ISSN: 0019-4824

The Indian Geographical Journal

Volume 95 June 2020 No.1

Editor: K.Kumaraswamy
Assistant Editor: K.Balasubramani

The Indian Geographical Society
Department of Geography
University of Madras
Guindy Campus
Chennai-600 025, India

Governing Council of the Indian Geographical Society

Authors, who wish to submit their manuscripts for publication in the Indian Geographical Journal, are most welcome to send them to the Editor only through e-mail: editorigs1926@gmail.com

Authors of the research articles in the journal are responsible for the views expressed in them and for obtaining permission for copyright materials.

For details and downloads visit: *www.igschennai.org* | *geography.unom.ac.in/igs*

Information to Authors

The Indian Geographical Journal is published half-yearly in June and December by The Indian Geographical Society, Chennai. The peer reviewed journal invites manuscripts of original research on any geographical field providing information of importance to geography and related disciplines with an analytical approach. The manuscript should be submitted only through the Editor's e-mail: **editorigs1926@gmail.com**

The manuscript should be strictly ordered as follows: Title page, author(s) name, affiliation, designation, e-mail ID and telephone number, abstract, keywords, text (Introduction, Study Area, Methodology, Results and Discussion, Conclusion), Acknowledgements, References, Tables and Figures. You may refer IGS website (*www.igschennai.org* | *geography.unom.ac.in/igs*) for reference.

The title should be brief, specific and amenable to indexing. Not more than five keywords should be indicated separately; these should be chosen carefully and must not be phrases of several words. Abstract and summary should be limited to 100 words and convey the main points of the study, outline the results and conclusions and explain the significance of the results.

Maps and charts should be submitted in the final or near-final form in JPEG format. The authors should however agree to revise the maps and charts for reproduction after the article is accepted for publication. Each figure should have a concise caption describing accurately what the figure depicts.

If you include figures that have already been published elsewhere, you must obtain permission from the copyright owner(s) for both the print and online format. Please be aware that some publishers do not grant electronic rights for free and it is informed that IGS will not be able to refund any costs that may have occurred to receive these permissions.

Acknowledgements of people, grants, funds etc. should be placed in a separate section before the reference list. The names of funding organisations should be written in full.

References should be listed in alphabetical order as per MLA format. The list of references should only include works that are cited in the text and that have been published or accepted for publication.

The manuscripts should be accompanied with a letter stating that it has not been published or sent for publication to any other journal and that it will not be submitted elsewhere for publication.

For details and downloads visit: *www.igschennai.org* | *geography.unom.ac.in/igs*

The Indian Geographical Journal

Contents

Volume - 95 Number - 1 **June, 2020**

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 1-21
ISSN 0019-4824

SOLID WASTE MANAGEMENT: A CASE STUDY OF HYDERABAD

Kalpana Markandey

Department of Geography, Osmania University, Hyderabad - 500 007
E-mail: kalpanamark@gmail.com

Abstract

With increasing urbanization, the amount of solid waste generated is multiplying multifold. The type of waste also reflects the level of development of the society and its cultural attainment. Municipal Solid Waste (MSW) is produced from residential, commercial, industrial and institutional activities. The proportion of waste production is an indicator of socio-economic affluence of the area. Higher standards of living lead to higher consumption and greater generation of waste. The solid waste generated and its composition is impacted by socioeconomic factors like the average family size, number of rooms, monthly income, and employment status. This paper is an attempt at examining the solid waste generation scenario in Hyderabad vis a vis other city of the world or the average Indian situation. It has been found that larger families generate less solid waste compared to smaller ones. The work of the Greater Hyderabad Municipal Corporation (GHMC) is examined in handling the solid waste. The municipal solid waste is examined over a temporal perspective, Waste composition, physical characteristics of waste, capacity of transfer stations, weight of garbage and waste generated per head per locality are studied as also the disposal of solid waste and loss of Municipal solid waste.

Keywords: Municipal solid waste , Waste composition, Characteristics of waste, Transfer stations, Waste generated per head

Introduction

Urbanisation, industrialization and a consumer-oriented society lead to rising levels of Solid Waste generation. With increasing urbanization, the amount of solid waste generated is multiplying multifold. The type of waste also reflects the level of development of the society and its cultural attainment. 'Waste characteristics vary according to season, income level, population, social behaviour, climate, and industrial production, the size of markets for waste materials and the extent of urbanization, effectiveness of recycling, and work reduction' (10). Municipal Solid Waste (MSW) is produced from residential, commercial, industrial and institutional activities. The proportion of waste production is an indicator of socio-economic affluence of the area. Higher standards of living lead to higher consumption and greater generation of waste. The composition of the waste is also a reflection of the economy of the area that generates the waste.

The solid waste generated and its composition is impacted by socioeconomic factors like the average family size, number of rooms, monthly income, and employment status. 'It was also reported that there is a direct relation between the solid waste composition and the social activities in the community. In addition, other factors including change in the source-sorting behaviour and consumption of goods are among other factors affecting the composition of the solid waste and the quantity in households. Socio-cultural, economic, legal, political and environmental factors as well as the available resources are the main issues that affect the MSW management in all countries' (5). 'Waste management is one of the priority issues concerning protection of the environment and conservation of natural resources' (1).

In 2002 there were 2.9 billion urban residents in the world who created about 0.64 kg of municipal solid waste (MSW) per person per day (0.68 billion tonnes per year). By 2012 there were about 3 billion inhabitants producing 1.2 kg waste per person per day (1.3 billion tonnes per year). By 2025 this is likely to increase to 4.3 billion urban inhabitants producing about 1.42 kg/capita/day of municipal solid waste (2.2 billion tonnes per year) (4). In China, for instance, municipal solid waste increased from 31.3 million tonnes in 1980 to 212 million tonnes in 2006. The rate of generation increased from 0.50 kg/ capita/day in 1980 to 0.98 kg/capita/year in 2006 (2). In Malaysia the per capita solid waste generation is 0.5 to 0.8 kg/person/day in which domestic waste is the main source; it has increased to 1.7 kg/person/day in major cities by 2003 (7). In Nigeria 'waste generation rates ranged from 0.44 to 0.66 kg/capita/day' (10). The case in Ghana is where 'metropolises generated higher waste (average 0.63 kg/person/day) than the municipalities (0.40 kg/person/day) and the least in the districts (0.28 kg/person/day) which are less developed. The high socioeconomic class areas generated the highest quantity of waste; 0.56 kg/person/day followed by the middle-class areas, 0.49 kg/person/day and the low-class areas 0.47 kg/person/day.' (6). Africa has an average of 0.78 solid waste per capita compared to an average of 1.22 kg per capita for developed countries (3). In India per capita generation rate of MSW is 0.2 to 0.5 kg/ day. It has also been found that larger families generate less solid waste compared to smaller ones. Here the situation is such that larger families consume from larger packs and the waste generated per head is less, whereas smaller families consume from smaller packs and the waste generated per head is more (6).'In most cities, the MSWM system comprises only four activities, i.e., waste generation, collection, transportation, and disposal. The management of MSW requires proper infrastructure, maintenance and upgrade for all activities' (9).

According to the UN, approximately 54% of the population lives in urban areas, which is expected to increase to 66% by 2050. India is projected to add 404 million urban inhabitants by 2050. The extensive increase in the population growth has led to the enormous generation of waste. Dearth of land for disposal of this waste is a major challenge. It can be handled using Geographic Information System (GIS) and Analytical Hierarchy Process (AHP). Factors taken into consideration for siting can be categorized into environmental and economic measures. Road networks and slope can be grouped under

economic category and water bodies, sensitive sites, groundwater levels and land use under environmental category. For these measures, thematic maps can be generated and then combined with AHP using GIS for site selection (13).

The task of the agency handling solid waste is becoming very challenging, more so in the developing countries where the community does not view itself as a stakeholder. The local government is saddled with the responsibility of collecting and disposing off solid waste. It will not be out of place to mention here, that the community is also a stake holder in this context and it has to be included in the entire scenario (14). As per the Constitution of India, waste management comes under the ambit of the state government and the Urban Local Bodies (ULBs). While Municipalities spend about 70% of their budget on Solid Waste Management, the metropolitan cities with a wider resource base spend about 10% of their budget on Solid Waste Management (14). 'In developing countries, local authorities spend 77-95% of their revenue on collection and the balance on disposal, but can only collect almost 50-70% of municipal solid waste (MSW) ' (10). Municipal solid waste management (MSWM) is overseen by the Municipal solid waste management and Handling Rules, 2016. According to these, the ULBs are responsible for implementing the requirements inherent in these rules as well as for the infrastructure required for the collection, storage, segregation, transportation, processing (recovery and recycling) and disposal of municipal solid waste s. Only the residual inerts after proper dispensation of waste are to be sent to the sanitary landfill in accordance with these rules. Composting, bio-methanation, pelletization with or without energy recovery and other thermal processes are to be adopted as processing techniques for municipal wastes. The Government of India is dealing with waste management under its flagship programmes like the Smart City Mission and the Swachh Bharat Mission (Clean India Mission). Several ministries and institutions are dealing with waste management and cleanliness on a priority basis. 'The management of hotels and function halls were asked to initiate in-situ composting, biomethanization or any other waste management techniques as mandated in the MSW Rules, 2016 to intensify the Swachh Bharat Movement' (16).

In Hyderabad, the Greater Hyderabad Municipal Corporation (GHMC) is the local government body which is responsible for waste collection and management. Towards this end they have field level staff who supervise and ensure collection of waste. There are vehicles (mostly tipper autos) which go from door to door in the morning hours and collect the waste at a small monthly levy per house. Livelihood facilities are also provided to the workers engaged in transporting the waste. For instance, each auto tipper operative gets access to 500 to 600 households for garbage collection and gets Rs. 50 per month from each of these households for the betterment of their livelihood.

The Municipality ensures that the waste or garbage is segregated into wet and dry components at the source, i.e. at the household level. This helps in the processing of the waste. For this each household is provided separate bins for wet and dry garbage and campaigns are held to sensitize the people. This has been a pioneering effort in the country

and now the other municipalities are emulating Hyderabad. Sanitary workers visit households and Residential Welfare associations to sensitize the people towards waste segregation. During the earlier decades, open garbage bins used to be placed on the roadside and were cleared once in a week. This used to lead to the menace of stray animals scavenging for food, flies, odours and diseases.

According to the reviewed sanitation, cleanliness and waste management exercise of Greater Hyderabad Municipal Corporation (GHMC), vehicles or tricycles are to collect household waste from the doorsteps of the residents. While on the one hand the municipal solid waste management rule of 2016 was being followed, on the other it also created environmental awareness, at the same time facilitating a quick clearance of the garbage from the residences. Decrease in the number of big dumper containers at some places will ultimately help in a smaller number of stray animals like dogs, rodents, pigs etc. moving around container locations and will decrease air and water pollution due to foul smell and spillover of waste.

'After 2014, GHMC greatly transformed the way of collection and transportation of waste. Majority of the garbage from residences in GHMC areas is collected from Swachh Auto Tippers. These auto tippers carry the garbage to transfer station where the garbage is shifted to the larger capacity vehicle (25 tonnes) to reduce the transportation cost' (16). Tricycles and wheel barrows are arranged for such of those places which have narrow lanes and by lanes and are not accessible by tippers. The waste thus collected is emptied into compactor bins. Specialized operation compactor vehicles collect the waste from compactor bins and transfer it to 25 tonne vehicles in transfer stations. 22 transfer stations (Fig. 1) are tactically built in the GHMC limits so as to reduce the cost of transportation. Thus, transportation of Solid waste is a multi-stage process, sometimes involving three stages where the first stage is through Public Private Partnership (PPP mode) and the later stages involve the direct intervention of GHMC. Thus, at times NGOs are involved in primary collection from the generation source to the collection points located at an intermediate level between generation sources and dumpsites. One has to also take cognizance of an intermediary stage at certain points where the Kabadiwala (people who buy waste paper, plastic items, old utensils etc from the doorstep) pitch in and they are responsible for recycling of the products. They thus, bring in an element of informal recycling into the waste collection chain as they ultimately sell these products for further processing. 78 Dry resource collection centers (DRCCs) are established by GHMC for collection and channelizing the dry waste for recycling. The DRCCs are maintained by ITC-WoW (74) and Godrej (4) under CSR (Corporate Social Responsibility) which aim towards generating Well-being or Wealth out of Waste.

However, it is also noticed that 'none of the major metros have any projects of significant scale of Solid Waste processing into operation. Capacity built up in the compost processing sector is on rise but the problems on account of seasonal nature of business, applicability to large capacities in view of geographical limitations on marketing front persist.

Thus, it is not surprising that dumping of wastes and open burning continues at places like Hyderabad, Pimpri and elsewhere. The dump sites are an eyesore inviting public indignation with open burning and leachate overflowing' (16). 'The residents of Hyderabad also need to change some day to day practices. In Hyderabad, disposing of solid waste in the public open drains is a common practice and no penalties are imposed on people who commit such an offence. Only in some areas, the municipality is active in collection and disposal of waste and in most parts of the city; people have to make their own provisions for solid waste disposal '(15).

'Solid waste management is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal' in most developing countries (10). It is also found that 'lack of resources such as financing, infrastructure, suitable planning and data, and leadership, are the main barriers in MSWM. The increase of service demands combined with the lack of resources for municipalities are putting a huge strain on the existing MSWM systems' (9). The restraints encountered in Solid Waste management include 'lack of institutional arrangement, insufficient financial resources, absence of bylaws and standards, inflexible work schedules, insufficient information on quantity and composition of waste, and inappropriate technology' (10).

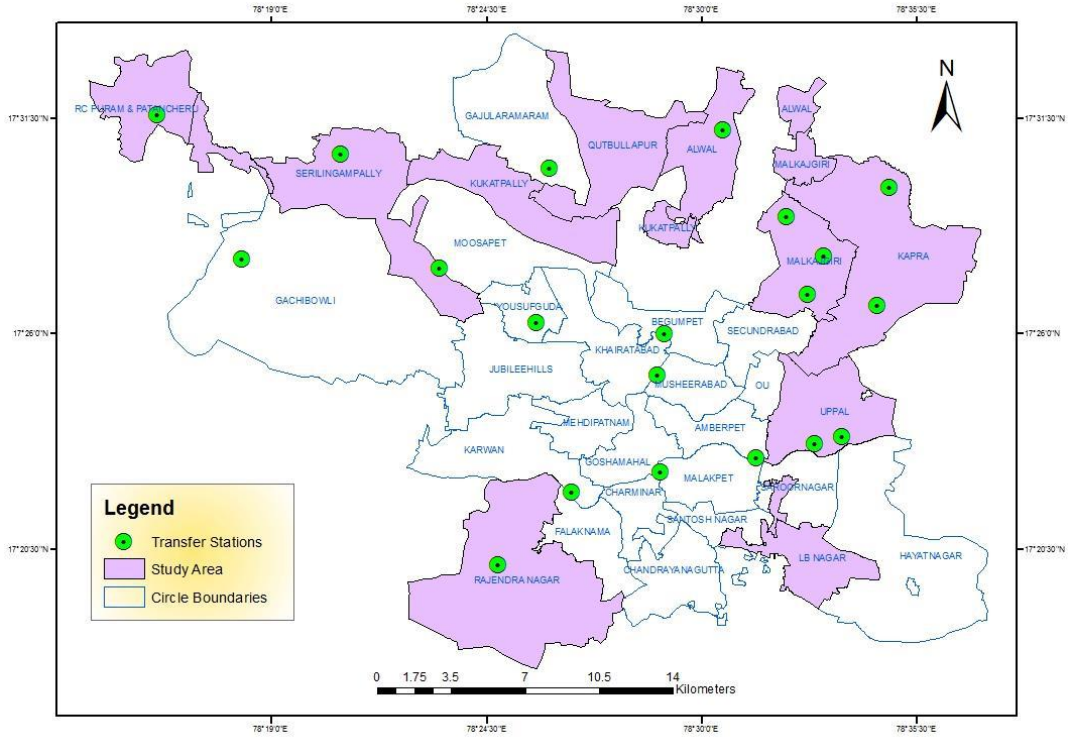


Fig. 1. Transfer Stations for Solid Waste in Hyderabad 2018 - 2019

There is an increase in the amount of garbage reaching the transfer stations as witnessed from the data for the past 3 years (Figure 2 and 3). This is due to efficient collection methods apart from other factors related to urbanization and consumerism which are on the upswing. The auto tippers have segregated spaces for storing the wet and dry garbage and this helps in utilising a lot of refuse material (Figure 4) and reduces the pressure on landfills. Recycling of paper, plastic and composting of organic material (Fig. 5) is now possible. Recycling of solid waste can generate resources like fertilizers, fuel, oil, gases, petrochemicals and plastic (10). In Africa 'few items are converted into new products for local use e.g. smelting of aluminum cans and scraps metals into household utensils, transforming old car tyres into shoes, ropes, flower pots; and paper and plastic waste articles into tourists' products. Paper and carton is transformed into newspaper (3)'. Recycling can also extend the life of the landfill by reducing the pressure on it (10). However, cognizance has to be taken of the fact that 'solutions for MSW management problems that are heavily based on sanitary landfill exploitation are not environmentally sustainable over a long-time horizon' (1).

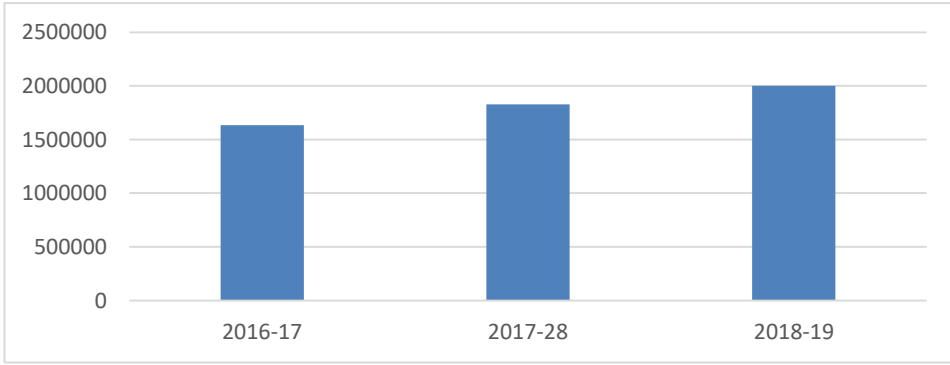


Fig. 2. Hyderabad City Municipal Solid Waste Received (in Tons)

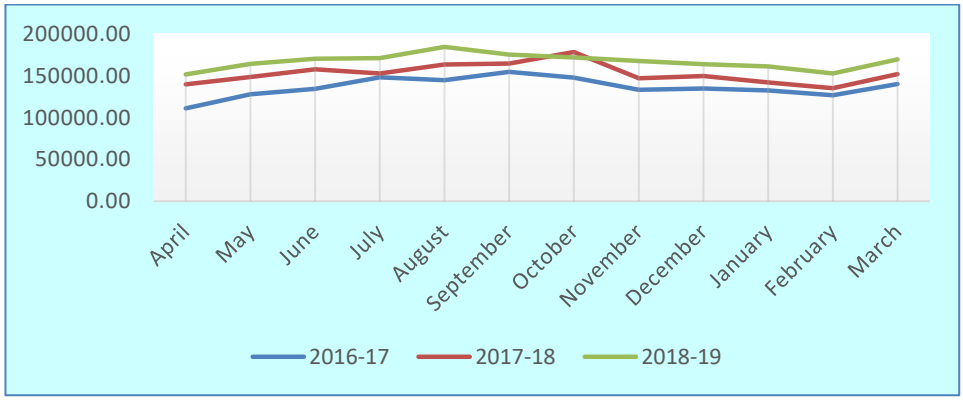


Fig. 3. Hyderabad City Municipal Solid Waste Received (in Tons): 2016-2019

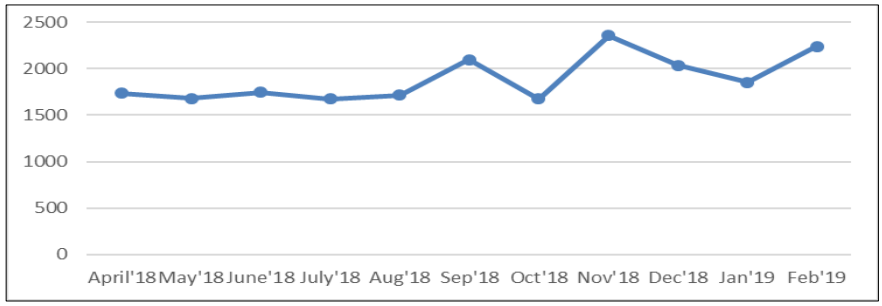


Fig. 4. Hyderabad City Total RDF: (Refuse Derived Fuel) Generated (Average tons/Day): 2018-2019

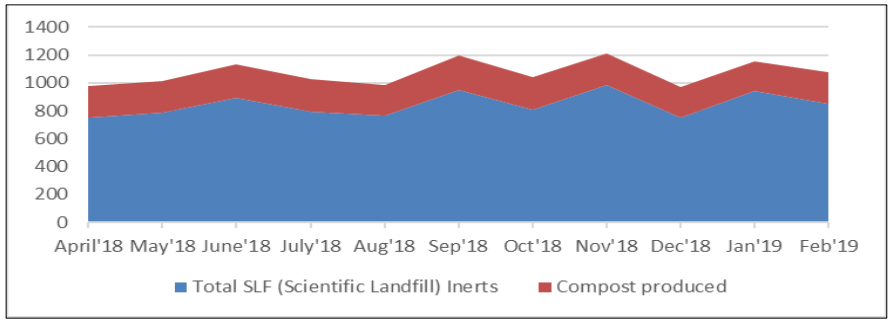


Fig. 5. Hyderabad City Recycled Solid Waste (Average tons/Day): 2018-2019

Fig. 6. Beautification of Garbage Vulnerable Points (GVPs) with Rangoli, Wall Paintings

An initiative on the part of GHMC has been beautification of Garbage Vulnerable Points (GVPs) with Rangoli, wall paintings (Figure 6) and by organising several social and cultural events. This deters people from dumping the garbage recklessly at these vulnerable spots. The total area of GHMC has been divided into five zones and 30 circles to carry out the waste management exercise.

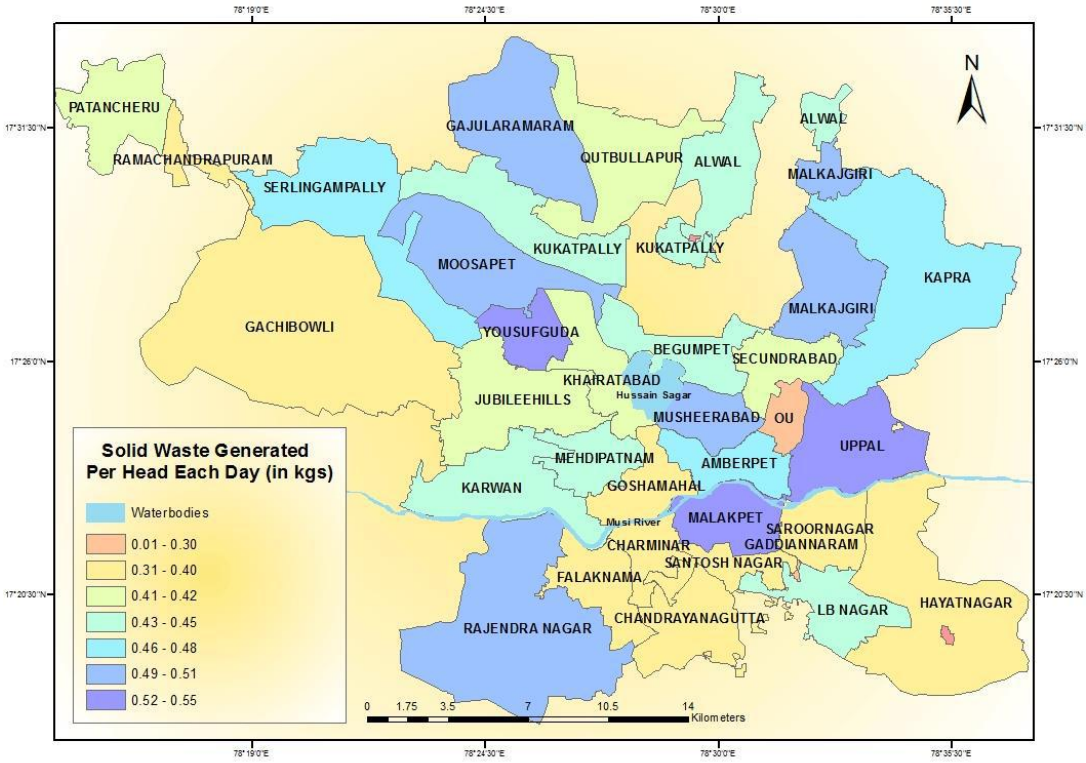


Fig. 7. Hyderabad City - Solid Waste Generated Per Head - 2020

'In Hyderabad, the per capita waste generation is 0.57 kg/cap/day which is on a higher side as compared to a number of cities, of which a large quantity remains uncollected leading to a lot of environmental and public health issues. Of the generated waste, only a small fraction gets treated and the rest disposed off in legal and illegal open dumpsites. The percentage of biodegradables present in the city's waste is relatively high at 54.2% indicating a good potential of opting for treatment of organic part of the waste (12).' A glance at Figure 7 reveals that Yousufguda and Malakpet, which are very much in the central city have a high amount of solid waste collected per head apart from Uppal on the eastern periphery. All these areas are densely populated. Most of the peripheral municipalities have relatively low levels of generation of solid waste per head. This, however, is notwithstanding localities like Charminar, Gosha Mahal etc which lie in the centre of the city and are equally densely populated.

However, they have large family size and prove the fact that larger families generate less solid waste compared to smaller ones as has been mentioned above. It is also found that most circles in the central part of the city have a larger capacity of the transfer stations, pointing to a core-periphery dichotomy so far as transfer and by implication generation of garbage is concerned to some extent (Figure 8). This however, is notwithstanding the fact that the number of transfer stations in the peripheral areas are many more compared to those in the hard core of the city.

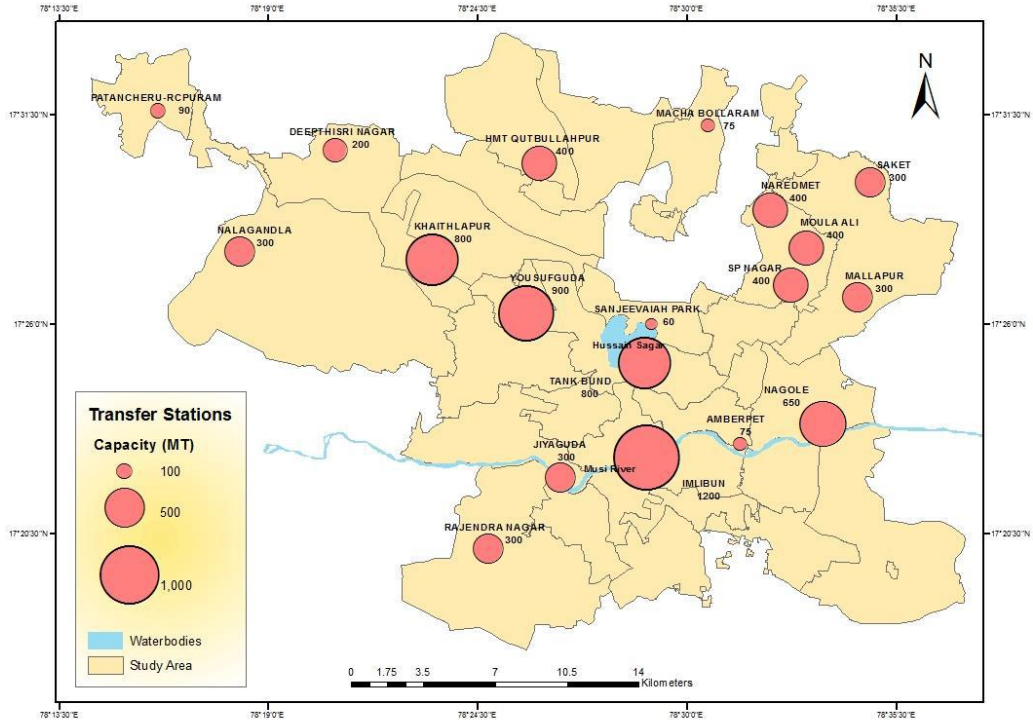


Fig. 8. Hyderabad City - Capacity of Transfer Stations - 2018-2019
Source: *GHMC*

Composition of Solid Waste

Food Waste along with green waste, coconuts etc, which is amenable to composting comprises the largest segment of Solid Waste in Hyderabad, it accounts for more than 50% of the solid waste generated in Hyderabad (Table 1). Thus if waste is segregated in all the households of all the localities in the city, the city has a huge potential for recycling it into organic manure for use in the market gardens in the peripheral areas of the city. Organic Waste is followed by waste from demolition and construction sites, comprising basically debris, stones, rocks, silt and earth apart from other waste fittings. This waste is associated with a lot of air pollution and is related to dust in the city.

Plastic waste which ranks next in order so far as the proportion of solid waste is concerned, presents a vital problem in solid waste management as it is found to clog natural and man-made drainage networks besides being a choking hazard to the animals, fish etc. Combination of waste types from different sources presents a further challenge as inert material from construction or demolition sites, street sweeping etc. add to the woes of people engaged in waste management.

Table 1. Average Waste Composition in Hyderabad

Component	Average % Fraction
Food Waste	48.22
Paper	7.26
Plastics	8.61
Rags/Cloths/Cotton	5.70
Green Waste , Coconuts	3.06
Rubber & Synthetics	1.82
Leather	1.29
Metals, Glass & Ceramic	2.18
Stone, Debris, Boulders, Silt , Earth	21.42
Others	0.53

Source: *Detailed Project Report for Integrated Solid Waste management for Hyderabad (Feb 2009) by SENES consultants for GHMC in DBSSRS Article - WTE INDIA Brief Revised*

A glance at Figure 9 and Table 2 lead one to infer that domestic household waste accounts for the largest single source of waste followed by waste from hotels and restaurants. Construction and demolition waste follows closely on the heels of this substantiating what has been said above vide Table 1. Markets, commercial establishments and meat shops etc. also generate a substantial amount of waste when put together. The chain of waste disposal from these sites has to be well maintained for a clean and hygienic environment. Not to be ignored is the hospital waste though it comprises a miniscule proportion of the total waste as it may contain toxic material which has to be properly disposed.

The GHMC has categorised the municipal solid waste into the following 5 categories (Table 3) citing all possible items that are included under each one of them:

1. Wet Waste
2. Dry Waste
3. Hazardous Household Waste
4. Sanitary Waste
5. Toxic Rejects

Table 2. Waste Generation from Various Sources

Sl. No	Type of Waste	Waste Generated (MT/Day)	Percentage Waste Composition
1	Domestic household waste	1,870	37.18
2	Commercial Establishments Waste	350	6.95
3	Hotels and Restaurants	666	13.24
4	Institutional Waste	125	2.48
5	Parks and Gardens	69	1.38
6	Street Sweeping Waste	325	6.47
7	Waste from Drains	175	3.47
8	Markets	479	9.25
9	Temples	35	0.70
10	Chicken, Mutton, Beef, Fish stalls	164	3.26
11	Cinema Halls	15	0.30
12	Function Halls	88	1.74
13	Hospitals	35	0.69
14	Construction and Demolition Waste	635	12.62
Total		5,030	100

***Source**: K. Vamsi Krishna, Venkateshwar Reddy, P. Rammohan Rao, Muncipal Solid Waste Management using, Landfills in Hyderabad City, International Journal of Engineering Research & Technology (IJERT), IJERTV4IS020842 www.ijert.org, Vol. 4 Issue 02, February-2015*

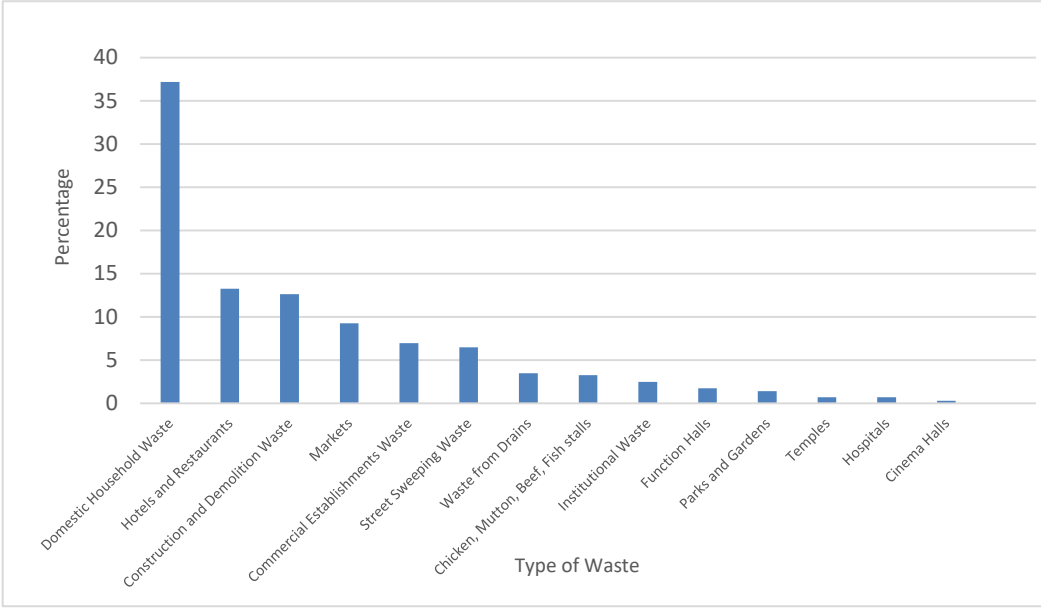


Fig. 9. Waste Composition in Hyderabad: 2015

***Source:** K. Vamsi Krishna, Venkateshwar Reddy, P. Rammohan Rao, Muncipal Solid Waste Management using, Landfills in Hyderabad City, International Journal of Engineering Research & Technology (IJERT), IJERTV4IS020842 www.ijert.org, Vol. 4 Issue 02, February-2015*

Table 3. Composition of Municipal Solid Waste

Si.No	Wet Waste	Dry Waste	Hazardous House Hold Waste	Sanitary Waste	Toxic Rejects
1	Vegetable Peels	Mop Stick	Mosquito Repellent refill bottles	Used sanitary napkins, Panty Liners , Sanitary Cloths	Dead Cockroaches , rats, Lizards etc.
2	Fruit Peels	Used Mop cloth	Mosquitoes repellent mats	Used condoms	
3	Rotten Vegetables / Rotten Fruits	Toilet Cleaning Brush	Used Odonil	Used syringes	
4	Left-over food	Brusher and Scrubs used for cleaning	Expired medicines	Used cotton and bandage	
5	Mango Seeds	Used and dirty foot mats or door mats	Tablets covers	Any piece of cloth, paper stained with blood or any other medical or sanitary waste	
6	Used Tea Bags	Bottles and container of pesticide	Syrups bottle	Diapers	
7	Used Coffee Powder from Filter	Used Tooth Brush	Injection bottles		
8	Egg Shells	Soap Covers	Other medicinal discards		
9	Rotten Eggs	Chocolate wrappers (Small Toffees or Candies)	Batteries		
10	Coconut Shells	Chocolate Wrapper for big bars	CD's		
11	Tender coconut shell	Butter Papers used to wrap butter	CFL, Tube light		
12	Coconut Fibre	Milk Covers/packets	Printer Cartridges		
13	Used flowers / leaves after Puja	Ghee/ Oil Packets	Broken clock watch electronics		
14	Spoiled spices	Curd Packets	Broken Thermometer		
15	Floor Sweeping Dust	Idly or any other Batter packets	Pieces of wires , old electronic parts , old phones, adapters, chargers blue tooth etc		
16	Meat and Non-Vegetarian Food Remains	Oil Cans	Expired Credit /Debit/loyalty Cards with Chip		
17	Bones	Package of food items	Broken Glasses		
18	Expired food items packets (like bread, biscuits, ready to eat food)	New paper	Old Paints		

19	Finger or toe nails	Old Posts	Expired cosmetics like lipsticks, nail polish etc.		
20	Remaining Pet Food	Used paper pieces	Bottles or Cans of Mosquito Sprays, Insecticide Sprays, Room Fresheners etc.		
21	Used Rangoli Power	Broken Stationery like pen, pencil eraser etc.	button cells		
22		Used Razor / Razor Blades			
23		Empty shampoo Bottle			
24		Empty Perfume bottle			
25		Thermocol			
26		Empty Bottles of floor or toilet cleaners			
27		Covers with just silver lining inside , like the ones in Lay packets , Kurkere packets etc.			
28		Unusable shoes			
29		Used Sachets of Shampoo, Tooth Paste, small quantity of Horlicks/Bournvita etc.			
30		Tetra Packets (Juices, Milks etc.)			
31		Small cartoon Boxed like in Corn Flakes etc.			
32		Used Tooth Paste Tubes			
33		Broken house hold Plastic items			
34		Tin Bottles, like Pepsi cans etc.			
35		Small Tubs like the ones used for jam, cheese, yogurt etc.			
36		Pieces of Aluminum Foils used to cover Ghee , Jam etc.			
37		Old Brooms			
38		Thermocol Balls from bean bags			
39		Used bottles, tubes, cans of Shaving cream , Deodorant, creams , etc.			
40		Leather, Rexine, Rubber, furniture, thermocol(expanded polystyrene)			
41		Hair			

Source: *GHMC, 2018-19*

About 55% of the total waste received at the Jawaharnagar plant is wet waste and 45% is dry waste. Out of the 45% dry waste, 13% is plastic waste. Figure 10 depicts the total weight of garbage being brought to the transfer stations from various parts of the city.

While data is not available for several units, yet it can be discerned from that which is available that most central parts of the city have a larger amount of garbage being transported than the peripheral areas. This is quite understandable in the context of dense packing of houses in the central parts, multi - housing structures and a more consumer-oriented economy there.

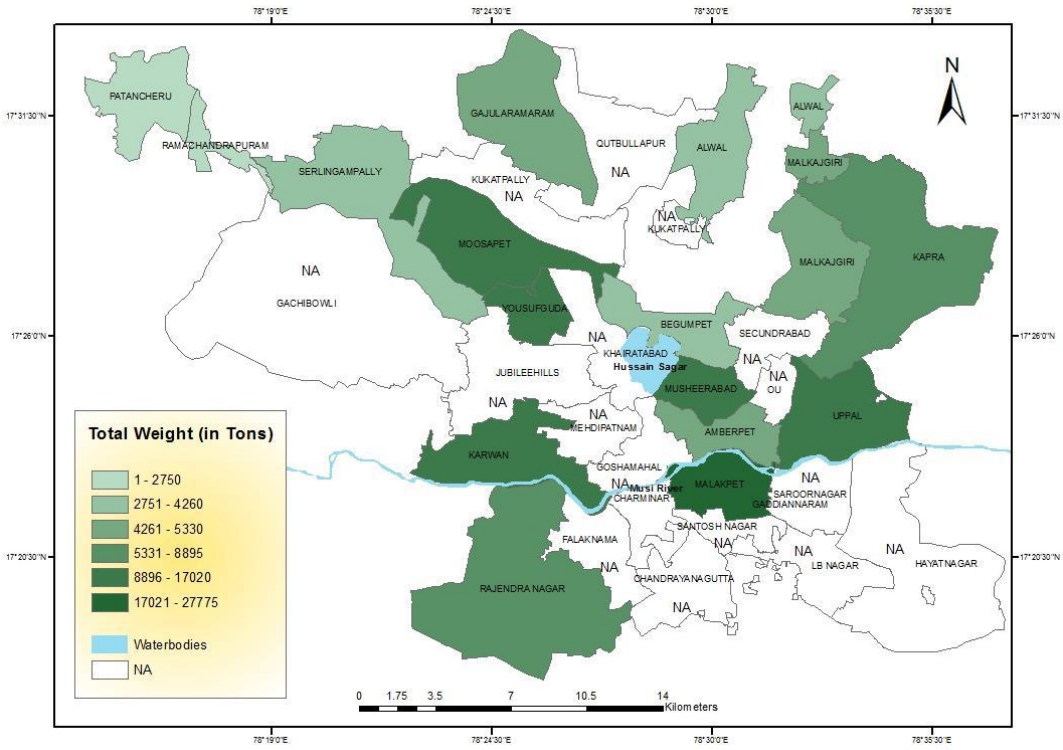


Fig. 10. Hyderabad City - Weight of Garbage - 2018-2019

It is found that in the composition of municipal solid waste in Telangana organic material accounts for 50 to 60% of the total waste, inorganic and recyclable material accounts for 25% (paper - 8.13, plastic, rubber - 9.22, metal and glass - 1 to 1.5, rags - 4 to 4.5 and others - 4% and inert material for 20 to 25% (8). By comparison waste in China is high on organic and moisture content, as kitchen waste accounts for 60% of the solid waste in that country (2). In Malaysia solid waste contains a high amount of organic waste and hence a high moisture content and more density. The main components of Malaysian waste are food, paper and plastic, which constitute 80% of the total weight (7). Organic waste is also a dominant characteristic in Nigeria. 'Studies in Bandung, Indonesia and Colombo, Sri Lanka have found residential waste composed of 78% and 81% compostable material, and market waste 89% and 90% compostable, respectively' (10). In Ghana 61% of the waste was organics, 14% plastics, 6% inert material, 5% paper, 3% metals, 3% glass, 1% leather and rubber, 1% textiles and 5% miscellaneous.

'However, organics and plastics, the two major fractions of the household waste varied considerably across the geographical areas. In the coastal zone, the organic waste fraction was highest but decreased through the forest zone towards the northern savanna' (6).

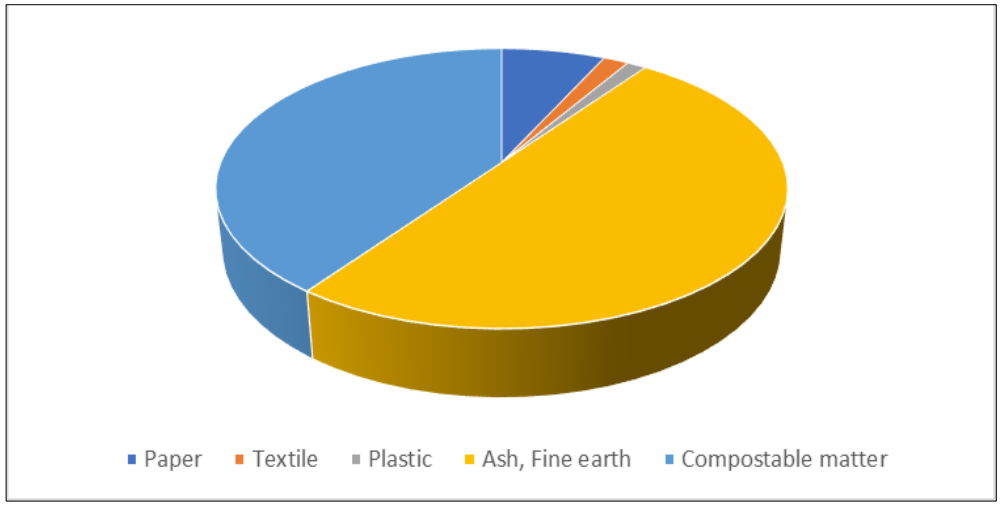


Fig. 11. Physical Characteristics of Municipal Solid Waste in India: 2000

Source: *Status of solid waste generation, collection, treatment and disposal in metro cities, (CPCB, 2000). In Mufeed Sharholy, Kafeel Ahmad, Gauhar Mahmood, R.C. Trivedi, Municipal Solid Waste Management in Indian Cities - A Review, Waste Management 28 (2008) 459-467*

It is evident from Fig. 11 that compostable material (40%) and inerts (50%) comprise a major part of MSW in most cities of India. There is an inverse correlation of organic waste in MSW and socio-economic status. 'The wastes are heavier, wetter and more corrosive in developing cities than developed cities (10)', they are also denser. 'High density reduces the effectiveness of compaction vehicles for waste transfer' (10).

Disposal of Solid Waste

Waste is handled in India in basically two ways, the methods comprise composting which includes aerobic composting and vermi - composting and Waste -to- energy (WTE) conversion which includes incineration, pelletization and biomethanation. While composting has been prevalent for a long time and is very popular in India, WTE is a relatively recent adoption in India. Less developed countries (like Nigeria) have open dumpsites. Incineration and WTE practices are considered too capital intensive and prohibitive there (10). Hyderabad has an RDF (Refuse Derived Fuel) plant at Jawaharnagar Processing and Disposal facility that was established in 2012 and has a capacity of 1600 TPD. With the commissioning of RDF plants the burden on landfills can be reduced and the fuel thus generated can be used like any conventional fuel (9).

In Hyderabad, Jawahar Nagar is also the site location for the dumping of municipal solid waste as well as for Composting and Incineration on a large scale. Generally, mixed waste is received at present from all circles, the mixed waste is segregated as wet and dry waste at the processing and disposal facility at Jawahar Nagar.

Ragpickers who constitute the informal sector in the solid waste management chain have a massive role to play in segregating and recovering material from solid waste at lower cost. 'Also, it has been noticed that the percentage of recyclables (paper, glass, plastic and metals) is very low, because of ragpickers who segregate and collect the materials at generation sources, collection points and disposal sites' (9). Rag pickers also collect segregated waste primarily at the household level, and after reaching the treatment plant, involve in secondary segregation, to send the wet waste for composting and dry waste for material recovery facility. 'Furthermore, in Delhi's waste management system at least 150,000 waste pickers divert more than 25% of all waste generated into recyclables. This management system saves the municipal authorities substantial costs' (5).

In the context of integrated waste management, thermal treatment is important as it decreases the quantity of waste, which goes into the landfill besides carrying out waste sanitization. 'The relative importance of incineration as opposed to other waste treatment and disposal options, including mechanical/biological treatment and sanitary landfilling, varies considerably from country to country, depending on specific waste management strategies as well as space availability for final land disposal ' (11).

The processes of Integrated waste management can be inferred from Figure 12, 'waste management systems include all processes from waste generation to landfilling, i.e.:

- Waste generation: all processes which produce waste during the production and distribution of products (industry and commerce) or the consumption of products (households);
- Waste collection, including source separation into different material streams Processing, including such steps as waste sorting, dismantling of products (e.g. end-of-life electrical and electronic equipment), and production of Refuse Derived Fuel (RDF). All these steps serve either to prepare waste for reuse or to suitably modify waste characteristics with a view to final land disposal;
- Recycling: production of secondary materials from waste, e.g. paper from waste paper, steel from ferrous metal scraps etc.;
- Waste treatment, including several technologies such as thermal treatment, chemical treatment of hazardous wastes, mechanical/biological treatment;
- Waste utilisation, covering all the utilisation options of waste after processing, e.g. use of treated bottom ash for road construction, compost for agricultural applications or thermal utilisation of RDF and Landfilling' (11).

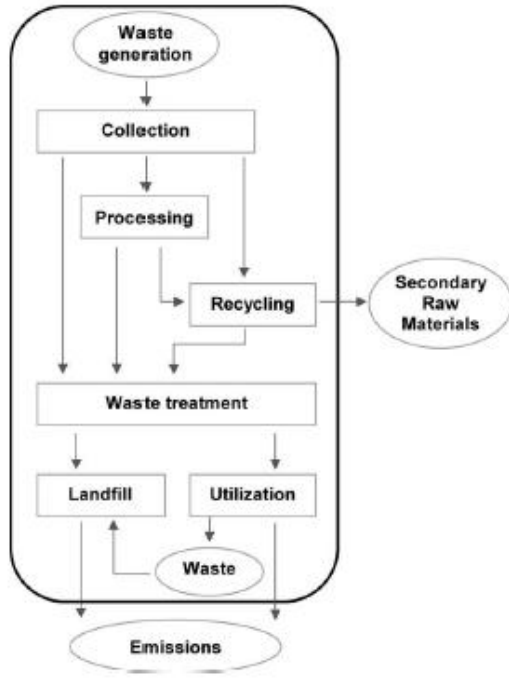


Fig. 12. Processes of Integrated Waste Management

Source: *Sabbas T. et al., Management of Municipal Solid Waste Incineration, Waste Management 23 (2003) 61–88*

Landfill, incineration and composting are conventional and much used technologies for waste disposal. However, so far as treating organic waste is concerned, they involve high energy; generate toxic methane gas and odour. Of late Bioethanol and Biodiesel are produced from organic waste in the developed countries (5).

Improper management of MSW is leading to soil, air, water and aesthetic pollution most of which have a telling effect on human health and well-being. Most often household hazardous wastes go into the landfill along with general household waste causing a risk to the environment. About 71% of the MSW on a worldwide scale goes into in the landfills. These may include batteries, mercury - containing waste, paint, vehicle maintenance products besides others.

Thus, 'landfills have evolved from just open dumps to highly engineered facilities that are designed to contain waste. They are separated from the environment, capture polluted water that contacts the waste (i.e. leachate), and control gas migration. A landfill site is designed as typically excavated and lined with a system that includes layers to protect groundwater by minimising the migration of leachate to the ground layers and to collect such leachate for treatment' (5) Efficient waste management can reduce Green House gases by producing energy and by applying compost to soils in the form of fertilizers.

'UNEP recommended a future waste management focused on the 3R concept (namely: Reduce, Reuse, and Recycle). These 3R are waste prevention, circular economy establishment, cleaner productions, and valorization of the waste by transformation into a source of energy and materials' (5).It is found that 'recycling is possible for nine kinds of materials: paper, heavy plastic, plastic bottles, plastic bags, organic material, metals, textiles, wood, and glass; these materials can be separately collected by different methods' (1). Use of waste as fuel, animal feed and recycling of bottles also helps in waste reduction (6).

Plastics which comprise hydrocarbons can be burned and can supply supplementary fuel which can replace fossil fuels in blast furnaces and brick kilns. However, when plastics are incinerated, they discharge more of greenhouse gases. The composite nature of food wastes renders them fit for bacterial growth which is conducive for the production of bio-pesticide. Thus, there is a concealed potential in different waste products which imparts a cyclic and circular dimension to the economy.

It is reported that in China 91.4% of MSW went into landfills, 6.4%was incinerated and 2.2% was composted. In 2007, 366 landfill sites were reported as against 17 compost plants, and 66 incineration plants. It is found that 'rapidly bio-degradable waste (food and kitchen waste), slowly bio-degradable waste (wood, paper, yard waste, composites) and non-bio-degradable waste (plastic, metal, glass, ash) account for 78%, 10% and 12% of total amount of MSW in China respectively, while these same types of solid waste account for 12%, 47% and 41% of total amount of MSW in EU, respectively' (2). In Malaysia also the landfills are the largest accommodators of solid waste, though there is some recycling and incineration in some of the islands (7). 'The uncollected waste is illegally dumped in open spaces, water bodies, storm-drainage channels, buried, burnt or deposited along the streets or roadsides. Many authors attribute the prevalence of parasites, tetanus, malaria, hookworm, cholera, and diarrhea so common in many African cities to unsanitary conditions caused by waste being simply strewn around (3)' In India a large proportion of the waste is organic in nature accounting for 40–60%, ash and fine earth accounting for 30–40% , paper for 3–6% and plastic, glass and metals - each less than 1% (9).

It is found that recycling modifies the composition of the refuse sent to incineration, it influences the heating value of the refuse that has to be burnt, and hence energy recovery (1). Around 600 trips per day (on an average) are made by dumping vehicles to the Transfer stations. It is evident from a comparison of Figure 11 and 12 that obviously such of those localities - most of which fall in the central part of the city - which have a greater weight of garbage to be transported make a greater number of trips. Most of these are in the central parts of the city.

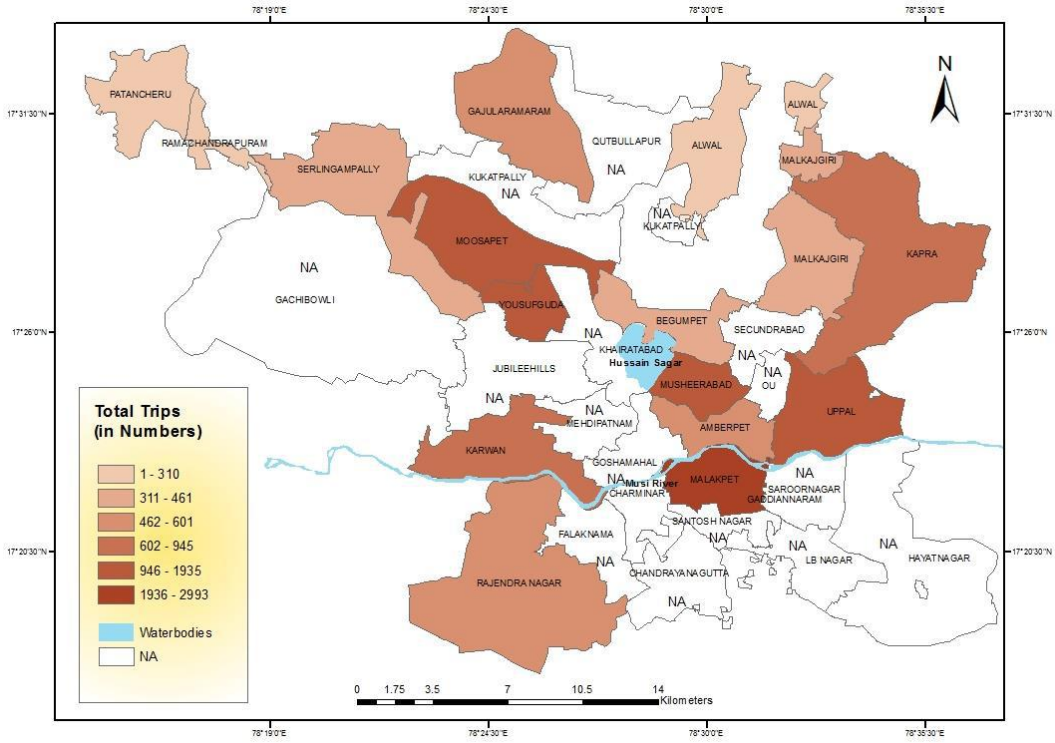


Fig. 13. Hyderabad City - Trips of Garbage Vehicles (2018 - 2019)
Source: *GHMC*

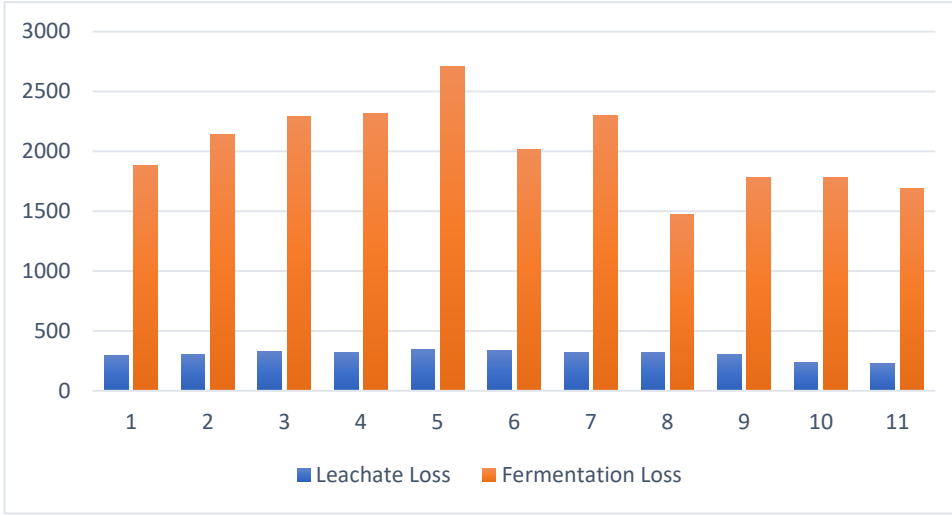


Fig. 14. Hyderabad City - Loss of Municipal Solid Waste (Average Tons per Day) 2018-2019

Loss of Municipal Solid Waste

The Figure 14 portrays the loss of municipal solid waste on account of leachate action and fermentation. The data pertains to the period from April 2018 to February 2019. Both the processes are chemical reactions, which take place at the level of the waste material as well as those changes that take place due to the movement of water and other solvents through the waste material. Thus, the climatic or weather conditions, vegetation and soil impact the amount of loss of the solid waste material. It is found from the figure below that while the loss is marginally more in the summer and rainy season, it is less so during the winter season due to obvious chemical reactions in the former two seasons. Leachate loss is, however, conspicuously less than the fermentation loss. During fermentation process, volatile gases are released. Therefore, the fermentation loss is more than leachate loss.

Conclusion

The average generation of garbage per head per day in Hyderabad is 0.57 kg per person per day. However, there are variations from one locality to another depending on the family size, location, socio economic characteristics, monthly income etc. The GHMC has modified the procedure of collection and disposal of solid waste in the past six years. Nevertheless, dumping of wastes and open burning continues. There is an increase in the amount of garbage reaching the transfer stations as witnessed from the data for the past 3 years. This is due to efficient collection methods apart from other factors related to urbanization and consumerism, which are on the upswing. GHMC has categorised solid waste as wet, dry, hazardous household waste, sanitary waste and toxic rejects. Most of the solid waste comprises Domestic Waste in which Food Waste dominates. 55% of the waste is wet waste and 45% is dry waste. There is a loss of municipal solid waste on account of leachate action and fermentation and this is more so during summer and the rainy season. Hyderabad has an RDF (Refuse Derived Fuel) plant with this the burden on landfills can be reduced and the fuel thus generated can be used like any conventional fuel. Improper management of municipal solid waste is leading to soil, air, water and aesthetic pollution most of which have a telling effect on human health and well-being.

Acknowledgements

I thank the Indian Council of Social Science Research (ICSSR) for providing me with the National Fellowship (vide letter no. F. No. 1 - 06/18-19 NF dated 14.12.2018) and this work is a part of that project. I also thank Mr. Koteswara Rao, Superintending Engineer GHMC and Ms. Jayashree, O/o Superintending Engineer GHMC for providing me with the data for this study. My thanks are also due to Dr. K. Srikanth for preparing the maps for this study.

