22. The sediment budget of May Zeg-zeg catchment and its components

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An overall approach to assess the effectiveness of soil conservation measures at catchment scale is the comparison of sediment budgets before and after implementation of a catchment management programme. In the May Zeg-zeg catchment (187 ha – Fig. 1) in Tigray, north Ethiopia, integrated catchment management has been implemented since 2004: **stone bunds** were built in the whole catchment (Fig. 2), vegetation was allowed to regrow on steep slopes and other marginal land (**exclosures**), stubble grazing abandoned, and **check dams** built in gullies (Fig. 3; Fig. 4). Land use and management were mapped and analysed for the situation before (2000) and after catchment management (2006) (Fig. 5; Fig 6), whereby attention was also given to the quantification of changes in soil loss due to the abandonment of stubble grazing (Table 1). Sediment yield was also **measured at the catchment's outlet**. A combination of decreased soil loss (from 14.3 t ha^{-1} y^{-1} in 2000 to 9.0 t ha^{-1} y^{-1} in 2006) and increased sediment deposition (from 5.8 to 7.1 t ha^{-1} y^{-1}) has led to strongly decreased sediment yield (from 8.5 to 1.9 t ha^{-1} y^{-1}) and sediment delivery ratio (from 0.6 to 0.21). This diachronic comparison of sediment budgets (Fig. 7; Fig. 8) revealed that integrated catchment management is most effective and efficient and is the advisable and desirable way to combat land degradation in Tigray and other tropical mountains.

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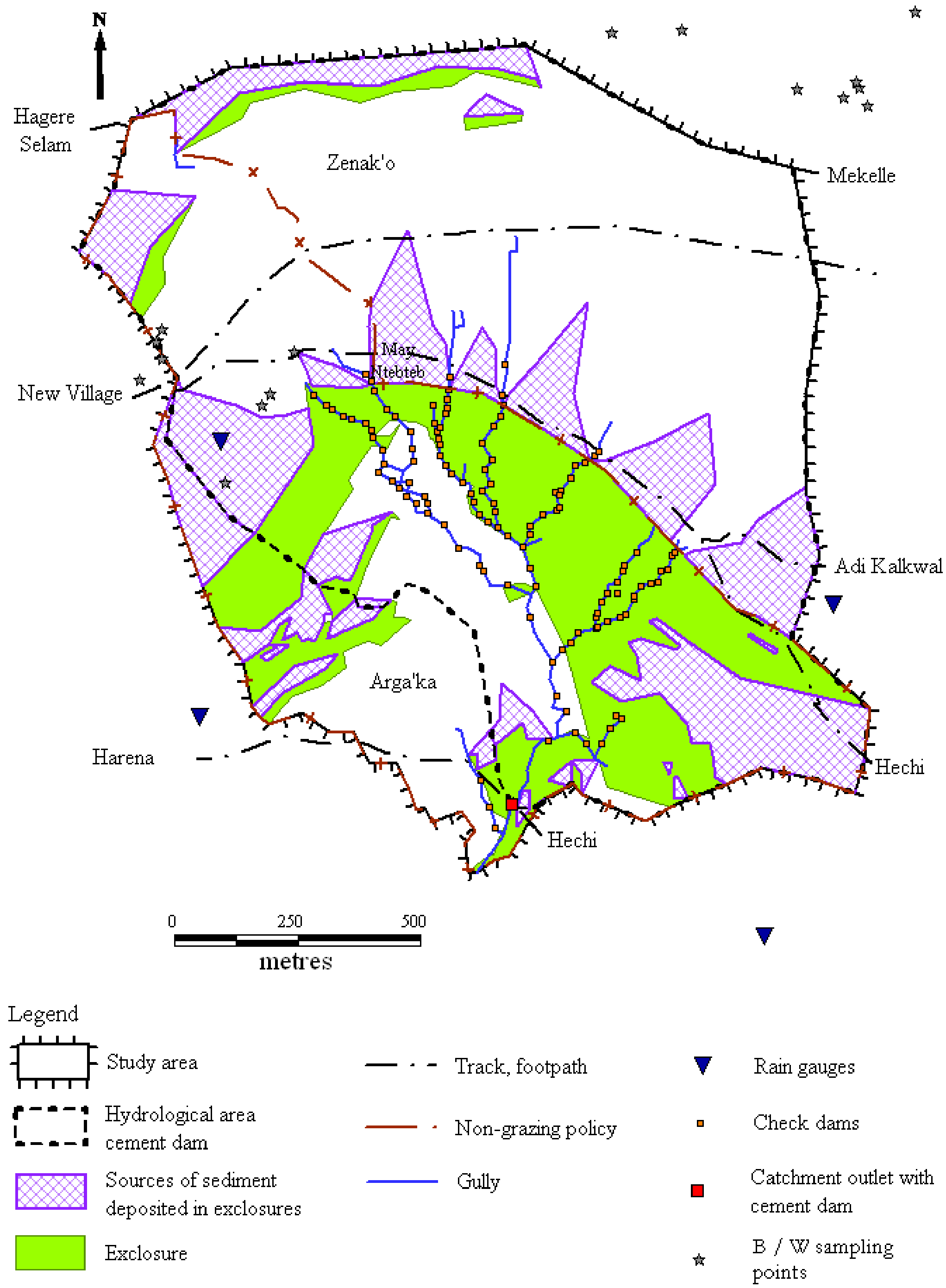


