

Identification and Mapping of Slum Environment Using Ikonos Satellite Data A Case Study of Dehradun, India

Ujjwal Sur*, Sadhana Jain**, B.S.Sokhi***

Abstract

In this study, an attempt has been made to identify and mapping of slums using the IKONOS (1m and 4m) satellite images and assessment of slum environment in GIS supported by ground verification. The slums were identified on the basis of visual interpretation and were captured manually using on-screen digitization method. Finally database was created and labeled with the help of necessary ground checks. The visual interpretation of the study area showed clearly the location and areal distribution of the slums. For this purpose, interpretation parameters like, pattern (layout), shape (roof types etc), size (small, medium, big), and tone and association were used. Then the slum areas were identified and labeled after detailed ground check. Detailed mapping of a particular slum area was carried out and database was prepared with the help of a structured questionnaire (household and physical infrastructure). The parameters taken for the case study were individual condition of houses like: roof material, wall material, access to houses, drainage (water logged or not), water supply (per capita, stand pipes, duration of supply, and storage of water), electricity, sewerage/ sanitation and street lighting.

INTRODUCTION

In the developing countries like India, the acute problem of slum formation is found not only in the big cities but also in medium and small cities and towns. Due to rapid urbanization and consequent haphazard growth, most of these cities have become congested and unhygienic. It is clear that rapid processes of accretion as a result of incessant flows of immigrants caused the present changes in aerial size of slum. In most of the municipal bodies proper up-to-date maps of slums along with proper database and

genesis of its growth are not available which create problem in developmental process. Thus, it is important to analyze the slum formation, slum morphology and impact on surroundings to improve quality of life of slum dwellers. Under these circumstances, remote sensing plays a leading role by virtue of its repetitive and synoptic coverage that may become a base map for many government and semi government organization in a very rapidly growing urban area.

