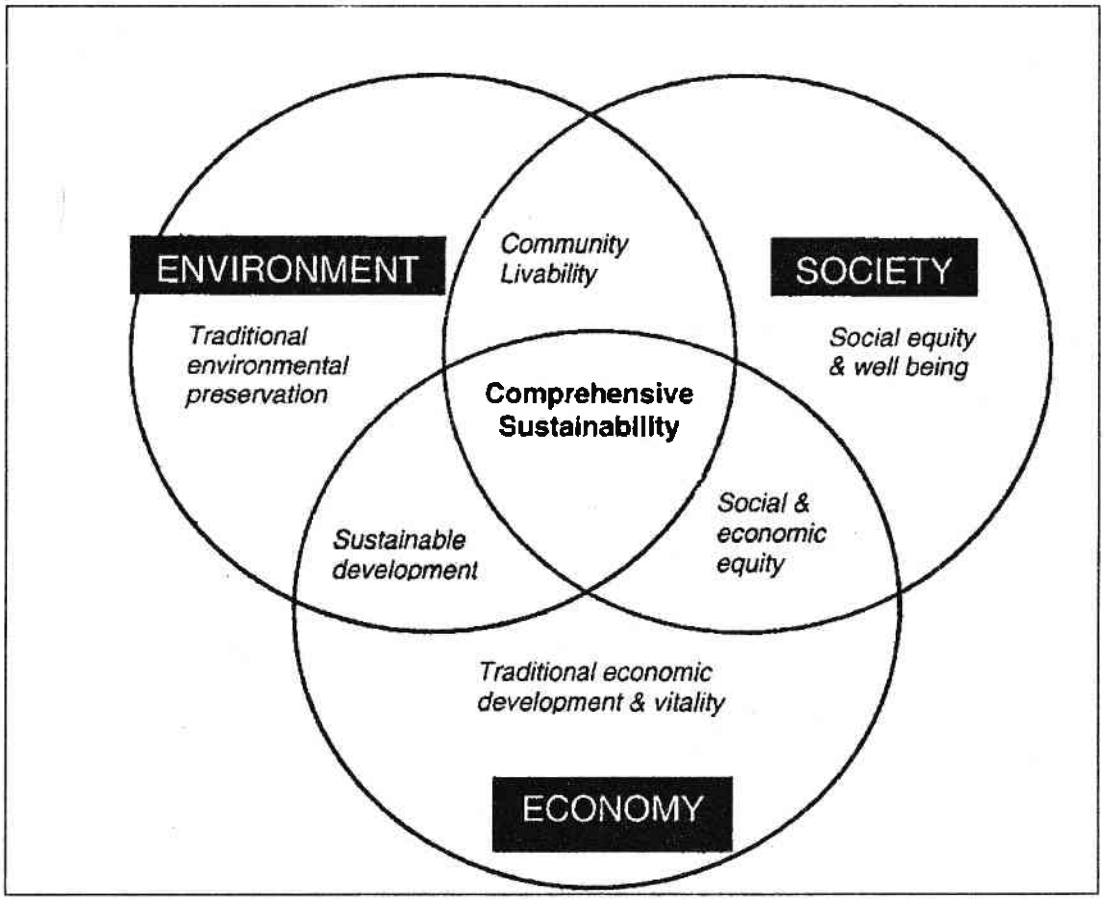

Fig. 1 The Three Spheres of Sustainability

Source: www.tcst.org

living under poverty line. Still Iranian rural economy is dominated by agricultural sector which accounts for 27% of GDP, 22.9% of employment opportunities, 82% of food supply and 35% of non-oil exports, plus considerable raw materials for industrial use (7). These figures show that rural economy has an important role in national economy. To establish a sustainable economy in rural areas, almost every village needs credit, clean seeds, infrastructure and guidance in crops and livestock production. They also need farm machinery, marketing facilities, cooperatives, water supplies and education. For a sustainable and efficient rural development, each village must be provided with all of these inputs and functions. Integration of the functions and efficient management demand an active and sustainable local communities and institutions. Today a large number of government organizations deal with the development of agricultural and other issues in rural areas. The institution which is most influential in rural development is the Ministry of Agricultural *Jihad*, which is responsible for the agricultural sector, forestry, natural resource, fishery and several rural industries. Other ministries are involved with the process of rural development according to their area of activities. This implies the sectoral approach in rural development prevails over the territorial approach in Iran. The rural problems are tackled by various government institutions, and this requires appropriate co-ordination among them. Lack of such co-ordination and co-operation among institutions and organizations involved in rural development is a serious problem affecting sustainable rural development in Iran. Thus, the main goal of millennium development in Iran should have a focus on methods of sustainable rural development. This depends on addressing the challenges of sustainable rural development in Iran. Thus the main objective of this study is to investigate major challenges of Iranian rural communities for achieving sustainable development, and provide some recommendations in this respect.

Materials and Methods

In this paper data and information were gathered through extensive survey questionnaires filled out by 60 experts of rural development of relevant departments of Management and Planning Organization, Ministry of Agricultural *Jihad* and Housing Foundation. Factor analysis was applied to analyze interrelationship between a large numbers of variables and to explain these variables in terms of their common underlying dimensions.