Figure 1. May Zeg-zeg catchment with location of SWC techniques (in 2006) as well as research instrumentation. BW stands for above-ground biomass.

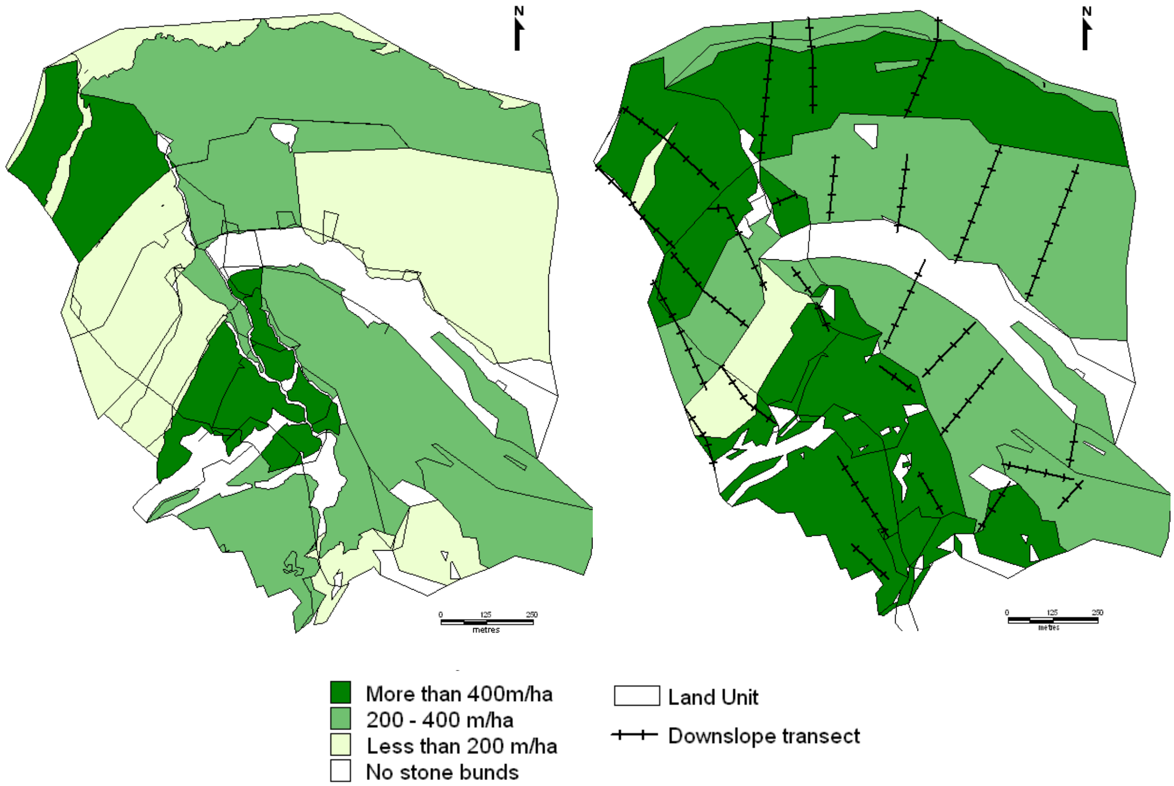
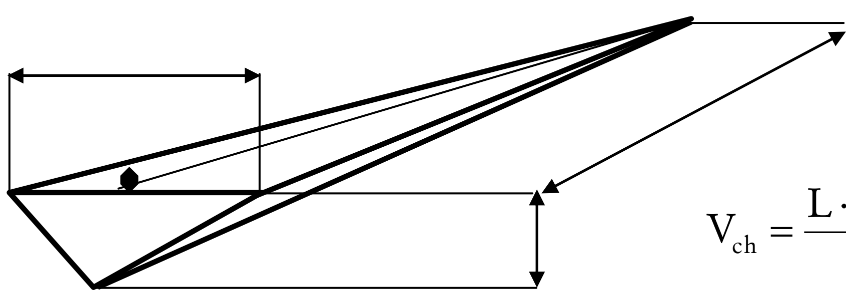


