Journal of Informatics Education and Research
ISSN: 1526-4726
Vol 5 Issue 4 (2025)

Geospatial Intelligence in Hotel Site Planning: A Decision Support Framework

[1]Chetan Mungantiwar, [2]Ravi Kshirsagar, [1a]Dr. Madhumita Mukherjee, [4]Shefali Joshi,

[5]Atul R Deshpande, [6]Samira Naik, [7]Dr. Sudipta Mukherjee

[1 & 2]Department of Hospitality Management, Dr. Vishwanath Karad MIT World Peace University, Pune, Maharashtra, India

[1a & 7]School of Business, Dr. Vishwanath Karad MIT World Peace University, Pune, Maharashtra, India

[4]NMIMS School of Hospitality Management, India

[5]Department of Wingsss Aviation & Hospitality, Pune, Maharashtra, India

[6]Department of Wingsss Aviation & Hospitality, Pune, Maharashtra, India

Abstract:

The process of choosing a hotel site is a very important project for businesses in the hospitality industry and, consequently, for every investment, the extent of market coverage and longevity. Conventional selection of sites is largely subjective, lacks the potential to incorporate spatial data and multi-criteria evaluation, and therefore achieves suboptimal decision-making in geographically or environmentally complex areas. This work tackles the problem by developing and implementing a powerful, data-driven strategy involving the utilization of Geographic Information System (GIS) technology combined with a Multi-Criteria Decision Support System (MCDSS). The study takes on the ecologically and scenically abundant Indian state of Sikkim as the study context for development, due to its great tourist opportunities and the need for sustainable and scientifically informed infrastructure development. This methodology utilizes quantitative and spatial analysis. The high-resolution spatial data layer comprising accessibility of road networks, proximity of tourist attractions, slope, elevation, and existing land use/land cover, were pre-processed and standardized, these layers were used as base-line decision criteria. With ArcGIS 2.0 software, Researchers integrated the Multi-Criteria Decision Support System (MCDSS), in which a weighting method, often the Analytical Hierarchy Process (AHP) or Weighted Linear Combination (WLC), was employed (not specified by MCDSS, but inferred through discussion). This integration enabled researchers to develop spatial models for modelling and displaying a composite Hotel Site Suitability Map. This step involved defining the extent of weights between criteria based on expert testimony and which factors would have more or less salience for the hotel growth in Sikkim setting. The Weighted Overlay of the ranked and weighted criteria was combined using ArcGIS 2.0 to obtain a continuous suitability scale that classified the study area towards areas of highly suitable, moderately suitable, marginally suitable, and unsuitable land for hotel development. The suitability map that is produced becomes a visible, measurable, scientifically acceptable decision tool for decision makers, minimizes the extent of subjectivity and risk from traditional approaches. The result suggests optimal locations that satisfy the need for financial viability with respect to the environmental and accessibility measures and would thus facilitate sustainable tourism development in Sikkim. This study shows the high effectiveness of integrating GIS and MCDSS as a robust spatial decision support system for complex land use planning problems in tourism.

Keywords: Geographic Information System (GIS), Hotel Site Selection, Multi-Criteria Decision Support System (MCDSS), ArcGIS, Sikkim, Suitability Analysis, Spatial Modelling.

Introduction: Optimizing Hospitality Infrastructure in Sikkim. The inconspicuous but significant North-Eastern state of Sikkim is a regular source for countless volumes of tourists from among domestic and foreign visitors. This sustained influx shows that Sikkim is now one of the top draws for tourists. Official figures from Sikkim Tourism show a remarkable upward surge in visitors from abroad, with 133,388 foreign arrivals in 2023. According to The Telegraph, this is up considerably (62,216 tourists) compared with the previous year, 2024. In addition, the domestic visit pattern of demand is similar as domestic tourists are just as popular in the state (1,196,468 tourists until September 2024). Even after such an increase in tourism demand, the current tourism infrastructure in the state faces the challenge of dealing with such a large volume of tourists. Additional developments and additional categories of accommodation facilities are clear targets for the hotel to develop well to improve the guest comfort and ensure service quality. Data from CEIC showed Sikkim offered 351,000 hotel rooms in 2024. The total capacity was 432,000 units for 2024 in particular. This

context is significant as it focuses on the supply side, the fluctuating supply side, and emphasizes that data-driven planning to expand the hospitality sector efficiently and meet future demand forecasts is crucial for the same.

