Population Explosion and Land Use Changes in Gurgaon City Region-A Satellite of Delhi Metropolis

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Abstract

In developing countries, rapid population growth has meant a decline in the arable land per capita and switch over to industrial, residential, commercial land uses. In 1961, for example, developing countries as a whole had an average of about one-half of a hectare of arable land per person; by 1992 the share had fallen to less than one-fifth of an hectare. If current trends in population growth continue, it is estimated that by 2050,the amount of arable land will be just over one-tenth hectare per person.

This paper is the case study of a town named Gurgaon in the urban shadow zone of capital city of India i.e. Delhi, in terms of its population explosion and land use changes. The population of Gurgaon has grown from 57 thousand in 1971 to 1.74 lakh in 2001. The growth rate has also indicated an increasing trend. In addition, the pressure of continuously growing metropolitan city is also changing the structure of the town and its surrounding neighborhood.

In this paper, the authors have tried to investigate the changes in land use pattern of Gurgaon region that have occurred over the past few decades, and have tried to associate them with population growth, urbanization and industrialization of the countryside.

For this purpose, multi-temporal RS and GIS data sets are used. Urban land use mapping was carried out using multi-temporal data IRS 1B LISS-II, IRS 1D LISS-III, IRS 1D PAN from 1993 to 2003. Topographical maps on the scale of 1:25,000 have been used for land use mapping for the year 1971.The spatial and temporal changes in various land uses have revealed that Gurgaon City and its surrounding region have been growing at a faster rate especially during the last decade and have a undergone a complete metamorphis in land use. Most of this transformation has been observed toward Delhi and Faridabad along major transport routes.

Introduction

In the emerging scenario in the world, 2.9 billion people of the total global population lived in urban areas 2000 A.D. (Table1) and it is expected to rise to 5 billion in 2030. Whereas only 47 percent of the world population lived in urban areas in 2000, the figure is likely to rise to 60% in 2030(Table1). At current rate of change, the world population will be divided in equal halves between the rural and the urban in 2007.

Although the population living in urban areas is rising, the proportion of population living in urban agglomerations or metro cities is still small. In 2000, only 6.5%of the urban population of

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the world lived in cities with population size more than 5 million. This figure is likely to reach 8.4 % in year 2015.
The proportion of world population living in smaller cities is considerably larger. In 2000, 52.5% of the urban dwellers lived in settlements with less than 500,000 population. In 2015, this figure is likely to be still over 50 percent.
One of the impacts of increasing urban population is on the cultivated land, which experiences decline on account of encroachment of it by industrial, residential, commercial, institutional activities and urban infrastructure.

Table1: Selected Indicators for the Urban and Rural Population by Development Group, 1950-2030.

Development Group	Population (billions)				Growth Rate (%)		Doubling Time(Years)	
	1950	1975	2000	2030	1950-2000	2000-2030	1950-2000	2000-2030
A Population size and growth								
Total Population								
World	2.52	4.07	6.06	8.27	1.75	1.04	40	67
More Developed Regions	0.81	1.05	1.19	1.22	0.76	0.07	91	998
Less Developed Regions	1.72	3.02	4.87	7.05	2.10	1.24	33	56
Urban Population								
World	0.75	1.54	2.86	4.98	2.68	1.85	26	38
More Developed Regions	0.45	0.73	0.90	1.00	1.40	0.38	50	185
Less Developed Regions	0.30	0.81	1.96	3.98	3.73	2.35	90	29
Rural Population								
World	1.77	2.52	3.19	3.29	1.18	0.10	59	714
More Developed Regions	0.37	0.31	0.29	0.21	-0.45	-1.09	----	----
Less Developed Regions	0.40	2.21	2.90	3.08	1.46	0.20	48	352
B Urban Indicators								
	Percentage Urban				Urbanization Rate(%)		Doubling Time(Years)	
	1950	1975	2000	2030	1950-2000	2000-2030	1950-2000	2000-2030
World	29.8	37.9	47.2	60.2	0.92	0.81	75	86
More Developed Regions	54.9	70.0	75.4	82.6	0.63	0.31	----	----
Less Developed Regions	17.8	26.8	40.4	56.4	1.63	1.11	42	62

Sources: United Nation Population Division, World Urbanization Prospects: The 2001 Revision.