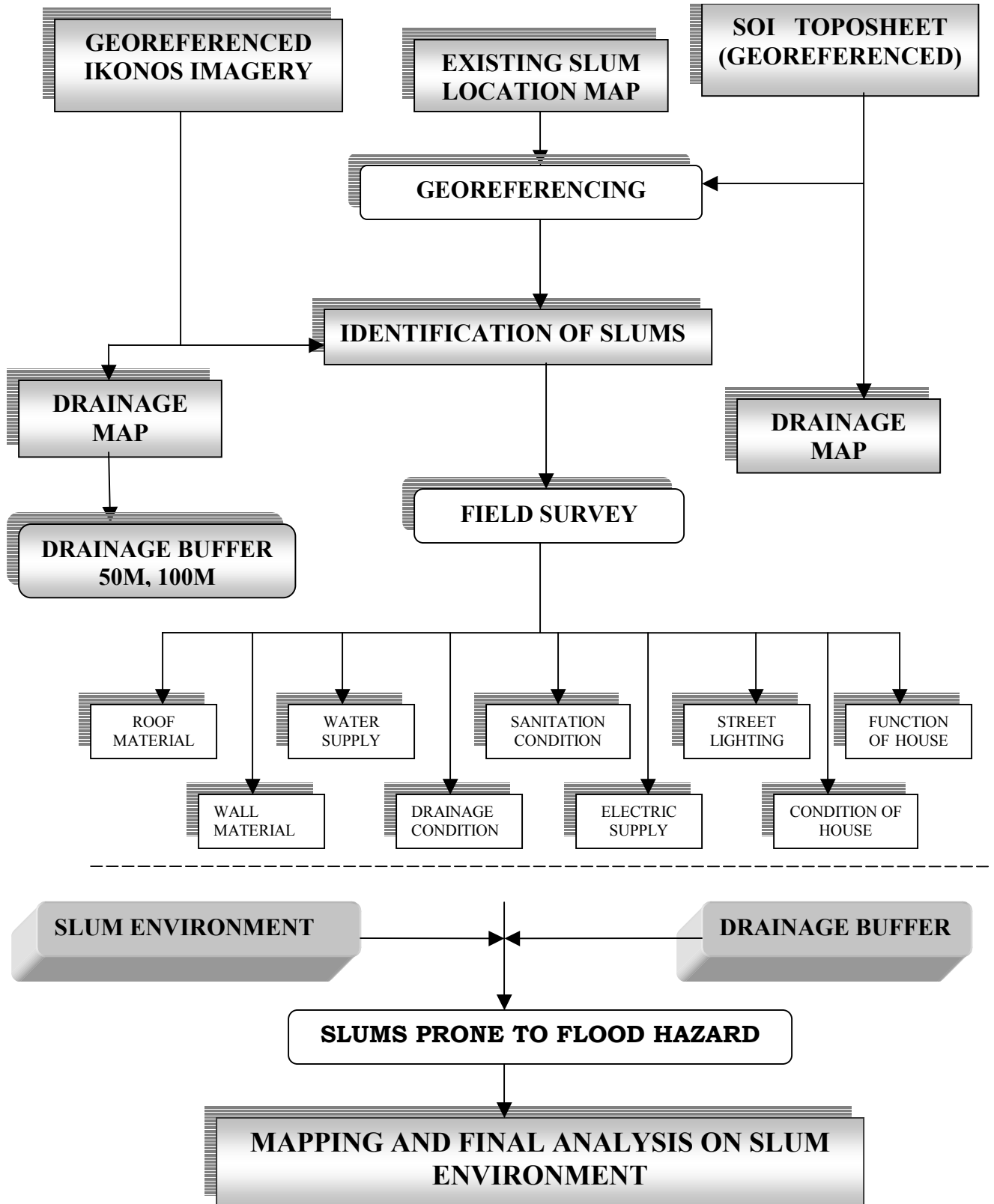
OBJECTIVES OF THE STUDY

The aim of the study was to locate slums and identify the physical characteristics of the slum areas that could be interpreted through high-resolution Ikonos satellite imagery. To present a comprehensive picture of the slums, two aspects, i.e. spatial distribution and growth, and physical infrastructural services related to slums had been taken into account. High-resolution satellite imagery (Ikonos satellite Data acquired April 2000 was used to detect, identify and delineate the slums in Dehradun to detect the changes that has taken place in terms of new slum development and to map condition of slum environment. GIS was used to identify the slum areas that had fallen under flood vulnerability.

METHODOLOGY

For the study of slums, Ikonos PAN and MSS Data acquired on April, 2000 and ancillary data like SOI Toposheet (53 J/3), at 1:50,000, 1988 and SOI Guide Map, at 1:20,000, 1982 were used. All the slum pockets identified were transferred to one base map, so as to get an overall spatial distribution and location of the slum area. In order to detect the slum areas, the following factors considered were: Small sized structures with high density; tone difference to get the idea of kachcha or semi- kachcha houses that were obvious in the slum areas; irregular internal street pattern having unmetalled and mostly unpaved; Areas of wastelands, such as on banks of Rivers or Canal, along railway line and road margin were taken as association for identification. The drainage map was prepared based on both Ikonos data and SOI topographical sheets. Case study area was selected based on certain factors and color printouts were taken for detailed field survey along with brief questionnaire. From slum location map and drainage map, slums located in vulnerable areas were marked. (Fig. No. 1 shows the flow diagram of methodology).

METHODOLOGY FOR IDENTIFICATION AND MAPPING OF SLUM ENVIRONMENT



LIMITATIONS OF THE STUDY

Due to time constraint only seven slums out of 113 were taken for intensive study. While updating the slum areas, it was not possible to make detailed map of all the slums. Lack of updated and relevant secondary data on slums was also a constraint.

