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Soil erosion on road and railways embankments in the Canyoles river Basin. Eastern Spain.

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Mediterranean landscapes are man-made. Its human ecosystems are characterized by a high population density, a long history of human settlement and an intense exchange of goods and people (Cerdà et al., 2010). This was possible due to a dense road network, most of it created during the Roman Empire. Modern roads and railways increased drastically during the last 30 years in the Mediterranean. Spain is a clear example of the acceleration of the road and railway infrastructures (Bel, 2005), especially during the 1960s as the tourism started to become a big issue in this part of the World. The increase in road and railways during the last 30 years resulted in a new transport system in Spain, which is based on high-speed railways and motorways. The characteristic of these infrastructures is that they were built by means of embankments, and little is now about the erosional response of those embankments to rainfall. The objective of this research is to assess the soil losses measured in road and railway embankments.

The Canyoles River watershed was selected as an example of a region with a dense and recently developed modern network of roads, motorways and railway. The Canyoles river watershed is the natural path between the Mediterranean coast and Central Spain, the capital of the country and the touristic regions. Two motorways and two railways were built or re-built during the last two years and this paper assesses their impact on soil and water losses. As soil erosion rates are dependent on the high intensity – low frequency rainfall events, rainfall simulation experiments (40 experiments) were conducted (1 m2 plots; 60 minutes duration; 78 mm h-1 intensity) were carried out over plots on 2 railway (n=10 + 10) and motorway (n=10 + 10) research sites in August 2011, under very dry conditions. Soil moisture was below 5 % in the top 2 cm soil layer.

The vegetation cover was very low in the two road and two railway embankments as the average cover was 4.2 % ranging from 1 to 7 %. Time to ponding was 135.8 seconds, ranging from 131.1 and 158.7 seconds within four road embankments. Time to runoff was also very quick, with 367 seconds, ranging from 326.9 to 376.9 seconds after the start of the rain. The runoff outlet was reached after 402.08 seconds, ranging from 367.1 to 428.5 seconds. Runoff was 56.25 % of the rainfall, ranging from 54.93 % in the Road1 embankments to 57.08 % on the Railway1 embamkments. Sediment concentration was 41.41 g l-1 in average for the 40 rainfall simulation experiments and ranged from 40.20 to 42.54 g l-1.

After 78 mm h-1 (156 liters on the 2m2 plots) of simulated rainfall during one hour, the total runoff collected was 87.75 %, with a very low variability within the four studied embankments an the 40 research plots (9 % variation coefficient).

The sediment yield collected during the 25-year return period experiments resulted in 3.67 Kg in average values with again a low spatial variability (18 % variation coefficient). The soil erosion registered in the four-studied road and railway embankments reached a value of 18.25 Mg ha-1 h-1.

The results shown above demonstrate that the water and soil losses in the road embankments under intense thunderstorms are very high, which is a general trend in Mediterranean ecosystems due to the climatologically conditions and the lack of restoration and rehabilitation strategies (Cerdà, 2007). The comparison with other research under different land uses show that the soil losses are very high on the road embankments due to the impact of the slope and the bare soil (Bakr et al., 2012) and show higher erosion rates than the unpaved forest roads (Jordán and Martínez Zavala, 2008). Scrublands, meadows, forest, and agriculture land in general show much lower soil losses at the study area (García Orenes et al., 2009). This is why most of the current research is developing strategies to control the soil and water losses (Persyn et al., 2004: Xu et al., 2006; de Oñae et al., 2009).

This paper concludes that the soil erosion on road and railways are not sustainable and they are the highest soil losses measured in the study area. Road embankments are triggering land degradation and Desertification processes as less water is available for the soil processes and more soil is lost.

Keywords: Road, Railway, Embankments, Erosion, Runoff.

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