Results and Discussion

In this study 58 challenges in respect of sustainable rural development were considered. In total 60 experts of rural development from four different ministries and organizations which are engaged in the process of policy – making, planning and implementation of rural development projects were selected to evaluate the major challenges of sustainable rural development in Iran. Factor analysis was applied to reduce the number of challenges and detect structure in the relationships between variables. KMO measure of adequacy (0.72) and Bartlett's Test of Sphercity (Approx. chi-Squar= 2512.39, with Sig. = 0.000) showed that the data are appropriate for factor analysis. Confirmatory factor analysis was used and out of 58 challenges only 35 challenges got clusterted

Table 1
Eigen Values and Variance explained by Each Factor

Factors	Eighen Value (%)	% of Variance
Economic Challenges	6.772	18.302
Management and Planning Challenges	5.062	13.608
Environmental Challenges	4.622	12.492
Social Challenges	3.941	10.651
Physical Challenges	3.845	10.391

into 5 factors which explained 65.52% of variance (Table 1).

Factor loadings of each variable are shown in Table 2. It is depicted from Table 2 that, lack of diversification in rural economy, particularly in non-agricultural sector (0.843), low income level (0.734), lack of commercialization in agricultural production (0.830), rural poverty (0.771), mechanization problem (0.734), lack of investment in tourism (0.811), low productivity in rural economy (0.769), insufficient allocation of budget for rural development (0.750), lack of basic infrastructure (0.825), and limited access to agricultural production markets (0.588) are the main challenges of economic sustainable development of rural areas. Economic challenges contain 27.93% of total explained variance (Table 1). Overall situation indicates that the rural economy is too much dependent on agriculture. The problems of agriculture, the poor shape of infrastructure that hinders the development of another industries, and the increasing average age of the rural population due to rapid out-migration of youths are the main obstacles towards successful economic development of rural areas. Second factor is related to management and planning challenges. This dimension includes 20.88% of total explained variance (Table 1). Interposing of various government organizations in rural development plans (0.831), theoretical weakness and lack of an appropriate operational model of sustainable rural development (0.907), absence of people participation in implementation and maintaining of rural development projects (0.928), lack of a coherent strategy for sustainable rural development (0.793), absence of participation of NGOs and local organizations in planning and implementation process of rural development projects (0.599), uncoordinated plans and policies for rural communities (0.804), and lack of sufficient attention for sustainable rural development (0.660) are among the major challenges of sustainable rural management and planning. Third factor is named environmental challenges which contain 19.07% of total

explained variance. Land use change from agriculture to non- agricultural activities (0.581), unfavorable ecological conditions for sustainable rural development (0.896), weakness in rural natural disaster management (0.672), lack of balance between human and natural resources (0.852), over-exploiting of underground water resources (0.629), use of unsuitable technology in agricultural sector (0.919), and rural sanitation problems (0.700) are considered among environmental challenges. Social sustainability is another important dimension of sustainable development. In this context Iranian rural communities face with various basic challenges. Lack of attention to villagers indigenous knowledge in various economic activities in general and agricultural activities in particular (0.722), shortage of job opportunity for rural youths (0.785), lack of awareness of villagers in respect of methods and principles of accessing sustainable development (0.684), insufficient population threshold in many rural settlements for providing social services (0.816), domination of unqualified work force in rural economic activities (0.631), and lack of social justice in providing socio-economic facilities between rural and urban areas (0.671) are important social challenges of sustainable rural development (Table 2). Social dimension includes 16.26% of total explained variance (Table 1). Factor analysis explored several physical challenges which contain 15.87% of total explained variance. Weakness in rural infrastructure (0.987), lack of an appropriate urban-rural linkage to provide socio-economic facilities (0.929), vulnerability of rural settlements to natural disasters (0.667), lack of an appropriate spatial organization of rural settlement system (0.890), and existing wide gap and disparities between urban centers and rural communities (0.670) are among important challenges of physical dimension of sustainable rural development.

Conclusions and Recommendations

It is true that more than 50 years of planning in Iran has led to better living conditions for villagers. But the point of concern here is that the community has to go a long way to achieve a sustainable local living. Most of the rural development projects have been designed and prepared through government agencies during the past five decades of planning with the least or lack of participation of rural people (1). It must be emphasized that this kind of centralized planning has been organized through centralized oil revenue. Now with the necessity for more decentralization and privatization, people's participation is very critical to the whole process of sustainable rural development. It is emphasized that rural development cannot be observed without public support and involvement of the whole society.

