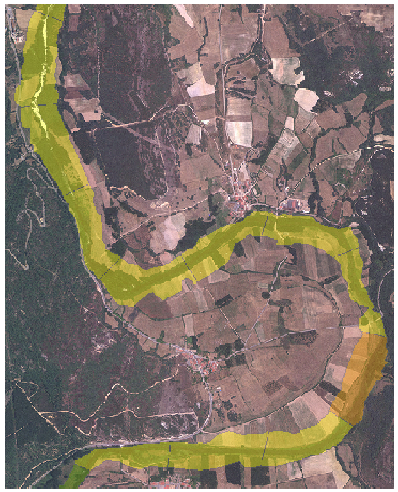
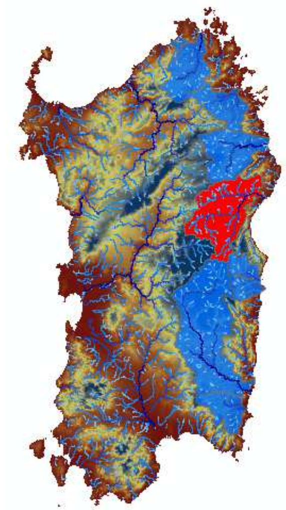
River network structure and riparian condition at large spatial scales: Application to the Sardinian fluvial systems

Progetto INHABIT - Habitat e stato ecologico: riposta biologica a possibili misure di ripistrino in fiumi e laghi italiani, October, 29-30, 2013, Milan, Italy



José Barquín*, González, M.A. and E. Estevez

IH-Cantabria, Universidad de Cantabria, Avda. Los Castros s/n, 39005 Santander, Cantabria, Spain
(*) barquinj@unican.es

Water Framework vs Habitats Directive

Management plans based on environmental assessment: the "good ecological status" (WFD) and the "favorable conservation status" (HD).

DIRECTIVA 2000/60/CE DEL PARLAMENTO EUROPEO Y DEL CONSEJO

de 23 de octubre de 2000

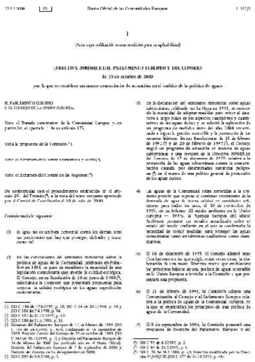
por la que se establece un marco comunitario de actuación en el ámbito de la política de aguas

DIRECTIVA 92/43/CEE DEL CONSEJO

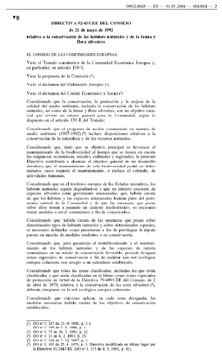
de 21 de mayo de 1992

relativa a la conservación de los hábitats naturales y de la fauna y flora silvestres

(DO L 206 de 22.7.1992, p. 7)



Good Ecological Status	**Objective**	Good Conservation Status
Biological: Macrophytes, Diatoms, Invertebrates, Fishes Water P&Q Characteristics Hidromorphological	**Indicators**	¿Ecosystem? ¿Habitat structure? ¿Population dynamics?
Water Bodies within Typologies	**Assesment Units**	¿@ which scale? ¿SAC?



The need to divide to understand and manage fluvial ecosystems

RIVER RESEARCH AND APPLICATIONS
River Res. Applic. **22**: 123–147 (2006)
Published online in Wiley InterScience
(www.interscience.wiley.com). DOI: 10.1002/rra.901

THE RIVERINE ECOSYSTEM SYNTHESIS: BIOCOMPLEXITY IN RIVER NETWORKS ACROSS SPACE AND TIME

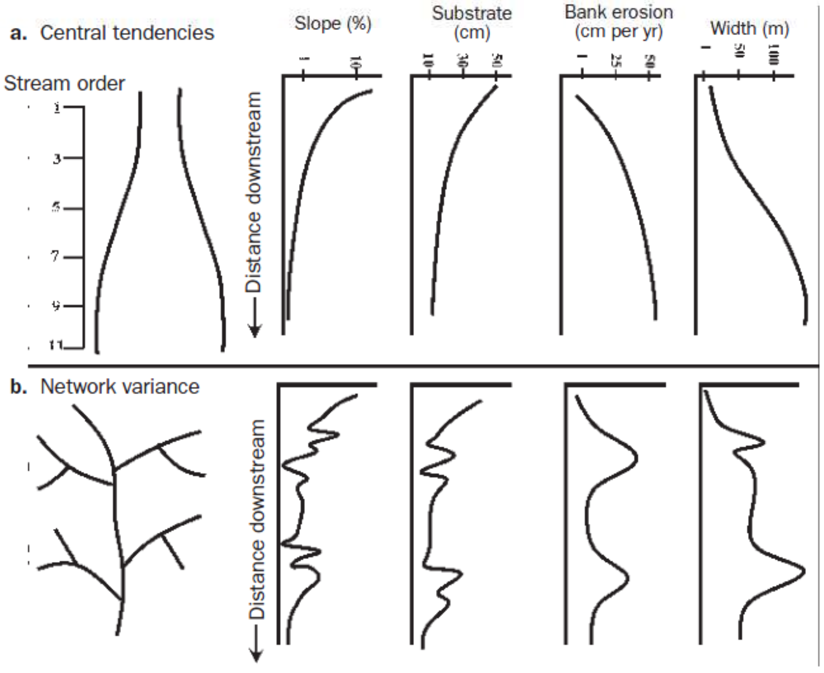
JAMES H. THORP[a]*, MARTIN C. THOMS[b] and MICHAEL D. DELONG[c]
[a] *Kansas Biological Survey and Department of Ecology and Evolutionary Biology, Higuchi Hall, University of Kansas, 2101 Constant Ave., Lawrence, KS 66047-3759, USA*
[b] *Cooperative Research Centre for Freshwater Ecology, University of Canberra, Canberra, ACT 2601, Australia*
[c] *Large River Studies Center and Department of Biology, Winona State University, Winona, MN 55987, USA*

Freshwater Biology
Freshwater Biology (2010) **55**, 147–170 doi:10.1111/j.1365-2427.2009.02204.x

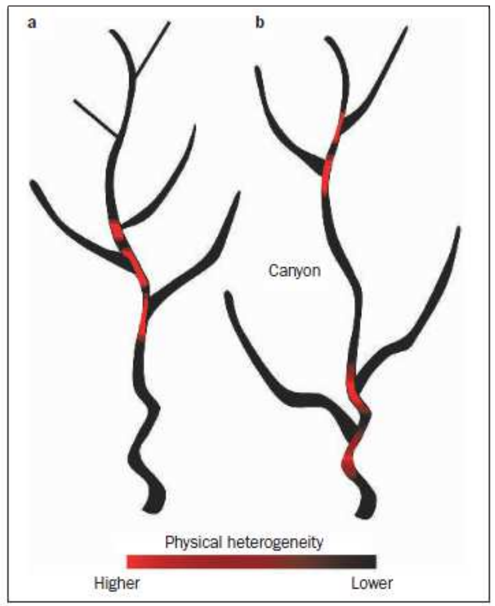
The ecological limits of hydrologic alteration (ELOHA): a new framework for developing regional environmental flow standards

N. LEROY POFF*, BRIAN D. RICHTER†, ANGELA H. ARTHINGTON‡, STUART E. BUNN‡, ROBERT J. NAIMAN§, ELOISE KENDY¶, MIKE ACREMAN**, COLIN APSE††, BRIAN P. BLEDSOE‡‡, MARY C. FREEMAN§§, JAMES HENRIKSEN¶¶, ROBERT B. JACOBSON***, JONATHAN G. KENNEN†††, DAVID M. MERRITT‡‡‡, JAY H. O'KEEFFE§§§, JULIAN D. OLDEN¶¶¶, KEVIN ROGERS****, REBECCA E. THARME†††† AND ANDREW WARNER‡‡‡‡

One of the major challenges in river ecology and management nowadays is identifying river reaches where hydrological and geomorphological characteristics are equivalent and maintained by similar river processes.



