Sediment connectivity assessment through a geomorphometric approach: a review of recent applications

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EGU General Assembly 2022

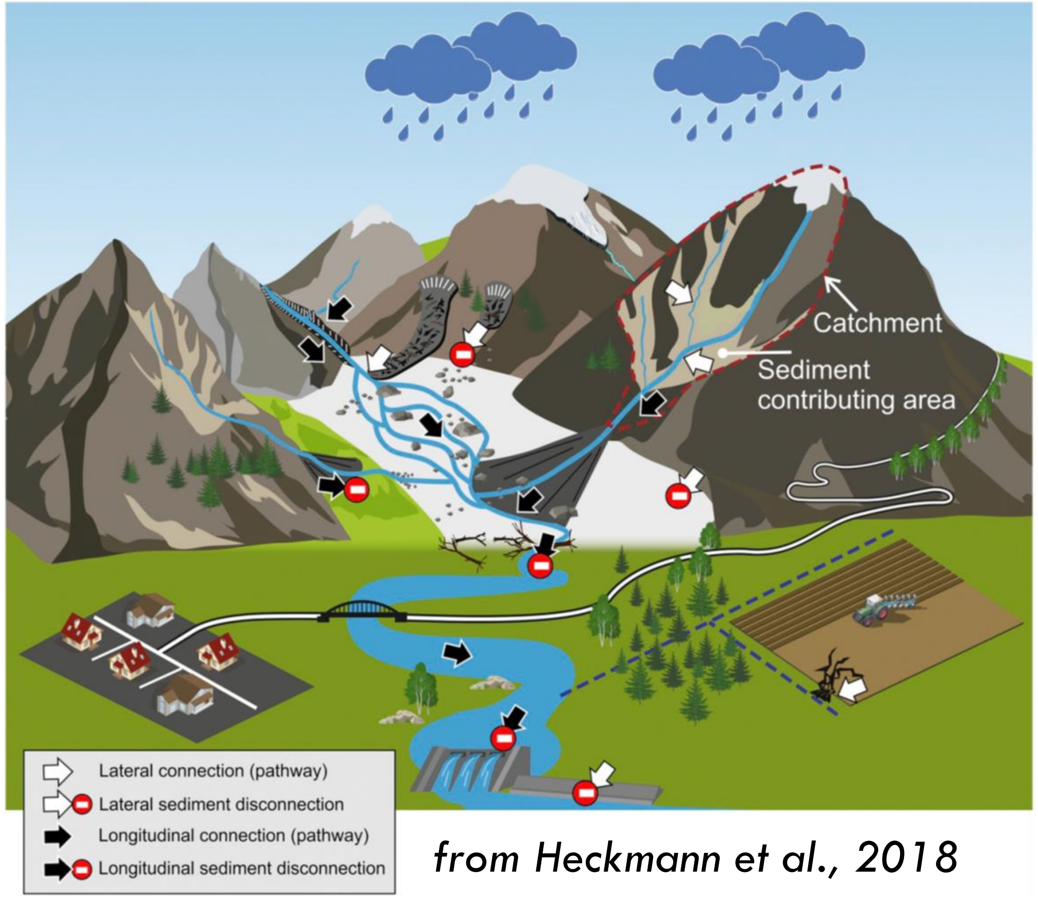
Sediment connectivity

Hydrological and sediment connectivity: the degree to which a system facilitates the transfer of water and sediment through itself, through coupling relationships between its components (Heckmann et al., 2018).

