

MGNREGA IMPLEMENTATION IN UTTARAKHAND - A MULTIDIMENSIONAL SPATIAL ANALYSIS

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Abstract

Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) is the world's most extensive social safety programme widely studied for its contribution to achieving poverty alleviation and strengthening the natural base in the country. However, there is a gap in research linking the programme implementation with the national and sub-national development goals, which are crucial to achieving the global goals of sustainable development. This study thus aims to derive district-level insights into MGNREGA implementation, taking Uttarakhand State as an example using spatial analysis tools. Getis-Ord statistic was used to obtain spatial clustering of the works implemented under the programme until 2017. Overlay analysis was synergistically applied on satellite images-based thematic envelopes, viz. land use land cover (LULC) and the terrain, which exerts a latent control on the overall programme implementation besides shaping the local development and planning efforts. The LULC and topography demonstrated a profound impact on the distribution of works in the State. Results obtained show a marked variation in work preference and their spatial clustering in various districts, thus, on the one hand, indicating the demand-driven nature of the programme and, on the other, its alignment with the local developmental needs of the State. The findings might help design fine-tuned plans for the State towards attaining far-reaching social-economic and environmental dividends. .

Keywords: Geotags, Spatial Analysis, Hotspot Analysis, GIS, MGNREGA, Uttarakhand.

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Introduction

The rural population worldwide is vulnerable to livelihood shocks and variability (Devereux, 2001). Comprehensive social safety net programmes are being implemented worldwide, bolstering the global efforts to ensure social security and overcome such vulnerabilities (Banerji et al., 2013). The developing countries rely significantly on income transfers, improved access to essential services and efficacious job markets, and durable assets (Barrientos & Hulme, 2009). Initiated more than a decade ago, Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) is a classic example of the world's most extensive social protection net. It is a legal mechanism that ensures at least a hundred days of guaranteed wage employment in a financial year to every rural household whose adult members volunteer to do unskilled manual work. It also supports the rejuvenation of the natural resource base by creating substantial and productive rural assets. These assets represent an item or property owned and made by the community, having value and being available to meet the requirements of the local area and its natural resources (Babu et al., 2013). Over 30,000 assets under 260 different activities as permissible (MoRD, 2018) are created annually under the scheme. These are grouped under four masterwork categories, viz. Category A: Public works relating to Natural Resource Management (NRM), Category B: Individual Assets for Vulnerable Sections, Category C: Common Infrastructure for NRLM (National Rural Livelihoods Mission) Compliant Women Self-Help Groups, and Category D: Rural Infrastructure for the ease of planning and monitoring (McCord & Paul, 2019).

Investments in MGNREGA, given their scale and importance in poverty alleviation and strengthening the natural resource base in rural India, have attracted the broad interests of researchers worldwide (Biswas, 2015). The scheme has been studied extensively regarding its socio-economic and environmental benefits (Bunning & De Pauw, 2017, Sarvade et al., 2019). Ahuja et al. (2011) studied the impact of MGNREGA on income and employment security,

migration, debt repayment, and the extent of participation in the State of Haryana. The scheme's contribution to women's empowerment through enhanced opportunity and involvement is well documented (Pellissery et al., 2011; Rajalakshmi & Selvam, 2017). Esteves et al. (2013) studied the environmental and socio-economic benefits of the scheme using block-level measurements of agricultural and livelihood vulnerability indices in Rajasthan, Madhya Pradesh, Andhra Pradesh, and Karnataka. Ravindranath and Murthy (2021) studied the carbon sink potential of MGNREGS and highlighted the climate mitigation co-benefits of the MGNREGA in the 18 agro-ecological settings in India. We argue that whereas significant research has been undertaken addressing the master categories A, B, and C, those related to the master category D, i.e., rural infrastructure, have not received sufficient attention despite being a vital component of local and regional development. Thus, there is a gap in research linking the MGNREGA implementation with the national and sub-national development goals, which are crucial to achieving the more important global goals of sustainable development. Another shortcoming is that most of the available studies use conventional approaches deploying participatory rural appraisal (PRA), mainly consisting of key informant surveys, focus group discussions, and secondary data. While such methods have potential advantages, they face several methodological issues primarily due to their qualitative foundation (Campbell, 2001). They also lack spatially explicit representation; hence, generalising these findings to larger scales is often limited due to the smaller sample size. Thus, it is recognised that novel methods are needed to allow a harmonious integration between the local participatory and regional planning to impulse a bottom-up land use planning process (Sedogo, 2002).