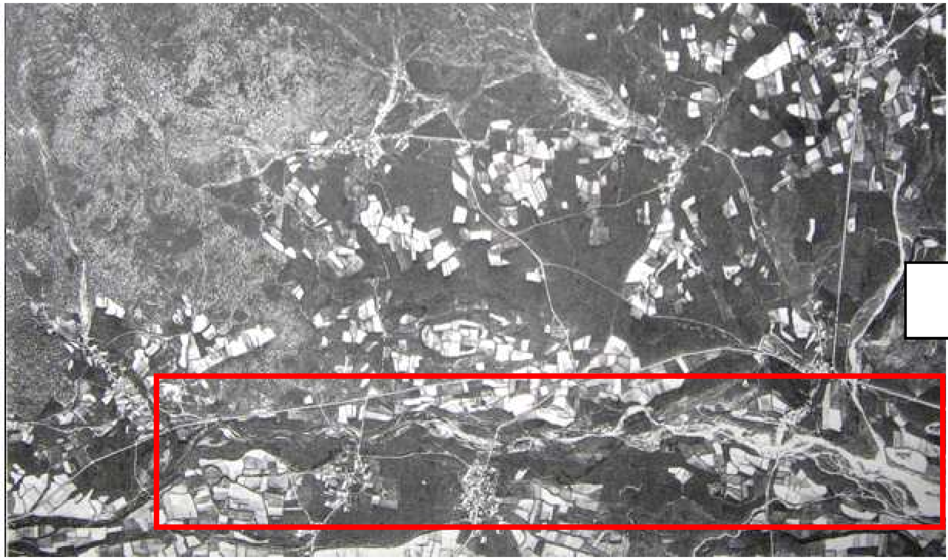
The dynamic network hypothesis discards the typical vision of a gradual downstream change and fosters a vision in which the many tributaries, valley shapes, valley side slopes, drainage and confluence density play a fundamental role on the longitudinal change of physical characteristics.



An example of how changes on the productive model shape landscapes and river morpho-dynamics…

The Híjar river, Ebro Headwaters, Northern Iberian Peninsula

1957



1985

2003

Land use change and riparian quality

Despite the importance of this river ecosystem element, riparian zones have been seriously damaged all throughout the world linked to land transformation for urbanization, agriculture and pasture uses. More than 40% of Earth's land has already been converted to anthropogenic uses (Barnosky *et al*. 2012).

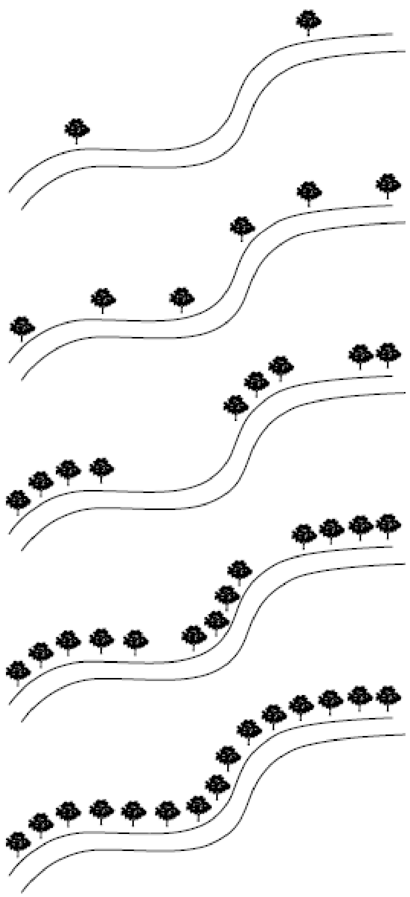
Low impacted reaches…

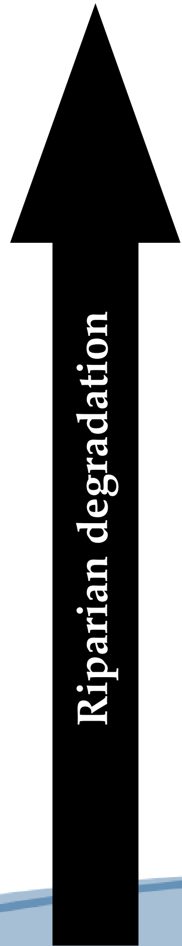
Resection and embankment for flood protection

Agriculture and pasture uses

Woody vegetation reduction

One of the most logical effects of removing woody vegetation on the riparian zone will be bank instability, what produces serious problems such as increased erosion rates, soil losses, increment of fine sediments, increasing phosphate inputs, and instream habitat degradation, among others





The importance of the catchment scale perspective

The fluvial landscape is composed by active and fossil channels, secondary channels, backwaters, confluence ambient, wetlands, fluvial floodplains and terraces and riparian vegetation (Fausch et al., 2002, Nakamura, 2006), and also by subsurface hyporheic fluxes and all associated biological elements (Poole et al. 2006).

However human activity has predated most of these areas and we lack in many sites a reference condition to pinpoint river restoration activities.

Hydrol. Earth Syst. Sci., 15, 2995–3015, 2011
www.hydrol-earth-syst-sci.net/15/2995/2011/
doi:10.5194/hess-15-2995-2011