- *Structural connectivity*
- *Functional connectivity*

Coupling

Decoupling



from Heckmann et al., 2018

Index of sediment connectivity

The connectivity index (IC) is computed using two components:

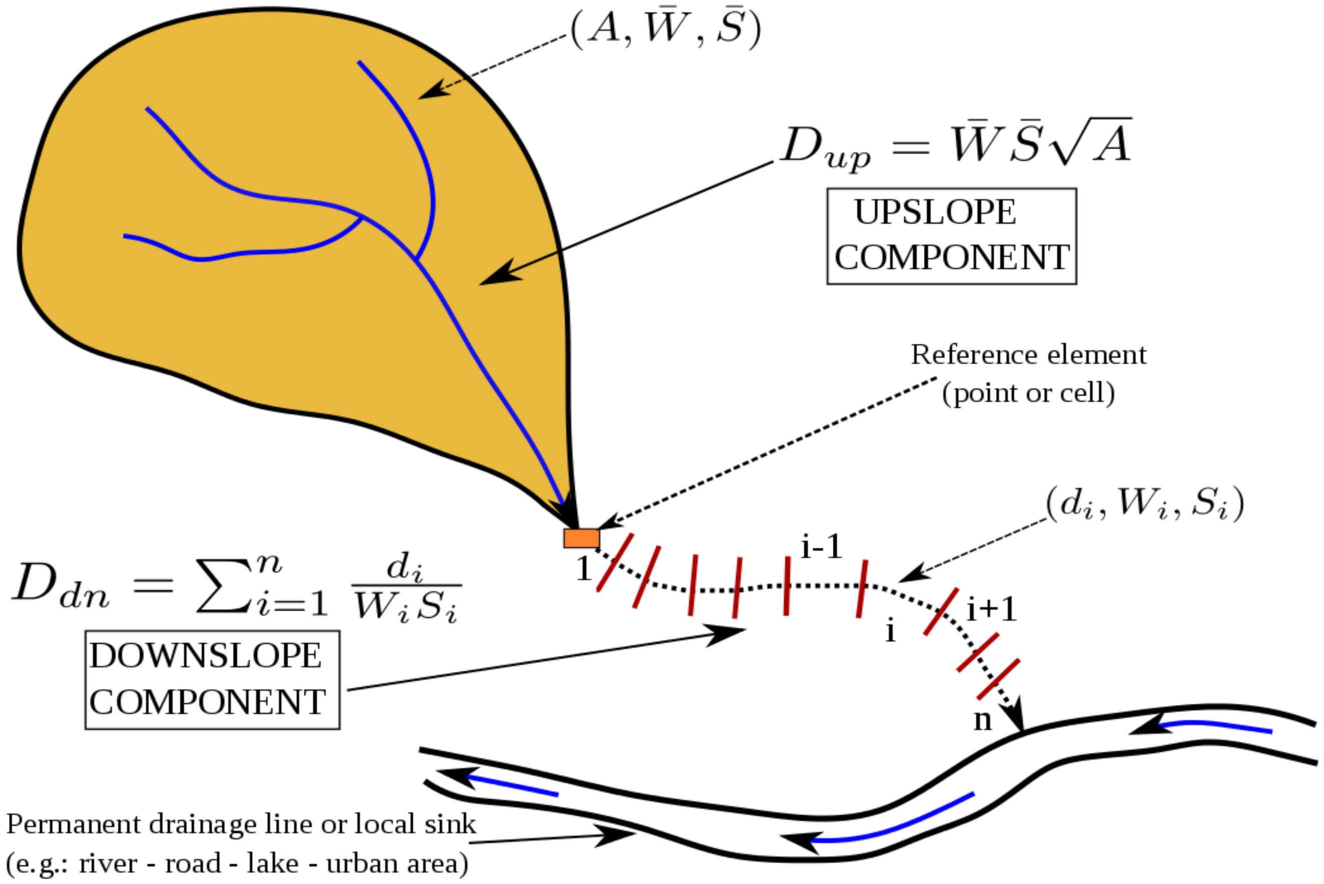
Upslope component D_{up}

potential for downward routing due to upslope area, mean slope and impedance factor.

Downslope component D_{dn}

flow path length that a particle has to travel to arrive to the nearest target or sink.