It is well acclaimed that all human activities on the earth have their spatial footprint. The images captured using remote sensing satellites hold the capability to decipher these earth system-human interactions. Satellite images, thus constitute a critical input for resource planning by providing

crucial contextual information on various features of the earth, its environment, and underlying processes (Tatem et al., 2008). The land use land cover (LULC) information and digital elevation models derived from remote sensing images are the most basic and widely used input in planning and development at almost every scale, viz. global, regional, national and sub-national. GIS provides a valuable tool for deriving high-value spatial insights and depicting visual impacts of development obtained from various sources, including satellite data. A suite of spatial analysis offers a vast opportunity to derive hidden insights by facilitating the superimposition of data of all sorts. These analyses range from simple overlay operations to more statistical tools that may be more confirmative or exploratory (Anselin & Getis, 1992). Applying GIS analysis in acquiring spatial know of MGNREGA implementation has been initiated recently, as evident from the studies on spatial clustering of works (Divya et al., 2019) and their spatial-temporal visualisation (Gupta et al., 2020). The spatially explicit mapping of the scheme's linkages with the sustainable development goals is also studied by Gupta et al.(2021), demonstrating the potential of such analysis in the sub-national level assessment of programme implementation and its role in achieving sustainable development. Mandla et al. (2020) used spatial analysis to identify improvements around irrigation tanks created under MGNREGA in Gural mandal, Vizianagaram district, Andhra Pradesh. However, we argue that there is a need to emphasise adopting spatial analysis approaches in studying the implementation of MGNREGA and various other Centrally sponsored schemes and their alignment with the local and national developmental needs.

This study is thus a novel attempt to derive district-level insights from MGNREGA implementation by synergistically applying spatial analysis tools and human capabilities to analyse further, envision, reason, and deliberate the spatial footprints of the scheme. Taking Uttarakhand as an example, our study aims to find the most preferred works under MGNREA, their spatial clustering at

the village level, and their distribution concerning the land use and terrain, which tend to exert a latent control on project implementation.

Study Area

The study is undertaken in Uttarakhand in India, having a total geographical area of 53,484km². Extending between latitude 28°45' to 31°30' N and longitude 77°30' to 81°5' E, it shares boundaries with China in the north, Nepal in the east, Uttar Pradesh in the south, Haryana and Himachal Pradesh in the west. It comprises 13 districts, 31 towns, 95 blocks, and 16,826 villages. The State has a highly diverse landscape with elevations ranging from 103m to 7184m above mean sea level. It is broadly categorised into Upper hills - Uttarkashi, Chamoli, Rudraprayag, Pithoragarh, and Bageshwar; Middle hills - Tehri-Garhwal, Pauri Garhwal, Almora, and Champawat, the hill regions of Nainital, and Chakrata tehsil of Dehradun. The foothills consist of the remaining area of Dehradun, Haridwar, Udham Singh Nagar, and the Nainital district. The average rainfall is 1000-2500 mm per year (Kala, 2014), most of which occurs during the southwest monsoon (Pratap et al., 2020). Of its total area, 63.42 per cent is under forest, and only 12.65 per cent is under cultivation (ISFR, 2017). While agriculture is the primary livelihood of the people, over half of the area under agriculture is rainfed. The agriculture sector continues to be the largest consumer of water in the State, accounting for 75 per cent of the total water demand. Despite multiple water sources, many districts of Uttarakhand face water scarcity due to their uneven distribution and routine diversion in various sectors, including energy, tourism, and urban use.

The State's total population and population densities are 1.01 crore and 189 per sq. km, respectively. The State's literacy rate is 79.63 per cent, with male and female literacy of 88.33 per cent and 70.70 per cent, respectively (Census of India, 2011). However, the State continues to face the challenges such as a lack of inclusive growth with stark differences between the hills and the plains, lack of rewarding employment and limited or

no access to health and education, poor access to potable water, issues of solid waste disposal, etc., coupled with severe problems of environmental degradation. Natural disasters and extreme events such as earthquakes, landslides, and cloudbursts are common in the State and directly impact tourism. Nevertheless, given its splendid natural resources, the State holds enormous potential for tourism development.

Data and Methods

The overview of the methodology used in the study is presented in Figure 1. The State administrative boundary was obtained from the SIS-DP project. The geotagged data of 4,44,369 MGNREGA assets representing the works implemented till 2017 was acquired from the Bhuvan Geo-MGNREGA portal. We performed

quality checks on the data for correctness, completeness, and consistency as it constitutes an essential parameter of large data (Tayi & Ballou, 1998). The records having missing work category names and those under work on individual land categories were mapped into the corresponding work categories based on the sub-category name available in the attribute table. Ambiguous records were encountered under the coastal area category, mainly consisting of belt plantations mapped into flood control and protection (FCP) measures. Other works such as infrastructure for Composting and Liquid Bio Manure and miscellaneous works (having less than 500 asset counts), mainly taken up to motivate the communities, were grouped into a new category, viz. Entry Point Activities (EPA). Thus, the final analysis considered 11 work categories (Table 1).

Table 1

Category-wise Number of MGNREGA Assets in Uttarakhand

S. No.	Work Category Name	No. of Assets
1.	Anganwadi/Other Rural Infrastructure (AORI)	7,059
2.	Drought Proofing (DP)	14,730
3.	Flood Control and Protection (FCP)	86,952
4.	Land Development (LD)	51,073
5.	Micro Irrigation Works (MIW)	14,922
6.	Entry Point Activities (EPA)	55,411
7.	Renovation of Traditional Water Bodies (RTWB)	9,582
8.	Rural Connectivity (RC)	67,762
9.	Rural Drinking Water (RDW)	995
10.	Rural Sanitation (RS)	89,471
11.	Water Conservation & Water Harvesting (WCWH)	46,412

Source: Authors.