Hydrology and Earth System Sciences

Creating a catchment scale perspective for river restoration

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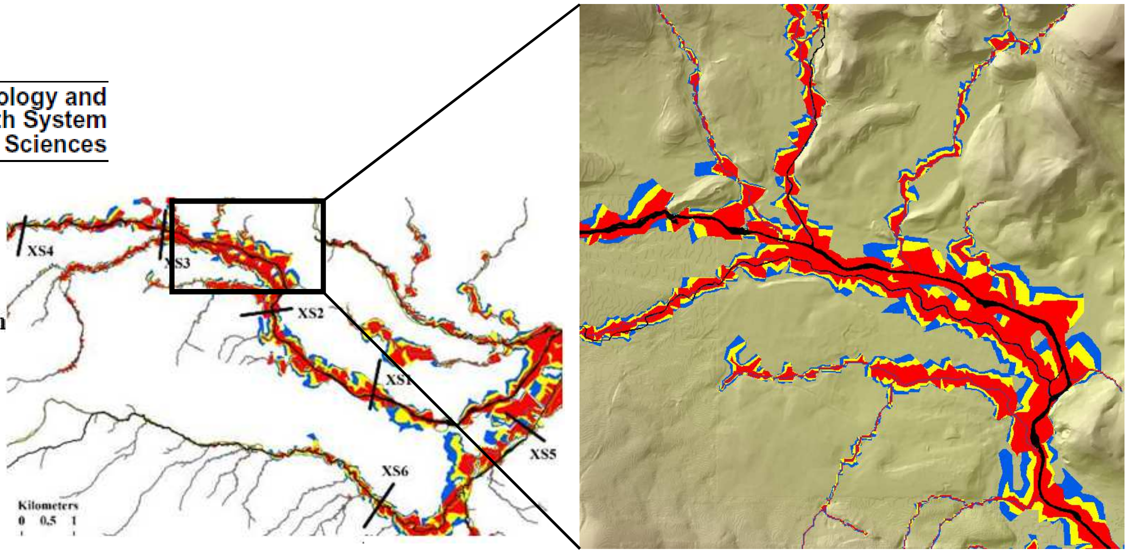
Received: 8 February 2011 – Published in Hydrol. Earth Syst. Sci. Discuss.: 25 March 2011
Revised: 7 July 2011 – Accepted: 15 August 2011 – Published: 27 September 2011



Defining fluvial landscapes at a catchment scale and identifying the main processes associated to their maintenance is well needed to establish a good policy for river catchment restoration planning

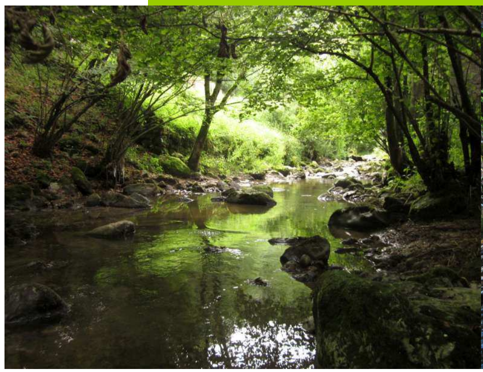
Main Objectives

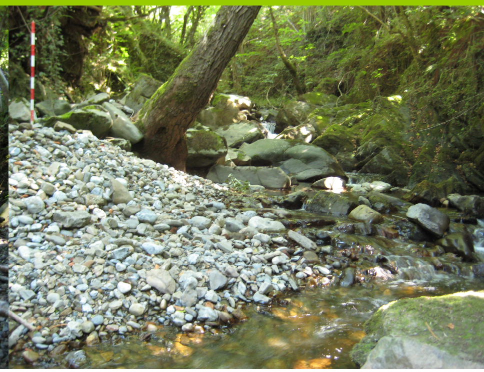
Activity 1: Assessment of land erosion trends, sediment transport balance, artificial structures and river longitudinal continuity in Sardinian INHABIT study areas

- **Characterise the possible impact of dams and weirs to the fluvial landscape at a catchment scale**

Activity 2: Assessment of main processes related to bank erosion and depositional/erosional zones at the catchment scale in Sardinian INHABIT study areas

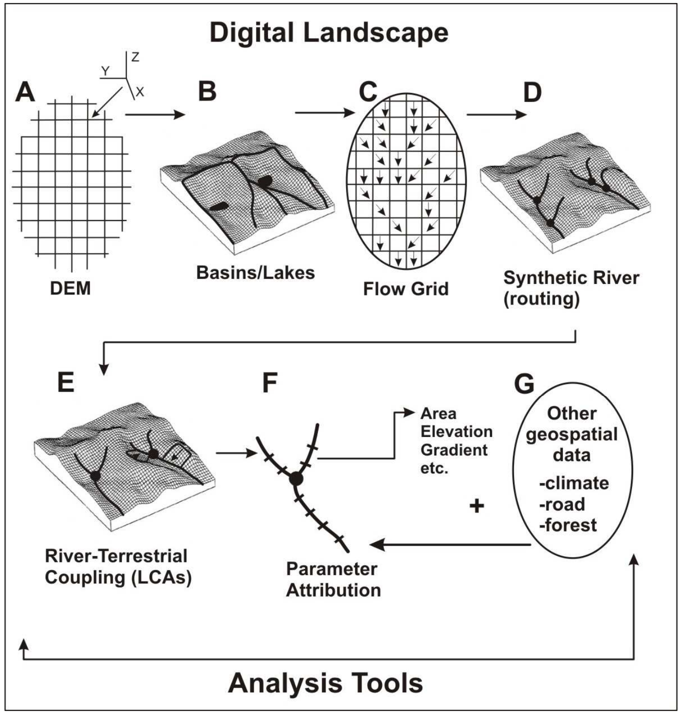
- **Model riparian condition to the entire Sardinian river network**
- **Link riparian condition to bank instability**



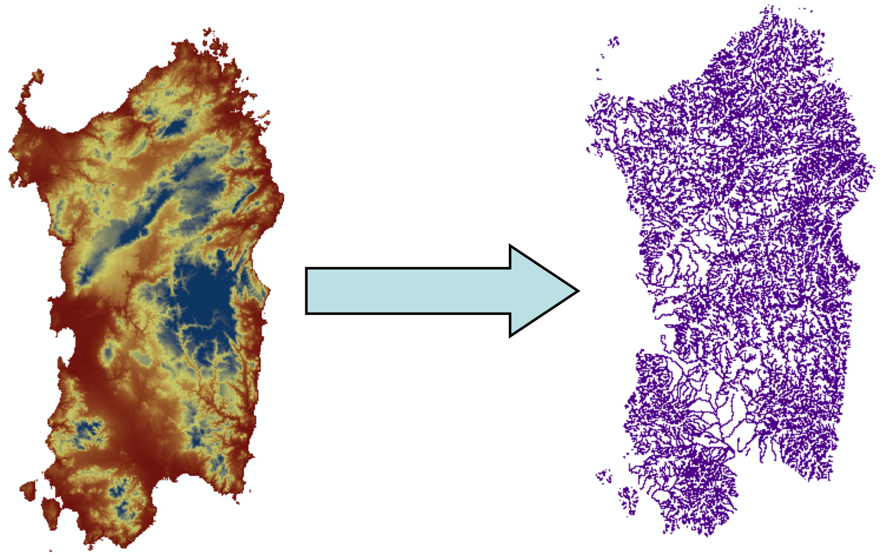



Obtaining the SRN - Methods

We derived a synthetic river network (SRN) for the Sardinian Island from a 20m DEM. This river network consisted on more than 63364 river reaches from 100 to 500 m length.