Today it is clear that rural communities face with various challenges in achieving a sustainable development. It seams that sustainable rural community development in Iran can be achieved through:

- Diversification of rural economy and capacity building of rural communities.
- Supporting job creation activities and promoting sustainable tourism, business and industrial activities based on rural social and economic potentials.
- Encouraging people for participating in the process of planning, executing and

Table 2

Factor Loadings of Challenges of Rural Communities for achieving Sustainable Development

Factor	Challenges	Factor Loadings
Economic Challenges	- Lack of diversification in non-agricultural activities	
	- Low level of income	
	- Insufficiency in commercialization of agricultural production in dominant agricultural operations	
	- Rural poverty	
	- Mechanization problem of agricultural sector	
	- lack of investment in tourism	
	- low productivity in rural economy (agriculture, rural industries, ...)	
	- Insufficient allocation of budget and credits for rural development	
	- lack of basic infrastructure for rural industrial development	
	- limited access to agricultural production markets	
Management & Planning Challenges	- Interposing of different government organizations in rural development plans	
	- Theoritcal weakness and lack of an appropriate operational model for sustainable rural development	
	- Weakness of people participation in implementation and maintaining of rural development projects.	
	- Lack of coherent strategy for sustainable rural development	
	- Absence of participation of NGOs and local organisations in planning and implantation of rural development projects.	
	- Uncordinated plans and policies for rural communities	
	- Lack of sufficient attention for sustainable rural development	
Environmental Challenges	- Land use change from agriculture to non-agriculture	
	- Unfavourable ecological conditions for sustainable rural development	
	- Weakness in rural natural disaster management	
	- Lack of balance between human and natural resources	
	- Over-exploiting of underground water resources.	
	- Use of unsuitable technology in agricultural sector	
	- Rural sanitation problems	

Table 2 (Contd.)
Factor Loadings of Challenges of Rural Communities for achieving Sustainable Development

Factor	Challenges	Factor Loadings
Social Challenges	- Lack of attention to indigenous knowledge in different dimensions of sustainable rural development	
	- Shortage of job opportunities for rural youths	
	- Lack of awareness of villagers to the methods and principles of accessing sustainable development	
	- Insufficient population threshold in many rural settlements for providing social services	
	- Domination of unqualified work force in rural economy	
	- Lack of social justice in providing socio- economic facilities between rural and urban areas	
Physical Challenges	- Weakness in rural infrastructure such as (road, health facilities, water, etc.)	
	- Lack/weakness of urban-rural network for constructing a logical linkage between rural centers and small towns to provide socio-economic services	
	- Vulnerability of rural settlements to natural disasters	
	- Lack of an appropriate spatial organization of rural settlement system	
	- Existing wide gap and disparities between urban centers and rural communities	

maintaining rural development projects.

- Establishing an appropriate urban- rural network to serve rural areas by small towns.
- New economic policy needs to be established encouraging micro-enterprise supported by micro-capitals, and national policy must secure, protect and improve rural livelihoods.
- A new rural sector strategy has to be prepared that incorporates the following objectives: structural change to the production system, with suitable utilization of productive resources and environmentally friendly technologies, and sustainably-managed resources; no urban bias in health, education and safe water provision; off-farm income and employment generation; decentralized and participatory decision making; functioning rural markets; and widely-shared rural economic growth.

References

1. APO (2004). *Role of Local Communities and Institutions in Integrated Rural Development.* APO.
2. Berkes F and C. Folke (1998). 'A System Perspective on the Interrelationship between

Natural, Human-made and Cultural Capital', *Ecological Economics*, 5.

3. Haman, Z.Dorota and A.Donald Brown (1994). 'Promoting Sustainable Agriculture and Rural Development'. Florida: Institute of Food and Agriculture. (Bulletin 293).
4. Hart M (1999). *Guide to Sustainable Community Indicators*. North Andaver: Hart Environmental Data.
5. Haughton G and C. Hunter(2003). *Sustainable Cities*. London: Jessica Kingsley Publishers.
6. Management and Planning Organization (2003). *Third Five Year Plan*. Tehran: MPO, Iran.
7. Ministry of Agriculture(1999). *Iran Agriculture at a Glance*. Tehran:Deputy of Planning, Ministry of Agriculture.
8. Ministry of Agriculture(2001). *Agricultural Statistics*. Tehran: Bureau of Information and Statistics, Deputy Ministry of Plan and Project.
9. Newman P and J. Kenworthy (1999). *Sustainability and Cities: Overcoming Automobile Dependence*. Washington, DC: Island Press.
10. Rivza B and S. Ancans (2000). *Actors, Institutions and Attitudes to Rural Development: The Latvian National Report*.
11. Roseland M(1998). *Toward Sustainable Communities: Resources for Citizens and their Governments*. Gabriolo Island: New Society Publishers.
12. Statistical Center of Iran (2005). *Socio-economic Changes of the Country from the View Point of Statistics*. Tehran: Statistics Center of Iran.
13. Water and Sewage Engineering Co (1999). *Situation of Water and Wastewater in the Country*. Tehran: Ministry of Energy.
14. World Commission on Environment and Development (WCED (1987). *Our Common Future*. New York:Oxford University Press.

