Topic 1: Numerical Simulation of Root-Reinforced Soil Slopes with Geosynthetics

Preliminary research question: How do roots and geomats interact to prevent slope failure?

Background & Motivation

Extreme weather and heavy rainfall increasingly threaten the stability of natural and engineered slopes. While traditional concrete-heavy stabilization works, nature-based solutions (combining vegetation roots with geosynthetic mats) offer a sustainable, resilient alternative. However, quantifying the exact mechanical contribution of root systems combined with artificial reinforcement remains an active numerical challenge.

Research Objectives & Methodology

1. **Case Study & In-Situ Data Extraction:** Review benchmark literature cases and extract real subsurface profiles and geotechnical parameters using open Dutch geological data (**DinoLoket**).
2. **Constitutive Modeling:** Model the soil-root-geomat composite system using numerical simulation software (e.g., PLAXIS, FLAC, or GeoStudio).
3. **Parametric & Comparative Analysis:** Evaluate slope stability under varying rainfall/load conditions, comparing:
    - Bare soil (unvegetated).
    - Geomat-only reinforcement.
    - Root-reinforced soil
    - Root-reinforced soil with geomat integration.

What You Will Deliver

- A validated 2D/3D numerical model reproducing field/flume benchmark data.
- A sensitivity matrix showing safety factors (F_s) across different root depths, densities, and mat configurations.
- Clear engineering guidelines comparing nature-based stabilization against conventional methods.

Key Skills You Will Gain

- Finite element/finite difference geotechnical modeling (PLAXIS / FLAC/Geostudio).
- Working with national geological GIS databases (**DinoLoket**).
- Slope stability assessment and soil constitutive behavior.

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