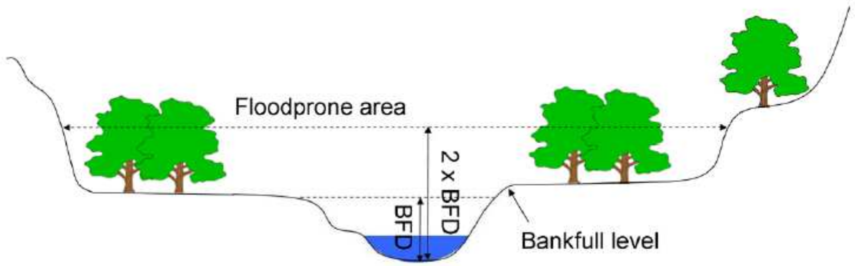
Using software from the NETMAP Platform (http://earthsystems.net/)



We used a regional regression to model Bankfull Depth (BFD) to all river reaches within the river network.

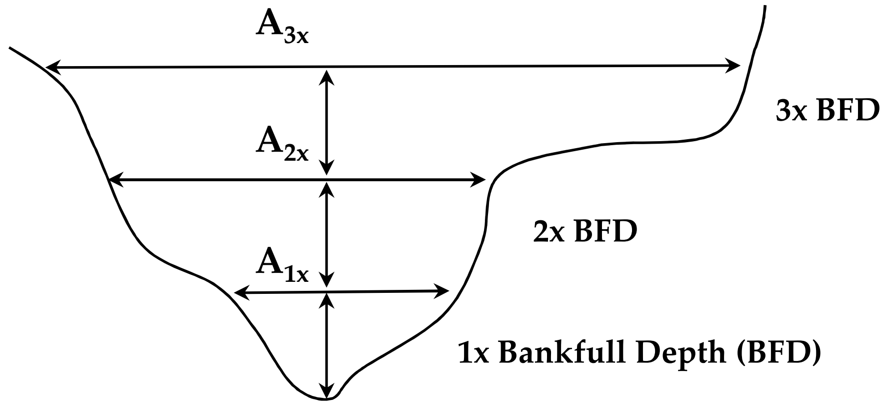
$$BFD = 0.63 * A^{0.1731} * P^{0.1516}$$

where A= catchment area (km^2) and P= mean annual precipitation (mm)



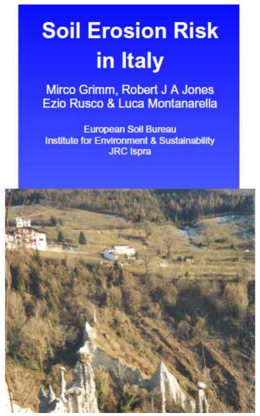
Fluvial landscape characterisation - Methods

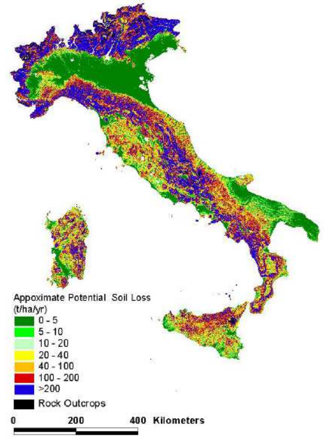
Floodplain width



We then calculated different floodplain widths for every river reach in the SRN using 1xBFD, 2xBFD and 3xBFD

Sediment Yield





We used NETMAP tools and GIS data (Grimm *et al.*, 2002) to calculate sediment yield for catchment and local wings to every river reach within the SRN

Confluence effects probability (Benda *et al.*, 2004)

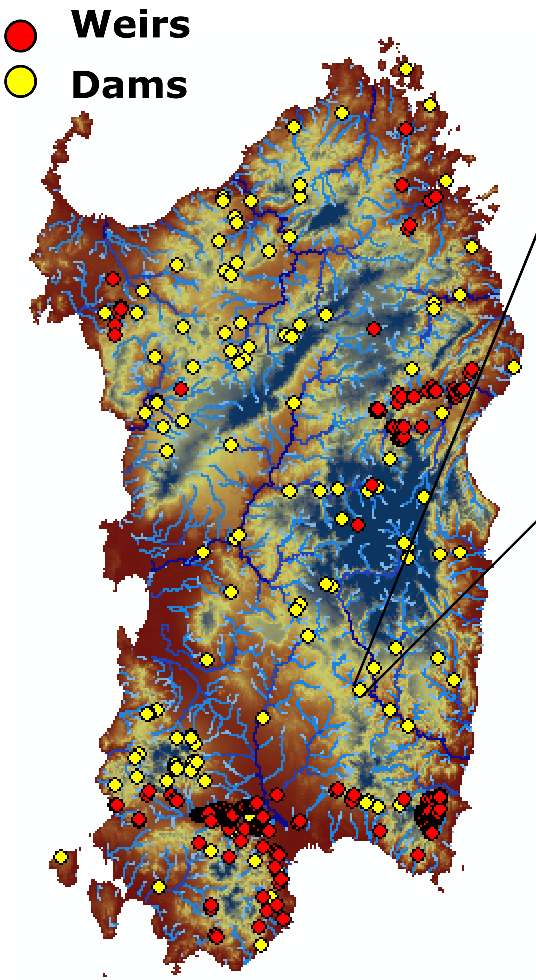
Pe = exp(g(x)) / (1 + exp(g(x)))

Pe = Probaility of effect

g(x) = probability funtion based on the relation of catchment symmetry

Confluence effects: wider floodplains, secondary channels, sediment bars, meanders, fluvial terraces, changes on substrate size and composition, deeper pools, etc… (Benda *et al.*, 2004)

Dam and Weir SRN characterisation - Methods



We derived some variables for the entire SRN by using GIS software developed by IH-Cantabria:

- Distance from the considered river reach to the nearest downstream pressure.
- Distance from the considered river reach to the nearest upstream pressure. In this case, because of computational limitations, the distance was limited to 5000 m.
- Number of pressures upstream from the considered river reach.
- Number of pressures in the considered river reach.

Delineation of riparian zones - Methods

The 50-yr flood has been indicated as an appropriate hydrological descriptor for riparian zones as it usually coincides with the first terrace or other upward sloping surface, and is a good indicator of high water table levels.

We derived "flood" polygons by generating a surface which intersects valley walls at a given number of BFD that best matched the 50 year flood polygon for every single river reach in the river network (Fernández *et al.*, 2012).

