All Sciences Proceedings
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2nd International Conference on Contemporary Academic Research
November 4-5, 2023 : Konya, Turkey

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APPLICATION OF GIS AND REMOTE SENSING IN GEOTECHNICAL ENGINEERING

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Abstract **–** Hazard Zonation Mapping (HZM) assesses the risk of natural or artificial disasters. This research focuses on landslide susceptibility in the Koh-e-Suleman Range, utilizing the Weighted Overlay Technique. Six factors—Geology, Elevation, Slope Inclination, Distance from Streams, Soil Type, and Annual Rainfall Intensity—were considered. Using a 10m pixel DEM raster, data from DSMW (Digital Soil Map of the World), FAO (Food and Agriculture Organization), and Climate Research Unit websites were gathered. Equal classes were assigned to all causative factors, except for soil type, where two categories existed. The Weighted Overlay method with equal risk influence for all factors was applied to create the landslide hazard map. The results categorized the study area into four hazard zones: HIGH, MEDIUM, LOW, and VERY LOW. Approximately 0.0048% of the area fell in the high hazard zone, 5.11% in the medium hazard zone, 74.27% in the low hazard zone, and 20.61% in the very low hazard zone. To validate the map's accuracy, the hazard zone percentages were compared with a global landslide hazard map from NASA, revealing that almost all the study area fell within low and very low hazard zones. No landslides were observed in these zones, indicating that nearly 95% of the study area is safe from landslides.

Keywords – Hazard Zonation Mapping, Artificial Disasters, Landslide, Weighted Overlay, Climate Research, Unit Websites

I. Introduction

The environment plays a crucial role in supporting human financial well-being and overall quality of life. Preserving the ecosystem is not only important for its intrinsic value but also to leave a legacy of sustainable natural resources. Sustainable land management seeks to balance environmental sustainability and economic prosperity, requiring effective policy, participation, and information. These elements are particularly vital in less developed nations where infrastructure is often lacking, and the country's social, economic, and historical customs, as well as management challenges, influence how these factors are balanced.

Landslides pose a significant threat worldwide, causing high mortality rates and economic damage compared to other natural disasters. Identifying and mapping landslides and assessing associated hazards and risks is complex due to the varied nature of landslides. This study aims to address this by providing a consistent terminology, validated tools, and a scientific basis for developing landslide maps, forecasting models, and forecasts.

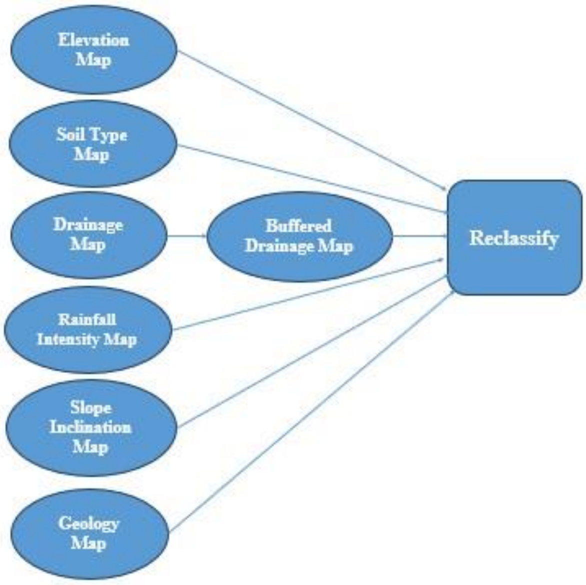
Recent efforts to assess landslide susceptibility have used various GIS and remote sensing approaches. The methodologies employed depend on factors like data accessibility, the scope of the analysis, and the specificity required for hazard mapping. Multivariate statistical methods, information models, and fuzzy set theory have enhanced landslide hazard evaluation. Geographic Information Systems (GIS) have also been used to model landslide hazards by considering the combined influence of various factors in landslide occurrences.

II. MATERIALS AND METHOD

Selecting the right research methodology can be a challenging decision for most researchers. The choice of methodology depends on the type of research, and data collection methods should align with the study's goals. This chapter reviews current literature on research methodologies, sampling, and data collection techniques, including qualitative, quantitative, statistical, and mixed methods. In this study, we used the statistical technique of Weighted Overlay to gather precise data for susceptibility mapping in Dg Khan's Tehsil mountainous region. Gathering satellite data involved completing project forms with the required input variables.