Figure 2. Stone bund densities in 2000 (left) and 2006 (right). Position of the 2006 downslope transects for measurement of stone bund density is indicated.



$$V_{ch} = \frac{L \cdot W \cdot D}{6}$$

Figure 3. Schematic representation (perspective) of the most common shape of sediment deposition behind check dams in a gully: black dot represents the deepest point, depth (D, m), length (L, m) and width (W, m)

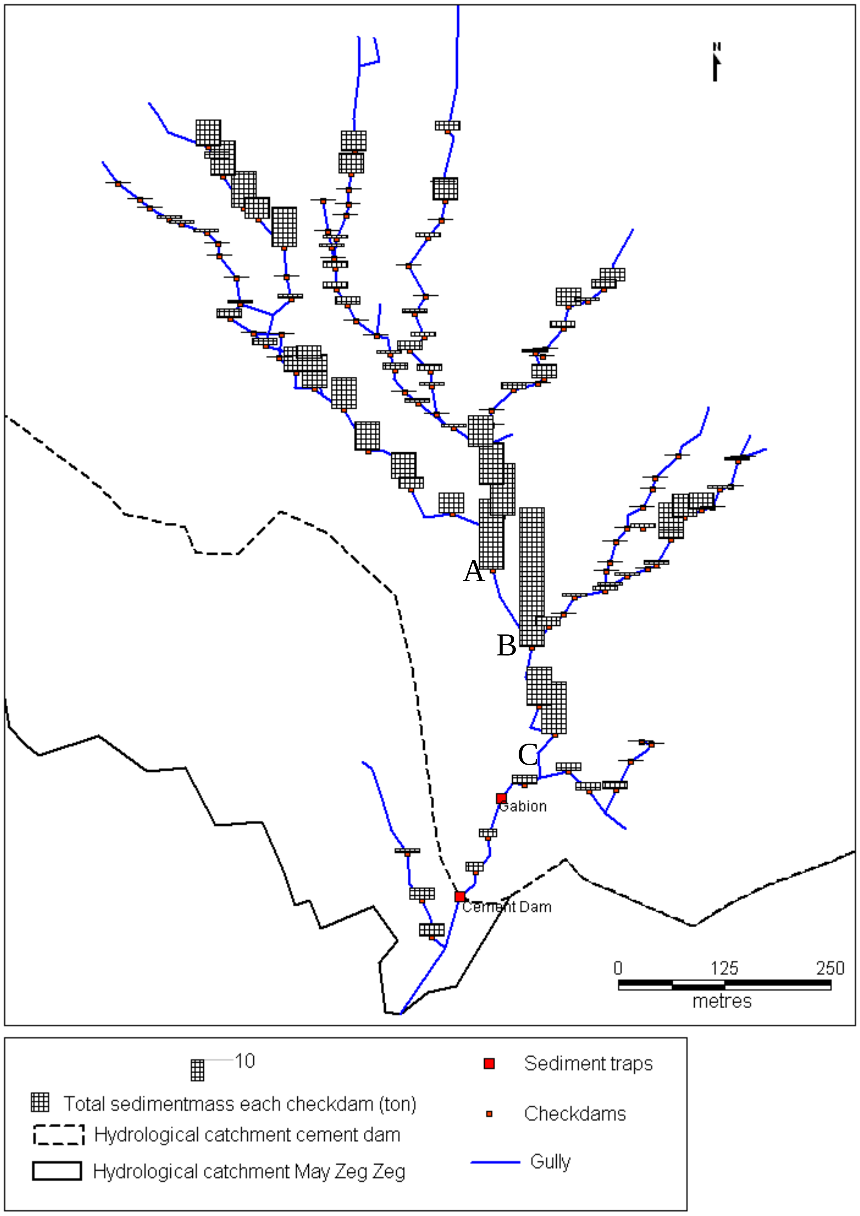


Figure 4. Measured sediment deposition (t) behind check dams in May Zeg-zeg; A, B and C are junctions in the gully system. See Figure 1 for location in the catchment of the gully system with check dams.

