

Preliminary evaluation of dropping characteristics and revegetation performance of vegetation pellets combined with geomats

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In landslide areas where direct human access is difficult, unmanned aerial vehicles (UAVs) have been previously employed to distribute artificial revegetation materials, known as vegetation pellets, for ecological restoration. However, previous trials have indicated that after deployment, vegetation pellets often fail to remain on steep slopes and tend to accumulate in depressions or erosion gullies, resulting in limited revegetation effectiveness. Geomats are commonly used materials for slope protection and soil erosion control. Therefore, this study combined vegetation pellets with five types of geomats commonly used in Taiwan to form different pellet-net packages and conducted experiments to evaluate their dropping characteristics and seed germination performance. The experimental results showed that pellet packages with larger mesh sizes experienced less reverse aerodynamic resistance during descent, resulting in faster falling velocities and wider dispersion. In addition, seed germination and plant growth were less constrained by the net density, leading to relatively favorable growth performance. In contrast, pellet packages with higher net density encountered greater air resistance during descent, allowing them to land more slowly and accurately at target locations; however, they may impose certain limitations on the later growth of woody species. Overall, the results indicate that integrating geomats with vegetation pellets can improve the application potential of UAV-based aerial revegetation techniques. Nevertheless, further studies are still required to optimize material design and construction techniques.

Keywords: vegetation pellets; geomats; vegetation materials; aerial seeding

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Introduction

Taiwan's steep terrain and intense rainfall result in frequent landslides. Early helicopter-based seeding was not sustained due to unclear regulations and limited experience. Unmanned Aerial Vehicle (UAV)-applied vegetation pellets improve vegetation cover but are constrained by downslope rolling and dry conditions. Geomats provide slope stabilization and support early plant growth. This study combines vegetation pellets with five geomats and evaluates their feasibility through drop and germination experiments.

Material and method

Vegetation pellets, composed of soil, fertilizer, fibers, and seeds, enhance seed protection and establishment under stress and can be applied in landslide areas. Geomats are widely used for slope stabilization and erosion control. In this study, pellets were combined with five geomats to form pellet-net packages (15 × 10 cm, six pellets per package). Drop and germination tests were conducted to evaluate their feasibility for landslide revegetation.



Erosion Control Blanket (ECB)



Cotton Erosion Blanket (CEB)



HDPE Shade Net (HDPE)



Polyester Mesh Geomat (PET)

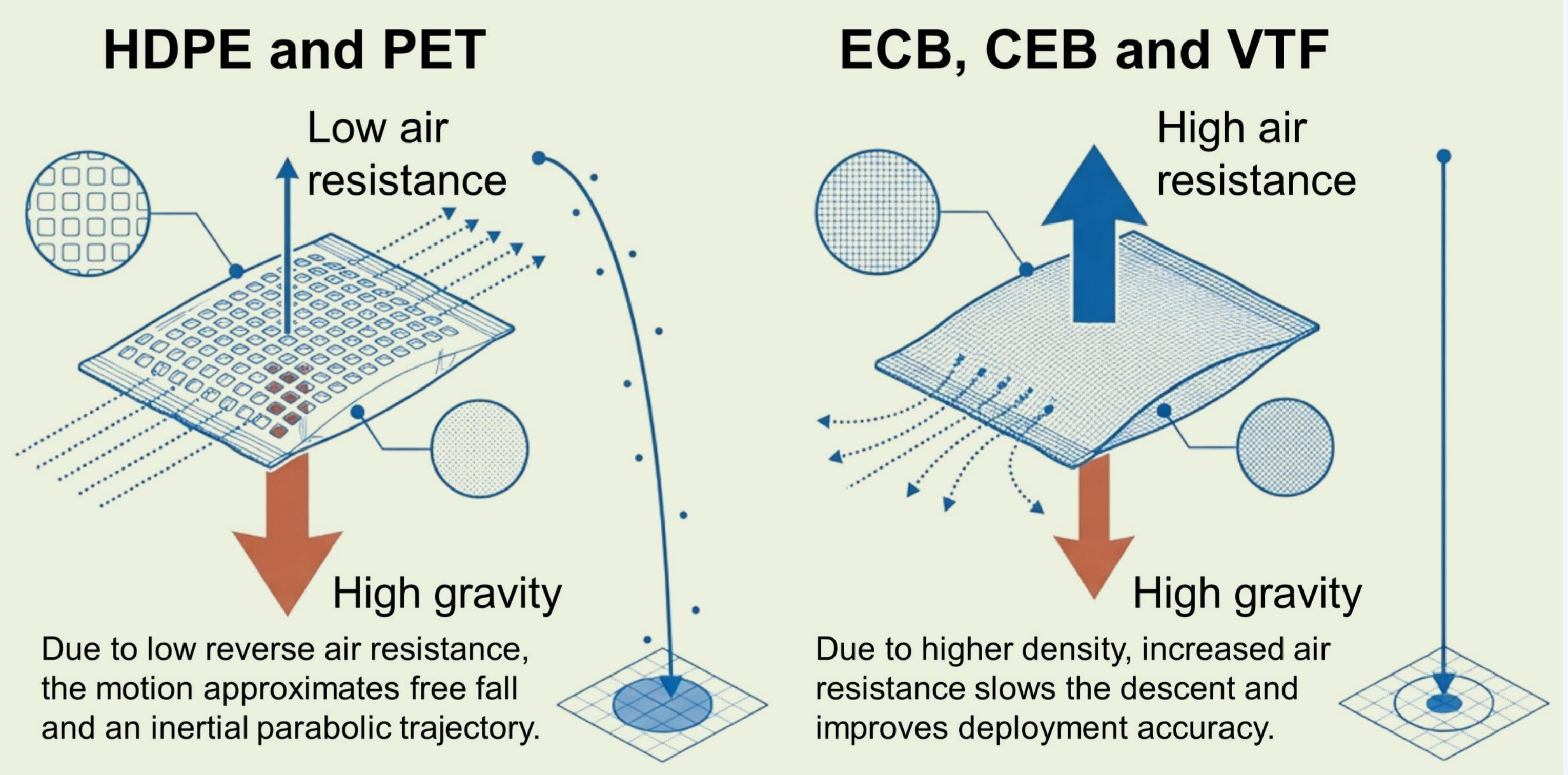


Vegetation Takino Filter (VTF)

Results and discussion

1. Drop performance

Results showed that mesh size and material significantly influenced drop velocity and dispersion. HDPE and PET with larger apertures and stiffer structures, experienced lower air resistance, resulting in faster descent and wider dispersion. ECB showed slightly reduced velocity but moderate dispersion due to higher density. In contrast, CEB and VTF exhibited high air resistance, leading to slower descent and limited dispersion.



2. Germination and growth

Under sufficient moisture, herbaceous seeds germinated around day 7, while woody seeds germinated around day 10. HDPE and PET packages allowed successful penetration and growth due to larger apertures. CEB and VTF packages supported early germination but later restricted woody plant growth. The ECB package with dense structure mainly allowed herbaceous growth.

Time-lapse Micro-cross-section	Day 7	Day 10	Day 30
Large mesh (HDPE/PET)			
Small mesh (CEB/VTF)			
Very fine mesh (ECB)			

Illustration generated with AI assistance (NotebookLM)

3. Overall evaluation

Overall, combining vegetation pellets with geomats effectively reduced downslope rolling and improved placement accuracy. Cotton-based materials (CEB, VTF) also enhanced moisture retention, benefiting plant establishment in landslide conditions. This approach shows strong potential to improve UAV-based aerial seeding, although further research on material properties and implementation techniques is required.

