HydroROOT: Hydrogel-Mediated Nutrient Mobilization & Soil Hydration to Counter Desertification

Parekh, Aksh (School: Washington High School)
Tamboli, Neev (School: American High School)

Resulting from climate change and aggressive farming practices, desertification is a major threat to the environment and survival of millions, as according to the United Nations, desertification deteriorates over 250,000,000 acres of fertile land per year, resulting in a loss of over $878 billion to the global economy. A novel approach to solving this problem is HydroROOT, which transports NPK nutrients and water from deeper soil layers to topsoil and catalyzes soil nutrient cycles with increased oxygen diffusion, utilizing the absorptive properties of hydrogels. Additionally, a Raspberry Pi embedded system utilizes a random forest ML model to manage hydrogel deployment most optimally using soil data while forecasting soil health to maximize resource-efficiency. Testing involved the optimization of different hydrogels (sodium alginate and guar gum hydrogels and their different variants) based on water and nutrient absorption and the mechanical stress experienced within HydroROOT. This forecasting mechanism follows the standard exponential smoothing equation [St = aXt + (1-a)St-1] to predict future soil needs so the system can efficiently allocate resources. The water absorption of 200?-heated sodium alginate hydrogels was 1.1 mL water per mL of hydrogel while nutrients of NPK increased by 6.66-3.33-3.33mg/kg soil, respectively and +7% moisture, higher than other hydrogel variants in different controlled environments to show soil and nutrient cycle revitalization. Anomalies in data collection and model accuracy didn't affect results, as verified with error analysis. HydroROOT's approach with the desertification gradient is crucial in containing desertification to prevent societal crisis by revitalizing dying ecosystems for the best of humanity and the environment.

Awards Won: