

Assessment of Encroachment in the Rispna River of Dehra Dun City (Uttarakhand)

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Abstract

Rivers in the city zones are more vulnerable to all kinds of disasters- flood, pollution, erosion, and deposition. Human interferences are found maximum. Slums are one of the characteristics of the river and stream banks of urban centers. The purpose of this study is to identify the pollution in the channel bed by the slum dwellers in Dehra Dun city. The main objective of the present description is to find out the causes and consequences of pollution in the Rispna River of Dehra Dun. The methodology has been adopted based on the primary and secondary data, SOI maps, Carteret and Google images, field investigation, and observation. The slum population of Dehra Dun was 9.34 percent and 3.23 percent of Uttarakhand as per the census 2011. Results show that the Rispna River is the most polluted in the city. The basic causes of river pollution are the unplanned development of slums in the channel bed by the process of encroachment. The slum population of Dehra Dun city is already crossed 158542 which are 3.23% of the state. Out of that 56% slum population live in 34 slums of the Rispna River catchment. The rate of encroachment of the channel bed is 4.6m/year during the last 54 years. Organic waste material and non-degradation materials are dumped by the slum dwellers in the river. It is estimated that about 659.3 MT/month of solid waste is dumped in the channel bed. The maximum PM2.5 emission, 20% was estimated by solid waste, 14% was estimated by domestic waste and 14% by transport. The impact of pollution is on the health of the nearby communities, air, and climate. Foul smells, dust, burning plastic, etc are affecting the health of children and old people. In the end, some suggestions are given for the eradication of Rispna River pollution.

Key Words: Pollution; Consequences; Solid waste; Slum; Encroachment

Introduction

In recent years with the economic, social, and infrastructural development, the urban centres are rapidly expanded in India. Rural migration to urban centres expanded the size and expansion of the cities and towns. Most of the towns are located near the bank of rivers or their confluences. Rivers are the backbone of human existence. The river encroachment has been uncontrolled in recent decades, especially in urban centres of India. The current extent of encroachments is in the form of residential settlements, road networks, businesses, industries, administrative infrastructure, etc. The wrongdoers and slum dwellers are self-willed and encroach on the river bed, flood plains, lake bottom, ponds, forest sites, and peripheries of the cities without thinking about the grim future, resource management, and sustainability of the environment (Raihan and Kaiser 2022). Many researchers have highlighted the causes and effects of water and waste pollution around the cities. Ahmed and Ismail (2018) point out the causes and effects of water pollution in the city of Delhi. Industrial waste and domestic sewage get discharged directly into rivers as a predominant cause of river water pollution. Kaur et al (2013) carried out a study on the assessment of idol immersion on the physical-chemical characteristics of the river. It revealed that idol immersion activity harms the water quality of the river Yamuna. Increasing population pressure, high rate of rural migration, generation employment in urban centers, and many others are the chief causes of unplanned growth of urban centres. Rivers in urban areas are facing many environmental problems such as

serious water pollution, flood problem, water logging disasters, waste disposal problem, health problems, noise pollution, and infrastructural and social development problem (Yibo Wang, et al 2020).

Encroachment means to advancement and development of anthropogenic structures into natural features around urban centres. The term also encompasses the placement of fill, the removal of vegetation, or the alteration of topography into such natural areas. The causes of encroachment are varying from sub-urban centres to metropolitan cities. Their impact can be observed on functions, interactions, and values of those natural areas in the form of loss of aquatic and terrestrial habitat, reduction of ecological processes, decline in water quality, natural stability, and loss of flood attenuation (Review Jan. 2017). The most encroachment problem is in flood plain, river corridors, hazardous sites, dry channel beds, and farm forest fringe. Placing structures or developing slums in flood plains or dry channel beds results in a loss of flood storage during monsoon season and heightens the risk to public safety. Due to the unplanned development, the natural drainage system is often diverted in different ways as a result water logging and flood problem is raised in the localities during the rainy season. Moreover, natural river channels continuously become shrinking and converted into a Nala. Somewhere these small Nalas are also occupied or covered by the dwellers. Such unwanted development in the cities can increase property's susceptibility to flooding damages causing a higher risk to public safety. Encroachment practices along the river channels result in a greater instability, excessive erosion, and sediment load by concentrating flows and increasing stream velocity and power (Review Jan. 2017). The extent of encroachment in the flood plain and channel beds reduces the infiltration rate of the ground which also contributes to the instability of the stream channel.

Therefore, analyzing and interpreting the current problem of river encroachment and proposing effective treatment measures, these problems have reached the point where urgent solutions are needed. Rispna and Bindal Rivers in Dehra Dun city are severely affected by the encroachment problems.

Area of the Study

Geo-dynamically the Rispna River catchment is a part of the Ganga River drainage system. Rispna River is a major river in the eastern part of Dehra Dun city. Dry river channels are locally known as Rao in Doon valley. Its ancient name was Rishi Parana which was later called Rispna. In the source region, its name is Arni Gad which rises from the Mussoorie hills (Landhour) in the north at the height of 2296m (7534 feet). After passing the distance of 12.5 km, it enters the Doon valley and its name has been changed to Rispna River. Onward it joins the Suswa River near Ramgarh village east of Clementown at the height of 575m. It flows from north to south direction which has a relative height of 1722 m. The average gradient of the river is about 61m/km but it varies from hill (177m/km) to Doon plain (20m/km). It has only one major tributary i.e. Nalapani Rao (24m/km). The area of the river basin is 63.61 km². The Rispna River is confined between latitudes 30° 14' 20" to 30° 27' 40"N and longitude 78° 01' 13" to 78° 6' 28"E bounded by the water divide of Rispna and Bindal River in the west and Baldi and Rispna water divide in the east respectively. MBT, Doon gravel fan (Nossin 1971; Nakata 1972; Singh et al. 2001; Thakur and Pandey 2004; Thakur et al. 2007), alluvial fans, terraces, and channel beds are prominent geomorphic features in the study area.

Rispna River (Arni Gad) is a very typical river that forms the intermittent drainage pattern in the Doon valley. It is a perennial river at the source but as it enters the Doon valley it becomes dry because of the thickness of the Doon gravels fan deposits. It flows 19 km on the Doon gravel bed in the Dun valley so that the channel water infiltrates under the gravel beds. As the thickness of the gravel bed decreases and clay or mud appears on the surface, the underground channel water further recharges on the surface before 2km from the confluence with Susua.

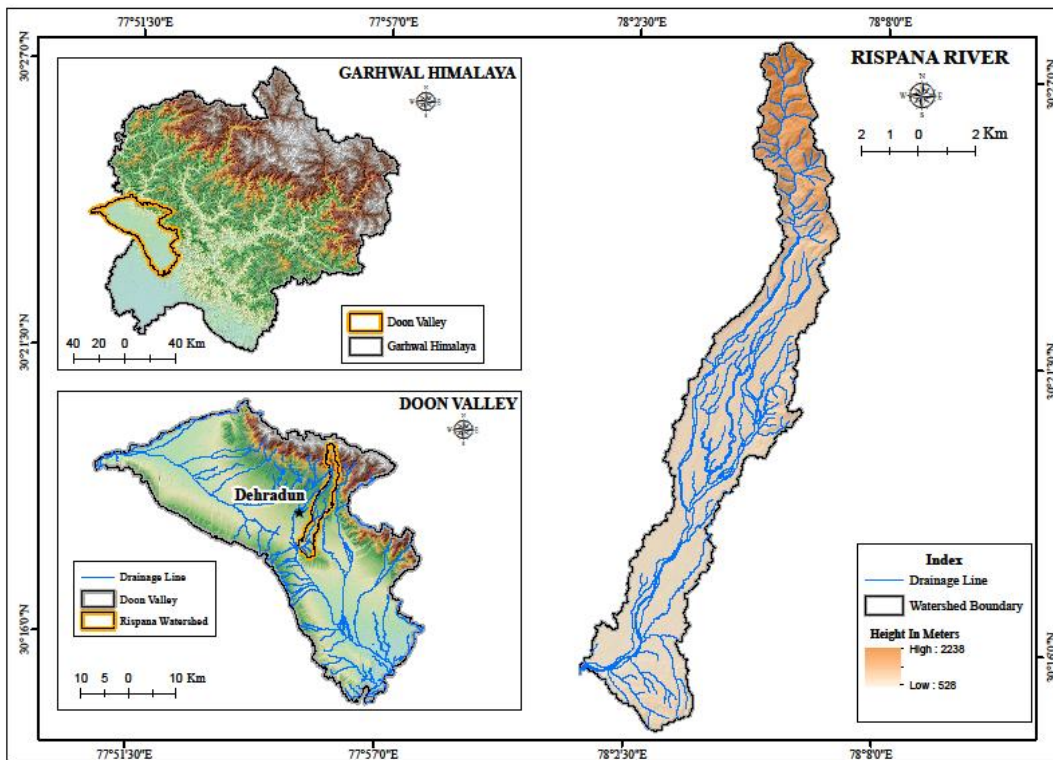


Fig.1 Location of Study Area (Rispna River)

Problem

After passing 75 years major cities of India are facing the problem of slums and encroachment on public land. The encroachment on the channel beds, wasteland, hazardous sites, flood-prone areas, Govt land, and public land is happening everywhere in and around the cities. Therefore, all cities have turned into slums. Look at Dehra Dun city, there is a large number of encroachments on the channel beds. The river of Rispna, Bindal, Nalapani, and Tons and their tributaries' channel beds are continuously under threat of encroachment. We must know the reality. The Supreme Court of India expressed concern over the encroachment on public land and observed this is a “sad story” that is going last 75 years and major cities have “turned into slums” (Times of India Dec.16, 2021). The encroachment practice is happening everywhere along the stream channel around the city of Dehra Dun. Unsystematic and unplanned slums are being developed. The city's drainage system is being completely collapsed. Pollution is increasing in the city. Along with it, rivers and streams bed are becoming piles of garbage. It has a direct impact on the health of the people living there. Therefore, the main issue of this investigation is that the encroachment problem has to be raised. It will be more appropriate to take some necessary steps to solve the problem.

Objectives of the Study

1. To identify the successive stages of encroachment in the Rispna River and its tributaries stream beds of Dehra Dun city.
2. To identify the causes and consequences of encroachment in the Rispna River and its tributaries' stream beds.
3. To identify the role of unplanned urban development and propose effective treatment measures to minimize encroachment in the channel beds.

Research Methodology

To fulfil the objectives it is necessary to develop a comprehensive research methodology for the analysis of riverbed encroachment in the study area. The base map is prepared based on a Topographical map (53J/3) surveyed in 1937-38 and a Guide map of Dehra Dun (Surveyed in 1965-68) on a scale of 1/20000. Geospatial techniques are used for the interpretation and analysis

of data and mapping. The Arc GIS 10 software was used for mapping. A comparison of pictures and data throughout the last 54 years (1968-2022) was done.

The width of the river flowing in the Doon valley was measured based on the Dehradun guide map (1968), topographical sheet (53J/3) published in 2006, and the Cartosat data image of the year 2022 with the help of Arc GIS software. The width of the river was determined by the cross-section of more than 70 segments. Similarly, the ward-wise width of the river is also determined from 1968 to 2022. The investigation stage involved a comprehensive field survey of the study area through longitudinal and transverse traverses, identification of sample sites, site photographs, and other collateral maps and literature. The field study base approach has been applied for interpretation.

Drainage System

Dehra Dun valley is an intermountain valley between the Lesser Himalaya range in the north and the Siwalik range in the south. Dehra Dun Township is located between the water divide of the Ganga and Yamuna Rivers. Rispna River is the part of Ganga drainage system. It rises from Mussoorie hills at the height of 2295 and joins in Susuwa River at the height of 575m near Mothorawala village. After passing 12 km from the Mussooree hills it enters Doon valley at the height of 900m near Rajpur. Topographically the Rispna River catchment is divided into two physiographic units i.e. mountainous terrain and Doon fan plain. About 20% area is hilly and 80% area is under the plain. The average gradient of the Lesser Himalaya terrain is higher (0.18) than Doon valley (0.02). In the source region, the river flows through a narrow V-shaped valley on the lesser Himalayas but when it enters the Dun valley its width increases and depth decreases which formed a braided channel (Fig. 2). Rispna River is perennial from its source but when it enters in the Doon valley near Rajpur it becomes dry under the Doon gravel belts. Numerous seasonal channels join in Rispna River in the Doon plain. Among them Nalapani Rao and its tributaries are prominent (Fig. 1). First and second orders gullies are dissected from the Doon alluvial fan from place to place. The main third and second-order streams are Amwala Rao, Jagatuwala Nala, and Badripur Nala.

Results of the Study

The study was conducted in the whole catchment of the Rispna River but encroachment analysis mainly has been conducted in the Doon fan plain along the Rispna River and its tributaries. The maximum encroachment of the river bank has been observed in the Doon valley. Successive stages of encroachment of the Rispna and Nalapani River beds have been assessed. The width of the channel bed, its distribution, and change detection results are shown in the following tables and maps.

Table 1: Successive stages of channel bed width (m) from 1968 to 2022

River in Doon	Guide map	Topo. map	Cartosat Data	Change Detection of width (m)		
	1968	2006	2022	1968 - 2006	2006 - 2022	1968 – 2022
Rispna R. average width (m)	319	87	68	232	19	251
Nalapani Rao average width (m)	137	115	25	22	90	112

Source: Data computed by authors

Table 1 show that the average width of the Rispna channel bed was 319m before 1968 which was reduced by 87 m up to 2006 and further reduced by 68 m up to 2022. During 38 years it was reduced by 232 m and 251 m during 54 years (Table 1). The reduction rate of the channel width of Rispna River is 4.6m/year followed by Nalapani Rao 2.1m/y (Table 2).

Table 2: Rate of encroachment of Rispna River and Nalapani Rao channel beds

River in Doon	Rate of encroachment		
	1968 - 2006 (38 years)	2006 - 2022 (16 years)	1968 – 2022 (54 years)
Rispna width (m)	6.1m/y	1.2m/y	4.6m/y
Nalapani Rao width (m)	0.6m/y	5.6m/y	2.1m/y

Source: Data computed by authors

After the formation of the Uttarakhand state in 2000, the cases of encroachment extensively increased. Most of the illegal encroachment has taken place in the small dry stream beds i.e. Jagatuwala, Amwala, and Badripur Khala near the most populated zone of the town. In some places, these Nalas are completely covered by slum dwellers. Somewhere or the other, there are no symbols of Nalas remaining on the surface. The anti-social elements involved in encroachment have no fear of authorities and laws as huts and houses appear right in the channel beds. Fig. 2 Location of Dehra Dun Nagar Nigam Ward in Rispna River