The development of the infrastructure that must be in place to accommodate the needs of a variety of clientele including tourists across different target markets require a substantial capital investment Buhalis, D. (2000). So careful, meticulous hotel planning is necessary. Researchers find that a higher proportion of hotels are suffering from financial losses based on shortcomings in planning and subsequently operating both domestically as well as internationally. This illustrates the need for scientific and data-driven planning methodologies before any hotel construction project starts. The use of the relevant statistical and analytical methodologies that validate and monitor a range of parameters and criteria is necessary to conduct an effective pre-project assessment. It is in this article that the focus will primarily be focused on identifying and systematically describing the requirement criteria/parameters which should also be established for detailed planning of hotel. Moreover, a conceptual framework of hospitality planning is shown by using the Geographic Information System (GIS) Chang, K. T. (2016) as a main tool of scientific decision-making, the commonly known a Spatial Decision Support System (SDSS) Nyimbili, P. H., & Erden, T. (2018). Researchers have contrasted conventional, manual decision-making processes in the planning process to scientific spatial analysis to find a quantitative discrepancy between results. Hotel development has unique features and demands expert management, notwithstanding potential resemblances to the development of many commercial business establishments Morrison, et. Al., (1996). Hotels are by nature a 'single-use' premises, earning the majority of revenue from offering a service-based business model Farag, H. F. I. (2022). Their inherent worth comes from being able to deliver guest services effectively Ford, R. C., Heaton, C. P., & Brown, S. W. (2001). Thus, the optimal design of a property such as a hotel is based on their unique operational and financial characteristics Morey, R. C., & Dittman, D. A. (1997).

Literature Review: A survey of the existing literature notes a conspicuous lack of tourism-related studies in the field of geospatial studies only of Sikkim. Although direct investigations in relation to tourism is scanty, several relevant GIS literature have emerged in recent decades, with general aspects of human civilization, infrastructure, and environmental issues in the state still being addressed as critical research problems. Ground-breaking GIS applications in Sikkim include: Landslide mapping Parise, M. (2001) and vulnerability zonation Venkatesh, R., et al (2020), Analysis of solar energy potential Kaynak, S., Kaynak, B., & Özmen, A. (2018), Socio-economic implications analysis Sarkar, A. (2011), Integrating medical plans and managing healthcare product delivery Barrick, I. J. (2008). Flood & disaster management Islam, Rabiul, et al. (2016) and natural hazard assessment Dragicevic, Slavoljub, et al. (2011). Creation and analysis of a road network Jenelius, E., & Mattsson, L. G. (2015).

Specific GIS Research Contributions in Sikkim: Landslide Detection: Chakraborty and Pradhan (2012) conducted a thorough study addressing landslide detection and information preservation for East Sikkim. They prepared a GIS based portal and model proposing a unified categorization of landslides. k-means and k-nearest neighbour classifiers worked together to determine optimal classifications in the study, which later were published on a web platform.

Renewable Energy Suitability: Ghosh et al. (2019) evaluated the feasibility of medium solar energy at a medium-scale production level. Quantum-GIS (QGIS) Flenniken, J. M., Stuglik, S., & Iannone, B. V. (2020) was the open-source project they made with Multi-Criteria Decision Making (MCDM) Massam, B. H. (1988) research. They set six of the exclusion criteria and utilized the Analytic Hierarchy Process (AHP) Darko, Amos, et al.(2019) to prioritize the locations of the potential sites to prepare a technology assisted suitability map. This paradigm greatly accelerated investment in that way drastically decreased the requirement of investment in visitable sites and avoided a lot of time and expense being incurred by investors.

Hazard and Vulnerability Assessment: Pal et al. (2019) specifically emphasized measuring landslide vulnerability zonation impact of adverse landslide zonation effects in West Sikkim. Furthermore, Pal et al. (2008) examined earthquake zonation hazards and identified eighty Potential Fracture System (PFSR) zones located in the state. Rawat et al. (2012) in South Sikkim also presented statistical analyses with GIS and Nath (2004) have conducted remarkable Hazards Zonation work with geospatial tools with the Himalayan area of Sikkim.

Ecotourism and Utilization of Land: Bhutia, J. N. (2024) to assess the potential of ecotourism sites and establish west Sikkim ecotourism system index. Other GIS applications encompass snow and glacier cover assessment (Krishna 2005),

Land Use/Land Cover (LULC) change detection (Mishra et al., 2020), and spatial environmental impact assessment (Banerjee et al., 2016).