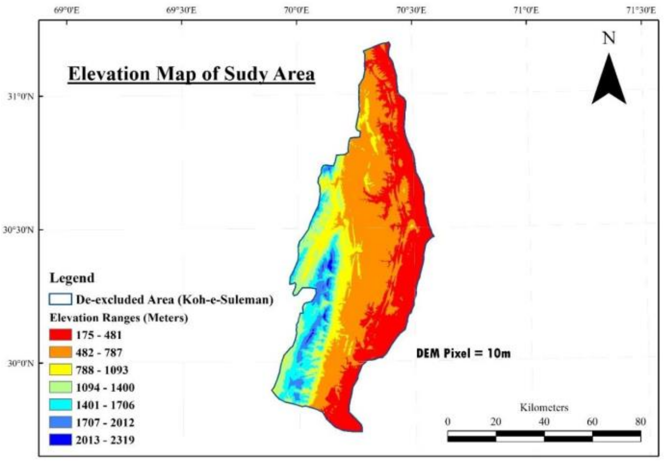
A. *Level-2 Framework*

A framework used for the development of LHZ map of Koh-e-Suleman using causative factor maps and weighted overlay Technique are as shown in the model below.



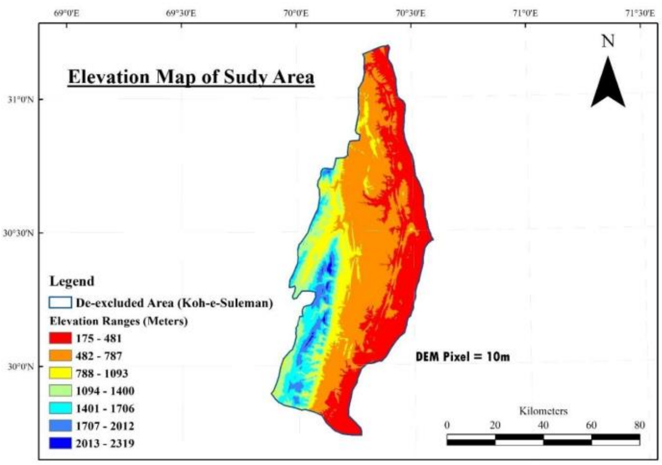
For the preparation of Elevation map of the study area, Add our study Area DEM Raster and the shapefile in ArcMap. Change the page into layout view by clicking on

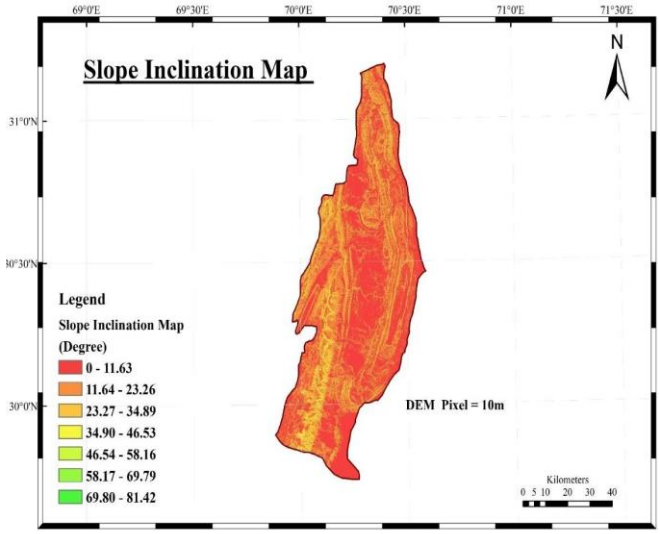
Layout view button. By following the path File > Print and Page Setup > Name as OneNote for Window 10 > Size as A4 > Orientation as Landscape > Tick Scale Map Elements Box > Ok. Classify the elevation and provide symbology to it using the path as Layer Properties > Symbology > Classified > Classes as 7 > Provide random color ramp >Apply > OK. Add Grids by Right Clicking within the Layout Page and the follow the path as Properties > Girds > Next > Next >Next > Finish > Apply > OK. Then insert Scale Bar, Title, and Text using Insert option in Menu Bar according to the Requirements. Save the file using the path as File > Export Map > Save as: JPEG > Resolution of 320dpi > Open. Our final Elevation map of the study area having 7 classes of elevation ranges and the DEM Pixel size of 10m is as shown below.