A point vector layer was generated using GIS software based on the geographical coordinate information available in the tabular data. Village-wise count of assets under each category was obtained by performing spatial join with the village administrative boundary. A district-wise enumeration of works was carried out to illustrate the work preference under the scheme in each district. Spatial clustering analysis was carried out to obtain the village clusters with a similar spatial density of works implemented (joint counts/village).

Moran's I technique was used to have a preliminary check on the presence of any global-level clustering pattern. The areas with or without significant spatial clusters were mapped further using Getis-Ord (Gi*) statistics, which gives statistically significant clusters with high (hotspots) and low values (coldspots) at different confidence levels, viz. 90 per cent, 95 per cent and 99 per cent (Ord & Getis, 1995). The fixed distance band method has been applied to overcome the impact of large polygons representing forest ranges and

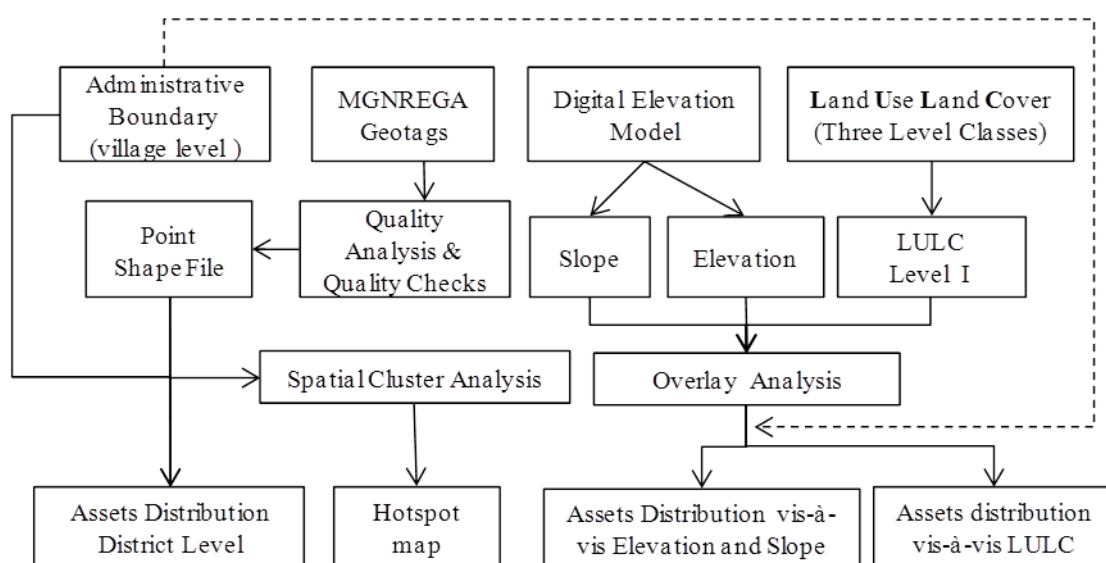
the perennial snow in the study area on the model. It ensures a specified critical distance value adequately representing all villages having at least one neighbour (Sanchez-Cuervo & Aide, 2013). The number of villages under each spatial cluster category was also enumerated using overlay analysis.

Overlay analysis was performed, and zonal statistics were derived to obtain terrain (viz. elevation and slope) and LULC-based distribution of works implemented. Digital Elevation Model (DEM) was derived using 14 Cartosat-1 satellite scenes covering the study area, which were

downloaded from the Bhuvan open data archive. The elevation map was classified into four classes (Figure 2) for broad-level analysis. The slope (Figure 3) was classified based on the standard United States Department of Agriculture classification system (Pamela et al., 2018). Land Use Land Cover (LULC) analysis has been carried out using a map prepared under the national resource census programme of the National Remote Sensing Centre prepared at a scale of 1:50k using IRS LISS-III data for the year 2016-17 (Figure 4).

Figure 1

Methodology Flowchart



Source: Authors.