While all these important contributions can be achieved with the aid of geospatial technologies, an important gap has developed:

2.1 Contextual Focus: GIS implementation has been introduced stepwise for general LULC, vulnerability assessment, and geoportal creation while most studies focused on the small areas or localized districts of Sikkim only.
2.2. Tourism-Based: Previous research on using Multi-Criteria Spatial Decision Support Systems (MC-SDSS) Ferretti, V., & Montibeller, G. (2016), has often either assessed specific tourism issues (such as ecological potential) or planned the entire situation.
2.3. Lack of Integrated Hotel Planning: Importantly, the literature review revealed no evidence of an integrated hotel site planning approach using GIS developed for the tourism destinations of Sikkim. It highlights the need for this research to establish a holistic GIS powered methodology for the selection of scientific hotel sites in Sikkim.

Methodology: Conventional hotel site selection methods usually depend on a limited set of conventional criteria, such as looking at tourist flows, seasonal trends, and general market access. Good information, but not scientific, as with the large-scale investment project, which could be quite large and requires a high capital, human resources (HR), and time investment Chen, C. F. (2006).. To boost the validity and impartiality of the decision-making process, this research combines the traditional insights with contemporary geospatial technology, i.e., Geographic Information System (GIS) tools and applications. At the heart of the method lies the dual-stage analysis of results from the sophisticated spatial models, alongside essential market insights derived from classical analysis, to form the best result, which is also the most robust. This study was carried out according to the systematic approach intended to meet the fixed goals while accurately estimating the site selection problem complexity. A comprehensive pool of relevant primary and secondary data was obtained from multiple authoritative sources in spatial, demographic, and economic parameters in the field of the research in the first stage of data collection. A search for the available literature was conducted comprehensively. Such a step was indispensable, especially while refining the research perspective as well as helping investigators to tailor the purpose of this study to take the best advantage of GIS in the intricate landscape of hotel planning and the evaluation of spatial suitability Uhodnikova, Olena, et al. (2024).

The central purpose of the methodology was to realise the Multi-Criteria Spatial Decision Support System (MC-SDSS) modelling and to show a scientifically sound method of hotel site planning and development using Geographic Information System (GIS) technology. ArcGIS software was used as the primary application for developing and maintaining the digital map layers (geospatial data). A set of fundamental criteria, which act as governing factors for the establishment of a new hotel, was determined and utilised in spatial modelling. These factors are critical for determining the most appropriate and feasible locations for the development of new hotels. . In this study of destination fetching modelling (H_{SM}) is given as:

$$H_{SM} = f \int_{i=1-10}^{w_i} (L_{ulc}, G_l, E, S, R_f, T_p, Sl).$$

Criteria Category	Symbol	Description
Land Use/Land Cover	L_{ulc}	Existing use and physical covering of the land (e.g., urban, forest, agriculture).
Geology	G_l	Subsurface structure and stability of the land.
Elevation	E	Altitude above sea level (influencing accessibility and climate).
Soil Type	S	Composition and engineering properties of the surface material.
Rainfall	R_f	Average precipitation levels (affecting construction and tourism viability).
Temperature	T_p	Average thermal conditions (influencing visitor comfort and operating costs).