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(Received: September 2007; Revised: December 2007; Accepted: February 2008)

Local Knowledge, Gender and Resource Management

Local Knowledge (LK) has existed for as long as human society has existed, but it is only in recent decades that it has been recognised and defined as such by the scholarly and scientific community. Over the last quarter century, the focus on people's participation in the research and development process began to build a parallel appreciation for traditional ways of doing and learning. Outsiders started recognizing the traditional ways the communities follow in realms of production and human and environmental health(1). The current emphasis on local and environmental knowledge has sprung from this more general awakening to the value of local knowledge. However, being able to determine what the terminology really refers to is the first challenge of being able to effectively access and use LK in research and development work at all levels, locally, nationally and internationally.

Both the instinctive adaptation of LK that takes place over just a few years, as well as the more stable body of knowledge transferred from generation to generation, can be valuable in a given process of research and action. However, current day knowledge is sometimes undervalued or dismissed by social science researchers, who see it as inauthentic compared to other forms of knowledge. Local knowledge (LK) (2) is considered as valuable as Traditional Ecological Knowledge (TEK). The main issue, however, is essentially whether or not the knowledge is still relevant or useful in the current local context. The utility factor contributes to the valuation of local knowledge as a legitimate area of research and exploration as well as a tool for future development and community action.

This term, LK, sometimes has been taken to refer solely to tribals discounting the fact that other local people may also possess valuable insights and understandings. In fact, the interpretation of the term, indigenous, can eliminate from consideration the knowledge of people who are migrants to the area, as they would be considered non-native or non-local populations. In many parts of the world, this effectively restricts recognition of women's roles in local generation, possession, and transmission. Women usually migrate after marriage to their husbands' locale and are therefore not usually native to the area they inhabit for the majority of their life.

The Purpose, the Study Area, and the LK

This paper examines the findings of a study of LK in the Thevaram basin of Tamil Nadu, India. The study was conducted during March 1999-March 2001. A Canadian intern had a project in five villages, Bodi Ammapatti, Maniampatti, Pottipuram, Rasingapuram and Silamalai of Theni district in Tamil Nadu on Women and LK (7) towards her Masters' research. This research used participatory approach to record LK, besides interview methods.

The five villages are in the rain shadow of the Western Ghats and are affected by desertification, and dunes are encroaching and drifting in an area of about 12,000 ha. The villages have a population of nearly 80,000, spread over 18 hamlets under five village *panchayats.* The people appear to be enterprising but they suffer from poverty too

□ The Indian Geographical Journal 82 (2) December 2007; published in June 2008

because of desertification and failing rainfalls; and so they require specific strategies for environmental management

Local Knowledge in Practice

In the interview process, women spoke more about traditional practices such as the customary medicines used to treat minor illnesses and more serious problems like snakebites. A few of them also mentioned a traditional connection between the environment and spiritual beliefs, an integrated perspective characteristic of 'sacred ecology' (2). In the context of belief, one refers to a particular *pooja* (prayer ceremony) wherein the community asks for rainfall and better weather conditions for their crops. In this particular *pooja*, offerings used to be made and prayers would be said at a community gathering. Of course, this kind of community gathering has been loosing its momentum in these days.

Soil Quality Improvement

Men, more than women, 58.2 per cent as compared to 48.0 per cent, indicated that there was a body of local knowledge relating to soil quality improvement strategies (Table 1). When questioned regarding their sources of information on soil quality improvement tactics, 42.5 per cent of the women indicated that neighbours were their main source, with 39.2 per cent relying on their own knowledge. Men predominantly (58.0 per cent) relied upon their own understandings as well, with only 32.6 per cent relying on neighbours. Male respondents were nearly as likely to get information from relatives (5.1 per cent) as from government officials (4.3 per cent) while women went to relatives (15.0 per cent) much more often than to government officers (3.3 per cent).

In the literature on traditional knowledge, it is women who are often privileged as being the keepers of traditions, particularly when it comes to information about the environment (4). In this case, however, the activity in question, soil improvement, is one for which men are generally traditionally responsible. Women have little input into the soil improvement process, and in fact, even their labour is little utilised in this process as most of the work is done with cattle, carts and ploughs.

Table 1
Souces of Information on Soil Quality Improvement Strategies among Villagers of the Thevaram Basin

Soil Quality Improvement	Local Knowledge % (#)		Sources of Information % (#)	
Female	Yes	48.0 (60)	Neighbours	42.5 (51)
	No	52.0 (65)	Relations	15.0 (18)
			Government	3.3 (4)
			Own Experience	39.2 (47)
Male	Yes	58.2 (82)	Neighbours	32.6 (45)
	No	41.8 (60)	Relations	5.1 (7)
			Government	4.3 (6)
			Own Experience	58.0 (80)

Sources: Field Survey 1999-2000. # Number

Women, whose traditional domain is in the home, tend to have more contact and communication with neighbours and relations than men and, as a result, consider sources of information from these familiar domains as most important. Men, in contrast, have more outside interaction, especially with officials in various capacities. As a result, they are as likely to go outside for information as they are to get information from family members. Also, the traditional gender positioning of the male as the head of the household helps to consolidate the fact that they rely first on their own knowledge and then later on others outside the family structure. They express a high degree of confidence and pride in their ability to make decisions and take actions of their own accord (3).