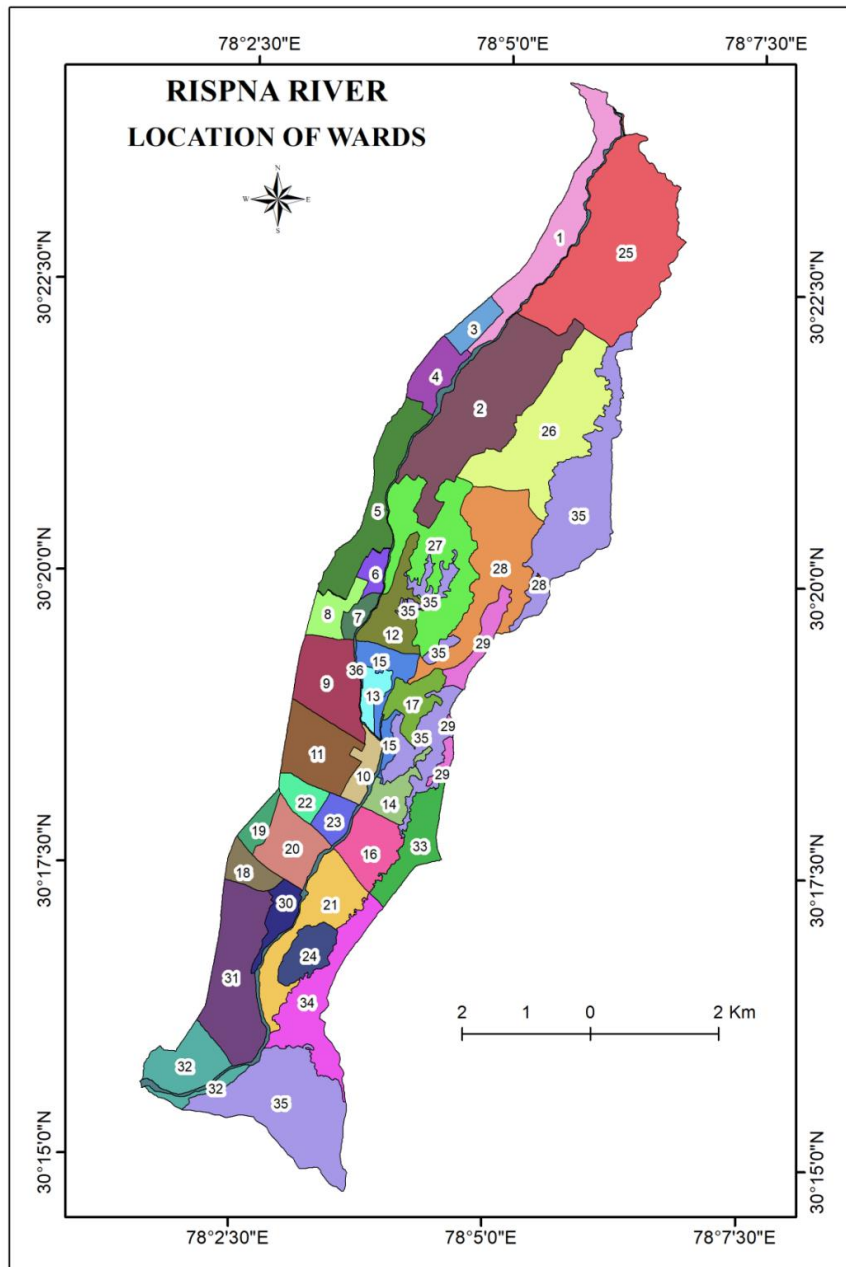


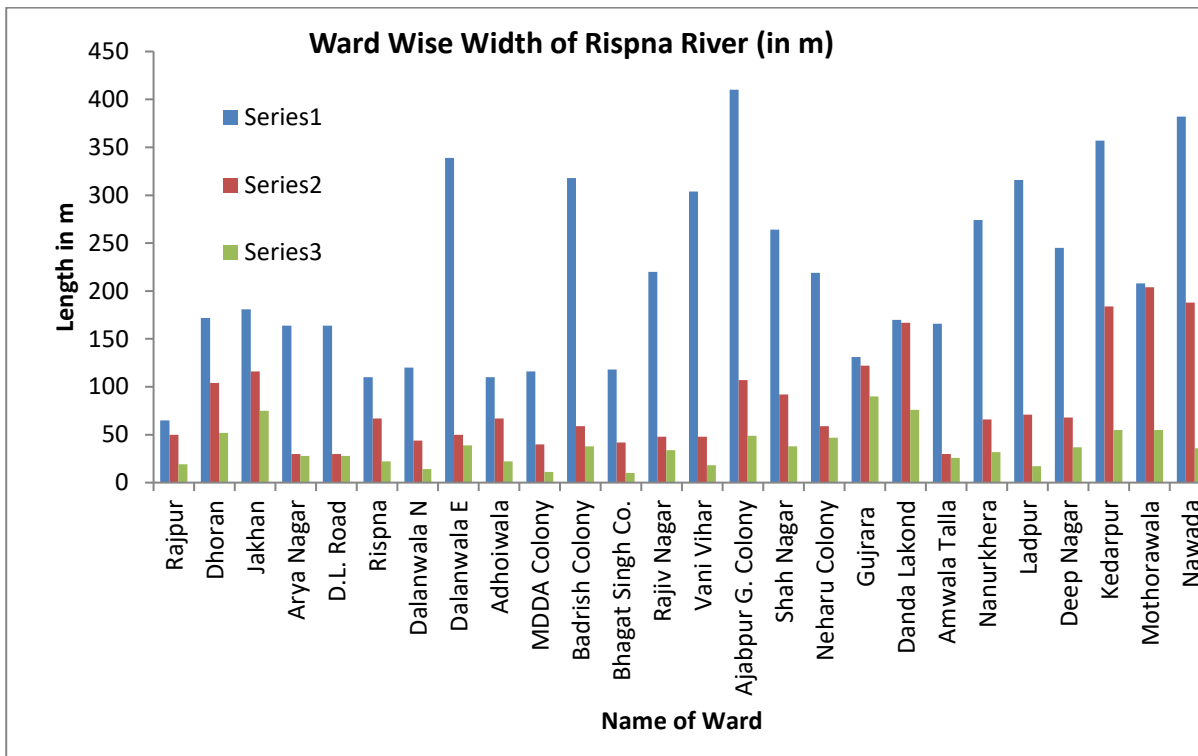
Fig 2: Location of wards in Rispna River, Dehra Du city