References

1. Costi P., Minciardi R., Robba M., Rovattib M. and Sacile R., An environmentally sustainable decision model for Urban Solid Waste Management, Waste Management 24 (2004) 277–295
2. Dong Qing Zhang, Soon Keat Tan, Richard M. Gersberg, Municipal Solid Waste management in China: Status, problems and challenges, Journal of Environmental Management 91(2010)1623e1633
3. Eric Achankeng, Globalization, Urbanization and Municipal Solid Waste management in Africa, African Studies Association of Australasia and the Pacific, 2003, Conference Proceedings - African on a Global Stage
4. Hoornweg, Daniel; Bhada-Tata, Perinaz. 2012. What a Waste: A Global Review of Solid Waste Management. Urban development series; knowledge papers no. 15. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/17388 License: CC BY 3.0 IGO
5. Hussein I. Abdel-Shafy, Mona S.M. Mansour, Solid waste issue: Sources, Composition, Disposal, Recycling, and Valorization, Egyptian Journal of Petroleum 27 (2018) 1275–1290.
6. Kodwo Miezah, Kwasi Obiri-Danso, Zsófia Kádár, Bernard Fei-Baffoe, Moses Y. Mensah, Municipal Solid Waste Characterization and Quantification as a measure towards effective waste management in Ghana, Waste Management 46 (2015) 15–27
7. Latifah Abd Manaf, Mohd Armi Abu Samah, Nur Ilyana Mohd Zukki, Municipal solid waste Management in Malaysia: Practices and Challenges, Waste Management 29 (2009) 2902–2906.
8. Manasa, M, Mounika, M. and Swapnapriya, T, Integrated Municipal Solid Waste Management: Case Study – Greater Hyderabad Municipal Corporation, Environmental Protection Training and Research Institute, Hyderabad May- June 2016.
9. Mufeed Sharholy a, Kafeel Ahmad, Gauhar Mahmood, R.C. Trivedi, Municipal Solid Waste Management in Indian cities – A review, Waste Management 28 (2008) 459–467.
10. Ogwueleka T. Ch., Municipal Solid Waste Characteristics and Management in Nigeria, Iran Journal of Environmental Health. Science and Engineering, 2009, Vol. 6, No. 3, pp. 173-180.
11. Sabbas T. et al, Management of Municipal Solid Waste Incineration, Waste Management 23 (2003) 61–88, Waste Management 23 (2003) 61–88.
12. Solid Waste Management for Neighbourhoods in Environmental Building Guidelines for Greater Hyderabad — Ver. 1.2(2010)
13. Srinivasa Rao T., Naga Babu I., Chandana N., MSW Landfill Site Selection for Hyderabad City Using GIS and AHP, Journal of Remote Sensing & GIS (JoRSG) Vol 9, No.1, (2018).
14. Tapas Kumar Ghatak, Municipal Solid Waste management in India: A Few Unaddressed Issues, Procedia Environmental Sciences 35 (2016) 169 – 175.
15. Wakode H B (2016), “Analysis of Urban Growth and Assessment of Impact of Urbanisation on Water Resources- A Case Study of Hyderabad, India” Ph. D Thesis, Faculty of Georesources And Materials Engineering of The Rwth Aachen University, Germany.
16. https://egov.eletsonline.com/2017/06/ghmc-making-cleanliness-hyderabads-recognition/
17. http://www.seas.columbia.edu/earth/wtert/sofos/DBSSRS_Article_-_WTE_INDIA_BRIEF_Revised.pdf

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 22-34
ISSN 0019-4824

GEOSPATIAL BASED CROSS - EXAMINATION OF DEFORESTATION, GROUNDWATER AND DESERTIFICATION PROCESS - THE SITUATION IN THE GUNDLUPET TALUK, KARNATAKA, INDIA

Arun Das S.[1], Umakanth[2], Sawant Sushant Anil[3], Koichi Kimoto[4], Chandrashekara Y.P.[5], Harsha B.S.[6] and Venugopal[7]

[1] Department of PG Studies in Geography, Mysore University, Mysore - 570 006
[2] Department of Geography, Government Boys College, Mysore University, Mysore - 570 006
[3] JSS Academy of Higher Education and Research, Mysore - 570 015
[4] Organisation for Academic Affairs, Kwansei Gakuin University, Hyogo - 662-8501, Japan
[5] Department of Geography, Karnataka State Open University, Mysore - 570 006
[6] Department of Geography, VidyaVaradaka College, Mysore University, Mysore - 570 002
[7] Environmentalist and Civil Engineer, Emerald Enclave, Mysore - 571 606
E-mail: arundasmysore@gmail.com

Abstract

Deforestation of the dense vegetative region for agricultural activity had given higher agriculture return in the initial periods. Over the period, a gradual change in climatic conditions, overexploitation of groundwater, and deforestation are engulfing this region into the desertification process. The slow transformation results in lower rainfall followed by lower agricultural production, lower-income, which prompts a substitute means of agricultural operation either through introducing an artificial source of irrigation, i.e., using borewells or tube wells. Historical evidence reveals that the land which has undergone these phases has finally transformed into an arid region and in a later period into the desert.

Keywords: Agriculture, Deforestation, Desertification, Sustainability, Groundwater

Introduction

The state of Karnataka is one of the 28 states of India. The peninsular land configuration has four different landforms that have evolved into four cultural, ethnic groups, and four federal states. The past geological history of this land reveals the dense forest cover varying from evergreen to dry deciduous type of vegetation. Over the period, human civilization on this land had gradually opted for permanent settlement from nomadism and food gathering. These permanent settlements brought immense pressure on land for the cultivation of crops. Around 2000 BC, the tribal community occupied this land, and around one thousand years later non-tribal community entered into this land for the agricultural practices. The southern part of Karnataka is bestowed with undulating topography and moderate rainfall throughout the year, which has produced a well-drained network of drainage systems controlled by the underlying geological structures.

All forms of physiographical favourable conditions paved the way for the luxurious growth of vegetation in the post-Holocene period. Later, the intermountain plateau and valley lands experienced severe deforestation in the initial course of the settlement. With the introduction of agriculture as the main occupation, a significant portion of the natural forest started declining. The moist deciduous forest, which was concentrated along the foothills and on the slopes of the mountains are clear evidence that it is a continuation of moist deciduous vegetation followed by dry deciduous forest with moderate to open canopy in Gundlupet taluk.

Retreating monsoon, which blows from northeast towards the southwest direction, produces rainfall during the first spell of the winter season, also referred to as 'wet winters' between September to December. Based on the distribution of rainfall produced due to the trade winds of the region, it is imperative to say that the land was bountiful enough to be filled by lush green vegetation and was abundant in fresh-water topography. The closely dissected stream network has 5 to 6 orders, which is a clear indication of good rainfall and suitable aquifers of the region. Added to these, thousands of lakes and tanks that were created by the fluvial cycle of erosion are yet another critical evidence to state that land had an excellent hydrogeological landscape placing the water table near to the surface level until the abuse of groundwater.

The geomorphological and hydrogeological settings of the land revealed that this land has hydro-geologically and climatically transformed. The decreased groundwater level is one of the significant indicators of this change. The primary reason behind the change in groundwater recharge capability is due to severe deforestation across this land. Usually, anthropogenic interference in any natural process has resulted in a severe catastrophe leading to irreparable damage, and the Gundlupet is a perfect example of this process. Although we understand that the earth process and stages are functioning towards transformation from one form of landscape towards another, that is from humid to sub-humid, sub-humid to semi-arid and semi-arid to arid and finally into the desert. However, when there is an intervention of humans in the process of its function, it is nothing less than accelerating a slow and gradual transforming process into an alarming speed, leading to total collapse in the intricate relationships existing between the significant ecosystems.

From this point of view, it is essential to make others understand the intensity of this problem. In this direction, the earth science scholars, Environmentalist, and Spatial planners have a responsibility to bring awareness about what could be the future probabilities after one hundred years on this land. Answering this question definitely will have serious thinking on the impact of the present-day abuse on natural resources like forest and groundwater. The main objective of this study is to introduce the readers on how a gradual change in climatic conditions, deforestation, and groundwater depletion can lead the human civilization into 'no water land' that is desert. The case study of Gundlupet taluk is just a replica of how reckless usage of groundwater and deforestation can result in climate change leading to severe desertification, which is unnoticed at present.

Study Area

The Gundlupet taluk is a fourth-order administrative unit of Karnataka state, a tiny land located towards southwest of Bangalore city and in the South of Mysore city. The Gundlupet is situated near to foothills and rests at an average elevation of 835 MSL. This taluk is on a plateau surrounded by mountains almost in all directions, excluding northeast (Figure 1).

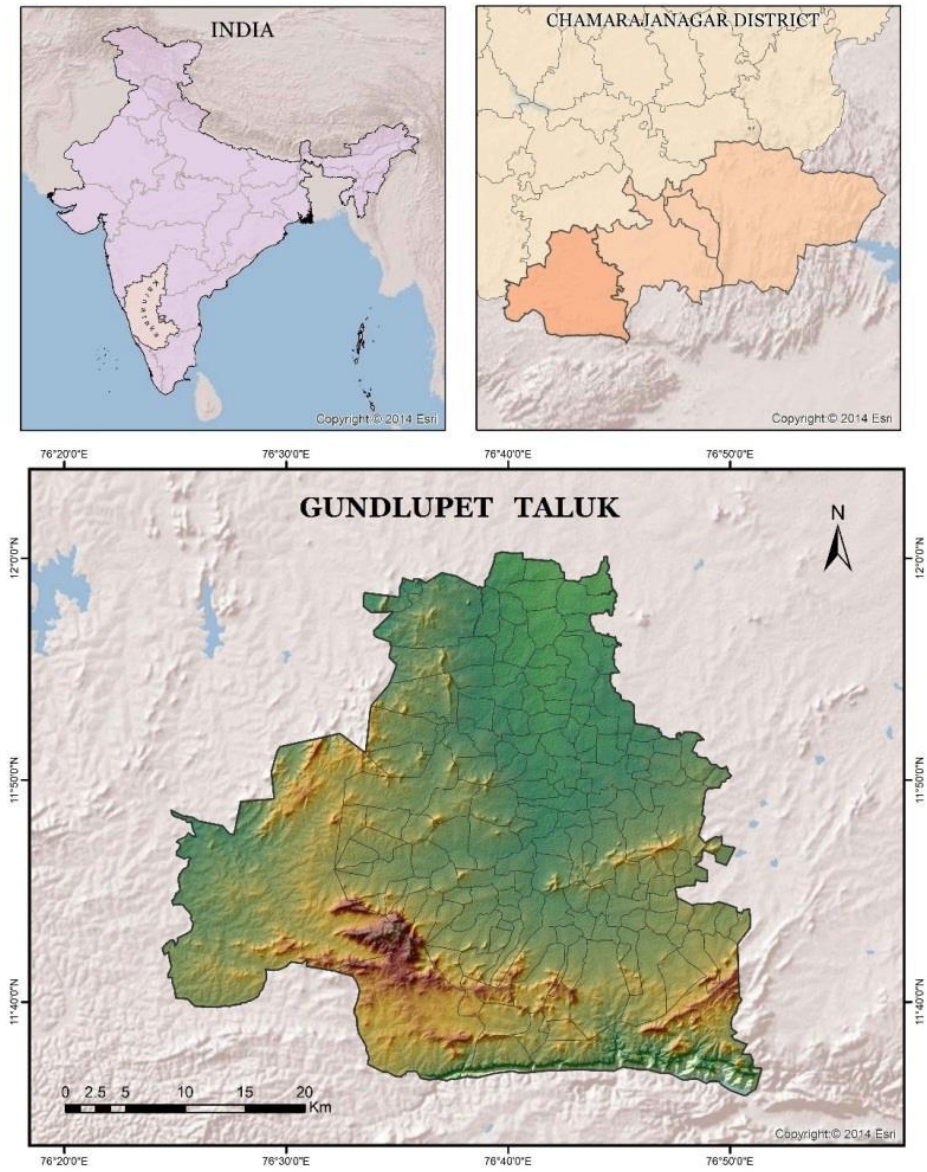


Fig. 1. Study Area: The Gundlupet Taluk in Karnataka State, India

Being located in the mid of southern peninsular India, Gundlupet was experiencing both southwest and northeast monsoon rainfall. Good rainfall conditions in most of the months in a year might have given rise to human habitation roughly one thousand years ago. In the past, it was a land of thick forest, given habitat to elephants, tigers, deer's, and other wildlife. In comparison, the present scenario of rainfall is different. The five-year average rainfall of the Gundlupet taluk indicates a decrease in rainfall from west to east. The forest-covered land experiences more than 67 cm per annum rainfall, and it decreases towards the east, which is a deforested land where the rainfall is less than 50 cm (Figure 2).

The Gundlupet taluk at present experiences less than 60 cm of rainfall per annum, and nearly 53,995 hectares of net sown area fall under this dry category of rainfall region. The primary source of irrigation is borewell, tank, and canal irrigation. Around 70 per cent of the land depends on rainfall. Concerning the total population size and the density of the Gundlupet taluk, it is fairly denser and populous land when compared with other taluks. The Gundlupet, as per the 2011 census, possesses a total population of 2,23,070 and an average population density of 163 per sq.km.

Database and Methodology

The database of this research study was generated from the field surveys and secondary data. The forest cover area which existed in the 1930s was demarcated using the Survey of India (SOI) toposheets. Landsat satellite images were used for calculating NDVI data, which subsequently used to demarcate recent forest cover in the Gundlupet taluk. Stratified Random Sample Survey was carried out for a few villages to understand the exact level of groundwater from the surface. The secondary groundwater level data procured from the Central Groundwater Board, Government of India. Livestock population data for the year 2012 was referred from the reports published by the Directorate of Economics & Statistics, Government of Karnataka. This data was used for projecting the livestock population for the year 2018. All the above stated spatial and non-spatial data were used for the analysis in the GIS platform. The result was validated using the GPS and ground truth data collected from each village in the study area.

Results and Discussion

Drainage

The drainage network of The Gundlupet taluk comprises first, second and third-order streams. Mainly, the rills and streams from the third order. As the slope is dipping from south to north, most of the rivers and streams take origin from the western, southern, and south-eastern mountains and flow towards the northern direction. Among the significant streams, Gundal and Mayar are the two major streams of this taluk, as shown in Figure 2. The primary stream forms the boundary line between the Karnataka and the Tamil Nadu State.

Deforestation

The 1930's topographical maps reveal that the forest cover was densely concentrated towards west and southwest of taluk, which happens to be the foothills of the region. From 1975 to 2018, the NDVI analysis performed using satellite images depict total deforestation of about 87sq km. In 1930 the total forest cover in the taluk was 691 sq.km, whereas it got reduced to 604 sq.km in 2018, losing 87 sq.km of the forest. The land under forest accounted for 46.78 per cent of the total geographical area in 1930, and it got reduced to 40.89 per cent in 2018 (Figure 2).

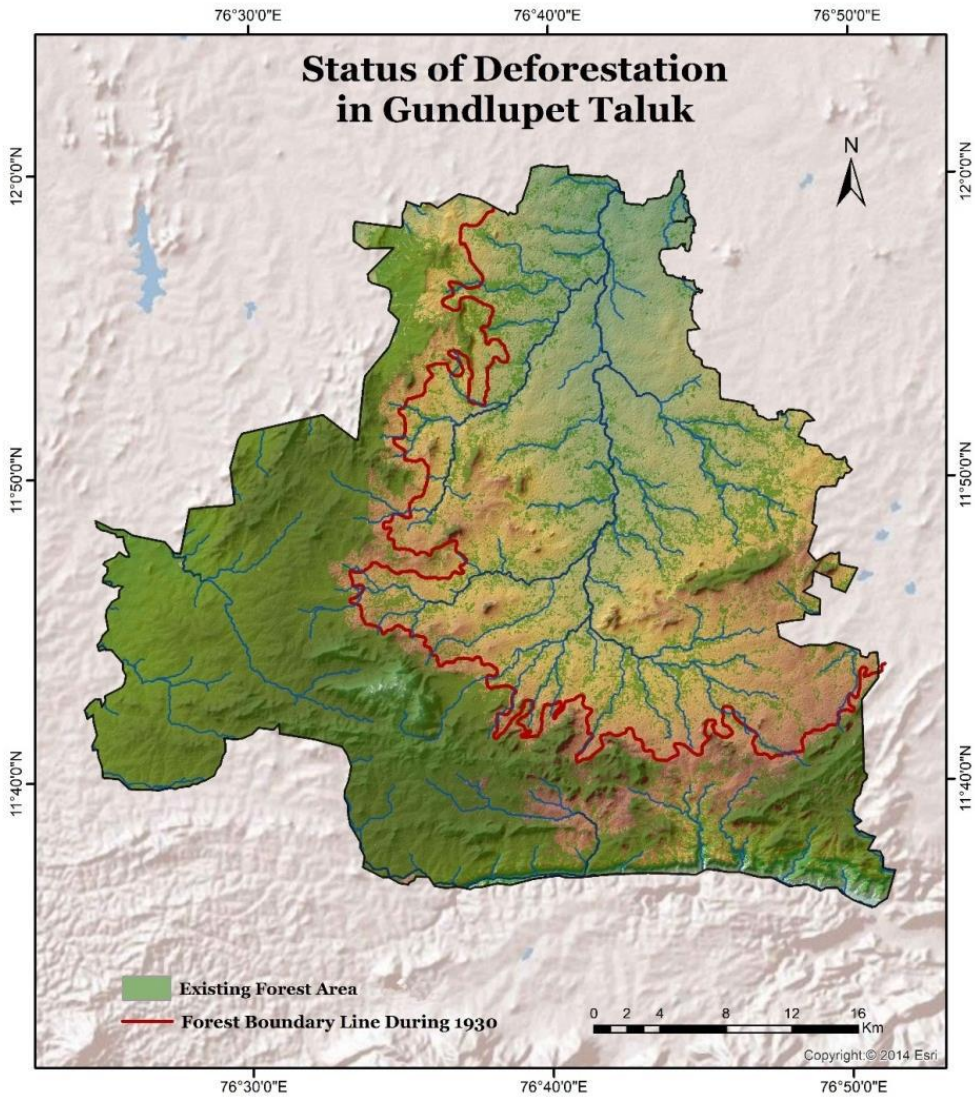


Fig. 2. Present Status of Forest (2018) Cover and its Boundary During 1930

The decrease in the forest over the period along the foothills of southern, south-western, and western parts is a clear sign of the transformation of forest land into agricultural land. The impact thus resulted in envisages decrease in rainfall. Another point to be noted here is, before 1930, the entire taluk had moist to dry deciduous forest, which has been deforested by the migrants of other states (Tamil Nadu and Kerala) and also during the world war periods under the British regime. As a result, this region has stepped into the climatic transformation from sub-humid to a semi-arid condition.

Over the years, the gradual decrease in rainfall has prompted the farmers to find an artificial source of water for agriculture that is through borewells. The total number of borewells dug in Gundlupet taluk until 2018 was 34,964 (Table 1). This is, in fact, great treachery on the land by man. The untrapped groundwater over the million years was trapped within a span of 5 to 7 years. A sudden harness of underground water has developed an imbalance between the rate of water recharge and the extraction of the groundwater. This imbalance resulted in the loss of moisture from the soil.

Table 1. Number of Bore Wells in Gundlupet Taluk

During	Tubewells	Other wells	Pumpsets	Total
2000	3,330	1,492	6,381	11,203
2010	5,989	2,501	11,107	19,597
2018	11,072	4,221	19,671	34,964

Source: *CGWB, 2010 (2018 data is projected using the base value from CGWB data)*

Agriculture

The Gundlupet taluk is located in a transitional zone of climatic condition, where the southwest monsoon and northeast rainfall recedes from the west and also from the east. The taluk possesses 40.7 per cent of the total geographical area under agriculture. Nearly 78 per cent of the agricultural land is under dry crop cultivation. Only 18 per cent of the land has been irrigated utilizing tube wells and borewells. Borewells account for 92.5 per cent of the total irrigated area followed by proper irrigation, which accounts for 7 per cent. This data envisages the extend of under groundwater utilisation.

Stratified random sample survey was carried out at the village level to understand the exact level of groundwater from the surface (Figure 3). The number of borewells has been increasing year by year because the land is facing a shortage of rainfall for the cultivation of crops. The total number of bores dug was 34,964 until 2018. Another interesting fact to be noted here is, almost all borewells have been dug within a decade. An increase in borewell irrigation speaks about the shortage of rainfall to cultivate dry crops such as ragi, jowar, and other millets. Secondly, although the cultivation of paddy, which is the most common crop produced in irrigation tracks, does not figure out either as a fifth or sixth ranking crop. This again proves that, although paddy accounts to be the top priority and also a status crop among the farming community, it is not cultivated due to a low yield of groundwater.

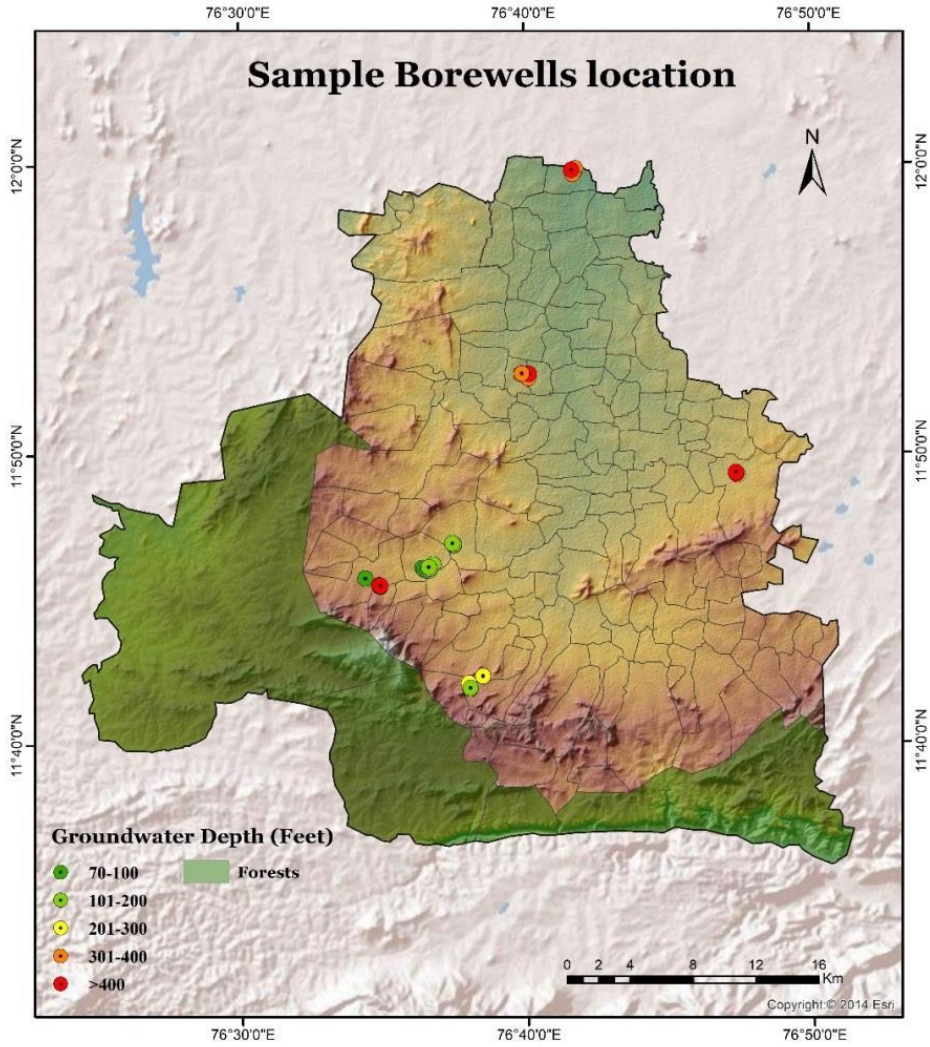


Fig. 3. Location of Sample Borewells and Groundwater Depth in Borewells

At present, there is an acute shortage of groundwater yield even to cultivate dry crops such as ragi and other Millets. The primary crop cultivated at present in this taluk is ragi, jowar, and maize. All these cereals put together accounts for 18,414 hectares of land. The pulses crops account for 13,108 hectares and oilseeds account for 9046 hectares. Cotton is another major dry crop of this region, accounting for 8451 hectares. Recently dug borewell farmers usually prefer to cultivate wet crops such as paddy and sugarcane because farmers consider the cultivation of wet crops is of high status, as such paddy accounts to 554 hectares and Sugarcane crop accounts to 3673 hectares. Cultivation of Sugarcane is preferred among wet crops since it is not labour-oriented farming.

The farmers who own borewells a decade ago had a good yield of under groundwater and became successful wet crop producers. Due to an increase in the number of borewells, most of the borewell yield has decreased. Even to produce the dry crops which were once cultivated naturally as a rain-fed crop, they need to be irrigated by groundwater sources. Thus, the overall scenario of agriculture in this taluk illustrates drastic transformation in the source of irrigation. The question that arises here is: what next if all the borewell does not yield water to produce any crop?

Livestock

Drastic fall in agriculture production has led to a decrease in income. To compensate for the loss of income, the farmers have shifted to livestock farming as an immediate option. Having a statistical glance of the livestock population again confirms that the taluk is holding a higher livestock population compared to other taluks of the district and, in comparison, to wet districts of the state. As per 2018 statistics, the total number of cattle's reared accounts to 76204, buffaloes 589696, sheep 33,549, and goats accounts to 266198. The density of domestic animals to the total geographical area compared to the adjoining taluks clearly states that the taluk is stepping towards an agriculture subsector that is animal husbandry (Table 2).

Table 2. Livestock Population and Density Projected for the Year 2018

Sl No	Taluk	Cattle	Buffalo	Sheep	Goat	Total	Density
1	Chamarajanagar	73,317	7,553	46,023	75,597	2,02,490	147.5875
2	Gundlupet	76,204	5,89,696	33,549	2,66,198	9,32,098	679.3717
3	Kollegala	1,01,127	3,200	31,102	18,203	1,53,632	111.9767
4	Yallandoore	11,127	647	6,915	4,692	23,381	17.04155

Source: *Dir. of Economics & Statistics, (Govt. of Karnataka, 2012)*

The growth rate of the livestock population in Karnataka is one of the best indicators of the desertification process. Until the land is rich enough to produce crops, the cattle population as acted as a supporting activity to the marginal farmers in this region. Among the marginal and low landholding farming communities of Karnataka, all agricultural operations are performed by ox and cow. The fodder produced from the crops supports animal husbandry as an auxiliary means of agriculture without additional burden on farmers (Biradar, Ramesh and Pathak, 2007). The situation of cattle population growth rate in Karnataka state is self-explanatory. Between 1974 - 2003, the cattle population growth rate had come down to -5.61 per cent. This change indicated that cattle-based farming has come to a halt in many districts. In the case of sheep and goat population, the growth rate has increased to 33.62 per cent and 15.64 per cent, respectively, between 1974 -2003 (Biradar and Sridhar, 2009). An increase in sheep and goat is a clear sign that the region is failed to produce enough food crops. The change in rainfall conditions and no water in most of the borewells, farmers have changed their agriculture occupation to sheep and goat rearing. Climatologically At present, this region can only produce floor grass and tinny plants during the rainfall season, which can feed only sheep and goats.

Cattle population directly depends on agriculture prosperity whenever agriculture is in good returns, the cattle population increases (Radder, Bhanj and Kaul, 2010). Whereas in the case of goat and sheep, if the agricultural production decreases, the domestication of these animals increases. Rearing of sheep and goats can be done without expenditure and also act as an excellent substitute for an agricultural income. Hence, when crop production in such an area decreases, there is an increase in the population of sheep and goats. On these grounds, sheep and goat rearing can be considered as an indicator of transformation in agriculture to semi agriculture, semi agriculture to animal husbandry, and from animal husbandry back to nomadism. Based on the present situation in Gudlupet taluk, it can be envisaged that the taluk is fast reaching towards nomadism if necessary measures are not implemented. Another situation is outmigration; seldom farmers may altogether discard the agro-based occupation and also migrate from the deforested land to some other place or city in search of non-agricultural jobs. Comparing the situation of Karnataka in general and the Mysore district in particular, the statistics indicate that the cattle population in the district of Mysore has been reduced from 1974 to 2000, and the growth rate has declined to -12.71 per cent. It is a clear indication of a decline in agriculture prosperity, and the farming community has inevitably switched over to a substitute source of income, i.e., animal husbandry through sheep rearing and goats. The rising population of sheep and goats has a negative impact on environmental degradation, which has not been taken seriously. Neglecting such an issue has serious consequences. Intensive rearing will further enhance the total removal of grassroots from the soil leading to higher soil erosion, soil leaching, infertility in the soil leading to no vegetation, and no scope for water recharge. Finally, this problem will further aggravate the non-availability of pasture land. Ultimately, when the land loses pasture for animal rearing, this directly brings down the sustainability of the region. This stage of the condition certainly indicates the land turning from arid to a desert.

Cross-Examination of Geospatial Results with the Secondary Data

The GIS overlay analysis technique was performed through a weighted score analysis. The result show, the high groundwater potential zone was found on the thick vegetative area, and a moderate potential zone was identified over the open forest region, low potential groundwater zone was identified over the deforested land. Some patches of moderate potential groundwater areas were identified in the reforested land. (Figure 3). The secondary data proved that the places where vegetative growth is existing at present in those pockets the level of groundwater are comparatively closer to the surface that is 45 to 60 metre (m), as against the places where deforestation has occurred a long ago. Especially along the east and northwestern parts of the Gundlupet taluk where the intensive agriculture is practiced, groundwater level has gone down beyond 150 m. Out of 34,964 borewells, almost 53 per cent of the borewells are defunct, and another 31 per cent of borewells are producing a low yield of water, which are insufficient and inadequate to produce either dry crops or the wet crops. Only reaming 16 per cent of the borewells are producing a good yield of water, which is sufficient to produce two-time dry crops (Table. 3).

Table 3. Selected Gramapanchayat Village Groundwater Information

Sl. No	Village Name	Total Numbers of Borewells	Agricultural purpose	Drinking purpose	Function	Non-function	Total No. of open wells
1	Aagathagowdanahalli	566	551	15	292	274	173
2	Chikatti	566	551	15	292	274	173
3	Berambadi	269	255	14	189	80	42
4	Hangala	214	196	18	131	83	26
5	Beemanabeed	2,710	2,700	10	1,355	1,355	21
6	Terakanambi	164	160	4	114	50	8
7	Kannegala	451	430	21	277	175	78

Source: *Gundlupet Taluk Panchayath*

Cross-Examination of Geospatial Results with the Sample Villages

In order to verify the results obtained from the overlay analysis, cross-examination of the intensity of the groundwater problem has been examined with the secondary data and geospatial results. Sample villages were selected from the three different water potential zones that were identified through overlay analysis, such as high, moderate, and low. Interestingly, The GPS survey conducted in the sample villages envisages that those villages which fall under high potential zone with thick vegetative cover possess high yield of water with an average depth of 64 m. The villages which were selected in the moderate groundwater potential zone with reforested background possess groundwater at an average depth of 68 m. In the case of villages which were chosen from low groundwater potential, i.e., in the deforested land (deforested about 80 years ago), envisages the level of groundwater at an average depth of 122 m, in the villages such as Agathagowdanahalli, Terakanambi, and Chikkatti (Table 4).

Table 4. Average Water Level in Metres

Village Name	Average Water Level in Metres
Agathagowdanahalli	113
Beemenabeedu	64
Berambadi	81
Kannegala	68
Chikkatti	107
Terakanambi	113
Melukammanahalli	80

The GPS and Ground truth data collected in each of these categories of villages, clearly reflects that the results obtained through overlay analysis has attained an accuracy level of 80 per cent and also proves that, the villages without forest cover have a severe threat of desertification. In these regions, the water depth has reached beyond 152 m (Table 5). Cumulative weightage results were further manifest that the intensity of desertification in the Gundlupet taluk is in an alarming phase. (Figure 4). The entire study area is divided into three zones, i.g. Sever, Moderate, and Zero Threat. The result obtained and placed in this paper will help planners, government as well as residents to tackle the problem.

Table 5. Village Level GPS Stratified Random Sample Survey

Legend	Village Name	Elevation (MSL)	Name of the Owner	Year of Installation	Depth of Bore well	Water Yield in Inches (post monsoon)	Water Yield in Inches (pre monsoon)
Thick Vegetative Covered Village with water potential	Berambadi	877.56	Chennabasappa	1995	180	2.5	1.5
	Berambadi	879.73	Shivappa	2003	170	2	1.5
	Berambadi	883.33	Subbashetty	2012	450	2.5	2
Moderate Potential zone with open forest	Beemenabeedu	833.1	Dasashetty	2007	200	1.5	1.5
	Beemenabeedu	841.51	Ganesha	2007	150	2	2
	Beemanabeedu	839.11	Gopalashetty	2009	180	2	1
	Beemanabeedu	840.07	Janakamma	2013	330	1.5	1.5
	Beemanabeedu	864.83	Swamesh	2013	184	1.5	0.5
	Kannegala	851.13	Basavaraju	2010	350	1	0.5
	Kannegala	850.89	Basavarjappa	2012	300	1	0.5
	Kannegala	854.73	Basappa	1997	100	2	1
	Kannegala	848	Jayaram	2011	180	1.5	0.5
	Kannegala	854.01	Mallappa	1995	80	1.5	1
	Kannegala	853.05	Rudrappa	2003	70	2.5	1
	Kannegala	846.8	Basappa	2011	380	1	0.5
	Kannegala	847.52	Mallappa	2010	350	1	1
	Kannegala	847.04	Madappa	2000	200	1	1
Deforested land with low potential village	Agathagowdanahalli	873	Mahadevappa	1999	350	2	2
	Agathagowdanahalli	791.28	Rajappa	2011	280	2	0.5
	Agathagowdanahalli	783.83	Shivanna	2013	400	2	1
	Agathagowdanahalli	782.15	Shivappa	2010	450	2	1.5
	Chikkatti	720.63	Shivanna	2002	300	3	1
	Chikkatti	722.79	Sundarnayka	2011	500	1.5	1
	Chikkati	728.56	Chandru	2002	180	2.5	1.5
	Chikkatti	723.51	Beeregowda	2006	270	2.5	1
	Chikkatti	723.75	Eshwara	2005	500	2	0.5
	Terakanambi	832.62	Govindanyka	1989	350	1.5	1
	Terakanambi	830.94	Mallikarjuna	1988	260	2	1
	Terakanambi	831.18	Sundarnayka	2011	500	1.5	0.5
Reforested land with moderate potential village	Melukammanahalli	935	Mahesh	2003	350	1.5	1
	Melukamanahalli	906.16	Krishnappa	1997	300	3	2
	Melukamanahalli	931.64	Narayanappa	2000	250	2	1.5
	Melukamanahalli	932.6	Rojanbin	2001	150	2.5	1.5

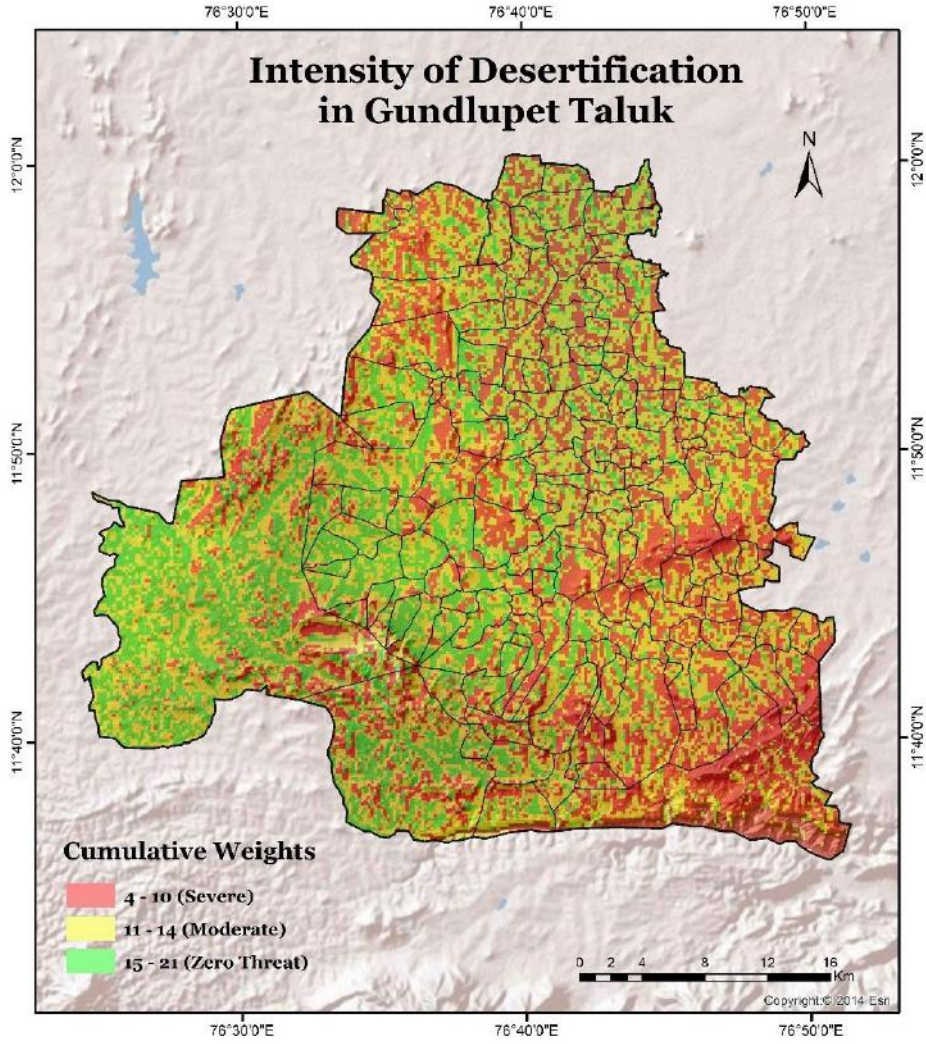


Fig. 4. Intensity of Desertification Process in the Study Area

Conclusions

The final remark that can be underlined from this study is, if a continuous process of deforestation added with the extraction of groundwater is continued, there is no doubt that this region will slowly get transformed from semi-arid to aid and in the later years into a desert, (approximately by 2100) if no measures are taken to reduce the on-going rate of transformation into desertification. The significant social impact seen in this region is, nearly 35 per cent of the dry land farmers are inevitably shifting their occupation from agriculture to livestock rearing, which is again a significant threat to the land and also intensifies the process of desertification.

About 20 per cent of farmers, as per the sample survey has no choice of either agriculture or livestock rearing, and they prefer to migrate from this region to some other places to find their livelihood. Apart from the above social impacts, there are also cases where drinking borewell water has caused health diseases, primarily kidney-related diseases. Based on the facts stated above, which were obtained through filed data, it can be concluded that the continuous extraction of groundwater has further weakened the environment and, to a greater extent, climate change. The trees which were thick, luxurious, and tall are getting shorten and drying much earlier than the expected lifespan of certain species as per the aged local farmers. If the same rate of groundwater extraction continues with depletion of forest cover, in future agriculture will become a far-off dream of this region. The effect of deforestation and over-exploitation of groundwater makes us realize that it is now time to reverse the desertification cycle, at least to decrease its intensification over the duration to keep human life less miserable.

Acknowledgement

This paper is a partial study taken from the Desertification Process in Karnataka State. The Major Research Project was sponsored by the University Grants Commission, New Delhi, India.

References

1. Bauer, A. M., Johansen, P. and Bauer, R. L. (2007) 'Toward a Political Ecology in Early South India: Preliminary Considerations of the Socio-politics of Land and Animal Use in the Southern Deccan, Neolithic through Early Historic Periods', Asian Perspectives, 46(1), pp. 3–35. doi: 10.1353/asi.2007.0001.
2. Biradar, N., Ramesh, C. R. and Pathak, P. S. (2007) 'Traditional livestock feeding practices in Northern Karnataka', Indian Journal of Traditional Knowledge, 6(3), pp. 459–462.
3. Biradar, N. and Sridhar, K. (2009) 'Consequences of 2003 Drought in Karnataka with Particular Reference to Livestock and Fodder', Journal of human ecology (Delhi, India), 26(2), pp. 123–130. doi: 10.1080/09709274.2009.11906173.
4. CGWB (2008) 'Government of India Groundwater Information Booklet Chamarajnagar District, Karnataka', Groundwater Information Booklet, (November), pp. 1–24.
5. Chouhan, T.S. (2005) 'Degree, Extent and Treatment of Desertification Hazards in India', Sociedade & Natureza, (Uberlândia,), pp. 901–919. Available at: http://www.seer.ufu.br/index.php/sociedadenatureza/article/viewFile/9800/5887.
6. Karnataka, G. O. F. (2010) 'Statistical Abstract of Karnataka 2009-2010'.
7. Radder, S. K., Bhanj, S. K. and Kaul, P. N. (2010) 'Cattle rearing patterns of farmers in northern Karnataka', International Journal of Rural Studies (IJRS), 17(1), pp. 1–5. Available at: http://www.vri-online.org.uk/ijrs/April2010/cattle-rearing-patterns-of-farmers.pdf.
8. Wei, L. et al. (2010) 'Land use history and status of land desertification in the Heihe River basin', Natural Hazards, 53(2), pp. 273–290. doi: 10.1007/s11069-009-9429-5.

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 35-61
ISSN 0019-4824

THE RELATION OF HAPPINESS AND LIFE SATISFACTION WITH INCOME OVER SPACE AND TIME IN INDIA: SUBJECTIVE WELL-BEING WITHIN, BETWEEN AND ACROSS STATES

Lakshmanasamy T.

Department of Econometrics, University of Madras, Chennai - 600 005
E-mail: tlsamy@unom.ac.in, tlsamy@yahoo.co.in

Abstract

This paper analyses the income-well-being relationship within-states, between-states and across-states overtime in India, in an attempt to validate the presence of Easterlin paradox in India that despite vast cross-country differentials in income levels the happiness level across countries is pretty much close and that rising income levels in any country is not systematically associated with happiness and life satisfaction. Using the five waves of the WVS pertaining to 12 major states of India for the period 1990-2014, the individual and average life satisfaction and happiness levels are related with NSDP per capita in each state and groups of states. The long-run income-well-being relationship, is analysed with changes in average well-being indicators and per capita NSDP. The analysis shows that there is considerable variation in the levels of subjective well-being indicators both within and across states as well as over time in India. While life satisfaction levels declined in most states, happiness level improved slightly in some states. The gains from income growth is comparatively better in low income states. In the long-run, changes in well-being indicators is not commensurate with changes in NSDP per capita. The results of this paper on the subjective well-being-income relationship in states of India validate the presence of Easterlin paradox in India. Economic growth in states of India seems to have not improved the human lot, in fact, leaves people more dissatisfied and less happy in life.

Keywords: Happiness, Life satisfaction, Easterlin paradox, Average income, Between and overtime relationship

Introduction

Ever since the Easterlin's (1974) findings that despite vast cross-country differentials in income levels the happiness level across countries seems to be pretty much close and that rising income levels in any country is not accompanied by corresponding rise in life satisfaction levels, much light has been shed on the income-happiness relationship. Though the level of happiness in developed countries is higher and in rises with income at individual level, at the aggregate level, such positive income-happiness relationship vanishes. The pertinent question asked is: whether increasing income increase the well-being of people?

Nordhus and Tobin (1972), assessing the relevance of income and economic growth for development in Is Growth Obsolete? also ask the same fundamental question: can economic growth be an engine of well-being? The answer is an emphatic no. Many researchers also claim that economic growth has little to do with well-being of people in developed countries, although some claim that there seems to be some connection between income and well-being in developing and transitional economies. The overwhelming evidence from developed economies on the absence of growth-well-being relation has led some even to suggest that economic growth should not be the initial goal of economic policy (Oswald, 1997).

Subsequent to the Easterlin's observation on the income-happiness paradox in the US, most studies replicated and further scrutinised the Easterlin hypothesis, employing a variety of data and methodology, comparing and contrasting the nature of income-happiness relationship in western developed and OECD countries. They find divergent evidences that accept as well as reject the Easterlin paradox; there is almost nil or only a marginal effect of income on happiness at the aggregate level. While earlier studies report zero relationship, some latter studies remark linear relationship between income and happiness in developed countries (Stevenson and Wolfers, 2008; Deaton, 2008; Inglehart et al. 2010; Layard et al. 2010). Further, empirical studies also observe that the income-happiness gradient is much smaller in developed countries than in developing countries (Blanchflower and Oswald, 2004; Clark et al. 2008; Clark and Senik, 2011; Diener et al. 2013; Clark, 2018). Neglecting the minor differences, within-countries and between-countries cross-section studies on income-happiness relationship in developed countries reach the same conclusion that within a country higher income people are happy, the income impact is comparatively low in developed countries, but, on average people in higher income countries are happier than lower income countries. However, the Easterlin's contradicting and controversial findings continues to persist and remain still an unsolvable paradox: whether the relationship between income and happiness in advanced countries is positive, negative or constant?

Another important question that is frequently asked is: Is the Easterlin paradox a rich country phenomenon? Does the Easterlin paradox applicable to developing countries also? (Clark and Senik, 2011). As Easterlin himself points out, hardly very few studies in developing countries analyse the income-happiness relationship, because of "limited and fragmentary nature of the available data" (Easterlin and Sawangfa, 2010). Graham and Pettinato (2001) argue that determinants of happiness in developing countries are almost similar as they are in developed countries. The systematic attempt to examine the income-happiness relation in terms of large sample of developing countries by Graham and Pettinato (2001) provides evidence to the presence to the Easterlin paradox in developing countries also and also lends support to the importance to the Easterlin's explanation of relative income differences. Other studies that focus on the broad determinants of happiness also observe positive relationship between happiness and individual income.

Sociologists Hagerty and Veenhoven (2003) also find a long-run positive relationship between income and happiness in developing countries. Clark et al. (2014) examining the cross-country income-happiness relationship using World Value Survey data (1981-2008) find a positive but curvilinear relation between average satisfaction and log GDP per capita. Majumdar and Gupta (2015) also using the WVS data for India (1990 to 2014) observe that the mean happiness in India increases during this period explaining that Indian people are more sensitive to absolute income rather than to relative income. Thus, there also exists some evidence that what Easterlin viewed in the US does not exist in developing countries including India.

To further validate his hypothesis in the developing world, Easterlin and Angelescu (2010) study the income-happiness relationship in 13 most populated developing countries in the world. The results reveal the absence of long-run relationship between economic growth and subjective well-being growth, and Easterlin attributes the phenomenon to of changes in family life and related issues. Again, Easterlin and his colleagues revisit the paradox with long years and more countries that include 17 Latin American countries, 17 developed countries, 11 Eastern European transition countries and 9 less developed countries from Asia, Latin America and Africa (Easterlin et al. 2010). This study shows that the rich country phenomenon is also observed in transition and poor countries as well. Revisiting his hypothesis, Easterlin (2017) checks whether his established paradoxical relation between income and happiness is lost or still exists. The OLS regression estimates still support his paradox, no matter what group of countries are used. Psychologists Diener et al. (2013) using data from Gallup World Poll for the period 2005 to 2011 for 158 nations analyse the income-happiness relation in poor countries against rich countries by including psychological factors like optimism which mediates income-happiness relation. They also find that within-countries income changes and SWB changes are not significantly different between richer and poor countries implying that raising income has the same effect on SWB in poor and rich nations. Thus, the income-happiness paradox now holds in countries ranging from rich to poor.

Thus, studies that systematically analyse the income-happiness relationship especially in developing countries fail to exhibit, akin to developed countries, any uniform consensus regarding the relationship between long-run income and happiness. Hence, the main objective of this paper is to analyse the relationship between subjective well-being and income in India. Aiming to examine the validity of Easterlin paradox in India, this paper replicates the Easterlin approach of within-countries, between countries and across-countries over time analysis in India as within-states, between states and across-states over time. Using the WVS on India, this paper tries to identify the nature of the relationship between income and subjective well-being, by regressing self-reported well-being on a set of covariates including income at the individual level as well as aggregate levels and personal demographic and economic characteristics.

Data and Empirical Analysis

To analyse subjective well-being the variations within and across states, and across-states over time in India, this paper examines the state-wise distribution of life satisfaction and happiness in the states in India. This paper uses data from the World Value Survey (WVS), the largest source of the cross-national survey in the world on happiness. Since its beginning in 1981, six waves of surveys have been conducted between 1981 and 2014. The WVS aims to understand and investigate the global changes in socio-cultural-political-religious values and beliefs. Additionally, the WVS also contains questions on subjective well-being and related areas. The WVS uses a random probability sampling design and a face to face interview is conducted by a locally appointed field organisation that is supervised and instructed by academic researchers. The WVS covers close to 97 societies from all the six continents constituting 88 percent of world population, the sixth wave (2014) includes 60 countries with more than 85,000 respondents. Being a part of the WVS Association, India has been surveyed since the second wave (1990) onwards. The WVS has started the survey in India in 14 major states with 2400 sample size, covering more than 90 percent of the nation's population and the sixth wave of WVS in India was conducted in 22 states with a sample size of 4078 respondents. In total, there are more than 10,000 observations in the WVS of India. This paper uses data for 12 major states in India, for those states that are continuously sampled in each of the five waves. The 12 states are Andhra Pradesh (AP), Bihar (BI), Gujarat (GU), Karnataka (KAR), Kerala (KER), Madhya Pradesh (MP), Maharashtra (MR), Odisha (ODISHA), Rajasthan (RAJA), Tamil Nadu (TN), Uttar Pradesh (UP) and West Bengal (WB). The final sample size for this study is 8,965 observations.

The WVS data provides various indicators of subjective well-being. There are three main direct measures on overall SWB. The happiness question asks respondents to evaluate their present life in terms of "Taking all things together, would you say you are… very happy, quite happy, rather happy and not at all happy". In this paper, the happiness level is recoded reversely as 'not at all happy'=1, 'rather happy'=2, 'quite happy'=3 and 'very happy=4. The life satisfaction question asks for an evaluation of whole life: "All things considered, how satisfied are you with your life as a whole are these days?" for which respondents self-select a value in a 10-point scale, starting with dissatisfied and ending with satisfied. The question on satisfaction with the financial situation of the household asks: "how satisfied are you with the financial situation of your household?" and a 10-point scale starts with completely dissatisfied and ends with completely satisfied. The happiness literature views all the three subjective well-being measures synonymously and interchangeably as an indicator of the true well-being of individuals as the respondents themselves assess and self-report their well-being level. While life satisfaction encompasses the whole life, happiness, being a feeling, may mean instantaneous or momentary gratification of the respondents.

Studies frequently use the life satisfaction in their analysis as its response scale is large in number compared to the happiness scale and it is a better measure for making cross-section comparison relative to the happiness measure (Di Tella and MacCulloch, 2006). Table 1 and Figure 1 present the average levels of the three subjective well-being indicators of the WVS across waves in India. It can be observed that even though the mean financial satisfaction is slightly low compared to the mean life satisfaction, variations in both variables are almost the same and they move in the same direction. But, the average level of happiness in India remains close to 3 across the waves, ranging from 2.92 to 3.12. However, the average life satisfaction in India shows a declining trend, a decrease from 6.69 to 5.16 between 1990 and 2014.

Table 1. Average Subjective Well-Being Levels in India, 1990-2014

WVS Wave	Mean Life Satisfaction	Mean Financial Satisfaction	Mean Happiness
1990-91	6.69 (2.28)	6.35 (2.21)	2.92 (0.79)
1995-96	6.44 (2.64)	6.08 (2.51)	3.04 (0.78)
2001-02	5.01 (2.14)	4.82 (2.19)	2.93 (0.79)
2006-07	5.82 (2.38)	5.28 (2.40)	3.00 (0.79)
2014-15	5.16 (2.74)	4.80 (2.64)	3.12 (0.85)
All waves	5.94 (2.52)	5.58 (2.46)	2.99 (0.80)

Note: Standard deviations in parentheses.

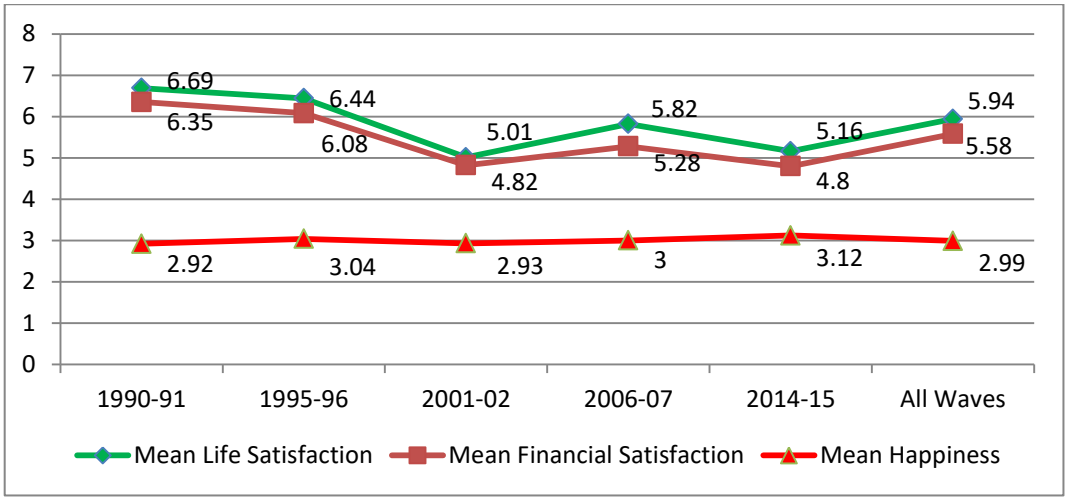


Fig. 1. Average Subjective Well-being Levels in India, 1990-2014

Table 2 presents the growth rate of NSDP in the 12 major states in India during the period 1990-2014. The growth rate of combined NSDP of all the 12 states together has increased from 5.51 percent to 7.16 percent during the 1990-2015 period. This growth pattern in the combined NSDP is almost close to the picture that is obtained from the national accounts-GDP of India at factor cost grew at 5.8 percent to 7.16 percent between 1990-91 to 2014-15. At the state level, growth has accelerated sharply in all states, except Karnataka.

The states with a growth rate below the national growth rate during the first period 1990-91 to 1999-2000 have registered faster growth rate in the third period 2010-11 to 2014-15. Especially the growth has been spectacular in the laggard states Bihar (2.85 to 11.03), Madhya Pradesh, Rajasthan and Uttar Pradesh, In Madhya Pradesh and Tamil Nadu growth rate has declined in the second period and rebounded in the third period. In Andhra Pradesh, Gujarat, Karnataka, Kerala and West Bengal, growth has declined in the third period between 2000-01 to 2009-10 and 2010-11 to 2014-15, whereas Bihar, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu and Uttar Pradesh experienced accelerated growth in this period. Thus, there has been contrasting growth performance and significant variations across states of India over time. As the coefficient of variation reveals, the degree of dispersion has declined in the second period, from 0.28 to 0.18, but increased in the third period, to 0.24. Thus, the acceleration of growth is evident not just for aggregate GDP, but even more strongly for individual states.

Table 2. Average Annual Growth Rate of NSDP in India, 1990-2014 (Percent Per Year)

State	1990-91 to 1999-2000	2000-01 to 2009-2010	2010-11 to 2014-2015	State	1990-91 to 1999-2000	2000-01 to 2009-2010	2010-11 to 2014-2015
Andhra Pradesh	5.2	7.59	5.56	Rajasthan	6.55	6.86	8.13
Bihar	2.85	8.65	11.03	Tamil Nadu	6.32	5.31	7.75
Gujarat	6.8	8.91	7.88	Uttar Pradesh	3.59	5.32	5.92
Karnataka	6.75	7.59	6.66	West Bengal	6.67	7.20	6.28
Kerala	5.99	7.79	6.15	Combined NSDP	5.51	7.06	7.14
MP	6.16	5.10	8.55	India GDP	5.83	7.21	6.86
Maharashtra	6.61	6.86	7.33	CV	0.28	0.18	0.24
Odisha	2.68	7.61	4.44				

Sources: Directorate of Economics and Statistics of respective states and CSO data series of India.

But, at the same time, India's rapid economic growth has raised inequities in economic growth pattern across states also. Studies show that the income share of the top 1 and 10 percent is not only high but also growing relative to the bottom 40 percent of the population of India (Chancel and Piketty, 2019). Parallel to the national and individual level inequality, the inter-state Gini coefficient of Gross State Domestic Product, a regional inequality measure, also shows an increasing trend during the period 1990-2014, as shown in Figure 2. Thus, it is clear that accelerated economic growth in India is also accompanied by a rapid rise in inequality. Though India is growing at the economic ladder, the well-being of Indians is not improving correspondingly. The World Happiness Index (2018) of the United Nations places India at the 133rd rank among the 156 countries in the world, a drop of 11 ranks from the 2017 rank, in which India stands below than its less developed neighbours. In fact, India's rank in the World Happiness Index is decreasing over the last few years. In 2013, it was 111st, 117th in 2015, 118th in 2016, and 122nd in 2017, with a continuous fall in the scores also.

The World Value Survey, the worldwide accepted largest on well-bring indicators, also reveal that happiness and life satisfaction are not in tandem with economic growth in India. The well-being indices are not moving in the same direction and at the same speed as income. Figure 3 reveals that the average life satisfaction has declined with an increase in average per capita NSDP across the states in India. While there have been 35 times increment in the growth rate of NSDPpc during 1990-2014, the average life satisfaction per state is reduced by around 1 percent over this period. Thus, there exist ample indications to presume that economic growth has not brought corresponding growth in subjective well-being not only at the aggregate national level but also in Indian states.