- There is general agreement that the land is good, but that the quality of the soil has markedly decreased over the years.
- Soil improvement strategies are becoming more expensive and less effective due to the long-term effects of chemical fertilizers and pesticides on the land.
- Traditional land reclamation methods are discounted as a viable agricultural improvement strategy because of prohibitive time and labour costs as well as a sense of futility in that they are not lasting measures, but rather, temporary interventions.

Water Management

Both men and women had equally mixed responses to questions of knowledge and use of the *theppam*, a traditional water management and irrigation strategy. Overall, 51.5 per cent of respondents reported having knowledge of the *theppam* structure while 48.5 per cent reported not having any understanding or information about it at all (Table 2). In fact, sixty per cent of women and and 67 per cent of men make use of the pump-sets to obtain the water required to meet their daily needs, be they agricultural or otherwise.

A *theppam* is essentially a small scale holding tank for water in agricultural areas. It is usually constructed by digging up the earth to make the tank of desired size, and then lining the structure with silt (*karambai*) to seal it so as to prevent water from percolating through. The *theppam* is usually located adjacent to the pumpset and is generally filled with water overnight, while the electricity is available. Then, the next day, the lands are irrigated not

Table 2
Use of Traditional Vs. Modern Water Management Strategies in the Thevaram Basin

Water Management Strategies	Use of *Theppam* % (#)		Use of Motor/ Pumpset % (#)	
Female	Yes	54.1 (53)	Yes	60.3 (73)
	No	45.9 (45)	No	39.7 (48)
Male	Yes	48.9 (65)	Yes	67.4 (97)
	No	51.1 (68)	No	32.6 (47)
Total	Yes	51.5 (118)	Yes	63.9 (170)
	No	48.5 (113)	No	36.1 (95)

Source: Field Survey 1999-2000. # Number

only with the use of the pumpset, but also with the water in the *theppam* getting released into the fields through a system of field channels. This practice improves irrigation efficiency as it speeds up the process and also allows more water to be available for release into the fields than would be possible using the pump-set alone. As electricity is not always available or reliable, the storing of water for irrigation also serves a very practical purpose.

Since the *theppam* is a micro-level, locally evolved strategy, its usage and reputation is fairly limited and varies widely from village to village depending on their particular circumstances. According to farmers interviewed about it, knowledge of the *theppam* as a water management practice has been diffused primarily by chance observation and word of mouth(5).

- Rainfall in the area is much lower now than in the past, causing a moderate level of water scarcity although the quality of the water remains relatively good.
- Traditional water management strategies such as the *theppam* are less widely known and less utilised than more recent strategies like the pumpset and the bore well, due to lack of dissemination of information and lack of interest in traditional practices.

Wind Prevention Strategies

While a majority of the people of the villages, approximately 55 per cent, was quite aware of strategies to overcome the effects of the high winds, such as tree planting, shelter belt and hedge construction, there was some discrepancy between women's knowledge and men's knowledge. Familiarity with the strategies of planting hedges and shelterbelts was almost on par among women. However, between women and men, knowledge of the planting of shelterbelts was higher among male respondents (81.3 per cent) than among females (62.9 per cent) (Table 3).

The discrepancy between women's and men's awareness of different wind prevention strategies has to do not only with the traditional gender division of labour, but also with the perception of hedge planting as being simple or easy work. In contrast, the construction of shelterbelts, staggered rows of varied species of trees, situated in a particular way as to break the wind, are considered to be in need of more technical expertise and thus are more of a male task and responsibility. In fact, historically, shelterbelts in this area have been the domain and responsibility of males, particularly of government extension workers. The local people themselves, rather than being involved in initiating and promoting shelterbelts on their own, have simply been

Table 3
Awareness of Wind Prevention Strategies in the Villages of the Thevaram Basin

Wind Prevention	Awareness of general strategies % (#)	Knowledge of planting hedges % (#)	Knowledge of constructing shelter belts % (#)
Female	57.3 (67)	62.7 (94)	62.9 (88)
Male	57.3 (67)	74.0 (111)	81.3 (122)
Total	139 positive responses	201 positive responses	210 positive responses

Source: Field Survey 1999-2000. # Number

hired to carry out some of the manual labour associated with the projects, including planting and "watching" over the trees.

- High winds still continue to disrupt daily activities in the study area; however, they are perceived to be more moderate now than in the past.
- The majority of people are aware of environmental strategies for wind prevention such as hedge building and shelterbelt construction, even if they do not have direct experience of them.
- People feel as if they do not have the expertise, nor the time and land available to take up hedge and shelterbelt initiatives of their own; instead, they feel that the government should reestablish an appropriate scheme.

Gender Analysis Matrices

The Gender Analysis Matrix (GAM) developed by Parker (6) under the auspices of UNIFEM was selected as a prime tool for use in the research here. The gender analysis matrix provides a forum for examining the interconnected nature of humans with their environment. As well, it reflects the notion that elements of community such as labour, time, resources and culture, are all an integral part of understanding how an ecosystem as a whole functions and how community members could most effectively operate in the context of their local situation.

