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Land cover change and fast soil degradation in the East African Rift Valley, Kenya

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The Kerio Valley (Elgeyo-Marakwet and Baringo county, Kenya) is part of the East African Rift Valley system; it is characterized by steep slopes and a large elevation gradient between the plateau and the valley floor. The study area is the Kimwarer river basin, between 2838 and 1202 m a.s.l.. The summit plateau is above 2500-2700 m a.s.sl., characterized by rolling hills and a cool/humid climate; potential vegetation is montane rainforest; most of it has been transformed into corn, tea and hay fields. Below the plateau, the Elgeyo Escarpment is steep and dissected by V-shaped valleys and active/inactive landslide scars, descending to 1300-1400 m a.s.l.. The potential vegetation is montane rainforest above ~2000 m, deciduous Acacia woods/shrublands below. Cultivations are increasingly substituting forests even in the steepest slopes. The Kerio Valley floor includes floodplains and low-steepness alluvial fans; the potential Acacia savannah has been mostly substituted by corn crops, later abandoned because of extreme soil erosion, resulting in a semi-desert habitat.

The soil types follow elevation and topography: organic carbon-rich Ferralsols are common on the high plateau, stony Umbrisols, Cambisols, Phaeozems are common in the high slopes of the escarpment, while Kastanozems are common in the low slopes; shallow remnants of Plinthosols and Vertisols are common in the valley floor.

Land-use change in the Kerio Valley floor happened during the ‘80s, when local people moved from pastoralism to agriculture; original Acacia savannah was disrupted by ploughing to permit cropping during the rainy seasons. Soil maps performed during that period describe soils as Ferralsols, with rooting depth limitations by lateritic crusts below 1-2 m. At present, the lateritic crust outcrops over large surfaces, and 2-5 m deep, 10-20 m large gullies cover >50% of the surface. The cultivations are thus being abandoned. The soil loss might be estimated conservatively ~100 t/ha/y; this is an extremely high value considering the almost flat surface. The average soil loss calculated by an adapted RUSLE method is 51 t/ha/y; there is an important underestimation by the model.

The erosion is much weaker in the upland Ferralsols, where soil is protected by high organic matter content and by the high productivity of the vegetation, helped by the absence of a truly dry season and the smaller evapotranspiration.

On the slopes of the escarpment, deforestation happened mostly after 2010, as visible from aerial photos. Umbrisols with thick A horizons are dominant under natural vegetation, but are not observed in deforested areas, evidencing a fast loss of the 30-50 cm A horizon (>320 t/ha/y). Deeper, less resistant horizons are exposed, and rills, gullies and mudflows develop after most rainstorms, with variations depending on soil type. The RUSLE model predicts average losses ~350 t/ha/y, with much higher values on the steep slopes.

The rainfall erosivity-R factor is high in tropical areas, and a preservation of a vegetation cover is necessary to impede a complete soil loss in just a few years. It is also extremely important to preserve the surface, organic-matter rich soil horizons, influencing soil erodibility-K factor.