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Modeling soil erosion and deposition utilizing remote sensing and GIS in the Tlata river basin, Morocco

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Four Landsat and Spot images were analyzed for a fifteen year period (1987, 1994, 2000, 2002) to determine the land cover and land use changes as well as the spatial patterns of erosion and deposition over this time period. Analysis of these satellite data identified six main land types (highly degraded lands, cereal (annual) crops fields, mixed farmlands, olive trees, reforested areas, and natural protected forest) in the 123 km^2 Tlata catchment of northeastern Morocco. After the determination of the areal distribution of each land type for each date, the soil losses were estimated through the incorporation of a developed RUSLE (Revised Universal Soil Loss Equation) module in a GIS framework. These static areal estimates of soil loss were then utilized in a newly developed sedimentation algorithm that models the down slope movement of the soil loss. These spatial (flow) movements were then evaluated to determine net erosion and deposition within the river basin for each time period.

Results of the land use-cover change analyses indicate that the badly degraded abandoned lands increased in areal extent in each time period; areas under cereal crops decreased in each time period; lands under olive cultivation generally increased; reforested areas, lands that have degraded too much for farming increased; mixed farmlands—comprised of cereal and tree crops show an increasing trend over the 15 year period; and finally areas of natural protected forest remained stable. The patterns of soil loss and deposition over the duration of the study period show a relation to both the changing land cover and the land facets found within the river basin. Soil loss remains high ($>$26 Mg $ha^{-1}yr^{-1}$) in all badly degraded areas throughout the whole time period; areas of cereal production located on hillslopes have moderate soil losses. This dynamic has been and is a harbinger of land use change—specifically

from cultivated to non-cultivated. However, flood plain areas under cereal cultivation experience net deposition and are sustainable. The same pattern holds true for areas of mixed farmlands. Olive cultivation areas overall are neither areas of deposition or erosion. Reforestation areas overall are areas of deposition, their areal expansion over the study period decreases soil losses and represents a reclamation strategy albeit one of slow recovery. The remote sensing and GIS analyses undertaken in this study presents an approach for assessing the spatial and temporal patterns of soil loss and deposition within the context of a stream basin or other valid investigation units experiencing land use-cover changes.