Figure 01: The key criteria integrated into the MC-SDSS model

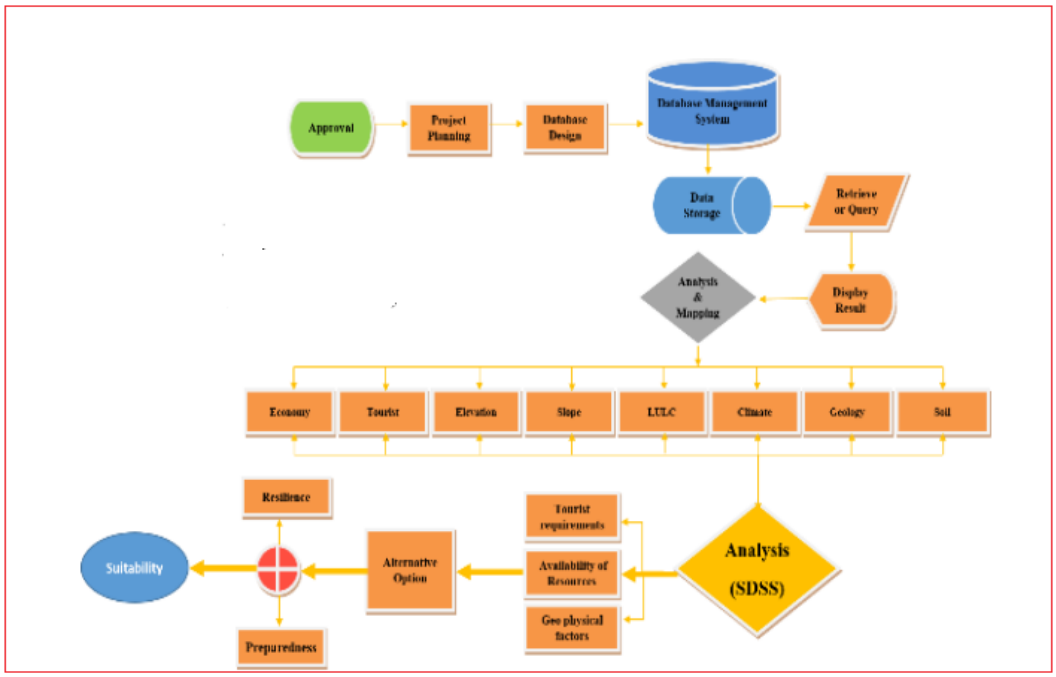

Figure 02: Process Flow Chart

Results and Discussion: A foundation plan was prepared at the initial stage covering parameters such as criteria factors like LULC (Lulc), Geology (G l), Elevation (E), Soil (S), Rainfall (R f), Temperature (T p) and Slope (S l), and inserted in the ArcGIS 2.0 Software. The second important stage after this is to set up a strong database management system leveraging GIS technology. This system is specially designed to efficiently capture, store and organise all relevant geospatial datasets. This spatial inventory is essential, which acts as a default resource for all successive spatial analysis, mapping and querying. The multi-layer datasets in this system provide high accessibility and are prepared for future spatial investigations or for generating analytical outcomes. The digital maps corresponding to each of the above criteria were created, visualised, processed digitally and imported into GIS software. This dataset was ready and standardized for being used as raw data as the raw material for the final suitability modelling. Different specific tourist locations were inserted in the digital map to recognise the importance.