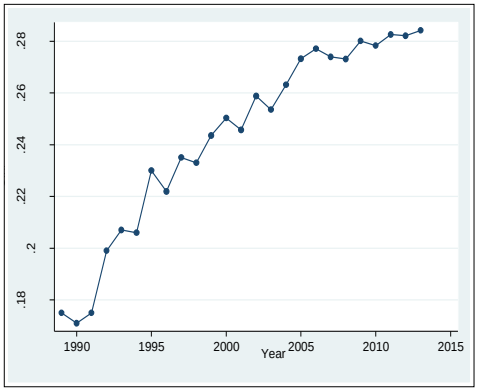


Fig. 2. Trend in Inter-State Income Inequality (Gini) in India, 1990-2014
Note: *Data are from Ahluwalia (2002) upto1998-99, and OECD(2017) Economic Survey: India from 1999-2000.*

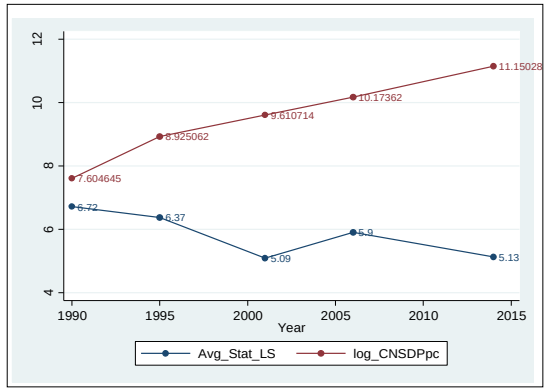


Fig. 3. Average Life Satisfaction and NSDP per capita Across States in India, 1990-2014
Sources: *Data on life satisfaction from WVS (1990-2014), and income from RBI: Handbook of Statistics on the Indian Economy, 2016-2017.*

Within-States Income-Subjective Well-being Relationship

Generally, individual income is expected to influence subjective well-being positively i.e. rich individuals and rich people in a richer state are happier than the poor and poor people in a state. Easterlin remarks that “As far as I am aware, in every representative national survey ever done a significant bivariate relationship between happiness and income has been found” (Easterlin, 2001, p.468). In his seminal paper, Easterlin analysing various data observes a positive but small effect of aggregate income on national level happiness and concludes that the cross-country income-happiness relationship as “ambiguous, if there is a positive association between income and happiness, it is certainly not a strong one” (Easterlin, 1974, p. 108). Subsequent attempts to find more evidence on the positive relationship between country’s income and happiness led to the conclusion that the positive relationship between aggregate income and happiness in a country holds only over low levels of income, on the “flat of the curve”, with the additional income “buying little if any extra happiness” (Clark et al. 2008, p. 96).

Although most literature now agrees that aggregate happiness increases with national income in poor income countries, there is less clarity on the magnitude of the positive relationship. The distribution of life satisfaction and happiness levels across the 12 states of India, reported in Table 3, shows a significant Pearson's chi-square value (980.61) indicating significant differences in the distribution of life satisfaction across the states. A comparison of the mean score of life satisfaction in these states reveals that the mean life satisfaction score is higher (6.79) in Tamil Nadu, while for people of West Bengal the score is only 4.83. In West Bengal, only 6 percent report complete life satisfaction while 15.10 percent report complete dissatisfaction with life. Out of twelve states, eight states achieve mean score of life satisfaction above the national average of 5.94. Surprisingly, in the economically poor states, Madhya Pradesh, Rajasthan and Uttar Pradesh, the average life satisfaction score is comparatively higher. The distribution of happiness level indicates significant variations across the states in India, with a significant chi-square value of 496.90. To be specific, more than 41 percent people in Odisha and Gujarat express that they are very happy with their current life, but only lower percentage of people in Andhra Pradesh, Kerala and West Bengal report happiness in life. Out of 12 states, five states achieve mean happiness level above the national average of 2.99. In general, more people in most states are happy.

Table 3. Life Satisfaction and Happiness Across States in India, 1990-2014

State	Dissatisfied	5th Level	Satisfied	Mean LS*	Not Happy	Rather Happy	Quite Happy	Very Happy	Mean happiness*
AP	41 (5.42)	210 (27.74)	75 (9.91)	6.14 (2.40)	13 (1.72)	157 (20.77)	462 (61.11)	124 (16.40)	2.92 (0.66)
Bihar	21 (2.38)	247 (27.97)	106 (12.00)	5.89 (2.36)	52 (5.70)	245 (26.86)	389 (42.65)	226 (24.78)	2.86 (0.85)
Gujarat	35 (6.82)	92 (17.93)	96 (18.71)	6.31 (2.75)	11 (2.14)	90 (17.48)	201 (39.03)	213 (41.36)	3.19 (0.79)
Karnataka	14 (2.61)	184 (34.33)	42 (7.84)	5.26 (2.20)	14 (2.65)	169 (31.95)	232 (43.86)	114 (21.55)	2.84 (0.79)
Kerala	9 (2.54)	88 (24.86)	52 (14.69)	5.97 (2.35)	15 (4.24)	61 (17.23)	212 (59.89)	66 (18.64)	2.92 (0.72)
MP	30 (4.55)	155 (23.52)	48 (7.28)	6.22 (2.21)	11 (1.55)	134 (18.93)	355 (50.14)	208 (29.38)	3.07 (0.74)
Maharash tra	81 (7.53)	297 (27.63)	99 (9.21)	5.73 (2.52)	61 (5.64)	265 (24.51)	420 (38.85)	335 (30.99)	2.95 (0.88)
Odisha	29 (7.73)	103 (27.47)	53 (14.13)	5.97 (2.56)	5 (1.33)	66 (17.51)	148 (39.26)	158 (41.91)	3.21 (0.78)
Rajasthan	23 (4.60)	123 (24.60)	82 (16.40)	6.13 (2.57)	11 (2.10)	43 (8.22)	271 (51.82)	198 (37.86)	3.25 (0.69)
Tamil Nadu	12 (1.63)	150 (20.35)	108 (14.65)	6.79 (2.13)	30 (4.05)	83 (11.20)	366 (49.39)	262 (35.36)	3.16 (0.78)
Uttar Pradesh	87 (5.42)	364 (22.67)	265 (16.50)	6.07 (2.67)	86 (5.27)	401 (24.56)	724 (44.34)	422 (25.84)	2.90 (0.84)
West Bengal	114 (15.1)	212 (28.08)	48 (6.36)	4.83 (2.55)	36 (4.77)	144 (19.10)	439 (58.22)	135 (17.90)	2.89 (0.74)
Pearson chi2	980.61 (Prob. = 0.00)				496.90 (Prob. = 0.00)				

Note: *Percentage figures in parentheses. * Standard deviation in parentheses.*

The average life satisfaction/happiness scores among low and high-income groups in the states in 2014 presented in Table 4, in 7 out of 12 states the mean happiness score for higher-income groups is greater than that for lower-income groups. But the mean difference is significant only in three states, Andhra Pradesh, Gujarat and Uttar Pradesh.

The results on the comparison of average happiness of top of the state's economic ladder with the bottom of the state's economic ladder also not in favour of any strong evidence of a positive relationship between individual income and happiness within-states at a point of time. From the state-specific average life satisfaction among the low and high-income groups presented in Table 4, it is observed that only in 4 out of 12 states, Bihar, Gujarat, Uttar Pradesh and West Bengal, the value of Chi2-statistic is significant. Among those four states, Bihar reports the lower level of average life satisfaction for higher-income groups than that of lower-income groups. In all other six states, except Karnataka, the average life satisfaction score is higher for low-income groups and lower for high-income groups, but the differences are not statistically significant. Therefore, within-states income-life satisfaction relationship fails to provide any strong evidence for the Easterlin hypothesis that on average higher-income people are more satisfied compared to lower-income group.

Table 4. Average Well-being among Low and High Income Groups in India, 2014

State	Mean Life Satisfaction			Mean Happiness		
	Low Income Group	High Income Group	Chi^2 Value	Low Income Group	High Income Group	Chi^2 Value
Andhra Pradesh	4.78 (2.57)	2.85 (1.77)	5.05	3.11 (0.86)	3.16 (0.41)	6.41*
Bihar	5.2 (1.42)	3.90 (1.65)	9.24*	2.1 (1.02)	3.0(0.31)	5.20
Gujarat	4.6 (3.21)	7.32 (2.71)	23.13***	2.88 (0.93)	3.6 (0.71)	10.14**
Karnataka	5.4 (2.27)	5.44 (2.40)	3.28	3.6 (0.5)	3.40 (0.50)	1.92
Kerala	4.55 (2.70)	-	-	2.55 (0.90)	-	-
Madhya Pradesh	6.0(2.60)	5.71 (3.38)	6.95	3.35 (0.84)	3.57 (0.75)	5.52
Maharashtra	3.60 (2.27)	3.50 (2.08)	9.24	2.85 (1.06)	3.07 (0.83)	5.57
Odisha	6.8 (0.78)	5.75 (1.70)	6.81	3.5 (0.70)	3.75 (0.50)	0.52
Rajasthan	2.46 (1.11)	-	-	3.60 (0.49)	-	-
Tamil Nadu	8.5 (0.71)	6.35 (2.05)	4.02	3.5 (0.70)	2.5 (1.08)	1.82
Uttar Pradesh	6.14 (3.08)	8.02 (2.16)	29.44***	3.12 (0.73)	3.35 (0.51)	6.48*
West Bengal	5.6 (2.38)	5.88 (2.52)	10.82*	3.46 (0.51)	3.44 (0.52)	0.01

Note: *Standard errors in parentheses. ***,**,* indicate level of significance respectively at 1, 5 and 10 percent level. - No observations.*

Figure 4 presents the average individual level of subjective well-being distribution within states across the WVS waves. It is clear variations exist in all the three measures of well-being not only over time in every state and across states but also variations between the three measures in each state and between the states. The mean scores of life satisfaction in six states decrease over time viz. Andhra Pradesh, Bihar, Gujarat, Kerala, Maharashtra and Rajasthan. In two states, Odisha and Tamil Nadu, the average scores of life satisfaction remain almost constant. In four states viz. Karnataka, Madhya Pradesh, Uttar Pradesh and West Bengal, subjective well-being measures exhibit raising trend over time. Further, the movement of financial satisfaction closely follows the pattern of life satisfaction in almost all states. When life satisfaction falls, financial satisfaction also decreases and when life satisfaction starts rising, financial satisfaction also tend to rise. But, in most cases, financial satisfaction lies below life satisfaction. The trend in happiness within in the states implies that in two states happiness shows raising trend viz. Karnataka and Odisha. In other states, average happiness across the waves stays almost constant.

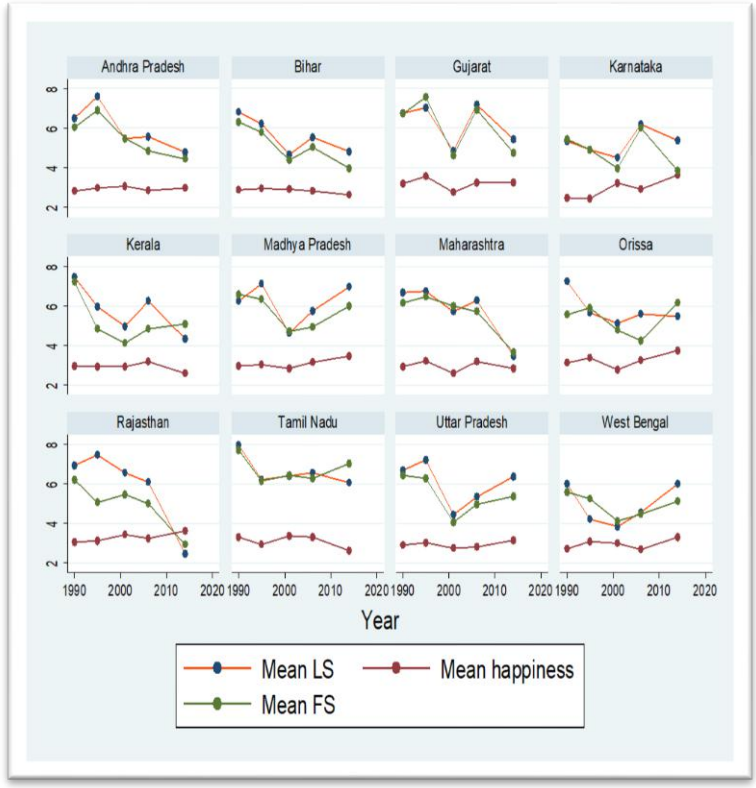


Fig. 4. Within-States Average Subjective Well-being in India, 1990-2014

Between-States Income-Subjective Well-being Relationship

Easterlin (1974) argues that one cannot predict the nature of the relationship between income and happiness across countries based on the within-countries happiness differences between rich and poor people. If it is so, the impact of average income on average national happiness will be larger than the impact of individual income on individual happiness levels (Easterlin, 1974). Therefore, Easterlin (1974) states that, if relative income matters more than the absolute income, then the between-countries well-being income coefficient would be smaller than the within-countries well-being-income coefficient. To refuting this, Stevenson and Wolfers (2008) compare the within-countries income-happiness gradient with between-countries income-happiness gradient using various international surveys and find evidence for the rejection of Easterlin's (1974) statement. They find evidence that income is an important determinant not only of individual happiness but also of a nation's happiness and observe higher-income coefficient in between-countries than in within-countries analysis. Therefore, in the between-states analysis, the average of the individual as well as state-level well-being-income relationship for each WVS wave is plotted against the log of average NSDP per capita of the states of India.

As can be observed from Figure 5, the NSDP per capita-individual average life satisfaction plots do not show any definitive evidence of an association between life satisfaction and income at the state level. In second and sixth (1990 and 2014) waves of WVS, the fitted lines slope negatively, whereas in third (1995), fourth (2001) and fifth (2006) waves, it is upward sloping. In the second wave, though the NSDP per capita is closer, Tamil Nadu has highest average life satisfaction of 8, while Karnataka has average life satisfaction less than 6 and all other 11 states have average life satisfaction score in between them. In third wave (1995) of WVS, NSDP per capita are both horizontally and vertically widely dispersed, so do the mean score of life satisfaction which varies between 2 to 8. The lowest average life satisfaction is reported in West Bengal and Karnataka and the highest is in Andhra Pradesh. Tamil Nadu, Kerala and Odisha have slipped to below 6 average life satisfaction score, while other states slightly improved their score. In the fourth wave, having less variation in both NSDP per capita as well as average life satisfaction across states, the average life satisfaction is positively associated with log NSDP per capita, suggesting that the states with the higher average NSDP per capita experience an increase in average life satisfaction. However, West Bengal still scores low average life satisfaction, Rajasthan has improved its score. The fifth wave confirms the positive relationship between NSDP per capita and average life satisfaction, implying that rising income level is increasingly associated with the higher average life satisfaction. While Tamil Nadu has regained the top score, West Bengal continued at the bottom of average life satisfaction level. The major higher-income states, Tamil Nadu, Gujarat and Maharashtra stand in the higher portion of average life satisfaction. On the other hand, poor-performing states, Bihar and Uttar Pradesh stand at the lower end of average life satisfaction.

The positive trend in income-life satisfaction relationship in the 2001 and 2006 waves of WVS in states of India disappears in the sixth wave. In contrast to the previous decade, the 21st century trend shows that average life satisfaction across states decreases as income increases with increased income dispersion. The poor states such as Uttar Pradesh and Madhya Pradesh score higher average life satisfaction while the richer income state Maharashtra has scored the lower average life satisfaction. In the sixth wave also, there is one clear outlier, Rajasthan. Overall, out of five waves between 1990 and 2014 in major 12 states of India, both NSDP per capita and average life satisfaction exhibit considerable variation both across states and over time. While the three waves show clear evidence of a positive relationship between the average state per capita income and average life satisfaction, in two waves the average life satisfaction is negatively associated with the NSDP per capita.

Further, the plots also show that while the low-income states improved the average life satisfaction across waves in latter waves, the high-income states experience swings in their average satisfaction levels, generally a declining trend. Thus, the results exhibit that even though there are only low differences in per capita NSDP of all 12 states, the wave-wise heterogeneity affect the direction of the relationship between state-level income and average life satisfaction in Indian states.

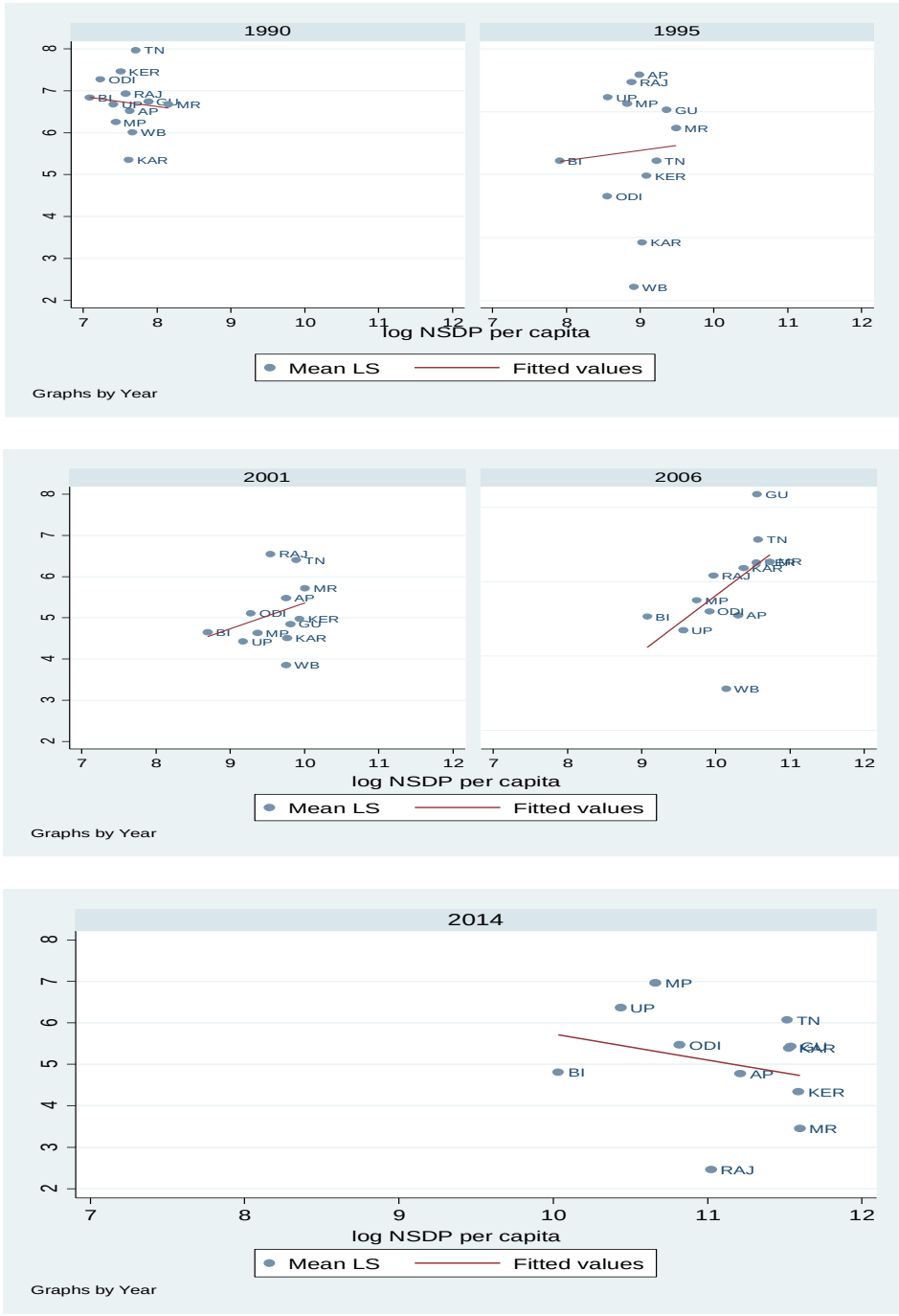


Fig. 5. Between-States Average Life Satisfaction and NSDP per capita Relationship in India, 1990-2014

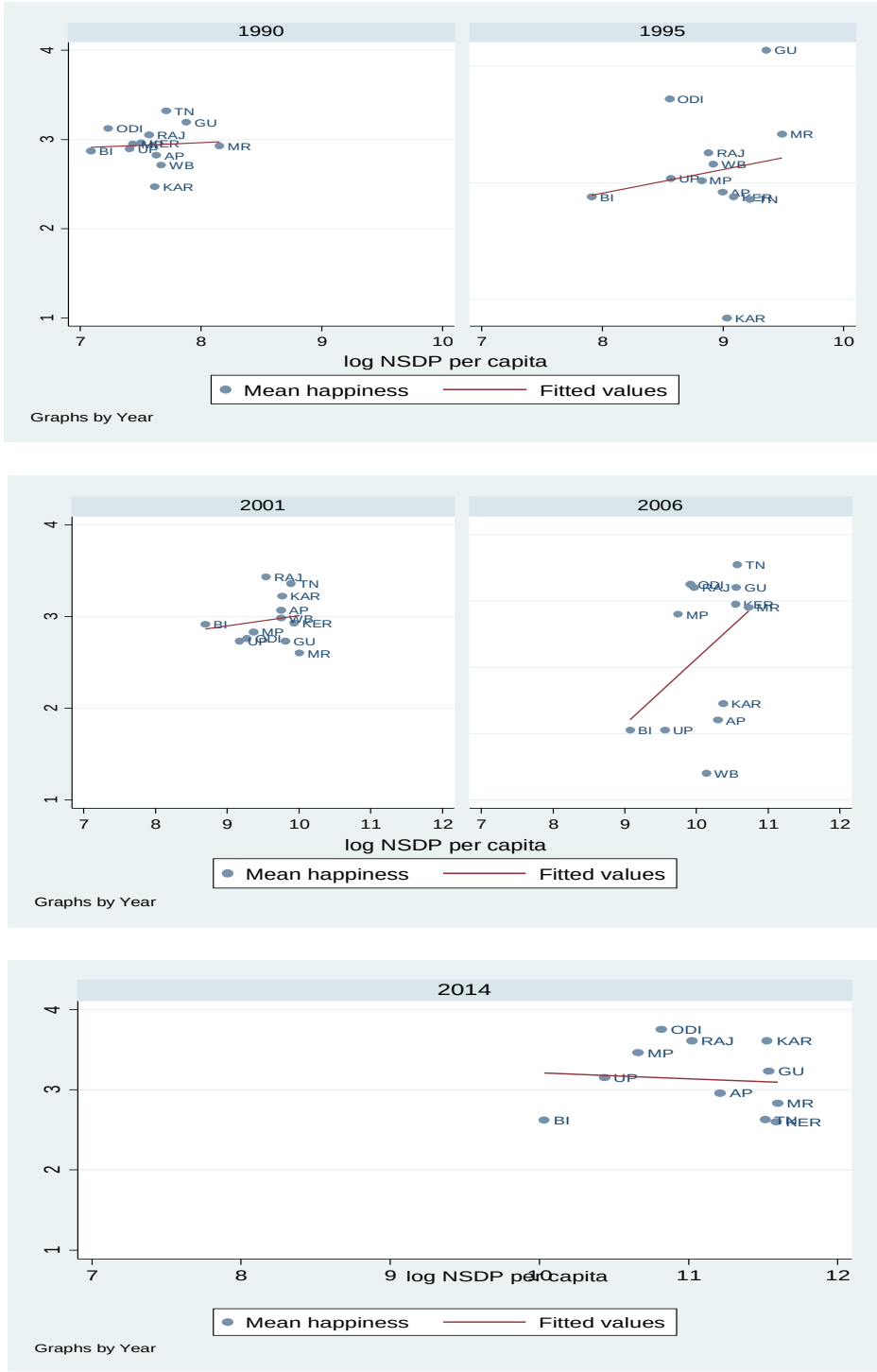


Fig. 6. Between-States Average Happiness and NSDP per capita Relationship in India, 1990-2014

Subjective Well-being Across Less-Developed, Developing and Developed States

This paper further investigates the income-well-being relationship the cross-states average income-average subjective well-being relationship for groups of Indian states. The 12 states are grouped into three broad categories based on the state NSDPpc (Mukherjee et al. 2014): developed states (NSDPpc higher than the second quartile or median), developing states (NSDPpc in between the first and the second quartile), and less-developed states (NSDPpc less than the first quartile). Table 5 presents the distribution of subjective well-being in the three groups of 12 Indian states. Life satisfaction, panel 2 analyses the distribution of happiness and panel 3 the distribution of financial satisfaction in developing, developed and less-developed states. The statistics associated with the life satisfaction distribution is worth noting. Less-developed states have a higher percentage (15.25 percent) of respondents who report that they are completely satisfied with their life. In developed states, 12 percent of respondents indicate complete life satisfaction and in the developing states, less than 10 percent of respondents are fully satisfied with their life. This result is also reflected in the mean score of life satisfaction in each group of states. The mean life satisfaction score for less-developing states is 6.03, while the mean scores of developed states are 5.97 and developing states is 5.74. The observation that people in less-developed states are more satisfied with life than people in developing states reveals that income may not be a sufficient indicator of life satisfaction always.

Table 5. Distribution of Well-being Indicators across Less-Developed, Developing and Developed States of India, 1990-2014

Life Satisfaction					
State	**Dissatisfied**	**5th Level**	**Satisfied**		**Mean LS***
Developed	241(6.06)	946(23.77)	469 (11.79)		5.97 (2.53)
Developing	130(6.43)	633(31.29)	192(9.49)		5.74 (2.39)
Less-Developed	124(4.61)	645(24.00)	410(15.25)		6.03 (2.59)
	Pearson chi 2= 223.78 Prob. = 0.000				
Happiness					
	Not At All Happy	**Rather Happy**	**Quite Happy**	**Very Happy**	**Mean***
Developed	173 (4.33)	864(21.65)	1,835(45.98)	1,119(28.04)	2.97 (0.82)
Developing	31 (1.49)	319(15.29)	1,144(54.82)	593 (28.41)	3.10 (0.69)
Less-Developed	141 (5.14)	673 24.52)	1,202(43.79)	729 (26.56)	2.91(0.84)
	Pearson chi2 = 144.09 Prob. = 0.000				
Financial Satisfaction					
	Dissatisfied	**5th Level**	**Satisfied**		**Mean FS***
Developed	251 (6.32)	976 (24.59)	359 (9.05)		5.73 (2.48)
Developing	109 (5.54)	650 (33.05)	162 (8.24)		5.38 (2.26)
Less-Developed	177 (6.57)	652 (24.21)	289 (10.73)		5.51 (2.55)
	Pearson chi2 = 264.81 Prob = 0.000				

Note: *Percentage figures in parentheses. * Standard deviations in parentheses.*

The distributional statistics reported in the second panel of Table 5 on happiness in developed, developing and less-developed states shows that about 28 percent of respondents in all states report that they are very happy with life. However, in contrast to the proportion of respondents who report happiness, in less-developed states also comprise comparatively a higher proportion of 5 percent unhappy people. On the other hand, only 1 percent of respondents in developing states report unhappiness with their current life. Comparisons of mean scores of happiness for these states disclose that developing states have a higher average score of happiness (3.10), in developed states, the mean happiness is 2.97 and in less-developed states, it is 2.91. In general, happiness is relatively high in both developed as well as less-developed states.

Similar to the results of life satisfaction, panel 3 of Table 5 shows that most respondents from less-developed states report they are financially satisfied. About 11 percent of respondents in less-developed states disclose that they are completely satisfied with their financial condition. However, in contrast to the higher percent of financially dissatisfied people in less-developed states, the proportion who report financial dissatisfaction is also high in less-developed states, nearly 7 percent in less-developed states indicate that they are not at all satisfied with their financial status. That is why the mean score of financial satisfaction in less-developed states reduces and stands in the second position after developed states. The mean score of financial satisfaction in the three groups of states stands closely at 5.73 for developed states, 5.38 for developing states and 5.51 for less-developed states. Still, people in less-developed states are financially more satisfied than those in developing states.

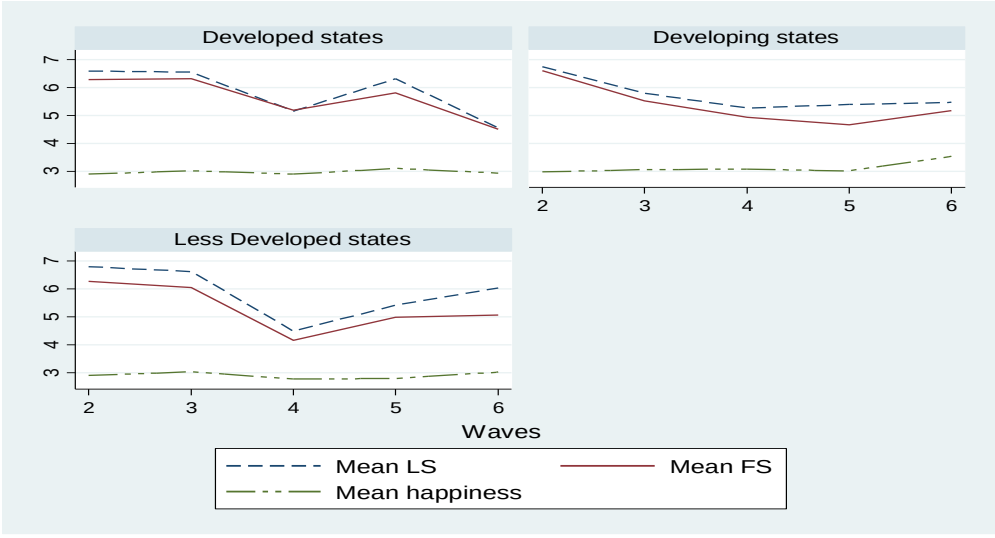


Fig. 7. Subjective Well-being Indicators across Less-Developed, Developing and Developed States in India, 1990-2014

Figure 7 presents the behaviour of the three well-being indicators in each of the groups of states across the WVS waves. A comparison of the mean scores of well-being indicators over the waves shows that life satisfaction and financial satisfaction moves in the same direction and financial satisfaction lies below life satisfaction. In developed states, both life satisfaction and financial satisfaction slope downward across the waves, but in less-developed states, both are raising. In contrast, both life satisfaction and financial satisfaction is almost horizontal in developing states, indicating the nil effect of income on life satisfaction. In the fourth wave (2001), life satisfaction as well as financial satisfaction decline in developed and less-developed states. Fifth wave onwards, both curves start to rise. In developed states, the happiness curve is horizontal, whereas in developing and less-developed states it starts to rise slightly after the 5^{th} wave.

Across States-Over Time Income-Subjective Well-being Relationship

Whether economic growth improves subjective well-being is a central question in happiness research. A time-series analysis of well-being-NSDP per capita allows an examination of whether the states that experience economic growth experience growing levels of subjective well-being. The within-states and between-states distribution of subjective well-being have generated opposing results on the subjective well-being and income relationship in India. Within-states association is consistent with the evidence available in cross-country studies (Easterlin, 1974, Stevenson and Wolfers, 2008), but the between-states association is not so consistent as in most waves and most states per capita income is negatively related to life satisfaction. From one side, one cannot say firmly that wealthy states have greater happiness than poor states. On the other side, it is clear that rich people are happier than their poor counterparts. Such opposite results question the validity of NSDP per capita or individual absolute income at a point of time as a key determinant of happiness. Naturally, the next question to be asked is: “do societies get happier through time as they become richer?” (Stevenson and Wolfers, 2008, p. 36). In other words, it is necessary to look at the dynamics i.e. changes of well-being in relation to income change across states over time.

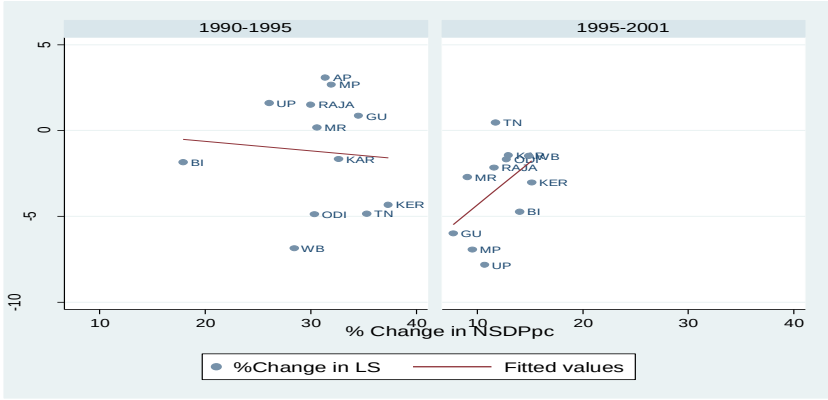
Further, the critics of Easterlin puzzle point out the flatness of subjective well-being-income relationship observed could well be due to the short period data and the most developed economy data. They argue that extending time series and including observations from more countries may provide evidence for the positive relationship between happiness level-GDP growth relationship (Stevenson and Wolfers, 2008). Easterlin himself points out that typically a decadal data could be useful to capture the dynamics of income-life satisfaction relationship. Hence, the long-run dynamic relationship between well-being and NSDP per capita is examined by looking at the changes in the relationship at different time intervals. In the short period analysis, changes in the income-well-being relationship between the adjacent waves for the four wave-pairs 1990-1995, 19995-2001, 2001-2006 and 2006-2014 are examined.

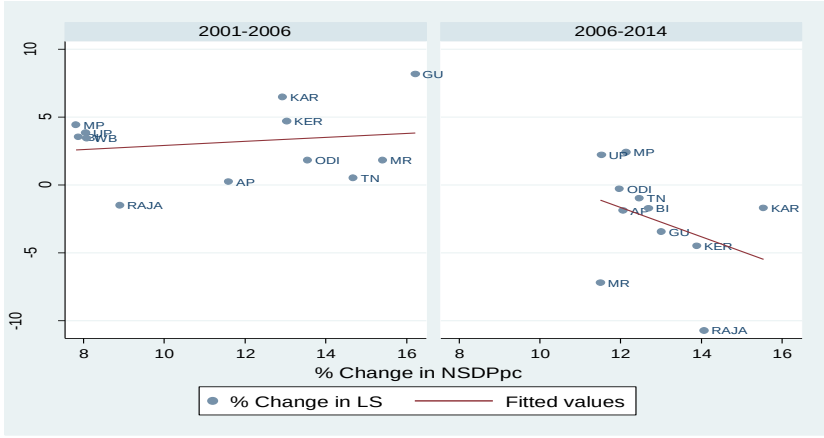
In the long period analysis, ten to fourteen years changes during 1990-2001, 1995-2006 and 2001-2014 are considered. Still longer period relationship is considered for fifteen and twenty years, for the periods 1990-2006 and 1995-2014. Finally, the overall dynamic well-being-income relationship is analysed by the relationship in the changes across all the waves and all the 12 states over the entire 24 years period.

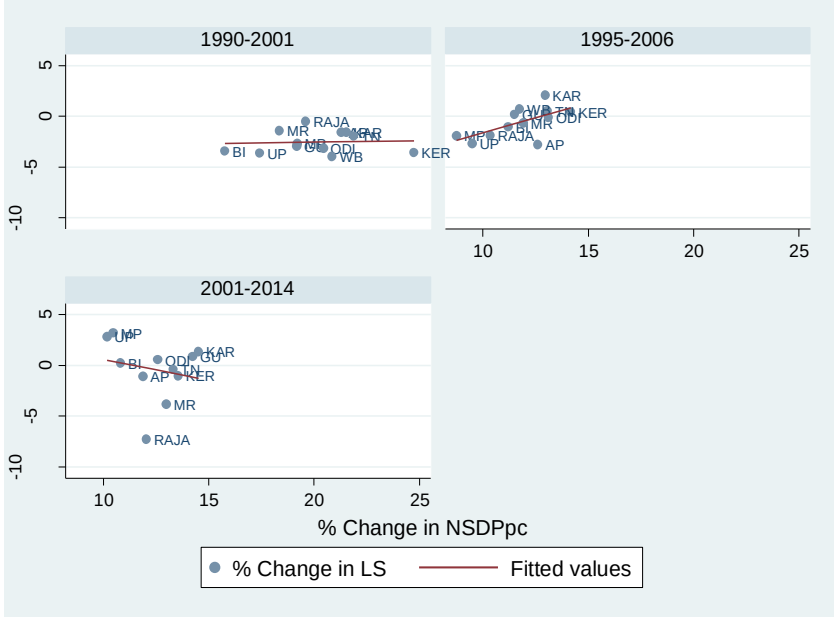
Figure 8 presents the adjacent wave differences for the four wave-pairs 1990-1995, 19995-2001, 2001-2006 and 2006-2014. A comparison of the relationship between changes in life satisfaction and state income across wave-pairs shows that there is no systematic relationship across wave-pairs. For instance, in the wave pairs 1990-1995 and 2006-2014, the fitted lines slope downward, with a higher negative relationship in the 2006-2014 period between the changes in the two variables. On the other hand, the remaining two adjacent wave-pairs experience a positive change in life satisfaction in response to an increase in NSDP per capita, the relationship being more strong in 1995-2001 period than in 2001-2006 wave-pair. The relationship between ten to fourteen years difference in life satisfaction and log NSDP per capita in Indian states, between 1990-2001, 1995-2006 and 2001-2014, shows that the changes in life satisfaction over a relatively long period is not so uneven as observed in the case of adjacent wave-pairs.

The shape of the fitted line in 1990-2001 is almost horizontal implying that improvements in economic growth do not accompany with the corresponding increase in life satisfaction. The percentage change in life satisfaction lies between -5 to 0. In the next the 11 years difference (1995-2006), changes in life satisfaction move upwards as the economy grows faster. Contrary to this, in the 2001-2014 time period, the annual change in life satisfaction declines with rising average state income. However, the rate of decline is relatively marginal. The results of comparison fifteen years and twenty years relationship between changes in life satisfaction and income growth reveal that with long span of time, higher rise in NSDP per capita is associated with a larger increase in life satisfaction. The long panel fitted lines for the wave differences 1990-2006 and 1995-2014 show upward slopes, depicting a positive relationship between changes in life satisfaction and economic growth over time. This finding is consistent with the findings of Stevenson and Wolfers (2008) that larger the positive changes in per capita GDP, higher the increase in life satisfaction.

A parallel analysis of the relationship between percentage changes in happiness and NSDP per capita over different time panels yield different results simultaneously corroborating the findings of both Easterlin (1974) as well as Stevenson and Wolfers (2008). In Figure 9, the slope of the fitted lines is positive in 7 out of 10 wave-pairs, in two wave-pairs (1990-1995 and 2001-2014). Though the annual changes in happiness are mostly positively related to economic growth in most of the states, significant growth of per capita NSDP in Indian states does not make the people happier. In other words, each doubling of per capita NSDP is associated with no increase in happiness.


1990-1995
1995-2001
% Change in NSDPpc
%Change in LS
Fitted values


2001-2006
2006-2014
% Change in NSDPpc
% Change in LS
Fitted values


1990-2001
1995-2006
2001-2014
% Change in NSDPpc
% Change in LS
Fitted values

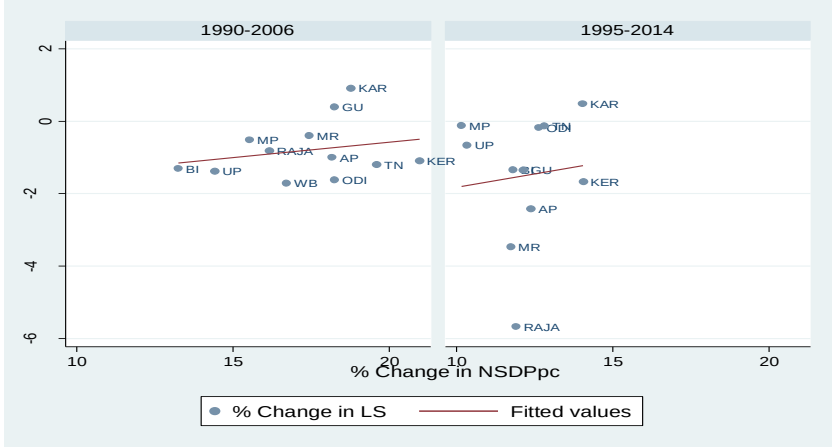
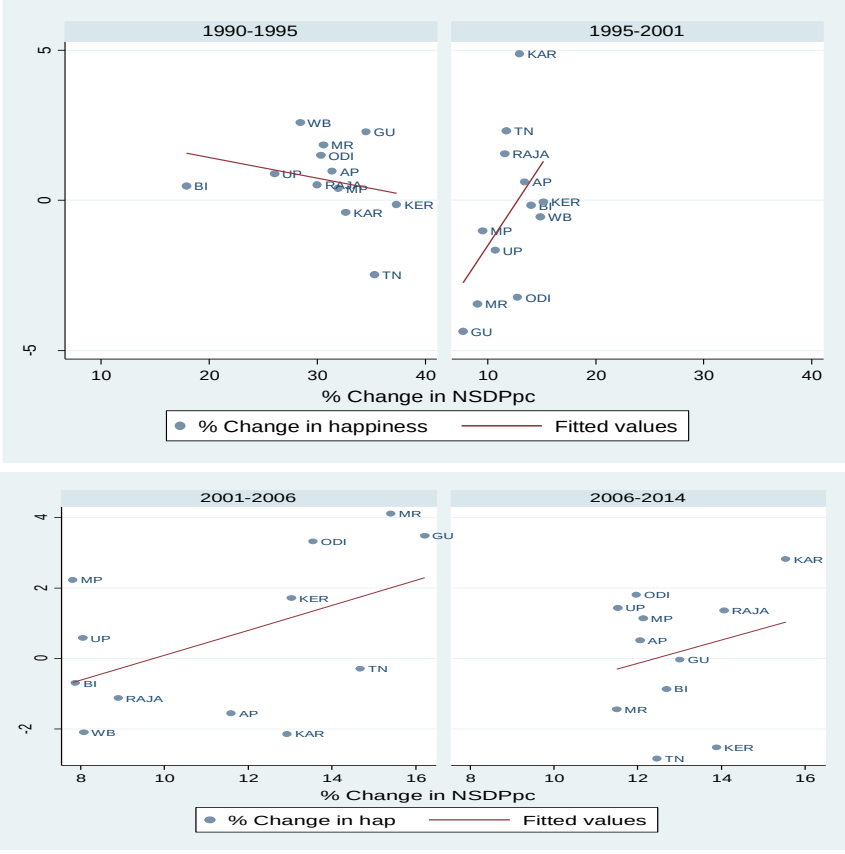


Fig. 8. Across-States Over-Time Relationship between Changes in Life Satisfaction and NSDP per capita in India, 1990-2014

Note: *Data are aggregated by calculating the average life satisfaction for each state for each wave.*



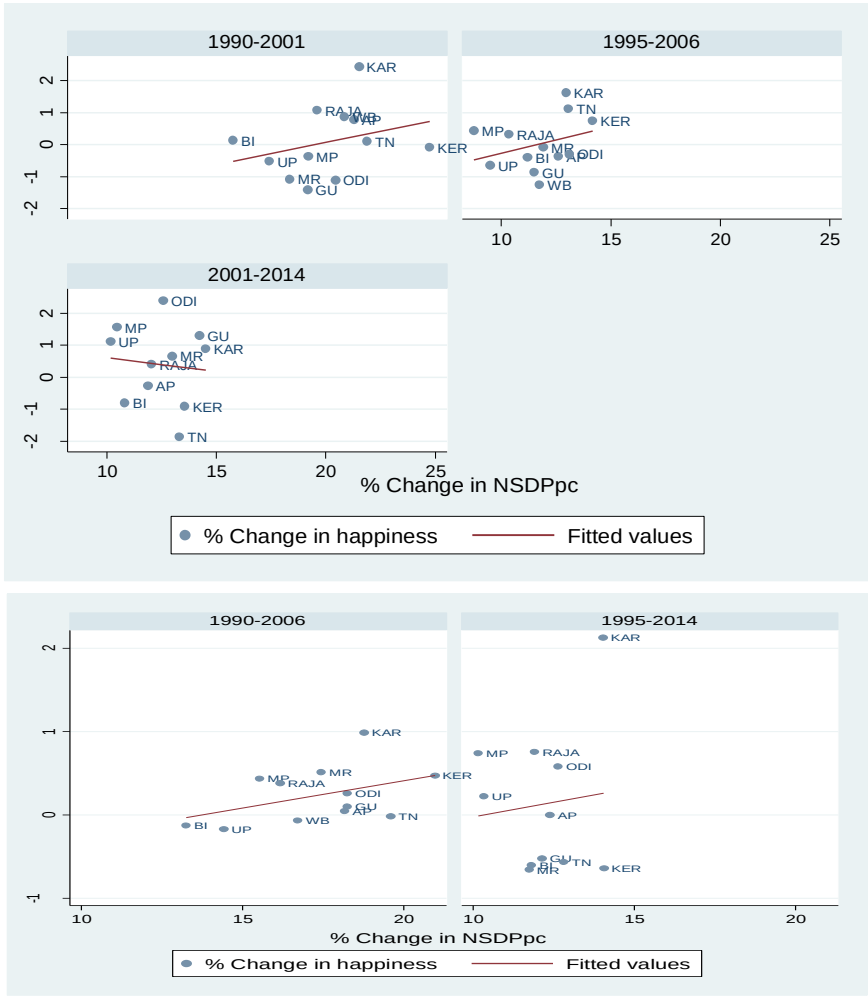


Fig. 9. Across-States Over-Time Relationship between Changes in Happiness and NSDP Per Capita in India, 1990-2014

***Note**: Data are aggregated by calculating the average life satisfaction for each state for each wave.*

Dynamic Income-Subjective Well-being Relationship across States-Over Time

The dynamic change over the entire time horizon of 24 years in subjective well-being indicators in each of the 12 states in India is presented in Table 6. It is observed that all states, except three states, experience decline in life satisfaction over a period of 24 years. While the mean score of the combined life satisfaction of all the 12 states decreased from 6.57 in 1990 to 5.16 in 2014, there is a considerable variation in average life satisfaction across the states over this period. Two states, Karnataka and Madhya Pradesh experienced a modest gain in their average life satisfaction score and in West Bengal the score remained the same at 6.01.

But, the degree of dispersion in life satisfaction across the states over time shows some fluctuation, in the range of 1 to 3, in average life satisfaction. Among the states that experience a decline in average life satisfaction, Rajasthan (-4.22) records the highest decline while Uttar Pradesh (-0.19) records the lowest percentage change in mean life satisfaction. Maharashtra also experienced comparatively highest decline (-2.72) in average life satisfaction.

Table 6. Subjective Well-being across States - Over-Time in India, 1990-2014

State	Life Satisfaction			Happiness		
	Mean LS (1990)	Mean LS (2014)	Percent Change	Mean Happiness (1990)	Mean Happiness (2014)	Percent Change
AP	6.53 (2.15)	4.78 (2.69)	-1.29	2.82 (0.67)	2.96 (0.83)	0.20
Bihar	6.83 (2.27)	4.81 (1.77)	-1.45	2.87 (0.94)	2.62 (0.79)	-0.38
Gujarat	6.74 (2.01)	5.44 (3.13)	-0.89	3.19 (0.67)	3.23 (0.82)	0.05
Karnataka	5.35 (1.90)	5.39 (2.35)	0.03	2.47 (0.65)	3.61 (0.49)	1.59
Kerala	7.46 (2.26)	4.34 (2.66)	-2.23	2.96 (0.70)	2.6 (0.92)	-0.54
MP	6.25 (2.40)	6.98 (1.97)	0.46	2.95 (0.85)	3.46 (0.58)	0.67
MR	6.68 (2.13)	3.45 (2.14)	-2.72	2.93 (0.78)	2.83 (0.99)	-0.14
Odisha	7.27 (2.32)	5.47 (1.38)	-1.18	3.12 (0.73)	3.75 (0.49)	0.77
Rajasthan	6.94 (2.22)	2.46 (1.12)	-4.22	3.05 (0.71)	3.61 (0.49)	0.71
TN	7.98 (1.29)	6.07 (1.89)	-1.13	3.32 (0.65)	2.63 (1.05)	-0.97
UP	6.69 (2.52)	6.37 (3.08)	-0.19	2.89 (0.79)	3.15 (0.71)	0.36
WB	6.01 (2.30)	6.01 (2.37)	0	2.71 (0.73)	3.3 (0.53)	0.82
Overall	6.57 (2.28)	5.16 (2.74)	-1.00	2.92 (0.79)	3.11 (0.85)	0.26

Note: Standard errors in parentheses.

On the other hand, it can be noted from Table 6 the average happiness of all the 12 states taken together slightly increased from 2.92 to 3.11 over the 24 years. The increase in mean happiness is about 0.26 percentage between 1990 and 2014 in Indian states. During this period, eight states experienced a modest rise in mean happiness. But, in four states, the mean happiness declined over time. These states are Bihar (-0.38), Kerala (-0.57), Maharashtra (-0.14) and Tamil Nadu (-0.97). Among the states where mean happiness increased overtime, Karnataka scores the highest percentage of increase in mean happiness (1.59), Gujarat (0.05) has experienced the lowest increase in mean happiness. Figures 10 and 11 present the dynamic relationship between changes in life satisfaction and happiness and log real NSDP per capita over the 24 years for all states. The comparison shows that changes in both life satisfaction and happiness are not in tune with positive changes in economic growth. A larger rise in NSDP per capita is not associated with even a marginal increase in well-being in Indian states (Figure 10). Between 1990 and 2014, only Madhya Pradesh has increased life satisfaction slightly while life satisfaction in Karnataka has remained the same despite a vast increase in income per capita. Even with a higher percentage increase in income in Kerala and Rajasthan, life satisfaction declined drastically. The fitted line of the relationship between changes in life satisfaction and per capita NSDP over 1990 and 2014 falls below the -1 percent change, indicating that life satisfaction levels indeed declined in Indian states, a finding too close to Easterlin (1974) findings.

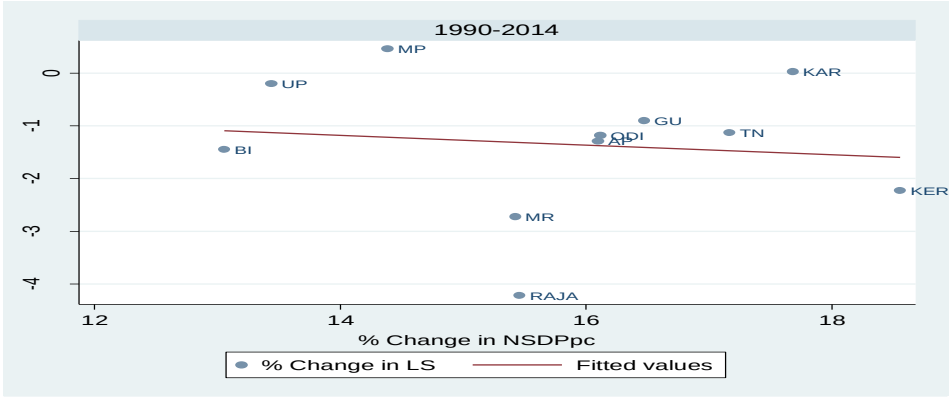


Fig. 10. Across States-Over Long Time Relationship between Changes in Life Satisfaction and NSDP per capita in India, 1990-2014

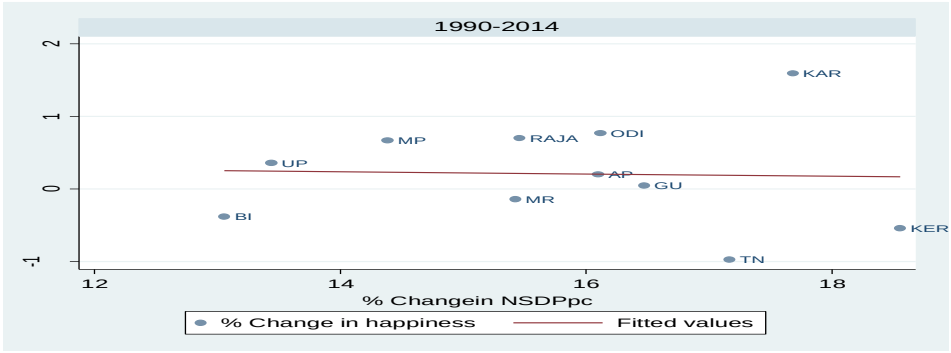


Fig. 11. Across States-Over Long Time Relationship between Changes in Happiness and NSDP per capita in India, 1990-2014

The relationship between percentage changes in happiness and economic growth over time shows that over long periods between 1990 and 2014, the trend line is almost horizontal with a slight downward slope (Figure 11). Though the annual change in happiness is positively related to economic growth in half of the states, more than twenty years of significant growth of per capita NSDP does not make the people happier. The only state which gains a better improvement is Karnataka, while Madhya Pradesh, Rajasthan and Odisha gain modestly. With higher per capita NSDP growth, Tamil Nadu and Kerala experienced more reduction in the happiness level of their people. Overall, each doubling of per capita NSDP is associated with almost nil increase in happiness. The fitted line of the relationship between changes in happiness and per capita NSDP over 1990 and 2014 shows that between 1990 and 2014, the changes in happiness and happiness in Indian states is too small compared to the change in log per capita NSDP, supporting the Easterlin's findings of lack of positive relationship between happiness and economic growth in the long-run. Thus, the long period (1990-2014) well-being-income relationship observed in Figures 10 and 11 validate the presence of Easterlin paradox, lack of a positive relationship between well-being and economic growth in India in the long-run.

The Figures 12 and 13 present the dynamic relationship between both life satisfaction and happiness and log real NSDP per capita across all the waves for all the states 12 states of India over the long time of 24 years (1990-2014). From Figure 12, it can be discerned that there is a negative relationship between life satisfaction and log NSDP per capita over time i.e. economic growth is accompanied by a decline in life satisfaction. While all the 12 states experience significant growth in NSDP between 1990 and 2014, but they also experience a decline in life satisfaction, except two states Karnataka and Madhya Pradesh. The average life satisfaction across the states has declined was 6.57 in 1990 to 5.16 in 2014. But in contrast to the long-term relationship of life satisfaction with log per capita NSDP, the average state-level happiness is moving upward with the rise in per capita NSDP over time (Figure 13). However, the slope of the fitted line is not as steep as what the received literature has observed for India (Inglehart et al. 2008; Majumdar and Gupta, 2015).

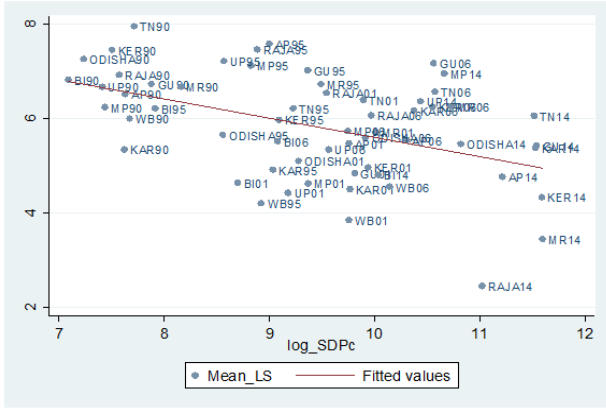


Fig. 12. Across States-Over Long Time Dynamic Relationship between Life Satisfaction and NSDP per capita in India, 1990-2014

***Note**: Each state is labelled as 90, 95, 01, 06 and 14 indicating the state WVS waves respectively.*

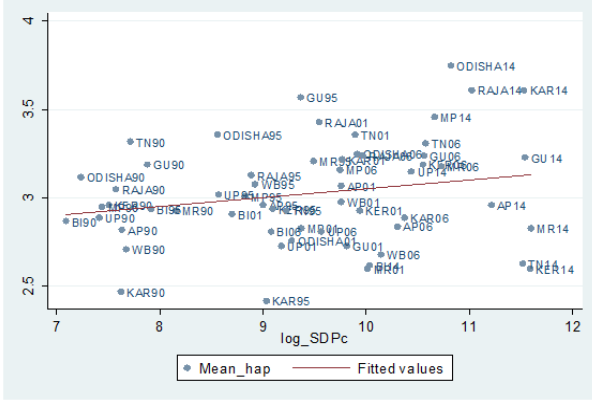


Fig. 13. Across States - Over Time Dynamic Relationship between Happiness and NSDP per capita in India, 1990-2014

***Note:** Each state is labelled as 90, 95, 01, 06 and 14 indicating the state WVS waves respectively.*

Growth, Inequality and Subjective Well-being

Consistent with Graham's (2017) findings for the US, the WVS Indian data also shows that in the long-run life satisfaction is decreasing or at least not rising with economic growth. Kahneman et al. (2006) argue that that within-countries analysis may bias the true relationship between country life satisfaction and income due to the idea of "focusing illusion". As the life satisfaction question allows people to evaluate their life by comparing themselves with others, then they kingpin their position relative to others considering the measure of income. Although this bias may have some impact on within-countries comparisons, it seems likely that cross-countries relationship between subjective well-being and GDP may also demonstrate the influence of other important factors such as quality of government or national laws, democracy, health or even unfavourable weather conditions, and many of these factors may rise or pull both GDP per capita and subjective well-being. Thus, "other factors such as increased savings, reduced leisure, or even increasingly materialist values, may raise GDP per capita at the expense of subjective well-being" (Stevenson and Wolfers, 2008, p. 35). In the long-run, India also experiences a negative trend in life satisfaction against the rapid growth in GDP. Among the lists of suspected factors that may absorb the benefits of economic growth and adversely affect the life satisfaction of a country, income inequality plays a significant role. Despite India's rapid strides on the economic front, income inequality has worsened recently (Chancel and Piketty, 2019).