V-shaped valleys and gorges

Open and concave valleys

Hydrol. Earth Syst. Sci., 16, 3851–3862, 2012
www.hydrol-earth-syst-sci.net/16/3851/2012/
doi:10.5194/hess-16-3851-2012

Hydrology and Earth System Sciences

Quantifying the performance of automated GIS-based geomorphological approaches for riparian zone delineation using digital elevation models

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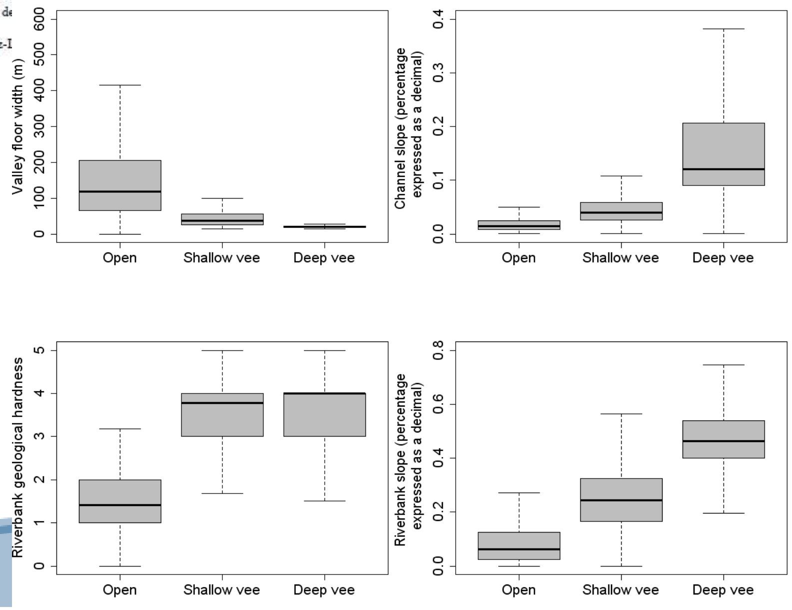
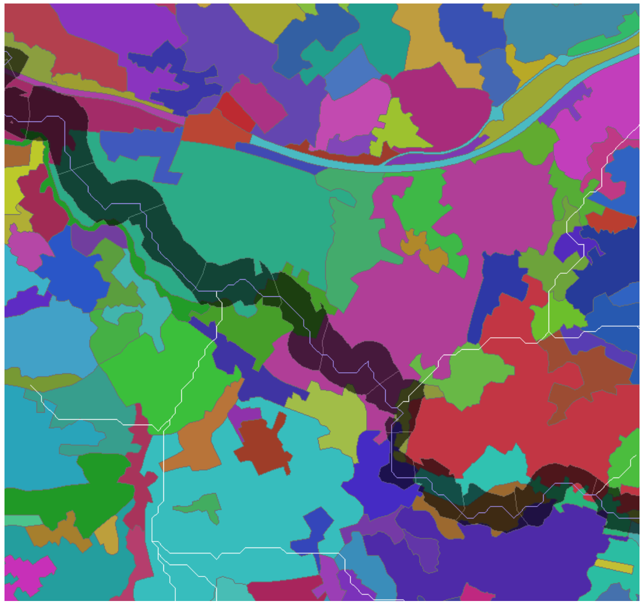
[*]now at: Institute for Environmental Sciences, University Koblenz-L
76829 Landau in der Pfalz, Germany
Correspondence to: D. Fernández (diegofgrm@gmail.com)

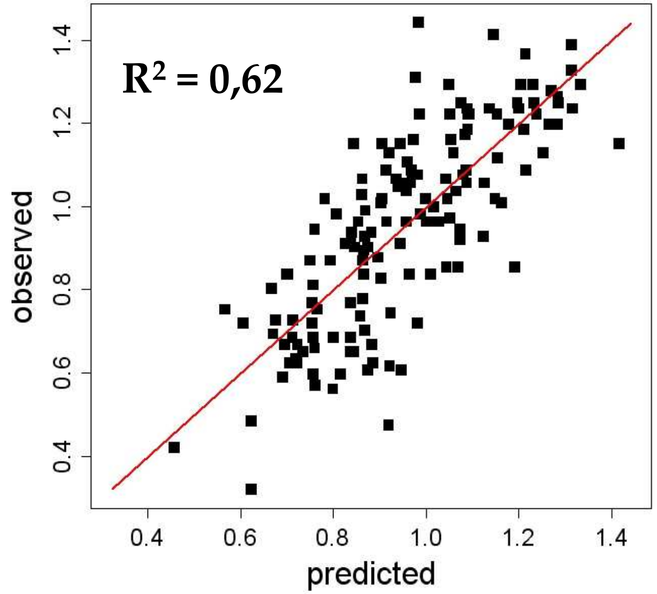


Modelling Riparian Condition- Methods

To model riparian condition we applied a RC model developed for northern Spain to the whole Sardinian Island (Fernández et al., in Press: Ecological Indicators).

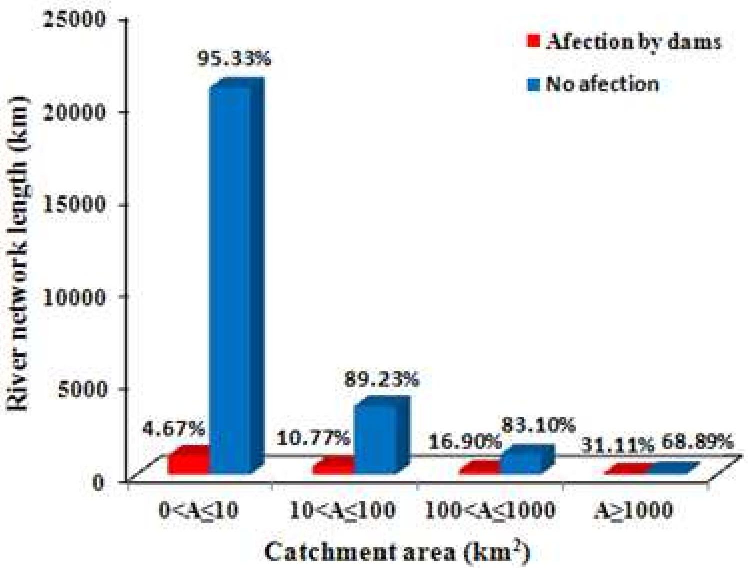
Riparian Condition scores were obtained riparian land use composition for the above obtained riparian areas using Multiple Linear Regression. Land use composition was obtained using

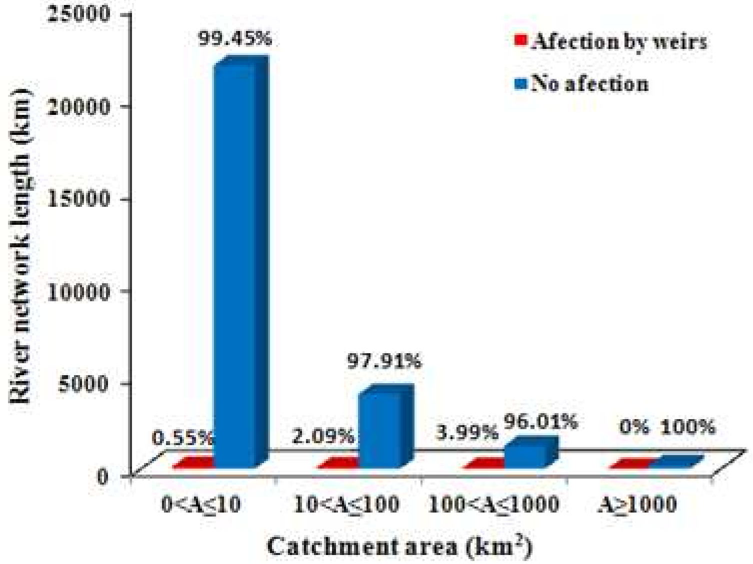




		Bank Instability Risk		
Soil loss (t/ha/yr)	0 >*SL* ≤1	Medium	Low	Low
	1 >*SL* ≤5	Medium	Medium	Low
	5 >*SL* ≤10	High	Medium	Low
	10 >*SL*	High	High	Low
		Bad-Poor	Moderate	Good
		Riparian Condition		