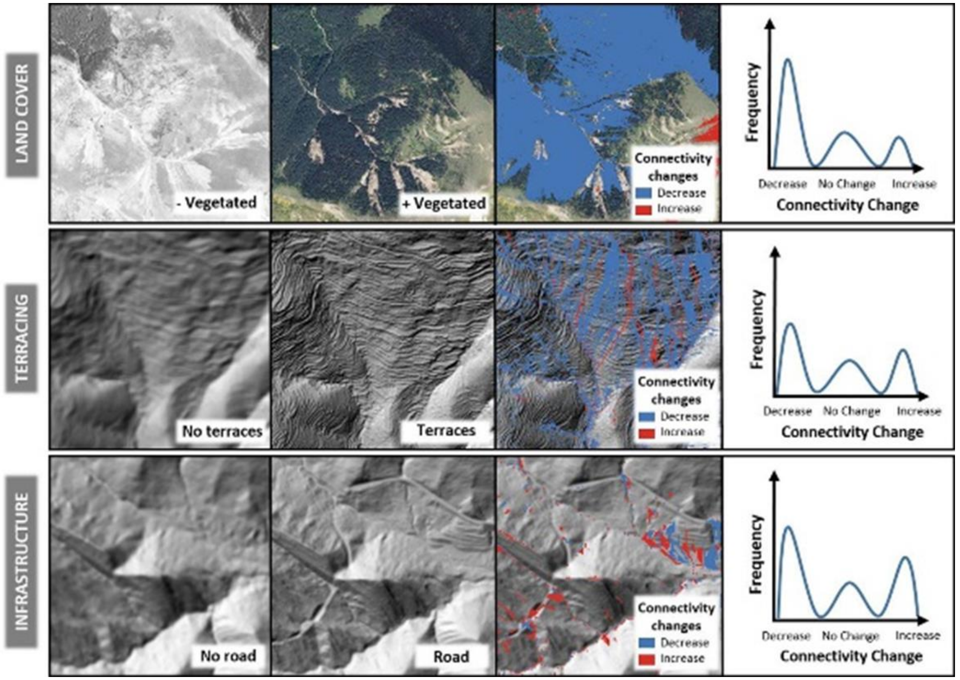
$$IC = log_{10}\left(\frac{D_{up}}{D_{dn}}\right)$$



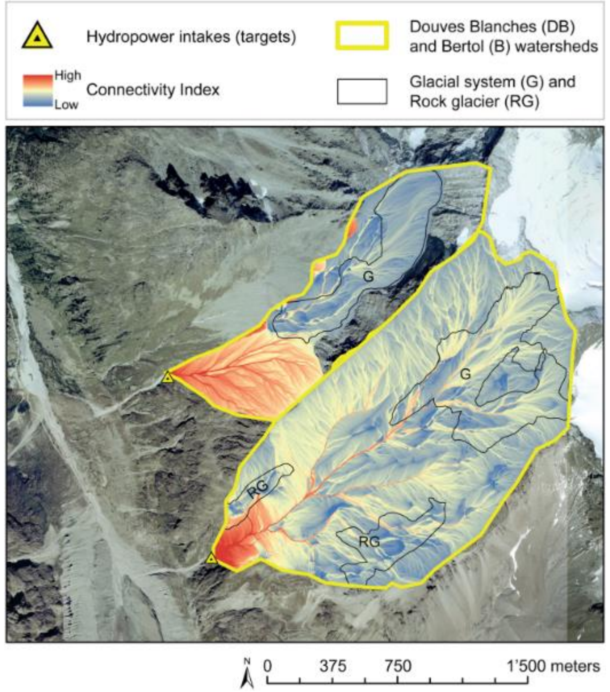
Borselli et al., 2008; Cavalli et al., 2013

