

TERRACED VINEYARDS: ASSESSMENT OF THE CURRENT SITUATION IN RELATION TO CLIMATE CHANGES IN THE PRIMORSKA REGION, SLOVENIA

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ABSTRACT

The Primorska region is renowned for its diverse landscapes, natural heritage, and long-standing viticultural tradition. Vineyards cover approximately 6,300 hectares and are distributed across four wine-growing districts with distinct climatic and soil conditions. Terraced vineyards represent a dominant structural feature, accounting for nearly 80% of vineyard area in Goriška brda and around 60% in the Vipavska dolina grapevine districts. Contemporary viticulture on terraces is increasingly constrained by two major factors - the abandonment of vineyards due to high production costs and the growing impact of climate-related stresses, including drought, heatwaves, and extreme rainfall events.

This study examines the environmental conditions shaping viticulture in the region, with particular emphasis on parent material and climate. The predominant parent material, Eocene flysch, facilitates the development of eutric brown soils suitable for vine cultivation but is highly susceptible to erosion. The sub-mediterranean climate is characterized by high summer temperatures, moderately cold winters, and relatively abundant but unevenly distributed precipitation, often occurring as high-intensity rainfall. The interaction of sloping terrain, erodible flysch substrate, and intense precipitation significantly increases the risk of soil erosion, topsoil loss, and landslides, thereby threatening the long-term stability of terraced vineyards. This was exemplified by severe soil erosion and landslides in Vipavska dolina in 2023 and Goriška brda in 2025 following extreme rainfall events. Future viticultural practices will require improved drainage systems, adaptation of soil management strategies, and interdisciplinary collaboration to ensure the sustainable management and preservation of terraced vineyards.



Figures 1 in 2: Grey Marl (left) and Flysch layers composed of marl and sandstone (right)



Figures 3 and 4: Soil erosion on flysch during intense rainfall in the village of Zavino, Vipavska dolina in 2023 (Photo: Bratašev, M. Civil Protection of the Municipality of Ajdovščina)



Figures 5 and 6: Landslides in terraced vineyards and Soil erosion during extreme rainfall events in Goriška brda in 2025

HOW TO PROCEED IN THE FUTURE

- Earthworks should be carried out during dry periods, preferably in summer, to minimize soil disturbance under wet conditions.
- Immediate establishment of vegetation cover (e.g. grassing or cover crops) on terraces and embankments.
- Terraces should be designed with appropriate longitudinal and transverse gradients, and with stable embankment geometries (recommended height-to-width ratio of approximately 1:1).
- Access roads, paths, and turning areas must be sufficiently wide, stable, and constructed with appropriate slope gradients.
- Efficient drainage systems must be implemented to control surface runoff and prevent water accumulation.
- The design and dimensioning of drainage infrastructure should explicitly account for extreme precipitation events.
- Rainwater retention structures should be incorporated to reduce peak runoff and enhance water management.
- Subsurface drainage systems should be installed where necessary to intercept groundwater and manage spring discharge.
- The involvement of geologists and hydrologists in the planning and design phases will become increasingly important.