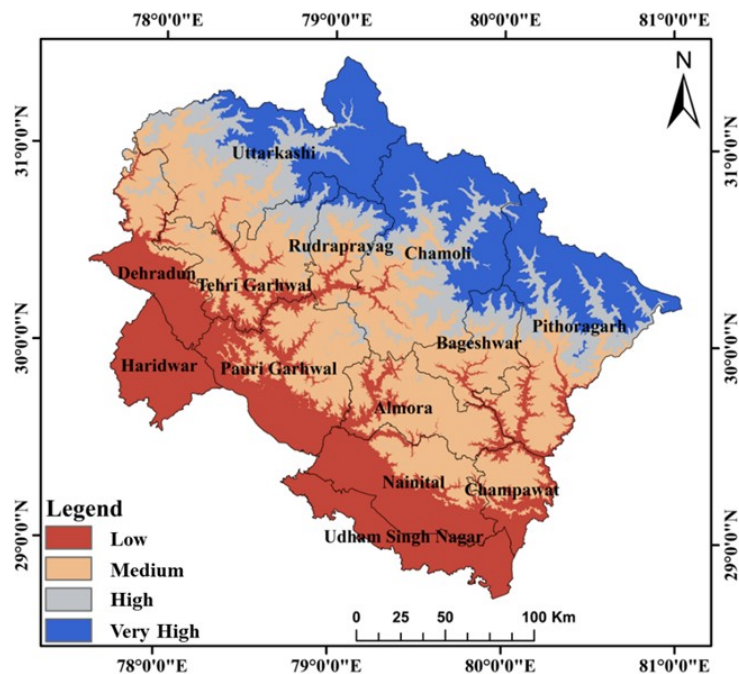
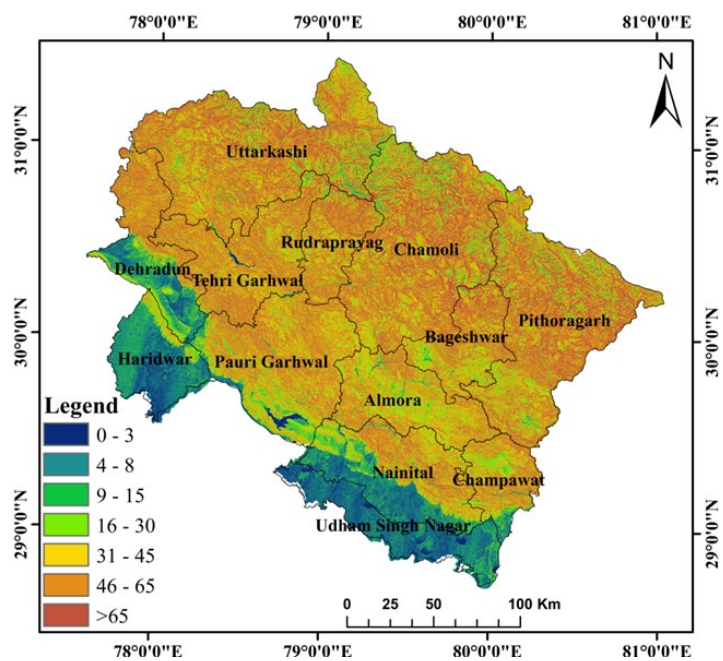
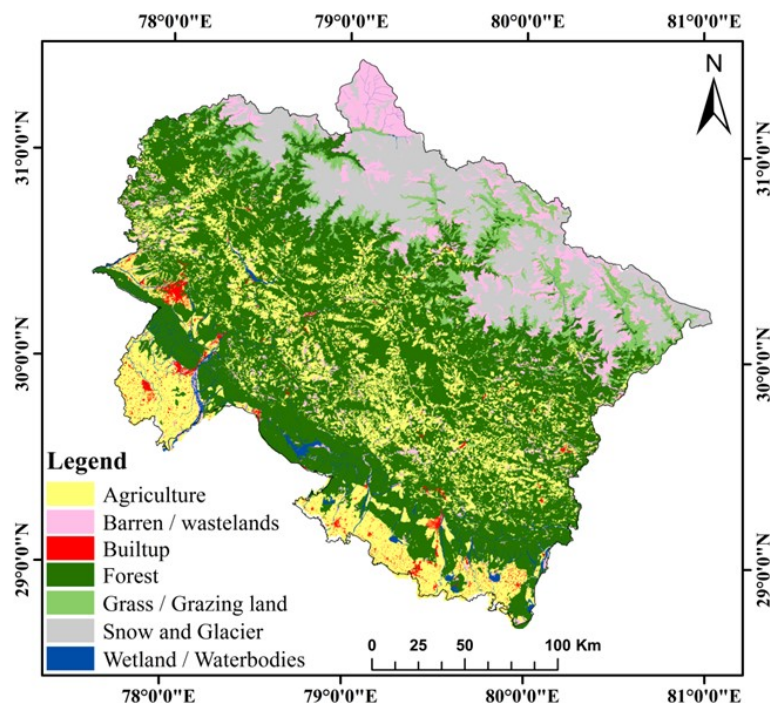
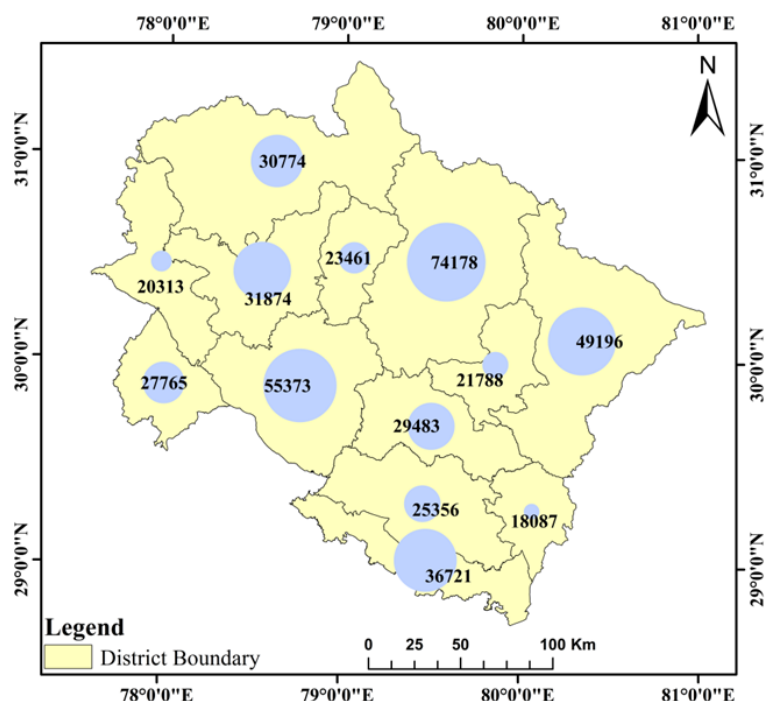
Figure 2*Digital Elevation Model of Uttarakhand (Source: CartoDEM)**Source: CartoDEM***Figure 3***Slope Map of Uttarakhand**Source: CartoDEM*

