



# Morphology and causes of landslides in Portalet area (Spanish Pyrenees): Probabilistic analysis by means of numerical modelling

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## ABSTRACT

The morphology and causes of a big landslide in the Pyrenees (Northeastern Spain), reactivated by the excavation of a parkinglot on the base of the landslide area, have been analysed. Through reconnaissance and instrumentation techniques and monitoring the morphology and failure terrain of the area are defined approximately and these results are checked by numerical modelling.

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## 1. Introduction

The landslide, as a form of mass movement, is one of the principal processes of hillslope erosion [1]. The temporal distribution of slope movements is determined by the occurrence of triggering factors, such as: rainfall, rapid snowmelt, volcanic eruption, earthquakes and human activity [2].

The susceptibility of a slope to failure is dependent on many factors, including the gradient of the slope, the geotechnical properties of the material involved and the presence of discontinuities. The amount of water entering a slope, which is a function of the vegetation cover, drainage, soil type and rock structure, is also a very important factor indicating the significant linkage between geomorphological hazards and the processes and conditions in the atmosphere and hydrosphere. Human activities can also play an important role in affecting the susceptibility of a slope to failure.

Landslides are always associated with a disturbance of the equilibrium relationship that exists between stress and strength in material resting on a slope. The relationship is determined by factors, such as the height and inclination of the slope and the density, strength cohesion and friction of those materials that form the slope [3]. Instability arises when the shear strength, or maximum resistance of the material comprising the slope to shear stress, is exceeded by a downslope stress. The shear strength depends on internal cohesion, which is independent of the weight of the overlying material. This

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cohesion is produced by the interlocking of particles that enables the material to rest at an angle and by the internal friction; the resistance of particles to slide across each other, which depends on the weight of the overburden. Both are also highly dependent on material type and state, particularly with regard to the lubrication of internal spaces.

The slope angle is an essential component of slope stability analysis. As the slope angle increases, the shear stress in soil or other unconsolidated material generally increases as well. Gentle slopes are expected to have a low frequency of landslides because of the generally lower shear stresses associated with low gradients [4–7].

Clay soils, the weathering product of rock mass, contribute to landslide occurrence because of their chemical and physical properties.

The properties of clays have been investigated for their effects on landslides because clay presents problems for geotechnical engineers owing to its complex nature. This derives from its plasticity, its low permeability and thus, the time dependency of pore water pressure change and volume change, its structure, chemistry and mineralogy.

It is clear that weathering and agricultural activity alter the nature and topography of the ground surface. Adverse human activities have also contributed to the creation of landslides; these include excavation works, irregular agricultural activity, embankments and in particular, drainage works. Water is one of the most predominant factors that cause landslides, which usually occur during periods of high precipitation. Therefore, in natural slope areas, it is important to construct drainage systems for collecting water, such that movement on the slopes can be reduced.

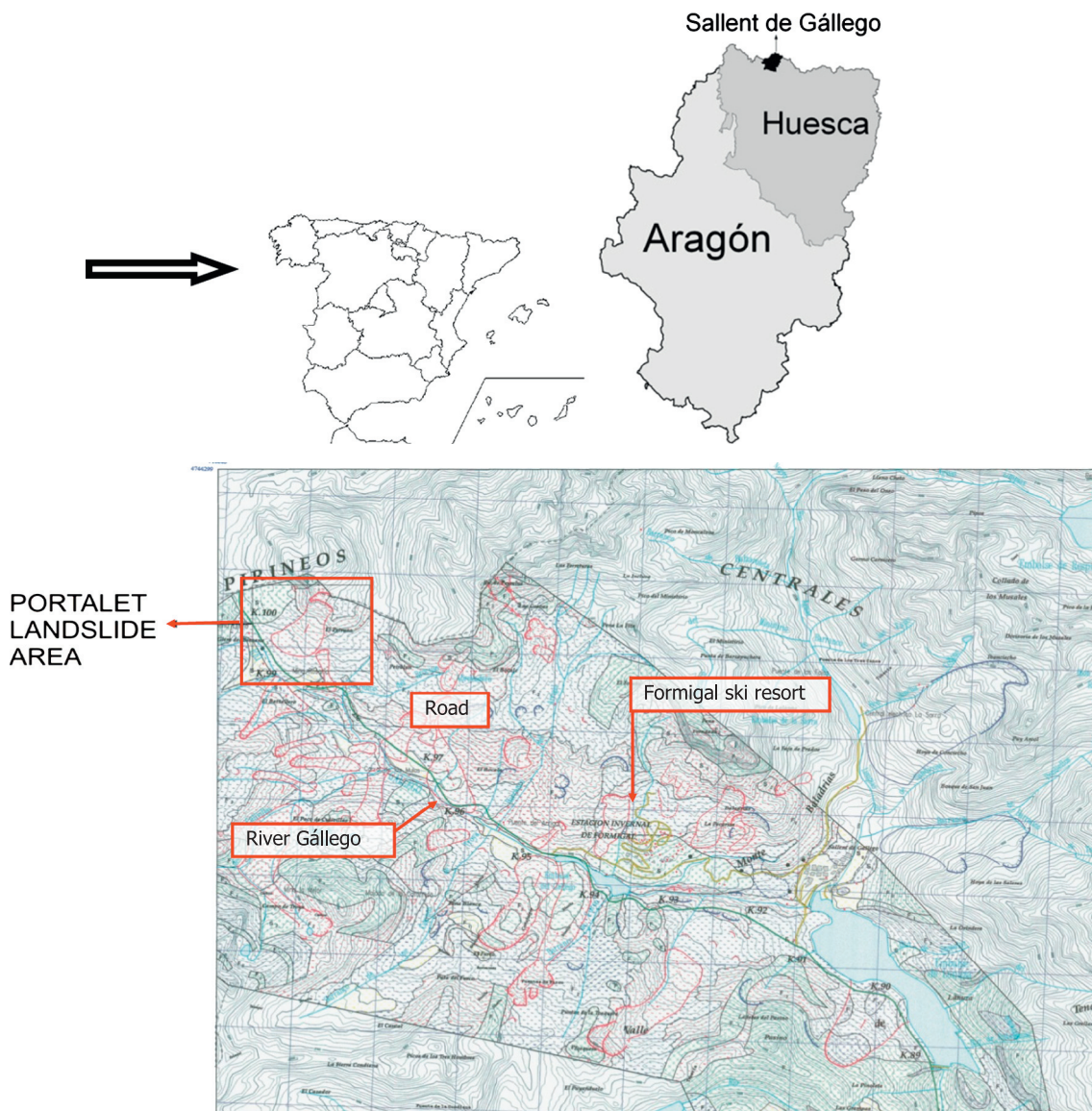


Fig. 1. Location of the area under study.

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