Geophysical Research Abstracts
Vol. 12, EGU2010-12968, 2010
EGU General Assembly 2010

Quantifying nutrient export and deposition with a dynamic landscape evolution model for the lake Bolsena watershed, Italy

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Excessive nutrient loads from upstream watershed activities such as agriculture, hydrological modifications, and urban runoff, have been identified as the leading cause of deterioration in assessed lakes and reservoirs (USEPA, 2000; Leone et al., 2001; Leone et al., 2003). Excessive nutrient transport into lakes and reservoirs may accelerate eutrophication rates, causing negative impacts on aesthetic and water quality. As reservoirs become eutrophic, they are depleted in oxygen and enriched in suspended solids, with heavy consequences for ecosystems and natural habitats.

Management of nutrient loads into reservoirs requires knowledge of nutrient transport and delivery from the watershed-stream system (Ripa, 2003). Managing uncultivated lands in watersheds may be a cost effective way to improve water quality in agricultural landscapes, and recent advances in landscape ecology highlight important relationships between the structural configuration of these lands and nutrient redistribution (e.g., Forman 1987; Barrett and others 1990). Many studies have been carried out to underline and explain how landscape characteristics and structure may affect these processes. In these studies, relations between land cover and nutrient storage were analyzed using geographic information systems (GIS) (e.g. Lucas, 2002).

Nutrients are generally transported from the landscape into streams during runoff events; however, they may also enter stream flow from other sources such as groundwater recharge and point source effluent discharges (Lucas, 2002; Nielsen, 2007; Waldron, 2008; Castillo, 2009). Water moves nutrients and delivers them to downstream water bodies such as lakes and reservoirs so that erosion phenomena play an essential role in determining nutrients fluxes and deposition.

On the one hand, several hydrological models take into account nutrients reactions, movements and deposition - coupling soil erosion processes with transport equations (Bartley, 2004; Lű, 2010). On the other hand, recent researches have been improving landscape evolution simulation models..

One such model, LAPSUS (LandscApe ProcesS modelling at mUlti-dimensions and Scales, Schoorl et al.,2002; Temme et al., 2009) has been applied to the Lake Bolsena watershed in Lazio, Italy. LAPSUS takes into account erosion as a naturally occurring process in landscape evolution and shapes landscapes by both erosion and deposition allowing interactions at different spatial and temporal resolutions and extents. An integrated approach to quantify nutrient export and deposition at catchment scale is presented and discussed here coupling such a dynamic landscape evolution model (LAPSUS) with the characteristic transport equations for nutrients.