Figure 4*Land Use Land Cover Map of Uttarakhand**Source: NNRMS, NRSC***Results****Distribution of Assets**

The overall distribution of MGNREGA works in Uttarakhand shows that RS is the most preferred work category, followed by the FCP, RC, and LD. However, in terms of district-level performance, Chamoli stands at the first position with the maximum number of works compared to the other districts, primarily Uttarkashi, which, despite having a similar geographical area, has almost half the number of works. Pauri Garhwal and Pithoragarh are the second leading districts in implementing the schemes (Figure 5). A closer assessment further shows that the works are carried out even in remote villages like Mana in Chamoli and Kuti in Pithoragarh, Mukhwa, and Liwari in Uttarkashi

(Figure 6). FCP is the most preferred work in Chamoli, Tehri Garhwal, and Uttarkashi. LD and RS are preferred in Pauri Garhwal and Pithoragarh, whereas in Udham Singh Nagar and Haridwar, we found that RS followed by RC are preferred. In Nainital and Dehradun, however, RS remains the most preferred work type implemented under MGNREGA. In the districts of Almora and Champawat, most of the works undertaken are in the WCWH category, followed by RC and FCP. Rudraprayag has EPA and RS as major works, while in Bageshwar, RS and FCP are the most preferred ones. The works related to AORI are more preferred in Tehri Garhwal, Pithoragarh, and Dehradun districts. RDW has been mainly preferred in Tehri Garhwal, Udham Singh Nagar, Pithoragarh, and Chamoli.

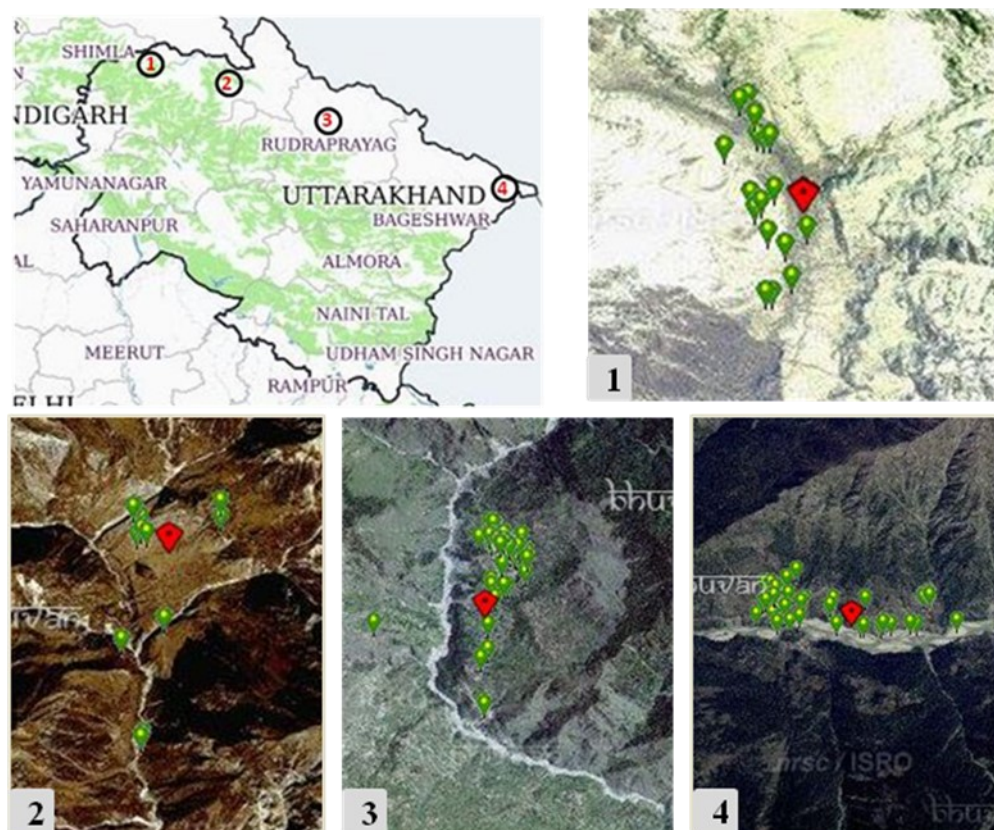
Figure 5*District Level Count of MGNREGA Assets in Uttarakhand***Table 2***District-wise Area, Asset Count (in descending order), and Most Preferred Work Category*

S. No.	District Name	Area (sq.km)	Assets	Most Preferred Work category
1.	Chamoli	8030	74092	FCP (30.8%)
2.	Pauri Garhwal	5329	55335	LD (21.2%) & RS (19.5%)
3.	Pithoragarh	7090	49127	RS (20.9%)
4.	Udham Singh Nagar	2542	36152	RS (23.1%) & RC (21.6%)
5.	Tehri Garhwal	3642	32002	FCP (22.7%)
6.	Uttarkashi	8016	30680	FCP (38.9%)
7.	Almora	3144	29615	WCWH (21.4%) & RC (21.0%)
8.	Haridwar	2360	27646	RS (31.8%) & RC (28.3%)
9.	Nainital	4251	25820	RS (25.9%)
10.	Rudrapur	1984	23434	EPA (23.2%) & FCP (19.9%)
11.	Bageshwar	2241	21780	RS (20.3%) & FCP (19.9%)
12.	Dehradun	3088	20440	RS (25.9%)
13.	Champawat	1766	18045	WCWH (20.3%) & FCP (19.9%)

Source: Authors.