Results – SRN Analysis



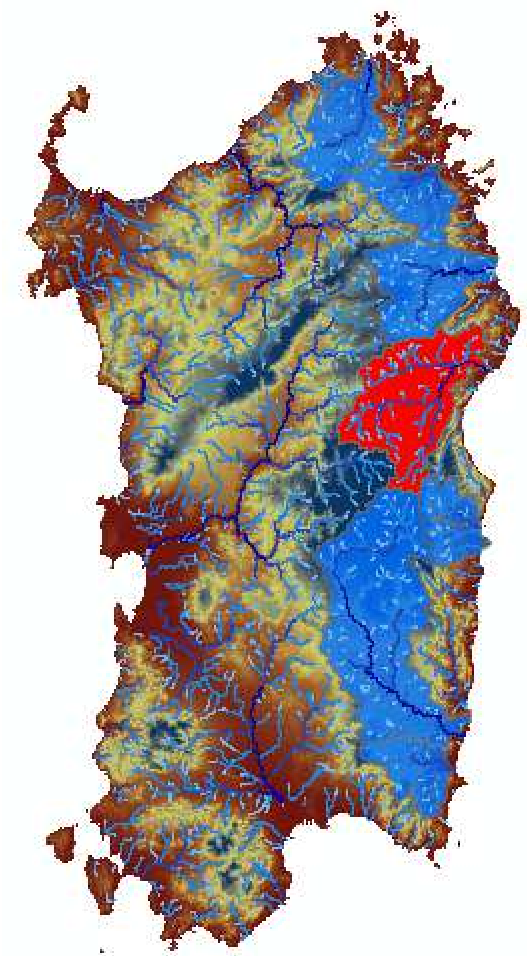


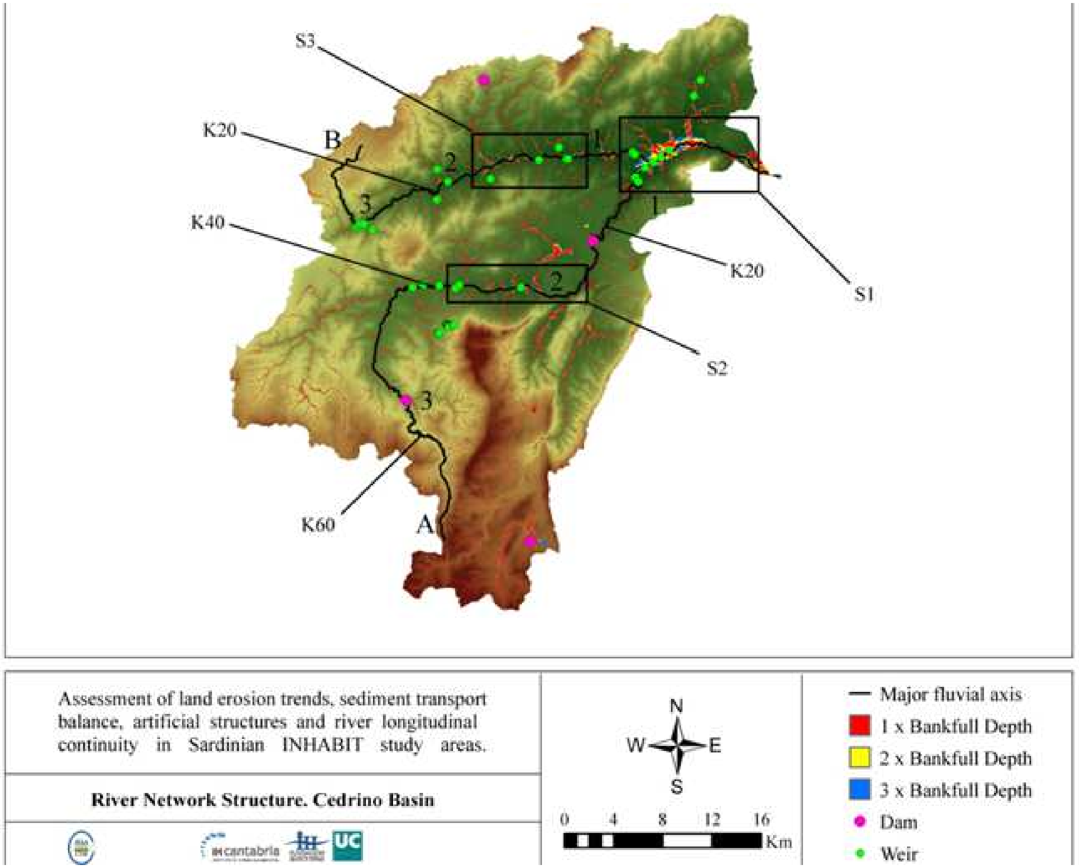
The length of river reaches that might be affected morphologically by dams is superior in small catchments areas (1020.34 km) decreasing with increasing catchment sizes (60.51 km for the largest catchment size class)

However, we find the contrary pattern if we take into account the percentage of affected river reaches for each catchment size class. Less than 5% of river reaches in small catchments might be morphologically affected by dams, while more than 30% of river reaches might be affected by dams in large drainage areas

