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Erosion measurements at various scales in a semi arid mountainous catchment - case of the Rheraya watershed, High Atlas, Morocco

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Erosion is a critical phenomenon in North Africa, under the combined effects of aggressive rainfall and soil fragility, increased by the grazing pressure on rangelands. However measurements of actual erosion rates are rare, especially in mountainous areas. Siltation of dams is estimated at more than 60 million m^3 annually in Morocco, which corresponds to a decrease of 0.5% of the storage capacity. The Rheraya watershed (225 km^2) is located in a semi-arid climat, in the High Atlas of Morocco. In order to assess erosion processes at various scales, three types of measurements were achieved on this area, namely rainfall simulation tests one square meter, erosion plots on 150 m^2, and catchment's discharge and associated sediments measurements.

Rainfall simulation experiments were achieved on 27 sites, measuring runoff and sediment charge. The turbidity was correctly measured thanks to the development of a new runoff collector which doesn't disturb the soil. In the scope of spatial extrapolation, we searched for indicators obtained from ground description variables and/or by laboratory tests on soil samples, which were well correlated with infiltration and turbidity of the simulations. For the various soils present in the study area, the results show a large variability of infiltration (from 1 to 70 mm h^{-1}) and turbidity (from 3 to 325 $g.l^{-1}$). Analysis showed that infiltration is correlated mainly with texture and soil surface opening, and that turbidity is related to the surface of bare soil exposed to runoff.

Six erosion plots of about 150 m^2, located on various soil and land cover conditions, were measured during four years. The observations showed very rare runoff events in the main part of the watershed, producing a low sediment load (between 0.015 and 2.5 $t.ha^1.year^1$). Conversely, runoff was much more frequent on silty badlands, producing about 95% of the watershed sediment (350 $t.ha^{-1}.year^{-1}$) despite their area was only 1% of the watershed. There was a significant linear relation between simulation turbidity and erosion plot turbidity. However, there was a great difference between infiltration estimates from the two types of measurements. Plot infiltrations estimates were only between 3 and 5 mm/h, but they were significantly correlated to the one from test, through an exponential relation.

Finally, an estimate of the overall erosion at catchment's scale was achieved from plots values extrapolated using a soil map, and gave about 3 to 4 $t.ha^{-1}.year^{-1}$. A good correlation was found between this watershed scale estimate and the catchment's exportation, indirectly validating the significance of both measurements. Moreover, both estimates were about the same, showing a sediment delivery ratio around one.

Keywords: erosion, rainfall simulation, erosion plot, sediment exportation