Chapter 8
Remote Sensing and GIS for Weed Detection Using Enhanced Spatial Insights: A Review

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ABSTRACT

Remote sensing (RS) and Geographic Information Systems (GIS) technologies are receiving significant attention due to their combined potential to revolutionize spatial analysis and enhance understanding of complex environmental and geographic phenomena. This integration has vast applications, spanning from urban planning to engineering technologies. Remote sensing and GIS play essential roles in detecting and mapping weed infestations in agricultural fields, facilitating precise weed management and reducing herbicide use. Advancements include high-resolution imagery and machine learning algorithms, which enhance detection accuracy and efficiency. This chapter reviews and discusses the framework of weed detection

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based on different techniques, modes of data collection, and categories of weed features, including spectral and spatial features of weeds. Additionally, it discusses the different challenges encountered in the detection of weed.

1. INTRODUCTION

Remote Sensing (RS) and Geographic Information Systems (GIS) are two technologies without which modern farming would not have been possible. They have lifted the industry to the level of spatial analysis, monitoring the environment as well as the process automation through the wide range of technologies. Remote sensing is the art of observing the surface of the Earth without physical contact. It is usually done by means of satellites, drones, or aircraft that have been loaded with sensors. These sensors capture the signals or images or any other form of data by then, these sensors can pick up distinct wavelengths like visible light, infrared, or radar to discover the changes even in physical properties like size and time across different media. Geographic Information Systems (GIS) systems mostly include tools for recording, storing, explaining and displaying location data on a map. GIS brings together the spatial data (the data that says the location) and the attribute data (the data that describes what it is) to make detailed maps and execute sophisticated spatial analyses (generally differentiation of spatial variables related to each other) (Bibhuti Bhusan & Giri, 2023)

In urban planning, the integration of RS and GIS can be very helpful in monitoring urban sprawl, managing land use, and assessing the environmental impacts (Kumar et al., 2023). In case of agriculture, these technologies can be utilized to monitor the health of crop, map the different properties of soil, and detect different type of weed infestations, leading to more efficient and precise farm management practices. This integration's capacity to track and evaluate changes over time also makes it indispensable for research on climate change, natural resource management, and catastrophe management. Using RS technologies, which offer high-resolution images and spectral data essential for precisely identifying weed species and separating them from crops, improves detection accuracy. In addition to monitoring weed growth patterns and identifying infestations at different phases of growth, temporal analysis of RS data can be used to plan timely treatments and gain insight into the lifecycle of weeds (Xu et al., 2023)

The ultimate result of combining RS and GIS technologies is precision weed management, which lessens the need for broad herbicide treatments and has a smaller negative impact on the environment. Farmers can minimize the impact of herbicide applications on non-target species and the environment while lowering chemical use and expenses by properly mapping weed infestations (Ghatrehsamani et al., 2023)