


Chapter 9

Technological Monitoring and Management in Hydrophyte–Based Heavy Metal Stress Management

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ABSTRACT

Remote sensing has emerged as a pivotal technology in the monitoring and management of heavy metal contamination in various environments. By utilizing satellite imagery, aerial photography, and advanced sensor technologies, researchers can effectively assess the spatial distribution and concentration of heavy metals in soil, water, and vegetation. This paper explores the various remote sensing techniques employed in heavy metal monitoring, highlighting their applications in detecting environmental stressors and assessing the health of ecosystems. Through the integration of remote sensing data with geographic information systems (GIS) and machine learning algorithms, it is possible to develop predictive models that facilitate timely interventions and remediation strategies. The findings underscore the importance

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of remote sensing as a non-invasive and efficient approach to environmental monitoring, providing valuable insights for policymakers and environmental managers in their efforts to combat heavy metal pollution.

1. INTRODUCTION TO HEAVY METAL STRESS

The plant kingdom has a basic role of supporting the large number of diverse forms of life on land and plants are an essential and vital part of the intricate mechanisms of osmotically excluding a variety of solutes (Kosal 2023). These solutes form major ionic, osmotic and gravitational forces which all work together towards improving water quality and water quantity in the ecosystems. The bioavailability of heavy metalloids in the essential rhizosphere can have a significant effect on the solute forces that control the uptake of water and the general effectiveness of plant water relations. In addition, the availability and the bioavailability of these toxic heavy metalloids in the root zone leads to a lethal ambiance likely to cause the breakdown of vital forces of cohesion and adhesion. Directly resulting thereof, the mechanisms of plant water uptake, transport, and transpiration receive seemingly contradictory signals, prompted by the overloading of the soil solution with metalloids, as well as the gravitational forces that act in the surrounding environment and also creates its impact. The fact that this is a problematic situation may become conditionally much worse when subjected to the conditions of water deficiency, which is confirmed by different experiments related to the exposure of plants to heavy metal stress (Goncharuk & Zagoskina, 2023). Consequently, due to the considerable functions that plants serve in ensuring that the soil-plant-atmosphere systems are balanced, there is an increasing need to research further on the influence of excessive heavy metal stress on the water relations of plants. It is also important to explore the physiological processes that cause the detrimental impact on the equilibrium of the solute forces which have become so significant to the plant health. This knowledge, in its turn, can facilitate the way to the creation of proper mitigation and remediation patterns, which is required to maintain the vitality of plants and the stability of their ecosystems (Grifoni et al., 2022). It can be found that heavy metals can be emitted to soil, as well as water resulting the several anthropogenic activities, which encompass mining, different smelting industries, geological weathering, the burning of fossil fuels, the use of fertilizers and pesticides, municipal framework related operations, the operation of thermal power plants, and improper discarding of electronic wastes. These heavy metals are very toxic and difficult to dispose of thus there is a serious environmental concern as the metals are prone to bioaccumulation in organisms. Plants are important components of the Earth eco systems and have been playing a central role in the survival of life on this planet since its

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