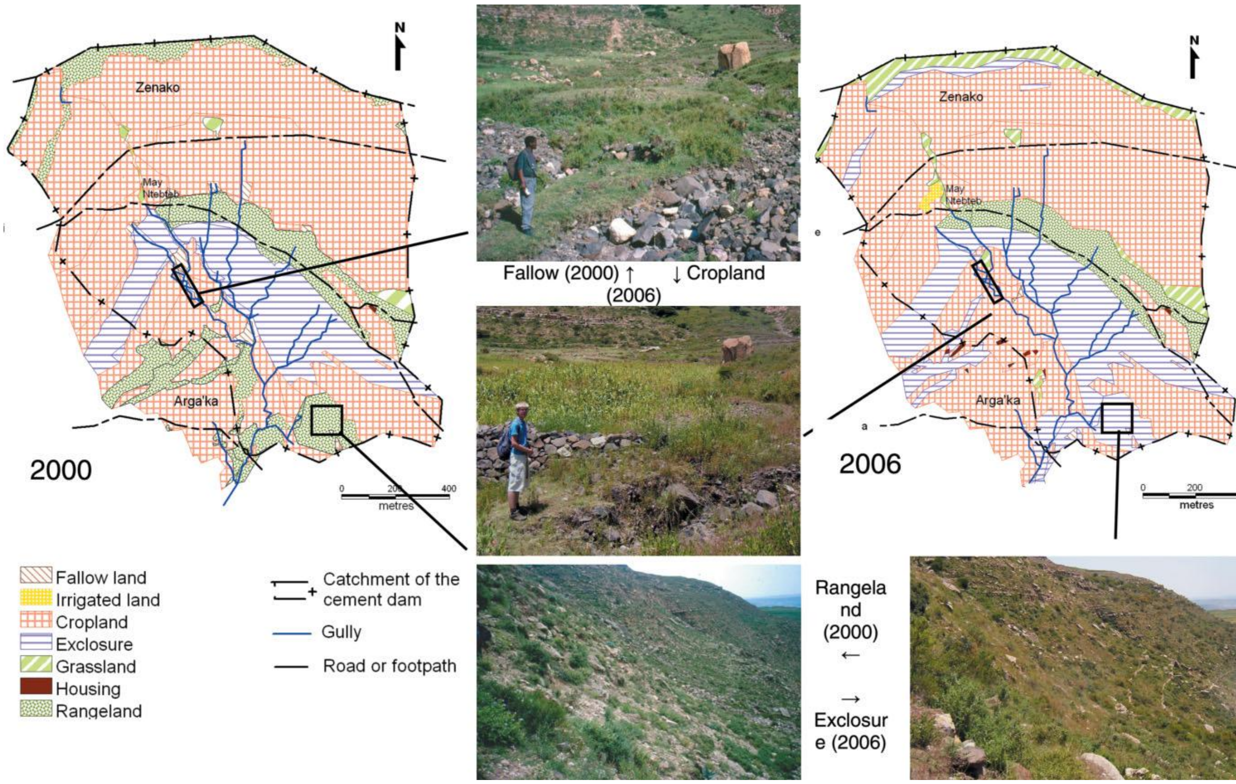


Figure 5. Land use maps of MZZ catchment in 2000 and 2006 with photographs of typical land uses in both years.

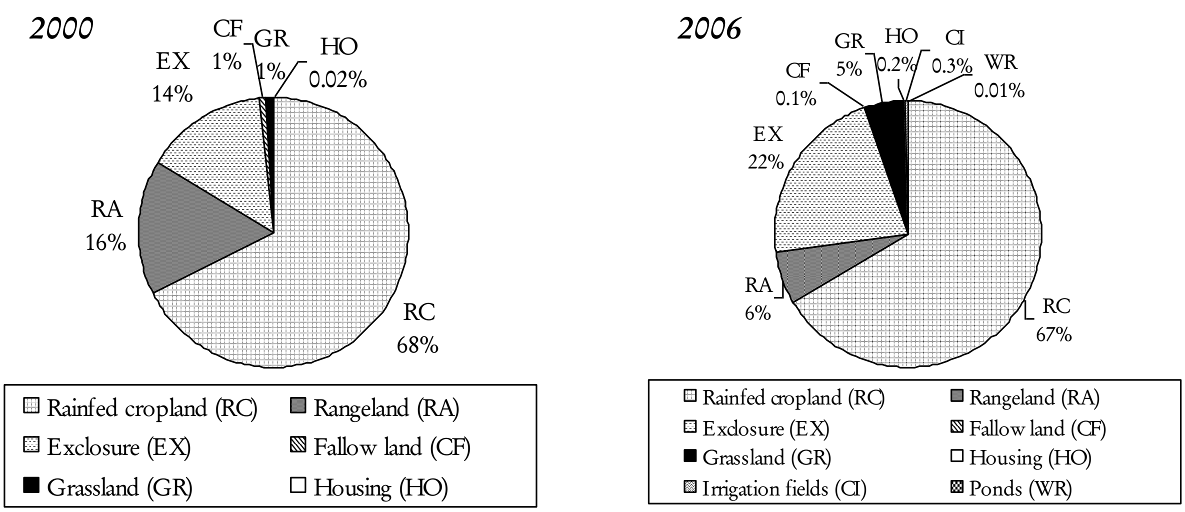


Figure 6. Relative areas of land use types in 2000 and 2006.

Table 1. Measured mean soil loss rates by sheet and rill erosion (t ha-1 y-1) for each land use category in the MZZ catchment.

Land-use category	Average yearly soil loss rate ($t\ ha^{-1}\ y^{-1}$)
Cropland[a]/free grazing[b]	9·9
Cropland[a]/non-grazing[c]	7·9
Exclosures	3·5
Grassland[d]	0·7
Housing[e]	0
Rangeland	17·4

[a] As temporary fallow land concerned only 1% of the catchment in 2000 and 0·1% in 2006, it has been incorporated in cropland for sediment budget calculations.
[b] On all cropland in 2000, and on part of the cropland in 2006.
[c] Assessed in this study.
[d] Value established in exclosures with continuous grass cover and 30% shrub cover.
[e] Farms and housing compound areas were measured around the outer stone fence: sediment produced within the compounds is assumed to be deposited also within that stone wall.