Overview on main applications

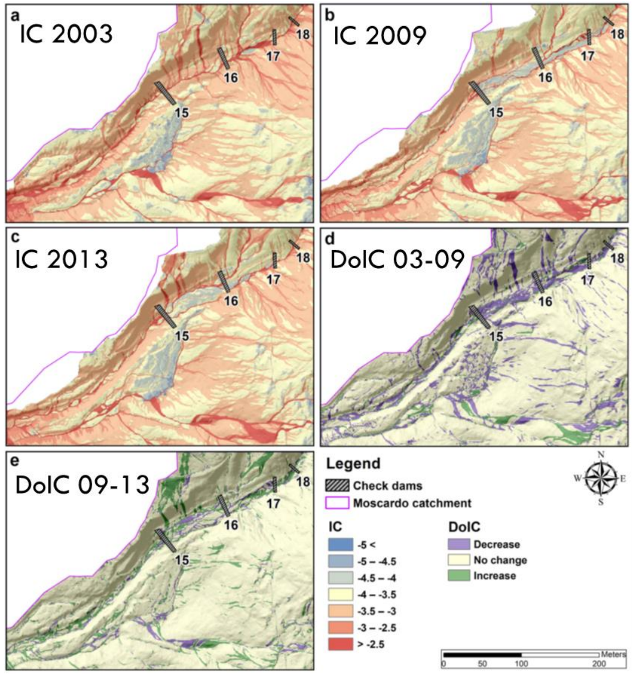
- IC to estimate hillslope sediment delivery ratio, prioritize sediment sources or to assess sediment supply (Vigiak et al., 2012; Tiranti et al., 2016; Surian et al., 2016; Persichillo et al., 2018);
- IC to comprehend the role of land use and topographic changes on sediment dynamics (Foerster et al, 2014; López-Vicente et al., 2017; Cucchiaro et al., 2019; Llena et al., 2019);
- IC as a key to understand the effect of human and natural disturbances (Evrard et al., 2013; Pellegrini et al., 2021)
- IC to study proglacial (Micheletti and Lane, 2016; Cavalli et al., 2019) and volcanic areas (Ortíz-Rodríguez et al., 2017; Martini et al., 2019) and their future evolution.