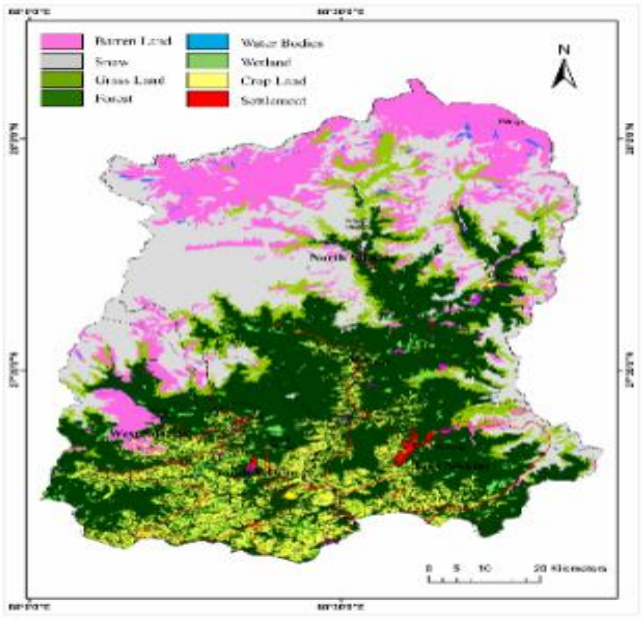

Figure 03: Land Use and Land Cover Map of Sikkim

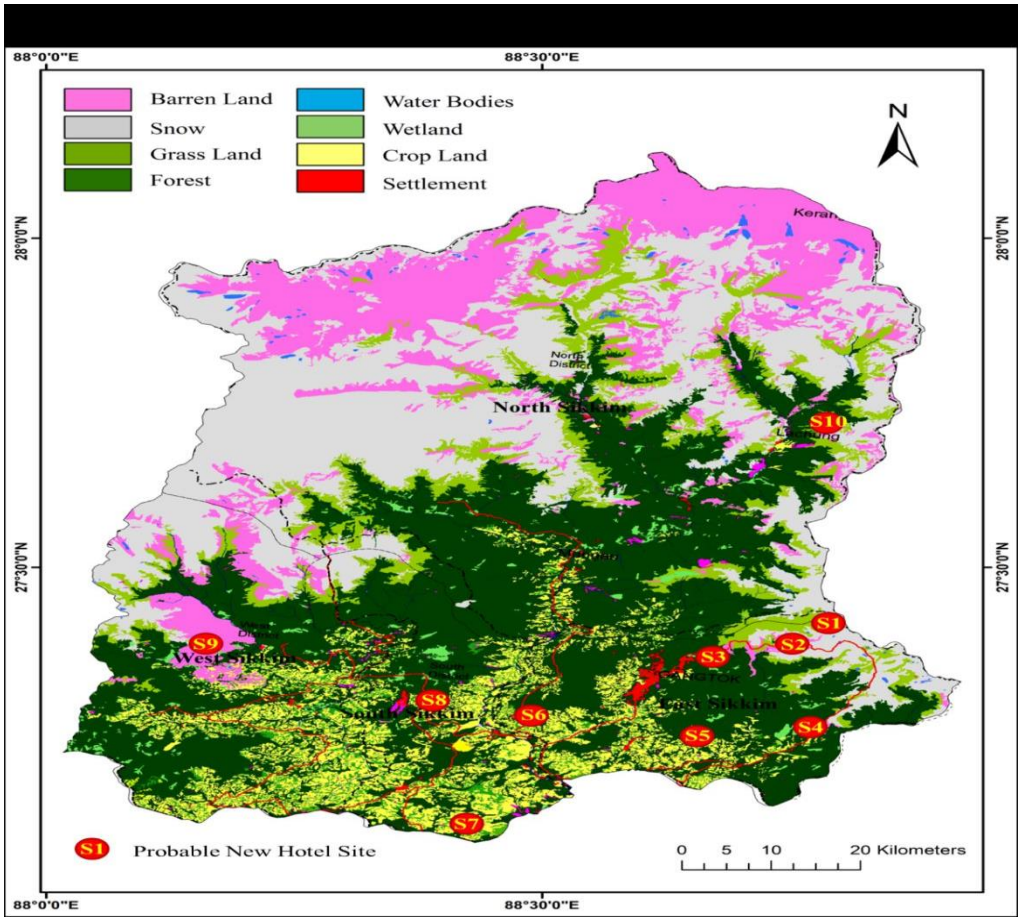

Figure 04: Probable Hotel Site Superimposed in the Land Cover Map

The identified sites possess several advantageous physical attributes: Temperature: The average ambient temperature across these locations ranges optimally between 11^0 C and 16^0 C. All sites benefit from excellent road connectivity and access to requisite auxiliary facilities. Based on the spatial attributes derived from the Land Use/Land Cover (LULC) and Elevation criteria (illustrated in Figures 3 and 4), specific construction and development strategies are recommended for each cluster of sites mentioned below in Figure 05 and Figure 06:

Cluster	(Referencing Figure 6.8)	Development Type	
S-1 & S-2	High Mountainous Region	Typical Wooden Hill Resorts	Suitable for specialized, low-impact construction that complements the challenging high-altitude terrain.
S-4, S-5, & S-6	Forest Area	Forest Bungalows or Eco-Lodges	Appropriate for sustainable, nature-focused accommodation that minimizes environmental footprint within forested zones.
S-3	Established Settlement Area	Business Class/Star Category Hotel	Ideal location for high-density, commercial construction to cater to business travelers or mainstream tourism within an existing urban framework.
S-6, S-7, S-8, & S-9	Barren Land or Cropland	Hill Resorts	These sites offer open, developable terrain, making them suitable for constructing standard, well-planned hill resorts.

