Application of innovative radar technology in the assessment of root system variability in the context of susceptibility of Scots pine to drought-induced mortality

The health and stability of forests are increasingly at risk due to climate change and human activities. One of the key challenges is the rising frequency of extreme weather events, such as prolonged droughts, which can lead to widespread forest mortality. Trees rely heavily on their root systems to access water and nutrients, making these underground structures crucial for their survival during environmental stress. Despite their importance, root systems remain one of the least studied aspects of forest ecosystems due to the difficulty of observing them directly.

This project focuses on understanding how the root systems of Scots pine, one of the most common tree species in Poland, adapt to different environmental conditions. Using groundbreaking technology—a multichannel ground-penetrating radar (GPR) —researchers will be able to study root systems in a non-invasive and detailed way. This innovative tool allows for high-resolution imaging of roots, enabling scientists to explore their structure and function without disturbing the soil.

The research will investigate several key questions. First, how do factors like soil type, moisture levels, and tree competition affect the growth and architecture of root systems? Second, how do root systems change with the age of the tree, and why are older trees often less able to adapt to environmental stress? Finally, can insights from root systems help predict which trees are most at risk of dying during droughts?

To answer these questions, the project will combine field studies with advanced data analysis. Researchers will scan root systems on 60 carefully chosen plots across Poland, covering a wide range of soil types and forest conditions. The GPR data will then be validated through selective root excavations to ensure accuracy. By integrating this data with existing information on tree and forest characteristics, scientists aim to develop models that link root system traits to tree health and mortality risk.

One of the most exciting aspects of this research is its potential to transform how we study and manage forests. Understanding root systems can provide valuable insights into how forests respond to climate change, helping foresters develop strategies to make ecosystems more resilient. For example, the findings could guide decisions about where and how to plant trees to reduce the risk of drought-related mortality.

This project also emphasizes the importance of cutting-edge technology in ecological research. The use of GPR represents a major step forward, allowing for large-scale studies of root systems that were previously impossible. The results could pave the way for more widespread adoption of such tools in forestry and environmental science.

Beyond its scientific impact, the project will also contribute to public awareness and education. The findings will be shared through scientific publications, conferences, and popular science articles. Moreover, two young researchers will join the team as scholarship holders, gaining valuable experience and training in this innovative field.

In summary, this project aims to shed light on the hidden world of tree roots, revealing their critical role in forest health and resilience. By combining advanced technology with ecological expertise, it seeks to address some of the most pressing challenges facing forests in a changing climate.