DATA BASE CREATION

On the basis of visual interpretation and necessary field survey, the slum location map within the municipal boundary area was prepared. To show the main factor affecting the location and distribution of slums, drainage map had been prepared and slum location map was superimposed on that. In the next step, each and every house was digitized for preparing detailed map of the study area. Data collected on the basis of field survey were transferred to the base map and other maps showing various parameters were prepared. To show the condition of different slums, maps were prepared showing comparison based on the parameters selected.

ANALYSIS

SLUMS IN DEHRADUN CITY AS A WHOLE

The slums in Dehradun city have experienced a drastic change as revealed from this study. It has been observed that the number of slums have increased from 75 in 1996 to 113 in 2000. The total area under slum is now more than 279.65 acre. Out of the 113 slums of Dehradun city, nearly 90 slums are developed along the two major non-perennial rivers, Bindal Rao and Rispana Rao (Fig. No. 1). Most of the river bed of these two rivers had become narrower due to encroachment of slums. Another remarkable feature came out from the study of the slums was that, out of the 113 slums, only 23 slums are away from the drainage channel. Most of these slums (23) have grown up either along the railway line that goes to Haridwar, or along the major city roads. It is observed that the slums are mostly developed as a continuous patch particularly in the central part of the Rispana Rao and Bindal Rao. However, it is seen that the growth of

slums is not restricted within the existing municipal ward boundary as two big slums have been identified near the Raipur road.

The slum expansion is due to the pressure of the population mostly on un-used, un-protected and un-suitable government land. In highly developed areas, the slum pockets do not expand as the land is not available for expansion and is better protected due to the higher cost. It is observed that though the extent of slums area is more in residential pockets, but there is a tremendous growth in the existing slum located along the linear features like drainage channels, roads, and railways and as a result mostly are linear in nature. The slums in inner city area are less in extent and are in stagnant situation than the slums in peripheries (as no provision for further growth is there). In Dehradun, the slums, in inner city area did not register any increase in number between 1996-2000, whereas the slums in the peripheral area registered a high growth.