Figure 05: Types of Hotel for Constriction

Sl. No	New Hotel Spot (Site)	LULC Type	Elevation in m	Slope (degree)	Tourism Suitability	Accessibility
1.	S1	Barren Land	3032	5.2	Moderately suitable	1.5 km from existing road
2.	S2	Barren Land	3385	8.2	Highly suitable	Well connected
3.	S3	Barren Land	2825	11.5	Highly suitable	Well connected
4.	S4	Crop land	2395	9.8	Highly suitable	Well connected
5.	S-5	Crop land	1211	6.4	Very highly suitable	Well connected
6.	S-6	Crop land	1056	4.6	Highly suitable	Well connected
7.	S-7	Crop land	1192	6.8	Very highly suitable	Well connected
8.	S-8	Crop land – Forest boundary	1251	8.4	Highly suitable	Well connected
9.	S-9	Barren Land	3452	12.5	Moderately suitable	2.1 km from existing road
10.	S-10	Barren land – Forest boundary	3809	14.8	Moderately suitable	0.25 km from existing road

Figure 06: Site Suitability Map

Conclusion:

In this research, all of the necessary components for informed and successful site selection were critically considered for a proposed hotel site development. Strongly, researchers infer that combining a well-structured, multi-level data structure with powerful analytical technologies is critical if both the site suitability and resilience is to be maximised, and the project will endure. For the selection process of the site, the first step is to extend the breadth of the base database. The geospatial core data is the most useful, but general and contextual variables become powerful in their use, where they are not always available. Namely, future versions of the database should incrementally aggregate individualised data based on tourist needs and market demands: demographics, spending habits, duration of stays, favourite facilities, and future travel fads, for instance. This market-based information offers essential context for the feasibility and value propositions of one location. Also, a comprehensive inventory and evaluation of resource availability and infrastructure capacities is required. This would include the level of reliability and capacity of utilities (water and power, telecommunications) and local labour supply/skills, and the strength of the local/territorial transportation network (roads and public transit, airports or major thoroughfares) infrastructure. Transparency in considering these operational considerations enables planning authorities to be precursors to potential project planning bottlenecks in a way that includes infrastructure, estimating the necessary capital expenditure to service infrastructure improvements, and planning a more practical and feasible project. Moving from one dimension of data aggregation to an informed-decision decision-making framework requires a solid methodology behind the analysis. One of the most important analytical engines is recommended for an SDSS deployment. An SDSS is not merely a mapping tool but a complete and integrated system that is used to support decision-makers in addressing complex spatial issues through the integration of database management, analytical modeling, and geographical visualization. The planning authority can use the SDSS to conduct a sophisticated spatial analysis, including weighted overlay, proximity analysis, and network analysis, to identify and rank sites that provide the best suitability based on specific criteria.

References:

1. Buhalis, D. (2000). Marketing the competitive destination of the future. Tourism management, 21(1), 97-116.
2. Barrick, I. J. (2008). *Transforming Health Care Management: Integrating Technology Strategies: Integrating Technology Strategies*. Jones & Bartlett Publishers.
3. Bhutia, J. N. (2024). *Sustainable Tourism Planning and Development: A Study of Selected tourist destinations of Sikkim* (Doctoral dissertation).