Table 3: Ward wise occupied average width (m) of River (1968-2022) and change deduction

S.N.	Name of Ward	(Guid map)	(Topo map)	(Cartosat Data)	Change Detection		
		Series I (1968)	Series II (2006)	Series III (2022)	1968-2006	2006-2022	1968-2022
1	Rajpur	65	50	19	5	31	46
2	Dhoran	172	104	52	68	52	120
3	Doon Vihar	-	-	-	-	-	-
4	Jakhan	181	116	75	65	41	106
5	Arya Nagar	164	30	28	134	2	136
6	D.L. Road	164	30	28	134	2	136
7	Rispna	110	67	22	43	45	88
8	Karanpur	-	-	-	-	-	-
9	Dalanwala N	120	44	14	76	34	106
10	Dalanwala E	339	50	39	289	11	300
11	Dalanwala S	-	-	-	-	-	-
12	Adhoiwala	110	67	22	43	45	88
13	MDDA Colony	116	40	11	76	29	76
14	Badrish Colony	318	59	38	259	21	80
15	Bhagat Singh Colony	118	42	10	76	32	108
16	Rajiv Nagar	220	48	34	172	14	202
17	Vani Vihar	304	48	18	256	30	286
18	Ajabpur Sa. Vihar	-	-	-	-	-	-
19	Mata Mand. Road	-	-	-	-	-	-
20	Ajabpur G. Colony	410	107	49	303	58	361
21	Shah Nagar	264	92	38	226	54	226
22	Dharampur	-	-	-	-	-	-
23	Neharu Colony	219	59	47	160	12	172
24	Defence Colony	-	-	-	-	-	-
25	Gujrara Mansingh	131	122	90	9	32	41
26	Danda Lakond	170	167	76	3	91	94
27	Amwala Talla	166	30	26	136	4	140
28	Nanurkhera	274	66	32	208	34	242
29	Ladpur	316	71	17	245	54	299
30	Deep Nagar	245	68	37	177	31	208
31	Kedarpur	357	184	55	174	129	302
32	Mothorawala	208	204	55	4	149	59
33	Nathanpur	-	-	-	-	-	-
34	Nawada	382	188	36	194	152	346

Source: Data computed by authors

Fig. 3: Successive stages of ward wise width of Rispna River (1968, 2006 & 2022)



The table 3 shows that 24 wards are in the Rispna River out of the total ward in Dehra Dun Nagar Nigam (Fig 2). The Nalapani Rao flows through the 16 wards. However, 8 wards are not touched the Rispna River (Fig 2). Ward-wise width of the river channel has been measured since 1968, 2006, and 2022 (Table 3). Based on the 1938 large-scale topographical map and 1968 guide map of Dehra Dun, the average width of the Rispna River has been measured in each ward. The maximum width of the river bed was measured in the ward of Ajabpur (410 m) Garhwali Colony (410 m), Nawada (382 m), Kedarpur (352 m), Dalanwala east (339 m), Badrish Colony (318 m) and Vani Vihar (304 m) (Fig. 3).

Till 1968, encroachment on the river bed in almost all municipal wards was at a minimum level. As the population of the city increased, the rate of encroachment also increased accordingly. The minimum width of the river channel was found in the ward of Rajpur (65m), Rispna (110m), Adhoiwala (110m), Dalanwal North (120m), and Bhagat Singh colony (118m) up to 1968. These wards were already extended towards the channel bed. Rajpur ward is an exceptional case because here Rispna River flows through a deep and narrow channel. So the width of the river is not so wide. As the river goes further down and the gradient of the river decreases, the river becomes wider.

By 2006, the average width of the river has reduced to 232m and remained at 68m. Table 3 reveals and Fig. 3 represents that after passing 3 decades from 1968 to 2006 minimum width and maximum encroachment of the Rispna River channel bed was found in the wards of D.L. Road (28m), Arya Nagar (30m), Dalanwala North (29m) and east (50m), Rispna (65m), Bhagat Sigh colony (42m), Vani Vihar (51m), Rajeev Nagar (50m), Amwala (30m) and Adhoiwala (67m). In general maximum encroachment has taken place in those wards which are largely populated zone of the town. However, as the trend goes the channel bed land is often used for Jhuggi-Jhopadi (Slum hut) and afterward construction of the cemented structure. Besides this minimum encroachment is observed in those wards which are recently incorporated into Municipal Corporation. Due to the rural environment, there has been very little encroachment, in which the major ward are Gujrara Mansingh, Dhoran, Danda Lakhond, Mathorawal, Kedarpur, Nawada, Badripur, and Nathanpur.

By 2022, the average width of the river has reduced to 19m (Table 1). The width of the river has reduced to less than 20 meters in about 7 wards (Table 3). In some places, the encroachment on both sides of the river has increased so much that the

width of the river is less than 10 meters (Photo Fig. 6 and 11). It is a matter of great concern which needs urgent attention. Continuous increasing encroachment on the bed of rivers is a sign of danger for the future.

Change Detection

In the last 54 years, the encroachment change detection pattern of the river bed has been calculated in Table 3 and it has been summarized in table 4. It shows that 11.76% of wards have a maximum change deduction (> 300m). The second highest change detection (200-300m) is found in 17.65% of wards. Minimum change detection (<100m) is calculated in 23.5% of wards. Rest of the 23.5% municipal wards, the change detection in encroachment has been between 100 and 200m. About 8 wards do not touch the Risipna River channel bed in the study area. Successive stages (from 1968 to 2022) of change detection of river bed encroachment have also been shown in Fig 5.