The matrix is broken down to examine impacts on labour (activities), time, resources and culture, and their implications for women,

Table 4
Sample Gender Analysis Matrix on Shelterbelt Construction

	Labour	Time	Resources	Culture
Women	Planting trees, watering, looking after trees until grown, making fences	8 a.m. to 2 p.m. Daily Salary: Rs.25	Pot for watering, knife for weeding, good path to get to the area	Good results for village
Men	Digging up the ground, making bunds, packing sand around plants, write petitions	6 a.m. to 1 p.m. Daily Salary: Rs.70 - 80	Implements for digging and packing sand, unity of vilalge people, education for writing petitions	N/A
Household	Those in joint families have support, those living separately don't get any help	4 p.m. to 6 p.m. (cooking time - only if living in own house)	Provisions for cooking	Workload increases if living separately from family home, increase stress
Community	Provide salary for workers, select the labourers, give new ideas	Supervising the labourers	Money and ability to select labourers without favouritism	People will fight if not selected for work, conflict if htere are not good results.

Source: Field Survey 1999-2000.

men, the household and the larger community. The structure of the categories is based on the assumption that different sectors of the community will be impacted differently by development initiatives (6, 8). It takes the form of a chart (Table 4) that works from the objectives or proposed activities of a project and analyses them, in a group setting, to gain a consensus on the possible outcomes or impacts of the proposal.

Summary

The study has examined, analyzed and revealed perspectives relating to LK and gender in local resources management in the villages of Thevaram basin in Theni district, Tamil Nadu, India, threatened constantly by desertification. People of the villages seem to be aware of LK in management of resources like land (soil), water and wind. They have categorically indicated that the LK has a very slender hold on resource management in these days. There has been a clear indication in their responses that men and women do take part in equal measure but they know and do differently the processes and practices in natural resources management. The gender analysis matrix reveals that different groups in the villages have different experiences of a given strategy.

Acknowledgement

The author wishes to acknowledge wholeheartedly the munificent grant from the Shastri Indo-Canadian Institute, New Delhi and Calgary for the study under the CIDA-SICI Partnership Programme Phase II, during 1999-2001.

References

1. Berkes F (1993). 'Traditional Ecological Knowledge in Perspective', in J.T. Inglis (ed.). *Traditional Ecological Knowledge: Concepts and Cases*. Ottawa: International Programme on Traditional Ecological Knowledge and IDRC.
2. Berkes F (1999). *Sacred Ecology: Traditional Ecological Knowledge and Resources Management*. Philadelphia: Taylor and Francis.
3. Goulet D (1989). 'Participation: The Road to Equity in Development?', *Labour and Society*, 14(1), pp. 1-21.
4. Hausler S (1992). 'Reformulating Social, Cultural, and Ecological Sustainability', *Journal of Sustainable International Development*, 2, pp. 46-50.
5. Oakley P and C. Garforth (1985). 'FAO Training Series, No. 11: Guide to Extension Training'. Rome: FAO.
6. Parker A. R (1993). 'Another Point of View: A Manual on Gender Analysis Training for Grassroots Workers'. New York: United Nations Development Fund for Women (UNIFEM).
7. Tummon N.M (2001). 'Gender and Participation in Rural Community Development in the Thevaram Basin, Tamil Nadu, India'. Guelph: University of Guelph. (Graduate Thesis).
8. Wavey R (1993). 'International Workshop on Indigenous Knowledge and Community-based Resource Management, Keynote Address', in J.T. Inglis (ed.). *Traditional Ecological Knowledge: Concepts and Cases*. Ottawa: International Program on Traditional Ecological Knowledge and IDRC.

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(Received: September 2007; Revised: January 2008; Accepted: March 2008)

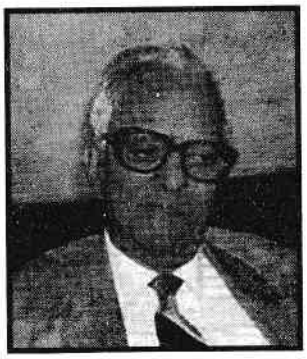
Obituary

Prof. Mohd. Shafi (1924-2007)

It is very difficult to believe that Prof. Mohd. Shafi, the doyen of Indian Geography, is no more. I have been closely associated with him since 1967, first as his student at post-graduate level, then as his research scholar and later as his colleague. He was not my teacher only, but '*guru*' in real sense, father and pillar of strength at every occasion. The vacuum which has been created by his demise will never be filled.

Prof. Mohd. Shafi, popularly known as 'Shafi Saheb' among his close friends, associates and students was born in a humble family on 1st August, 1924 in Jaunpur. He did both his High School (Government High School) in 1941 and Intermediate (Kshattriya Inter college) in 1943 from Jaunpur, B.A. (Allahabad University) in 1945, M.A. (Aligarh Muslim University) in 1947, and Ph.D. (London School of Economics) in 1956.