Results – SRN Analysis

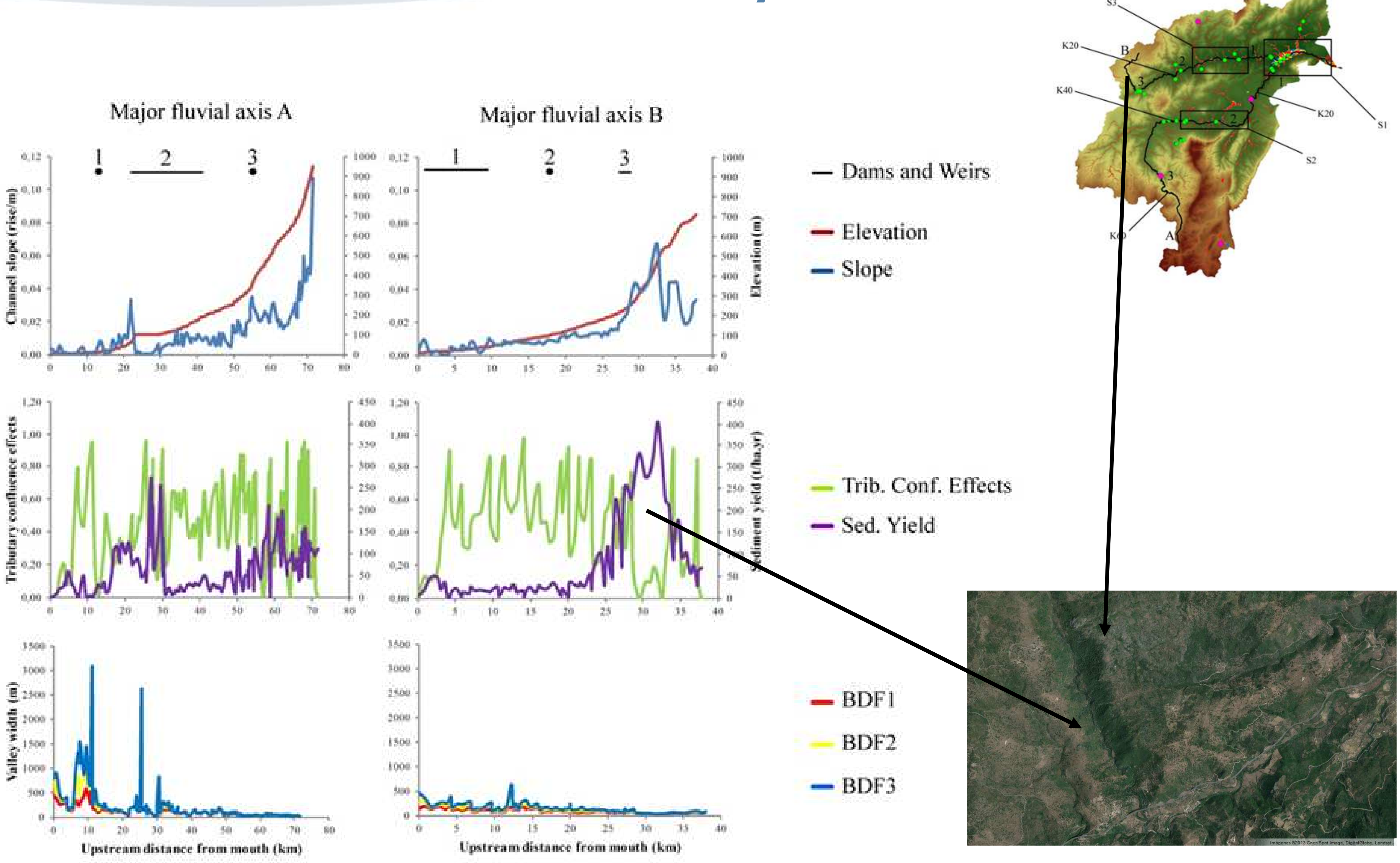
We performed the SRN analysis in 4 catchments out of the 10 selected, although we generated data for all of them. This is an example using the Cedrino catchment…



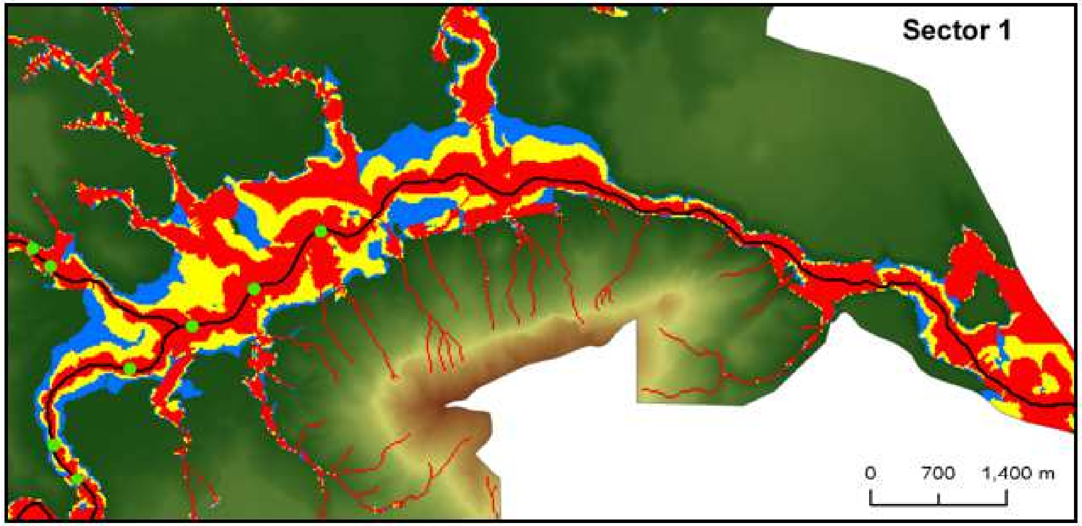


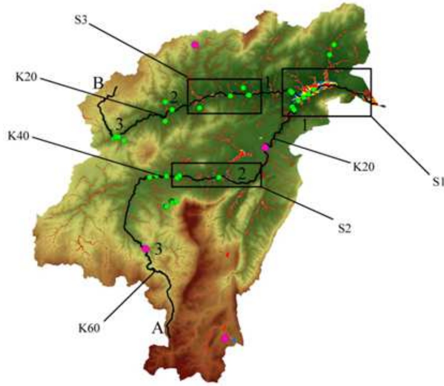
The Cedrino basin drains almost 1078 km2 and could be divided in two major fluvial axes with a length of 70 and 38 km

Results – SRN Analysis: Cedrino



Results – SRN Analysis: Cedrino



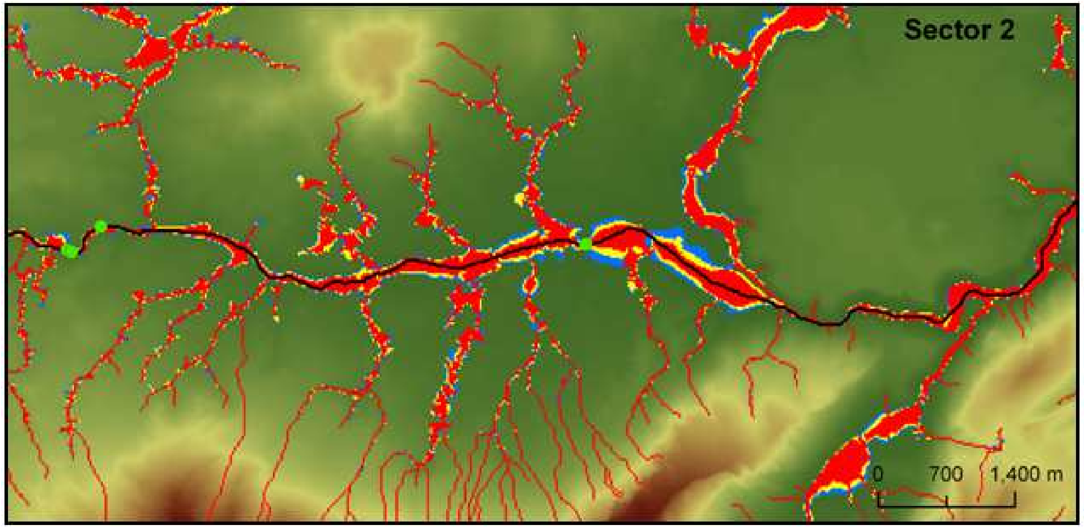


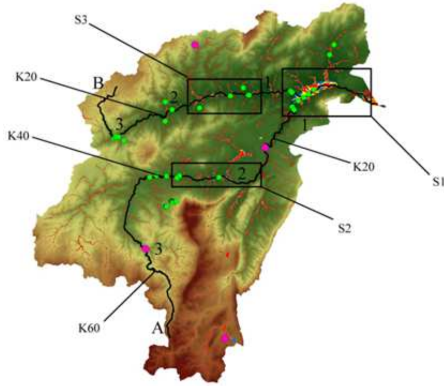
Wide fluvial landscapes over 1000m wide are predicted to occur within river kilometer 0 to K10, right below the confluence of the two major tributaries within the catchment.