Fig. 4: Ward wise distribution of change detection of width in Risipna River

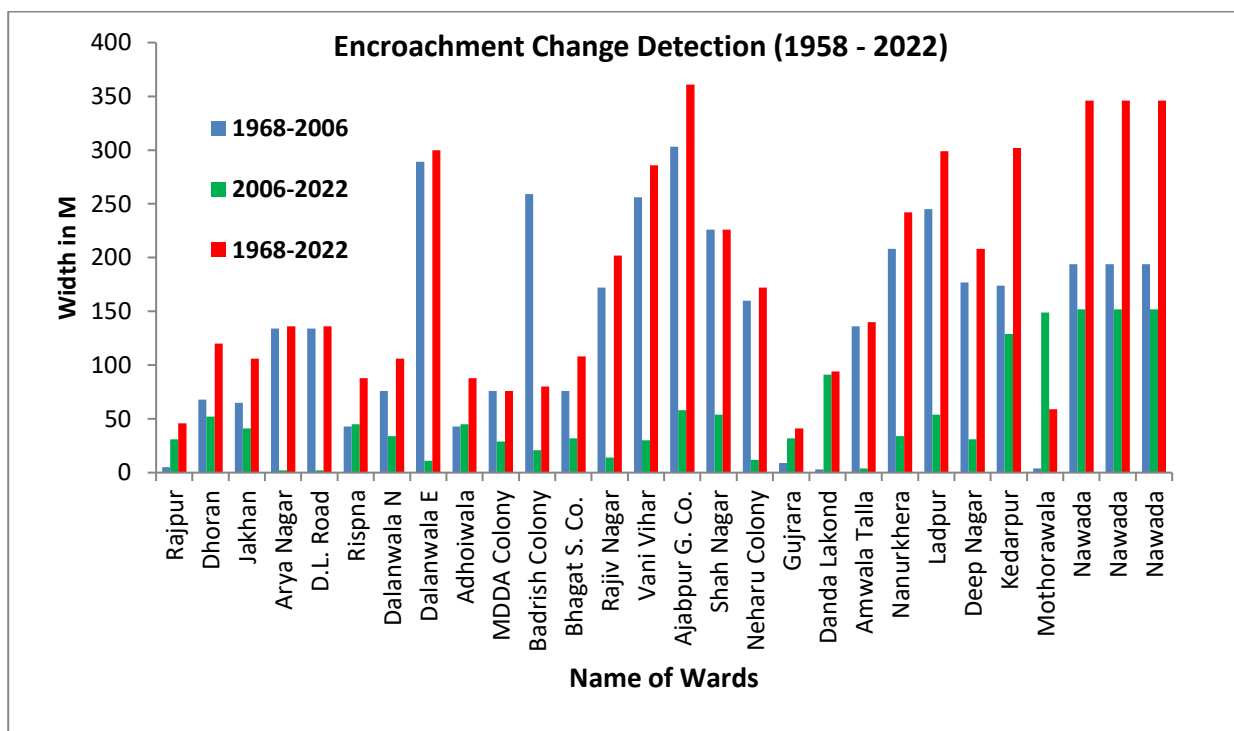
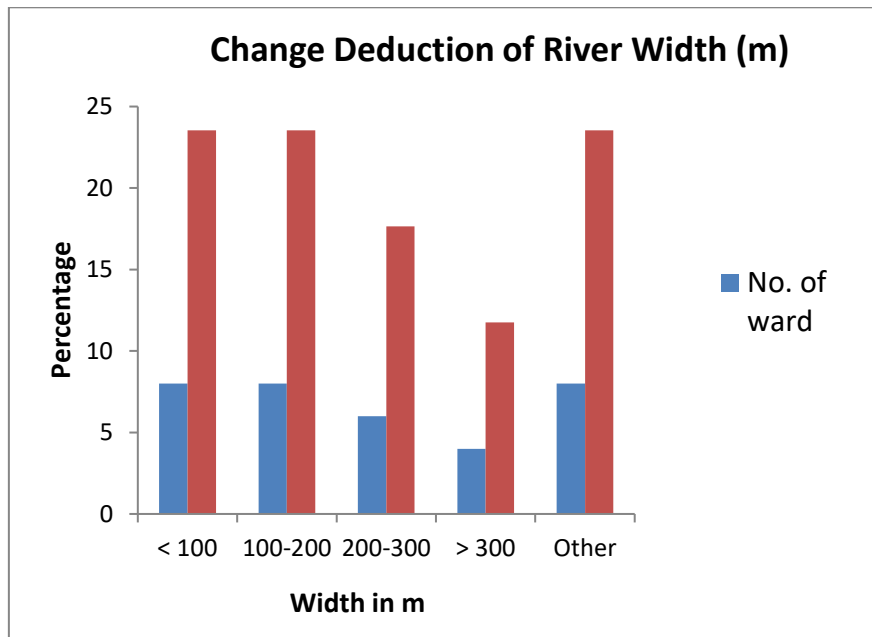


Table 4 Distribution of change detection of channel width (1968 to 2022)