As a result much of the currently cultivated land is being lost. Worldwide, an estimated 5 million to 7 million hectares of farming land disappear each year, are taken out of production because of accelerating *land degradation* and *rapid urbanization*. As populous agricultural areas become even more crowded, arable land is likely to come under increasing pressure. Agricultural yields could fall as land becomes more degraded, putting the livelihoods of millions of subsistence

farmers at risk. In this study, an attempt is made to investigate into the growth of urban population and its related impact (loss) on the agricultural land in a satellite town (Gurgaon) of Delhi metropolis.

Gurgaon, the nearest urban centre to Delhi has been experiencing fast changes in population growth and land use during the recent decades. Its vicinity to international airport and good infrastructure has attracted several multinational companies of Europe, UK, USA, and Canada to set up their industrial units in the Udyog Vihar-industrial area of the city.

Gurgaon town and its surrounding area are coming up very fast in the field of industrial development on account of close proximity to Delhi, a well known market for raw material, finished goods and a nerve centre of various commercial activities. Gurgaon city is located very close to Delhi 32 km.from the capital city.

This study was carried out in Gurgaon region located within coordinates of *latitudes* $28^0 24'$ N and $28^0 30' 30''$N and *longitudes* $76^0 59' 15'' E$ and $77^0\ 7'$ E located in the National Capital Region of Delhi. Gurgaon is a rolling plain dominated by the extensions of *Aravallis*. *Aravalli* offshoots are along the western parts of the district and extend up to the Union territory of Delhi in the north – east and south – west direction.

Objective

The main objective of the study is to identify the extent of decline in agricultural land use due to urbanization and industrialization in Gurgaon, a process which is accelerated on account of both vertical and spatial expansion of metropolitan Delhi.

Besides, the other objectives are to

- Identify the spatial pattern of agro land loss in last few decades,
- Analyse the urban encroachment by making use of remote sensing and geographic information systems techniques;
- Analyse the causal factors of agro land transformation.

These objectives are attained with the help of following database:

- Collateral data: temporal population data from the census of India and other central and state agencies; Cadestral data from land records of revenue department and 'topographical maps (Scale1: 25,000)' from Survey of India.
- Creation of GIS layers: digitization of agricultural land, built up area, wasteland etc.
- Remote sensing data from National Remote Sensing Agency, Hyderabad.
- Geo-correction of remote sensing data with the help of topographical maps.

Research Design and Methodology

The land use exercise has been based on the satellite data and topographical maps. It has been processed through the help of remote sensing software Geomatica, Erdas and GIS Software Arc-GIS (Arc Info, Arc Map). The study has been carried out with the specific aim and objectives to analyse the nature, growth rate and location of land use changes by using remote sensing and GIS. The integration of remote sensing and GIS is a powerful tool and decision support system for urban growth management and land use changes.

The data collection was carried out in two phases. This involved primary data collection and secondary data collection. To understand the complexity of a dynamic phenomenon such as agricultural land, land use change analysis, city expansion pattern and computation of land transformation, indicators were determined. An interpretation key *(Appendix table1)* was developed on the base of nature of data and the requirements of the exercise. The *table 4* is based on. land transformation map (figure 4). Detailed interpretation key is given in Appendix *table1*.

The characteristics of land use, roads and railway network and the agricultural area from different time series imageries, toposheets were also digitized; individual layers for each character were digitized. The highway passing in the mid of the city is digitized separately using Arc Gis (ArcInfo&ArcMap).
The extension of agriculture land in the last three decades (1971-2002) was determined by computing the area of the entire agro land from the digitized toposheets, imagery and comparing it with the area obtained from the different time periods. The following key (Table2) was adopted for the detailed study of the core of the city and the transformation of its landuse.

Table 2: Land use classes considered in image classification

Land use class	*General description/Subclass*
Built-up Land	Included Dense, Moderate, Sparse as well as Rural Habitat, Land under Industrial, Institutional, Commercial, Recreational, Transportation, Services uses etc.
Agricultural Land	Cropland, Fallow land, Forest and Plantation, Open space (residential purpose), etc.
Water Bodies	River, tank etc.
Waste Land	Scrub land, Water logged etc.
Others	Hill, Rock, Tank, River etc.