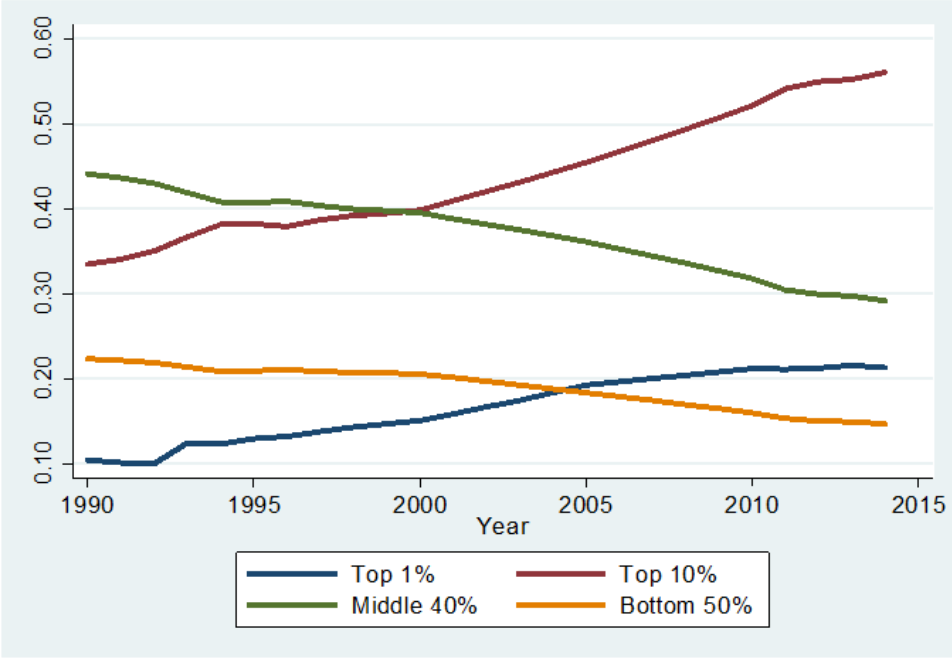


Fig. 14. Share in National Income by Income Groups in India, 1990-2014
Source: *World Inequality Database (2017).*

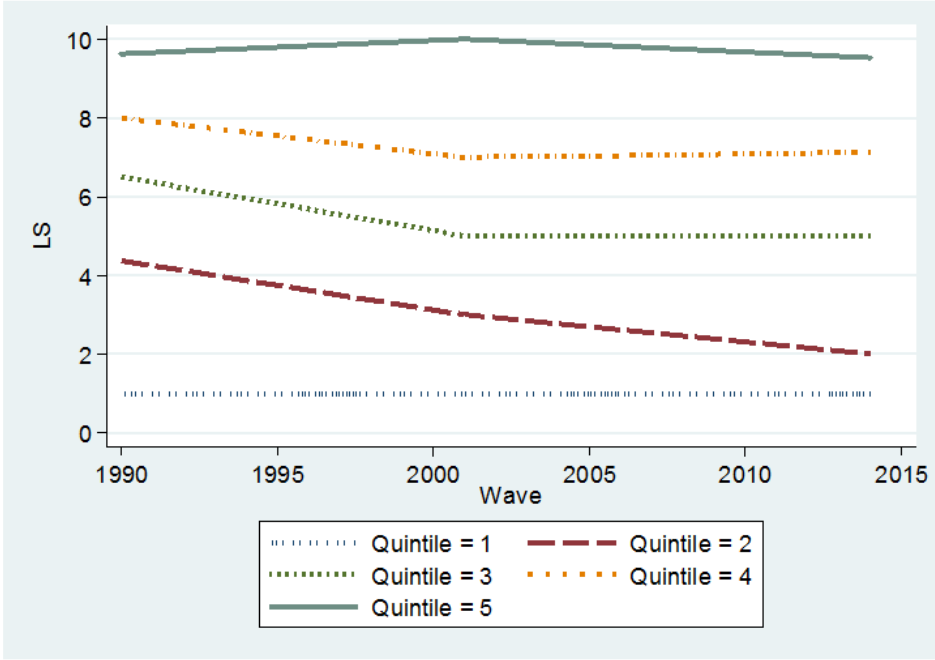


Figure 15. Life Satisfaction by Income Quintiles in India, 1990-2014

Figure 14 presents the share of incomes groups in the total income of India between 1990 and 2014. It is observed that the income share of bottom 40-50 percent has declined drastically while that of top 1-10 percent has increased sharply. However, Figure 15 shows that average life satisfaction of bottom income group is not only low but also flat. Similarly, the average life satisfaction of top income groups is high but also flat. But there has been a decline in life satisfaction in the middle-income groups. Thus, income increase has not impacted life satisfaction both at the lower and upper satisfaction levels and among the bottom and top income groups in India.

Conclusions

This paper examines the relevance of the Easterlin (1974) paradox in India, that despite vast cross-country differences in income levels the happiness level across countries is pretty much close and that rising income levels in any country is not accompanied by the corresponding rise in life satisfaction levels. To validate the Easterlin paradox in India, this paper replicates the Easterlin approach of within-countries, between countries and over time across-countries analysis, this paper analyses the income-subjective well-being relationship within-states, between states and across-states over time in India. Using five waves of WVS data for 12 major states of India for a long period of 1990-2014, the average levels of life satisfaction and happiness in each of the 12 states are compared, both within and across states as well as at the individual and aggregate income levels. Further, states are grouped as developed, developing and less developed states and their well-being levels are compared. To understand the long-run relationship between well-being indicators

and income, changes in life satisfaction and happiness are compared with changes in NSDP per capita over a longer period of 24 years.

The analysis of this paper shows that there is a considerable variation in the levels of subjective well-being indicators both within and across states as well as across time in India. The within-states income-well-being analysis shows that while life satisfaction levels have declined in most states, happiness level has slightly improved. The between states analysis shows that there is not much difference in well-being levels among the 12 states. In the grouped states analysis, both life satisfaction and happiness in developed states are either decreasing or remain constant over time while the less-developed states have slightly improved their well-being levels. The across-states-over time analysis shows that the long-run changes in NSDP per capita have not been accompanied by any commensurate improvement in well-being indicators in India. The dynamic relationship between changes in life satisfaction and economic growth is almost inverse and that of income growth and happiness change is nil over a longer period in Indian states. Overall, the examination of the subjective well-being-income relationship in states of India closely validates the presence of Easterlin paradox in India. Thus, economic growth in states of India seems to have not improved the human lot but seems to leave people more dissatisfied and less happy in life

Acknowledgement

The author is grateful to Ms. K. Maya for her excellent research assistance.

References

1. Blanchflower, D.G. and A.J. Oswald (2004) “Well-being Over Time in Britain and the USA”, Journal of Public Economics, 88, 7-8, 604-609.
2. Chancel, L. and T. Piketty (2019) “Indian Income Inequality, 1922–2015: From British Raj to Billionaire Raj?” Review of Income and Wealth, 65, S1, S33-S62.
3. Clark, A.E. (2018) “Four Decades of the Economics of Happiness: Where Next?”, Review of Income and Wealth, 64, 2, 245-269.
4. Clark, A. E. and C. Senik (2011) “Will GDP Growth Increase Happiness in Developing Countries?”, in R. Peccoud (eds.): Measure For Measure: How Well Do We Measure Development?, Paris: STIN, 99-176.
5. Clark, A.E.S. Fleche and C. Senik (2014) “The Great Happiness Moderation”, in A.E. Clark and C. Senik (eds.): Happiness and Economic Growth: Lessons from Developing Countries, Oxford: Oxford: Oxford University Press, 32-139.
6. Clark, A.E., P. Frijters and M. Shields (2008) “Relative Income, Happiness and Utility: An Explanation for the Easterlin Paradox and Other Puzzles”, Journal of Economic Literature, 46, 1, 95-144.
7. Deaton, A. (2008) “Income, Health, and Well-being Around the World: Evidence from the Gallup World Poll”, Journal of Economic Perspectives, 22, 2, 53-72.
8. Diener, E., L. Tay and S. Oishi (2013) “Rising Income and Subjective Well-being of Nations”, Journal of Personality and Social Psychology, 104, 2, 267-276.

9. Di Tella, R. and R. MacCulloch (2006) “Some Uses of Happiness Data in Economics”, Journal of Economic Perspectives, 20, 1, 25-46.
10. Easterlin, R.A. (1974) “Does Economic Growth Improve the Human Lot? Some Empirical Evidence”, in P.A. David and M.W. Reder (eds.): Nations and Households in Economic Growth, New York: Academic Press, 89-125.
11. Easterlin, R.A. (2001) “Income and Happiness: Towards a Unified Theory”, Economic Journal, 111, 473, 465-484.
12. Easterlin, R. A. (2017) “Paradox Lost?”, Review of Behavioral Economics, 4, 4, 311-339.
13. Easterlin, R.A. and L. Angelescu (2010) “Happiness and Growth the World Over: Time Series Evidence on the Happiness-Income Paradox”, in H. Hinte and K.F. Zimmermann (eds.): Happiness, Growth, and the Life Cycle, Oxford and New York: Oxford University Press, 56-81.
14. Easterlin, R.A. and O. Sawangfa (2010) “Happiness and Economic Growth: Does the Cross-Section Predict Time Trends?”, in E. Diener, D. Kahneman and J.F. Helliwell (eds.), International Differences in Well-Being, New York: Oxford University Press, 166-216.
15. Easterlin, R.A., L.A. McVey, M. Switek, O. Sawangfa and J.S. Zweig (2010) “The Happiness-Income Paradox Revisited”, Proceedings of the National Academy of Sciences USA, 107, 52, 22463-22468.
16. Graham, C. (2017) Happiness for All? Unequal Hopes and Lives in Pursuit of the American Dream, Princeton: Princeton University Press.
17. Graham, C. and S. Pettinato (2001) “Happiness, Markets and Democracy: Latin America in Comparative Perspective”, Journal of Happiness Studies, 2, 3, 237-268.
18. Hagerty, M.R. and R. Veenhoven (2003) “Wealth and Happiness Revisited: Growing Wealth of Nations Does Go with Greater Happiness”, Social Indicators Research, 64, 1, 1-27.
19. Inglehart, R., R. Foa, C. Peterson and C. Welzel (2008) “Development, Freedom, and Rising Happiness: A Global Perspective (1981-2007)”, Perspectives on Psychological Science, 3, 4, 264-285.
20. Kahneman, D., A.B. Krueger, D. Schkade, N. Schwarz and A.A. Stone (2006) “Would You Be Happier if You Were Richer? A Focusing Illusion”, Science, 312, 5782, 1908-1910.
21. Layard R., G. Mayraz and S. Nickell (2010) “Does Relative Income Matter? Are the Critics Right?”, in E. Diener, J.F. Helliwell, and D. Kahneman (eds.): International Differences in Well-being, Oxford University Press, 139-165.
22. Majumdar, C. and G. Gupta (2015) “Don’t Worry, Be Happy: A Survey of the Economics of Happiness”, Economic and Political Weekly, 50, 40, 50-62.
23. Nordhaus, W. And J. Tobin (1972) “Is Growth Obsolete?”, in M. Moss (ed.): The Measurement of Economic and Social Performance, Cambridge, MA.: National Bureau of Economic Research, 509-564.
24. Oswald, A.J. (1997) “Happiness and Economic Performance”, Economic Journal, 107, 445, 1815-1831.
25. Stevenson, B. and J. Wolfers (2008) ""Economic Growth and Subjective Well-being: Reassessing the Easterlin Paradox”, Brookings Papers on Economic Activity, 39, 1, 1-102.

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 62-75
ISSN 0019-4824

THE URBAN CHALLENGE: PROVISIONING OF BASIC SERVICES IN NOTIFIED AND NON-NOTIFIED SLUMS OF INDIA

Anuradha Banerjee[1], Joydeep Saha[2] and Dinabandhu Mondal[1]

[1] CSRD, School of Social Sciences, Jawaharlal Nehru University, New Delhi - 110 067
[2] Department of Geography, Bijoy Krishna Girls' College, Howrah - 711 101
E-mail: banerjee.anb@gmail.com, anuradha_csrd@yahoo.co.in

Abstract

This paper attempts to explore whether the gaps, related to water and sanitation services, between 'notified' and 'non-notified' slums have reduced or not across nine selected states over a decade of decentralized governance regime, and also to relate the issues of service provisioning within the slum development planning and policy domain. Using the secondary data provided by NSSO from 2002 to 2012, across three different Rounds, this paper focuses on the condition of basic services, it's temporal changes and the role played by various stakeholders in improvement of slums. It finds that while 'notified' slums continue to receive services and remain in more or less better condition, 'non-notified' slums still have a long way to go.

Keywords: Slum, Basic Services, Sanitation, ULB, Planning

Introduction

In an academic sense, the notion of 'slums' in India is complex, and added to that the 'definition' followed by Census of India and National Sample Survey Organisation (NSSO), and a substantial number of legal documents, create a taxonomy of 'notified' and 'non-notified' slums. NSSO, since 2002 to 2012, has been categorising 'notified' and 'non-notified' slums, and then 'defines' the respective categories of slums as: 'Areas notified as slums by the concerned municipalities, corporations, local bodies or development authorities were termed notified slums', and 'any compact settlement with a collection of poorly built tenements, mostly of temporary nature, crowded together, usually with inadequate sanitary and drinking water facilities in unhygienic conditions, was considered a slum by the survey, provided at least 20 households lived there. Such a settlement, if not a notified slum, was called a non-notified slum'. Census of India also agrees largely with this 'definition', as it denotes own one as: 'A Slum, for the purpose of Census, has been defined as a residential area where dwellings are unfit for human habitation by reasons of dilapidation, overcrowding, faulty arrangements and design of such buildings, narrowness or faulty arrangement of street, lack of ventilation, light, or sanitation facilities or any combination of these factors, which are detrimental to the safety and health".

Census of India, in 2011, categorizes slums into three categories - 'notified', 'recognized' and 'identified'. The first category is 'notified' by state/local administration through legal acts; second one is also 'recognized but not formally notified' by these bodies; and the last category is defined as 'A compact area of at least 300 population or about 60-70 households of poorly built congested tenements, in unhygienic environment usually with inadequate infrastructure and lacking in proper sanitary and drinking water facilities'. Two things appear very clearly from these definitions – one, recognition and notification of slums are done by Urban Local Bodies/Parastatal Agencies and second, non-notified slums are hardly availing basic amenities like drinking water and sanitation system. The only visible difference in these two definitions is the minimum cut-off in the number of households, and it has been argued that with increasing events of slum eviction cycles and breakdown of large slums into smaller clusters in Indian cities today, present census definition lacks inclusive nature (Bhan and Jana, 2013).

The paucity of basic services in residential areas lived by poor people, according to Mitlin (2005), is one of the basic reasons behind chronic urban poverty. It is also generally portrayed in the literature that urban poor mainly live in slums. While the notified slums usually receive some basic services provided by Urban Local Bodies or Parastatal Agencies, non-notified slums remain less served in India. Even if policymakers often suggest amelioration of the living condition of those places where urban poor live, in practice, demolition and dislocation of large-sized slums is not uncommon. In addition to that, continuous inflow of new migrants into large cities lead to the formation of small-sized slum clusters over a period of time. As the entire process of 'recognition' and 'notification' of slums takes time, these clusters mushroom haphazardly, and that too without basic services like water and sanitation. Against such a backdrop, this paper attempts to explore whether the gaps between 'notified' and 'non-notified' slums have reduced or not. This paper also attempts to focus on the condition of basic amenities, its temporal changes and the role played by various stakeholders in improvement of slums while relating the issues of basic service provisioning within India's slum development planning and policy domain.

Database and Methodology

After looking at the database on slums in both Census of India and NSSO files, few issues need to be discussed before moving onto the main paper. Firstly, in both the datasets, only the availability of amenities like drinking water and latrines is captured, not adequacy. Secondly, Census captures household level information on availability and accessibility of such amenities, whereas NSSO takes into account slum level information, gathered from the knowledgeable persons living in the slum. Thirdly, 'It is for the first time in Census 2011 that datasets on Housing stock, Amenities, and Assets based on the House listing and Housing Census are being released. In Census 2001, information on Slums was released only on demographic characteristics based on the Population Enumeration. For this purpose, Slum Blocks were identified in statutory towns having a population of 20,000 by the local authorities at the time of population enumeration phase.

In Census 2011, slum blocks have been delineated in all statutory towns irrespective of population size' (Census of India website[1]). Fourthly, NSSO provides an additional information, i.e. change in the 'conditions' of these amenities and 'sources of improvement'. Fifthly, as already mentioned, NSSO data is more inclusive in nature as compared to Census dataset. Given all such advantages and disadvantages of both datasets at the outset, it would be more judicious to use NSSO dataset on slums, across three different Rounds, i.e. 58th Round- 'Condition of Urban Slums' (2002), 65th Round- 'Some Characteristics of Urban Slums' (2008-09) and 69th Round- 'Key Indicators of Urban Slums in India' (2012). For all three Rounds, nine common states, for which data is available, have been taken into account: Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Tamil Nadu, Uttar Pradesh and West Bengal. This paper largely focuses on the physical aspects of the living environment in slums. In terms of living environment, some of the basic urban amenities related to water and sanitation have been taken into consideration. These are: drinking water, latrine, drainage, sewerage, and garbage disposal. Another point is that these indicators have direct linkages with health, hygiene, and well-being of slum dwellers (WHO). Conspicuously, a majority of existing research works on slum environment are based on the primary survey in particular cities/towns. These papers are helpful to assess the ground situation of slums. But, macro-level discussion of slums' living environment, where a composite and analytical picture is depicted, could draw the attention of policymakers for prioritizing issues and directing slum improvement schemes. Undoubtedly, Census 2011 provides important information on slums for each statutory towns, but the decadal data is not sufficient. In case of NSSO data, unequal and inadequate distribution of sample slums in different geographical regions, to a considerable extent, limits the scope of a detailed analysis in this paper.

Results and Discussion

Changing Number of Slums

In absolute figures, the number of slums has consistently declined over three Rounds. This is truer in case of 'notified' slums, whereas 'non-notified' slums, in between 58th and 65th Round, do not show much change. If one looks at the percentage figures, the share of 'notified' slums have declined, whereas the share of 'non-notified slums' has increased. This re-establishes concerns of 'exclusionary urbanization' raised by urban experts (for example, see Kundu and Saraswati, 2012), which assert that cities have become so hostile these days, that poor migrants are unable to find a space to live and work. The figures in Table-1, absolute and percentage, also show the proliferation of non-notified slums as compared to notified slums, thereby leading one to presume that poor migrants, if able to settle in cities for livelihood, stay in very small clusters, and might need strong political roots and temporal stability to get 'recognition' and 'notification' from concerned ULBs/Parastatal Agencies.

[1] MS-PowerPoint Presentation on 'Housing Stock, Amenities and Assets in Slums – Census 2011', available in censusindia.gov.in

This decline of notified slums is sharper in Maharashtra, and less in Andhra Pradesh. States like Uttar Pradesh, West Bengal, and Gujarat show a substantial increase in the number of 'notified slums' in between 58th and 65th Round, and then again a certain drop in the 69th Round. Karnataka, in the last two Rounds, does not show much change. Maharashtra and Andhra Pradesh exhibit consistent increase in the proportion of 'non-notified' slums over three Round. Odisha's scenario is beyond any possible explanation, and one of the plausible reasons is the very small number of sample slums in 58th and 69th round. 65th Round data for Odisha shows a higher proportion of non-notified slums as compared to notified slums.

Table 1. Estimated Number of Notified and Non-notified Slums, 2002-2012

	58th Round (2002)			65th Round (2008-09)			69th Round (2012)		
State	**Notified**	**Non-Notified**	**Total**	**Notified**	**Non-Notified**	**Total**	**Notified**	**Non-Notified**	**Total**
Uttar Pradesh	775 (29.3)	1,868 (70.7)	2,643 (100.0)	1,334 (55.7)	1,060 (44.3)	2,394 (100.0)	836 (46.1)	978 (53.9)	1,814 (100.0)
West Bengal	2871 (35.3)	5,253 (64.7)	8,125 (100.0)	2,475 (49.1)	2,570 (50.9)	5,045 (100.0)	1274 (32.2)	2684 (67.8)	3,958 (100.0)
Odisha	11* (2.7)	390 (97.3)	401 (100.0)	630 (32.3)	1,323 (67.7)	1,953 (100.0)	12* (1.6)	744 (98.4)	756 (100.0)
Madhya Pradesh	1530 (68.9)	691 (31.1)	2,221 (100.0)	759 (34.3)	1,456 (65.7)	2,215 (100.0)	1327 (81.2)	308 (18.8)	1,635 (100.0)
Gujarat	413 (26.9)	1120 (73.1)	1,533 (100.0)	1,342 (39.9)	2,017 (60.1)	3,359 (100.0)	865 (29.6)	2,058 (70.4)	2,923 (100.0)
Maharashtra	10189 (61.2)	6472 (38.8)	16,661 (100.0)	9,282 (54.5)	7,736 (45.5)	17,018 (100.0)	1954 (25.3)	5,769 (74.7)	7,723 (100.0)
Andhra Pradesh	6384 (82.7)	1,340 (17.3)	7,724 (100.0)	3,964 (75.5)	1,285 (24.5)	5,249 (100.0)	3,224 (71.0)	1,315 (29.0)	4,539 (100.0)
Karnataka	1178 (59.4)	805 (40.6)	1,983 (100.0)	1,118 (49.7)	1,132 (50.3)	2,250 (100.0)	716 (50.3)	708 (49.7)	1,424 (100.0)
Tamil Nadu	930 (29.4)	2,234 (70.6)	3,164 (100.0)	1,711 (52.8)	1,663 (47.2)	3,374 (100.0)	1,208 (51.1)	1,156 (48.9)	2,364 (100.0)
Total	24,282 (54.6)	20,174 (45.4)	44,456 (100.0)	22,616 (52.8)	20,243 (47.2)	42,859 (100.0)	11,414 (42.1)	15,721 (57.9)	27,135 (100.0)

***Note**: Figures in parentheses refer to percentage; * Small size of sample slums*
***Source**: Calculated from NSSO data, 58th Round, 65th Round and 69th Round*

Drinking Water Supply

In 'notified slums', the tap is the main source of drinking water supply, followed by tube wells. Over three Rounds, use of wells has gradually declined. In West Bengal and Tamil Nadu, slums reporting the use of taps have declined in between 58th and 65th Round, and then picked up in 69th Round. In many slums of Uttar Pradesh and Madhya Pradesh, during 58th and 65th Round, tube well is the major source of water supply. In 'non-notified' slums also, the tap is the major source of water supply. But its coverage, although gradually picked up in between 58th and 65th Round, but again declined in 69th Round. Wells have consistently declined, and other sources of water supply have consistently gone up in non-notified slums.

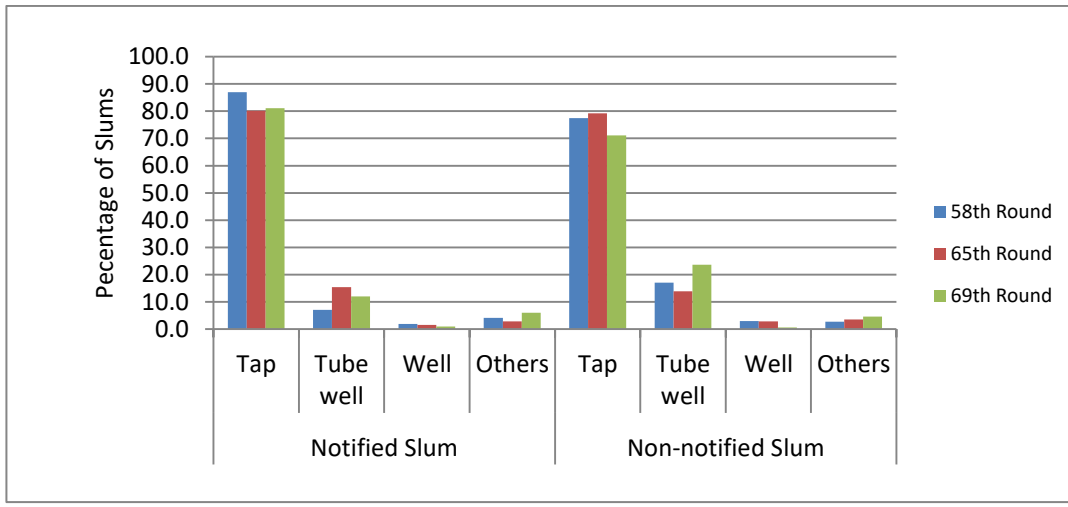


Fig. 1. Sources of Water Supply in Slums, 2002-2012

***Source**: Calculated from NSSO data, 58th Round, 65th Round and 69th Round*

Maharashtra and Madhya Pradesh report a consistent decline in coverage of tap water in non-notified slums, whereas the exactly opposite situation is observed in Andhra Pradesh and Karnataka. Maharashtra also reports a consistent increase in slums with tube well as the main source of water. In Andhra Pradesh, there is a consistent decline in the percentage of slums dependent mainly on tube well. Gujarat and Madhya Pradesh exhibit higher proportion of slums where water comes from other sources. It should be noted that percentage of 'notified' slums having 'tap' as a major source of drinking water is somewhat unchanged in between 65th and 69th Round. It might point towards sluggish role played by ULBs/Parastatal Agencies. Parallely, the percentage of 'notified' slums with other sources of drinking water is increasing, leading one to presume that small-scale private water providers are supplying treated drinking water in large-sized containers. Those slum dwellers who can afford it, and are concerned about spreading of water-borne diseases in slums might be opting this source of drinking water.

Latrine Facilities

So far as 'notified slums' are concerned, proportion of slums with 'shared' latrines has consistently declined across three Rounds. However, slums having 'public/community' latrine, after increasing in between 58th and 65th Round, saw a decline in the 69th Round. Exactly opposite situation prevails in case of slums with 'own' latrines. Uttar Pradesh and Madhya Pradesh report a consistent decline in the percentage of slums with 'public/community' latrines over the three Rounds. But, West Bengal and Tamil Nadu exhibit consistent increase in slums having such type of latrines. Gujarat's case, in terms of slums having 'own' latrines, is beyond any possible explanation (84.9, 10.3 and 94.5, respectively in the three Rounds). Only Madhya Pradesh, and to some extent Karnataka, report some improvement in terms of slums with 'own' latrines.

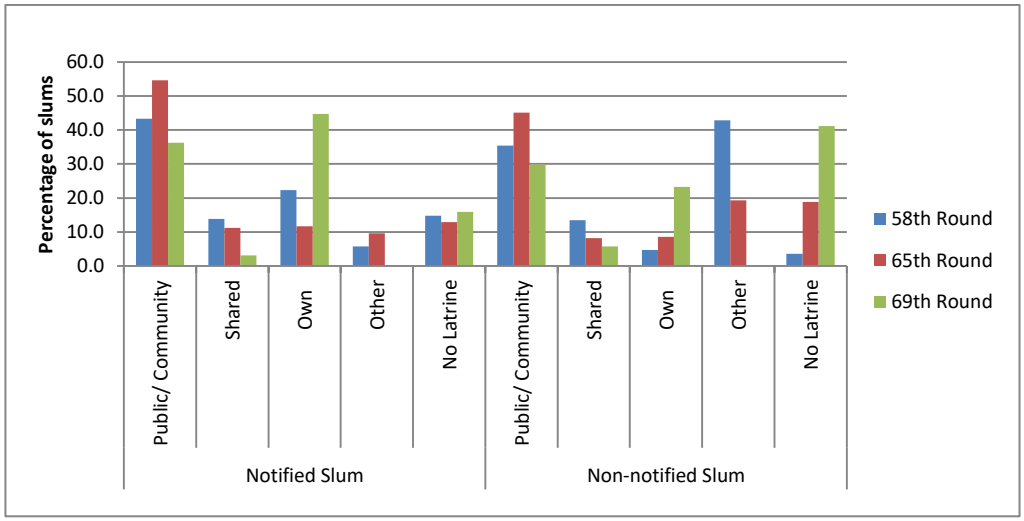


Fig. 2. Types of Latrines in Slums, 2002-2012

***Source**: Calculated from NSSO data, 58th Round, 65th Round and 69th Round*

In non-notified category also, slums with 'shared' latrines have consistently declined in percentage terms, and corresponding shares of 'own' latrines have gone up. It is shocking to note that percentage of slums without latrines have consistently gone up - from 3.5, 18.9 and 41.1, respectively in the three rounds. Madhya Pradesh and Karnataka report a consistent decline in the percentage of slums with 'public/community' latrines, whereas Tamil Nadu shows exactly the opposite trend. Maharashtra exhibits consistently increasing shares of slums with 'own' latrines. 69th Round provides an additional data on 'public latrines' where user charges are applicable. In states like Madhya Pradesh, Tamil Nadu, Uttar Pradesh and Maharashtra, a large chunk of notified slums has such type of latrines. In states like Gujarat, Uttar Pradesh, Karnataka, Maharashtra and Tamil Nadu, one can find a higher proportion of such slums. As per NSSO estimates, West Bengal and Odisha do not have such latrines.

Drainage System

In notified slums, across three Rounds, one can see gradual improvement in terms of 'underground' drainage system, although 'covered drains' show an increase in between 58th and 65th Round, and then a certain decline in the 69th Round. The same trend is applicable to 'open pucca' type of drainage system. It is heartening to observe that slums without drainage system have declined from 14 to 7.8 percent. Otherwise, it is difficult to interpret the trends. Gujarat, for instance, reports 84.9 percent slums with 'underground' drainage system in 58th Round, declining to 14.3 percent in 65th and then surprisingly again, this figure stands at 93.5 percent in the 69th Round. West Bengal reports a consistent increase in slums with 'covered' drainage, whereas Andhra Pradesh reports a consistent increase in slums having 'open pucca' drainage system.

Table 2. Absence of Drainage System - Changing Profile, 2002-2012

State	58th Round (2002)		65th Round (2008-09)		69th Round (2012)	
	Notified Slums	Non-Notified Slums	Notified Slums	Non-Notified Slums	Notified Slums	Non-Notified Slums
Uttar Pradesh	0.9	71.2	8.7	54.1	2.0	71.8
West Bengal	0.1	38.8	9.4	19.5	0.3	45.6
Odisha*	0.0	90.0	48.8	49.4	100.0	55.3
Madhya Pradesh	31.4	38.4	0.0*	13.0	15.1	27.8
Gujarat	2.1	73.4	62.1	39.9	2.5	59.6
Maharashtra	9.6	22.6	0.0*	9.0	5.8	26.3
Andhra Pradesh	21.4	65.7	7.2	37.4	8.8	43.7
Karnataka	35.6	25.3	0.0*	14.5	0.0*	12.8
Tamil Nadu	16.1	43.9	23.7	33.2	20.2	36.8
Total	14.0	41.3	9.7	22.8	7.8	39.8

***Note**: * Absence/Negligible Presence of Sample Slums*

***Source**: Calculated from NSSO 58th Round, 65th Round and 69th Round*

In non-notified slums, certain positive changes have occurred in terms of 'underground' drainage system. In case of 'open pucca' drainage, there is not much change. It is difficult to assess the trends of the absence of drainage system in non-notified slums. Although in between 58th and 65th Rounds, the percentage of slums without drainage system has declined substantially, 69th Round data reflects the almost same situation as of 58th Round. Drainage type of 'open katcha' category reports increase in between 58th and 65th Rounds, and then a sudden drop in the 69th Round. At the state-level, almost double percentage of non-notified slums report 'underground' drainage system in Maharashtra over 58th and 69th Rounds. Gujarat also shows almost same results. Maharashtra also exhibits consistent decline of slums having 'open pucca' type of drainage system, and the exact opposite situation prevails in Tamil Nadu. In West Bengal, there is a small decline in the percentage of slums with 'open katcha' drainage system over three Rounds.

Waterlogging

In non-notified slums, there is a consistent decline in the percentage of slums having waterlogged condition over the three Rounds. However, one cannot discern any particular pattern in case of notified slums. Uttar Pradesh reports a consistent decrease of such notified slums, whereas Gujarat and Karnataka exhibit consistent increase over the three Rounds. Uttar Pradesh and Maharashtra show a consistent decline in the share of non-notified slums with waterlogging problems.

Sewerage

In between 58th and 65th Round, coverage of underground sewerage in notified slums (Ref. Figure 3) has not changed much, although this has certainly increased as observed in the 69th Round. Maharashtra reports a deviation from such trends with certain increment, whereas states like Tamil Nadu, West Bengal and Gujarat exhibit such trends.

Karnataka and Andhra Pradesh exhibit certain improvement in between 58th and 65th Rounds, and then not much change up to the 69th Round. Over three Rounds, there is a very low increment in the percentage of non-notified slums with underground sewerage system (Figure 3). Uttar Pradesh and Maharashtra report continuous increment in the percentage of such slums over three Rounds. West Bengal and Gujarat report increment in between first two Rounds, and then again a slump in the latest one. It should be noted that the cities in general and slums, in particular, do not have the separate system for draining out sewerage waste and storm water. The analysis shows that most of the slums, especially non-notified ones, lack proper drainage system as well as underground sewerage, added to the burden of waterlogging in the rainy season. This deplorable living condition often leads to spreading of diseases.

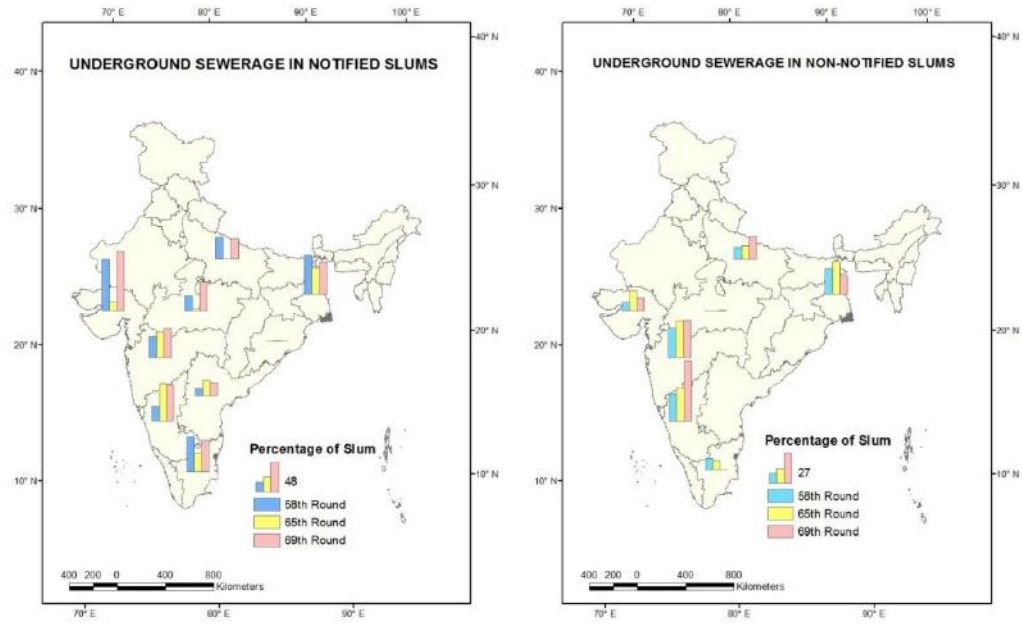


Fig. 3. Underground Sewerage in Notified and Non-Notified Slums

Garbage Disposal

In more than 75 percent of the notified slums, the arrangement of garbage disposal is borne by Urban Local Bodies (ULBs) like Municipality or Municipal Corporation. This is very much prominent in highly urbanized states like Maharashtra and Tamil Nadu. However, for non-notified slums, residents and other agencies also have some contribution. Over three Rounds, ULB service coverage for non-notified slums has gradually improved, from 47.3 to 59.5 percent. On the other hand, the absence of garbage disposal arrangement is more prominent in non-notified slums as compared to notified slums. In such non-notified slums, over three Rounds, the role of residents has not changed much.

However, the role of other agencies has sharply declined to zero in between 65th and 69th Rounds. Given the fact of gradual pace of ULB service coverage in these slums, the corresponding percentage of slums without any garbage disposal arrangement has suddenly gone up from 22.7 to 32.7 percent. In few states like Uttar Pradesh and Andhra Pradesh, the percentage of such type of slums without such arrangement has consistently declined.

Table 3. 'No Arrangement for Garbage Disposal' - Changing Profile, 2002-2012

	58th Round (2002)		65th Round (2008-09)		69th Round (2012)	
	Notified Slums	**Non-notified Slums**	**Notified Slums**	**Non-notified Slums**	**Notified Slums**	**Non-notified Slums**
Uttar Pradesh	1.7	81.5	16.0	54.3	12.0	46.4
West Bengal	4.1	43.2	11.3	22.3	6.0	39.2
Odisha*	100.0*	81.2	32.8	48.1	0.0*	68.5
Madhya Pradesh	41.4	59.1	48.3	23.7	18.0	30.1
Gujarat	4.2	30.1	62.3	32.7	3.0	61.2
Maharashtra	10.5	17.0	2.6	6.3	13.8	18.3
Andhra Pradesh	16.2	62.1	2.6	39.8	7.7	23.4
Karnataka	49.9	55.3	0.2	14.9	3.8	12.6
Tamil Nadu	0.9	46.5	11.5	39.0	26.4	27.0
Total	**14.4**	**41.0**	**10.8**	**22.7**	**11.5**	**32.7**

***Note**: * Absence/Negligible Presence of Sample Slums*
***Source**: Calculated from NSSO 58th Round, 65th Round and 69th Round*

With the introduction of Urban Local Bodies and NGOs' growing contribution in slum amelioration schemes, residents' role sometimes gets minimized to a certain extent, and sometimes it again revives. Perhaps due to the slowdown of NGO's role in one hand and residents' increasing awareness level lead to such revival. Sengupta (1999) has argued that at the end of the day, slum residents experience the real situation of their living environment. Therefore, environmental management at the community level is seriously required. His study on slums of Howrah in West Bengal shows how such community can play a role in amelioration of living environment.

Gaps between Notified and Non-Notified Slums

It is sensible to assess the gaps between notified and non-notified slums. Strictly speaking, notified and non-notified slums are not truly comparable for 58th Round. A criterion of minimum 20 households was attached with non-notified slums in 58th Round. However, this criterion is applicable to both categories of slums in 65th, as well as in 69th Round. Slums are heterogeneous in socio-cultural characteristics, perhaps due to different growth histories. Some of the notified slums are very large and old in cities. It is therefore judicious to examine whether gaps exist between notified slums and non-notified slums, and whether there is any change over three rounds.

Notified slums supposedly get more attention from policymakers through Government and NGO initiatives. For instance, a study done by Hazra and Goel (2009) on solid waste management system in Kolkata (i.e. capital of West Bengal) has found that 'registered' slums are mainly characterized with door-to-door garbage collection, whereas

'unregistered' slums are still depending on garbage disposal at vacant land and canal with no further pick-up.

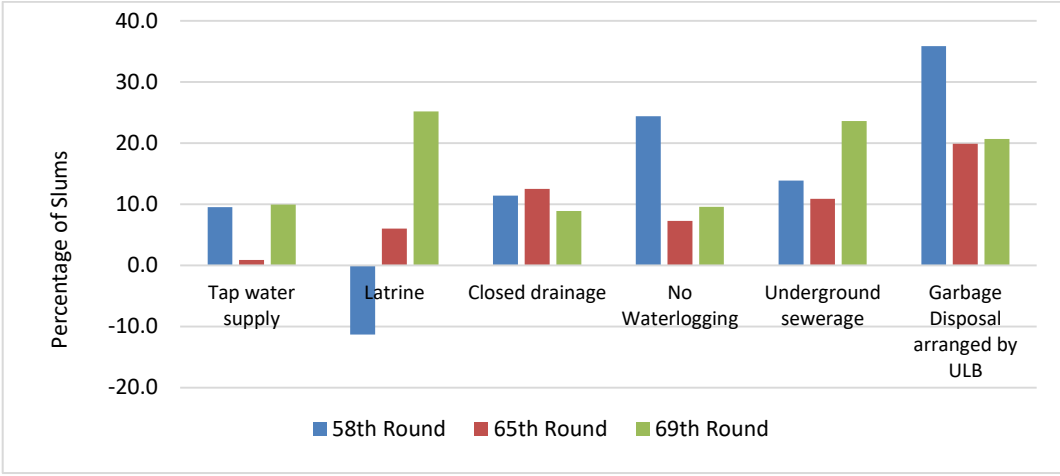


Fig. 4. Changing Gap between Notified and Non-Notified Slums, 2002-2012
***Source**: Calculated from NSSO 58th Round, 65th Round and 69th Round*

As evident from Figure 4, the gaps between notified and non-notified slums have continued in terms of latrine availability. In case of four selected indicators, i.e. 'tap water supply', 'no waterlogging', 'underground sewerage' and 'garbage disposal by ULB', the gaps have reduced in between 58th and 65th Round, and again increased in the 69th Round. Only so far as 'closed drainage' is concerned, the gap has reduced from 58th to 69th Round, after a small increase in 65th Round.

Planning and Policy Perspectives: A Critical Review

Since late 1980s to early 2000s, various government-sponsored schemes (e.g. National Slum Development Programme i.e. NSDP, 1996; Valmiki Ambedkar Awas Yojana i.e. VAMBAY, 2001) had attempted to ameliorate living environment of slums. But, the inadequacy of funds and diversion of little available funds were some of the challenges that NSDP experienced in reality (India: National Report, 2001). Eleventh 5-year Plan document (2007-12), also, observed that slum dwellers were largely deprived of basic urban facilities like water supply and sanitation.

Existing schemes of VAMBAY and discontinued scheme of NSDP were subsumed into Integrated Housing and Slum Development Programme (IHSDP)**.** It also aimed at ameliorating living conditions of slum dwellers as well as holistic slum development in terms of shelter and other physical amenities. An Approach to the Twelfth 5-year Plan (2011) noted that urban poor still 'lack access to basic amenities such as water supply, sanitation, healthcare, education, social security and decent housing' and are going through 'multiple deprivations and vulnerabilities'. A major finding that emerges is that in spite of various Government initiatives, a larger chunk of urban poor is living in the squalor of slums and squatter settlements.

One should note that there have only been mere changes in names and funding patterns for all these schemes, but the focus (i.e. amelioration of living environment in slums) and components (physical infrastructure like water supply and drainage system and social infrastructure like health centres and schools) have remained more or less same. Apart from this, the norms and guidelines attached to many of these schemes are itself problematic. For instance, the 'basic norms' of Environmental Improvement of Urban Slums, as per Delhi Urban Shelter Improvement Board – the nodal agency maintaining *jhuggi-jhopdi* clusters in Delhi, mandates '1 Tap/hydrant for 50 persons' / '1 WC Seat for 25 persons'. Although it appears sensible to Government, one-hour water supply in summer thereby allows only 3 minutes for a 5-member household in general and long waiting time in the line for toilet use and consequent chaos might lead slum dwellers to defecate openly, especially in the morning. Another thing appears clearly: Government is gradually moving towards slum-free cities to facilitate cities' beauty and economic growth or say to promote urban management. Scholars have argued that urban rich and poor live in a symbiotic socio-economic sphere and share common public space (Patel, 2011). However, urban poor have little to say in political decision making. As evident in Delhi, preparation of Commonwealth Games (2010) as part of 'world-class city' has led to the demolition of several slums. Delhi's slum policy, being biased against poor residents, tends to create mushrooming of squatter settlements (Dupont, 2008).

Although Jawaharlal Nehru Urban Renewal Mission (JNNURM), the major urban programme launched in 2005, had two attached schemes for Non-Mission Small & Medium Towns: (1) Urban Infrastructure Development Scheme for Small And Medium Towns (UIDSSMT) – binding together the existing programmes of Integrated Development Scheme for Small and Medium Towns (IDSMT) and Accelerated Urban Water Supply Programme (AUWSP) and (2) Integrated Housing and Slum Development Programme (IHSDP) – subsuming the existing programmes of VAMBAY and discontinued National NSDP. However, most of the projects undertaken in JNNURM were concentrated in relatively more developed states like Maharashtra, West Bengal, Tamil Nadu, Uttar Pradesh, Andhra Pradesh and Gujarat. Out of total funding of JNNURM (Approximately Rs.18462 crore), Basic Service for the Urban Poor (BSUP) component received only 22.7 percent and Urban Infrastructure and Governance (UIG) received 77.3 percent (Kundu and Samanta, 2011).

There was a systematic decline in the percentage of population covered by JNNURM with size-class of urban centres (ibid.). Scholars have critically argued that through advocating neo-liberal urban agenda, this scheme was biased and was against the poor people in a number of ways. Construction of flyovers and roads often relocated them from demolished slums, and some of the prescribed reforms like full cost recovery and user charge policies along with the participation of private agencies hit them hard. Another issue was the limited technical and financial capacity of small and medium towns (Mahadevia, 2006; Mukhopadhay, 2006; Chandran, 2010). Rajiv Awas Yojana (RAY), launched in 2011, also aimed towards providing basic urban amenities to slum dwellers as well as finding

suitable vacant land for rehabilitating them in affordable houses, finally to reach a goal of slum-free cities in the long run. NSSO data provides an opportunity to make some comments on 'changing conditions' - 'improvement', 'no change', 'deterioration' and 'neither existed nor existing' (Table 4 and 5)

Table 4. Changing Conditions in Notified Slums

Parameter	IMP	NOC	DET	NENE
Water Supply	45.0	51.9	2.0	1.1
Latrine	33.6	52.8	6.6	6.9
Drainage	40.2	52.1	1.5	6.3
Sewerage	28.5	51.7	1.0	18.8
Garbage Disposal	36.5	58.3	0.5	4.7

Note: *IMP – Improvement; NOC - No Change; DET – Deterioration; NENE – Neither Existed Earlier Nor Existing Now*

Source: *Calculated from NSSO, 69th Round*

Table 5. Changing Conditions in Non-Notified Slums

Parameter	IMP	NOC	DET	NENE
Water Supply	42.7	43.3	3.8	10.2
Latrine	34.1	40.0	2.1	23.7
Drainage	31.7	40.4	1.7	26.2
Sewerage	19.7	48.5	2.2	29.5
Garbage Disposal	37.0	43.1	2.2	17.7

Note*: IMP – Improvement; NOC - No Change; DET – Deterioration; NENE – Neither Existed Earlier Nor Existing Now*

Source*: Calculated from NSSO, 69th Round*

In 'notified' category of slums, on an average, almost 50 percent have observed no change in all these parameters during last five years. The condition of notified slums, except latrines to a certain extent, has not deteriorated. In almost 19 percent notified slums, sewerage system neither existed, nor existing now. Only in case of latrines, higher shares of notified slums have seen deterioration as compared to non-notified slums. A significant chunk of non-notified slums, in general, report water and sanitation facilities in the category of 'Neither Existed Earlier nor Existing Now'. In this category too, the gap between notified and non-notified is larger in parameters like drainage, latrine, and sewerage system.

Around 40 percent of the non-notified slums have not seen any changes in conditions of enlisted five parameters in last five years. One should note that whatever improvement is happening on the ground, the responsibility is borne by the Government. Cycles of eviction and absence of tenurial rights amidst vulnerabilities of the informal economy, residents are not very active in making and owning such amenities. NGOs are conspicuously absent, especially in smaller cities and towns, which needs further exploration.

Recently launched Swachh Bharat Mission (SBM) attempts to check open defecation, not only by constructing new toilets but also raising awareness and monitoring. It also intends to put a curb on littering through the proper arrangement of solid and liquid waste collection. Another recent initiative, is the Smart City Mission (SMC).

While aspiring for 'inclusive cities', it intends to 'drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology… Area-based development will transform existing areas (retrofit and redevelop), including slums, into better-planned ones, thereby improving liveability of the whole City'[2]. It should be pointed out here that unless 'better planning' of slums significantly improve provisioning of drinking water and sanitation services, the stated purpose of SMC, i.e. improving 'quality of life', creating 'employment' and enhancing 'income for all, especially the poor and the disadvantaged' is bound to get hampered or failed. Poor quality of drinking water and inadequate sanitation facilities will lead to deterioration of health and hygiene conditions, and therefore consequent morbidity will reduce the working capacity of slum dwellers. Lack of proper toilet facilities will force women to defecate openly, making them vulnerable to sexual abuse, thereby again defying SMC's one 'core infrastructural element', i.e. 'safety and security of citizens, particularly women'[3]

Conclusion

As per NSSO estimates, the proportion of 'notified' slums have declined, whereas the proportion of 'non-notified slums' has increased. While considering water and sanitation-related indicators, no such specific temporal pattern can be discerned across the states. Over the three Rounds, use of 'well' has declined in notified as well as notified slums, and in both the categories of slums, 'tap' is the main source of drinking water. It suggests that government's initiatives of piped water supply through taps have yielded some positive results. In the non-notified category, slums having 'shared' latrines have consistently declined. In the category of notified slums, across three Rounds, there is a gradual improvement in terms of 'underground' drainage system, and decline of slums without drainage system has declined from 14 to 7.8 percent. In the category of 'non-notified' slums, there is a consistent decline in the percentage of slums having waterlogged condition over this decade.

In between 58th and 65th Rounds, the proportion of notified slums with underground sewerage has not changed much, although it has certainly picked up as observed in the 69th Round. A very low increase in the percentage of non-notified slums with underground sewerage system is also observed. ULB service coverage for notified slums has gradually improved, although the absence of garbage disposal arrangement is more prominent in non-notified slums as compared to notified slums. The gaps between notified and non-notified slums have continued to increase in terms of latrine availability. Four indicators, however, show inconsistent results (i.e. decline of gaps in between 58th and 65th Round, and increase in 69th Round). The evaluation of plans, policies, and schemes coupled with latest Round observations on changing conditions of water and sanitation related parameters suggest that slums still need better availability of amenities. Non-notified slums are in comparatively poorer condition, because a lion's share of these

[2] http://smartcities.gov.in/upload/uploadfiles/files/What%20is%20Smart%20City.pdf as viewed on 25th February, 2017

[3] Ibid.

clusters have not seen the presence of any services earlier and even now in last five years, these services are conspicuously absent. Given the fact of very low shares of expenditure allotted under BSUP in JNNURM, discontinuation of RAY and only limited expansion of Swachh Bharat Mission programme, it is understandable that slums will take much time to even get such basic amenities, and the gap between notified and non-notified slums may continue to remain at large. This also raises broader issues of how to achieve inclusive urban growth and make out cities resilient and smart.

Acknowledgements

We are thankful to the former Research Scholars of CSRD, namely, Sharmistha Singh for providing NSSO raw dataset and, Asha Bauri and Biswajit Kar for helping in data extraction methods. CSRD deserves special mention for making raw NSSO dataset available.

References

1. Bhan, G., & Jana, A. (2013). Of slums or poverty: Notes of Caution from Census 2011. Economic and Political Weekly, 48(18), 13-16.
2. Chandran, D. (2010). An appraisal of Jawaharlal Nehru National Urban Renewal Mission (JNNURM): Case Studies of Thiruvananthapuram and Kochi, MPhil Dissertation, Jawaharlal Nehru University, New Delhi, India.
3. Dupont, V. (2008). Slum Demolitions in Delhi since the 1990s: An Appraisal. Economic and Political Weekly, 43(28), 79-87.
4. Hazra, T., & Goel, S. (2009). Solid waste management in Kolkata, India: Practices and Challenges. Waste Management, 29, 470-478.
5. Kundu, A., & Saraswati, L. R. (2012). Migration and Exclusionary Urbanisation in India. Economic and Political Weekly, 47 (26-27), 219-227.
6. Kundu, D., & Samanta, D. (2011). Redefining the Inclusive Urban Agenda in India. Economic and Political Weekly, 46(5), 55-63.
7. Mahadevia, D. (2006). NURM and the Poor in Globalising Mega Cities. Economic and Political Weekly. 41(31), 3399-3403.
8. Ministry of Urban Development and Poverty Alleviation (2001). India: National Report - Progress of Implementation of the Habitat Agenda (1996-2000), Istanbul +5 UNCHS (Habitat) Conference, 2001.
9. Mitlin, D. (2005). Understanding chronic poverty in urban areas. International Planning Studies. 10:1, 3-19.
10. Mukhopadhay, P. (2006). Whither Urban Renewal?. Economic and Political Weekly, 41(10), 879-884.
11. Patel, S. B. (2011). Inclusionary Housing. Economic and Political Weekly, 46(43), 13-14.
12. Sengupta, C. (1999). Dynamics of Community Environmental Management in Howrah Slums. Economic and Political Weekly, 34(21), 1292-1296.
13. World Health Organization. http://www.who.int/water_sanitation_health/en/ (Accessed on 20th February, 2018).

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 76-87
ISSN 0019-4824

GIS BASED SPATIAL ACCESS TO PEDIATRICIAN SERVICES - A CASE STUDY OF SELECTED MUNICIPAL CIRCLES OF HYDERABAD

Srikanth Katta

Department of Geography, College of Science, Osmania University, Hyderabad - 500 007
E-mail: katta.sreekanth@gmail.com

Abstract

The spatial access and dynamics of a changing population in urban areas with changing health care needs require frequent and logical methods to evaluate and assist in primary health care access and planning. Spatial or geographical access is an important aspect of the planning process. Healthcare accessibility analysis based on GIS is a logical method that can be applied to test the degree to which equitable access is obtained. In reality, a person will always go to their closest facility; GIS analysis is however based on this assumption of this rational choice. Inputs to the analysis are supplied in the form of healthcare facilities and demand estimates in the form of people who are actually seeking the healthcare service. GIS is used to determine catchment or buffer areas for each healthcare facility, allocating demand to its closest healthcare facility limiting access based on facility capacity and accessibility through a road network. The catchment or buffer area analysis results from each of the three demand scenarios are compared with actual situations in the form of nearest facilities and mapped origins of the number of users at each facility. The major objective of the study is to show the use of GIS to quantify and improve the access to health care resources in terms of availability (supply of services which meets the population needs) and Accessibility (physical access along with travel time and cost) in Circle No. 2, 9 and 10 of GHMC, Hyderabad.

Keywords: GIS, Accessibility, Hospital locations, Population, Demand areas, Catchment/buffer zones and Travel time

Introduction

Healthcare is very important for community well-being. Variations in the accessibility, obtainability, and affordability of the people to healthcare facilities, however, make for differences or disparities in healthcare in different population groups. The differences or difficulties in geographic access to health care facilities can be attributed to the location of facilities, transportation services, and population distribution in a specified area. The accessibility to healthcare is an important aspect of human health, it is a complicated process and mainly depends on the nature of the population which they need to service.

One of the most important features affecting the health status of the population is the distance between the populated places and the location of health care facilities. Travel time, to reach the health care facilities is also an important factor and the time distance most often is related to the route distance, though there may be exceptions to the case. Also in developing countries like India, the route distance may not be a direct derivative of the actual terrestrial distance as traffic snags and bottlenecks may be the direct straight-line relation between the two variables. Travel time, especially in the case of health emergencies also determines the survival rates of people and hence the efficacy of the services. The present study focuses on the concept of the location of the right type of healthcare facilities within the optimum travel time. This again mainly depends upon the spatial arrangement of the population, health care facilities, and road connectivity. The study and analysis of this spatial structure form the basis for the measurement of various problems and healthcare incongruences due to a shortage of required healthcare facilities which are basically needed for the local people. Generally, infants and children face a lot of difficulties in getting proper health care within designated time intervals due to poor access to health care services. There is a need to project the status of healthcare services in a region to reveal the actual needs of the healthcare services by the people in that particular region. GIS can easily facilitate this. The components like hospital locations, population, and road network provide the estimated travel time between a hospital location and a patient. Here the real-time travel estimates and network analyst tools in GIS are used to get the estimated travel time between source and destination, which are specific to the population groups residing in defined locality boundaries. The study area includes Circle No. 2, 9, and 10 of Greater Hyderabad Municipal Corporation, Hyderabad, Telangana.

Database and Methodology

The datasets used here are Greater Hyderabad Municipal Corporation Circle and Ward boundaries, Hospital Locations data (Only Specialties), Google Imagery, and Road Network. The optimal travel time in the service areas for the various specialties in healthcare is defined by the service zones generated using ArcGIS. These service zones are mainly considered within a 1 km radius from each specialty and are divided based on 5 Minutes, 10 Minutes, 15 Minutes, and 20 Minutes travel times within the specified radius in the 3 circles of Greater Hyderabad Municipal Corporation area under consideration. *Heat maps* are generated for the pediatrician services with a 1km radius from each point location. The location of hospitals is represented in terms of density or clustering of hospitals, and public access to these pediatrician services is shown in four categories of access zones like:

1. Very high access zone**:** *Represented as white color zones on the map*.
2. High access zone**:** *Represented as brown color zones on the map*.
3. Moderate access zone**:** *Represented as green color zones on the map*.
4. Low access zone**:** *Represented as light green color zones on the map*.
5. Service Limits of proposed care centers**:** *Represented as pink color on the map*.

Here the travel time-based services will not be common to all the specialties, because every specialty in healthcare has an optimal time for treatment for lowering the mortality rates and for the safety of the patient's health.

Results and Discussion

Here the ward wise Physician-to-patient ratio is not taken for the study because it is not a precise measure of access to healthcare. Some patients may be able to approach the nearest specialist or physician in the adjacent ward, while others may travel still longer distances to see the physicians or specialists even in the same ward. Therefore the distance from centroid in a group of healthcare facilities and the population residing in and around the hospital locations are considered for estimating the nearest hospital or specialty in the region. Regarding the road network, all three regions Uppal, Habsiguda, and Ramanthapur have a very good and well-connected road network. The travel time is calculated based on real-time travel, road, and traffic conditions. Proposed care centers are suggested in the areas which are not included in the 1 km range of the existing specialties. The centroid is chosen such that it covers a 1 km radius in unserved areas.

Circle-2

Circle-2 is located in the east zone of Greater Hyderabad Municipal Corporation with Habsiguda, Uppal, and Ramanthapur as municipal wards. The highest population density is found in Uppal followed by Habsiguda and Ramanthapur. All three wards have a well-connected road network with good transportation facilities in Habsiguda and some parts of Ramanthapur and Uppal. The details of specialty services like pediatricians in Circle-2 are given in detail below.

Pediatrician Services

These are well known pediatric services in Circle-2, in which the hospitals are located in Habsiguda, Ramanthapur, and Uppal area.

The following Figure 1 represents the pediatric services and access zones in terms of nearest pediatric facilities and estimated travel times for the people to access the pediatric services. Heat maps are generated for the pediatric services with a 1km radius from each point location. The location of hospitals is represented in terms of concentration of hospital and public accessibility to these pediatric services is shown in four categories of access zones like:

1. Very high access zone: It represents the pediatric facilities within 5 minutes of travel time. The density or presence of pediatric services is comparatively more in this region. This zone forms the core area of the region with vital commercial and residential areas. Parts of Ramanthapur and Habsiguda are included in this zone.

2. High access zone: This zone represents the pediatric facilities within 5-10 minutes of travel time. This zone borders the white-colored zone and is with a lower density of pediatric services when compared to the white-colored zone. Some part of Habsiguda falls under this zone.

3. Moderate access zone: It represents the pediatric facilities within 10-15 minutes of travel time from the core area under consideration. This zone is at the rim of the brown-colored zone with no pediatric services but comes under the influence of a brown colored zone. Uppal comes under this zone and is partially inland when compared to the white and brown zones. People in this zone depend mostly on personal transport for accessing the pediatric facilities.

4. Low access zone: It represents the pediatric facilities within 15-2020 minutes of travel time. This zone is around the green-colored zone with very minimum pediatric services, this zone comes under the buffer area of a 1 km radius of the pediatric services located in the core area of the region. People in this zone completely depend on personal transport for accessing pediatric services.

Four new pediatric services in a linear stretch of the north to south are proposed with a 1 km radius from the point of location in circle 2 so that no area in the circle is left un-served or under-serviced. Tables 1, 2, and 3 represent the details of pediatric hospitals and the number of specialty doctors.