Average Width in m	No. of ward	%	No. of ward
< 100	8	23.53	4, 14, 46, 47, 48, 59, 60 and 85
100-200	8	23.53	7, 28, 49, 5,9, 13, 61 and 57
200-300	6	17.65	29, 50, 51, 55, 62, 63 and 82
> 300	4	11.76	54, 83 and 96
Other	8	23.53	6, 15, 30, 52, 53, 56, 58,

			and 94
Total	34	100.00	

Fig. 5 Change Deduction of Chanel Width (from 1968 to 2022)



Discussion

In 1968 the Dehra Dun has been taken out from the Meerut division to the Garhwal division. The fast contraction in the width of the channel bed started after 1971 when Bangladesh became independent. Large numbers of Bangladesh refugees enter illegally in India and started to settle around the major cities of India. The second phase of encroachment was started in 1980 under the regime of the Congress Government and continued up until 2000. Large numbers of Bihari labourers, pourers, backward, sweepers, cleaners, and Muslims have enclosed the dry channel beds and flood plain of the Dehra Dun city. The third phase of encroachment was started after the formation of Uttarakhand state in 2000. Further large numbers of outside labourers, un-employers, contractors, builders, and rural migrants are started to come in Doon valley for work on the construction of hotels, buildings, roads, colonies, apartments, and many other developmental activities. Simultaneously, they started to encroachment the public land, river channel beds, ponds, forest land, and wasteland illegally. Unfortunately, there was no check to control the encroachment. Due to no curb on them by the government, town planning department, municipality, and Nagar Nigam, their morale got high and their numbers increased. They further stated encroachment to other areas.

A significant role played by the leaders of political parties in the acceleration of encroachment and patronizing them. Instead of removing the encroachments, the leaders of political parties and governments have started providing facilities like roads, electricity, water, health, etc at the encroachment localities for seeking votes in elections and efforts have to be made to make them permanent residents. The courage of the encroachers became higher and higher. The local people's representatives distributed public land on lease in their respective wards. Under the guise of the lease, the encroachment became more intense. Some influential persons, contractors, builders, leaders, etc. also encroached on public lands and banks of rivers for monetary gain. It is observed that these antisocial elements first encroach on the land and then sell it to the slum dwellers without registration at an expensive price. This game is still going on continuously. The elements involved in encroachment have no fear of authorities and laws as huts and houses appear right in the channel beds. Most of the illegal encroachment has taken place in the small dry stream beds i.e. Jagatuwala, Amwala, Nanurkheda, and Badripur Khala near the most populated zone of the town. In some places, these Nalas are completely covered by slum dwellers. Somewhere or the other, there are no symbols of Nalas anywhere on the surface.

Similarly, Nalapani Rao has the worst condition between Raipur road to the confluence between Nalapani and Rispna Rivers near Vani Vihar, Bhagat Singh colony, and MDDA Colony. There are ample possibilities of encroachment on the Nalapani Rao. Builders, contractors, and anti-social elements constantly keep an eye on when to go to the river bed. The administration has been playing absolutely no role in its part to curb haphazard construction and encroachment of the river bed. In some places, another trend emerges of dumping debris in the channel bed for occupying it. Rivers serve as a dumping ground for solid domestic waste. Initially, sweepers, Dalits, and outside laborers started to live in their plastic tent huts near the solid domestic waste site. After a short period, they started to construct cemented structures along with narrow streets. Arya Nagar, Rispna, D. L. Road, and Dalanwala eastwards are the most prominent examples of this type of slum development. It's a major threat as on one side, it's the encroachment of the river, and on the other, construction activities on the unstable dry channel bed is a disaster in making as flash floods during monsoon season would cause to be washed away leaving foundations of such construction gone (Ahmed and Prasad, 2021). It is a well-known fact that the unplanned trend of urbanization is the primary cause of encroachment throughout Dehra Dun's cities.

Impact of Encroachment

Encroachment on river banks, channel beds, national and state high way, and any public land is a very serious problem within and around the cities. The health of the Rispna River has significantly dropped last few decades. A survey is conducted by authors on the Rispna River from Rajpur to the confluence point in 2023. Thousands of illegal encroachments are embedded in the river bed which rise several problems in the city (Fig 9 and 10). The increasing trend of slums in the Rispna River banks and bed are the biggest problem that destroying the natural ecosystem of the river. The natural channel width is continuously being narrowed by the construction of houses on both sides of the river (Photo Fig. 11 and 12). The result of this is that in the rainy season, the water level of the river starts flowing above the normal level by about 10 to 15 percent. The extreme level of polluted and sediments water is not only hazardous to the environment but also cost the slum dwellers their lives.

Encroachment on the flood plain and river bed and a series of unplanned construction of slum houses on both sides of the river channel have suspended the natural flow of rainwater (Photo Fig. 6). Due to the uneven drain condition, rainy water flows through streets and roads during the rainy season in the other residential areas which create pollution problems in the city. This cause choked drains, open garbage dumping, and mosquito menace problems. This health factor not only disturbed the slum people but also the nearer residents (Photo Fig 10). This problem can give rise to diseases such as poor productive health, lower energy levels, damaging central nervous function, and damage to blood composition, lungs, kidneys, liver, and other vital organs of the human body.