Population growth in Gurgaon:
Gurgaon has been a small but important urban centre in the neighborhood of Delhi. A district headquarter; its important lay in providing space for the defence and wireless station during the British period. The airport later turned to be an important international airport for Delhi.
As table 3 reveals, the city had a small population of 4765 in 1901. The population grew at the rate of 1.46 percent during 1901-1911. It faced a decline during 1911-1921 of (-6.48percent) in line with the rest of India, a period when epidemics, took a heavy toll of India's population. In the subsequent decades of 1931 and 1941,its rate of growth had been higher than national average.

Table 3:Urbanization Trends in Gurgaon 1901 – 2001

Year	*Urban population*	*Decadal growth%*
1901	4765	--
1911	5461	14.61
1921	5107	-6.48
1931	7208	41.14
1941	9935	37.83
1951	18613	87.35
1961	37868	103.45
1971	57151	50.92
1981	89115	55.93
1991	121486	36.32
2001	173542	42.85

Sources: Census of India, Economic Division, Govt. of India.

The partition of India in 1947 and subsequent migration of people (Hindus and Sikhs) from newly formed Pakistan to India resulted in a sharp increase in population, reflected in the next two decades (Table3). Population grew by 87.35 % between 1941-51 and by

103.45% during 1951-61. The location of Gurgaon vis-à-vis Delhi has always been a positive factor in inviting people and industrial activity. And hence population continues to grow at a higher rate than the national average, though the rate of growth has declined. Between 1981-91, there has been a substantial decline in population growth (36.32%). It appeared as if Gurgaon had reached a period of stability in population growth.
A change in economic policies of the 1990's leading to a trend in globalization, led to the influx of multinational companies and increase in residential; commercial; industrial space and further increase in population. The growth rate of 42.85 percent between 1991-2001, the population of Gurgaon city in 2001 census was enumerated as 1,73,542.

Table 4: Population Growth in the Villages of Gurgaon Region

Villages	Total Population			1971-81	1981-91	1971-81	1981-91
	1971	1981	1991	Decadal Growth	Decadal Growth	Decadal Growth %	Decadal Growth %
Begumpur Khhtola	889	1044	1416	155	372	29.41	70.58
Chakkarpur	1509	1808	2525	299	717	29.42	70.57
Fazilpur Jharsa	838	1150	1532	312	382	44.95	55.04
Gurgaon Rural	8080	32956	82710	24876	49754	33.34	66.67
Islampur	1182	1632	2436	450	804	35.88	64.11
Jharsa	7020	7506	8480	486	974	33.28	66.71
Kadipur	787	2646	3310	1859	664	73.68	26.31
Naharpur Rupa	507	622	1586	115	964	10.65	89.34
Nathupur	2133	3076	3508	943	432	68.58	31.41
Salokhara	714	1065	1986	351	921	27.59	72.40
Shamashpur	593	752	946	159	194	45.04	54.95
Sikandarpur Ghosi	997	1679	2772	682	1093	38.42	61.57
Sirhaul	1947	2098	2638	151	540	21.85	78.14
Tigra	712	1031	1333	319	302	51.36	48.63
Tikri	492	658	701	166	43	79.42	20.57
Wazirabad	3871	4754	5670	883	916	49.08	50.91
Total	32271	24015	32206	32206	59072	35.28%	64.71%

Sources: District Census Handbook (1971,1981,1991), Gurgaon District, pub. by Govt. of Haryana, India.

The villages in Gurgaon region have shown (table4) a much higher growth rate than Gurgaon city, the average being 64.71% during 1981-91decade compared to 36.32% for the city. Four villages have shown a growth rate of more than 70% during the same decade. Between 1971-81, population in Gurgaon city grew almost by 56 percent while the population in villages grew only by 35.3%. The tables are turned during 1981-91. The estimates indicate that the rate of growth of population in these villages is likely to be higher still during 1991-2001 on account of industrial, residential and commercial spaces created in the city region as a result of globalization.

Table 5: Comparison of areas under different land uses

Land use class	1971		1993		2002	
	1971		1993		2002	
	Area (sqkm)	%	Area (sqkm)	%	Area (sqkm)	%
Built-up land	11.36	8.96	51.14	40.34	84.2	66.42
Agricultural land	102.67	80.99	64.24	50.67	33.59	26.50
Waste land	7.48	5.90	6.97	5.50	5.01	3.95
Others	5.26	4.15	4.42	3.49	3.97	3.13
Total	126.77	100	126.77	100	126.77	100

Sources: Topographical Maps1971, IRS IB 1993,IRS 1D 2002 & IRS 1D PAN Merge data[1].