Table 1. Habsiguda Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Sai Thirumala Orthopaedic and Children's Clinic	1
2	Surender Rao's Clinic	1
3	Shree Lalitha Children Clinic	1

Table 2. Uppal Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Ankura Hospitals	10
2	Spark Hospital	2
3	Shree Hrishikeshaya Hospital	1

Table 2. Ramanthapur Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Children's Clinic	1
2	Jayakrishna Hospital	2
3	Matrix Hospital	1
4	Manasa Hospital	1
5	Saicharan Hospital	1
6	Swati Children Hospital	1

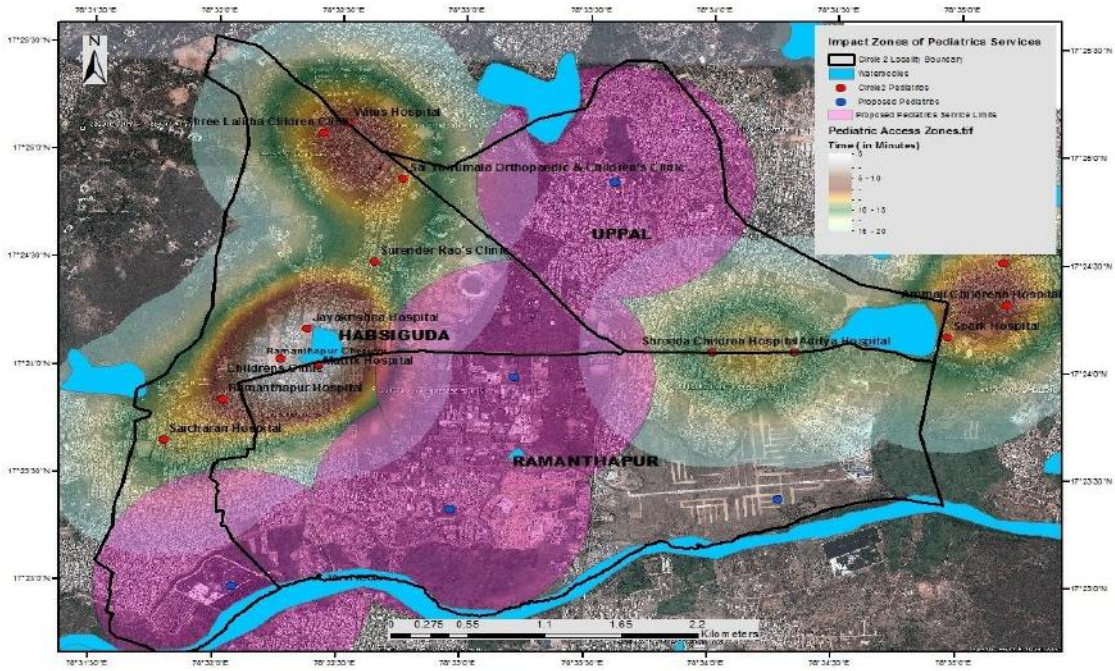


Fig. 1. Circle 2: Pediatrics Services

Circle-9

Circle-9 is located in the central zone of Greater Municipal Corporation of Hyderabad with 16 wards of Musheerabad, Bholakpur, Adikmet, Gandhinagar, Golnaka, Nallakunta, Baghlingampally, BaghAmberpet, Amberpet, Ramnagar, Kachiguda, Barkatpura, Vidyanagar, Domalguda, Himayatnagar, and Kavadiguda. These wards have been arranged in descending order of population density. All sixteen wards have a well-connected road network with good transportation facilities. The details of specialty services like Pediatricians in circle-9 are analyzed below.

Pediatric Services

There are as many as 9 well known pediatric services in Circle-9, of which 2 hospitals are in Amberpet, 2 in Barkatpura, 1 in Domalguda, 2 in Gandhinagar, 1 in Musheerabad and 1 in Vidyanagar. The following Figure 2 represents the pediatric services and access zones in terms of the nearest pediatric facilities and estimated travel time for the people to access the pediatric services. Heat maps are generated for the pediatric services with a 1km radius from each point location. The location of hospitals is represented in terms of density of hospitals, and public access to these pediatric services is shown in four categories of access zones like:

1. Very high access zone: It represents the pediatric facilities within 5 minutes of travel time. The density or presence of pediatric services is comparatively more in this region. This zone forms the core area of the region with important commercial, educational and residential activities. This zone is found in parts of Barkatpura, Kachiguda, Adikmet, Vidyanagar, and Baghlingampally.

2. High access zone: It represents the pediatric facilities within 5-10 minutes of travel time. This zone is around the white-colored zone with comparatively less number of pediatric services when compared to the white-colored zone. Parts of Bholakpur, Gandhinagar, Kavadiguda, Musheerabad, and Ramnagar fall under this zone.

3. Moderate access zone: This zone represents the pediatric facilities within 10-15 minutes of travel time. This zone is around the brown-colored zone with less number of pediatric services. This zone is partially interior when compared to the white and brown colored zones. People in this zone depend mostly on personal transport for accessing the pediatric facilities.

4. Low access zone: It represents the pediatric facilities within 15-2020 minutes of travel time. This zone surrounds the green-colored zone with a very less number of pediatric services, this zone comes under the buffer area of a 1 km radius of the pediatric services located in the core area of the region. People in this zone completely depend on their own transport for accessing pediatric services. The remaining wards come under the influence of service zones of adjacent hospitals in the circle.

Two new pediatric care centers are proposed in the areas of Amberpet and Baghamberpet which can serve a 1 km radius from the point of its location. Tables 4, 5, 6, 7, 8, and 9 represent the details of pediatric hospitals and the number of specialty doctors.

Table 4. Amberpet Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Pulse Medical Centre	1
2	Yashoda Women And Children's Clinic	1

Table 5. Gandhinagar Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Sanjeevani Children's Clinic	1
2	Sruthi Children’s Clinic	1

Table 6. Barkatpura Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Bristlecone Hospitals	4
2	Shalini Hospital	1

Table 7. Musheerabad Pediatricians 2019-2020

S.No	Hospital	Number of Doctors
1	Dr. Apparao Clinic	1

Table 8. Domalguda Pediatricians 2019-2020

S.No	Hospital	Number of Doctors
1	Sai Vani Super Speciality Hospital	1

Table 9. Vidyanagar Pediatricians 2019-2020

S.No	Hospital	Number of Doctors
1	Abhaya BBC Children Hospital	2

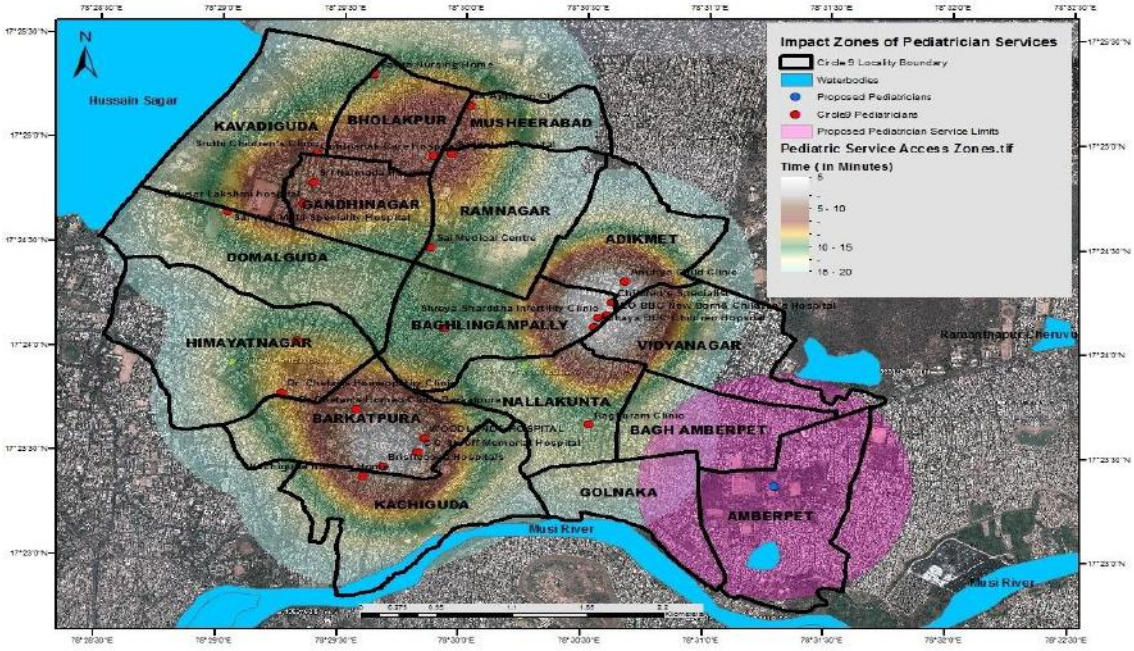


Fig. 2. Circle 9: Pediatrics Services

Circle-10

Circle-10 is located in the central zone of Greater Municipal Corporation of Hyderabad with 15 wards of Rahmathnagar, Borabanda, Yousufguda, Balkampet, Erragadda, VengalRao Nagar, Panjagutta, Srinagar Colony, Khairtabad, Ameerpet, Sanathnagar, Banjara Hills, Somajiguda, Shaikpet and Jubliee Hills. The highest population densities of these wards are also listed in the same order starting from Rahmathnagar (highest) to Jubliee Hills (lowest). All fifteen wards have a well-connected road network with good transportation facilities. The details of specialty services like Pediatricians in Circle-10 is as follows:

Pediatric Services

There are 29 well known pediatric services in circle-10, of which 1 hospital is in Ameerpet, 10 hospitals are in Banjara Hills, 1 in Borabanda, 3 in Erragadda, 2 in Jubilee Hills, 2 in Khairtabad, 1 in Panjagutta, 2 in Somajiguda, 3 in Srinagar colony and 4 in Yousufguda. The following Figure 3 represents the pediatric services and access zones in terms of nearest pediatric facilities and estimated travel time for the people to access the pediatric services. Heat maps are generated for the pediatric services with a 1km radius from each point location. The location of hospitals is represented in terms of density of hospitals and public accesses to these pediatric services are shown in four categories of access zones like:

1. Very high access zone: It represents the pediatric facilities within 5 minutes of travel time. The density or presence of pediatric services is rather more in this region. This zone forms the core area of the region with important commercial and residential activities. This zone is found in parts of Ameerpet, Somajiguda, Srinagar colony, Panjagutta, and Banjara Hills.

2. High access zone: It represents the pediatric facilities within 5-10 minutes of travel time. This zone is around the white-colored zone with a fairly lower density of pediatric services when compared to the white-colored zone. Sanathnagar falls under this zone.

3. Moderate access zone: It represents the pediatric facilities within 10-15 minutes of travel time. This zone is around the brown-colored zone with scattered pediatric services. This zone is partially interior when compared to the white and brown colored zones. People in this zone mostly depend on personal transport for accessing the pediatric facilities.

4. Low access zone: It represents the pediatric facilities within 15-2020 minutes of travel time. This zone is around the green-colored zone with no pediatric services, this zone comes under the buffer area of a 1 km radius of the pediatric services located in the core area of the region. People in this zone completely depend on personal transport for accessing pediatric services. The remaining wards come under the influence of service zones of adjacent hospitals in the circle. Two new pediatric care centers are proposed in the area of Jubilee Hills which can serve a 1 km radius from the point of its location.

Tables 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19 represent the details of pediatric hospitals and the number of specialty doctors.

Table 10. Ameerpet Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Challa Hospitals	3

Table 11. Jubilee Hills Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Apollo Hospitals	13
2	Sai Jyothi Clinic for children	1

Table 12. Banjara Hills Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	The Birthplace Hospital	2
2	Pragna Hospitals	3
3	Dr. P Nirajan Rao's Clinic	1
4	Rainbow Children's Hospital	11
5	Care Hospital	5
6	Motherhood Hospital	2
7	Dr. P Avinash's Clinic	1
8	BirthRight by Rainbow	6
9	Radiant Hospital - Institute of Mental Health, Addiction & Rehabilitation	1
10	Star Hospitals	4

Table 13. Khairtabad Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Vijay Marie Hospital	2
2	Vigneshwara Clinic	1

Table 14. Panjagutta Pediatricians 2019-2020

S.No	Hospital	Number of Doctors
1	Little Stars Children's Hospital	6

Table 15. Borabanda Pediatricians 2019-2020

S.No	Hospital	Number of Doctors
1	Deeksha Children's Clinic	1

Table 16. Somajiguda Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Vivekananda Hospital	1
2	The Deccan Hospital	2

Table 17. Erragadda Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Sai Srinivasa Children's Clinic	1
2	Bal Gopal Children Clinic	1
3	Poojitha Hospital	1

Table 18. Srinagar Colony Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Tanvir Hospital	2
2	Nikhil Hospitals	1
3	Amrutha Clinic	1

Table 19. Yousufguda Pediatricians 2019-2020

S.No	Hospitals	Number of Doctors
1	Fehmicare Hospital	3
2	Venkatapathi Raju Clinic	1
3	Deepu Children And General Clinic	1
4	Radha Nursing Home	1

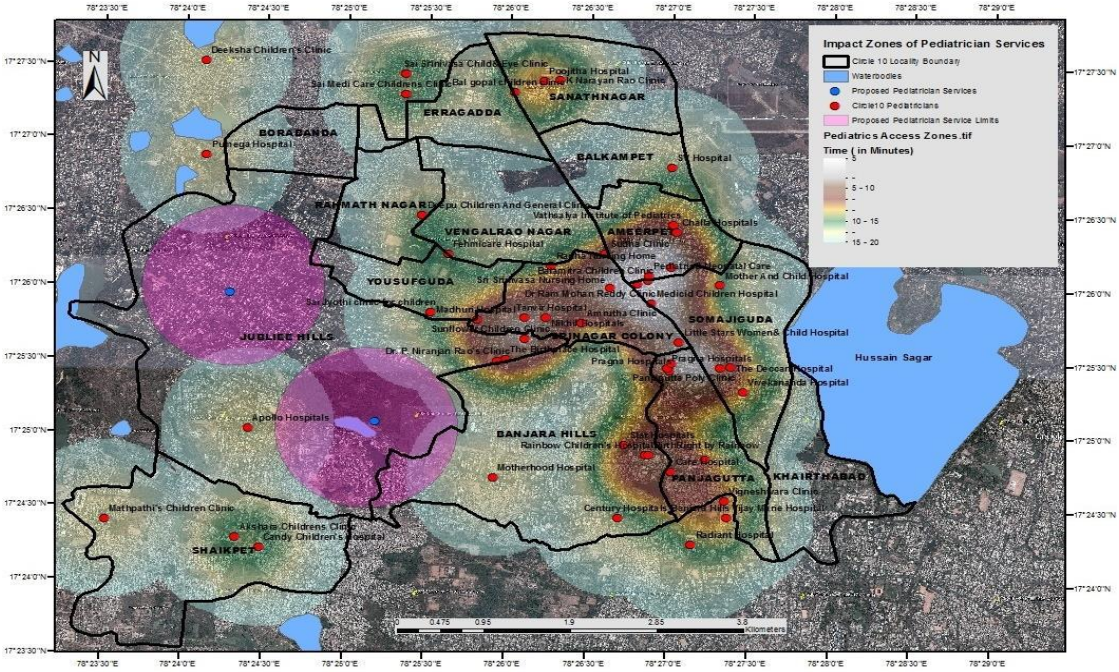


Fig. 3. Circle 10: Pediatrics Services

Conclusion

The pediatric specialty services are not distributed evenly in all the wards, some wards have more pediatric services and some with less number of pediatric services. These services are in easy access zones except in a few wards. The services must be more in number and easily accessible with less travel time in Circle 2, Circle 9 & Circle 10. New pediatric specialty service locations have been proposed at various locations in the wards which are in short of services. The major specialty services which are under a network of hospitals must be easily accessible by the patients. This is possible only with good spatial accessibility. The sharing of patient data among the hospitals and diagnostic centers also helps in the faster and effective treatment of patients. This also helps in reducing the medical expenses of the patients. This is possible only with the improvement of urban and health infrastructure in the study area.

Acknowledgment

The author is grateful to the Indian Council of Social Science Research (ICSSR), New Delhi for the award of ICSSR Post-Doctoral Fellow that greatly helped to complete this research.

References

1. Adkins, R. J., G. R. Anderson, T. J. Cullen, W. W. Myers, F. S. Newman, and M. R.Schwarz. 1987. ‘‘Geographic and Specialty Distributions of WAMI Program Participants and Nonparticipants.’’ Journal of Medical Education 62 (10): 810–7.
2. Al-Taiar A, Clark A, Longenecker JC, Whitty CJM: Physical accessibility and utilization of health services in Yemen. Int J Health Geogr 2010, 9:38.
3. AmericanMedical Association. 2001. Physician Characteristics and Distribution in the U.S., 2001 Edition. Chicago: American Medical Association.
4. Blandford JI, Kumar S, Luo W, MacEachren AM. It’s a long, long walk: accessibility to hospitals, maternity and integrated health centers in Niger. Int J Health Geogr. 2012;11:24.
5. Blumenthal, D. 2004. ‘‘New Steam from an Old Cauldron - The Physician-Supply Debate.’’ New England Journal of Medicine 350 (17): 1780–7.
6. Brabyn L. and C. Skelly. 2002. Modeling population access to New Zealand public hospitals. International Journal of Health Geographic. 1 (3): 1-9.
7. Clark RA, Coffee N, Turner D, Eckert KA, van Gaans D, Wilkinson D, et al. Application of geographic modeling techniques to quantify spatial access to health services before and after an acute cardiac event. Health Serv Outcomes Res. 2012;125:2006–14.
8. Clark RA, Driscoll A, Nottage J, McLennan S, Coombe DM, Bamford EJ, et al. Inequitable provision of optimal services for patients with chronic heart failure: a national geo-mapping study. MJA. 2007;186(4):169-73.
9. Delamater, P., Messina, J., Shortridge, A., & Grady, S. (2012). Measuring geographic access to health care: raster and network-based methods. International Journal ofHealth Geographics, 11 (1), 15.
10. Guagliardo, M. F. 2004. ‘‘Spatial Accessibility of Primary Care: Concepts, Methods, and Challenges.’’ International Journal of Health Geographics 3 (1): 3.
11. Hossein -Zadeh, M. et al, "Analysis of spatial and spatial distribution of health centers – Health and Home Care City Branch", pp. 8-1.
12. Hydrae, Abdullah and Assad Nezhad Roushti, M. (1390), " Analysis of Access and locate health services using GIS (Case Study: Zanjan hospital ", Research in Human Geography, No. 73, 1389.
13. Joseph, A. E., and P. R. Bantock. 1982. ‘‘Measuring Potential Physical Accessibility to General Practitioners in Rural Areas: A Method and Case Study.’’ Social Science and Medicine 16 (1): 85–90.
14. Joseph, A.E.; Bantock, P.R. Measuring potential physical accessibility to general practitioners in rural areas: A method and case study. Soc. Sci. Med. 2002, 16, 85–90.

15. Knox, P.L. The intra urban ecology of primary medical care: Patterns of accessibility and their policy implications. Environ. Plan. A 1978, 10, 415–435.
16. Konrad, T. R., R. Slifkin, C. Stevens, and J. Miller. 2000. ‘‘Using the AMA Physician Masterfile to Measure Physician Supply in Small Towns.’’ 16 (2): 162–7. Geographic Distribution of Physicians 1951.
17. Luo, W.; Wang, F. Measures of spatial accessibility to health care in a GIS environment: Synthesis and a case study in the Chicago region. Environ. Plan. B Plan. Des. 2003, 30, 865–884.
18. Munoz UH, Kalestal C. Geographical accessibility and spatial coverage modeling of the primary health care network in the Western Province of Rwanda. Int J Health Geogr. 2012;11:40.
19. Oppong JR, Hodgson MJ: Spatial Accessibility To Health-Care Facilities In Suhum District, Ghana. Prof Geogr 1994, 46(2):199–209.
20. Ravelli, A. C. (2011). Travel time from home to hospital and adverse perinatal outcomes in women at term in the Netherlands. BJOG: An International Journal of Obstetrics & Gynaecology, 457-465.
21. Schuurman N, Berube M, Crooks VA: Measuring potential spatial access to primary health care physicians using a modified gravity model. Canadian Geographer-Geographe Canadien 2010, 54(1):29–45.
22. Williams, A. P., W. B. Schwartz, J. P. Newhouse, and B. W. Bennett. 1983. ‘‘How Many Miles to the Doctor?’’ New England Journal of Medicine 309 (16): 958–63.

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 88-94
ISSN 0019-4824

POPULATION TRENDS IN MANGROVE FOREST IN THE GODAVARI DELTA, EAST COAST OF INDIA

Hema Malini B.[1], Demudu G.[1], Ananda Ratna Kumar K.[1] and Nageswara Rao K.[2]

[1] Department of Geography, Andhra University, Visakhapatnam - 530 003
[2] Department of Geo-Engineering, Andhra University, Visakhapatnam - 530 003
E-mail: bhmalini@yahoo.com

Abstract

Lifestyles in the highly inaccessible mangrove forests at the coastal fringes are in many ways primitive and less widely known similar to the traditional patterns of the tribes inhabiting the hills. We analysed the temporal trends in population in the mangrove forest along the Godavari Delta coast, in East Godavari district in Andhra Pradesh. Village-wise census data pertaining to five decades from 1971 to 2011 indicated that the Godavari Mangrove Forest (GMF) region was relatively sparsely populated when compared to that of the district as a whole. In spite of an overall increase in the total population in the five revenue villages including their 21 hamlets in GMF region, the growth rate was relatively low among the combined SC & ST population when compared to the population of all other communities in the region. Similarly, the percent share of SC & ST population has declined prominently in four out of the five revenue villages during the period.

Keywords: Population, Mangrove Forest, Godavari Delta

Introduction

Coastal zones, largely being low-lying areas at the interface between the land and water are highly vulnerable to various natural and anthropogenic hazards. Natural hazards such as storms and tsunamis and the associated seawater-surges as well as inland floods lead to coastal inundation, and loss of life besides destroying the economy. On the other hand, human activities at global scale, such as climate change-induced ice-melt and sea-level rise, and at regional scale, such as upstream dam construction that deprive the sediment inputs into the sea, as well as at local scale, such as coastal construction and land use changes, cause coastal erosion and land loss, and degradation of coastal ecosystems (Kumar et al., 2019). Yet the coastal zones in general are densely populated owing to rich resource base in terms of fertile soils and copious water and marine resources (Ahmed, 2019; Sui et al., 2020). The coastal fringe lands especially in the estuarine regions in the river deltas exhibit some of the specialized ecosystems such as mangrove swamps, tidal mudflats, lagoons and tidal channels. Lying in the intertidal zone very close to the sea level, these estuarine regions harbour a variety of rich floral and faunal assemblages. Interestingly, even these relatively inaccessible and seemingly harsh environments are also home for traditional fishing communities (Seary et al., 2020).

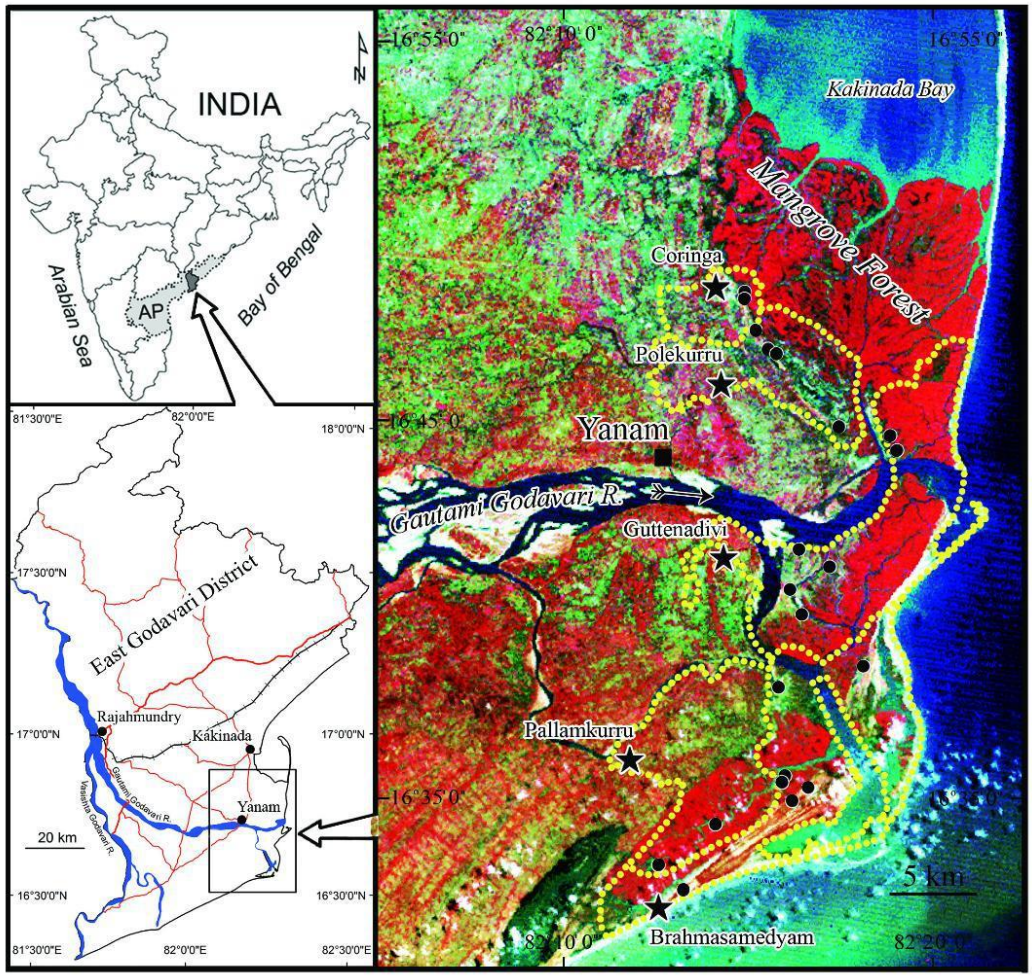


Fig. 1. Satellite image showing the Gautami Estuarine zone along the Godavari delta fringe, east coast of India. The Mangrove Forest vegetation appears in the image in bright red colour from Kakinada Bay in the north to Brahmasamedyam in the south all along the coast. The yellow-coloured dotted polygons represent the village boundaries. The location of the five main villages (black coloured star symbols), and the 21 hamlets in the mangrove forest area (black coloured dots) are also shown. The top left panel shows the location of East Godavari District (in Andhra Pradesh (AP) State in India. The rectangle box in the bottom left panel, along the coastal part of East Godavari District indicates the location of the area shown in the satellite image.

Contrary to the dense population base of the coastal zones, the estuarine regions, especially along the delta front coasts, however, are relatively sparsely populated. With the available limited space for habitations, the human settlements are relatively small and almost isolated from one another (Rao and Prasad, 1979).

These coastal fringe dwellers are among the poorest and most marginalized communities in the world. Braving recurring coastal hazards and deprived of even the basic amenities, these hapless communities thrive on subsistence economy obtained from capture fishery, cattle and duck-rearing, mangrove produce and shell collection (Feller et al., 2017; Rao, 2018). Coastal inhabitants used the mangroves for centuries (Luther and Greenburg, 2009). People living in the mangrove forests at the transition between the dry land and open ocean follow a, more or less, similar primitive lifestyle of the tribes inhabiting the hills. As mangrove forests are highly inaccessible, the basic information of mangrove dwellers such as distribution of population and its size, and their lifestyles is not known to the outside environment.

Monitoring the temporal changes in the populations of the estuarine regions and coastal fringe zones are an effective way of understanding the environmental and ecological drivers of their livelihood conditions. Therefore, this study is an initial effort in this direction by taking the population of the mangrove forest region in the Godavari delta fringe coast, as a case study. The main objective of the present study is to analyze the distribution and temporal trends in population of the coastal mangrove forest area of Godavari Delta region along the east coast of India.

Study Area

The River Godavari, the second largest river system in India, drains over 312,812 km^2 area across the Deccan Plateau. The 1465-km-long Godavari River joins the Bay of Bengal through its two major distributary channels, namely Gautami Godavari and Vasishta Godavari rivers. In the process, the river builds a large delta covering ~5820 km^2 of area on the country's eastern seaboard in Andhra Pradesh. The Gautami distributary channel and its terminal branch, Nilarevu, together make up the northern part of the Godavari delta coast exhibiting a river dominant morphology with extensive mangrove forest and associated mudflats, occasional sandy beach ridges and an intricate network of tidal channels, whereas the southern part of the delta coast built by the Vasishta and its terminal branch, Vainateyam, is characterized by wave-dominated features such as closely spaced beach ridges (Rao et al., 2005).

The mangrove forest region including the human habitations representing the estuarine part on both sides of the Gautami distributary channel, extending between 16º 32' and 16º 49' N latitudes, and between 82º 10' and 82º 22' E longitudes covers 377 km^2 of area (Figure 1). There are a total of 21 human habitations in this region. Administratively, all these small settlements are hamlets of five revenue villages, namely Coringa, Polekurru, Guttenadivi, Pallamkurru and Brahmasamedyam that are located along the landward fringes of the mangrove forest in East Godavari district (EG Dt) of Andhra Pradesh State (Figure 1). Hereinafter, the study area including the landward boundaries of the five revenue villages is referred to as Godavari Mangrove Forest (GMF) region.

Database and Methodology

Population data were collected for five census years i.e. 1971, 1981, 1991, 2001 and 2011 from the respective Census reports. Distribution and temporal trends in the total population as well as Scheduled Caste and Scheduled Tribe communities were analysed. The population trends of the five revenue villages and the GMF region as a whole are compared with that of the District.

Results and Discussion

Population Trends: GMF Region and EG Dt

Data on decadal population of the GMF region indicated that the area is relatively sparsely populated during the five census decades, 1971–2011, when compared to the EG Dt (Table 1). The population density in GMF was 110/km^2 in 1971 against the district's density of 282/km^2. Although the population density increased in GMF from 1971 through to 2011, its rate of increase has always been lower than that of the district (Table 1). Analysis of the trends in population among different social groups in GMF showed variations when compared to that of the district as a whole. The ratio of the combined population of scheduled Castes (SC) and scheduled Tribes (ST) with the combined population of all other communities (Others) in GMF region was higher than in the district initially during 1971 and 1981, but decreased in the subsequent decades through 1991 to 2011. In fact, SC & ST population in GMF declined consistently by a clear 2% during 1971–2011 from 22.9% in 1971 to 20.9% by 2011, whereas it has increased by ~2% in the district during the period (Table 1).

Table 1. Population Trends in GMF and EG Dt, 1971-2011

Census Year	Decadal Population									
	Godavari Mangrove Forest (GMF)					East Godavari District				
	SC And ST Communities Combined	Others	Total	Growth Rate	Population Density	SC And ST Communities Combined	Others	Total	Growth Rate	Population Density
1971	9,570 (22.9%)	32,148 (77.1%)	41,738		110	6,36,818 (20.6%)	24,50,444 (79.4%)	30,87,262		285
1981	10,625 (22.5%)	36,570 (77.5%)	47,195	13.1	125	7,94,879 (21.5%)	29,06,161 (78.5%)	37,01,040	19.9	342
1991	13,227 (22.6%)	45,204 (77.4%)	58,431	23.8	155	10,02,140 (22.7%)	35,39,082 (77.3%)	45,41,222	22.7	420
2001	13,772 (21.3%)	51,001 (78.7%)	64,773	10.9	172	10,73,201 (21.9%)	38,28,219 (78.1%)	49,01,420	7.9	453
2011	14,024 (20.9%)	53,167 (79.1%)	67,191	3.7	178	11,58,464 (22.5%)	39,95,832 (77.5%)	51,54,296	5.2	477

Table 2. Village-Wise Population Trends in GMF, 1971-2011

Year	Coringa			Polekurru			Guttenadivi			Pallamkurru			Brahmasamedyam			GMF Total
	SC & ST	Others	Total	SC & ST	Others	Total	SC & ST	Others	Total	SC & ST	Others	Total	SC & ST	Others	Total	
1971	1,330 (18.3%)	5,943 (81.7%)	7,273	2,448 (18.3%)	10,910 (81.7%)	13,358	1,404 (24.3%)	4,369 (75.7%)	5,773	4,235 (46.0%)	4,973 (54.0%)	9,208	173 (2.8%)	5,953 (97.2%)	6,126	41,738
1981	1,364 (16.1%)	7,127 (83.9%)	8,491	2,807 (17.5%)	13,225 (84.5%)	16,032	1,161 (17.9%)	5,309 (82.1%)	6,470	5,142 (48.3%)	5,494 (51.7%)	10,636	151 (2.7%)	5,415 (97.3%)	5,566	47,195
1991	1,785 (16.4%)	9,090 (83.6%)	10,875	3,666 (18.5%)	16,174 (81.5%)	19,840	1,722 (19.9%)	6,947 (81.9%)	8,669	5,842 (48.0%)	6,333 (52.0%)	12,175	262 (3.8%)	6,660 (96.2%)	6,922	58,481
2001	1,892 (15.8%)	10,100 (84.2%)	11,992	3,894 (17.0%)	18,976 (83.0%)	22,870	1,670 (17.7%)	7,763 (82.3%)	9,433	6,208 (49.8%)	6,260 (50.2%)	12,468	118 (1.5%)	7,902 (98.5%)	8,020	64,783
2011	1,983 (15.9%)	10,512 (84.1%)	12,495	3,925 (16.0%)	20,625 (84.0%)	24,550	1,567 (17.0%)	7,658 (83.0%)	9,225	6,347 (51.1%)	6,076 (48.9%)	12,423	202 (2.4%)	8,296 (97.6%)	8,498	67,191

Table 3. Comparison of Population Growth Rates: Village-Wise, GMF as a Whole and EG Dt, 1971-2011

Village Names	Population								
	1971			2011			Growth Rate (%)		
	SC & ST	Others	Total	SC & ST	Others	Total	SC & ST	Others	Total
Coringa	1,330	5,943	7,273	1,983	10,512	12,495	49.1	76.9	71.8
Polekurru	2,448	10,910	13,358	3,925	20,625	24,550	60.3	89.0	83.8
Guttenadivi	1,404	4,369	5,773	1,567	7,658	9,225	11.6	75.3	59.8
Pallamkurru	4,235	4,973	9,208	6,347	6,076	12,423	49.9	22.2	34.9
Brahmasamedyam	173	5,953	6,126	202	8,296	8,498	16.8	39.4	38.7
GMF Total	9,590	32,148	41,738	14,024	53,167	67,191	46.2	65.4	61.0
EG dt. Total	6,36,818	24,50,444	30,87,262	11,58,464	39,95,832	51,54,296	81.9	63.1	67.0

The population growth rate has shown a mixed trend in GMF region as well as in EG Dt. For instance, the population in GMF region has grown by 13.1% between 1971 and 1981; but has shown a significantly higher growth of 23.8% in the next decade, 1981-1991 (Table 1). However, during the subsequent two census decades, the population growth in the region has decelerated to 10.9% and a mere 3.7% during 1991-2001 and 2001-2011, respectively. Although a similar initial increase and subsequent deceleration in the population rates were recorded at the district level, the relative growth rates were somewhat different when compared to GMF region. The initial increase between 1971 and 1981 was 19.9% in EG Dt, which was way higher than that of GMF region (Table 1). In the next decade, 1981-1991, both GMF and the district showed increased rates of growth. But in relative terms, GMF has shown a much higher growth rate from 13.1% to 23.8% against a marginal increase from 19.9% to 22.7% in the district. Similarly, the differences persisted in the deceleration rates as well between GMF and the district in the subsequent decades. The population growth rate in GMF region between 1991 and 2001 decelerated from 23.8% to 10.9%, whereas in the district, the deceleration was from 22.7% to as low as 7.9%. But during the next decade, 2001-2011, the rate of deceleration was from 10.9% to 3.7% in GMF region, which was much higher than in the district (Table 1).The relatively higher growth rate between 1981 and 1991 in GMF region than in the district as a whole was perhaps due to the severe deforestation of mangrove vegetation and development of commercial aquaculture in the region during the corresponding period (Kubo et al., 2018), which encouraged migration of labour force into the region. However, further instigation is needed to ascertain this phenomenon.

Population Trends: Village-Wise

The ratio of SC & ST population to that of the other communities has been very low at <20% in four out of the five revenue villages in GMF region with a minimum of 1.5% to 2.8% in Brahmasamedyam village (Table 2). Only in one village, Pallamkurru, the share of SC & ST population has been high at 46.0% as in 1971 and even increased to more than the half mark at 51.1% by 2011. Another significant observation from the data is the percent share of SC & ST population has consistently declined in four villages during 1971–2011, from 18.3% to 15.9% in Coringa, from 18.3% to 16.0% in Polekurru, from 24.3% to 17.0% in Guttenadivi and from 2.8% to 2.4% in Brahmasamedyam with some minor fluctuations in between. Understandably, the ratio of the combined population of all other communities (other than SC & ST) has shown an increasing trend at four out of the five villages with

Brahmasamedyam representing the highest of all at 97.2% in 1971 and 97.6% in 2011. In Pallamkurru, However, the percent share of the other communities declined from 54.0% in 1971 to 48.9% by 2011.

Overall Population Growth Rates: 1971–2011

Analysis of growth rates by comparing the population in 1971 with that in 2011 at the five revenue villages, and GMF as a whole as well as the EG Dt has shown variable trends. Among the five revenue villages, Polekurru has recorded the highest growth rate of its total population by 83.8% from 13358 in 1971 to 24550 by 2011 with 60.3% increase in SC & ST, and by 89.0% among other communities (Table 3). This has been closely followed by Coringa village, which showed 71.8% increase in its total population between 1971 and 2011, with 49.1% and 76.9% increase among SC & ST and other categories, respectively. While the lowest growth rate of 11.6% of SC & ST population was recorded in Guttenadivi, the lowest values of 22.2% for other categories and 34.9% for total population were in Pallamkurru revenue village. Polekurru and Coringa villages, which witnessed higher population growth rates, are close to the mega natural gas terminal built by Reliance Industries Limited during 2000s near the hamlet Gadimoga in the revenue village Polekurru just south of Coringa village. This perhaps has generated good employment opportunities for construction workers as well as operational staff and therefore encouraged large migrations into these villages leading to highest growth rate of population when compared to the other villages in the region. However, this phenomenon needs further field instigation. The data on the overall population growth rates between 1971 and 2011 showed a phenomenal 81.9% increase in SC & ST population in EG Dt against 46.2% growth in GMF region (Table 3). However, the increase of others categories population was relatively more at 65.4% in GMF region against 63.1% in EG Dt. However, propped up by the higher increase in SC & ST population, the growth rate of the total population was also higher at 67.0% in EG Dt, when compared to 61.0% in GMF region. This indicates an overall outmigration, or a low rate of increase in SC & ST population of GMF region, when compared to that of EG Dt, probably reflecting the limited livelihood options of the mangrove environment.

Conclusion

This preliminary study of decadal trends in population revealed that GMF region, with its characteristic low economic potential and harsh living environment, is sparsely populated in more or less isolated settlements, most of which are located either surrounded by dense mangrove forest or along the coastal edge. A significant jump in the SC & ST population in GMF region during 1981-1991 probably reflects improved employment opportunities in the burgeoned commercial aquaculture sector within the region. The phenomenal increase in the percent growth of all categories of population, especially in Coringa and Polekurru villages indicated the possible improved employment opportunities in the mega industry that has come up there. The overall lower growth rate of SC & ST population in GMF region when compared to that of EG Dt probably reflects emigration

from the low economic environment in the hazard prone GMF region. However, detailed field investigations, which are underway in the region, throw more light on the drivers of the population trends in GMF region.

Acknowledgements

The first author Prof. B. Hema Malini is grateful to Indian Council of Social Science Research (ICSSR), New Delhi for the award of Senior Fellowship (F.No.2-16/2018/19/SF/Gen), which enabled pursuance of this research.

References

1. Ahmad, H. (2019) Bangladesh coastal zone management status and future. Journal of Coast Zone Management, Vol. 22:1. doi:10.24105/2473-3350.22.466.
2. Feller, I.C., Friess, D.A., Krauss, K.W. and Lewis III, R.R. (2017). The state of the world's mangroves in the 21st century under climate change. Hydrobiologia, Vol. 803:1–12, DOI 10.1007/s10750-017-3331-z.
3. Kubo, S., Nagakumar, K.Ch.V., Demudu, G., Hema Malini, B., Nageswara Rao, K., Agrawal, R., Ramakrishnan, R. and Rajawat, A.S. (2018). Monitoring of eco-restoration of mangroves through time series satellite images: a study on Krishna–Godavari deltas, East coast of India. Geographical Review of Japan Series B, Vol. 90(2): 66–75.
4. Kumar, K.Ch.V.N, Demudu, G., Dinesan, V.P., Gopinath, G., Deepak, P.M., Lakshmanadinesh, K., Nageswara Rao, K. (2019). Erosional responses of eastern and western coastal regions of India, under global, regional, and local scale causes. In: Ramkumar, M., James, R.A., Menier, D., Kumaraswamy, K. (Eds), Coastal Zone Management, UK: Elsevier, 155-179.
5. Luther, D.A., and Greenberg, R. (2009). Mangrove: a global perspective on the evolution and conservation of their terrestrial Vertebrates. Bioscience, Vol. 59: 602-612.
6. Rao, N.K. (2018). Coastal wetland dwellers: aspirational communities in 'forward' districts. Proceedings of National Seminar on Transformation of Backward Areas: Issues, Challenges and Strategies, Panjab University, Chandigarh.
7. Rao, N.K. and Prasad, T. (1979). Effect of landforms on the pattern, size and spacing of rural settlements in the Krishna Delta, India. The Indian Geographical Journal, Vol. 54 (1): 31–39.
8. Rao, N.K., Sadakata, N., Hema Malini, B. and Takayasu, K. (2005). Sedimentation processes and asymmetric development of the Godavari deltas, India. In: Gioson, L. and Bhattacharya, J.P. (Eds.), River Deltas—Concepts, Models and Examples, Special Publication No. 83 SEPM, 435–451.
9. Seary, R., Spencer, T., Bithell, M. and McOwen, C. (2020). Measuring mangrove-fishery benefits in the Peam Krasaop fishing community, Cambodia. Estuarine, Coastal and Shelf Science, 106918.
10. Sui, L., Wang, J., Yang, X. and Wang, Z. (2020). Spatial-Temporal Characteristics of Coastline Changes in Indonesia from 1990 to 2018. Sustainability, Vol. 12: 3242.

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 95-110
ISSN 0019-4824

COMPOSITE INDICATORS IN EVALUATING THE PATTERNS OF REGIONAL DEVELOPMENT IN KONGU UPLANDS, TAMIL NADU, INDIA

Jasim H.R. and Kumaraswamy K.

Department of Geography, Bharathidasan University, Tiruchirappalli - 620 024
E-mail: jasimhr2013@gmail.com, kkumargeo@gmail.com

Abstract

Patterns of regional development is not a unidirectional or unstick affair, but it has various dimensions such as demographic, social, infrastructural, agricultural, industrial, educational, political and so on. The main objective of this paper is to study patterns of regional development in Kongu Uplands, Tamil Nadu and to identify the fundamental geographical elements of these patterns. The United Nation Development Programme (UNDP) standard statistical development index assessment is adopted for estimating and computing the patterns of regional development in Kongu Uplands. The block level data have been collected from Census Hand Book, Economic and Statistical Hand Book, Planning Commission of Tamil Nadu, G-Return data etc. There is high development in the aspect of demographic development with 0.628 index score. This is followed by human development with 0.626, industrial with 0.601, infrastructural development of 0.591 and agriculture of 0.503 index scores respectively. The correlation result of the study area is highlighting the positive and moderate (0.63) relationship between each dimension under investigation and overall development. Overall, Kongu Uplands fall under the category of moderate development in terms of regional development. So, Kongu Uplands needs proper planning and management for attaining balanced development in all dimensions.

Keywords: Regional development, UNDP, G- Return, Correlation, Kongu Uplands

Introduction

The study of regional development has been a major research aspect in regional geography, particularly after 1950. Studies on regional development are mostly related to identifying the levels of developments among the villages, blocks, taluks, districts, states and nations and ascertaining the disparities between them. Usually the disparities within the smaller areas are much greater than larger areas. Regional disparities in the levels of development have become a major concern for any type of spatial planning development. This is a multi-dimensional concept which is controlled by a number of factors observed in an area. Nowadays the focus theme of research and planning are connected to demographic, social, agricultural and infrastructural upliftment of the rural and urban zones.

The modes of development like planning, industrialisation, rapid development of transportation and communication, development of banks, improvement of different types of educational institutions, health facilities and other amenities are the major elements that contributes in the regional development. Nevertheless, in real practices these infrastructural services may not be available in a uniform distribution pattern in a region. As a result, regional disparities do occur in a given time and space (Nagaraj and Murthy, 2007).

There are enough evidences to support that regional disparities are highly alarming and increasing in majority of the developing countries. Regional disparities in income and human capital are often source of conflict and dissatisfaction in federal system. Therefore, when development in different areas occur unequally, it becomes politically very important to resort to corrective policy measures (Singh and Chauhan, 2011). The unrestricted and uncontrolled process of growth leads to the imbalance in the economic, social, demographic and cultural sectors of a region. Inequalities in the regional development is due to the over, under or non-utilisation of physical and cultural resources. The elimination of imbalances in the regional development is crucial from the point of integrating national security and political stabilities. If the disparities in terms of development are denied again and again, these disparities may pose a threat to the existence of a region. Overall, Kongu Uplands fall under the category of moderate development in terms of regional development. So, Kongu Uplands needs proper planning and management for attaining balanced development in all dimensions.

Study Area

Kongu Uplands geographically lies between $10^0$10' - $12^0$10' North and $76^0$40' - $78^0$25' East, which covers an area of 26,000 sq. km. which is almost one fifth of the total geographical area of Tamil Nadu. The Uplands is drained by the river systems of Cauvery and its tributaries of Bhavani, Noyyal and Amaravati. More than 70 percent of the Uplands are meant to agriculture especially in its central plain regions. The people in this region earn a considerable share of their livelihood through agricultural and industrial activities. Administratively, the western boundary of the study area shares its boundary with state of Kerala. The region comprises of eight Districts viz. Coimbatore, Tiruppur, Erode, Karur, Salem, Namakkal, Tiruchirappalli and Dindigul. The districts of Coimbatore, Tiruppur and Erode completely covers in the study area while Karur, Salem, Tiruchirappalli, Dindigul and Namakkal shares only a small portion of the study area. There are 37 taluks and 81 blocks that falls in the Kongu Uplands.

Database and Methodology

The study explores the data on various demographic, social and economic variables, human resource development, agricultural, industrial and infrastructural sectors. Blocks have been taken as the unit of study. The Survey of India toposheets within in the scale of 1:2,50,000, block level maps from state government and Census Hand Book are utilised to demarcate the physical and block boundary of the study area.

The geology and geomorphology of the area and its surroundings are analysed through maps and report of Geological Survey of India (GSI) and LISS III Satellite Image. Block wise information on population, population attributes, land use, irrigation, cropping pattern, agricultural labours, birth rate and death rate are collected from Census Hand Book, Agricultural Offices (G-Return data) of concerns districts and planning Commission of Tamil Nadu.

Infrastructural, health, education and industrial related data are gathered from Deputy Directorate of Health and Sarva Shiksha Abhiyan (SSA) (2011-2014), Census Hand Book and Report (2001 and 2011), Economic and Statistical Hand Book (2014-2015), State Planning Commission of Tamil Nadu Report (2003 and 2016-2017), various industrial survey reports and UNDP annual Report. Based on the information collected, GIS software is used to prepare thematic spatial information for evolving appropriate development strategies and planning for the study area.

Sums of sixty indicators are considered in assessing the overall development. The United Nation Development Programme (UNDP) methods are adopted for computing and analysing the composite indices of the study. The spread sheet is used for computing the correlation analysis of checking the effect and relation of obtained results. ArcGIS 10.1 environment is used for preparing and analysing the various thematic maps related to regional development.

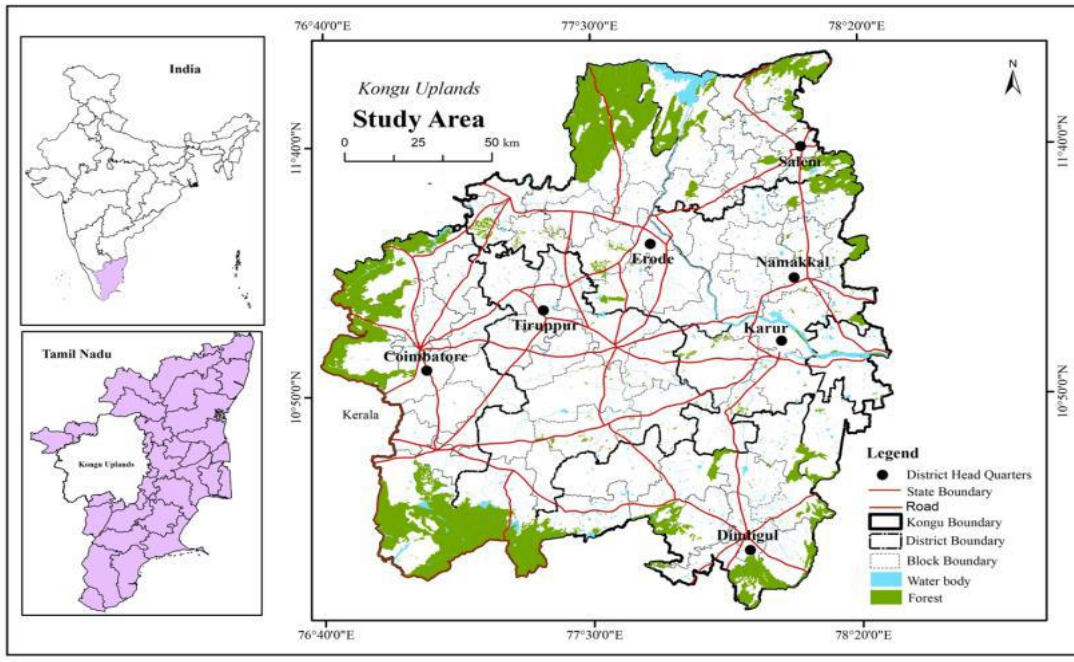


Fig. 1. Study Area - Kongu Uplands

Indicators of Regional Development

The following indicators are considered to examine the regional development of Kongu Uplands. All these indicators are selected based on case studies of national and international development agencies.

Table 1. Indicators of Regional Development

Demographic Development	Human Resource Development	Agricultural Development	Industrial Development	Infrastructural Development
Population Distribution	Standard of Living	Percentage of Cultivators	Location Quotient of Industry	Education Facilities
Population Growth	Health	Percentage of Agricultural Labours	Industrial Intensity Rating	Availability of Cooking Fuel
Crude Birth Rate	Education Development	Number of Agricultural Labours	Total Industrial Workers	Drinking Water
Crude Death Rate	Gender Empowerment	Percentage of Cultivable Area to Total Area	Percentage of Industrial	Toilet Facility
Density of Population	Labour Market	Irrigated Area to Total Cultivable Area	Industrial Workers to Main Workers	Electricity
Literacy Rate	Happiness Index	Net Area Zone	Industrial Workers to Total Workers	Pucca House
Sex Ratio	Child Development	Number of Agricultural Marketing	Industrial Power Supply	Pucca Road
Juvenile Sex Ratio	Multi-Dimensional Poverty	Rural Population		Total Road Length
Occupational Structure	Net Area Cultivated		Post offices	
	Gross area Cultivated			
	Agricultural Credit Society			
	Crop Intensity			
	Gross Irrigated Area			
	Irrigation Intensity			
	Irrigated area			
	Irrigated Area			
	Unirrigated Area			

Results and Discussions

The procedure of regional development has been analysed through sixty variables categorised into following headings:

1. Demographic Development
2. Human Development
3. Agricultural Development
4. Industrial Development and
5. Infrastructural Development

All these indicators directly or indirectly depict the various phases of socio-economic and human development. An entire picture of these appropriately chosen variables is extracted by the computation of the composite index. The composite indices for the five spheres of development indicators and overall development index of regional development are obtained for analysing the pattern of regional development in Kongu Uplands. The pattern of regional development for the variables is discussed, after that overall development is described.

Patterns of Demographic Development

The level of demographic development is not evenly distributed throughout the study area. It has been already mentioned that the demographic process and patterns of regional development are undividable from each other. The pattern of demographic development is assessed with the help of nine indicators. These indicators include population distribution, crude birth rate, crude death rate, density of population, literacy rate, male, female literacy rate, sex ratio, occupational structure and juvenile sex ratio. High development in terms of demography is concentrated in 39 blocks of the Uplands region. The major portion of high demographic development is found in the entire portion of the western and southwestern parts of the study area. The high-level development is also focused on the southeastern portion of the study area. Finally, high level development trend is found in isolated blocks of the central and eastern parts of the study area. The high development in this region is due to the high literacy rate, favourable sex ratio to female population, low birth and death rate, high occupation structure and so on. The moderate development of demographic pattern is found in the northeastern blocks of the Ammapet, Kolathur, Mecheri, Kadayampatti, Omalur, Veerapandi, Panamarathuppatti, Mc. Donald Choultry, Ammapet, Rasipuram etc. This is followed by the central blocks of the Uplands such as Kangeyam, Pongalur, Palladam, Modakkurichi, Chennimalai, Avinashi, Kundadam, Mulanur etc. Some blocks of north, east and southeastern parts of the study area also exhibits the same pattern of development. Low category includes five blocks only. It contributes seven percentage of total demographic development in this area. It consists of Kadavur, Nambiyur, Tharamangalam, Anthiyurand Konganapuram.

The Konganapuram is the least developed block with an index value of 0.371. It can be noticed in the two blocks in the north, two blocks in the northeast and one block in southeast.

Table 2. Levels of Demographic Development

Category	Percentage of Area Covered	Index Score	Block Name
High	48	> 0.500	Pollachi, North, Palani, Dindigul, Sarkasamakulam, Palani, Karamadai, Sulur, Perianickanpalayam, Pollachi South, Salem, Madukkarai, Athoor, Vedasandur, Athoor, Vedasandur, Athoor, Vedasandur, Reddiarchattiram, Thondamuthur, Veerapandi, Erumaipatti, Dharapuram, Kinathukadavu, Udumalpet, Sulthanpett, Vellakoil, Namakkal, Mohanur, Shanarpatti, Kodumudi, Uthukuli, Omalur, Erode, Perundurai, Tirupur, Thoockanickanpalayam, Aravarakurichi, K. Paramathi, Madathukulam, Elaichipalayam, Sankari, Karur, Annur, Thoppampatti, Paramathi, Gundimangalam
Moderate	45	0.400-0.500	Modakkurichi, Mecheri, Tiruchengode, Mulanur, Panamarathuppatti, Kadayampatti, Ottanchittram, Guziliamparai, Rasipuram, Vadamadurai, Avinashi, Chennimalai, Thottiam, Thanthoni, Vennathur, Sathyamangalam, Kolathur, Nangavalli, Gobichettipalayam, Kangeyam, Kabilarmalai, Palladam, Bhavani, Pallipalayam, Mc. Donald Choultry, Pallipalayam, Puduchatram, Senthamangalam, Kundadam, Pongalur, Idappady, Bhavani, Krishnanarayapuram, Mallasamudram, Ammapett
Low	7	< 0.400	Kadavur, Nambiyur, Tharamangalam, Anthiyur, Konganapuram, Anaimalai

Patterns of Human Development

The level of human development is also not evenly distributed throughout the study area. It is an attempt to identify with the help of eight major dimensions of human development. Assessment parameters are standard of living, health, education, labour index, gender empowerment, happiness index etc. Overall, the Kongu Uplands experiences high human development index with the index value of 0.626. High development in terms of human development is concentrated in 59 blocks of the Uplands regions. The major portion of high human development is found in the north, northeast and northwest of the study area. The high-level development is also concentrated on the south, southeastern and southwestern portions of the study area. Finally, high-level development trend is found in isolated blocks of the central Uplands and central eastern parts of the Uplands regions. The moderate development of demographic patterns is found in the north blocks of the Erode, Bhavani, Gobichettipalayam, Nambiyur, Avinashi, Uthukuli, Panamarathuppatti, Thoockanickanpalayam etc. This is followed by the central blocks of the Uplands such as Vellakoil, Pongalur, Gundimangalam, Chennimalai, Dharapuram, Kundadam and Mulanur.