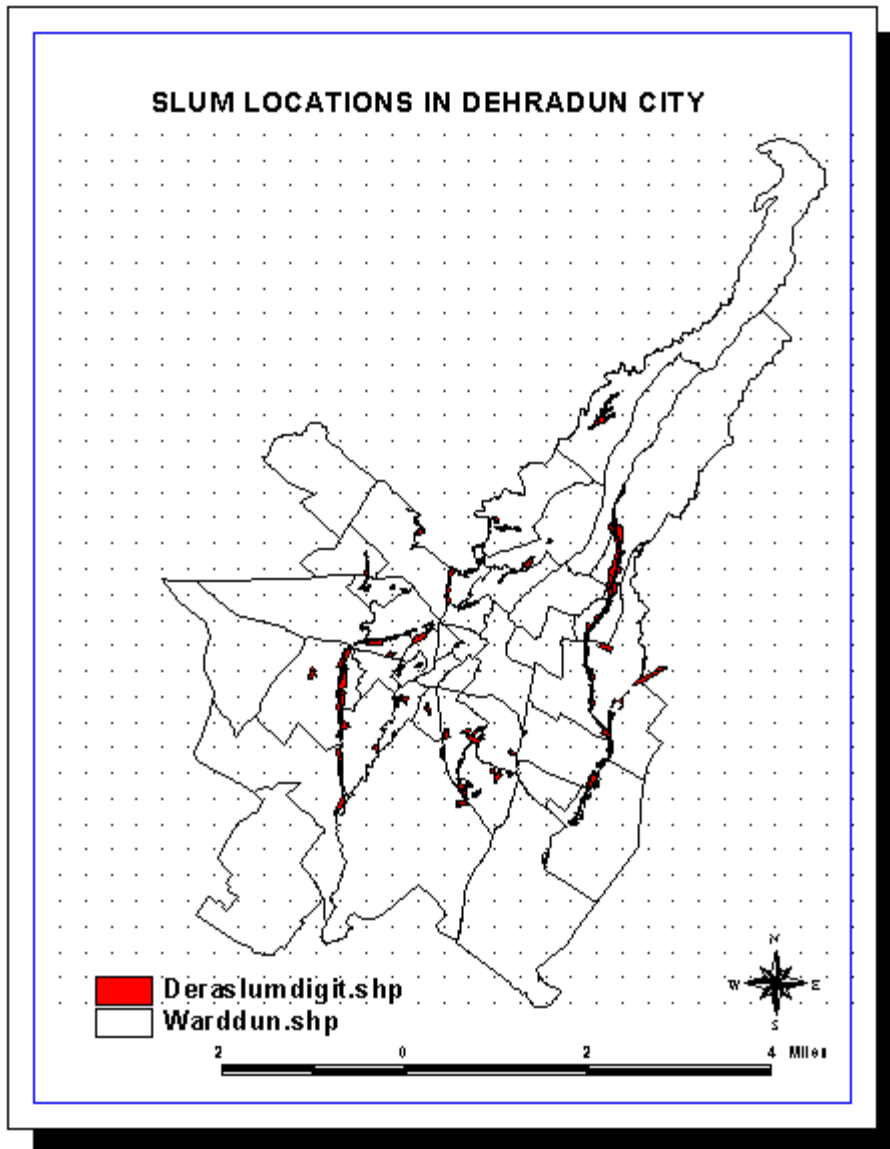


Fig. No. 2

STUDY AREA

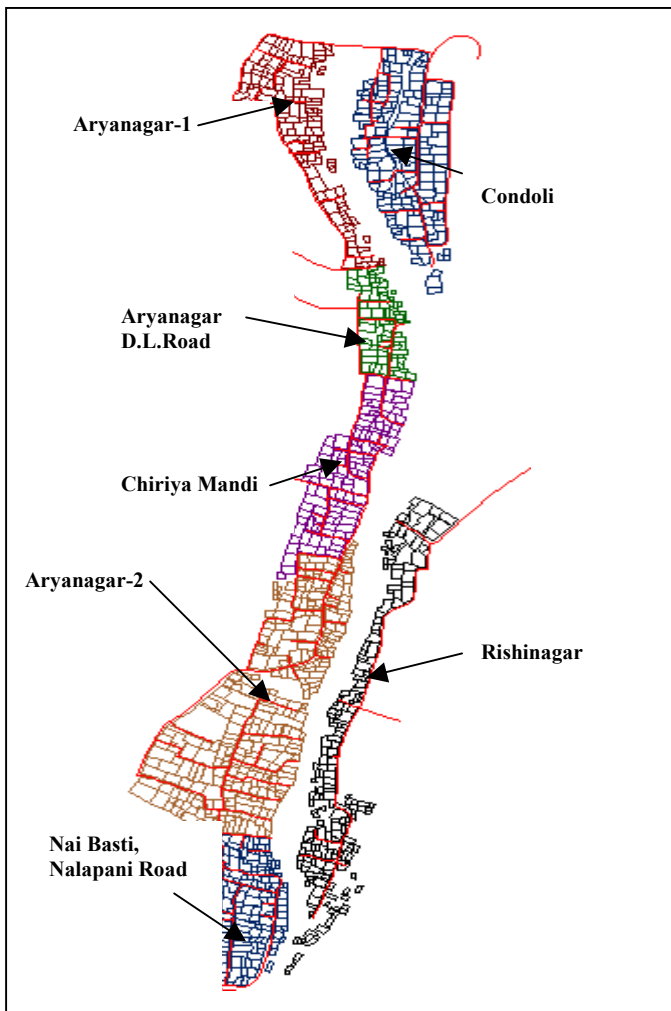


Fig. No.2

The internal land use and utility were studied through satellite imagery and through field survey to find out the causes for sporadic and haphazard development of Slums. The present study area constitute 7 different slums , namely Aryanagar-1, Aryanagar D.L.Road, Chiriya Mandi, Aryanagar-2, Nai Basti Nalapani Road, Kondoli, Rishinagar (fig.no.-2). Thus, the satellite imagery was found very useful in marking the layout pattern of slums, by-lanes, counting the buildings (structures), water logged areas etc. However the imagery does not show the activity within buildings, but show only the site adaptation. Detailed building uses e.g. the shops, small temples etc. could only be confirmed only during field survey. The SLUMS ENVIRONMENT in the study area has

been analyzed and mapped based on the following parameters (Detailed study of Condoli slum is shown in Fig. No. 3).