Llena et al., 2019

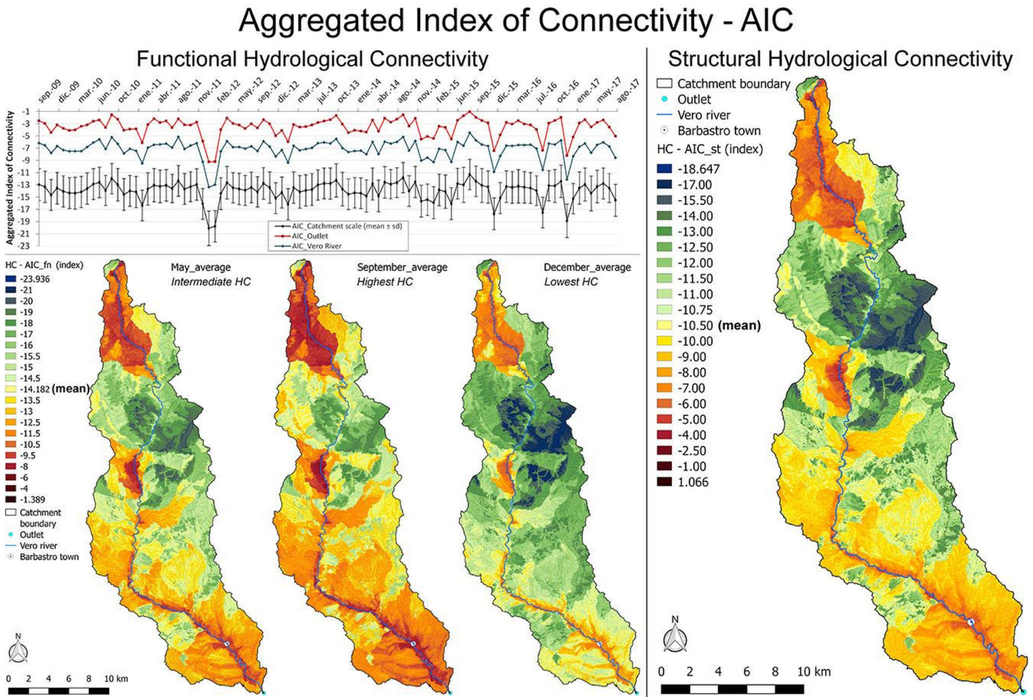


Micheletti and Lane, 2016

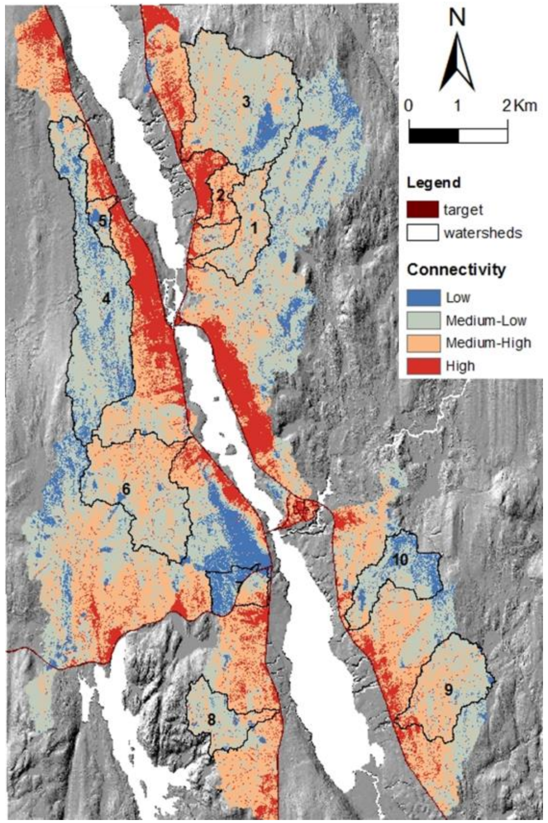


Cucchiaro et al., 2019

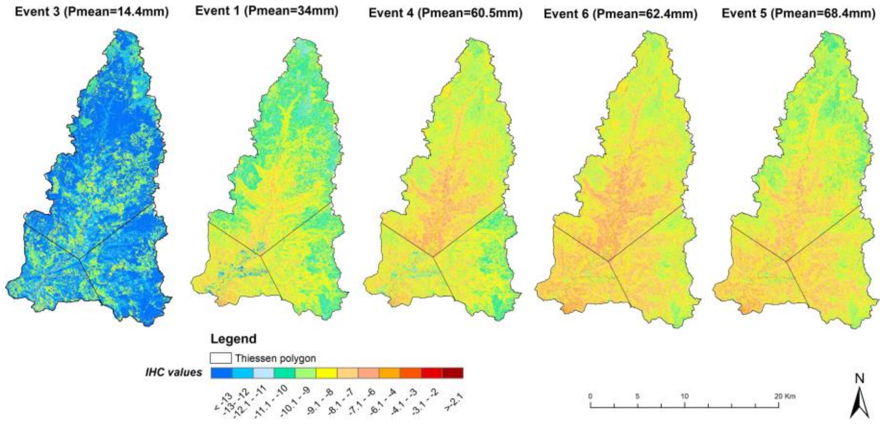
- Kalantari et al. (2017) modified IC including a functional weighting factor based on surface runoff estimate by curve numbers and considering spatially and temporally variable forcing.
- López-Vicente and Ben Salem (2019) proposed a new aggregated index (AIC) based on topography, C-RUSLE factor, RUSLE2 rainfall erosivity, residual topography and soil permeability, to model structural and functional flow and sediment connectivity.
- Zanandrea et al. (2021) integrated two parameters on the runoff generation (SCS Runoff Curve Number method) and the characteristics of the antecedent precipitation.