After his post-graduation in 1947, he joined the Department of Geography, Aligarh Muslim University, as Survey Assistant, became a Lecturer in 1948, Reader in 1959, Professor and Head of the department in 1962. He remained as the Head till his retirement in 1984 after which the University appointed him as Professor Emeritus. Under his stewardship, the department got a place on the International Map. His meticulous style of work, self discipline, punctuality, hard work, and management of time and people around him, paved the way for his success. He used to say that he imbibed all these qualities from his teachers at different stages. He used to enter the class at the stroke of the bell. His lectures were so engrossing that 'one period' appeared to be too short and always left an appetite for knowing more. He had the interest of students



Prof. Mohd. Shafi

at heart. He religiously adhered to the 8 a.m. to 5 p.m. schedule. After his retirement he refused to fade away and followed the same schedule. He remained creatively active, fully involved and full of vigour. I adored him from heart but always felt jealous of him that I can not put same amount of work as he did.

Geography was his first love. And his geographical philosophy was the same which he learnt at London School of Economics. Shafi Saheb's personality had the permanent influence of his research supervisor, Professor Dudley Stamp, a leading light in Geography in those days. He was a 'Stampian' all his life. His study of 'Land Utilization in Eastern Uttar Pradesh' was a trend setter for future researches in the field of Agricultural Geography at Aligarh. He developed the strong study group of Agricultural Geography for Indian scholars, and Aligarh School of Landuse Studies under Shafi Saheb earned the department world-wide acclaim. He had successfully supervised 34 Ph.D. theses. He had written 13 books on various aspects and published 139 research papers in national and international journals. His work has been

widely cited in books and journals both abroad and in India. He had presided over meetings of International Geographical Congress in London (1964), Kingston, USA and Mexico (1966), Leige (1967), Prague (1967), Budapest (1971), Montreal (1972), Moscow (1976), Riyadh (1982), Tokyo (1986), Damascus (1981), Rio-de-Janerio (1982), Paris (1984), Barcelona (1986), Auckland (1987), Sydney (1988), Istanbul (1989) Budapest (1989) Beijing (1990), Washington (1992), The Hague (1996) and Seoul (2000).

Many honours were conferred on him both at national and international levels. At the international level, he was awarded several medals by various prestigious institutions by the University of Leige (1967) and by the Ministry of Higher Education, Syria (1981). He delivered the Diamond Jubilee convocation address in the University of Makerare (1982) and University of Anger (1984). He became Chairman of the International Commission on 'Comparative Research in Food Systems of the World' (1980-84); Vice President of IGU (1984-88, 1988-92), and honorary member of Royal Geographical Society (1987). 'Diploma of Merit' was conferred to him by the World Cultural Council, Mexico (1989); Russian National Academy of Sciences conferred 'Academician' to him (2002); and IGU conferred 'Laureate d' Honnour' in Glasgow (2004).

At the national level he had been the President of the National Committee for the IGU (1976-1985), and President of National Association of Geographers, India (1984); Bhoo Vigyan Vikas Foundation conferred 'Bhoogol Ratna' (2001); UGC conferred 'Saraswati Saman' (2002); and Poorvanchal University conferred 'Poorvanchal Ratna' (2003). Government of India in recognition of his services to the society conferred him the title of 'Padma Shiri' (2001). At the University level he had held almost all posts like Head, Dean, Provost, Director of Academic Programme, Pro-Vice Chancellor, Vice Chancellor and Pro-Chancellor.

Affectionate, gentle, caring, down to earth, principled that is how I would describe him. His scholarship was profound and dedication to academics was complete. Commitment to his students, colleagues and to his work was unparallel. My last meeting with him was at his home on Tuesday 21st Nov.'07; I found him engrossed in his work. He was writing a book on 'Kazakhistan'. Same week on Saturday he was admitted to the Medical College hospital. For two weeks he remained there in an unconscious state and on Monday December 9th 2007, at 3 a.m., he left for his heavenly abode. He died in harness and was a true *"Karamvir"*. He is survived by his two sons, three daughters, grandchildren, students, colleagues and friends who fondly remember him. May the family members have the strength to bear the loss. I feel privileged to have been a student of Shafi Saheb and his teachings will be my permanent possessions. I on my part, shall endeavour with all my might to keep the flame lit by him aloft.

Prof. (Mrs.) Abha Lakshmi Singh
Department of Geography
Aligarh Muslim University, Aligarh

Dr. Sudarsi Madhuri (1971-2008)

Dr. Sudarsi Madhuri, a promising young geographer at the Sri Krishnadevaraya University, Anantapur, Andhra Pradesh, suddenly passed away at the age of 36 on January 18, 2008, after a brief illness and hospitalization. It is so sad and unfortunate she left us all at this young age itself. It is a great loss to the department at Anantapur, Geographic community in Andhra Pradesh, and her friends around. With her meritorious work, a few months back only, she got elevated to associate professorship in the same University, and it is cruel that end has come so quickly for an affectionate and sincere colleague who had

Dr.Sudarsi Madhuri

wonderful potentials to serve this great country and Andhra Pradesh. Born in Visakhapatnam on July 8, 1971 as a fourth child to the loving parents of Sri S.Sudarsanam and Mrs. Girijavani, she completed her schooling in St.Joseph's Convent and Fort Catholic Girls' School, and Intermediate and B.Sc. in B.V.K. College, Vishakapatnam. She did masters in Geography in Andhra University and carried out her research for M.Phil in 1995. She joined as Assistant Professor of Geography at Sri Krishnadeveraya University in 1998. During her tenure at Anantapur, she successfully got her Ph.D in 2004 for her work on drought climatology, under the able supervision of Prof. Y.Ramanaiah.