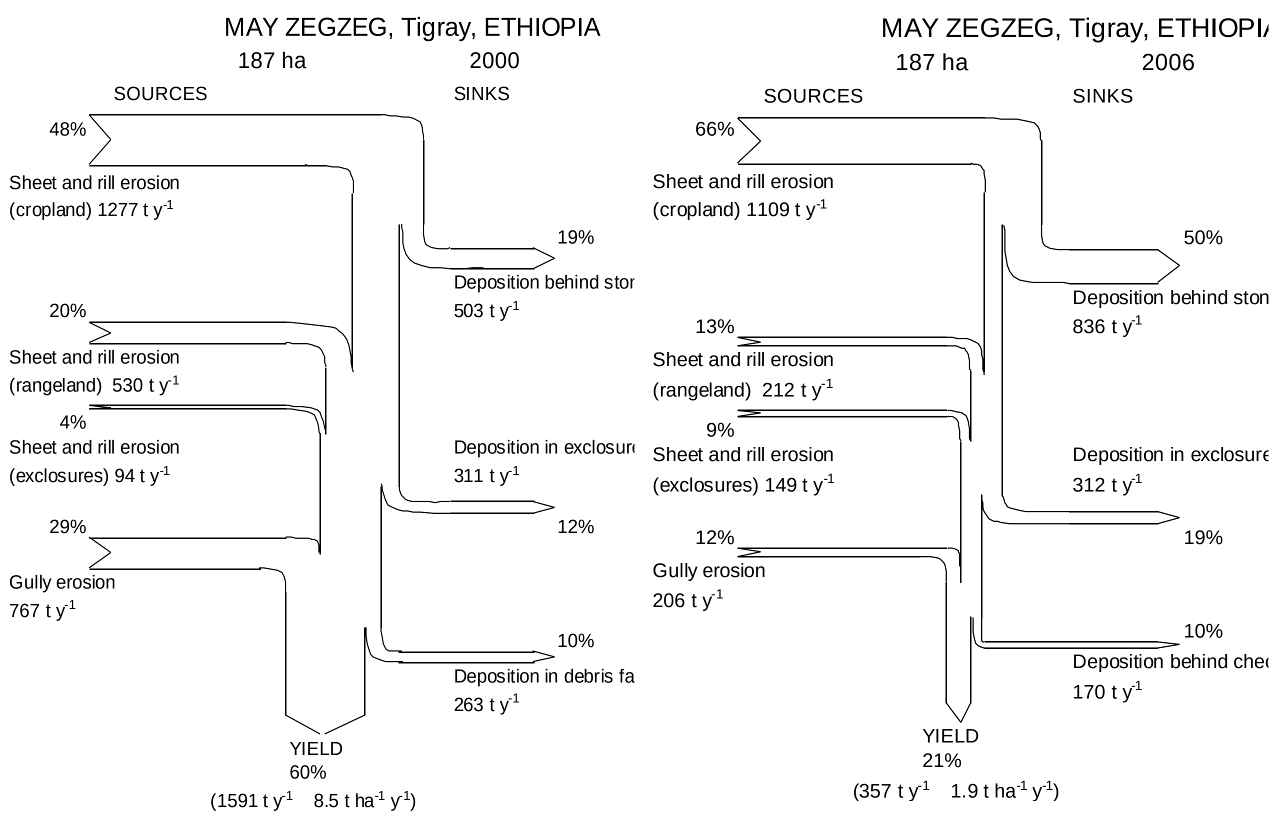


Figure 7. Sediment budgets for MZZ catchment in 2000 (left) and 2006 (right) with computation of sediment sources and sinks. Width of arrows is proportional to sediment masses involved.