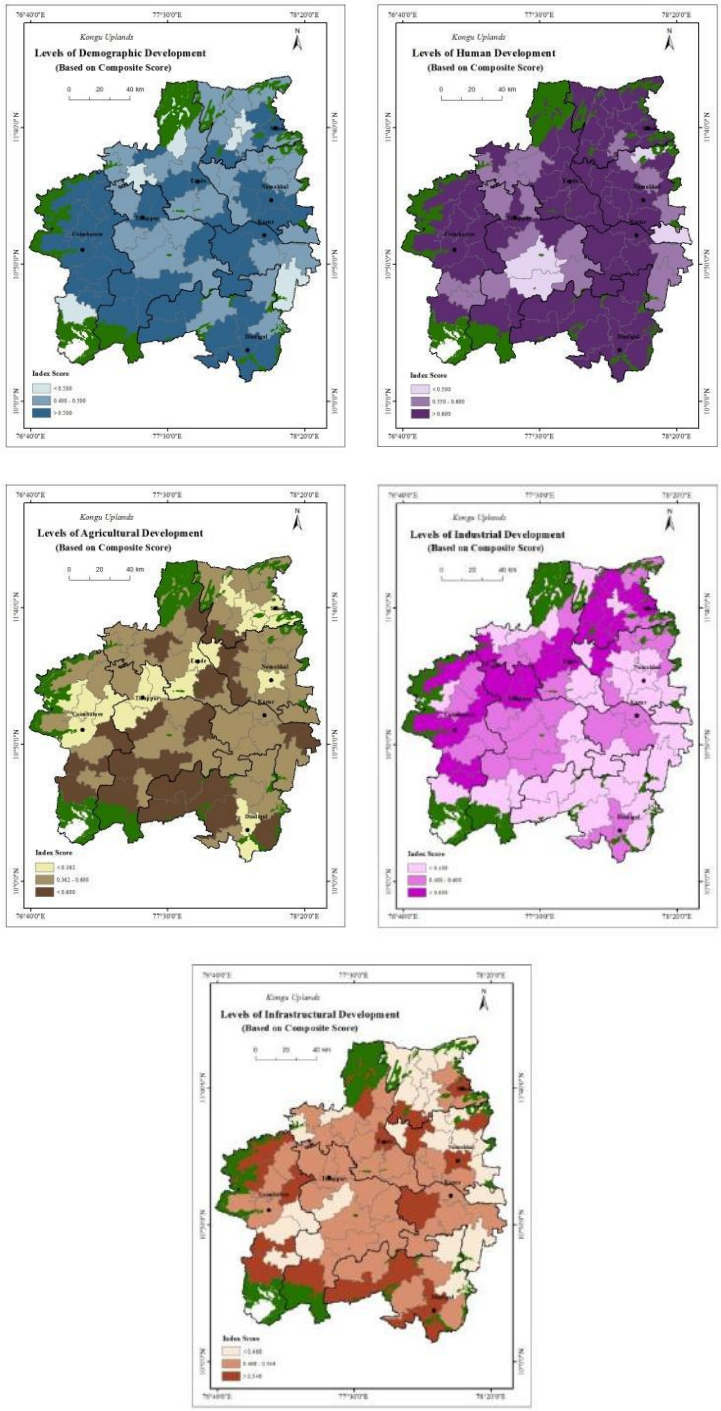


Figure 2. Various Dimensions of Regional Development

The next category of moderate development is found in the northeastern blocks of the Vennathur, Mallasamudram, Veerapandi, Puduchatram and Mc. Donald Choultry. The last group of moderate development is concentrated in the area of southeast which consist of Krishnanarayapuram and Kadavur blocks of the Karur district. Thottiam block in western part of the Tiruchirappalli district comes under the bottom level of development with an index value of 0.414. Some isolated areas of south central and northeastern portions also come under this group. The pattern of low development in this area is because of low performances of high infant mortality rate, low sex ratio, high density of population, low gender empowerment index, low amount of agricultural wages especially in women participants, less access in education development and so on.

Table 3. Levels of Human Development

Category	Percentage of Area Covered	Index Score	Block Name
High	73	> 0.600	Dindigul, Kolathur, Perianickanpalayam, Salem, Nangavalli, Sulur, Vedasandur, Paramathi, Karamadai, Reddiarchattiram, Palani, Idappady, Athoor, Veerapandi, Sarkasamakulam, Madukkarai, Namakkal, Kabilarmalai, Erode, Tiruchengode, Rasipuram, Kodumudi, Mecheri, Ottanchittram, Guziliamparai, Karur, Annur, Pallipalayam, Perundurai, Sankari, Shanarpatti, Kadayampatti, Tharamangalam, Sathyamangalam, K. Paramathi, Elaichipalayam, Modakkurichi, Bhavani, Kinathukadavu, Chennimalai, Thondamuthur, Sulthanpett, Udumalpet, Omalur, Aravarakurichi, Palladam, Thanthoni, Mohanur, Vadamadurai, Senthamangalam, Thoppampatti, Panamarathuppatti, Ammapet, Anaimalai, Kangeyam, Tirupur, Anthiyur, Madathukulam, Konganapuram
Moderate	23	0.550-0.600	Thoockanickanpalayam, Pollachi North, Mallasamudram, Pongalur, Erumaipatti, Gobichettipalayam, Puduchatram, Avinashi, Nambiyur, Pollachi South, Mc. Donald Choultry, Uthukuli, Bhavanisagar, Mulanur, Vellakoil, Krishnanarayapuram, Gundimangalam, Kadavur
Low	4	< 0.550	Dharapuram, Vennathur, Kundadam, Thottiam

Patterns of Agricultural Development

The agricultural development in the Kongu Upland is moderate with index value of 0.503. A pattern of high agricultural development is found in the 21 blocks of the Uplands of Tamil Nadu. The high development is concentrated in the south and south western portions of the Uplands that extended from Pongalur block in the north to Anaimalai block in the southwest and Reddiachitram in the southeast. Besides this, agriculture is highly developed in the north, central and east which is extended from Anthiyur in the north to Krishnanarayapuram in the east and western limits of this category is Gobichettipalayam.

The major portion of the moderate development in terms of agriculture is found in the central to south eastern portions. This category extended from Kangeyam in the northwest to Vennathur in the southeast. Second category is focused on the near northeastern parts of the study area. The third category of moderate development is found in the extreme north and northeastern area which includes Kolathur, Mecheri, Kadayampatti, Idappady and Konganapuram. The next category consists of north, northeast and the western portion of the study area. The moderate agricultural development is due to the intermediate availability of agriculture developmental infrastructure. The pattern of low development of agriculture consists of 16 blocks of the study area. The composite value of this category ranges below 0.400. It shares an account of 19 percent of total geographical area of Uplands. The least development is found in the Tirupur and Salem blocks of the Uplands.

Table 4. Levels of Agricultural Development

Category	Percentage of Area Covered	Index Score	Block Name
High	27	> 0.600	Udumalpet, Anaimalai, Gundimangalam, Ammapett, Avinashi, Thoppampatti, Erumaipatti, Omalur, Palani, Vedasandur, Pollachi North, Krishnanarayapuram, Nangavalli, Gobichettipalayam, Ottanchittram, Shanarpatti, Vellakoil, Anthiyur, Reddiarchattiram, Dharapuram, Sulthanpett, Sulur
Moderate	54	0.362-0.600	Puduchatram, Mc. Donald Choultry, Pongalur, Modakkurichi, Kadavur, Sankari, Thottiam, Rasipuram, Tiruchangode, Madathukulam, Mecheri, Nambiyur, Paramathi, Karamadai, Kabilarmalai, Kundadam, Konganapuram, Vennathur, Thoockanickanpalayam, Kinathukadavu, Kolathur, Vadamadurai, Aravarakurichi, Pollachi South, K. Paramathi, Mohanur, Bhavani, Karur, Annur, Idappady, Kadayampatti, Kodumudi, Thondamuthur, Sathyamangalam, Mallasamudram, Perundurai, Elaichipalayam, Athoor, Bhavanisagar, Guziliamparai, Senthamangalam, Palladam, Tharamangalam
Low	19	< 0.362	Dindigul, Mulanur, Kangeyam, Salem, Sarkasamakulam, Thanthoni, Chennimalai, Madukkarai, Erode, Tirupur, Pallipalayam, Dindigul, Perianickanpalayam, Panamarathuppatti, Namakkal, Veerapandi

Patterns of Industrial Development

Industrial development is the important dimension of assessing the overall development of patterns of regional development in the study area. Regional development in terms of industrial structure is examined based on eight variables. This consist of industrial workers, percentage of industrial workers, percentage of industrial workers to total population, percentage of industrial workers to main workers, location quotient, industrial intensity rating and availability of power supply for industries.

The blocks having high levels of industrial development (above 0.600) is found in the isolated areas of the study region. It is found in the pocket's areas of northeast, central and western areas of the Uplands. It includes the blocks of Salem, Tirupur, Erode, Nangavalli, Omalur, Mecheri etc. Moderate levels of industrial development (0.400 – 0.600) is observed in 41 blocks of the Uplands. It has been observed in major areas of central, western central, some isolated areas of south, southeast, north, northeast and northwest. The block characterised by low levels of industrial development are found in the 17 percent of total areas of the Uplands regions. The index value of this region is below 0.400. It is mainly found in the eastern, southeastern, south, southwest, west and northern portions. This distribution is not continuous. Kadavur and Kolathur stand at low position in terms of industrial development with index value of 0.031 and 0.010.

Table 5. Levels of Industrial Development

Category	Percentage of Area Covered	Index Score	Block Name
High	30	> 0.600	Salem, Erode, Mc. Donald Choultry, Sankari, Sulur, Bhavanisagar, Idappady, Tirupur, Mecheri, Bhavani, Omalur, Aravarakurichi, Shanarpatti, Mallasamudram, Uthukuli, Puduchatram, Nangavalli, Madukkarai, Thondamuthur, Pallipalayam, Namakkal, Thanthoni, Modakkurichi
Moderate	53	0.400-0. 600	Pollachi North, Pollachi South, Rasipuram, Tiruchangode, Vennathur, Athoor, Kinathukadavu, K. Paramathi, Avinashi, Annur, Konganapuram, Panamarathuppatti, Kodumudi, Vedasandur, Dindigul, Karur, Kundadam, Paramathi, Perundurai, Senthamangalam, Sulthanpett, Kadayampatti, Kangeyam, Palladam, Kabilarmalai, Veerapandi, Sarkasamakulam, Chennimalai, Nambiyur, Gundimangalam, Pongalur, Gobichettipalayam, Karamadai, MohanurAmmapett, Elaichipalayam, Palani, Thoppampatti, Anaimalai, Erumaipatti, Sathyamangalam, Perianickanpalayam
Low	17	< 0.400	Kolathur, Kadavur, Reddiarchattiram, Udumalpet, Ottanchittram, Tharamangalam, Thottiam, Guziliamparai, Vadamadurai, Vellakoil, Anthiyur, Mulanur, Madathukulam, Thoockanickanpalayam, Krishnanarayapuram

Patterns of Infrastructural Development

Types and pattern of infrastructural amenities are the pre-condition to all types of development, especially social and economic development, whether agriculture or manufacturing or services. The rate of development may be motivated by the stipulation of high-quality infrastructural services. It is an endeavour to examine the overall development in terms of infrastructural development in Kongu Uplands. The level of this development is unevenly distributed in space. The level of infrastructural development in the study area has been calculated by using the eight indicators. These are proportion of cooking fuel facilities, toilet facilities, drinking water facilities, availability of electricity, percentage of pucca house, total road length, number of post offices and educational facilities. The overall Kongu Uplands infrastructural development is moderate with index value of 0.591.

The high infrastructural development is focused on south, southeast, southwest, west, north, northwest and some isolated blocks of the northeast. The moderate infrastructural development observed in 37 blocks mostly which falls under the range of 0.468 to 0.546. It shares 46 percent of total infrastructural development. Moderate development is seen in central, south, north, northwest and isolated sections of northeastern etc. The Thottiam is the least block in terms of infrastructural development with the index value of 0.366. The isolated area of northwest, northeast, southeast some central, southwest and eastern portions of the study area is depicting low developments in terms of infrastructural facility. The low infrastructural development is because of less percentage of toilet facility, cooking fuel facility, drinking water service, etc. are responsible for this condition.

Table 6. Levels of Infrastructural Development

Category	Percentage of Area Covered	Index Score	Block Name
High	25	> 0.546	Ottanchittram, Salem, Sulur, Dindigul, Namakkal, Perianickanpalayam, Athoor, K. Paramathi, Erode, Karamadai, Anaimalai, Udumalpet, Anthiyur, Pollachi North, Sankari, Tiruchangode, Palani, Rasipuram, Bhavani,
Moderate	46	0.468-0.546	Modakkurichi, Reddiarchattiram, Krishnanarayapuram, Kodumudi, Thoppampatti, Madukkarai, Paramathi, Sathyamangalam, Avinashi, Tirupur, Madathukulam, Avinashi, Karur, Mulanur, Chennimalai, Gobichettipalayam, Thondamuthur, Aravarakurichi, Shanarpatti, Uthukuli, Kundadam, Vedasandur, Perundurai, Mohanur, Kangeyam, Annur, Kabilarmalai, Omalur, Panamarathuppatti, Dharapuram, Thanthoni, Nambiyur, Ammapet, Vellakoil, Palladam, Sarkasamakulam, Veerapandi, Thoockanickanpalayam
Low	29	< 0.468	Vadamadurai, Pallipalayam, Kadavur, Mecheri, Puduchatram, Kinathukadavu, Erumaipatti, Guziliamparai, Pollachi South, Mac. Donald Choultry, Konganapuram, Vennathur, Sulthanpett, Elaichipalayam, Kadayampatti, Pongalur, Gundimangalam, Tharamangalam, Kolathur, Mallasamudram, Nangavalli, Senthamangalam, Bhavanisagar, IdappadyThottiam

Overall Development

The score of overall development is acquired from aggregating the composite scores of all the five sets of indicators viz. demography, human development, agriculture, industry and infrastructure. This assessment based on 58 variables grouped into above said five major classes. The analysis clearly shows that there is disparity in the levels of regional development. It explicitly shows that the blocks or regions are better developed with agriculture and the other infrastructural services are sufficiently available. In some block, human development is high and demographically developed.

There is high development in the dimension of demographic development with index score of 0.628. This is followed by human development with 0.626, industrial development with 0.601, infrastructure with 0.591 and agriculture with 0.503. In overall, Kongu Uplands fall under the category of moderate development in terms of regional development with index value of 0.570. The overall development is classified into the following groups and briefly discussed here.The table shows that 27 blocks of the Uplands with composite index score more than 0.593 are categorised as having area of high development in the levels of regional pattern. It accounts only 33 percent. Blocks belonging to this category are namely, Salem, Sankari, Sulur, Erode, Udumalpet, Pollachi North and Palani. The Salem block stands at top position in term of overall development. The high regional development is concentrated in the northeast, central and southwest which extended from Salem to Sarkasamakulam blocks in the study area. Some isolated blocks of east, southeast and southern blocks also come under this category. The high development in this area coincides with human development, demography and industrial development.

The second category of development i.e. moderate category consists of 40 blocks of the Uplands regions. The overall 50 percent of the total geographical area is covered by the moderate regional development. It shows that the major portion of the study area come under this category. It is concentrated in the blocks of the central Uplands region except Palladam. The next area is north, majority blocks of the northeast, east, southeast and western parts of the study area. The moderate development is due to the medium developments in the dimension of the demography, human development, agriculture, industry and infrastructure.

Table 7. Levels of Overall Development

Category	Percentage of Area Covered	Index Score	Block Name
High	33	> 0.593	Sulur, Salem, Sankari, Erode, Udumalpet, Pollachi North, Dindigul, Palani, Shanarpatti, Madukkarai, Palani, Gundimangalam, Omalur, Thoppampatti, Karamadai, Vedasandur, K. Paramathi, Tirupur, Karur, Ottanchittram, Nangavalli, Mc. Donald Choultry, Athoor, Namakkal, Ammapett, Reddiarchattiram, Annur, Mecheri, Anaimalai, Avinashi, Sarkasamakulam
Moderate	50	0.508-0.593	Anthiyur, Pollachi South, Sulthanpett, Bhavani, Perianickanpalayam, Vellakoil, Modakkurichi, Tiruchangode, Kodumudi, Perundurai, Puduchatram, Aravarakurichi, Erumaipatti, Gobichettipalayam, Idappady, Paramathi, Thondamuthur, Dharapuram, Elaichipalayam, Thondamuthur, Uthukuli, Kinathukadavu, Veerapandi, Bhavanisagar, Kabilarmalai, Madathukulam, Pallipalayam, Guziliamparai, Mohanur, Nambiyur, Pongalur, Mallasamudram, Thanthoni, Thoockanickanpalayam, Kadayampatti
Low	17	< 0.508	Krishnanarayapuram, Vennathur, Kundadam, Chennimalai, Kangeyam, Palladam, Sathyamangalam, Konganapuram, Kolathur, Panamarathuppatti, Kadavur, Senthamangalam, Vadamadurai, Mulanur, Anaimalai, Tharamangalam, Thottiam

A low level of regional development in the Kongu Uplands is represented by composite index score less than 0.450 in 14 blocks. It shares 17 percent of overall regional development in the study area. This consists of Tharamangalam, Mulanur, Kadavur, Mc. Donald Choultry, Senthamangalam, Bhavanisagar, Thottiam etc. The bottom development in terms of regional pattern is found in Thottiam block with the index value of 0.430. Low development is observed in the isolated areas of north, northwest, east, southeast, southwest and some central areas of the study area. This low level of regional development is due to the low performances of demographic development, human development, agricultural development, industrial and infrastructural development. As a whole, Kongu Uplands experience moderate level of regional development with index score of 0.570.

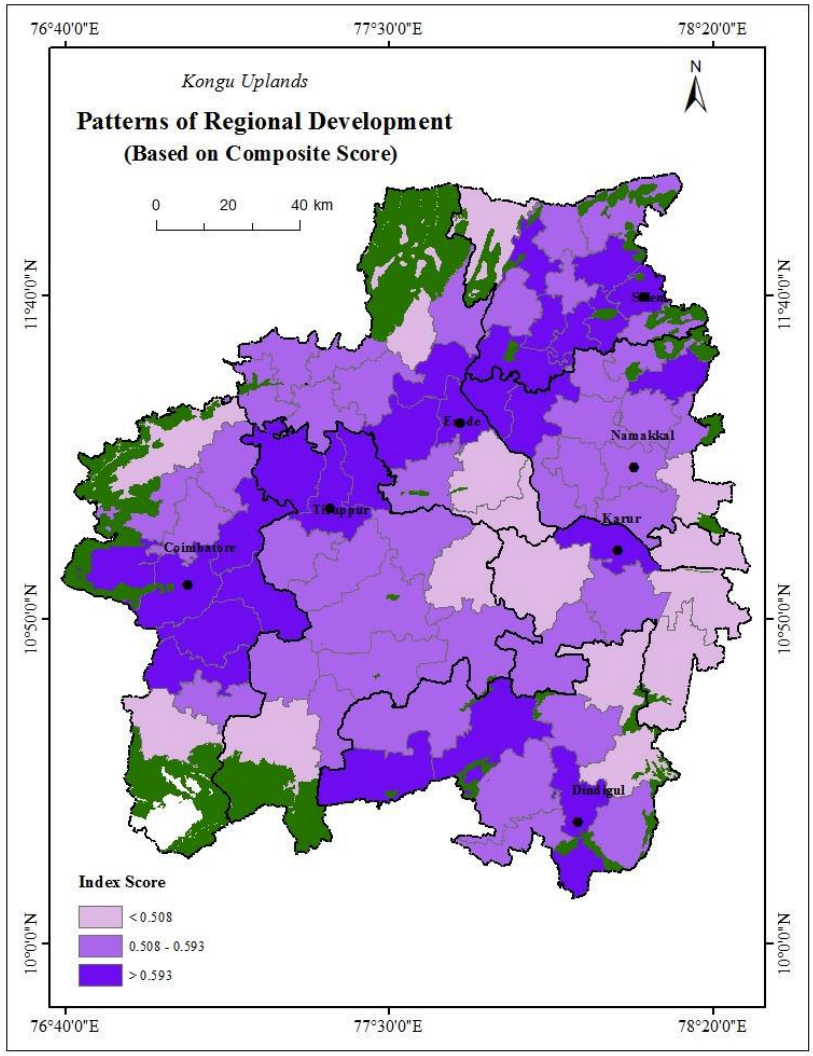


Fig. 3. Patterns of Regional Development

Correlation Analysis

Correlation analysis may be defined as the relationship between two variables either in terms of positives or negatives. This analysis shows the strength and weakness of variables associated with another variables. For this present study, five independent variables and one dependent variable have been chosen. The independent variables include demographic development, human development, agricultural development, industrial and infrastructural development. The dependent variable is overall development of the study area. However, it is required to perceive how these five independent variables are correlated with the overall regional development of the Kongu Uplands. Excel sheet is used to examine and derive the result on the Spearman's rank correlation. The range of correlation lies between positive one to negative one. The correlation analysis gives an idea about the degree, direction and trends of the variables.

The correlation between demographic development and overall development score is 0.65. This clearly shows that there is a strong relation between demographic and overall development in the study area. The relation is also positive in nature. This shows that there is a tendency for increasing overall development along with demographic development. The table 8.7 shows correlation ranks of different dimensions. This dimension is highly influenced on the overall development of the study area. The correlation between human development and overall development rank value is 0.46. This value reveals that there is positive relation between independent and dependent variables to determine the overall development. This relationship is also, positive but weak. There is a trend to move overall development in the direction towards the human development. There is an increasing trend in these two indicators which affect the overall development in the Kongu Uplands. The correlation between agricultural development and overall development is weak. The rank values of these two variables are 0.37. This also indicates that there is a tendency to move in the same direction; increasing the agricultural development leads to the improvement in overall development. The correlation between industrial development and overall development is also weak. The rank values of these two variables are 0.46. This also indicates that there is a tendency to move in a same direction; increasing the agricultural development leads to the increase in overall development. The rank correlation of the infrastructure and overall development state there is a moderate and positive correlation between these two variables. The rank score is 0.63. In overall, the study area is highlighting the positive and moderate (0.63) relationship between demographic, human, agricultural, industrial, infrastructural development and overall regional development.

Table 8. Rank Correlation of Various Dimension of Regional Development

Dimensions	Spearman's Rank Correlation	Remark
Demographic Development	0.65	Positive and Moderate
Human Development	0.46	Positive and Weak
Agricultural Development	0.37	Positive and Weak
Industrial Development	0.46	Positive and Weak
Infrastructural Development	0.63	Positive and moderate

Overall Performance of Various Dimensions of Development

The Table 9 shows the overall development of the study area and the performance of each domain such as demographic, human development, agriculture, industrial and infrastructural development. Each domain exhibits different magnitudes of development which depends on designated variables under the investigation. Demographic domain is the most influencing on overall development with index value of 0.628. This is followed by human development domain, industrial domain, infrastructural domain and agricultural domain with index values of 0.626, 0.601, 0.591 and 503 respectively.

Table 9. Overall Performances of Various Dimensions of Development

Category	Index Score	Rank	Remark
Demographic Development	0.628	1	H
Human Development	0.626	2	H
Industrial Development	0.601	3	H
Infrastructural Development	0.591	4	M
Agricultural Development	0.503	5	M
Overall Development	0.570		M

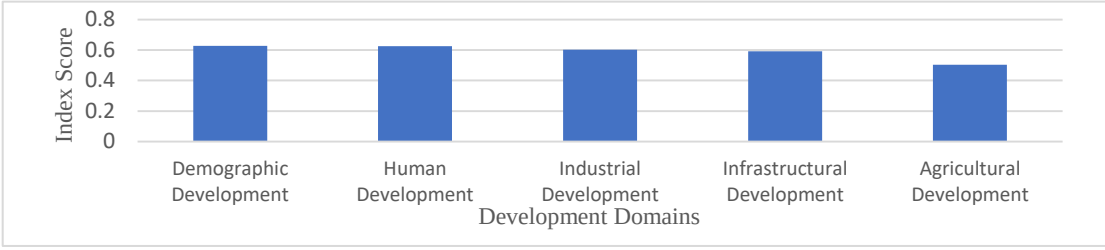


Fig. 4. Overall Performances of Various Dimensions of Development

The high development is noticed in the demographic, human and industrial dimensions with a negligible change. Infrastructure and agriculture comes under the moderate development domains. In overall, Kongu Upland display moderate patterns of regional development with index score of 0.570.

Conclusion

Regional development is not a static concept. The word development denotes the progression of varying in a positive way or towards betterment. So, an analysis of spatial variations in the patterns of regional development is highly significant. There is high development in the aspect of demographic development with 0.628 index score. This is followed by human development with 0.626, industrial with 0.601, infrastructural development of 0.591 and agriculture of 0.503 index scores respectively. The outcome of the research also exhibits that blocks or regions of agriculture are better developed, in others the infrastructure is sufficiently available and some areas marked high in human development and other areas are industrially and demographically developed.

The composite effect of all these dimensions leads to the degree and magnitudes of overall patterns of regional development of the study area. The correlation result of the study area is highlighting the positive and moderate (0.63) relationship between each dimension under investigation and overall development. Overall, Kongu Uplands fall under the category of moderate development in terms of regional development. So, Kongu Uplands needs proper planning and management for attaining balanced development in all dimensions.

Acknowledgement

The authors gratefully acknowledge the financial support received from the University Grants Commission, New Delhi for providing UGC-BSR Research Fellowship to Mr. H.R. Jasim and UGC-BSR Faculty Fellowship to Prof. K. Kumaraswamy for conducting research in Department of Geography, Bharathidasan University, Tiruchirappalli.

References

1. Agartan, T.I. (2012). Marketization and Universalism: Crafting the Right Balance in the Turkish Health Care System, Current Sociology, 60 (4), pp. 456 - 471.
2. Agarwal, A.N., and Kundal, L. (1997). Economics of Development and Planning, Vikas Publishing House Pvt. Ltd, New Delhi.
3. Cocek Ladislav. (2010). Pattern of Regional Development in Siberia: A Multivariate Statistical Analysis, Geographica Pannonica, 14 (1), pp.14 - 22.
4. Human Development Report. (2016). Human Development for Everyone, United national Development Programme, New York.
5. Jagadish Singh and Alok Chauhan. (2011). Regional Disparities in Levels of Development in Rajasthan, Journal of the Institute of Indian Geographers, 33(2),pp. 231-245.
6. Kumaraswamy, K. and Sivagnanam, N. (1988). Regional Resources Appraisal through Factor Analysis Technique - A Case Study on the Countries of Monsoon Asia, Indian Journal of Regional Science, 20 (1), pp.39 - 44.
7. Misra, R. P. (2007). Geography of Health: A Demography Geography of Life and Death, Concept Publishing Company, New Delhi, pp.139 - 160.
8. Mitra, A. (1961). Levels of Regional Development in India, Census of India, 1(1).
9. Nagaraj, H. and Murththy K. (2007). Geographical Analysis of Regional Disparities – A Case Study of Chitradurga District, Karnataka, Journal of the Institute of Indian Geographers, 29 (1), pp. 75 - 82.
10. Rajendra Suryawanshi and Nandakumar Sawant. (2011). Regional Disparities in Rural Thane District, Maharashtra: An Overview, Journal of the Institute of Indian Geographers, 33(2), pp. 217 - 229.
11. Tamil Nadu Human Development Report. (2017). Planning Commission of Tamil Nadu, Chennai.
12. Zankiahadi, A. (2001). Factors Analysis and Factors Determine in the Human Development of Great Cities, Iranian Journal of Research in Geography, p. 6.

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 111-122
ISSN 0019-4824

ASSESSMENT OF LAND DEGRADATION THROUGH GEOSPATIAL TECHNOLOGY IN KODAVANAR WATERSHED, A PART OF AMARAVATHI BASIN, TAMIL NADU

Prawin B. and Masilamani P.

Department of Geography, Bharathidasan University, Tiruchirappalli - 620 024
E-mail: masilamani.ap@gmail.com, prawin24geo@gmail.com

Abstract

Land degradation is a human-induced or natural process which negatively affects the land, to function effectively within an ecosystem. Land degradation is a concept in which the value of the biophysical environment is adversely affected, temporary or permanent decline in the productive capacity of the land. Geospatial based Analytical Hierarchy Process (AHP) has been adopted to assess the land degradation impacts in Kodavanar watershed a part of Amaravathi Basin Tamil Nadu. This study is helpful for proper land management and sustainably in preparing land-use policies. The geographical location of the study area lies between 10˚ 11' 37" -10˚ 27' 30" North latitudes and 77 ˚37'46"-78˚ 01' 10" East longitudes and the study area convers an area of 2254 sq km. land degradation of the study area has been classified into five major categories, they are very low, low, moderate, high, very high. The very low degraded land is seen in the south western part of the study area where the mountain ranges of Perumal malai has been located, almost all the low degraded land is seen in the foot hills of the hills present in the study area, moderate degradation took place in the plain regions and the high degradation is noted in the southern central part of the study area where the Dindigul urban is located, very high land degradation is took place almost along the river banks of the Kodavanar river. About 131.9 sq km (5.77%) comes under the very low degraded area, 468.8 sq km (20.5%) comes under the low degraded area, 705.9 sq km (30.8%) comes under the moderate degraded area, 548.8 sq km (24%) comes under the high degraded area, 429.96 sq km (18.8%) comes under the very high degraded area.

Keywords: Land degradation, Analytical Hierarchy Process (AHP), Kodavanar watershed

Introduction

Land degradation is generally understood to be the reduction or loss of biological or economic productivity resulting in decreased yields, incomes, food security, and the loss of vital ecosystem services. These impacts, in turn, serve to weaken the peace and stability of land-dependent communities (Barbut, Monique, and Sasha Alexander 2016). Thus, there appears to be a demonstrable link between land degradation and human security, especially when we consider how poverty and hunger lead to migration and conflict. The

use of remote sensing and Geographic Information System (GIS) techniques makes land degradation estimation and its spatial distribution possible with reasonable costs and better accuracy in larger areas (Reddy et al., 2018). The use of space borne multispectral data shown, it's potential in deriving information on the nature, extent, spatial distribution, and magnitude of various kinds of degraded lands. The advantages of assessing land degradation through remote sensing are consistency of data, fairly near real-time reporting, and a source for having spatially explicit data (Koshal, 2010).

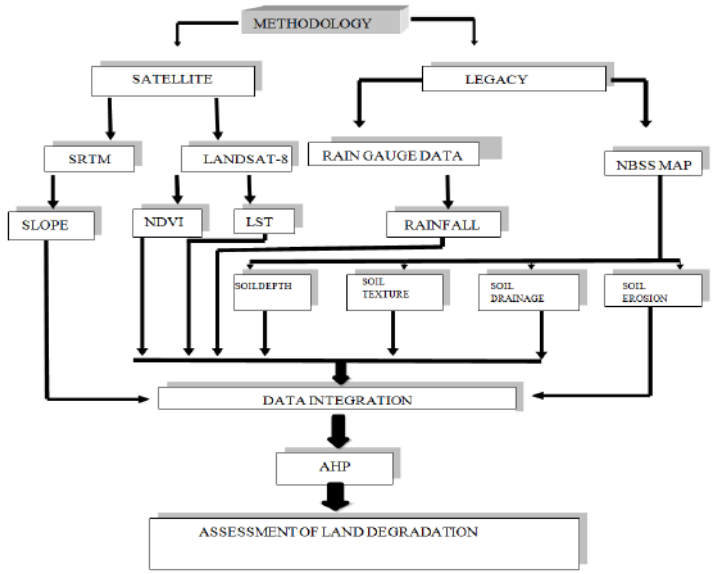


Fig. 1. Methodology of the Study

The AHP, which is used as a decision analysis device (Saaty, 1980), is a mathematical method developed by Saaty in 1977 for analysing complex decisions involving many criteria (Kurttila et al., 2000). It is widely used by decision-makers and researchers. The main aim of the study is the assessment of land degradation and its impact. The main objectives of the study are the determination of land degradation and the integration of different factors using the Analytical Hierarchy Process (AHP) and GIS to delineate the land degradation zones within the Kodavanar watershed. Finally, the ultimate need of the study is to suggest appropriate land resource planning, management, and conservation measures.

Study Area

The study area is located in the parts of Dindigul and Karur Districts, Tamil Nadu, India. The Kodavanar River originates in Pandrimalai and Sirumalai Hills lies south of Dindigul District at an altitude of 1350 m above mean sea level. The geographical location of the study area lies between 10˚ 11' 37 " - 10˚ 27 ' 30 " North latitudes and 77 ˚37 '46 " - 78˚ 01' 10 " East longitudes (Figure 2) and the study area covers an area of 2,254 sq km.

The study area is covered by hilly ranges of the Sirumalai, Senkurchi, Pandrimalai, and Rangamalai, Slope trend of the study area moving toward north and northeast direction. In the plains, altitude is 360 m in the southern sides and 120 m in the northern part of the Kodavanar watershed. The drainage pattern of the watershed covers of dendritic and sub-dendritic. The average annual precipitation for the study area ranges from 489 to 1078 mm. The main Kodavanar river flows from south to north direction it joins the Amaravathi river at Kovilur village towards the south of Karur District. The study area has a hot tropical climate. The maximum and minimum atmospheric temperatures are 37.5°C and 19.7°C in plains and 20°C and 7.7°C in hill stations, respectively.

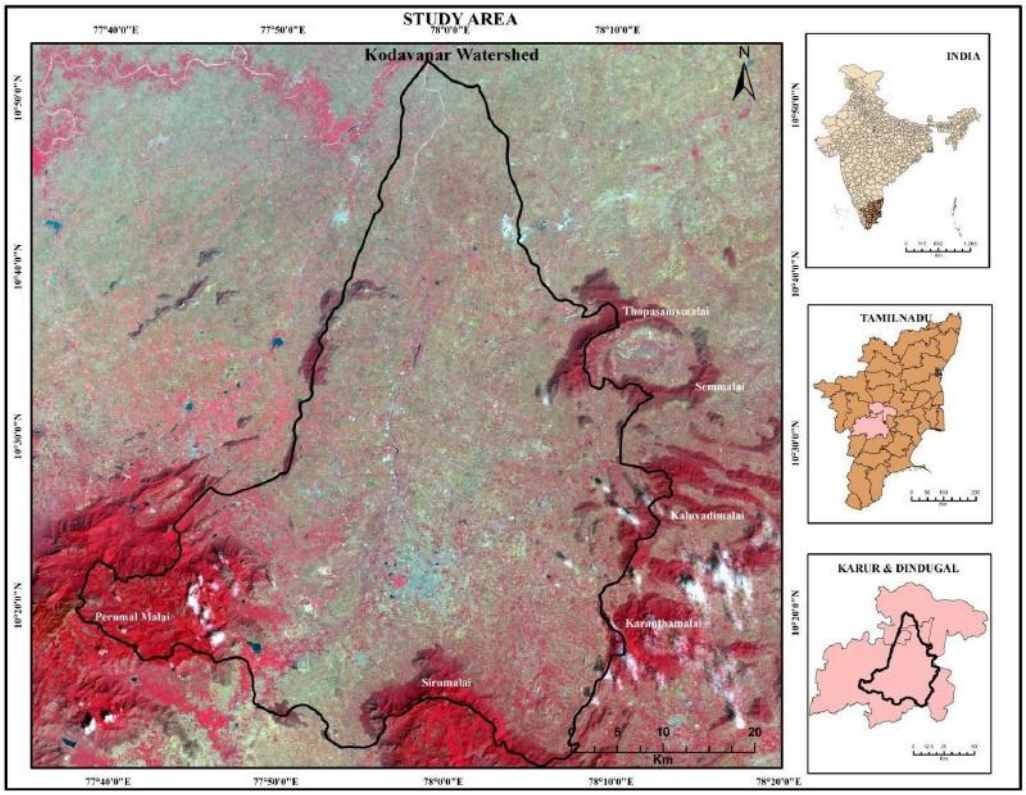


Fig. 2. Study Area - Parts of Dindigul and Karur Districts, Tamil Nadu

Database and Methodology

In the present study, two important datasets were used namely satellite data sets and legacy datasets. In addition to these two datasets meteorological data (rain gauge data) has been incorporated for validating satellite based rainfall data. Landsat 8 satellite data products have been used in this study to analyse vegetation index and temperature distribution of the study area. Slope map was prepared from SRTM DEM (30m). Soil parameters namely soil depth, drainage, texture and soil erosion has been compiled from soil resource database of NBSS Tamil Nadu.

Result and Discussion

Normalized Difference Vegetation Index (NDVI)

The Normalized Difference Vegetation Index (NDVI) is a numerical indicator that uses the visible and near-infrared bands of the electromagnetic spectrum and is adopted to analyse remote sensing measurements and assess whether the target being observed contains live green vegetation or not (Sivakumar et al., 2004). NDVI values range from -1.0 to +1.0. Area of barren rock, sand, or snow usually shows very low NDVI values (for example, 0.1 or less). Sparse vegetation such as shrubs and grassland crop may result in moderate NDVI values (approximate 0.2 to 0.5). High NDVI of dense vegetation areas approximate 0.6 to 0.9.

The NDVI map shows the area of vegetation and non- vegetation. The values of NDVI has been classified as five categories as very low (0-0.2), low (0.2-0.3), moderate (0.3-0.4), high (0.4-0.5) and very high (>0.6) is shown in the Figure 4(a). The high intensity of very high vegetation is seen in very minor portion in the lower southern and south-western portion. The high vegetation is seen in the south-western and below then the moderate vegetation is sparsely distributed all over the parts of the study area. The very low vegetation is highly concentrated in the central part of southern region where the Dindigul urban is located.

Land Surface Temperature (LST)

In this study satellite based temperature data has been collected LST=BT/1+w*{BT/P}*Ln (e) by using this algorithm the land surface temperature of the study area has been calculated. The value of the LST has been classified into five classes, the temperature ranges between 15˚c to 36˚c. The values are reclassified according to the study into very low (<15˚c), low (15-20˚c), moderate (20-25˚c), high (25-30˚c) and very high (>30˚c) is shown in the Figure 4(b). Almost entire plain region of the study area lies in the very high and high temperature zones, low and very low temperature zones are present in the hilly region of the study area. The temperature changes in the study area is due to the altitude variation. The high elevated regions reflect less surface temperature and low elevated regions reflects high surface temperature.

Rainfall

The rainfall data for the period of one year for Karur and Dindigul District were taken from IMD department. The monthly data was converted into annual rainfall data. This data consist of twelve rain gauge station records, which are distributed over the study area. Rainfall influenced the vegetation cover and erosion factors. The value of rainfall ranges from 400mm to1800mm and it has been classified as five categories such as very low (400mm), low (400-800mm), moderate (800-1200mm), high (1200-1600mm) and very high (1600-1800mm) is shown in the Figure 4(c).The highest rainfall recorded in the elevated region of the Kadavur watershed lies in the middle eastern part and the lowest rainfall is

recorded in the upper north eastern part of the Kodavanar watershed. Most part of the study area records the low rainfall. The place where the rainfall recorded as very high and high, the vegetation cover also will be high and very high. If the place where the rainfall recorded as very low and low, the vegetation cover also will be low and very low. This shows the strong influence in the identification of degraded land.

Slope

Slope is the one of the important terrain parameter for quantifying land degradation scenario. The topography of the land determines the velocity at which surface runoff flow, which in turn determines the erosivity of the runoff. For this study slope also chosen as an important parameter and slope has been generated from resampled SRTM DEM and it classified into 6 categories namely level to nearly level (<5), very gentle sloping (5-10), gentle (10-15), moderate (15-25), moderately steep (25-35) and steep sloping (>35) is shown in the Figure 4(d).The Kodavanar Watershed is plain region, so 90% of the basin comes under the category level and nearly level, hilly regions in the study area comes under the steep sloping.

Soil Depth

Soil depth of different categories has been identified over the study area. Namely very deep, deep, moderately deep, moderately shallow and shallow. Deep soils are always support better growth of vegetation while shallow and moderately shallow soil prevent the growth of crops as well owing to erosion by water. The Figure 5(a) shows the soil depth of the Kodavanar Watershed in which almost 60% of the study area covered by the shallow depth (25- 50cm) and the other categories of soil depth are equally distributed in every parts of the study area. Soil depth is seen mostly in the minor portion of southern and central region, whereas the whole Kadavur Watershed falls under deep soil depth (100-150cm).

Soil Drainage

There are four different soil drainage has been recorded in the study area namely excessively drained, imperfectly drained, moderately drained and well drained is shown in the Figure 5(b). Excessively drained drainage easily erodes the mineral content from soil. Excessive soil drainage has been identified over the sandy cover region of the study area. In this region water removes top soils very rapidly with respect to sandy soils are concern. The coarse grained and inability to store water. Major portion of the study area fall under the well-drained soil and it mostly in the eastern part of the study area. Next to that moderately well drained soil is concentrated in the south west region and extending up to central region and then there is narrow stretch of excessively drained soil extending from northern to south eastern part while the imperfectly drained soil is noticed only in the upper most northern region.

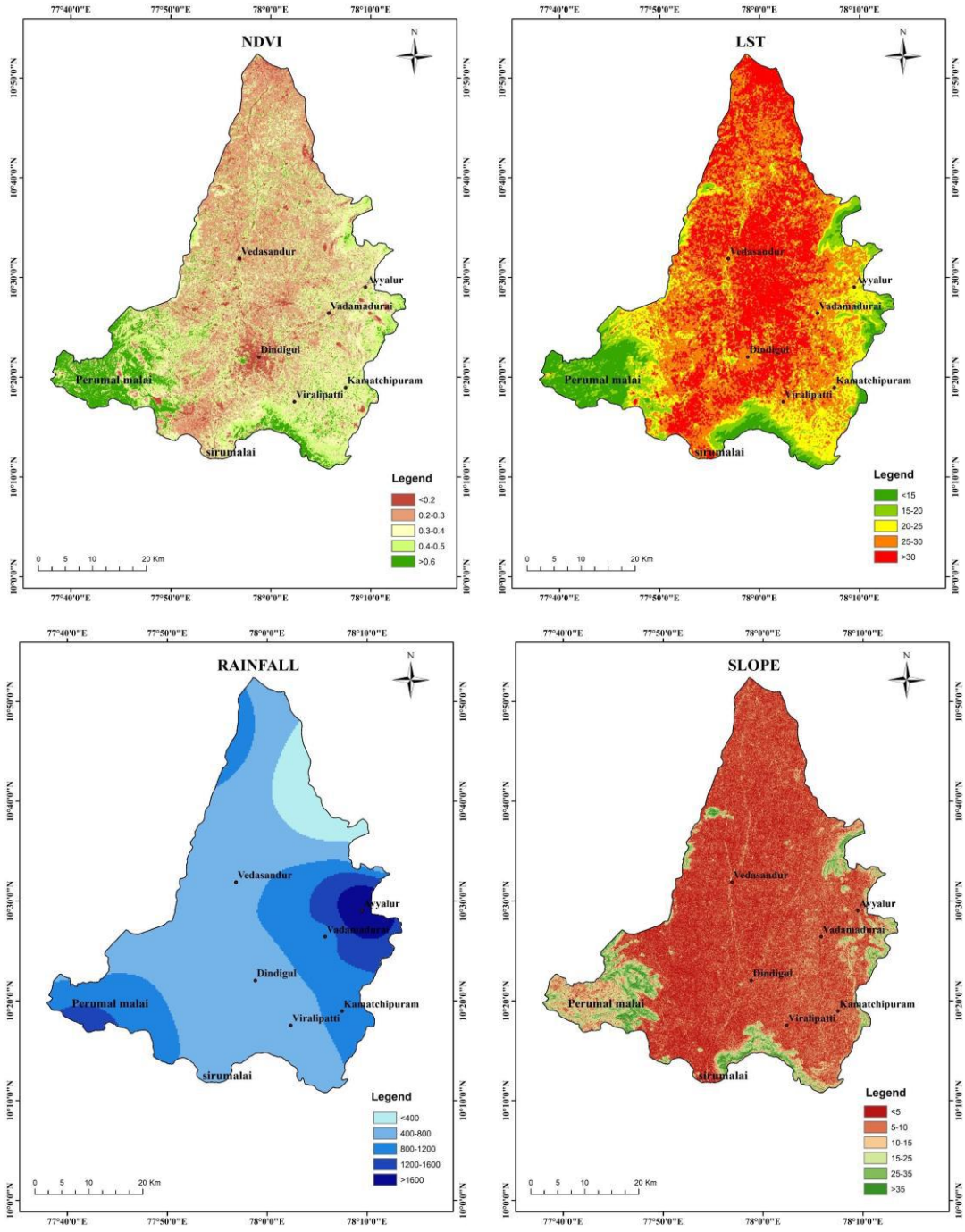


Fig. 4 (a) Normalized Difference Vegetation Index (b) Land Surface Temperature (c) Rainfall (d) Slope

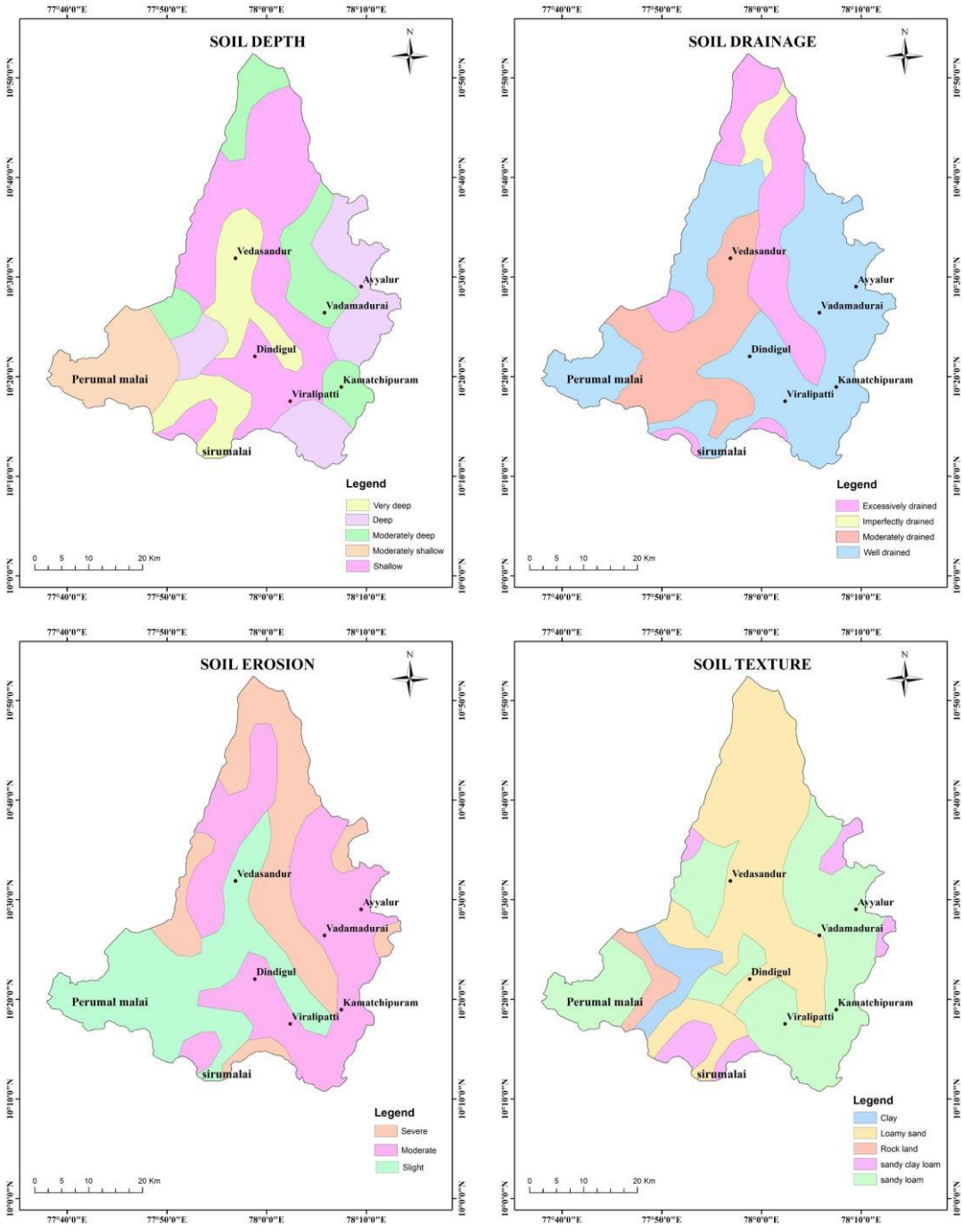


Fig. 5 (a) Soil Depth (b) Soil Drainage (c) Soil Erosion (d) Soil Texture

Soil Erosion

Soil erosion of the study area is classified into three categories they are severe (>200mm), moderate (100-150), slight (<50mm) is shown in the Figure 5(c). The slight soil erosion is intensely seen in the south western hilly region and extent up to the central and south eastern region then the severe erosion of soil is mostly noticed in the northern region and extend some narrow stretch towards the south eastern parts and then the rest of the south eastern and north western parts of the area is recorded as moderate soil erosion.

Soil Texture

Soil texture is classified into five different types namely clay, loamy sand, rock land, sandy clay loam, sandy loam is shown in the Figure 5(d). Sandy soil is easily drained by rain as well as it is easily transported long distance by wind. The particle size of sand is comparatively large thus water holding capacity is very less and inability to retain nutrients. Loam is considered as ideal for gardening and agricultural uses because it retains nutrients well and retain water while still allowing excess water to drain away. The study area is dominantly covered by loamy sand followed by sandy loam.

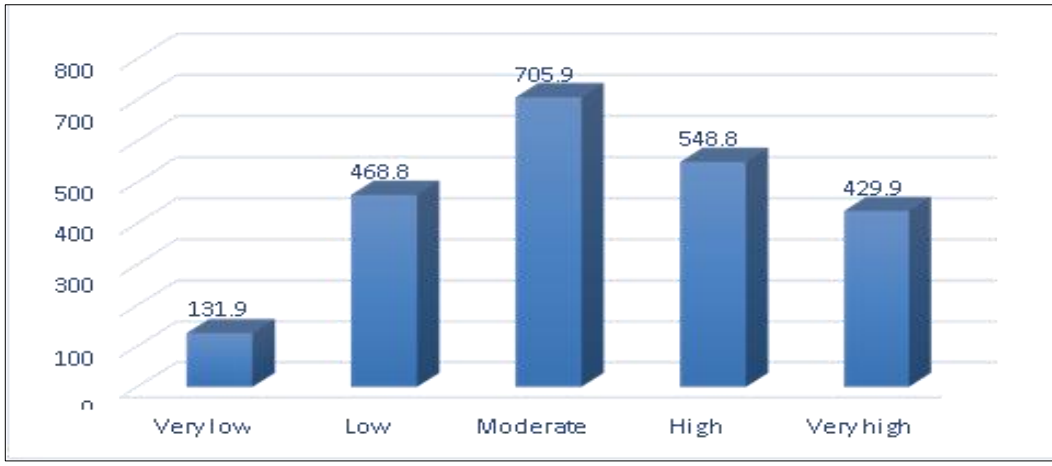


Fig. 6. Land Degradation in Kodavanar Watershed (area in sq.km)

Table 1. Land Degradation Parameters

	NDVI	LST	Rainfall	Slope	Soil Depth	Soil Texture	Soil Erosion	Soil Drainage
NDVI	1	2	4	5	5	5	2	5
LST	1/2	1	3	4	6	7	1/2	4
Rainfall	1/4	1/3	1	3	3	3	1/3	2
Slope	1/5	1/4	1/3	1	3	3	1/4	2
Soil Depth	1/5	1/6	1/3	1/3	1	2	1/6	2
Soil Texture	1/5	1/7	1/3	1/2	1/2	1	1/5	3
Soil Erosion	1/2	2	3	4	6	5	1	6
Soil Drainage	1/5	1/4	1/2	1/2	1/2	1/3	1/6	1

Table 2. Land Degradation Parameters Weights and Class Weights

Parameter	Class	Range	Rank
NDVI	Very Low	> 0.2	5
	Low	0.2-0.3	4
	Moderate	0.3-0.4	3
	High	0.4-0.5	1
	Very High	> 0.6	1
LST	Very Low	> 15	1
	Low	15-20	1
	Moderate	20-25	3
	High	25-30	4
	Very High	> 30	5
Rainfall	Very Low	>400	4
	Low	400-800	3
	Moderate	800-1,200	2
	High	1,200-1,600	1
	Very High	>1,600	1
Slope	Very Gentle	>5	1
	Gentle	5-10	1
	Moderate	10-15	2
	Moderate Steep	15-25	3
	Steep	25-35	3
	Very Steep	>35	4
Soil Texture	Clay		2
	Loamy Sand		3
	Rock Land		1
	Sandy Clay loam		4
	Sandy Loam		5
Soil Erosion	Moderate		3
	Low		1
	Severe		5
	Slight		2
Soil Drainage	Excessively Drained		4
	Imperfectly Drained		3
	Moderately Drained		2
	Well Drained		1
Soil Depth	Very Deep	>150	1
	Deep	100-150	2
	Moderately Deep	75-100	3
	Moderately Shallow	50-75	4
	Shallow	25-50	5

Assessment and Mapping of Land Degradation in Kodavanar Watershed

For quantifying and mapping of land degradation within the study area, appropriate themes were considered and AHP based weights were assigned to each parameter and their classes according to their influence on land degradation. All the parameters taken for the study has been reclassified and converted into raster data format and the weight age process has been carried out for the identification to land degradation in the Kodavanar watershed. For example, NDVI is parameter for analysing land degradation or it is an important indication to land degradation, so it‘s significant and scale was high, thus maximum theme weight has been assigned to NDVI, followed by soil erosion, LST, rainfall, slope and soil parameters.

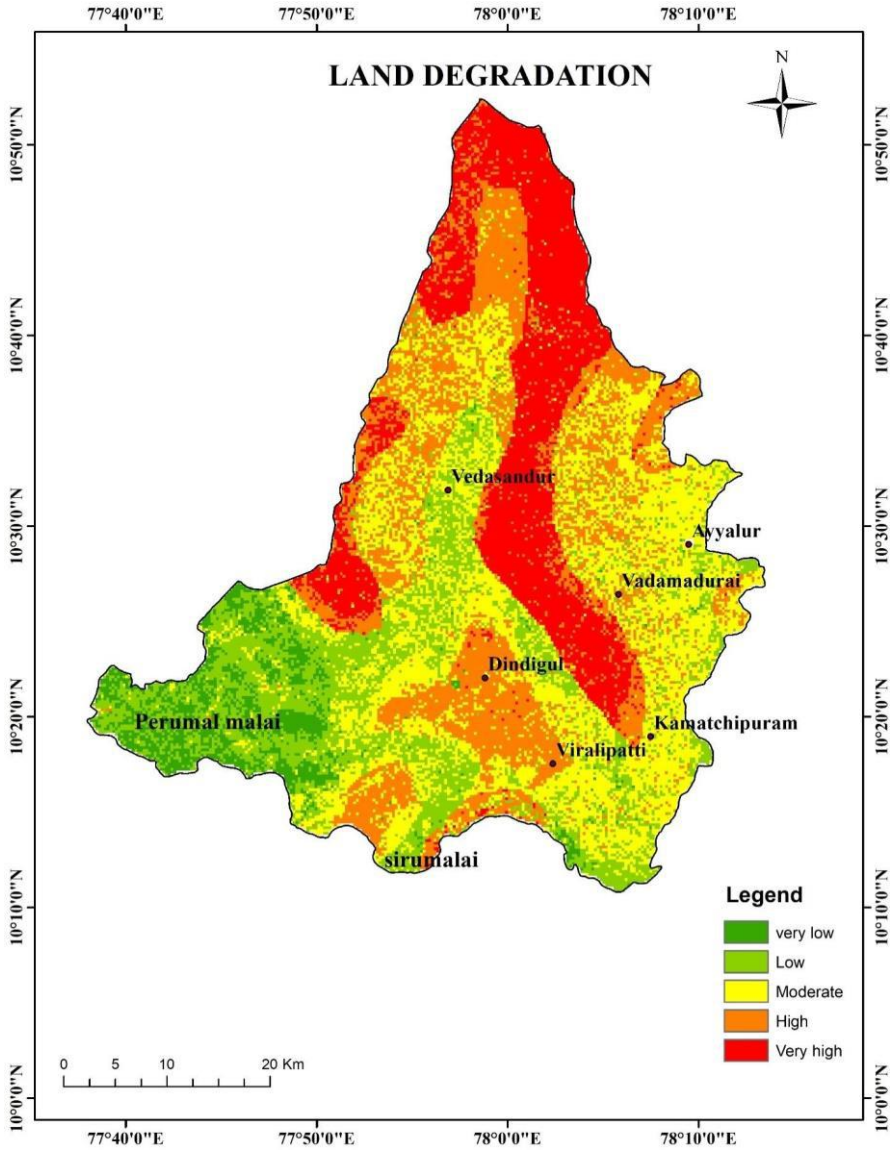


Fig. 7. Land Degradation in Kodavanar Watershed

Finally, all the class weight for each indicators were entered into a weighted overlay model in GIS to produce a raster output map that would display the level of land degradation Table 1 and 2 shows the parameters and their theme weights and class weights. Based on the analysis of the NDVI very low (0-0.2), low (0.2-0.3), moderate (0.3-0.4), high (0.4-0.5) and very high (>0.6). The high intensity of very high vegetation is seen in very minor portion in the lower southern and southwestern portion. The high vegetation is seen in the southwestern and lower south eastern parts then the moderate vegetation is sparsely distributed all over the parts of the study area. The very low vegetation is highly concentrated in the central part of southern region where the Dindigul urban is located.

Conclusions

Analysing the land surface temperature showed that comparatively high temperature prevails over central part of the study area. Almost entire plain region of the study area lies in the very high and high temperature zones, low and very low temperature zones are present in the hilly region of the study area. The temperature changes in the study area are only because of the altitude variation in the study area. While analysing the rainfall data highest rainfall recorded in the elevated region of the Kadavur watershed lies in the middle eastern part and the lowest rainfall is recorded in the upper north eastern part of the Kodavanar watershed. Most part of the study area records the low amount of rainfall. Among the soil parameters soil erosion is the most important parameter for the identification of land degradation, so it has been given more weight when compare to other soil parameters. Detailed analysis of each parameter helped to identify land degradation. Based on the analysis of each parameter indicate that where the less vegetation cover and high rate of erosion seems to be falls under the degraded category. The land degradation of the Kodavanar watershed has been classified into five major categories, they are very low, low, moderate, high, very high. The very low degraded land is seen in the south western part of the study area where the mountain ranges of Perumal malai has been located, almost all the low degraded land is seen in the foot hills of the hills present in the study area, moderate degradation took place in the plain regions and the high degradation is noted in the southern central part of the study area where the Dindigul urban is located, very high land degradation is took place almost along the river banks of the Kodavanar river. About 131.9 sq.km (5.77%) comes under the very low degraded area, 468.8 sq.km (20.5%) comes under the low degraded area, 705.9 sq.km (30.8%) comes under the moderate degraded area, 548.8 sq.km (24%) comes under the high degraded area, 429.96 sq km (18.8%) comes under the very high degraded area.

References

1. Ahmad, N. and Puneeta Pandey. (2017). Assessment and monitoring of land degradation using geospatial technology in Bathinda District, Punjab, India. Solid Earth, 9:75-90.
2. Barbut, Monique, and Sasha Alexander. "Land degradation as a security threat amplifier: The new global frontline." Land Restoration. Academic Press, 2016. 3-12.
3. Gao. J. and Yansui, Liu. (2010). Determination of land degradation causes in Tongyu Country, Northeast China via land cover change detection, international Journal of Applied Earth Observation and Geoinformation, 12:9-16.
4. Hassan et al. (2015). Integration of Remote Sensing and GIS to assess vulnerability of environmental degradation in North - Western Bangladesh. Journal of Geographic Information System, 7:494- 505.
5. Janhantab, Z., Ali Asghar Ale Sheik, Ali Darvishi Boloorani.and Hossein Teimouri. (2017).Spatial- temporal Modeling of Land Degradation, using Weighted Overlay Index model. A case Study on Ninevehprovince, Iraq. European journal of Geography, 4:118-141.