Table 6: Comparison of changes areas under different land uses

Land use class	Changes	Area	Percentage of Changes	
	1971-93	93-2002	1971-93	1993-2002
	Area in (sqkm.)	Area in (sqkm.)	%	%
Built-up land	39.78	33.06	50	50
Agricultural land	38.43	30.65	48.30	46.35
Waste land	0.51	1.96	0.65	2.96
Others	0.84	0.45	1.05	0.69
Total	79.56	66.12	100	100

Sources: Topographical Maps1971, IRS IB 1993,IRS 1D 2002 & IRS 1D PAN Merge data[1].

The statistics reveal that of the 126 sq kms. as total area of Gurgaon city/region, nearly 81 % was under agriculture in 1971. It was reduced to around 51% (50.67%) in 1993 and to 26.5% in 2002. The rate of decline has been higher during the last decade. Between 1971-93, 38.43 sq kms. of agricultural land was lost while between 1993-2002, 30.65 sqkms. of agricultural land was lost. The area under 'built up land' category increased substantially from 11.36 sq kms. in 1971 to 84.2 sq kms. in 2002, the percentage share having increased from 8.96 in 1971 to 66..42 in 2002. The rate of increase of built up area has been higher between 1993-2002 (3.6 sq kms per annum) when 33.06 sq kms. were added to this category compared to 1971-93 period (1.81 sq kms. per annum) during which 39.78 sq kms. were added. This time period has witnessed 33 percent decline in wasteland (from 7.48 sq kms. to 3.95 sq kms.), more rapidly during the last decade than the first two decades. 'Other land uses' have reduced to 59 % from 1971 to 2002(from 5.15 sq kms. to 3.13 sq kms.). The rate of decline in this case is reduced during the 1993-2002,compared to 1971-1993-time period from 1.05 percent to 0.69 percent respectively (Table 6).

Land Transformation: Spatial and temporal

[1] Topographical maps No.53 H/3/1,H/3/2,H/2/3,53D/14/6,D/15/6,53/D/15/5, Satellite data IRS 1B LISS-II 1993,IRS 1D LISS-III 2002, IRS 1D PAN (LISS-III+PAN Merge) and Existing maps.

In this study, Considerable changes in land use has occurred during the last few decades. The change may be on the specific area or the entire region. The change from rural to urban land use is so fast that the resultant need and complex uses coupled with shortage of land have led to speculation and increase in land values. The ever-growing difference between the demand and supply of house sites has increased the cost of land in the city which has ultimately led to pressure in fringe area which has given rise to proliferation of unauthorized development of land uses-residential, industrial and other land uses.

Table 7: Detail of changes in various Land Uses

Code	*Land use categories*	*1971-93*	*1993-2002*
1	Built up Land	11.36	47.82
1-5	Built up Land -Others	-	0.42
2-1	Agroland- Built up Land	39.42	55.64
2	Agroland	63.35	5.84
2-3	Agroland-Water	0.0057	0.11
2-4	Agroland-Wasteland	-	0.24
2-5	Agroland-Others	1.78	1.43
3-1	Wtaer bodies- Built up Land	0.0093	0.15
3	Water bodies	0.0069	0.014
4-1	Wasteland- Built up Land	-	2.45
4-2	Wasteland-Agroland	-	1.61
4	Wasteland	6.75	4.77
4-5	Wasteland-Others	-	0.96
5-1	Others- Built up Land	0.35	3.21
5-2	Others-Agroland	0.89	1.07
5-4	Others-Wasteland	0.18	-
5	Others	2.62	1.04
	Total	126.77	126.77

Sources: Topographical maps1971, Satellite Data IRS IB 1993,IRS 1D 2002 & IRS 1D PAN Merge data.

The table (7) reveals that three subcategories of land-use have undergone substantial changes. The maximum change has occurred in Agro land, which has declined, from 63.35% of the total land in 1971 to 5.84 % in 2003. Next in order is the 'Built-up land', which has improved its share from 11.36 percent to 47.82 percent. Next significant change occurred in Agro land. Built up land from 39.42% to 55.64%.