Figure 6

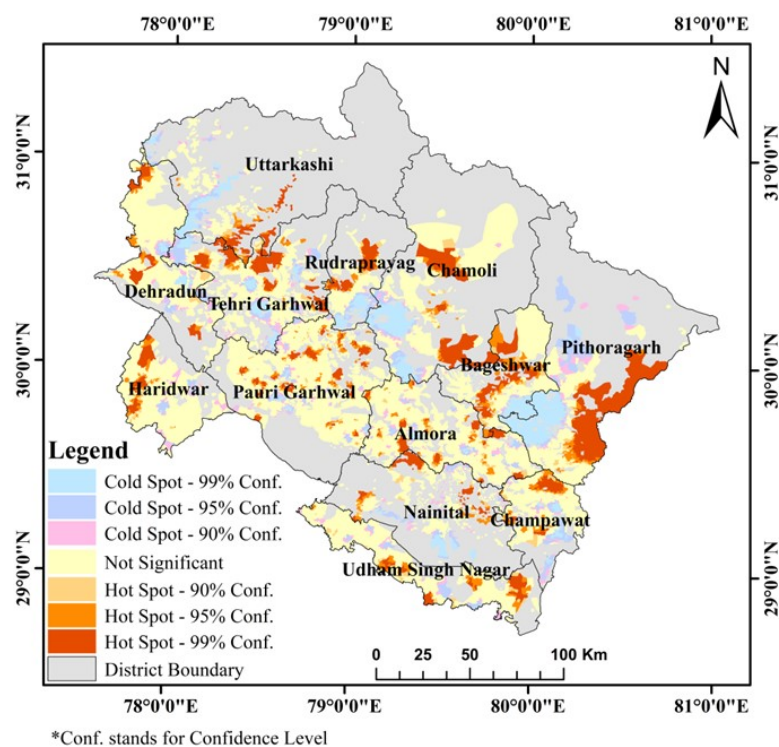
Northern Part of Uttarakhand from Bhuvan in Map View (1. Mana Village, Chamoli; 2. Mukhwa Village; 3. Liwari Village, Uttarkashi; 4. Kuti Village, Pithoragarh)



Spatial Clustering of Assets

The spatial clustering of assets revealed a varying pattern across the districts. Big-sized hotspots were observed in Pithoragarh, Chamoli, and Bageshwar districts, whereas multiple discretely distributed smaller-size spatial clusters were observed in Dehradun, Haridwar, Uttarkashi, Udham Singh Nagar, Almora, and Tehri Garhwal (Figure 7). The significantly larger coldspots were observed along the district boundaries of Dehradun-Uttarkashi, Rudraprayag-Chamoli, and Bageshwar

-Pithoragarh. Tehri Garhwal, Pauri Garhwal, and Champawat districts consist of Isolated and small-sized coldspots. The number of villages in each spatial cluster under different confidence levels (Table 3). Pithoragarh district has the maximum number of villages under hotspot with 99 per cent confidence, followed by Tehri Garhwal and Pauri Garhwal. The maximum number of villages in the coldspot class with 99 per cent confidence occurs in Pithoragarh, Chamoli, and Tehri Garhwal.

Figure 7*Spatial Cluster Map of MGNREGA Assets in Uttarakhand***Table 3***District-wise Count of Villages under Clusters with Different Confidence Levels*

Spatial Cluster with Level of Significance	District													Total
	Almora	Bageshwar	Champawat	Chamoli	Dehradun	Haridwar	Nainital	Pauri Garhwal	Pithoragarh	Rudra Prayag	Tehri Garhwal	Udham Singh Nagar	Uttarkashi	
Hotspot 99% Confidence	120	123	73	151	44	43	120	163	307	148	260	50	128	1730
Hotspot 95% Confidence	103	76	44	29	19	11	50	162	88	26	52	33	45	738
Hotspot 90% Confidence	58	30	25	38	14	24	34	103	50	10	52	29	18	485
Not Significant	1680	400	410	537	537	482	499	2607	407	263	898	513	299	9532
Coldspot 90% Confidence	149	8	42	40	43	31	86	194	56	21	163	31	18	882
Coldspot 95% Confidence	108	32	69	97	48	39	145	160	129	77	240	26	52	1222
Coldspot 99% Confidence	37	165	26	336	41	0	145	61	593	128	173	4	120	1829
Total	2255	834	689	1228	746	630	1079	3450	1630	673	1838	686	680	16418

Source: Authors.