6. Kurttila, M., Pesonen, M., Kangas, J., Kajanus, M., 2000. Utilising the analytic hierarchy process (AHP) in SWOT analysis – a hybrid method and its application to a forest-certification case. Forest Policy and Economics 1 (1), 41–52
7. Loukrakpam, C. and Dr. Bakimchandra oinam. (2018). Geospatial based Land Degradation mapping and monitoring in North Eastern India: A case study in Manipur. Conference paper March 2018.
8. Masoudi, M., Parviz. J. and Biswajeet, P. (2018). A new approach for land degradation and desertification assessment using geospatial techniques. Natural hazards and Earth System Science, 18:1133-1140.
9. Reddy, GP Obi, Nirmal Kumar, and S. K. Singh. "Remote sensing and GIS in mapping and monitoring of land degradation." Geospatial Technologies in Land Resources Mapping, Monitoring and Management. Springer, Cham, 2018. 401-424.
10. Saaty, T.L., 1990. How to make a decision: the analytic hierarchy process. European Journal of Operational Research 48, 9–26.
11. Sirengo, R.K., Charles N., Mundia. and Arthur W. Sichangi. (2018). Modelling Land Degradation in Migori country. SSRG International Journal of Agriculture and Environmental Science (SSRG-IJAES) 5:32-44.
12. Sivakumar, M. V. K., et al. "Satellite remote sensing and GIS applications in agricultural meteorology." Proceedings of the Training Workshop in Dehradun, India. AGM-8, WMO/TD. Vol. 1182. 2004.
13. Tagore, G.S., Bairagi G.D., Sharma, N.K., Bhelawe, S. and Verma, P.K. (2012). Mapping of Degraded Lands Using Remote Sensing and GIS Techniques. 12:29-36.
14. Weinzier, T., Jan Wehberg., Jurgen Bohner. and Olaf Conrad. (2016). Spatial Assessment of Land degradation risk for the Okavango River catchment, Southern Africa. Land degradation and development, 27:281-294.
15. Wubie, A.M. (2015). GIS Based land degradation Assessment for Sustainable land Management: The Case of Bench Maji Zone, Ethiopia, Africa. International Journal of research and Innovations in Earth Science, 2: 2394-1375.

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 123-135
ISSN 0019-4824

MAPPING THE MANAGEMENT PRACTICES OF DOMESTIC E-WASTE: A CASE STUDY OF WEST DELHI

Shitika Bhatia[1], Subhash Anand[1], Virendra Nagarale[2] and Om Jee Ranjan[1]

[1] Department of Geography, Delhi School of Economics, University of Delhi, Delhi - 110 007
[2] Department of Geography, S.N.D.T. Women's University, Pune - 411 038
E-mail: sanandpv@yahoo.co.in, drnagarale@gmail.com

Abstract

Electrical and electronic products have increasingly become an essential part of everyday human life worldwide. Nowadays, we are becoming completely dependent on it. But every machine has its own life after that it will waste forever that is called e-waste. So, discarded electronic items are becoming the most hazardous waste in mainly urban cities. The fast trend of generating e- waste is requiring more attention because if we do not pay attention to the management of this, then later on it will become a big problem. In this paper it has been tried to understand the perception of the people and the level of awareness among them regarding sustainable e-waste management practices. It's better management and handling is directly or indirectly influenced by the level of awareness among people. Present study is based on primary survey including few concerns about e-waste respectively; the current methods of disposal of e-waste by households with the perception of the people and the level of awareness among them regarding sustainable e-waste management practices.

Keywords: Domestic E-waste, Generation, Consumers, Awareness, Disposal, Management, Strategies West Delhi

Introduction

Electrical and electronic products have increasingly become requisite part of everyday human life. Electronics equipment seems to have penetrated every aspect of our modern everyday life. Home appliances which were considered luxury items few years back are now commonly found in everyday use. Increasing urbanisation, modern consumerist lifestyles accompanied by our need to move forward technologically and economically have come with a threat i.e. enormous waste. Households consume large quantities of consumer durables such as washing machines, refrigerators, television etc. which make our lives convenient (Vnugopal, 2011). Moreover, technological development and affordability of telecommunication equipment like computer/laptops and mobile phones have led to increase in personalization of such products (Wath et al., 2010). Rapid metamorphosis in technologies, expanded purchasing powers and the competition amongst the consumers to acquire the latest has resulted in shorter life span and high obsolescence rate of electronic

goods worldwide (Bradley, 2014). Thus, the state of the art electronic equipments today suddenly becomes obsolete tomorrow (Balde et al., 2015). Waste includes computer and its accessories (monitors, keyboards, printers, central processing units) typewriters, mobile phones and chargers, remotes, headphones, compact discs, batteries, LCD/plasma televisions, air conditioners, refrigerators, washing machines and other household appliances (Upadhyaya, 2015).

Waste includes computer and its accessories (monitors, keyboards, printers, central processing units) typewriters, mobile phones and chargers, remotes, headphones, compact discs, batteries, LCD/plasma televisions, air conditioners, refrigerators, washing machines and other household appliances (Upadhyaya, 2015). According to UN report 'Global E-Waste Monitor 2014' compiled by United Nations University (UNU), global e-waste volume has hit a new peak - reached 41.8 million tons (Mt) in 2014 up from 39.8 million tons in 2013 (Balde et al., 2015). Global per capita generation has been pegged at 5.9 kilogram per inhabitant (UNEP, 1992). Developing countries are experiencing a boom in their own e-waste (Dutta, 2017). With the increase in population, urbanization, increasing capacity, economic growth and changing lifestyle orientations, it is speculated that developing countries will triple their electronic waste production over the next few years (Olowu, 2012). India is the fifth largest producer of e-waste in the world and third in Asia after China and Japan; discarding 1.7 million tons of electronic and electrical equipment in 2014 (PTI, 2014).

In India, electronic industry is one of the fastest growing industries and is driven by IT, Consumer Electronics and Telecom (Press Information Bureau, 2016). Recent policy changes in India have led to an influx of leading multinational companies to set up electronics manufacturing facilities and R&D centers for hardware and software (Badoni, 2009). So as electronic industry growing; electronic wastes management related problem is also increasing steadily (Dwivedy and Mittal, 2013). It is also estimated that of the total e-waste generated yearly globally 75 per cent to 80 per cent is shipped to countries in Asia and Africa for “recycling” and disposal (Perkins, 2014). As per the estimates of Director General of Foreign trade, illegal imports of e-waste in the country stand at about 50,000 tons annually (Rajya Sabha, 2011). So, either domestically generated or imported, electronic waste is piling up across India. One of the Sustainable Development Goals adopted by world leaders in 2015 aims to make cities and human settlements inclusive, safe, resilient and sustainable which includes safe removal and management of solid waste (Kidee et al. 2013). The fact that 95 per cent of 18 lakh tons i.e. around 17 lakh tons of e-waste generated by India per year is ‘recycled’ by unorganized sector (Khetriwal, 2009).

In India, Delhi is the second largest generator of electronic waste after Mumbai (The Hindu, 2016). According to an ASSOCHAM study, the current level of e-waste generation in Delhi is 55000 metric tons per annum (The Times of India, 2013). Rapid product innovations and replacement especially in information and communication technology, change of technology from old CRT TVs to flat screen TVs and monitors along with economies of scale has given way to lower prices for many electronics and has

increased global demand for many products that eventually end up as e-waste (CEAMA, 2014). These can contaminate soil and groundwater. The deadly mix of toxins can cause severe health problems in those handling the waste (DPCC, 2010). Delhi has emerged as the main hub of e-waste recycling in India, and perhaps the world and is emerging as the world's dumping yard for e-waste (Puckett, 2002). The main e-waste recycling hubs in Delhi NCR are Mayapuri, Kanti Nagar Extension, Old Seelampur, Turkman Gate, Shastri Park, Lajpat Nagar, Kirti Nagar, Karkardooma, Mustafabad, Mandoli, Meerut, Ferozabad (DPCC, 2010). E-waste in India comes under the purview of Hazardous Wastes (Management, Handling and Transboundary Movement) Rules 2008, E-waste (Management and Handling) Rules, 2011 and the recent E-waste (Management & Handling) Rules, 2016 (PTI, 2014; Kaur and Goel, 2016). The present paper aims to understand the perception of the people and the level of awareness among them regarding sustainable e-waste management practices. Because of the increasing trend in e-waste is becoming a burning issue in urban areas of developing countries like India. It's better management and handling is directly or indirectly influenced by the level of awareness among people.

Study Area

West Delhi District of the National Capital Territory (NCT) of Delhi has been selected for the present study. NCT of Delhi is the Capital Territory of India situated at $28^0$37′ North to $28^0$61′ North and 77°14′ East to $77^0$23′ East in Northern India (Census of India, 2011). It has an area of 1483 square kilometre (Anand, 2010) having population of about 16.7 million, making it the second most populous urban agglomeration (showing rapid growth trend) in India (Census of India, 2011). Delhi is the largest commercial center in northern India (The Times of India, 2013). The overall population density is 11,320 persons per square kilometre which is the highest as compared to all India and other states and union territories. Delhi was divided into eleven districts namely North-West, North, North-East, South, South-West, East, West, Central, South East and Shahadra (Census of India, 2011). The district of West Delhi is the fourth largest district in Delhi with an area of 130 square kilometres. It is the third most populous district with 25,43,190 persons and the fourth highly densely populated district with 19563 persons per square kilometre (Census of India, 2011). West Delhi is divided into three tehsils: Punjabi Bagh, Patel Nagar, and Rajouri Garden (Fig.1). Slum cluster of Raghubir Nagar R - block is a part of Rajouri Garden Tehsil while, LIG flats of BG-2 block, MIG flats of A-2B, HIG flats of C A Apartments and Posh areas of West Punjabi Bagh are part of Punjabi Bagh Tehsil. The level of literacy in West Delhi District is 87.12 per cent and is a little more than the state average. Following the trend of population growth and urbanisation, the literacy rate has also increased in the last three decades.

Database and Methodology

The present study is based on primary data but secondary data have been used to know about general pieces of information. The background information about the study area like extent, area, demographic characteristics, urbanisation level and socio-economic

profile has been collected from Delhi Statistical Handbook, Census of India and Economic Census of Delhi. Apart from this, data and other useful information have been collected from organisations like Municipal Corporation of Delhi, Delhi Pollution Control Committee, Central Pollution Control Board, ASSOCHAM, Toxic link, Centre for Science and Environment, The Energy Research Institute. Much data has also been collected from e-journals, government publications and other websites

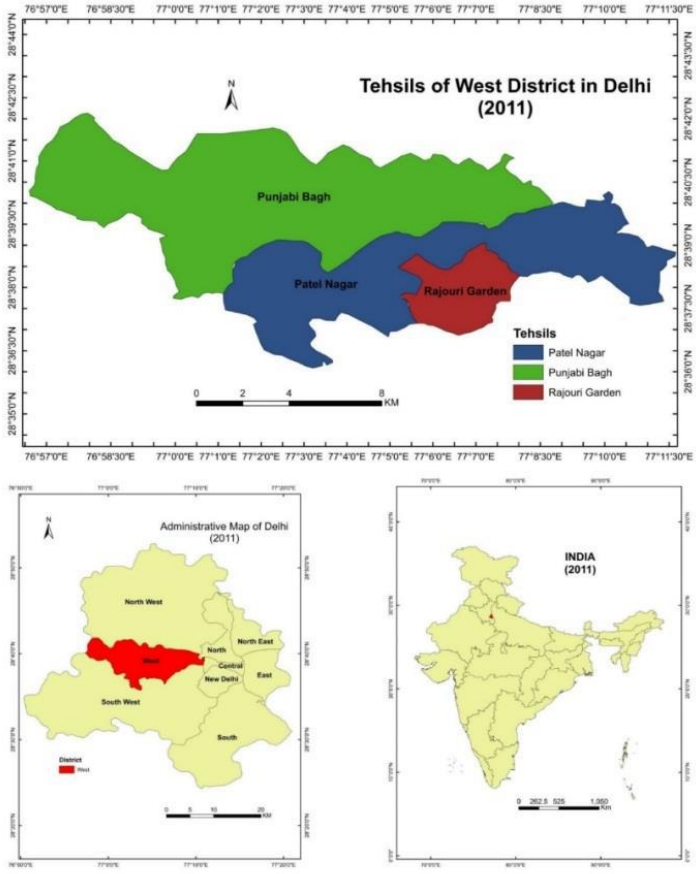


Fig. 1. Location of Study Area
***Source**: Census of India, 2011*

A survey has been conducted to gather primary data. A sample of 300 households for the study has been selected based on stratified random sampling. Five categories of households has been considered - squatter settlements, bungalows in posh areas and Delhi Development Authority's designated Low Income Group (LIG), Middle Income Group (MIG) and High Income Group (HIG) and sixty households from each of the five categories have been selected randomly during the field survey which is based on semi-structured questionnaire. The questionnaire consisted of closed ended questions with multiple-choice options and it had three sections.

The first was about baseline information related to education, household size, annual income of the household. The second section dealt with the practices they followed for disposing unwanted electronic pieces of equipment. The third section had questions about their perception and awareness regarding e-waste and its management. In addition, interviews of 10 junk dealers (*kabadiwalas*) have been conducted to understand the handling and disposal practices of e-waste at the junkyard. Collected metadata has been analysed statistically to fulfillment the objective of the study.

Income Levels of Households

It can be seen that most of the households across the household categories have maximum frequencies in 4 to 6 members per household. Income is one of the most important factors in determining consumer behavior. The data collected for annual income of household has been divided into appropriate class intervals of less than Rs. 3 lakh, 3 to 6 lakh, 6 to 9 lakh, 9 to 12 lakh and above Rs. 12 lakh (Table 1).

Table1. Annual Income per Household

Annual Income per Household (Rs.)	Slums	LIG Flats	MIG Flats	HIG Flats	Posh Areas
Less than 3 Lakh	45	1	-	-	-
3 Lakh to 6 Lakh	15	43	44	25	-
6 Lakh to 9 Lakh	-	11	11	20	19
9 Lakh to 12 Lakh	-	3	3	6	21
Above 12 Lakh	-	-	2	8	20

***Source**: Primary Survey, 2017*

The findings for this section have been most comprehensible. It resembles a diagonal matrix with slums in the lowest income bracket and as one move towards posh category the corresponding values move to higher income brackets (Table 1). It can be seen here that the average income per household for Raghubir Nagar slum cluster R- block is far below other income groups. For further analysis, Raghubir slum cluster R block, LIG flats BG-2 block, MIG flats A-2 B, HIG flats CA apartments and posh areas of West Punjabi Bagh have been represented as income groups in ascending order.

Results and Discussion

Nature and Pattern of E-Waste Generation in Households

Indian consumer electronics market is highly underpenetrated, much below the world average levels (CEAMA, 2014). In order to assess the quantum and composition of domestic e-waste generated, it is important to know the level of penetration of electronic products viz. TV, refrigerator, washing machine, computer/laptop and mobile phones in West Delhi. Data shows that for all income groups, except slums, on an average a household possessed multiple units of each electronic product. They owned at least one TV, one refrigerator, one washing machine, one computer/laptop and in fact three mobile phones. Most of the slum dwellers are engaged in blue collar jobs which do not necessarily

require possession of computer/laptops and low disposable income and affordability. However, television and mobile phones were commonly found.

Correlation analysis has been employed to identify is there is any relation between (a) the average number of electronic equipments owned by a household and size of the household (b) the average number of electronic equipments owned by a household and income level. The correlation coefficients 'r' and coefficients of determination 'r^2' calculated for the two sets of data (Table 2).

Table 2. Correlation of Electronic Equipment per Household with Household Size and Income Level

Electronic Equipment Owned per Household	Household Size		Income Level	
	(1)	(2)	(3)	(4)
	r	**r^2**	**r**	**r^2**
Television	0.761	0.5791	0.942	0.8874
Refrigerator	0.065	0.0042	0.85	0.7225
Washing Machine	-0.0164	0.0003	0.81	0.6561
Computer / Laptop	-0.0424	0.0018	0.79	0.6241
Mobile Phone	0.608	0.3697	0.99	0.9837

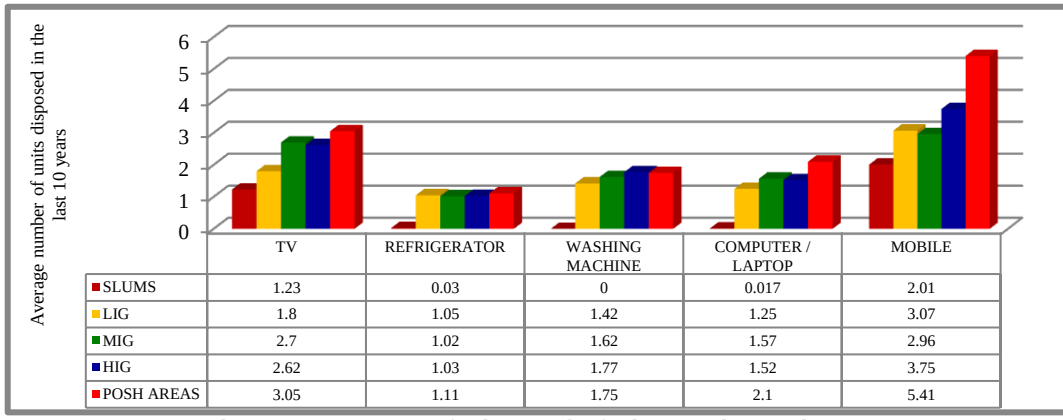
***Source**: Primary survey, 2017*

Electronic equipment owned by each household invariably has strong positive correlation with income levels as all values for 'r' in column (3) are more than 0.5. This implies that as the income level increases, possession of each type of product per household increases. Moreover, the average of coefficients of determination 'r^2' is 77.48 per cent. This means that about 77 per cent of the variation in ownership of a product is determined by income level. It is also highlighted that across the products there are variation in ''r^2'. 88.74 per cent of variation in possession of TV per household is determined by income level. Similarly, in case of refrigerators, washing machines, computer/laptop and mobile phones, 72.25 per cent, 65.61 per cent, 62.51 per cent and 98.37 per cent of variation in possession is determined by income level respectively. In the case of TV and mobile phones the correlation between household size and number of units possessed is strong and positive correlation. In case of refrigerator, washing machine and computer/laptop, coefficient of determination between the two data sets is very weak. Negative values of r have been found in cases of washing machines and laptops. This means that greater value of one variable correspond to lesser value in the other variable.

Frequency of Disposal of Electronics Equipment

Frequency of disposal has been calculated by assessing the number of units of each electronic product disposed by a household in the past ten years. Higher the frequency of disposal implies that a greater number of units have already entered either a second hand market or e-waste stream in the last ten years (Figure 2). It has been found that each household surveyed (except in case of households in slums of Raghubir Nagar) has value greater than one for columns (Figure 2).

This means that on an average each house surveyed in LIG flats BG-2 block, MIG flats A-2 B, HIG flats CA apartments and posh areas of Punjabi Bagh areas disposed at least on electronic equipment in the last 10 years.



	TV	REFRIGERATOR	WASHING MACHINE	COMPUTER / LAPTOP	MOBILE
SLUMS	1.23	0.03	0	0.017	2.01
LIG	1.8	1.05	1.42	1.25	3.07
MIG	2.7	1.02	1.62	1.57	2.96
HIG	2.62	1.03	1.77	1.52	3.75
POSH AREAS	3.05	1.11	1.75	2.1	5.41

Fig. 2. Frequency of Disposal of Electronic Equipment

Source: Prepared by Authors

Hence, based on primary survey, two inferences can be made from the above analysis. First is that electronic products have well penetrated our society in the last 10 years. Second, is that all income groups other than slums have access to all the products. Mobile phone is the higher than respective column in all other clusters. This leads to the finding that in the area studied; the electronic equipment that has been disposed the most in the last ten years is mobile phone.

Obsolescence of Electronics Equipment

Obsolescence is defined as significant decline in competitiveness, usefulness, or value of an article or property. Obsolescence occurs generally due to availability of alternatives that perform better or are cheaper or both, or due to changes in user preferences, requirements, or styles. For the purpose of this particular study, only the rate of obsolescence has been studied which can be obtained by simply knowing the age at which an electronic product became obsolete to the user and has been disposed because faster a product is disposed, faster it enters a second hand market or e-waste stream and a new product is bought to replace the older one (Figure 3).

This finding points towards prevalence of lowest age of disposal of mobile phones at 2.86 years. One feature that distinguishes the obsolescence rate of mobiles from the rest of the products is that none of the handset has been reported to run beyond 7 years and 1.3 per cent of them were discarded in less than one year. This indicates higher obsolescence rate for mobile phones than all other electronic products surveyed. The average age of a unit of computer/laptop, TV, washing machine and a refrigerator is 3.82 years, 5.02 years, 5.64 years and 6.83 years respectively. However, these figures carry a limitation as it does not take extreme values higher than 7 years into consideration.

However, it is noteworthy to mention that majority of refrigerators i.e. around 53 per cent were used beyond 7 years before they were disposed. Other products which were used beyond 7 years are washing machines (around one fifth) and TVs (only 9 per cent) (Figure 4).

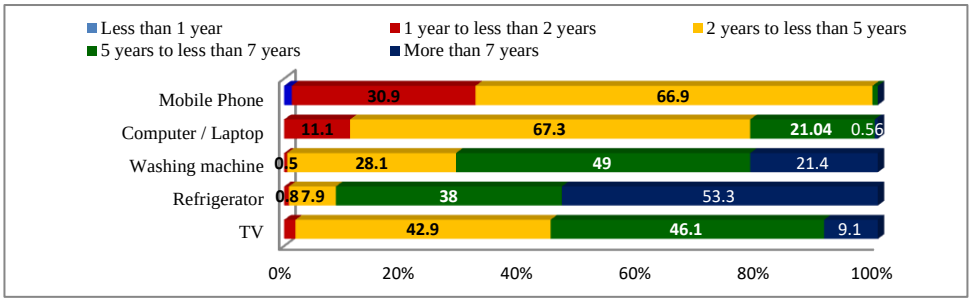


Fig. 3. Obsolescence Rate of Electronics Equipment

***Source**: Primary survey, 2017*

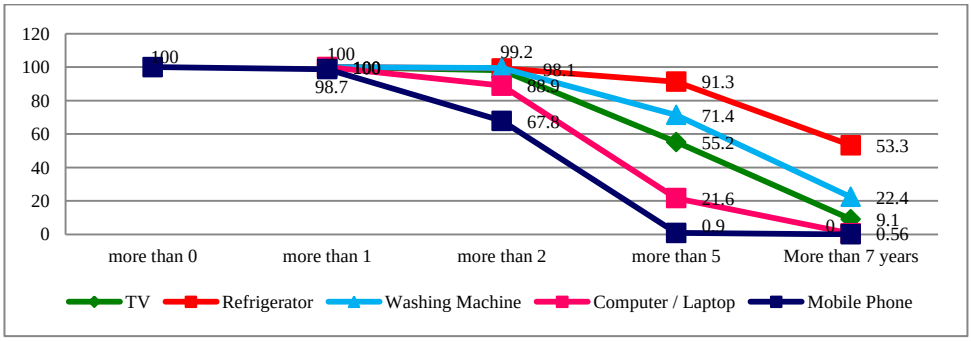


Fig. 4. More than Ogive for Utility of Electronics Equipment

***Source**: Primary Survey, 2017.*

This graph has been purposefully used to show what proportion of units was usable beyond specific number of years. It shows that 53.3 per cent of refrigerators, 22.4 per cent of washing machines, 9.1 per cent of TV and negligible share of computers could be used beyond 7 years. Remarkable visual output from the ogive is that most of the refrigerators were still in use beyond 5 years followed by washing machine, TV, computer/laptop and mobile phones in order. Among all the equipment under study, mobile phone is the one which had the lowest share of units in use after 2 years.

E-Waste: Reuse and Consumer's Awareness

Stakeholders awareness is necessary to control e-waste generation and its proper management. In order to understand the perception of the respondents about e-waste a big majority about eighty eight per cent of the respondents believed that the components of the unused electronics can be used and only 2 per cent of the respondents considered unused electronics as complete waste. Another vital aspect looked into was the most important consideration of the people while disposing their unused products (Figure 5).

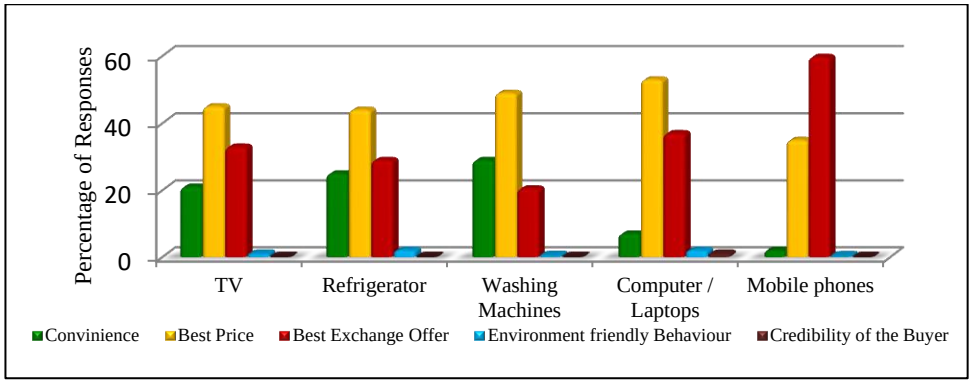


Fig. 5. Perception about Important Considerations during Disposal
***Source**: Primary Survey, 2017*

It was discovered that overall, 'best price' has been the most popular consideration among the respondents. In all cases except for mobile phones, it was the most significant consideration while disposing the product. During disposal of a mobile hand set availability of best exchange offer played the most vital factor. Economic benefits from the waste have overridden any other consideration including environment.

In order to comprehend the perception of the residents in the study area about potential risks of e-waste, they were asked about any threat posed by growing amount of e-waste in India (Figure 6). It has been observed that more than one fourth of the participants had no perception of any hazard arising out of growing e-waste in the country and 3 per cent of them perceived that there no such risk at all. Around 6 per cent of them agreed there was some risk but had no specific information about the issue. Out of all the options negligible proportion of respondents marked health hazard. However, it was noted that 56 per cent of the respondents in the study area recognised the threat posed by e-waste to the environment and 8 per cent of them reported that there is a risk to both health as well as to the environment (Figure 6).

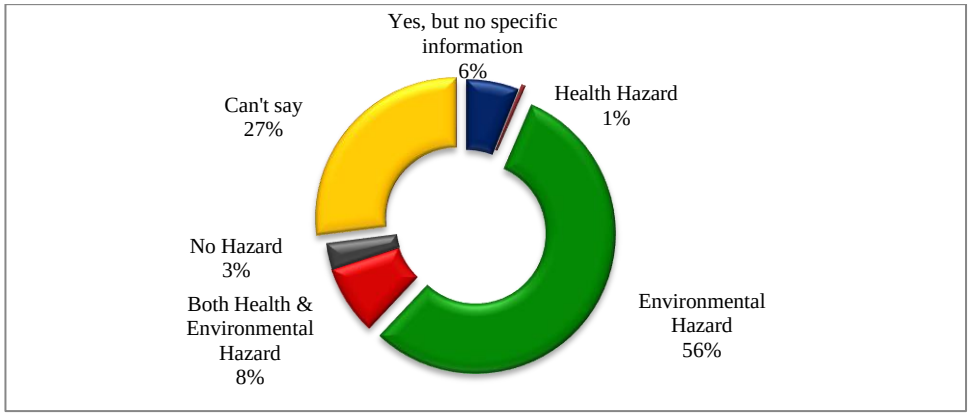


Fig. 6. Public Perception Regarding Hazards of E-Waste
***Source**: Primary survey, 2017*

The results indicate that around two third of those surveyed were of view that growing e waste poses a risk either to health or environment or to both. The participants were also enquired if they aware about presence of any precious components in e-waste. From the primary survey data, it was revealed that 52 per cent of them were not sure about it and 46 per cent denied the presence of precious fractions in e waste. Only 2 per cent of the total respondents were agreed that they are aware. Knowledge of laws and rules in force in the country has been known to play an important role in determining the individual preference. The level of awareness regarding policy for e-waste management in India has been found abysmally low. It has been found out that none of the respondents claimed to know the policy regarding e-waste handling, disposal or management in force in the country. An overwhelming 93 per cent of the respondents in the study area marked 'not aware of any policy. Around 3 per cent said that there is no such policy.

E-Waste Management Strategies and Stakeholder's Willingness

Willingness to do something is the first successful achieved stage of strategic plan. No plan can be successful without will. The participants in the study area have been asked if they were willing to forego economic benefits from unused electronic equipment by giving them for free if they were ensured that environmentally sound management techniques will be adopted to recycle them. A majority (63 per cent) has been found to be unwilling whereas 28 per cent of them were ready to give their unused products for free for environmental cause (Figure 7).

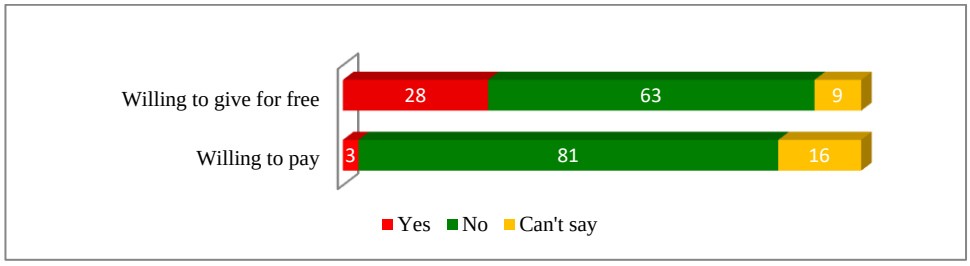


Fig. 7. Respondents Participation in Environmentally Sound E-Waste Management Strategies

***Source**: Prepared by Authors*

Junk Dealers and E-waste Management

Junk dealers are the primary supplier of domestic e-waste to bigger dealers (Rajya Sabha, 2011). They are involved in collection, handling, transportation, storage, dismantling and in many other processes during the movement of e-waste which are known to have toxins. Even crude dismantling can cause harm to the health of the workers and release toxins in the environment. For instance, the method of 'recycling' of CRT TV units and computer monitors by junk dealers includes manual breakage of the glass at the shop. The CRT glass contains an extensive variety of hazardous substances such as heavy metals and persistent organic pollutants.

Apart from mercury, phosphorous, barium oxide and strontium oxide, the glass of one CRT device contains 1 - 4 kilograms of lead mostly in the form of lead oxide. Crushing of CRT glass releases the contaminants into air, soil and groundwater and poses risk to occupational health and safety. Junk dealers are not aware about these hazardous risks. The level of awareness regarding the risk to health posed by hazardous pollutants present in electronic equipment was found to be highly insignificant. Low level of awareness regarding occupational hazards also attributed to absence of any safety measures taken by them. This observation has been seen in the light of the fact that compulsory registration of recyclers has been mandated by E-waste (management and handling) Rules, 2011 which have been in force since 01 May, 2012. None of the interviewees had any information about the rules regarding e-waste handling. Despite the provisions for punitive measures in case of violation of E-waste (management and handling) Rules, 2011, abysmally low level of awareness regarding the rules has been observed among those interviewed. As per the study done by Anand (2010) the four R's (reduce, reuse, recycle and recovery) is best strategies to manage the waste.

Conclusion

From the study conducted, it has been found that most of the householders surveyed did not perceive their unused electronic equipments as waste. Popularity of the belief that the discarded products are used to recover the components indicates that the residents had an idea of existence of some industry which would be involved in reuse and recycling of disposed electronic products. Most people are neither aware of existence of any precious components in the electronics nor of toxicity. Highly unaware of the occupational hazards, no safety measures have been found to be adopted while dismantling the e-waste. The study reveals that electronic equipments have well penetrated the area under study in the last ten years. The study uncovers the peculiar case of mobile phones in the electronics market as well as in generation of electronic waste in the study area. Lack of awareness among consumes as well as junk dealers has led to environmentally unsound techniques of disposal. The study has proved that income level has a positive correlation with ownership as well as frequency of disposal of a product which proves the first hypothesis of the study conducted. The popular belief found among the residents is that government or municipality must be financially responsible for e-waste management. Negligible number of respondents have been found to be willing to financially participate in environmentally sound and sustainable e-waste management. Their unwillingness to forego economic benefits in return of their unwanted electronics resulted in low level of participation in environmentally sound e-waste management strategies. It is economy which has been found to run the whole informal recycling sector of which junk dealers (kabadiwalas) are the first and most important link. They have been found to be highly unaware of the issues associated with e-waste. Even the compulsory registration with CPCB as mandated under the Hazardous Waste (Management, Handling and Trans-boundary Movement Rules), 2008 has not been found be acknowledged by any of the junk dealer which can invite punitive measures. In order to have urban sustainability, awareness level of people and junk dealers should be enhanced by using different modes.

References

1. Anand, S., 2010. “Solid Waste Management” Mittal Publications, New Delhi.
2. Badoni, P.D., 2009. “Waste management in India” *Technology Focus*; 52-58.
3. Balde, C.P., Wang, F., Kuehr, R., Huisman, J. (2015): The global e-waste monitor - 2014, United Nations, University, IAS - SCYCLE, Bonn.
4. Bradley, L. (2014) “E-Waste in Developing Countries Endangers Environment, Locals”, U.S. News, 1st August https://www.usnews.com/news/articles/ 2014/08/01/e-waste-in-developing-countries-endangers-environment-locals accessed on May 03, 2016.
5. CEAMA, 2014. “Opportunities and Challenges in Consumer Electronics & Home Appliances”, accessed at https://www.scribd. com/document/242141479/ Consumer-Appliances-Report
6. Census of India. 2011. Government of India New Delhi. Accessed at http://www.censusindia.gov.in/2011-Common/CensusData 2011.html
7. DPCC (2010). Public Notice issued. 11th March. Accessed at http://dpcc.delhigovt.nic.in/ewaste-action.html accessed on May 20, 2016.
8. Dutta, S. 2017. E waste: Tackling India’s Next Big Waste Problem. NDTV, 30th May http://swachhindia.ndtv.com/e-waste-tackling-indias-next-big-waste-problem-6126/ accessed on June 7, 2017.
9. Dwivedy, M., Mittal R.K. 2013. “Willingness of residents to participate in e-waste recycling in India” *Environmental Development* 6 (2013): 48-68.
10. Kaur, H.and Goel, S. (2016). E-Waste legislations in India - A Critical Review.*Sage Publications,* 41(1), 63-69
11. Khetriwal, D.S. 2009. “Producer responsibility for e-waste management: Key issues for consideration - Learning from Swiss experience” *Journal of Environmental management* 90 (2009): 153-165. doi: 10.1016/j.jenvman.2007.08.019
12. Kidee, P., Naidu, R., and Wong, M.H. 2013. “Electronic Waste Management Approaches: An Overview” *Waste Management* 33(2013): 1237-1250. doi: 10.1016/j.wasman.2013.01.006
13. Olowu, D. 2012. “Menace of E-wastes in Developing Countries: An Agenda for Legal and Policy Responses” *Law, Environment and Development Journal* 8, 59.
14. Perkins, D.N. 2014. “E-Waste: A Global Hazard” *Annals of Global Health* 80: 286-295. doi:10.1016/j.aogh.2014.10.001
15. Press Information Bureau, 2016. “Estimated Generation of E Waste”, July 18, 2016, accessed at http://pib.nic.in/newsite/mbErel.aspx?relid=147206
16. PTI. 2014. “E-waste market growth in India to surpass China's: Report”. The Economic Times. December 30, 2014 Accessed at http://articles.economictimes.indiatimes.com/ 2014-12-30/news/575289 92_1_e-waste-research-report-compound-annual-growth-rate
17. PTI. 2014. “India 5th biggest generator of e-waste in 2014: UN report” The Times of India. Newspaper.
18. Puckett, J., Byster, L., S., Gutierrez, R., Davis, S., Hussain, A., Dutta, M. (2002). Exporting Harm: The high-tech trashing Asia. Accessed at http://archive.ban.org/E-waste/technotrashfinalcomp.pdf February 25, 2015.
19. Rajya Sabha. 2011. “E-Waste in India” Research Unit (LARRDIS), Rajya Sabha Secretariat, New Delhi. Accessed at http://rajyasabha.nic.in/rsnew/publication _electronic/E-Waste_in_india.pdf June 2011.
20. The Hindu. 2016. “Bangalore is major e-waste generator” Accessed at http://www.thehindu.com/news/cities/bangalore/bangalore-is-major-ewaste-generator/article5347935.ece# June 02, 2016.

21. The Times of India. 2013. “Delhi’s growth steady but slowdown casts shadow” Accessed at http://timesofindia.indiatimes.com/city/delhi/Delhis-growth-steady-but-slowdown-casts-shadow/articleshow/19079210.cms March 20, 2013.
22. UNEP. 1992. “Report of the first Meeting of the Conference of Parties to the Basel Convention”, held at Piriapolis, Uruguay, December 03-04, 1992 accessed at http://www.basel.int/TheConvention/ConferenceoftheParties/RulesofProcedure/tabid/2281/Default.aspx
23. Upadhyaya, A. 2015. “China’s solar panels cause dark spots in Indian market”, 3rd January Accessed at http://articles.economictimes.indiatimes.com/2015-01-03/news/57633 9181tata-power-solar-panels-gagan-pal June 05, 2015.
24. Vnugopal, V. 2011. “Disposal of household e-waste and unaddressed issue”, The Hindu, 22nd August. Accessed at http://www.thehindu.com/todays-paper/tp-national/tp-tamilnadu/disposal-of-household-ewaste-an-unaddressed-issue/article2381282.ece June 14, 2015.
25. Wath, S.B., Vaidya, A.N., Dutt, P.S., and Chakrabati T. 2010. “Roadmap for development of sustainable E-waste management system in India” *Science of the total Environment* 409: 19-32. doi:10.1016/j.scitotenv.2010.09.030

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 136-146
ISSN 0019-4824

SPATIAL ANALYSIS OF CRIMES IN TIRUCHIRAPPALLI CITY, TAMIL NADU

Mary Santhi P. and Balaselvakumar S.

Department of Geography, Periyar E.V.R. College (Autonomous), Tiruchirappalli - 620 023
E-mail: sbaalakumar@gmail.com

Abstract

The index of crime concentration has been calculated for the Tiruchirappalli city in the year 2012 to 2017, that among all the 18 police stations the Sessions Court, Airport and Edamalaipattipudur police stations had recorded the maximum concentration of rubbery with 1.3%, Burglary with 1.1% and murder for gain with 5.5%, when the total crime rate in a particular police station (PR) was compared to the total major crimes in the study area (SR). This been found because of alcohol and drug abuse, poverty, peer influence, family and society circumstances, greed, anger, and revenge.

Keywords: Crime concentration, Crime rate, Police station, Population, Geoinformatics

Introduction

Crime is not equally distributed across the world. Criminologists have explored crime distribution and the factors supposed to contribute to these between-area differences in crime at many levels of geography (Weiburd et al. 2012; Eck and Weisburd 1995; Evans and Herbert 1989; Felson 1987; Pierce et al. 1988; Weiburd and Green 1994; Weiburd et al. 1992; to examine the impact of structural characteristics on levels of crime across states (Loftin and Hill 1974), cities (Baumer et al.,1998), neighbourhoods (Bursik and Grasmick. 1993; Wilson 1987). Some places suffer from significantly higher rates of crime than others (Guerry 1833; Park 1925; Shaw and McKay 1942; Reiss and Tonry 1986; Sampson 1985; Smith 1986) and even single addresses (Sherman et al.1989). Recently, the term concentration has been used to describe the tendency of crime to be tied to a small number of places within a given city. Theoretical reasons to believe that any observed variation in the concentration of crime may have implications for the total volume of crime, which occurs within a city's borders. The spatial concentration of crime is associated with differences in crime.

Study Area

Tiruchirappalli city's base map had been framed from the Survey of India (SOI) Toposheets Nos. 58 J/9, 10, 13 and 14. The city lies between the latitudes 10° 43' 40"- 10° 53' 00" North and the longitudes 78° 38' 14" - 78° 48' 50" East (Figure 1). The Cauvery delta begins to form 16 km west of the city, where the river splits into two the Cauvery and

the Kollidam to form the island of Srirangam. The topography of Tiruchirappalli city is relatively flat and its average elevation is 88 metres from mean sea level. Some isolated hillocks grow beyond the surface, the topmost of which is the Rockfort. Its projected age is 3,800 million years and it is marked as one of the ancient rocks in the world.

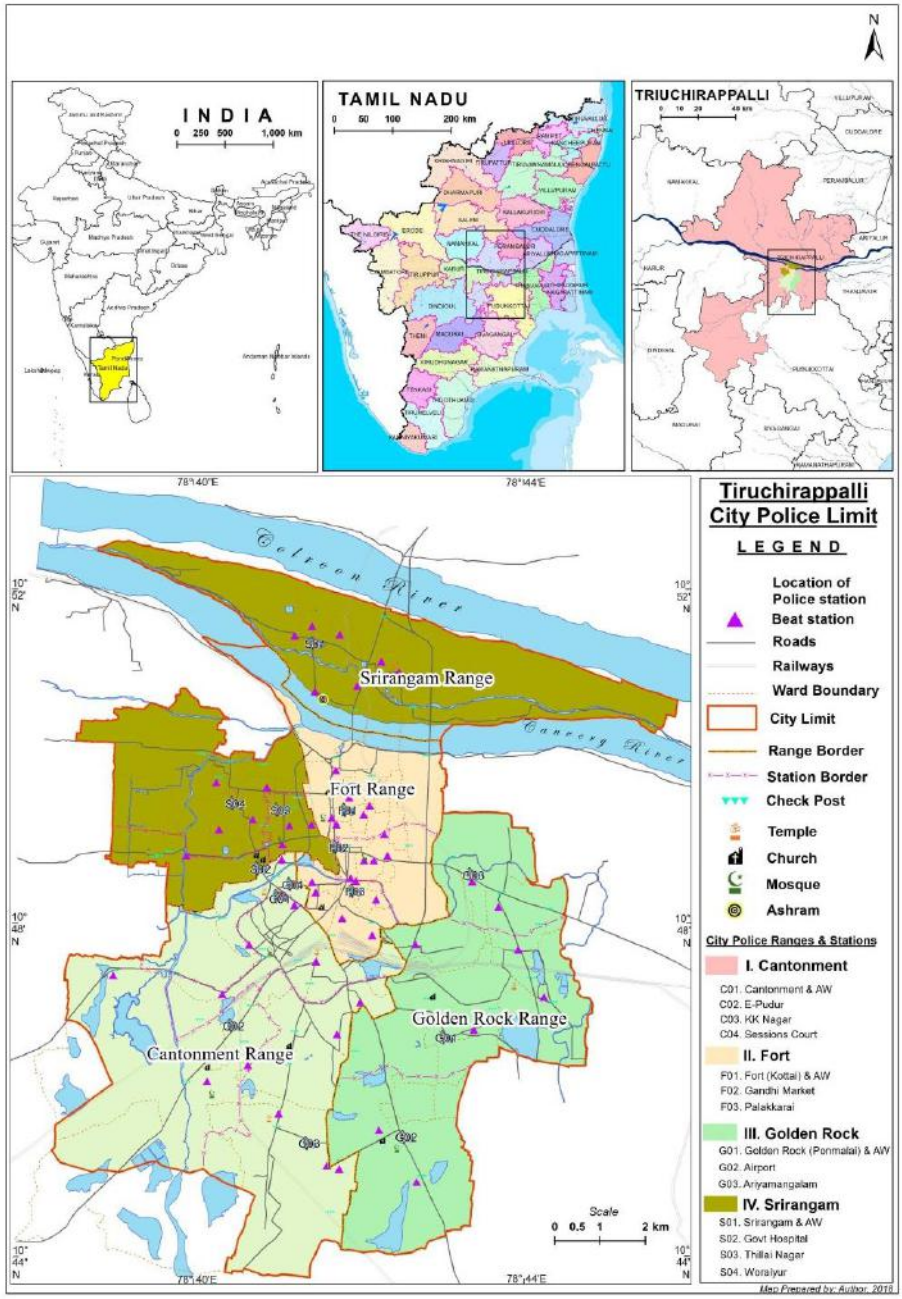


Fig. 1. Location of the Study Area - Tiruchirappalli City Police Limit

Other prominent hillocks include the Golden Rock, Khajamalai, Uyyakondan Thirumalai and Thiruverumbur. The river Cauvery and its distributary Kollidam facilitate Tiruchirappalli city also the city is fertilised by the Uyyakondan, Kudamuritti and Koraiyar canal. The land closely adjoining the Cauvery River, which crosses Tiruchirappalli city from west to east, consists of fertile alluvial soil deposits on which crops like paddy, banana and sugarcane are cultivated and in dry soil, finger millet and maize are cultivated nearby. Further south, the surface is enclosed by poor quality black soil. A belt of cretaceous rock known as the Trichinopoly group runs to the northeast of the city and the southeast there are layers of Achaean rocks, granite and gneiss covered by a thin bed of conglomeratic laterite.

Database and Methodology

The index of concentration of a certain crime would give the concentration of that crime in a particular area to its surrounding area of persons and property. These indexes volume of crime rate have been calculated for murder, murder for gain, dacoity, theft, burglary and robbery crimes for the years 2012 and 2013, 2014 and 2015, 2016 and 2017 of Tiruchirappalli city for better understanding of each crime in a particular police station with its population. The following formula is used to assess the police station-wise concentration level of above said crimes which were considered as major crimes in the study area (Hari Shripati Vanamore 2012).

CR= PR/SR

where, CR= concentration rate of X crime
PR = % of X crime in the total crimes in a particular police station.
SR= % of X crime in the total crimes in the study area.
The resultant map gives the police station-wise concentration of major crime.

Results and Discussion

Index of Crime Concentration of Murder

From the year 2012 to 2017, a high concentration of murder was reported in the police stations of Edamalaipattipudur with 1.7%, Palakkarai, and Gandhi Market with 1.6%. The medium concentration of murder was recorded in Sessions Court with 1.5%, Cantonment and Golden Rock police stations with 1.2%, Ariyamangalam and Government Hospital police stations with 1.4%. The low concentration of murder was found in Thillainagar police station with 1.0%, K.K. Nagar and Srirangam police stations with 0.5%, Airport police station with 0.6%, Woraiyur police station with 0.7% and Fort police station with 0.8% (Figure 2).

In 2012 and 2013, a high concentration of murder was found in Airport, Golden Rock, Edamalaipattipudur, Cantonment, Gandhi Market, Government Hospital and Ariyamangalam police stations with 1.0% to 1.9%. Only Thillainagar police station showed a

medium concentration of murder with 1.0%. K.K. Nagar, Fort, Srirangam and Woraiyur police stations reported low concentration of this crime with 0.01% to 0.8%, and Sessions Court and Palakkarai police stations did not register any crime of murder.

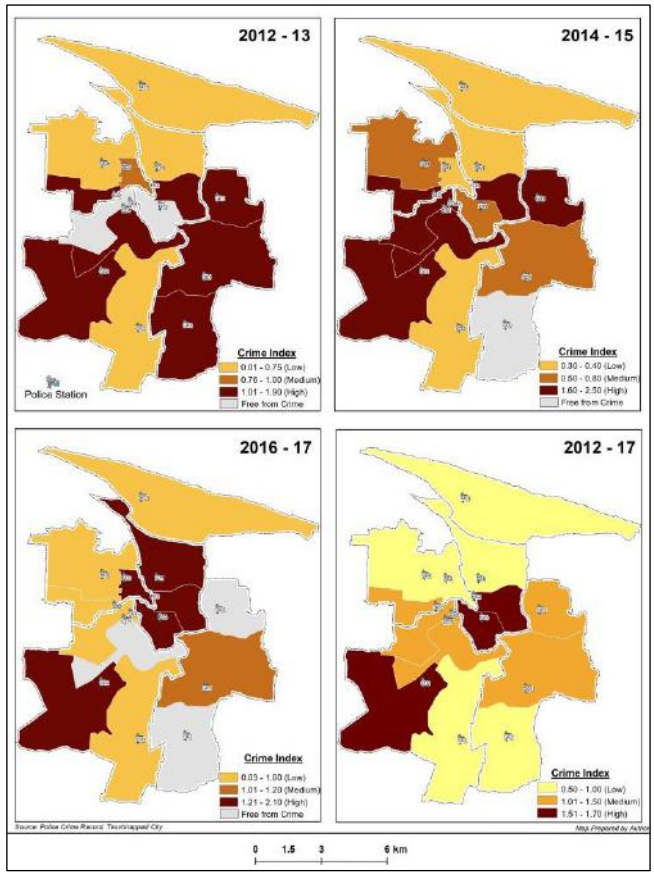


Fig. 2. Concentration of Crime - Murder

A high concentration of murder was found in Cantonment, Sessions Court, Edamalaipattipudur, Ariyamangalam, Gandhi Market and Government Hospital police stations with 1.0% to 2.5%. Golden Rock, Palakkarai and Woraiyur police stations recorded medium concentration with 0.5% to 0.8% and low concentration of this crime was recorded in K.K Nagar, Fort, Srirangam and Thillainagar police stations with 0.3% to 0.4%. Only Airport police station was free from the crime of murder in the years 2014 and 2015.

In the years 2016 and 2017, a high concentration of murder was found in Fort, Palakkarai, Edamalaipattipudur, Gandhi Market and Thillainagar police stations with 1.2% to 2.1%. Golden Rock police stations recorded medium concentration with 1.2%. Low concentration of this crime was recorded in Sessions Court K.K Nagar, Srirangam, Woraiyur and Government Hospital police stations with 0.0% to 1.0% and Cantonment, Airport, Ariyamangalam police stations did not record any crime of murder.

Index of Crime Concentration of Murder for Gain

From the year 2012 to 2017, a high concentration of murder for gain was recorded in Sessions Court police station with 5.5%, the medium was recorded in Edamalaipattipudur, Thillainagar and Government hospital police stations with 2.3% to 2.9%. Low concentration of murder for gain was found in K. K Nagar and Fort police stations with 1.2% to 1.7% and the rest were free from this crime (Figure 3). In the years 2012 and 2013, a high concentration of murder for gain was found in Thillainagar police station with 8.0%. Low concentration of this crime was reported in Edamalaipattipudur police station with 5.0%, and other police stations were free from this crime.

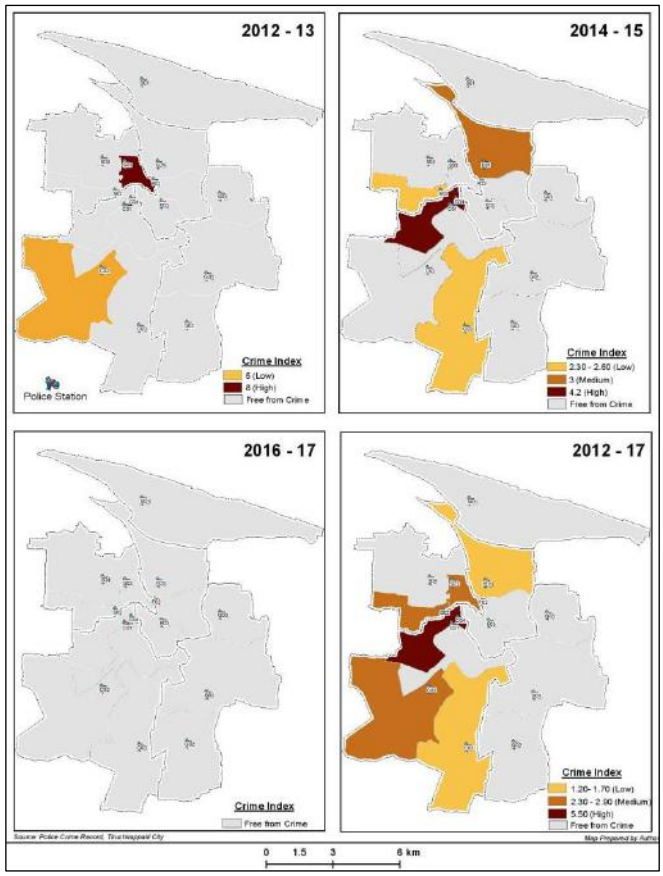


Fig. 3. Concentration of Crime - Murder for Gain

A high concentration of murder for gain was found in Sessions Court police station with 4.2%. Fort police station was recorded as medium concentration area with 3.0%. Low concentration of this crime was recorded in Government Hospital and K. K Nagar police stations with 2.3% to 2.6% and the other police stations did not record any crime of murder for gain in the years 2014 and 2015. There was no record of murder for gain in any police stations in the years 2016 to 2017.

Index of Crime Concentration of Dacoity

From the year 2012 to 2017, the crime of dacoity was recorded only in Srirangam police station, with 8.2% and the rest of the police stations were free from this crime. In 2012 and 2013, the entire city was free from the crime of dacoity. A high concentration of dacoity was found in Srirangam police station in the years 2014 and 2015 with 5.0% and in the years 2016 and 2017 with 6.5% and the rest was free from the crime of dacoity (Figure 4).

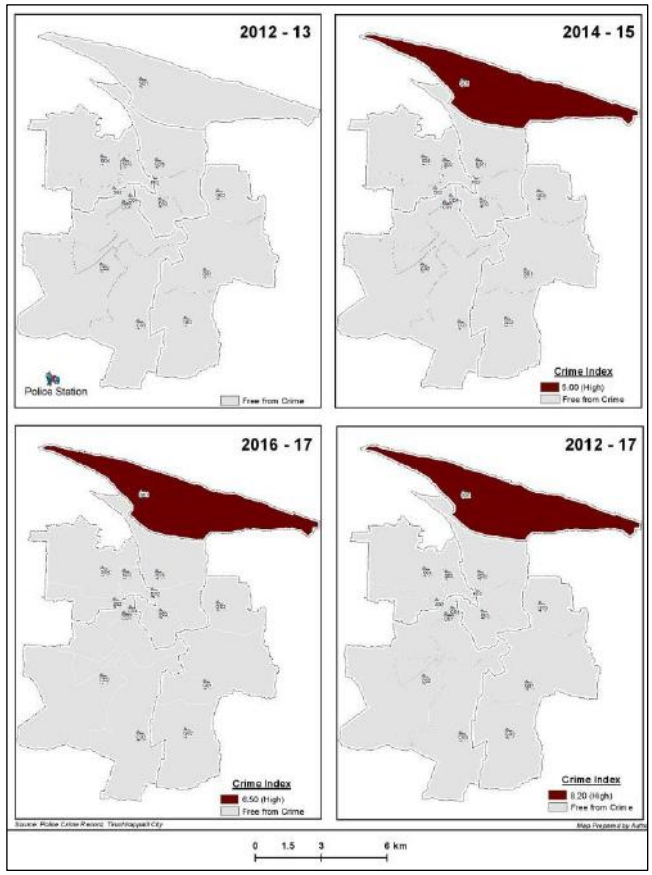


Fig. 4. Concentration of Crime - Dacoity

Index of Crime Concentration of Burglary

From the year 2012 to 2017, a high concentration of burglary was reported in Ariyamangalam police station, with 2.5%. Medium concentration was recorded in Edamalaipattipudur, K.K. Nagar, Srirangam, Woraiyur and Government Hospital police stations with 1.1% to 1.5% and low concentration of burglary was found in Cantonment, Golden Rock, Fort, Palakkarai and Gandhi Market police stations with 0.5% to 1.0% (Figure 5). Airport and Sessions Court police stations were free from this crime.

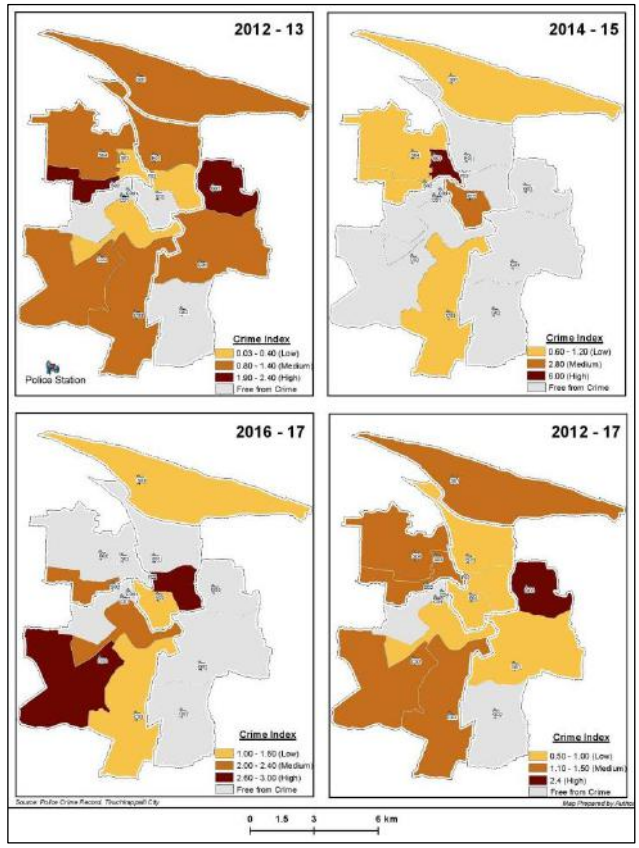


Fig. 5. Concentration of Crime - Burglary

In 2012 and 2013, a high concentration of burglary was found in Ariyamangalam and Government Hospital police station, which is 1.9% to 2.4%. Srirangam, K. K. Nagar, Woraiyur, Fort, Golden Rock and Edamalaipattipudur police stations recorded 0.80% to 1.4% as medium concentration areas. Low concentration of burglary was recorded in Cantonment, Gandhi Market and Thillainagar police stations with 0.0% to 0.4% and others were free from burglary.

A high concentration of burglary was found only in Thillainagar police station with 6.0% and Palakkarai police station recorded medium concentration with 2.8%. Low concentration of this crime was found in K.K Nagar, Government Hospital, Woraiyur and Srirangam police stations with 0.6% to 1.2% and the rest were free from burglary in the years 2014 and 2015.