López-Vicente and Ben Salem (2019)

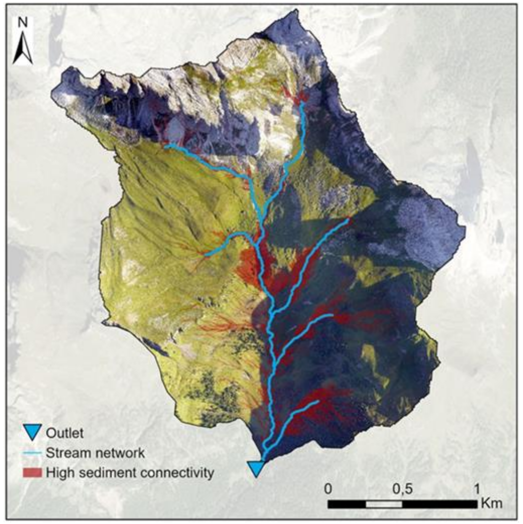


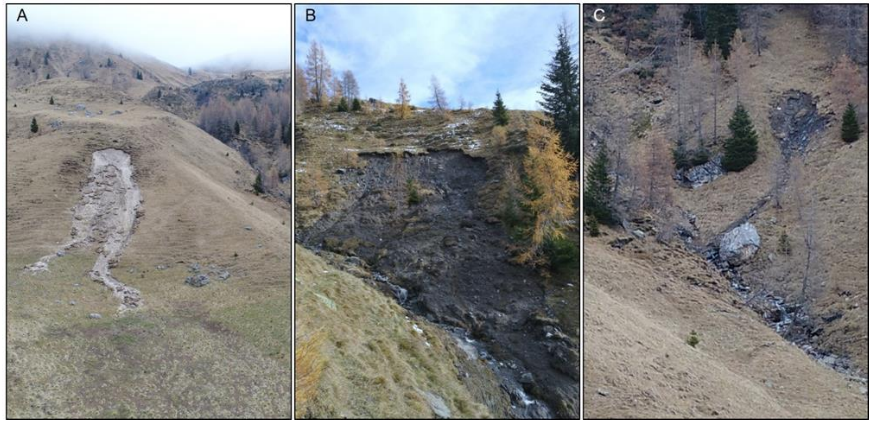
Kalantari et al. (2017)



Zanandrea et al. (2021)

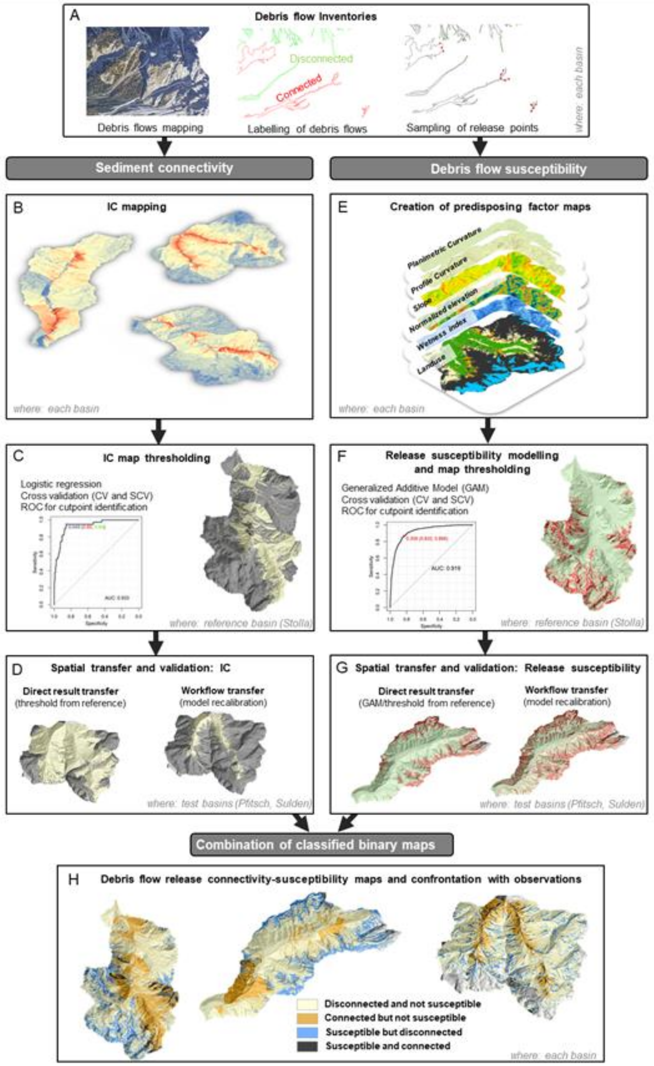
Availability of detailed event-based landslide inventories paves the way for developing more quantitative approaches in IC analysis by defining (dis)connection thresholds (Martini et al., 2022) and using the connectivity framework into susceptibility assessment (Steger et al., accepted in ESPL)