Distribution of Assets vis-à-vis terrain

Wide variation in terrain in Uttarakhand exhibits a significant control on its demographic distribution, socio-economic fabric, and natural settings. With this understanding, the distribution of preferred works implemented under MGNREGA was analysed, concerning the terrain using elevation and slope (Table 4). The distribution of assets is highest in the foothills/low elevation areas (100-1100m above MSL), followed by medium elevation areas (1101-2400m above MSL), which constitute the maximum area of the State. Beyond this, no works have been carried out, which may be attributed to the uninhabited terrain due to perpetual snow cover in these areas. As expected, such distribution is apparent since higher elevation areas have issues of accessibility and less population density. However, viewing this distribution concerning the work category gives valuable insights into the scheme's contribution to the State's development. FCP, RS, and RC are found to be the most preferred works in foothills and low-altitude areas, followed by medium elevations. However, in the medium elevations, significant works were taken up additionally in LD and WCWH, highlighting the alignment of the scheme towards developing resilience in the State through various natural resource management works.

Similarly, although very few works have been executed in the highest elevation zone, they appropriately depict the local preference for FCP since flash floods are common in the region. The highest preference for RC and RS highlights the contribution of MGNREGA in meeting the elementary needs of road connectivity and sanitation. However, works under RDW need considerable attention in other State districts,

especially in the higher altitudes, as they face severe water scarcity.

The distribution of assets concerning the slope classes shows varying degrees of preference. The highest numbers of works were found distributed in the moderately steep class, followed by hilly and steep slope classes (Table 5). These are mainly under FCP, followed by LD and RC. FCP is also the most preferred work in all the slope classes except in the flat and undulating slopes, clearly indicating the importance of such measures in place for mitigating landslides, which are a common feature in the fragile environment of the western Himalayan region. RC is the third most preferred work in the State, especially in the undulating and steep areas to provide connectivity to commute.

Distribution of Assets vis-à-vis Land Use Land Cover

In Uttarakhand, the forest is the primary land cover class, followed by agriculture, snow, and glaciers. The overlay of MGNREGA works with the LULC has been carried out to understand works' preference against the major LULC classes, viz. Agriculture, Barren/ wastelands, Built-up, Forest, Grass / Grazing land, Snow and Glacier, and Wetland/Water bodies (Table 6). As expected, the majority of work, i.e., 63.48 per cent, was taken up in the agricultural areas since they are closely associated at the community level and tend to concentrate in the vicinity of rural set-up and agriculture base. However, a significant volume of work (21.74 per cent) is also taken up in the forested areas, mainly related to FCP and WCWH. RS, EPA, and RC are the most preferred works in the built-up areas.

Table 4*Percentage Distribution of Total and Category-wise MGNREGA Assets at Different Elevations*

Elevation (Range in m)	% Area	Assets Count & %	AORI	DP	FCP	LD	MIW	EPA	RTWB	RC	RDW	RS	WCWH
Low (100-1100)	40.26	262003 (59%)	↓	↗	↗	↗	↗	↗	↗	↗	↓	↑	↗
Medium (1101-2400)	29.36	181523 (41%)	↓	↗	↑	↗	↓	↗	↗	↗	↓	↗	↗
High (2401-4100)	10.32	840 (0.2%)	↓	↗	↑	↗	↗	↗	↗	↗	↓	↗	↗
Very High (4101-7200)	20.06	0 (0%)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Grand Total	100.00	444366 (100%)	↓	↗	↗	↗	↗	↗	↗	↗	↓	↑	↗

Table 5*Percentage Distribution of Total and Category-wise MGNREGA Assets in Different Slope Classes*

Slope Classes (Range in %)	% Area	Assets Count & %	AORI	DP	FCP	LD	MIW	EPA	RTWB	RC	RDW	RS	WCWH
Flat (0-3%)	7.47	49668 (11.18%)	↓	↗	↗	↗	↗	↑	↓	↗	↓	↑	↗
Undulating (4-8%)	6.39	34403 (7.74%)	↓	↗	↗	↗	↗	↗	↓	↗	↓	↑	↗
Moderately Sloping (9-15%)	5.02	26855 (6.04%)	↗	↗	↑	↗	↗	↗	↓	↗	↓	↗	↗
Hilly (16-30%)	12.90	96379 (21.69%)	↓	↗	↑	↗	↗	↗	↗	↗	↓	↑	↗
Moderately Steep (31-45%)	18.84	125510 (28.24%)	↓	↗	↑	↗	↗	↗	↗	↗	↓	↗	↗
Steep (46-65%)	26.48	91481 (20.59%)	↓	↗	↑	↗	↗	↗	↗	↗	↓	↗	↗
Very Steep (> 65%)	22.88	20073 (4.52%)	↓	↗	↑	↗	↗	↗	↗	↗	↓	↗	↗
Grand Total	100.00	444369 (100%)	↓	↗	↗	↗	↗	↗	↗	↗	↓	↑	↗

Table 6*Percentage Distribution of Total and Category-wise MGNREGA Assets vis-à-vis Land Use Land Cover*