In the years 2016, and 2017, a high concentration of burglary was found in Edamalaipattipudur and Gandhi Market police stations with 2.6% to 3.0%. Government Hospital and Cantonment police station recorded medium concentration with 2.0% to 2.4%. Low concentration of this crime was recorded in Srirangam, Palakkarai and K.K Nagar police stations with 1.0% to 1.6% and the rest were free from the crime of burglary.

Index of Crime Concentration of Theft

From the year 2012 to 2017, Fort police station reported a high concentration of theft with 1.9%. Medium concentration was recorded in Gandhi Market, Airport, K.K. Nagar and Cantonment police stations with 1.1% to 1.4 % and low concentration of theft was found in Government Hospital, Thillainagar, Srirangam, Woraiyur, Ariyamangalam and Edamalaipattipudur police stations with 0.8% to 1.0% (Figure 6).

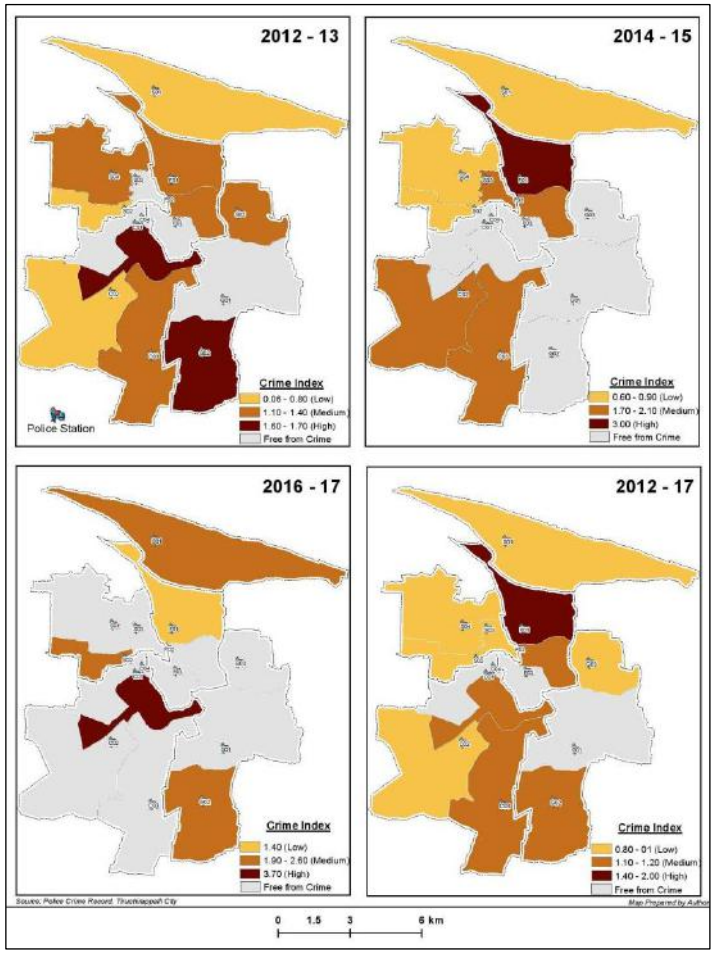


Fig. 6. Concentration of Crime - Theft

In 2012 and 2013, a high concentration of theft was found in Airport and Cantonment police stations with 1.6% to 1.7%. Woraiyur, Gandhi Market, Fort, Ariyamangalam and K.K. Nagar police stations showed a medium concentration of theft with 1.1% to 1.4%. Srirangam, Government Hospital and Edamalaipattipudur police stations reported low concentration of this crime with 0.6% to 0.8 % and the rest were free from theft.

A high concentration of theft was found only in Fort police station with 3.0%. Thillainagar, Gandhi Market, K.K. Nagar and Edamalaipattipudur police stations recorded medium concentration with 1.7% to 2.1%. Low concentration of this crime was found in Government Hospital, Srirangam and Woraiyur police stations with 0.6 to 0.9% and others were free from theft in the years 2014 and 2015.

In the years 2016 and 2017, a high concentration of theft was found only in Cantonment police station with 3.7%. Government Hospital, Srirangam and Airport police stations recorded medium concentration with 1.9% to 2.6%. Low concentration of this crime was recorded only in Fort police station with 1.4% and the rest were free from theft.

Index of Crime Concentration of Robbery

From the year 2012 to 2017, Golden Rock and Airport police stations were reported as high concentration areas of robbery with 1.3%. Medium concentration was recorded in Woraiyur, Thillainagar, Srirangam, Palakkarai, Fort, K.K. Nagar, Sessions Court and Cantonment police stations with 1.0% to 1.1% and low concentration of robbery was found in Edamalaipattipudur, Ariyamangalam, Gandhi Market and Government Hospital police stations with 0.6% to 0.8% (Figure 7).

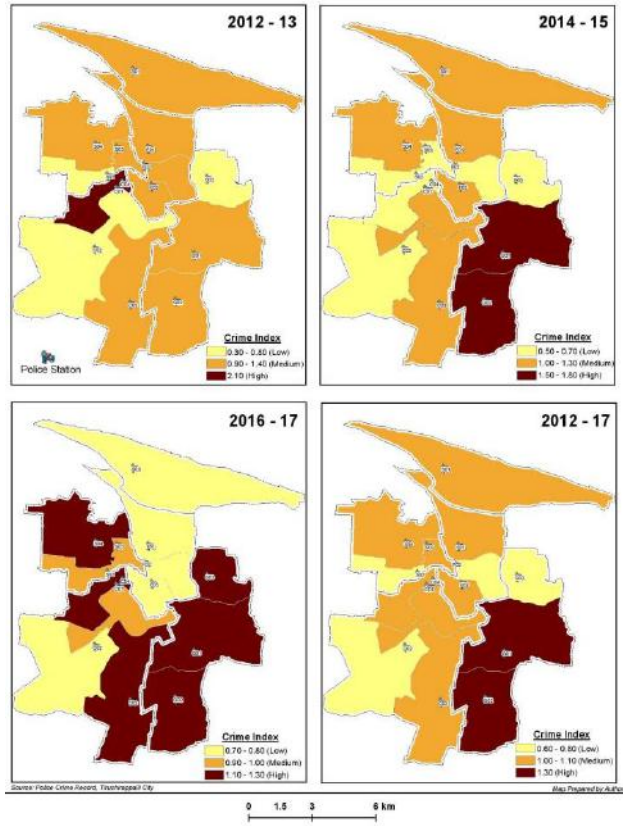


Fig. 6. Concentration of Crime - Robbery

In 2012 and 2013, a high concentration of robbery was found only in Sessions Court police station with 2.1%. K.K. Nagar, Golden Rock, Airport, Fort, Palakkarai, Gandhi Market, Srirangam, Thillainagar and Woraiyur police stations showed medium concentration with 0.9% to 1.4% and low concentration of this crime was recorded in Cantonment, Edamalaipattipudur, Ariyamangalam and Government Hospital police stations with 0.3 to 0.8%.

A high concentration of robbery was found in Golden Rock and Airport police stations with 1.5% to 1.8%. Cantonment, K.K. Nagar, Fort, Palakkarai, Srirangam and Woraiyur police stations recorded medium concentration with 1.0% to 1.3% and low concentration of this crime was found in Government Hospital, Thillainagar, Gandhi Market, Ariyamangalam, Edamalaipattipudur and Sessions Court police stations with 0.5% to 0.7% in the years 2014 and 2015.

In the years 2016 and 2017, a high concentration of robbery was found in Sessions Court, K.K. Nagar, Golden Rock, Airport, Ariyamangalam and Woraiyur police stations with 1.1% to 1.4%. Cantonment, Thillainagar and Government Hospital police stations recorded medium concentration with 0.7% to 0.8% and low concentration of this crime was found in Fort, Palakkarai, Gandhi Market, Edamalaipattipudur and Srirangam police stations with 0.0% to 1.0%.

Conclusion

The concentration of crimes varies with police stations as well as time and the following levels of crimes in the city of Tiruchirappalli have been formed to assess the police station-wise concentration of crimes. The concentration score of each police station has been calculated for major crimes of the city, and it shows that Edamalaipattipudur, Sessions Court and Thillainagar police stations recorded a high concentration of murder and murder for gain. A high concentration of burglary and theft was recorded in Ariyamangalam, Airport and Fort police stations. Golden Rock, Airport and Sessions Court police stations reported a high concentration of robbery and only Srirangam police station recorded a high concentration of dacoity in the city. Therefore, it is finalized that among all the 18 police stations the Sessions Court, Airport and Edamalaipattipudur police stations had recorded the maximum concentration of major crimes in the city for the years 2012-2017, when the total crime rate in a particular police station (PR) was compared to the total major crimes in the study area (SR). The main causes for the index of concentration of major crimes in the study area are poverty, parental neglect, low self-esteem, alcohol and drug abuse, peer influence, hormones changes, family and society circumstances, greed, anger, jealousy, revenge, pride etc.

Acknowledgement

The authors are thankful to Tiruchirappalli City Commissioner of Police for providing the necessary data to carry out this study.

References

1. Baumer, E., Lauritsen, L.J., Rosenfeld, R. and Wright, R., (1998): "The Influence of Crack Cocaine on Robbery, Burglary and Homicide Rates: A Cross-City, Longitudinal Analysis", Journal of Research in Crime and Delinquency, Vol. 35, No. 3, pp. 316-340.
2. Bursik, R., and Grasmick, G.H., (1993): "Neighborhoods and Crime: The Dimensions of Effective Community Control", Lexington Books, New York.
3. Eck John., E. and Weisburd, D., (1995): "Crime Places in Crime Theory", In: Eck, J.E. and Weisburd, D. (Edited), Crime and Place: Crime Prevention Studies, Willow Tree Press, Monesy, Vol. 4, pp. 1-33.
4. Evans, J.D. and Herbert, T.D., (1989): "The Geography of Crime (RLE Social & Cultural Geography)", Routledge Publishers, London, https://doi.org/10.4324/9781315848587
5. Felson, M., (1987): "Routine Activities and Crime Prevention in the Developing Metropolis", Criminology, Vol. 25, No. 4, pp. 911-932.
6. Guerry, A.M., (1833): "Essay on Moral Statistics of France", Clearwater, Paris.
7. Hari Shripati Vanamore (2012): "Spatial Patterns of Crimes in Maharashtra (A Geographical Perspective). Shri Jagdishprasad Jhabarmal Tibrewala University, Jhunjhunu (Unpublished Ph.D thesis)
8. Loftin, C., & Hill, R. H., (1974): "Regional Substructure and Homicide: An Examination of the Gastil-Hackney Thesis", American Sociological Review, Vol. 39, No.5, pp. 714-724
9. Park, R. E., (1925): "The City: Suggestions for Investigation of Human Behavior in the Urban Environment", In: Park, R. E.; Burgess, E. W (Eds). The City, University of Chicago Press, Chicago, pp. 1-46.
10. Pierce, L.G., Spaar, S. and Briggs, R.L., (1988): "The Character of Police Work: Strategic and Tactical Implications", Center for Applied Social Research, Northeastern University, Boston.
11. Reiss, A.J. and Tonry, M. (1986): "Communities and Crime", University of Chicago Press, Chicago
12. Sampson, R.J., (1985): "Structural Sources of Variation in Race-Age-Specific Rates of Offending Across Major U.S. Cities", Criminology, Vol. 23, No. 4, pp. 647-673.
13. Shaw, C.R. and McKay, H.D., (1942): "Juvenile Delinquency and Urban Areas: A Study of Rates of Delinquents in Relation to Differential Characteristics of Local Communities in American Cities. The University of Chicago Press, Chicago.
14. Sherman, L. W., Patrick Gartin, and Michael Buerger (1989): "Hot Spots of Predatory Crime: Routine Activities and the Criminology of Place", Criminology, Vol. 27, No. 1, pp. 27-56.
15. Smith, S., (1986): "Crime, Space and Society", Cambridge University Press, Cambridge, DOI: https://doi.org/10.1017/S0021932000018459
16. Weisburd, D. and Green, L., (1994): "Defining the Street Level Drug Market", In: D. L. MacKenzie and C. Uchida (Eds), Drugs and Crime: Evaluation Public Policy Initiatives, Sage Publications, California, pp. 61-76.
17. Weisburd, D., Maher, L. and Sherman, W.L., (1992): "Contrasting Crime General and Crime Specific Theory: The Case of Hot Spots of Crime", In: Advances in Criminological Theory, Freda Adler and William S. Laufer (Eds), Transaction Press, New Jersey, pp. 45-69.
18. Weisburd, D., R.G. Elizabeth and Sue-Ming Yang (2012): "The Criminology of Place: Street Segments and our Understanding of the Crime Problem", Oxford University Press, Oxford.
19. Wilson, W. J., (1987): "The Truly Disadvantaged: The Inner City, the Underclass and Public Policy", University of Chicago Press. Chicago

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 147-150
ISSN 0019-4824

Review

THE VULNERABLE ANDAMAN AND NICOBAR ISLANDS - A STUDY OF DISASTERS AND RESPONSES

by Punam Tripathi: Routledge, London And New York, 2018, 334 page + XIX, 58 Figures, 64 Tables (ISBN:978-1-138-32355-1), Rs.1095

The book titled 'The Vulnerable Andaman and Nicobar Islands: A Study of Disasters and Responses' is an attempt to examine the incidence of disasters in Andaman and Nicobar Islands since recorded history and to analyse nature and impact of responses that follow the occurrence of each disaster event. To the author of this book, disaster is an 'event that causes large scale killing and destruction within a short period' (p. 18). Disaster results from a combination of incidences of hazards, exposure, and vulnerability. It not only disrupts the regular lives of affected communities and the area concerned but also halts development efforts. Due to societal relevance, policy implications, and multi-disciplinarily, the subject of disaster management is an emerging field, drawing the attention of scholars of various disciplines, professionals, policymakers, and the even larger society.

Punam Tripathi, developed this book from her doctoral dissertation accomplished in the Department of Geography, Delhi School of Economics, Delhi. The objective of this book is 'to understand the overall profile of disasters - the facts, causes, damage, response and recovery - in the Andaman and Nicobar (A&N) Islands' (p.ii) and to raise some critical questions concerning the approach to disaster management in the country. It is here that the book transcends the geographical boundary of Andaman and Nicobar Islands, and provides significant lessons with implications.

The A & N Islands experienced three types of disasters: the epidemics in the late nineteenth century, World War II, and the Tsunami, 2004 (p.18). The partition of India in 1947 added a new dimension to the vulnerability of the A & N Islands. This book consists of 11 chapters forming two distinct parts. The first part comprising of the 2,3 and 4 Chapters discusses human-induced disasters caused by ex-situ anthropogenic factors. Incidence of the 19thcentury epidemics was a direct result of the expansion of British rule and their decision to use this island as a penal colony. The A & N Islands were affected and witnessed a loss of 90 percent of the tribal population. The native people, who grew up as part of nature without any exposure to the outside world, were physically, mentally, and culturally invaded in the name of civilizing them. A similar situation was reported from other parts of the world as well. The sixteenth-century witnessed the destruction of native people in the New World by the Europeans. The settlement of non-native people in the A & N Islands has started growing since the last few decades of the18th Century. The Islands turned into a British colony, and the local tribal people became subject to the colonialist mechanism with no choice left for themselves.

The next disaster was the World War II. The tiny Islands turned into the battleground between the British and the Japanese, suffered from the Wartime damages. The A & N Islands became part of British India after the War there were reconstruction activities in selected areas of the Islands. The partition of India added a new dimension to cultural invasion. The mainland India treated the A & N Islands as 'dump yard' to settle the refugee population (p. 81). The situation has not improved much in the post-independence period, and the local tribal people continue to suffer from increasing vulnerability. Colonial hegemonistic intrusion by the British, the Second World War, and settlement of refugees following the partition of India in 1947 singularly and in combination affected the original inhabitants to the verge of extinction. The tribal people not only dwindled in number but also lost much of their habitat and become culturally defenseless. Thereby, the vulnerability of traditional people of the A & N Islands has elevated further.

The Chapters from 5 to 10 have deliberated on the incidence of the 2004 Tsunami and related issues. The 2004 Tsunami was one of the worst natural hazards and affected several countries in Asia. Globally, the number and scale of natural hazards are increasing over the years. Apart from the A & N Islands, the states of Tamil Nadu and Kerala have also experienced the Tsunami devastation. However, the A & N Islands were the worst hit. It is important to note that the Tsunami was not on the list of hazards in India before 2004. Discussion in the book addresses the occurrence of the 2004 Tsunami, damage, vulnerability, response, compensation, and recovery. The configuration of the A & N Islands changed. People living in these islands have suffered from physical damage, psychological problems, and emotional stress.

The Tsunami impacts were devastating for the Islands. Its aftermath continued in subsequent years. Even now, reconstructions are not complete. The author discussed forest destruction, impact on coral reef, affected livelihoods-fishing, agriculture, livestock, small scale industry, tourism, and damages to infrastructure including schools, medical services, water supply, power supply and communication, transport, and housing. The damage index computed based on 11 indicators is a good exercise. Placing islands under different categories of damages helps to evolve the place-based planning. The author has also worked out a 'damage divide' between the Andaman Islands and Nicobar Islands (p. 145) and attributes high damage experienced in the Nicobar Islands due to its vulnerable nature. The concentration of infrastructures in susceptible areas is the main factor behind so much damage.

The Chapter 7 is on vulnerability and the Tsunami. The Vulnerability factors have been central to the development of disaster research (Alam and Collins, 2010). There are contestations about the definition of the term vulnerability and the underlying factors to compute it. There is also a contextual issue to which vulnerability is linked. Nevertheless, in broad terms, vulnerability refers to the population's capacity to anticipate, cope with, and recover from the impact of a hazardous event.

Several factors like response processes, infrastructure, socially uneven exposure, settlement development patterns, and livelihoods contribute to it. The author discussed all these issues and tried to compute the composite vulnerability index considering socio-economic variables and the state of infrastructure facilities. This concept is in tune with the emerging global thrust of following integrated and multidisciplinary approaches, which will 'allow consideration of the physical context, the complexity and dynamics of social and environmental systems, and the relationship between them. A holistic approach will encourage more effective risk governance and management through development of preventative strategies to face risks and disasters' (Charlotte, 2011 :11)

The discussion on vulnerability covered four issues: spatial pattern, its correspondence to killed and damaged, vulnerable group, and underlying causes of vulnerability. The author conducted a sample survey to assess vulnerability. Analyses also bring out the state of physical infrastructure and the condition of homes during pre and post Tsunami. The discussion further covers the identification of the vulnerable population covering both tribal and non-tribal people. Tribal Nicobaries are the foremost vulnerable people due to several reasons that include the introduction of state programmes.

In Chapter 8 on the response, the deliberations cover the topics of disaster management during the Pre-Tsunami period, phase of immediate response-response of military, post-tsunami relief camp, the response of the NGOs, long term phase of response-allocation of funds for Tsunami relief, reconstruction, and rehabilitation, the expenditure of fund, reconstruction of infrastructure, building of post Tsunami houses, and restoration of livelihood. The following two chapters discuss compensation and recovery. The Chapter on recovery discusses the impact of the response and brings out ground reality. The author conducted extensive fieldwork to assess people's perception of the Government/non-government organizations' response to the Tsunami, which has been attempted by critically examining the recovery of assets and resources.

After detailed analysis, she has highlighted various issues that have policy connotation. One among her concluding observations, that "the focus was on reconstructing what has damaged in situ instead of taking the Tsunami as an opportunity to rebuild islands equitably" merit proper consideration to plan for Disaster Management. This concept is increasingly gaining ground across the world.

There were responses following each disaster. However, these responses were not sufficient. In some instances, like that during the partition and the refugee settlement, the vulnerability of the A & N Islands increased. Even response to the 2004 Tsunami did not address the vulnerable situation of the tribal Nicobarese. There are several such lessons to search out from the 2004 Tsunami and its management.

The author has succeeded to trace disaster incidence in the A & N islands in detail. Assessment of hazard, exposure, and vulnerability are valuable tools for people and policymakers to mitigate disaster risk. India's disaster management program has changed from a reactive, emergency response to a pro-active risk reduction approach following the 2004 Tsunami and also the Gujarat earthquake in 2001. To be handiest, decision-makers across various lines of state must have a robust understanding of the complex matrix of hazards, exposure, and vulnerability, and use this information to plan measures to form safe and resilient communities (The World Bank, 2012). This book serves a good purpose in this direction for Andaman and Nicobar Islands. The type of data generated, the utilisation of the RTI and the depth of analysis are commendable. This study on the A & N Islands goes to be useful for a pro-active approach in disaster management.

The analytical approach adopted to treat the subject matter, and the coverage has widened the horizon of this book from a case study of the A & N Islands to a critical evaluation of disaster management now practiced in the country. It is a valuable addition to the body of literatures dealing with vulnerability, hazards, and disaster management. The geographers, professionals, and students who are interested in the A & N Islands and the policymakers will find this book useful. As the starting point of research, this book embodies the high potential of a young researcher like Punam Tripathi. We are sure that she will bloom as an erudite researcher in geography in future and will contribute to the discipline.

Acknowledgment

The author expresses his gratitude to the Indian Council of Social Science Research (ICSSR), New Delhi for award of the ICSSR National Fellow that helped to complete this research.

References

1. Alam, E. and Collins, A.E., (2010). Cyclone Disaster Vulnerability and Response Experiences in Coastal Bangladesh. Disasters, 34 (4): 931–54.
2. Charlotte V. et al. (2011). Assessing Vulnerability to Natural Hazards in Europe: From Principles to Practice: A Manual on the Concept, Methodology, and Tools. Move, European Commission Research & Innovation D.G. Seventh Framework Programme, Cooperation Theme 6.
3. The World Bank, (2012) Disaster Risk Management in South Asia: A Regional Overview. The World Bank, Washington DC.

Dr. Srikumar Chattopadhyay, ICSSR National Fellow
Gulati Institute for Finance and Taxation, Thiruvanatapuram - 695 017
E-mail: srikumarc53@gmail.com

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 151-153
ISSN 0019-4824

Review

MAPPING PLACE NAMES OF INDIA

by Anu Kapur: Routledge, 2 Park Square, Milton Park, Abingdon, Oxon OX14 4r N And 52 Vanderbilt Avenue, New York, NY 10017, First Published 2019, Rs.695

This is an extraordinary book. Its uniqueness lies in a research based exploration of place names in India as these originated, evolved, changed and in some cases even disappeared through the ancient, medieval, colonial and post-independence periods of Indian history. The diverse interpretative connotations of the name of each state and union territory of India are placed under special lenses. The author convincingly observes that a place name mirrors the ecology, culture, polity and history of its habitat at large. It fixes the identity of various elements of a habitat within the rubric of a single word and serves as a bridge between its inhabitants and the world at large.

To achieve the well-defined objectives of the book, the author had to go through a plethora of historical texts, Imperial Gazetteers, settlement reports, travelogues, and parliamentary debates, among other sources. The real challenge lay in arriving at an authentic interpretation of place names covering all parts of linguistically diverse India through time and space. This was done with a remarkable ingenuity. This became possible only through interweaving of Geography of India and History of India.

The book under review is organised into nine chapters, each comprising sub-topics related to the theme. The chapter 1 introduces us to the meaning of place names, their significance in representing the ecology, culture, history and politics of the area in which these are located, and a variety of ways in which places can be identified without their names, such as Postal Index Number, latitude and longitude, path and row numbers on satellite imageries, What3words, and so on. The number of place names in India is reckoned as 1.5 to 2 million.

The chapter 2 details the origin of a variety of names which India carried from time to time, such as Jambudweep, Bharat, Hindustan, and of course India. The debates and conflicting views relating to adoption of the official name for India on the eve of independence are effectively represented. The adoption of the name as 'India that is Bharat 'finds a convincing explanation.

The chapter 3 offers an analytical frame work for understanding the origin and significance of names of states and union territories in India. An interesting observation is made by stating that National Anthem of India, 'Janaganamana', written by Rabindranath Tagore much before independence, covers virtually every part of the country. The multiple

interpretations of the names and states and union territories are projected as representing the ecological specificity, ethnic diversity, linguistic variety and historical experience of different parts of India. In the process a tapestry of the Indian Geography, through time, gets woven. This chapter, of course, offers a powerful discourse.

The chapter 4 deals with the etymology of place names in India. This the author calls as the phase of Sanskritisation. Several of place names of this period were linked with those of temples, gods and goddesses, and saints. Haridwar is an example. The number of sacred places of Hindus, Buddhists and Jains is impressive on the map of India today.

The chapter 5 covers the Persianization phase of place names in India. This refers to the medieval period of history when a large part of the country came under the rule of the Muslims. Hence the place names of this time find an association with Allah, or the name of the Muslim rulers or commander-in-chief, or a victory celebration. Take Allahabad as an illustration. In some cases, the place names of Sanskritisation phase were given an Islamic rendering.

The chapter 6 is titled as the phase of Englishization and Anglicization of place names. This was the colonial period of India history. In the case of Englishization, the place names, like that of hill stations, cantonment or railway stations, carried the name of some English viceroy or dignitary. Mussoorie readily comes to mind in this case. In the context of Anglicisation, the existing names were transformed or reworded in a manner that these became convenient to pronounce or spell by the English people. Kodagu became Coorg. Herein were involved the administrative and commercial convenience and interests of the British rulers.

The chapter 7 links the issue of place names with the ongoing sentiment of nationalism. An attempt is made here to figure out the impact of political ideology on the process of naming of places. Harnessing the information made available by the Census of India, an in-depth analysis is made of changes in the place names of India during 1941 to 2011. The primary focus here is on district names. The author regrets the lack of any well-defined policy on place names in India. Any issue is resolved on case to case basis.

The chapter 8 deals with the democratization phase of place names. In a very interesting manner, the discourse in this chapter is based on a interpretative study of parliamentary debates concerning finalisation of names of states and union territories of India or changes therein from time to time. Such a situation was very emotive at the time of reorganisation of states in 1956. Here we clearly understand how the matter of capital versus regional name, foreign versus indigenous name, single versus multiple names, existing versus popular names, and inclusive versus exclusive names were resolved through heated debates in the parliament. The democracy was at its best at such occasions.

The final chapter of the book is by way of a prognosis. It takes into account the names of sub-regions which are aspiring to be future states or union territories of India. This phase is marked by a sentiment of placenism, which in simple words can be equated with topophilia or intense love for one's habitat. This finds an expression through movements based on ethnic, linguistic or historical considerations.

The book is indeed an innovative treatise on place names. The core messages of the book are summed up in two phases: Place Gathers and Place Matters. Place gathers signifies that their names are a synthesis of the ecology, culture, economy, politics and history of the area of their location and place matters means that their names give birth to an emotional bonding of an individual with his or her habitat. The author rightly underlines the atma of a place as an ultimate geographic reality. If we are to realise this reality, a study of the book Mapping Place Names of India is a must for any one.

Prof. H. Nagaraj
Department of Studies in Geography, University of Mysore, Mysuru - 570 006
E-mail: nagarajh66@yahoo.com

The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 154-161
ISSN 0019-4824

Archives - 1

AN APPEAL TO THE UNIVERSITIES OF INDIA FOR CONSIDERING THE POSITION OF GEOGRAPHY AS A SCIENCE

By

Professor M. B. Pithawalla, D.Sc. (Geography), *Karachi.*

from **The Indian Geographical Journal**
Formerly Known as **The Journal of The Madras Geographical Association**
(Volume XVI, 1941, pp.33-41)

It is high time now to make an earnest appeal, through the medium of this popular Journal, to the authorities of all the Universities of India, for considering seriously the position of *Geography as a Science* and for developing its studies in the Faculties of Arts. Science, Commerce, Agriculture and Technology. Though Geography is a science of recent growth, it is not to be regarded in any way to be less important than the other branches of Science; on the contrary its claims are superior to those of some branches at least, and in this respect it must be remembered that its studies are greatly neglected by our Universities, unlike those of the West, which prescribe it not only as an independent subject of study and research but also as a subject allied to history, economics, ecology, anthropology, military science, etc. Hitherto Geography has been considered as a dry subject of no great importance, a mere matter of facts and figures to be crammed up at the Matriculation or Intermediate Arts examination only. But this state of affairs must now change and it must be regarded as a science of vital importance to India.

Comparative Statements of Indian and Foreign Universities

In support of my views, I give below a Statement (marked A) showing the position of Geography in all the 19 Indian Universities and another (marked B) showing its position in some foreign Universities. From these it will be clearly seen that while some advanced Universities have introduced Geography not only as a subject for examinations in the Arts as well as Science Faculties but also as a subject of research for higher degrees, others have done practically nothing in the matter, e.g. Bombay. By them just a spoonful of it has been prescribed for the Matriculation examination as a minor section of a paper and as an optional subject merely for the First Year or Intermediate Arts but without any practical test or examination, so that full scope has been given to the candidates for mugging up the subject, for examination purposes. Such an attitude of a great University towards *a subject of vital importance to students* is indeed deplorable. I have, since 1932, made frequent

appeals to the authorities in this connection in my own individual capacity but have invariably failed and papers have been merely filed or recorded.

Importance of Geography as a Science in these times

Geographical studies, in my opinion, must be considered to particularly important especially in these days of a world conflagration. Mr. N. Subrahmanyam, the Editor of this Journal has cleverly called it a *Geography War*. The League of Nations did their level best to popularise it. This is indeed a War in which geographical circumstances and geographical factors are performing a most prominent function. It is the geography of Europe and other affected parts of the world that has been the director of all land, sea and air operations. Several of the British and other professors of Geography are now working with the R.A.F., Fleet and Army at many places. Great nations such as U.S.A. are making defence preparations based upon the geography of their lands. But, unfortunately for our country, the students are kept painfully ignorant of these vital factors. For India particularly, Geography, must be of far more importance to them than even history, because the present position of the world affairs shows an ever-increasing interdependence of one nation upon another, and the more they know about each others outlook, the better would it be for all, as the more likely we will all be to come to an amicable understanding and friendly relationships. I make bold even to say that the political and social problems in India itself can be easily solved, if our young men and women are made really to understand the *natural factors* working *behind* all human struggles and endeavours. It is, therefore, that many foreign Universities, which are up-to-date, encourage Geography and geographical research at their centres.

Utilitarian Value

Geography has an educative as well as utilitarian value. There is an increasing demand for specialist Geography teachers in all our Schools, Primary and Secondary. The Madras University diploma has been so highly valued in South India and the Madras Geographical Association has shown the way to workers in the other parts of India, by means of the Vacation and Refresher Courses, how we can make our school teaching ever fresh and ever living. More than anything else, our students should know all about the natural resources of our country and of other countries coming in contact with it, so that they may, when their time comes, give their share in the proper regeneration and development of their mother land which has such vast potentialities. Even the weathers and climates of India are so poorly understood by many; there is a great loss of knowledge and consequently the rising generation is becoming more and more powerless ad restless.

Geography has an Interpretative Function

Geography has also an *interpretative function*. It elucidates and re-interprets the complex relations between the physical environment on the one hand and the distribution, mode of life and economic and social activities of man on the other hand, both in the present and the historic past. Such an elucidation of new relationships is accepted by

Western geographers as a contribution to Science; but in this respect also our Indian Universities are very backward.

An Aid to other Sciences

The aid, which geographical research can render to allied subjects, history, economics, sociology, commerce, agriculture, etc., is valuable. No study of these subjects could be *complete* or *thorough without the background of Geography* given to it. This aspect of our Science has been well emphasised by foreign Universities, such as London, Oxford and Cambridge, as will be seen from the Statement B.

India's Contribution to Indian Geography

Not depending upon outsiders, our University students should soon learn to give their share in producing a reliable, and scientific Geography of India, which yet remains to be explored. This requires specialistic knowledge, which we must foster at our University centres (*Vide* My note on M.A. and M.Sc. courses). Instead of making our students dreamers and idle dabblers in politics, we must help them to turn out good and useful work for the advancement of our country. In this direction, a good beginning has been made by local Indian geographers at Madras, Aligarh and Calcutta who deserve our grateful thanks.

Practical Side of Geography

It is a grave mistake to suppose that there is no practical side of Geography. All our teaching is ruined on this account and the science of Geography is murdered. While there is always a practical University examination in connection with other Science subjects viz., Physics, Chemistry, Biology and Geology, there is no practical examination held, even at the Intermediate stage, by some of our Universities. The result is that students are tempted to *cram* the facts of geography without knowing their bearing on daily and practical life. Students have much to learn and do practical work both in the laboratory and in the field. Among the practical aspects of Geography are field surveying, aerial surveying river, lake and ocean explorations, mountain expeditions, map making and map reading, enlarging and reducing maps, cartographical representation of data and statistics and identification of specimens of various kinds in different physiographic regions of India and other lands. All this requires *laborious* laboratory and field work and exercises which no other branch of Science needs. It is, therefore, absolutely necessary that with every theoretical Paper in Geography, there must be a *practical and oral test* so that the whole study may become *realistic*.

Board of Studies in Geography

All this cannot be achieved unless a *special* and *competent* Board of Studies in Geography is instituted by the Universities. Hitherto the work has been relegated to other Boards of Studies *indifferent* to the interests of Geography or to persons *incompetent* to deal with the subject adequately. Unlike other subjects of study, Geography has many branches, all of which should be properly represented on the special Board; otherwise the

subject would suffer considerably. In the University of London, for example, there are as many as 18 Members, representing physical historical, economic, biological, agricultural, ecological, anthropological, archaeological, commercial, and human geography, etc. With such a Board there must also be made provision for a representative of it on the Academic Council and the Executive Body of every University, so that plans made by experts in the line may not be thrown aside by *laymen* and *interested* parties, as has been the case hitherto.

To sum up

I earnestly desire that Geography and geographical teaching in our Indian Universities should be placed on proper and sound lines without unnecessary delay, so that the rising generation in our country may not suffer and their education may not be defective. For this purpose only and with no other motive, I appeal to the authorities to achieve the following as soon as possible:

(1) Separation of Geography from History at the Matriculation Examination, as a compulsory subject.
(2) Introduction of Geography at the Intermediate Arts, Intermediate Science, Intermediate Commerce, B.A., B.Sc., B.Com. and B.Sc. (Economics) as an optional subject with Papers as well as Practical Examinations.
(3) Encouragement of geographical research side by side with allied subjects of Ancient and Modem History, Economics, Sociology, Anthropology, Archaeology, etc., at the University Schools and Departments of Economics, Sociology etc., and at other Institutions affiliated to the Universities for post-graduate research.
(4) Introduction of Geography in the Department of Military Science as a compulsory subject.
(5) Institution of a Diploma in Geography for School Teachers (for a 2-years' course after Matriculation), if it is not yet done.
(6) Establishment of a Chair of Geography in the Universities for all Honours and postgraduate teaching, or in case it is already established, its expansion into a University Department of Geography in relation to Economics, Sociology and History on the Art side and to Geology and Biology on the Science side, with a well-equipped laboratory and facilities for field work.
(7) Institution of a special Board of Studies in Geography, or if one is already in existence, its expansion in such a manner as to serve the interests of all the branches of Geography, and its proper representation on the Academic Council and the Syndicate.

STATEMENT A

*Position of Geography in Indian Universities (those marked * have developed the Science well)*

No.	Name of University	Inter Arts	Inter Science	B.A.	B.Sc.	Other Exams	M.A. M.Sc.	Ph. D.	Remarks
1	AGRA	.....	.....	B.A. (2 Papers)	.....	Inter Com. (1 Paper)	.....	.....	.....
*2	ALIGARH	Inter Arts (2 Papers)	Inter Sci. (2 Papers)	B.A. Pass (2 Prs., 1 Pr.) B.A. Hons. (5 Prs., 1 Pr.)	B.Sc. Pass (2 Prs., 1 Pr.) B.Sc. Hons. (5 Prs., 1 Pr.)	B. Com. (1 Paper) B.T. (1 Paper) B.A., B.Sc., Eco. (1 Paper)	M.A., M.Sc. (8 Prs., 1 Pr.)	Ph. D. Thesis	1 Uni. Reader 4 Lecturers 4 Demonstrators
3	ALLAHABAD	.....	.....	B.A. Pass (2 Papers)	.....	B. Com. (1 Paper)	.....	.....	Allied with Commerce 1 Reader 3 Lecturers.
4	ANDHRA	Inter Arts (2 Papers)	Inter Sci. (2 Papers)	.....	.....	B. Com (1 Paper)	.....	.....	.....
5	ANNAMALAI	Inter Arts (2 Papers)	Inter Sci. (2 Papers)	.....	.....	.....	.....	.....	.....
6	BENARES	.....	.....	.....	.....	B.T. (1 Paper) Inter Com. (1 Paper)	.....	.....	.....
7	BOMBAY	.....	.....	.....	.....	F.Y.A. (2 Paper) B.T. (1 Paper)	.....	.....	D.Sc. can be taken by published Research.
*8	CULCUTTA	Inter Arts (2 Prs., 1 Pr.)	Inter Sci. (2 Prs., 1 Pr.)	B.A. Pass (2 Prs., 1 Pr.) B.A. Hons. (4 Prs., 2 Pr.)	B.Sc. Pass (3 Prs., 1 Pr.) B.Sc. Hons. (4 Prs., 2 Pr.)	B.T. (1 Paper) Military Cer. (1 Paper)	Proposed M.A., M.Sc. (5 Papers) (3 Practicals)	.....	1 University Lecturers-In-charge.
9	DACCA	.....	.....	.....	.....	B. Com. (1 Paper)	.....	.....	.....
10	DELHI	Inter Arts (2 Papers)	.....	.....	.....	.....	.....	.....	.....
11	LUCKNOW	.....	.....	.....	.....	.....	.....	.....	.....

12	MADRAS	Inter Arts (2 Papers)	Inter Sci. (2 Paper)	B.A. Pass (5 Prs., 1 Pr.)	.....	L.T. (2 Papers) Dip. Ed. (1 Paper) Dip. Geo. & Ec. (5 Prs., 1 Pr. With Thesis)	.....	.....	2 University Lecturers.
13	MYSORE	Inter Arts (2 Papers)	Inter Sci. (2 Paper)	.....	.....	B.T. (1 Paper)	.....	.....	2 University Lecturers B.A. & B.Sc. Courses are contemplated.
14	NAGPUR	Inter Arts (2 Papers)	.....	B.A. Pass (2 Papers allied with History)	.....	.....	.....	.....	.....
15	OSMANIA	Inter Arts (2 Papers)	.....	.....	.....	Dip. Ed. (1 Paper)	.....	.....	.....
16	PUNJAB	Inter Arts (2 Papers)	.....	B.A. Pass Hon. (2 Prs., 1 Pr.)	.....	B.T. (1 Paper)			Questions of making Geography as a Science subject & of introducing it in M.A. are under consideration.
17	PATNA	Inter Arts (2 Papers)	.....	B.A. Pass Hon. (3 Papers)	.....	.....	.....	.....	.....
*18	RANGOON	Inter Arts (2 Papers) (1 Practical)	Inter Sci. (2 Paper) (1 Practical)	B.A. Pass Hon. (3 Paper) (1 Practical)	B.Sc. Pass (3 Paper) (1 Practical)	B. Com. (1 Paper) B. Ed. (1 Paper)	.....	.....	1 University Professor 2 Lecturers and 2 Demonstrators
19	TRAVANCORE	Inter Arts (2 Papers)	Inter Sci. (2 Paper)	.....	.....	L.T. (1 Paper)	.....	.....	.....

N.B. 1. The above information has been gathered by me from the latest edition (1940) of Handbook of Indian Universities (Inter-University Board, India) and by personal enquires.

2. In some of the above Universities, Geography is prescribed only on paper, but the Colleges affiliated to them have not seriously started its teaching. Though there is dearth of qualified University Teachers of Geography, an attempt is not yet made by the authorities to induce men of Science to take up geographical research.

STATEMENT B

Position of Geography in Foreign Universities

N.B. - In well-known foreign Universities of Great Britain, Europe and America, Geography and geographical research have a prominent position in various Faculties, Arts, Science, Commerce, Economics Agriculture etc.

University of London.

1. Geography is an optional subject for all Arts and Science examinations from the Intermediate to the final degree stage.
2. There is a special Academic Diploma in Geography instituted for Teachers.
3. Geography is a subject of research for postgraduate degrees of M.A., Ph.D., D.Litt., and D.Sc.
4. For B.Sc. (Economics), Geography is a *compulsory* subject at the Intermediate stage and again an optional subject at the degree stage e.g. Geographical discussions and geographical background of International Relations.
5. For M.Sc. (Economics), there is prescribed a detailed economic geography of an area or some aspect of geography chosen from agricultural, industrial or historical geography of a major region, population problems etc.
6. For B.A. Final Honours in Anthropology, there is a *compulsory* course of geological and geographical conditions of racial and cultural developments and the distribution of races.
7. At the London School of Economics especially, provision has been made for maintaining one Professorship, two Readerships and three Lectureships in Geography, besides similar posts in other University and affiliated Colleges for Arts and Science.

University of Cambridge.

1. Geography is prescribed for Intermediate Arts and Science, B.A., B.Sc., Intermediate Commerce and B.Sc. (Economics).
2. In the Final Honours and Post-graduate courses, there prescribed Historical Geography, Agricultural Geography, Cultural Literature on Geography, Geographical Distribution of British Industries, etc.
3. Research Seminars in History teach *Historical Geography* especially.
4. There is a Diploma in Geography for Secondary Teachers.
5. The University maintains a Professorship and a staff to carry on Laboratory and Field Work for Geography.

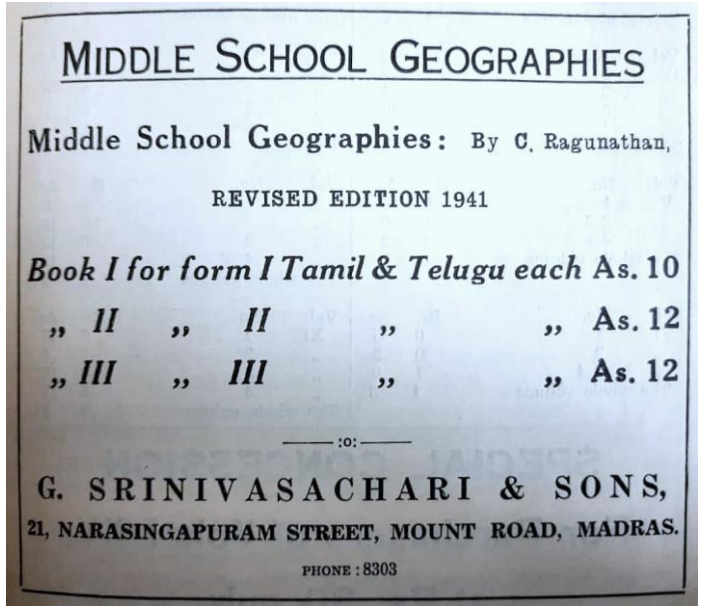
University of Oxford.

1. This University maintains a special Honours School of Geography, designed to provide a course of instruction in Geography, which may afford a preparation for further study and for geographical exploration.
2. In the Honours School of Modern History, *all* candidates are expected to have some knowledge of political and descriptive Geography.
3. There is a Diploma in Geography instituted and candidates for it are required to present a *thesis* of geographical description of a selected district as a part of their examination.
4. Special Certificates are issued for Proficiency in Surveying and General and Regional Geography.
5. At the B.A. and B.Sc. examinations, Geography is an optional subject.
6. Research and Superior degrees e.g. D. Phil. can be taken in Geography.
7. A Professorship and Staff are maintained at the Honours School.

N. B. Information has been gathered from the University Calendars or Handbooks.

Advertisement in the Journal

***from* The Indian Geographical Journal**
***Formerly Known as* The Journal of The Madras Geographical Association**
(Volume XVI, 1941, p.115)



The Indian Geographical Journal
Volume 95 (1) June - 2020, pp 162-164
ISSN 0019-4824

Archives - 2

News and Notes

***from* The Indian Geographical Journal**
***Formerly Known as* The Journal of The Madras Geographical Association**
(Volume XVI, 1941, pp.105-108)

Ourselves. - The Journal of the Madras Geographical Association has completed its 15th volume with the last issue for 1940; and it now emerges under the new title of "*The Indian Geographical Journal*," in response to calls and suggestions from several friends in Northern and Western India. The change is not a mere nominal one, but involves great responsibility; and it has not been lightly undertaken without deep consideration and forethought. With the experience we have gathered these 15 years and with the co-operation and goodwill of competent geographers in India who have so kindly and willingly offered their help and support, we hope to run it successfully as an All-India Journal.

* * * * *

There would have been no need for this change if the proposed *Indian Geographical Federation* had come into being with its own organ. In accordance with the suggestion made by the British Geographers at the Calcutta Session of the Indian Science Congress in January 1938, a Committee was appointed to urge Provinces and States where Geographical Associations or Societies did not exist, to start them, and to bring them together into a federation for several purposes among which the running of an All-India Geographical Journal as its organ was prominently mentioned. But despite earnest and strenuous attempts for more than three years, it was not possible to get new associations started in several States and Provinces for the simple reason that Geographical studies had no proper place in their Universities and Colleges, and very few persons were consequently interested in the subject. Nor was there any enthusiasm or desire among the few existing Associations to come together. Under these circumstances the call came to us as the oldest Geographical Association in India with the longest journalistic record of achievement; and we have responded with the fullest hope of getting support and encouragement from all in our endeavours to serve the cause of Geography in this country.

* * * * *

Our aim and policy shall not be merely provincial; and our appeal and service shall be to the several Universities and Colleges in the whole of India. We shall stand as hitherto for Geographical search as well as for dissemination of geographical knowledge, but in a far wider field.

* * * * *

Geography in the Indian Science Congress. - Meantime, it is most distressing to learn that the Indian Science Congress has decided at its Benares Session in January last to amalgamate its short-lived Geography Section with the Geology Section - a decision which is tantamount to abolishing it - on a chance vote taken at a Meeting of the General Committee in an almost empty house on a cold winter night in the teeth of unanimous opposition of all the Geographers present.

* * * * *

In this connection it may not be out of place to trace the history of this short-lived Section. For over two decades, the Indian Science Congress Association which is considered to be the premier scientific Association in India, had not though of Geography at all a subject worthy of any place in it - so low has been the position of Geographical studies in Indian Universities and Colleges. For the Indore Session of the Congress in 1936, the Section of Geology was nominally expanded to include Geography also, under the title of the Section of Geology and Geography, when there were 16 papers contributed on Geology and *none* on Geography. At the Hyderabad Session next year (1937), the Joint Session bad 52 papers, of which only three were on Geography.

* * * * *

Then came the Silver Jubilee Session of the Congress at Calcutta in 1938, when window-dressing was required against the visit, of the British Geographers; and so, a Section of Geography was temporarily created for that year only. But even under such conditions, the Section had 21 papers contributed, which were all agreed generally to be good. Thanks to the action taken by the British Geographers, who, by means of a resolution in the Section, well as by a separate memorandum, pleaded for its permanence, the Executive Committee of the Congress decided to retain it permanently. The wisdom of this action was proved by the fact that at the Lahore Session next year (1939), there were again 20 papers for the Geography Section as against 18 papers for the Geology Section at the same time.

* * * * *

Despite all this phenomenal progress, however, at the Madras Session in 1940, a Damocles' sword was hung over the Section in the shape of the proposal to re-amalgamate Geography with Geology; and due to strong opposition, an amendment was carried to consider the question again next year, thus putting off the evil day. At Benares in January this year, the one existing body in India that could bring all the Geographers together on a common platform was practically annihilated with a year's lease of life at Dacca.

* * * * *

For the Dacca Session of the Congress Geography will accordingly have a separate section *for the last time*, after which it will be an annexure to Geology. We take this opportunity to congratulate Mr. George Kuriyan, Head of the Department of Geography in the University of Madras, who has been elected President of the Section, and Prof. Nafis Ahmed of Islamia College, Calcutta, who has been elected Recorder of the Section.

* * * * *

The aims and outlook of Geology and Geography are so variant that the votaries of the two subjects cannot be expected to work together usefully in an unequal and unwilling partnership. Nor do the Geologists seem to be happy over this consumption. It is, therefore, to be hoped that the question will be raised again and decided in favour of Geography, restoring it to its proper place with a separate Section of its own.

* * * * *

It is this gloomy prospect that drove some ardent to the length of discussing an annual Indian Geographical Conference, like the Economic, Philosophical, Oriental and other Conferences. But the proposal has not so far materialised, though it denotes the strength of the feelings of disappointment and resentment at the decision to close the Section.

* * * * *

It is under these circumstances that a long cherished idea has been put into action, - that our Journal has changed into an All-India one to provide a common organ and a liason to all workers in the field of Geography in this vast country.

* * * * *

The War and Geography. - The unsatisfactory position and immature development of Geographical studies in most Indian Universities are largely responsible for the general absence of geographic outlook even in the educated Indian, for the improper appreciation here of the part played by Geography in this great world conflagration such as the underlying geographical causes that led to it or the geographical factors at work steering or shaping the course of it. And when the Peace Settlement is made, Geographical considerations will have to enter largely, if that settlement is to be abiding.

* * * * *

Our country has been lucky so far to escape the grave calamities that have befallen so many of the European countries; but even in this country it is interesting to note the rapid reactions and adjustments to the War. The resources of the land are now better taken stock of, better worked up and better utilised; unexported materials like groundnuts are attempted to be used in new ways within the country itself; and substitutes are being tried for dyes, drugs and other things that are in great demand but cannot be imported. Even heavy industries are coming in, rather slowly though.

* * * * *

The Indian Geographical Journal
Volume 95 (1) June - 2020, p 165
ISSN 0019-4824

News and Notes

THE INDIAN GEOGRAPHICAL SOCIETY

Department of Geography, University of Madras, Chennai - 600 025

UG & PG Results of 10th IGS Talent Test - 2020

THE IGS FOUNDER PROF. N. SUBRAHMANYAM AWARD

With the Cash Prize of Rs. 10,000/-

(First Prize: Rs. 5,000/-, Second Prize: Rs. 3,000/- & Third Prize: Rs.2,000)

UG Results of 10th Talent Test - 2020				
Register Number	**Name**	**Institute**	**Rank**	**Photo**
1708053	D. Bharath	Department of Geography, Government Arts College (Autonomous), Karur - 639 007.	1	
17UGE1173	V. Kokilavani	Sri Vijay Vidyalaya College of Arts and Science, Nallampalli, Dharmapuri - 636 807	2	
171GEO30	P. Priyankadevi	Department of Geography, Nirmala College for Women (Autonomous), Coimbatore - 641 018.	3	

PROF. A. RAMESH AWARD

With the Cash Prize of Rs. 15,000/-

(First Prize: Rs. 7,000/-, Second Prize: Rs. 5,000/- & Third Prize: Rs.3,000)

PG Results of 10th Talent Test - 2020				
Register Number	**Name**	**Institute**	**Rank**	**Photo**
18MAG220	T. Radhakrishnan	Department of Geography, Government Arts College (Autonomous), Coimbatore - 641 018.	**1**	
P18GE25371	L. Anju	Department of Geography, Sri Meenakshi Government Arts College for Women (Autonomous), Madurai - 625 002.	**2**	
GEO1515	S. Juliat	Department of Geography, Bharathidasan University, Thiruchirappalli - 620 024.	**3**	

Please Note:

1) The Winners are requested to make arrangements to attend the award ceremony function being arranged in the IGS Annual Conference to be held at Department of Geography, University of Madras, Chennai on 08.03.2020 at 2:00 p.m.
2) For any queries, kindly contact the Coordinator Dr. K. Kumaraswamy (94421 57347) / Co-coordinators Dr. G. Bhaskaran (94444 14688) / Dr. R. Jegankumar (98947 48564) / Dr. K. Balasubramani (99440 60319).

National Online Meet on

Development of Geographical Institutions in India

4-7, September 2020

Organised by

The Indian Geographical Society

Department of Geography, University of Madras, Chennai-600 025

www.igschennai.org http://geography.unom.ac.in/igs/

Supported by

Department of Geography
Bharathidasan University, Tiruchirappalli

Department of Geography
Central University of Tamil Nadu, Thiruvarur

Circular

Background of the Meet

Indian geography is growing slowly but steadily over the past one hundred years of its existence in the country. There are a number of geography associations in the country, some are very old and some relatively new. These regional and national level geographical institutions have limited inter and intra-level networks between them. There are equally a sizeable number of journals published by these institutions in geography and allied fields, but only a few are indexed in reputed databases. There is a need to assemble and discuss the issues and prospects for symbiotic development of all such institutions and their publications, keeping in view the dynamic nature of the discipline. Under these circumstances, the Indian Geographical Society (IGS) is intended to host a national level online meet to discuss various issues and prospects for sustainable development of geographical institutions in India from 4th to 7th of September, 2020.

Correspondence Mail ID
igschennai1926@gmail.com

About IGS

The Indian Geographical Society (IGS), the oldest Geographical Society in India, was established in Chennai (Madras) on 16.3.1926 at Presidency College Campus by a team of Indian and British Geographers, lead by Mr. N. Subrahmanyam M.A., L.T., F.R.G.S., the Chair of Geography at Teachers' Training College, Saidapet, Chennai. At present, the Society is housed at the Department of Geography, University of Madras, Chennai.

The IGS is bi-annually publishing The Indian Geographical Journal since 1926. From its inception, the Journal is maintaining its quality and contributing to the development of geography in various spheres of the discipline. In 1941, the Madras Geographical Journal was renamed as the Indian Geographical Journal, with the ambition to broaden its scope to a national level. The Society was very much appreciated by eminent British Geographers like Professors Fawcett, Ogilvie and Dudley Stamp. You may visit www.igschennai.org for further details about the activities of the Society.

Organisers

Prof. K. Kumaraswamy, Editor - IGS Journal
ICSSR Senior Fellow, Department of Geography, Bharathidasan University, Tiruchirappalli - 620 024
kkumargeo@gmail.com Mobile 09442157347

Prof. R. Jaganathan, General Secretary – IGS
Professor and Head, Department of Geography, University of Madras, Chennai - 600 025
rjnathan@gmail.com, Mobile: 09444917006

About the National Meet

The Meet aims at networking all the Geographical Societies and Associations in India under one roof for the purpose of discussing their multi-faceted activities for overall symbiotic development.

The common points for discussion by each institute in the Meet include:

1. **Name and Address of the Society / Association** (Registration Number, Website Address, Phone Number, Mail ID, etc.)
2. **Genesis / Formation of the Society / Association** (Year and Place of Establishment, Founders, etc.)
3. **Details of Recent General Body / Executive Council Meeting Held** (Date and Place, Important decisions taken, etc.)
4. **Members** (Number of Life Members, Annual Members, Institutional Members etc.)
5. **Awards Instituted** (Name of the Awards, Details of Awardees)
6. **Conferences / Seminar / Workshops Organised** (Annual / Occasional, Collaborating Agencies, Other details)
7. **Details of Competitions / Quiz / Tests conducted** (Geographical coverage, Level of participants (School/UG/PG), Mode of conduct (direct/online) etc.)
8. **Publications** (Journal, Books including Regional languages, Monographs / Proceedings with details of ISBN, ISSN, Impact Factor, UGC-CARE, Significant indexing, Sales procedure etc.)
9. **Your Society and National Educational Policy 2020** (Plan for Online meetings, Curriculum development support, e-content preparation, Webinars etc.)
10. **Any Other Points you wish to share regarding your Society / Association:**

Representatives of the respective institutions are requested to present their activities on the above line (approx. 30 minutes). It is requested to submit the said points to the organisers for documentation and further action.

Registration for Participation

There is no registration fee for the participation. The interested individuals may fill the online form to receive the link of the Online Meet. E-certificate will be issued to all the participated institutions and individuals.

Link: https://forms.gle/b2ar3hvroQ8nKTZ49

Last Date for Registration: 03.09.2020 (5:00 pm)

Event Coordinators

Prof. G. Bhaskaran, Treasurer – IGS
Department of Geography, University of Madras, Chennai – 600 025, grbhaskaran@gmail.com, 09444414688

Dr. K. Balasubramani, Asst. Editor – IGS
Dept. of Geography, Central University of Tamil Nadu, Thiruvarur - 610 005, geobalas@gmail.com, 09944649258

Dr. R. Jegankumar, Joint Secretary – IGS
Dept. of Geography, Bharathidasan University, Tiruchirappalli – 620 024, jegankumar@gmail.com, 09894748564

List of Geographical Institutions in India

Aligarh Geographical Society, Aligarh
Allahabad Geographical Society, Allahabad
Association of Bengal Geographers, Burdwan
Association of Geographers in Bihar and Jharkhand, Patna
Association of Geographical Studies, Delhi
Association of Geography Teachers of India -Trust, Chennai
Association of Marketing Geographers of India, Gorakhpur
Association of North Bengal Geographers, Siliguri
Association of Population Geographers of India, Chandigarh
Association of Professional Geographers, Delhi
Association of Punjab Geographers, Patiala
Bombay Geographical Association, Mumbai
Deccan Geographical Society, Pune
Eastern Geographical Society, Bhubaneswar
Geographical Society of Arunachal Pradesh, Itanagar
Geographical Association of Mizoram, Aizawl
Geographical Society of India, Kolkata
Geographical Society of Northeastern Hill Region, Shillong
Geographers Association, Goa
GeoMap Society, Hyderabad
Gujarat Geographical Association, Ahmedabad
Himachal Pradesh Geographical Society, Shimla
Himalaya Samiksha Parishad, Kolkata
IGU-India, New Delhi
Indian Council of Geographers, Patna
Indian Environment Society, Delhi
Indian Geographical Foundation, Kolkata
Indian Geographical Society, Chennai
Indian Institute of Geomorphologists, Allahabad
Indian Society of Spatial Scientists, Kolkata
Institute of Indian Geographers, Pune
Institute of Landscape, Ecology and Ekistics, Kolkata
Karnataka Geographers Association, Bagakot
Kerala Geographical Society, Palakkad
Konkan Geographers Association of India, Sindhudurg
Maharashtra Bhugolshastra Parishad, Pune
National Association of Geographers, India, Delhi
National Geographical Society of India, Varanasi
North-East India Geographical Society, Guwahati
Rajasthan Geographical Association, Bhilwara
Rayalaseema Geographical Association, Tirupati
Regional Science Association, India, Kolkata
Telengana Geographical Society, Hyderabad
Union of Geographic Information Technologists, Bengaluru
Uttar Bharat Bhoogol Parishad, Gorakhpur

Note: The other Geographical Institutions are requested to contact the organisers to participate the National Meet.