a) COMPOSITION OF ROOF MATERIALS

On the basis of field survey, it was found that out of total 1222 houses in the study area, 585 houses (44%) have roof made up of concrete, followed by tin and plastic in 372 houses (25%) (Table-1). Particularly in Aryanagar-2 and Chiriyamandi concrete is dominant roof material. After concrete, tin and plastic is the second major roof material. In Rishinagar, Nalapani Nai Basti and Aryanagar D.L Road the number of houses having

Table-1: Composition of Roof Material

	Aryanagar -1	Aryanagar .D.L.Road	Chiriyamandi, Aryanagar	Aryanagar -2	Nai Basti, Nalapani Road	Rishinagar	Condoli	Total
Asbestos	14	3	2	25	29	19	10	102
Concrete, Tin, Plastic	5	2	4	5	17	12	28	73
Concrete	58	29	79	190	88	70	71	585
Concrete and Plastic	1	0	0	2	0	0	2	5
Concrete and Tin	10	4	5	16	2	0	2	39
Plastic	4	0	0	1	0	2	0	7
Tin	5	0	8	13	1	7	3	37
Tin and Plastic	32	42	19	60	57	101	61	372
Wood and Plastic	0	0	2	0	0	0	0	2

tin and plastic as roof material are more than that of made up of concrete. Asbestos is the third important roof material, present in 102 houses (11%) in all the slums. The other type of material is rarely used and less in number.

b) COMPOSITION OF WALL MATERIALS

Wall is an important part of a building and reflects the economic condition. Table-2 shows that out of the 1222 houses in this area 1065 houses (88%) are made up of bricks.

Table-2: Composition of wall material

	Aryanagar -1	Aryanagar .D.L.Road	Chiriya Mandi, Aryanagar	Aryanagar -2	Nai Basti, Nalapani Road	Condoli Gaon	Rishinagar	Total
Brick	117	68	119	294	179	149	139	1065
Brick and Stone				1				1
Mud	1			5	5		12	23
Mud and Plastic					3			3
Plastic						8	6	14
Tin					3			3
Unburned Brick	14	12		12	4	16	54	112
Wood					1			1

One of the most important pictures comes from Chiriya Mandi slum where all the houses are made up of brick. Unburned brick is the second important wall material found in 112 houses (9%) in that area.

c) CONDITION OF WATER SUPPLY

In the study area 520 houses (43%) don't have the piped water connection. Availability of water to houses is highest in Aryanagar-2 where more than 73% houses have water connection (table-3). The condition is same in Aryanagar-1. But in Rishinagar and Aryanagar D L Road the situation is really bad. In Rishinagar about 64% of houses lack this facility. In rest of the areas the condition is medium.

Table-3: Physical Infrastructural Facilities

	Water Supply		Electric Supply		Sanitation		Drainage		Street Lighting	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Aryanagar-1	83	49	96	36	84	48	40	92	62	70
Aryanagar. D.L.Road	34	46	49	31	31	49	32	48	36	44
Chiriya Mandi	90	29	86	33	89	30	94	25	76	43
Aryanagar-2	229	83	242	70	228	84	205	107	203	109
Nai Basti, Nalapani Road	102	92	141	53	124	70	122	72	103	91