LULC Classes	% Area	Assets Count & %	AORI	DP	FCP	LD	MIW	EPA	RTWB	RC	RDW	RS	WCWH
Settlements	1.23	41323 (9.30%)	↓	↓	↗	↗	↗	↑	↓	↗	↓	↑	↗
Wetland / Waterbodies	2.31	6603 (1.49%)	↓	↗	↑	↗	↗	↗	↓	↗	↓	↗	↗
Grass / Grazing land	6.97	7697 (1.73%)	↓	↗	↑	↗	↓	↗	↗	↗	↓	↗	↗
Barren / Unculturable wastelands	8.35	10059 (2.26%)	↓	↗	↗	↗	↓	↗	↓	↗	↓	↗	↗
Snow and Glacier	13.30	9 (0%)	↓	↓	↑	↓	↓	↓	↓	↗	↓	↗	↓
Agriculture	20.49	282086 (63.48%)	↓	↗	↗	↗	↗	↗	↗	↗	↓	↗	↗
Forest	47.35	96592 (21.74%)	↓	↗	↗	↗	↗	↗	↗	↗	↓	↗	↗
Grand Total	100.00	444369	↓	↗	↗	↗	↗	↗	↗	↗	↓	↑	↗

↑ : Assets% ≥ 20; ↗ : Assets% < 20 & ≥ 10; ↘ : Assets% < 10 & ≥ 5; ↓ : Assets% < 5 & ≥ 2; ↓ : Assets% < 2

AORI- Anganwadi/ Other Rural Infrastructure; DP- Drought Proofing; FCP- Flood Control and Protection; LD- Land Development; MIW- Micro Irrigation Works; EPA- Entry Point Activities; RTWB- Renovation of traditional water bodies; RC- Rural Connectivity; RDW-Rural Drinking Water; RS-Rural Sanitation; WCWH-Water Conservation and Water Harvesting

Source: Authors.

Discussions

MGNREGA implementation in Uttarakhand shows a marked spatial variability, as found in our study. Even in the remotest village with an inhospitable set-up, the presence of geotags reflects an inclusive approach. In terms of the most preferred works, although RS, FCP, RC, and WCWH top the list, considerable works are taken up under EPA and LD, which further reflects the demand-driven nature of the scheme. Uttarakhand attracts a large number of domestic as well as inbound tourists (Kumar et al., 2015). It also aims to secure a position among India's top five and further top three tourist destination States by 2024 and 2030, respectively (UVD, 2018). Since hygiene and road connectivity are paramount in providing good tourism facilities besides meeting the local people's aspirations, the high preference for RS and RC works is a testimony of the government's efforts toward boosting overall tourism. The highest number of works taken up in Haridwar, Dehradun, and Nainital further makes it evident since they attract a deluge of tourists during the peak seasons. RS works in remote areas may be seen as a means for promoting homestays, which is a potential segment for Uttarakhand tourism to supplement the demand due to lack of sufficient facilities and as a livelihood strategy for the local communities (Macek, 2012).

The hotspot analysis carried out in the study illustrates a marked variation in the spatial clustering of the assets across the State. It provides a more reliable measure for evaluating MGNREGA performance than the existing practice taken up primarily based on asset counts alone. In-depth analysis can be taken up in the selected clusters to determine the factors influencing such patterns. For example, one can evaluate whether it is due to the actual demand-driven nature of the programme or its lopsided implementation favoured by various local actors and vested interests. Similarly, the coldspots may be evaluated based on the decrease in demand stemming from the programme's success, the reduction in the supply of the work, or the gradual 'closing' of the valves.

Such analysis also provides the spatial reference to evaluate its wide-ranging impacts on the landscape. However, we suggest ensuring the data quality and careful selection of spatial analysis to optimise the results considering the data's nature and the mapping's purpose (Khaledian & Miller, 2020). Selecting an appropriate scale of spatial analysis is another crucial aspect, as any change in the scale of observation or analysis significantly affects the unit size, shape, spacing, etc., as well as the statistical relationships and outcomes of the phenomenon being observed (Dungan et al., 2002).

A combined effect of natural and anthropogenic activities makes Uttarakhand one of the most severely disaster-prone States in the country (USDMA, 2015). The increasing demographic pressures and clearing forests for infrastructure development are among the pressing issues in the State. According to the Forest Survey of India, an increase of 23 km² has been observed due to the rise in trees outside the forest. Still, a decrease of 49 km² has occurred due to rotational felling and developmental activities in the State from 2015 to 2017 (ISFR, 2017). The LD and FCP work taken up under MGNREGA in the study area represents a significant contribution toward building ecosystem resilience in the fragile set-up of the State (Mahapatra et al., 2018; Samra, 2019; Dobhal et al., 2020). These works in the forest areas and upper reaches also highlight the efforts being made under the aegis of MGNREGA to ensure a continued flow of multiple ecosystem services developing in the lowland areas. In light of the increased susceptibility of the region to natural disasters due to climate change, we recommend that the quantum of such works and efforts should be encouraged more in the future.

Conclusion

The implementation of MGNREGA in Uttarakhand shows significant spatial variation in the works' preference and distribution across land use, cover, and terrain. The findings of the study might be helpful in further designing and fine-tuning plans for the State to generate far-reaching social-

economic and environmental dividends. Usage of spatial tools for such studies is recommended to overcome the bias encountered in conventional PRA exercises. It will also help inform where data collection efforts need to be concentrated during fieldwork, thus reducing the cost and efforts, especially in the arduous terrain.

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Author's Contribution:

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