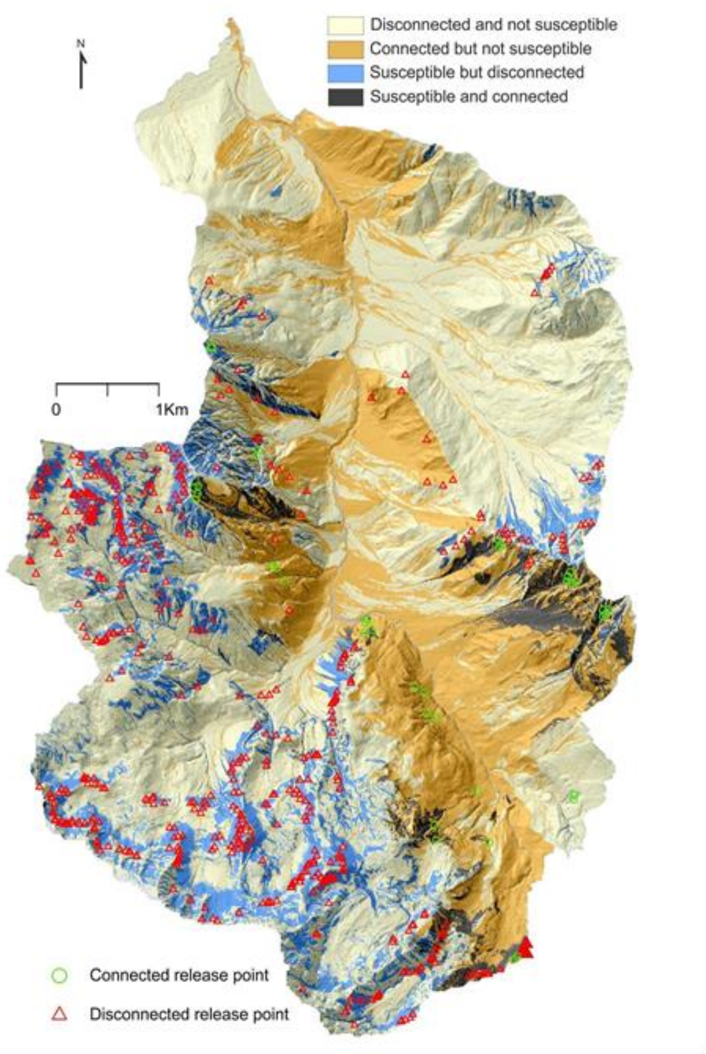




disconnected connected functionally conn.

Martini et al., 2022





Steger et al., accepted in ESPL

Final remarks

- ✓ IC has proved a useful tool for a rapid spatial characterization of sediment dynamics both at catchment and regional scales;
- ✓ DEM quality and resolution and weighting factor choice have a strong effect on IC results;
- ✓ The reported applications demonstrate that a reliable assessment of sediment connectivity via a geomorphometric approach, especially when integrated with a sediment sources inventory, is useful for giving management priorities;
- ✓ Recent researches show very promising process-based and quantitative applications that could help to conceive a new geomorphometric approach pivotal for an improved characterization of sediment connectivity.

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