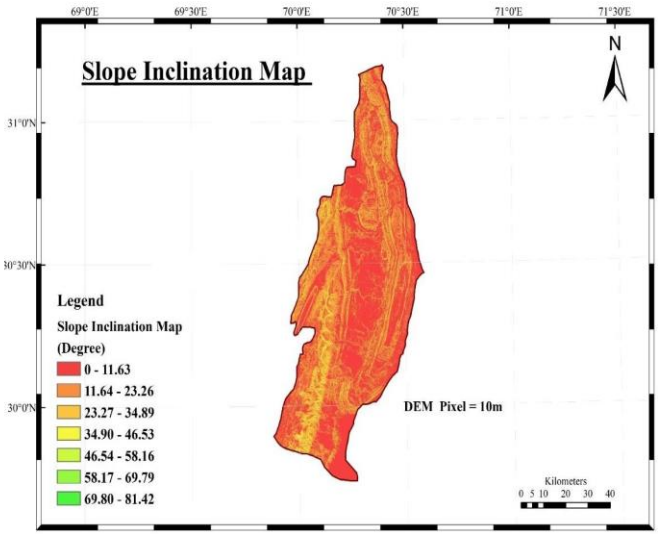


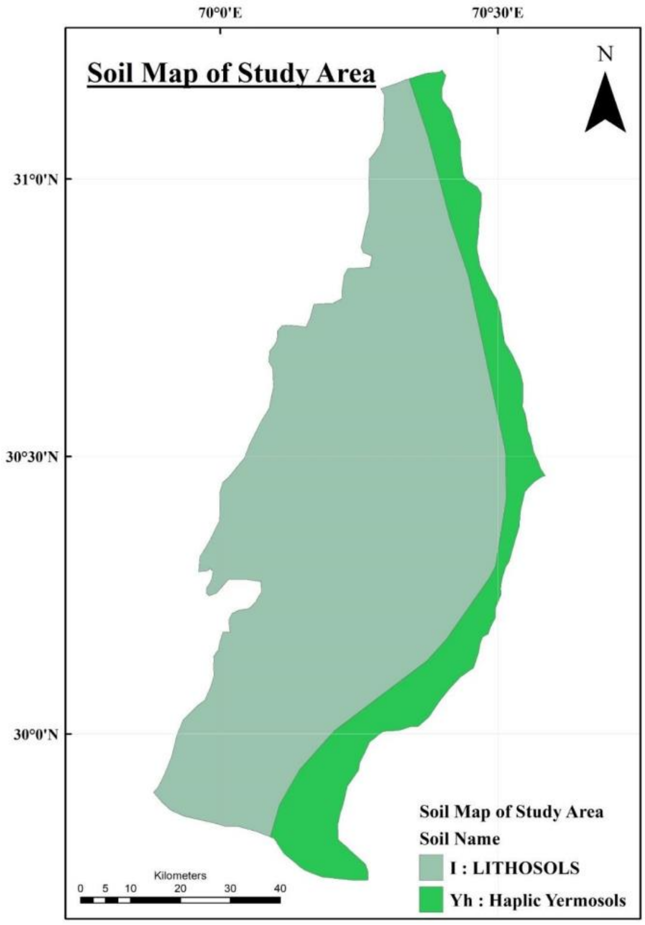
III. RESULTS

This research focuses on landslide susceptibility mapping in the Koh-e-Suleman Range using the Weighted Overlay Technique. Six causative factors, including Geology, Elevation, Slope Inclination, Distance from Streams, Soil Type, and Annual Rainfall Intensity, were considered. These factors were standardized except for soil type. The results revealed four zones: HIGH, MEDIUM, LOW, and VERY LOW landslide intensity. The majority of the study area falls within the medium and low susceptibility zones, indicating safety from landslides based on these factors.









IV. CONCLUSION

This study highlights the vital connection between GIS and satellite imagery techniques for Landslide Hazard Zonation Mapping (LHZM). When mapping vast areas with limited historical landslide data, the weighted overlay technique proves valuable. After reviewing relevant literature, five key landslide factors were selected, assigned weights and scores based on terrain understanding, and assessed. Results indicated that proximity to rivers and streams, slope inclination, and rainfall intensity had the most significant impact on landslides.

Proximity to rivers and streams emerged as the primary landslide driver, with increased landslides occurring near water bodies due to fluctuating water levels from heavy rainfall and snowmelt in major rivers.

The weighted overlay statistical approach facilitated the calculation of quantitative values for all variables and produced hazard classes. This technique allowed for consistent handling of variable maps with the same pixel size, resulting in the final landslide hazard map.

Geospatial technology enabled the identification of landslide-prone zones, subsequently confirmed through field research.

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