The following three-maps depict land use pattern in and around Gurgaon city in 1971,1993 and 2002, the fourth map shows the land use changes in last decade. The villages in Gurgaon region can broadly be classified into three categories based on the process of their transformation: rural - dominated with agricultural land where people depend on primary activities; transitional- change sets in and the rural activities get affected by it; urban – the urban is complete both in space and functions and the area becomes almost part and parcel of urban landscape. The process of expansion of the urban area is clearly brought out in figures 1,2,and3.

Fig 1: Land Use Map1971

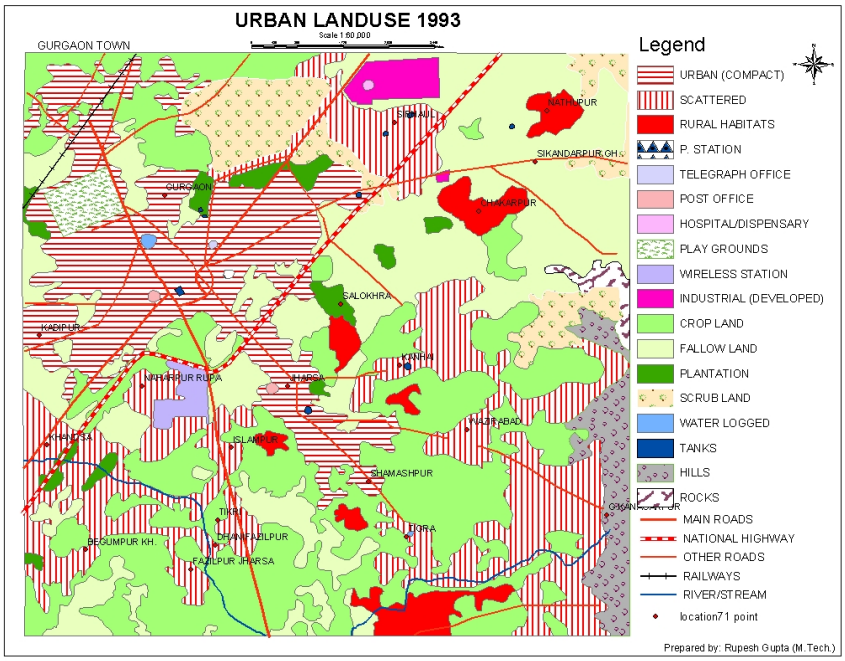

Fig 2:Land Use Map1993

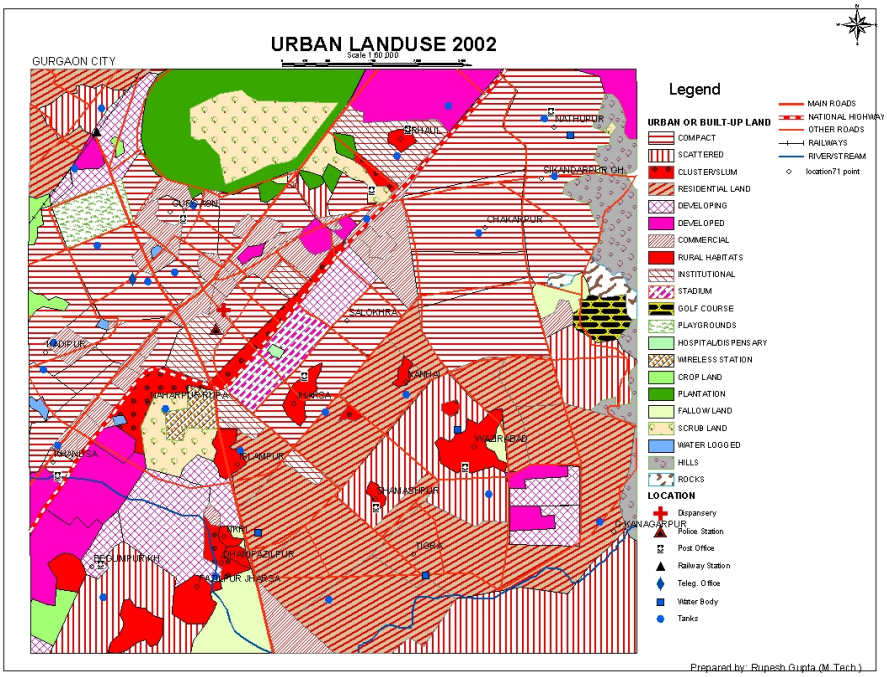

Fig3: Land Use Map 2002

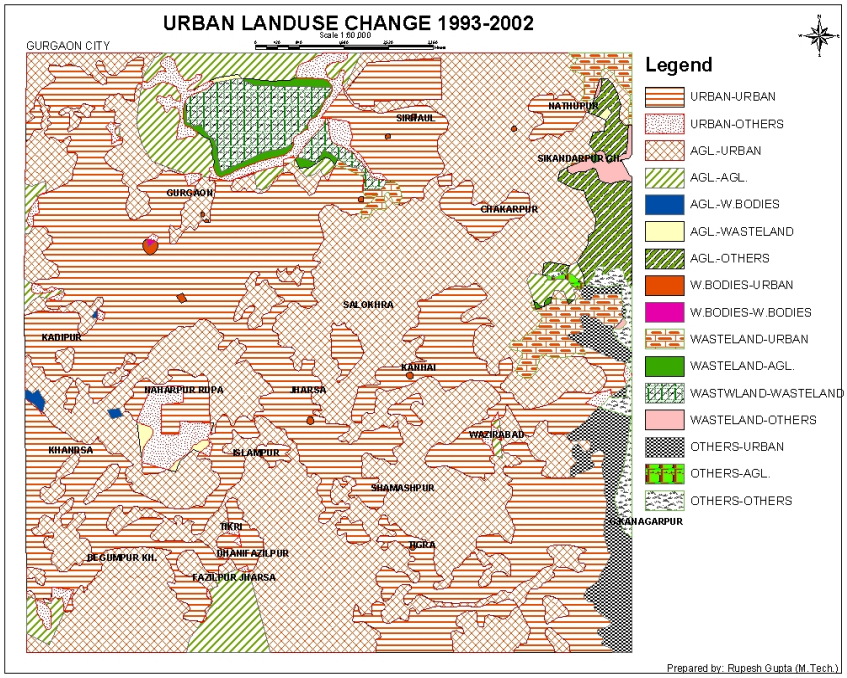

Fig 4: Land Use Change Map 1993-2002.

Figure 4 (urban land use change 1993-2002) highlights the following:

- Major agricultural land is converted into industrial, residential and the other land uses. Wasteland, hill, and forest area are also affected from city expansion.
- Major land use- Residential is converted to commercial in the core city.
- The rapidly urban expansion in Gurgaon region has taken place at the cost of wasteland and agricultural land. The impact of mega city Delhi and the development of physical infrastructure specially the transport system has triggered the land use changes.