Condoli	87	86	130	43	116	57	105	68	62	111
Rishinagar	77	135	147	65	108	104	194	18	41	171
TOTAL	702	520	891	331	780	442	792	430	583	639

d) SANITATION CONDITION

The slums of study area show medium to better sanitation condition as 780 houses (64%) in the area have sanitation facility and 442 houses (36%) without sanitation (table-3). But if we take the slums individually into account, it reveals an interesting picture. Only in Aryanagar D L Road the number of houses without sanitation is high (61.25%). In rest of the slums though the number of houses with sanitation is higher (65.58%).

e) DRAINAGE CONDITION

In the area under study, it has been observed that out of 1222 houses 643 houses (52.62%) don't have any drainage facility (table-3). Wherever drainage facility is available in 579 houses (47.38%) and all the drains are open drains. Out of seven slums in that area, four slums have very bad drainage condition particularly in Rishinagar where out of 212 houses, 193 houses (91.04%) are without any drainage. Only Aryanagar-1 and Chiriya Mandi have relatively better drainage condition. Wherever open drains are available, though either they are too narrow or half the portion is filled up with garbage.

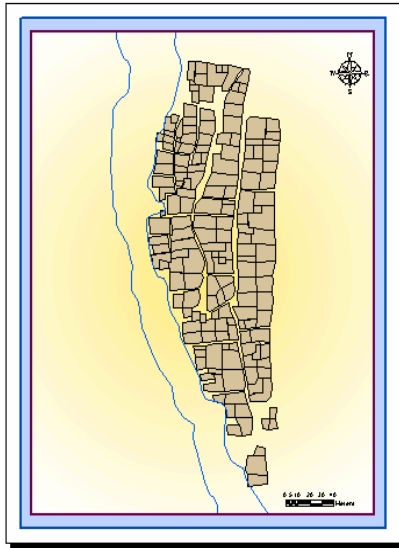
f) ELECTRIC SUPPLY

In the study area, out of total 1222 houses, 891 houses (72.91%) have electric supply; where as 331 houses (27.09%) do not have this facility (table-3). Though it has been observed that in some houses the overall condition is very bad, but electricity is available.

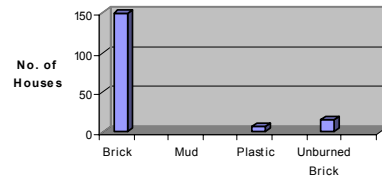
g) STREET LIGHTING

Most of the houses in this area do not have street lighting. It is seen that only 583 houses (47.71%) have this facility (table-3). The condition is worse in both Rishinagar and Condoli Gaon, where 170 houses (80.19%) out of total 212 houses and 111 houses

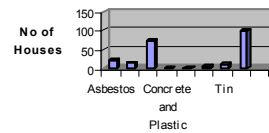
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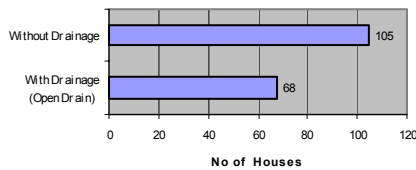
COMPOSITION OF WALL MATERIAL



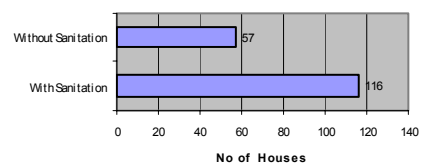
COMPOSITION OF ROOF MATERIAL



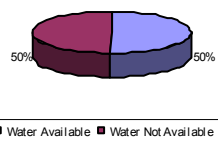
PROVISION FOR DRAINAGE



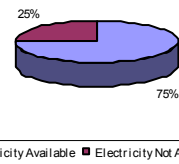
PROVISION FOR SANITATION



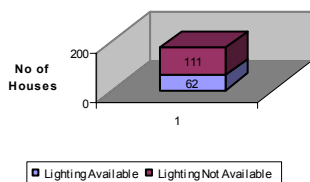
AVAILABILITY OF WATER IN HOUSES



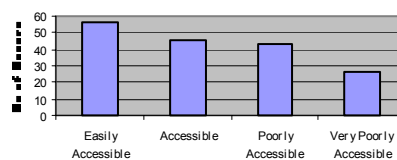
PROVISION FOR ELECTRICITY



AVAILABILITY OF STREET LIGHT



ACCESS TO HOUSES



OBSERVATIONS

- Very bad condition
- Drainage and street light facility is worst
- Accessibility medium
- Semi kachcha and semi pakka houses are more in number