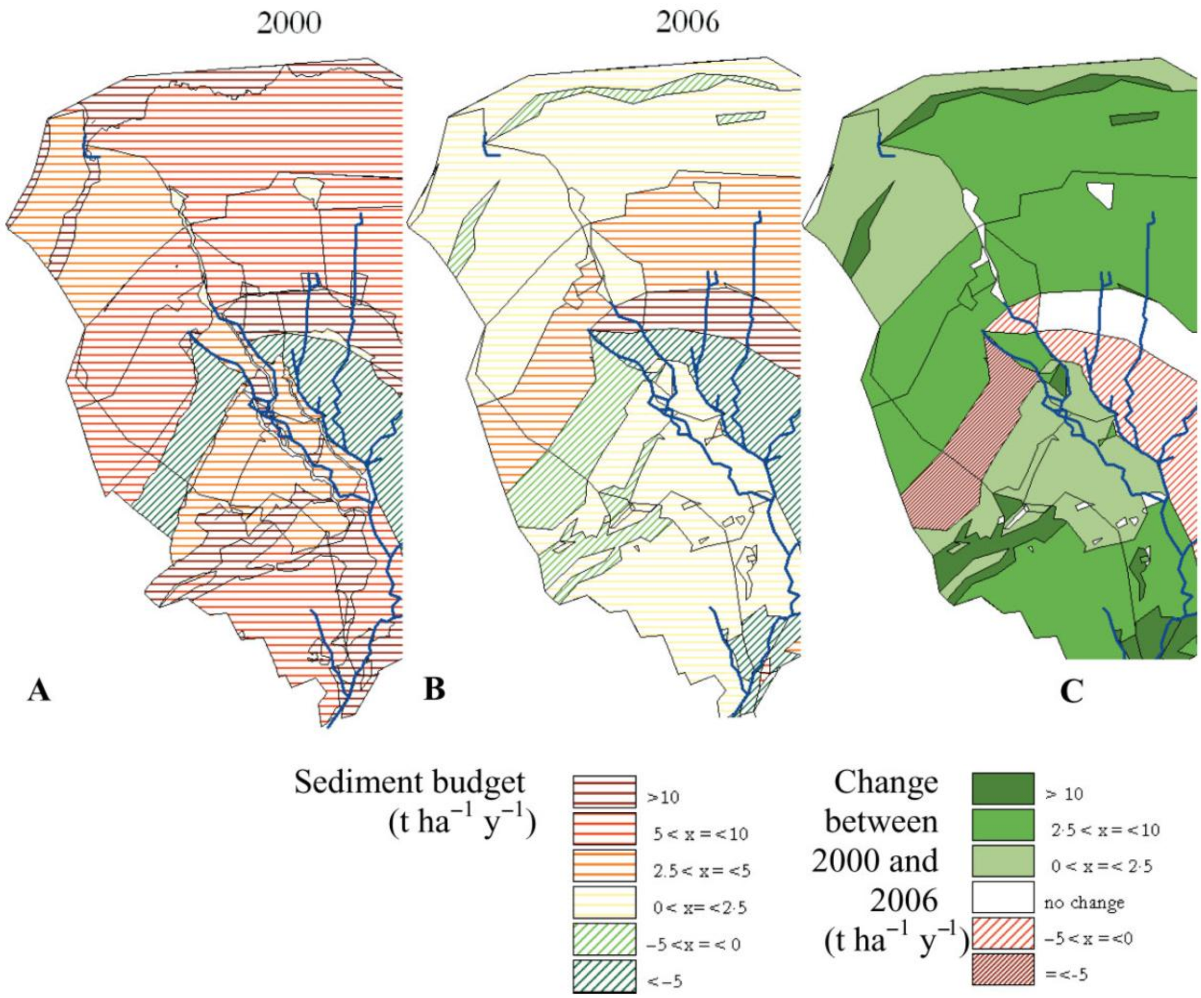


Figure 8. Sediment budget (sediment production minus sediment deposition = sediment yield) (t ha-1 y-1) for each land unit in 2000 (A) and 2006 (B). Sediment delivery areas (sources) are positive (red) and sediment deposition areas (sinks) are negative (green). (C): changes between 2000 and 2006 with improvements (green) and declines (red), related to decreased sediment input. Gully erosion and deposition behind check dams are not represented.