- The open areas, greenery of surrounding area as well as its vicinity to Delhi are some factors, which attract the people towards this satellite city.

It has been observed that agriculture land located in the surrounding region of the city have shown a declining trend due to population growth and growth of economic activities *(fig3)*. The city has grown towards Delhi and Faridabad along the main roads. The above maps show the vast changes occurred during last ten years and these changes are reflected in the loss of land under fellow, agriculture and open lands (waste lands).

Appendix Table 1

Scheme of Urban Land Use Classification

1	Urban or Built-up	11	Residential area	111	Compact or Dense
				112	Scattered or Moderate
				113	Cluster/Slum
				114	DLF
				115	Residential Colony
		12	Residential land or Open space		
		13	Commercial		
		14	Industrial	141	Developed
				142	Developing
		15	Transportation	151	Railways
				152	Main roads
				153	National highway
				154	Others roads
		16	Institutional		
		17	Recreational	171	Parks/Gardens
				172	Playgrounds
				173	Stadium
				174	Golf course
2	Services	21	Railway station		
		22	Police station		
		23	Post office		
		24	Telegraph office		
		25	Hospital/Dispensary		
		26	Wireless station		
3	Rural	31	Rural habitats		
4	Agricultural land	41	Crop land		
		42	Fallow land		
		43	Plantation		
5	Wastelands	51	Scrub land		
		52	Water logged		
6	Water bodies	61	River/Streams		
		62	Tanks		
7	Others	71	Hills		
		72	Rocks		

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