(64.16%) out of total 173 houses respectively don't have any street lighting facility. In Aryanagar -1 and Aryanagar D.L.Road the availability of street lighting is also less. It has been observed that in most of the slum areas which are closer to the main road, or commercial center etc., street lighting facility is better.

h) ACCESS TO HOUSES

It has been observed that out of the total 1222 houses in the study area, 441 houses (37%) are easily accessible, 465 houses (39%) are accessible, 259 houses (21%) are poorly accessible and 147 houses (13%) are very poorly accessible. The houses having very poor accessibility were approached through riverbed. However in Rishinagar the accessibility condition is relatively bad as poorly accessible and very poorly accessible houses together account for 54.25% (i.e. 115 houses) out of the total 212 houses. The internal streets are neither paved nor sufficiently wide for introducing any kind of basic municipal services. The surface of the streets are uneven and become unapproachable in monsoon

i) BUILDING CATEGORY

On the basis of Census of India criteria the houses in the study area has been divided into four categories, namely pakka, semi-pakka, semi-kachcha, kachcha. Almost all the slums have pakka houses as dominant, except in Rishinagar and Aryanagar D.L.Road, where the numbers of semi-kachcha houses are slightly more. Although numbers of kachcha houses are very low, Rishinagar has got the major share. Out of the 1222 houses in the slum area, only 44 houses (3.6%) are fully kachcha house. In the study area 690 houses (56.46%) are pakka houses and 374 houses (30.6%) are semi-kachcha houses and only 114 houses (9.24%) are semi-pakka houses (Census of India housing criteria).

j) LIVING CONDITION

House condition is one of the determinant factors regarding the slum environment. House condition in slums has been considered on the basis of all the other parameters selected. Out of the 1222 houses, only 17 houses (1.4%) fall under very good condition, 137 houses (11.5%) are under good condition, 432 houses (35.3%) having medium condition, 232 houses (18.9%) having bad condition and 404 houses (32.9%) having very bad conditions.

FLOOD RISK VULNERABILITY IN SLUMS

For the purpose of risk vulnerability in slums, 50m and 100m buffer have been drawn around drainage (fig. no.-4). It has been observed that out of the 113 slums in the study area only 23 slums are located away from the drainage channel. Within the 50mt. buffer zone 63 slums are located, while 27 slums are located within 100m buffer zone. That is a total of 90 slums are located within the 100mt. buffer zone (nearly 80%). Mostly these slums were developed by encroaching land in the riverbeds or near to that.