Another serious impact is the dumping of domestic solid waste in the riverbed (Photo Fig 7 and 8). Waste dumped in areas when not treated start smelling which causes the breeding of mosquitoes. These mosquitoes become the reason for diseases later on. Plastic dumped as waste cannot decompose but it choked the street drains and rivers. Plastic dumped as waste can be consumed by animals, resulting deaths of animals. The collected waste emits greenhouse gases, which increase the amount of carbon dioxide in the atmosphere, resulting in the warming of our environment. The result of this has come in the form of rising temperatures. The whole Rispna River in Dehra Dun is full of plastic and garbage waste by the slum dwellers. Plastic that is not decomposed releases a harmful chemical called Di Ethyl Hydroxyl Lamine which causes immense harm to human health. Somewhere slum dwellers burn the plastic and garbage waste in the channel bed. The smoke from the burning waste emits hazardous amounts of smoke into the air which leads to air pollution. The polluted air around the channel bed is responsible for various diseases such as asthma.

The state government departments are also responsible for constructing technogenic works in the channel bed. The electricity department has laid an electric line on the river bed. During a flood in the rainy season, pieces of clothes and plastic flow in the river and get stuck on the electric poles which promotes pollution on the river bed. Somehow it also blocks the channel

flow. Similarly, the Municipal Corporation has laid a 20-meter-deep sewerage line on the river bed, which is eroding the channel bed from Arya Nagar Ward to Rispna ward. Deep erosion of the river bed threatens to erode the base of slum houses which is a sign of danger to come (Photo Fig 11 and 12). It has been seen that somewhere slum dwellers' toilets and latten pipes are open in the river. The dung of all the small and big dairies of the city is drained into the drains, which ultimately goes into the river and polluted the channel.

Suggestions

1. The first and foremost suggestion is that the demarcation of river channel bed boundaries is needed to be prepared by that people understand that the area beyond this step is restricted.
2. Strict rules should be framed by the government for the encroachers so that they cannot occupy illegally any public land, river, and stream beds, flood plain, landslides zone, and very sensitive land.
3. Municipal Corporations and Development Authority need to take strict actions against illegal encroachment and construction activities.
4. The government should also control its public representatives who foster an encroaching community.
5. There should be a strong rein on the land mafia, builders, contractors, and political elements of the city, who are involved in the encroachment.
6. For the effective implementation of the laws, a team of enlightened citizens should be formed in each municipal ward, which would mark the encroachment places in their ward from time to time and further control the encroachment.
7. There is also a need to make the local society aware that they should keep an eye on encroaching elements to keep their surroundings clean and save the environment from pollution.
8. There is an urgent need to make the Rispna River clean and pollution free for which a proper waste disposal mechanism is needed in the town to dispose of solid waste in a safe and efficient manner.

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References

1. Ahmad S. and Ismail S., 2018. Water pollution and its sources, effects, and management: A case study of Delhi. *International Journal of current Advance Research*, Vol.7, Issue 2(L), Pp 10436-10442.
2. Ahmed S. T. and Prasad K., 2021. Assessment of River Encroachment and Changing Land Use Patterns in Rajouri Town (J&K). *International Journal of Lakes and Rivers*. Vol. 14, No. 1, pp. 71-80.
3. Kaur et al, 2013. Water quality assessment of River Yamuna in Delhi stretch during Idol immersion. *International Journal of Environmental Sciences*, Vol. 3(6), Pp 2122-30.
4. Nakata, T., 1972. Geomorph History and Crustal Movement of the Foot Hills of the Himalaya. *Science Reports of the Tohoku University, Sedai, Japan* 22 (1) 39-177.
5. Nossin, J.J., 1971. Outline of the geomorphology of the Doon valley, Northern U.P., India. *Zeitschrift Geomorphol. N.F.*, 12, 18–50.
6. Raihan and Kaiser, 2012. Assessment of river encroachment and land-use patterns in Dhaka city and its peripheral rivers using GIS techniques, *International Journal of Geomatics and Geosciences* Volume 6 Issue 2, 2015.
7. Singh, A.K., Prakash, B., Mohindra, R., Thomas, J.V. and Singhvi, A. K., 2001. Quaternary alluvial fan sedimentation in the Dehra Dun valley piggyback basin, NW Himalaya: tectonic and paleo-climatic implications. *Basin Research*. Vol. 13, Pp449-471.
8. Thakur, V.C., Pandey, A.K., 2004. Late Quaternary tectonic evolution of dun in fault bend propagated fold system, Garhwal Sub-Himalaya. *Curr. Sci.* 87 (11), 1567–1576.
9. Thakur, V.C., Pandey, A.K., Suresh, N., 2007. Late Quaternary–Holocene evolution of dun structure and the Himalayan Frontal Fault zone of the Garhwal Sub-Himalaya, NW India. *J. Asian Earth Sci.* 29, 305–319.
10. Yibo Wang et al, 2020. Analysis and Prevention of Urban River Pollution. *Journal of Physics: Conference Series Paper*, Open Access.
11. Das S., Singh R. and Pandey V K, 2019. Hydro-Meteorological investigation and Phyto-chemistry in Rispna River Catchment, Uttarakhand. *Journal of Pharmacognosy and Phyto-chemistry*.

List of Photographs



Fig. 6: Field photograph showing construction of building on the channel bed.



Fig. 7: Field photograph showing construction of sewage tank on the channel bed.



Fig.8: Field photograph showing evidences of dumping of domestic waste by the slum dwellers in the river.



Fig. 9 and 10: Field photograph showing series of slums both the bank of the Risrna river and pollution on the channel bed.



Fig. 11 and 12 Field photograph showing evidences of encroachment on river bed for construction of buildings, electric pole and digging of channel bed for sewerage line.