Indeed it is a very difficult and painful to write this end note on a friend with whom we had been closely associated for more than fifteen years. We met her first around 1990. A tall and slim figure of 5 feet 7 inches with strikingly long beautiful hair neatly plaited and dressed in bright-coloured clothes, and skillfully wading through the city and the campus on her little two-wheeler, Luna, she soon became one of the familiar girls in the campus. She was a talented sports-woman and represented district inter-collegiate and University in basket-ball. She was a key player in the A.P State hand ball team in 1991. She was gifted with a melodious voice and was the lead singer in cultural programmes of the campus. With her excellent oratory and drafting skills she was every where in the campus participating in all academic, sports, cultural and competitive events. She was doing exceedingly good in her studies too. She was a committed teacher and got actively engaged in research activities of the department. As a warden of the girls' hostel in the University, she did a commendable job. She was a very a compassionate and deeply a religious girl, and was liked by every one. As a selfless worker, she is always considerate for poor, and took active participation in serving the marginalized community, especially in imparting education.

She is willingly committed and dependable a person. The hard work and the amount of responsibilities what she undertook during the National Seminar on Climate Change at Andhra University in 2006 organized by Prof.S.Sachidevi, and at the International Conference on Natural Hazards at Sri Krishnadeveraya University in 2006 were appreciated by every one and fondly recalled by all who participated in those seminars. It was always pleasant to work with her. The sudden and premature loss of an able and affectionate scholar resulted in a void in the department of Geography at Anantapur. Dr.Madhuri is no more now but she lives eternally with us.

Dr.(Ms.). P. Suneetha
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Prof. S. Shanmuganandan (1951-2008)

It is very sad that Dr.S.Shanmuganandan, Professor of Geography, Madurai Kamaraj University, Madurai, suddenly passed away. Unmindful of his health, he was working for academic excellence relentlessly in the last three decades. Born on 13th May 1951 at

Professor S.Shanmuganandan

Thiruchirappalli, Tamil Nadu, Professor Samarajalingam Shanmuganandan had his education till graduation at Thiruchirappalli, and then at Chennai; he obtained his doctorate degree for his work on geography of health under the supervision of Late Prof.A.Ramesh, then professor of Geography at the University of Madras. His academic career was a brilliant one. He secured first rank in the B.A. Degree, and First Class and Second Rank both in the M.A. and M.Phil degrees of the University of Madras.

He joined Madurai Kamaraj University in 1977 as Lecturer and rose to the position of Professor and Head of the Department of Geography and Chair Person of the School of Earth and Atmospheric Sciences. He won several awards during his illustrious academic and research career. He received a Certificate of Merit and Queen Mary's College Golden Jubilee Jawaharlal Nehru Memorial Award for securing First Rank in B.A. Once again the same award was conferred on him for his high score in M.A. He was awarded ICSSR Fellowship for his doctoral programme. He won the Commonwealth Fellowship for his Post-Doctoral Research in the University of Nottingham, U.K. He participated in a number of national and international seminars, and his presentations and participations received a larger appreciation and acceptance.

He served the Board of Studies of several universities in India, and had been in the Editorial Board of several national and international journals. He was internationally known for his work on geography of health. He was the most widely-travelled geographer from India. He has over 150 research papers to his credit. He successfully guided a number of scholars for the award of Ph.D. and M.Phil. Under his leadership the Department of Geography was selected for the Special Assistance Programme (SAP) of the UGC. During his tenure, he was able to initiate a PG Diploma in Geographic Information Systems under the UGC Innovative Programme. He worked hard towards equipping the GIS laboratory of the department with advanced hardware and software.

His zeal for bringing awareness about a healthy environment made him to be the founder for the Indian Society for Environmental Health (ISEH) with Madurai as the headquarters. This became a major forum for the interaction of eminent doctors and academicians. The society is also involved in the conduct of free medical camps and seminars creating awareness among the rural population and youth. The Society took initiatives to install an incinerator at the Thathaneri burial ground in Madurai for incineration of biomedical waste collected from major hospitals in and around Madurai.

Though the subject of health was very close to his heart, he never cared for his own health, and sad that he got succumbed to the sudden end. Only time will heal the wound in the minds of his family members, students and colleagues who are in deep shock due to his sudden demise. A void has been created in the department, and it may take time to get it filled in. He is survived by his wife and a daughter. May His Soul Rest in Peace.

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Composed & Printed at
Bhattarams
W8 VSI Estate, Thiruvanmiyur, Chennai 600 041
Tel: 2454 3303 Email: bhattarams@gmail.com