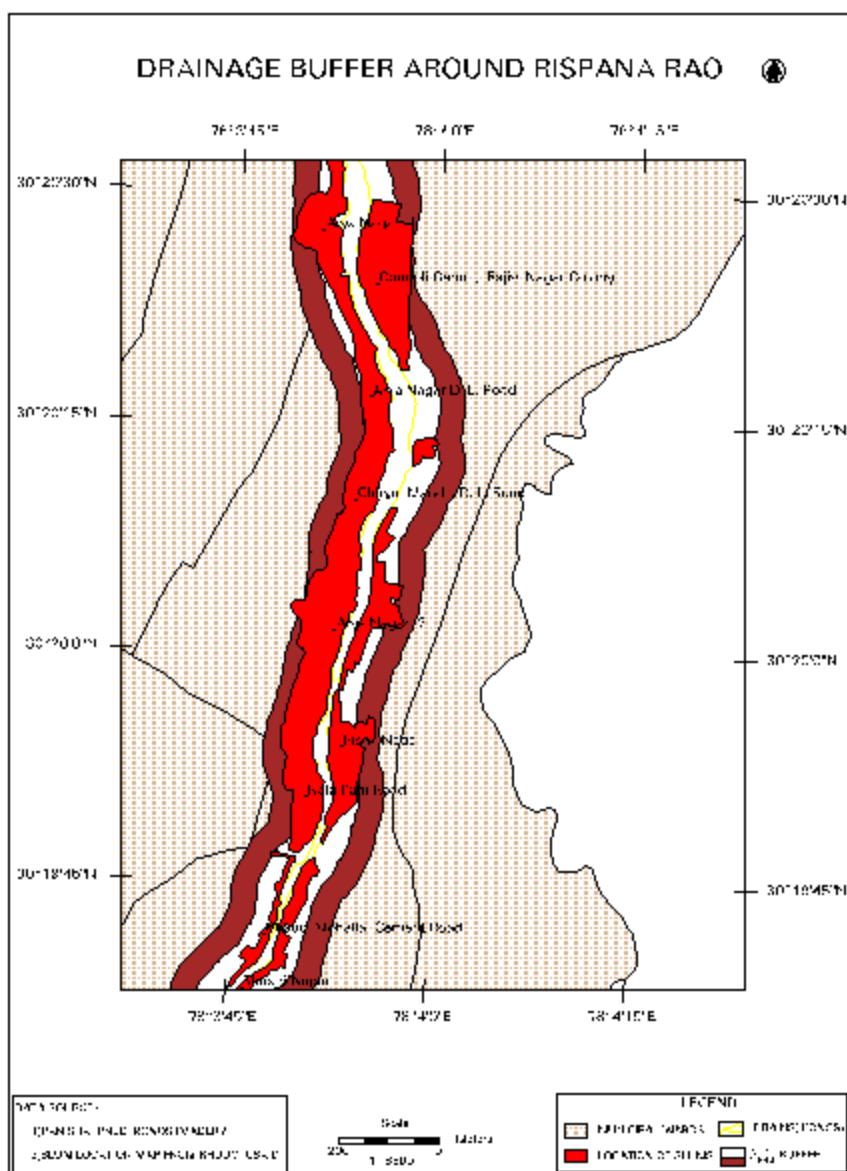


Fig. No. -4

CONCLUSIONS

Most of the slums have developed in the γ the natural drainage channels. This factor raises an important issue regarding the safety of the slums i.e. slums subjected to environmental risks (like flash floods). Most of the slums may wash out and may cause immense loss to human life and property. Regarding the study area it has been observed that although most of the slums are marginal slums, but the condition is not so bad in terms of living. The large number of pakka houses, better sanitation condition,

available electricity, access to house etc. gives us picture of a slum area having mixed socio-economic condition.

It has also been concluded that the slum houses located in the right bank of the river are better than that of the left bank. Because the right bank slums are more or less stabilized because of its nearness to the important commercial canter grown along D.L Road and there is less provision for further construction of slum houses. On the contrary, in the left bank, slum houses are developing fast and the important services like water, drainage, electricity, are lacking. Access to houses and sanitation condition is very poor along with street lighting. This is mostly due to the barrier of river between slums and main city area. Here, in most of the portion purely slum condition prevails.

From the above study it may be concluded that most of the slums in Dehradun were formed by encroaching the major drainage channel, and flash flood may damage most of the slums located in this area. So, proper care, planning and management should be taken to mitigate the flood risk vulnerability in slums. The urban planner therefore, has to take these facts into consideration and also monitor the vulnerable areas for checking the growth and expansion of the slums.

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** Student and Research Scholar, Human Settlement Analysis Group, Indian Institute of Remote Sensing (NRSA), Dehradun, India.*

***Scientist, Human Settlement Analysis Group, Indian Institute of Remote Sensing (NRSA), Dehradun, India.*

****Scientist and Head, Human Settlement Analysis Group, Indian Institute of Remote Sensing (NRSA), Dehradun, India.*