4. Banerjee, P., & Ghose, M. K. (2016). Spatial analysis of environmental impacts of highway projects with special emphasis on mountainous area: an overview. *Impact assessment and project appraisal*, *34*(4), 279-293.
5. Chang, K. T. (2016). Geographic information system. International encyclopedia of geography: people, the earth, environment and technology, 1-10.
6. Chakraborty, S., & Pradhan, R. (2012). Development of GIS based landslide information system for the region of East Sikkim. *International Journal of Computer Applications*, *49*(7).
7. Chen, C. F. (2006). Applying the analytical hierarchy process (AHP) approach to convention site selection. *Journal of travel research*, *45*(2), 167-174.
8. Dragicevic, S., Filipovic, D., Kostadinov, S., Ristic, R., Novkovic, I., Zivkovic, N., ... & Djurdjic, S. (2011). Natural hazard assessment for land-use planning in Serbia.
9. Darko, A., Chan, A. P. C., Ameyaw, E. E., Owusu, E. K., Pärn, E., & Edwards, D. J. (2019). Review of application of analytic hierarchy process (AHP) in construction. *International journal of construction management*, *19*(5), 436-452.
10. Farag, H. F. I. (2022). *Revenue Management and Pricing in Hotel Industry: Analysing the Impact of Open Pricing on Hotels Revenue Performance* (Doctoral dissertation, Universidad Rey Juan Carlos).
11. Ford, R. C., Heaton, C. P., & Brown, S. W. (2001). Delivering excellent service: Lessons from the best firms. *California Management Review*, *44*(1), 39-56.
12. Flenniken, J. M., Stuglik, S., & Iannone, B. V. (2020). Quantum GIS (QGIS): An introduction to a free alternative to more costly GIS platforms: FOR359/FR428, 2/2020. *Edis*, *2020*(2), 7-7.
13. Ferretti, V., & Montibeller, G. (2016). Key challenges and meta-choices in designing and applying multi-criteria spatial decision support systems. *Decision Support Systems*, *84*, 41-52.
14. Ghosh, K., & De, S. K. (2022). Evaluation of hydro-geomorphic responses to climate change in North Sikkim District, Sikkim, India. In *Climate Change, Disaster and Adaptations: Contextualising Human Responses to Ecological Change* (pp. 21-33). Cham: Springer International Publishing.
15. Islam, R., Kamaruddin, R., Ahmad, S. A., Jan, S., & Anuar, A. R. (2016). A review on mechanism of flood disaster management in Asia. *International Review of Management and Marketing*, *6*(1), 29-52.
16. Jenelius, E., & Mattsson, L. G. (2015). Road network vulnerability analysis: Conceptualization, implementation and application. *Computers, environment and urban systems*, *49*, 136-147.
17. Kumar Nath, S. (2004). Seismic hazard mapping and microzonation in the Sikkim Himalaya through GIS integration of site effects and strong ground motion attributes. *Natural Hazards*, *31*(2), 319-342.
18. Krishna, A. P. (2005). Snow and glacier cover assessment in the high mountains of Sikkim Himalaya. *Hydrological Processes: An International Journal*, *19*(12), 2375-2383.
19. Kaynak, S., Kaynak, B., & Özmen, A. (2018). A software tool development study for solar energy potential analysis. *Energy and Buildings*, *162*, 134-143.
20. Morrison, A. M., Pearce, P. L., Moscardo, G., Nadkarni, N., & O'Leary, J. T. (1996). Specialist accommodation: Definition, markets served, and roles in tourism development. *Journal of travel research*, *35*(1), 18-26.
21. Morey, R. C., & Dittman, D. A. (1997). An aid in selecting the brand, size and other strategic choices for a hotel. *Journal of Hospitality & Tourism Research*, *21*(1), 71-99.
22. Massam, B. H. (1988). Multi-criteria decision making (MCDM) techniques in planning. *Progress in planning*, *30*, 1-84.
23. Mishra, S., & Jabin, S. (2020, October). Land use land cover change detection using landsat images: A case study. In *2020 IEEE 5th International Conference on Computing Communication and Automation (ICCCA)* (pp. 730-735). IEEE.
24. Nyimbili, P. H., & Erden, T. (2018). Spatial decision support systems (SDSS) and software applications for earthquake disaster management with special reference to Turkey. Natural Hazards, 90(3), 1485-1507.
25. Parise, M. (2001). Landslide mapping techniques and their use in the assessment of the landslide hazard. *Physics and Chemistry of the Earth, Part C: Solar, Terrestrial & Planetary Science*, *26*(9), 697-703.
26. Pal, A., Tsusaka, T. W., Nguyen, T. P. L., & Ahmad, M. M. (2023). Assessment of vulnerability and resilience of school education to climate-induced hazards: a review. *Development Studies Research*, *10*(1), 2202826.
27. Rawat, M. S., Rawat, B. S., Joshi, V., & Kimothi, M. M. (2012). Statistical analysis of Landslide in South district, Sikkim, India: using remote sensing and GIS. *J Environ Sci Toxicol Food Technol*, *2*(3), 47-61.

28. Sarkar, A. (2011). Socio-economic implications of depleting groundwater resource in Punjab: A comparative analysis of different irrigation systems. *Economic and Political Weekly*, 59-66.
29. Uhodnikova, O., Zhyhlo, V., Cirella, G. T., Vlashchenko, N., Karpenko, L., & Moroz, N. (2024). Modern Trends and Spatial Planning of Hotel Complexes: Navigating Uniqueness, Challenges, and Post-War Development in Ukraine's Tourism Landscape. *Handbook on Post-War Reconstruction and Development Economics of Ukraine: Catalyzing Progress*, 213-229.
30. Venkatesh, R., Abdul Rahaman, S., Jegankumar, R., & Masilamani, P. (2020). Eco-environmental vulnerability zonation in essence of environmental monitoring and management. *The international archives of the photogrammetry, remote sensing and spatial information sciences*, *43*, 149-155.