This large floodplain shows considerable differences in surface area between one, two and three bankfull depths. This could be indicating the presence of flood defenses restricting the width of the fluvial landscape.

Moreover, the many weirs present in this area might also be restricting and conditioning the possibility of reaching a full fluvial landscape development

Results – SRN Analysis: Cedrino

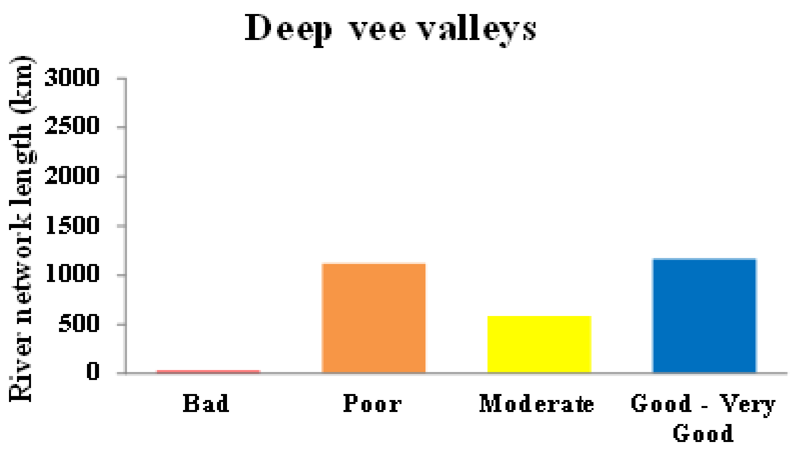


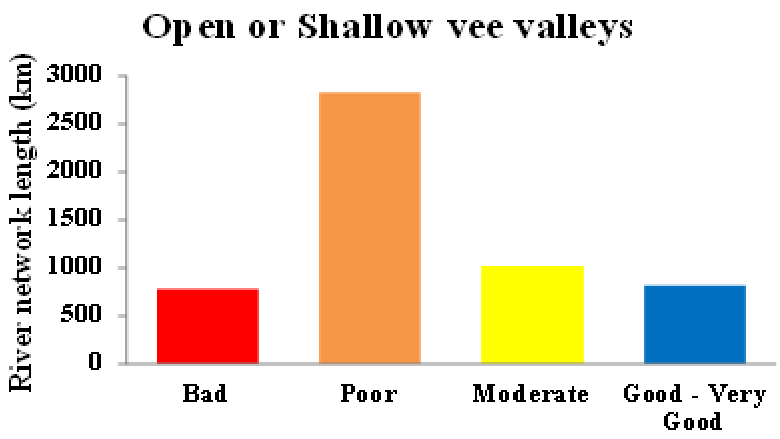


River reaches between K20 and K40 have a large probability of tributary effects and they have large contributions of sediment from the adjacent hillsides. This results in larger floodplains within this sector, predicting floodplains width of up to 500m.

The many weirs and a large dam on the lower part of this sector might disrupt severely natural morphological dynamics, preventing the full fluvial landscape development.

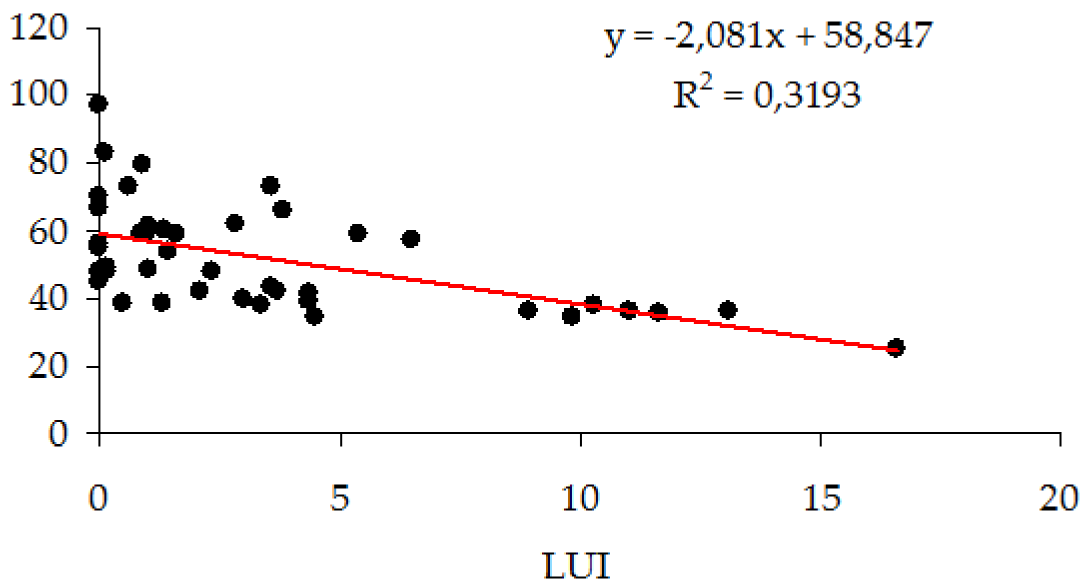
Results – Riparian Condition



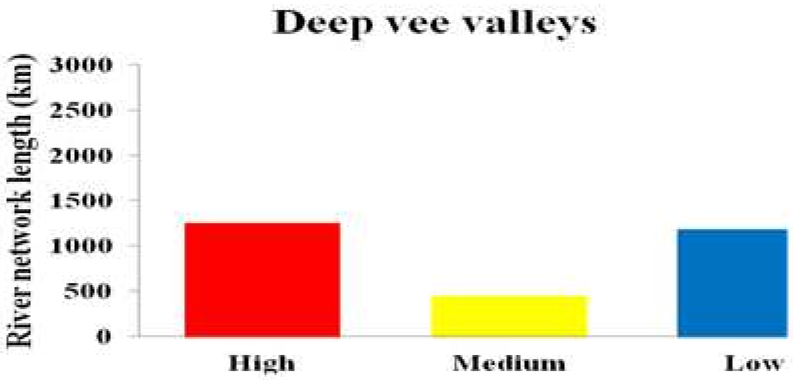


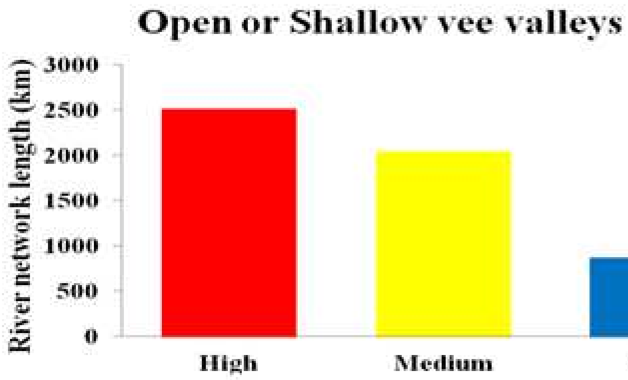
- Riparian condition related to valley morphology

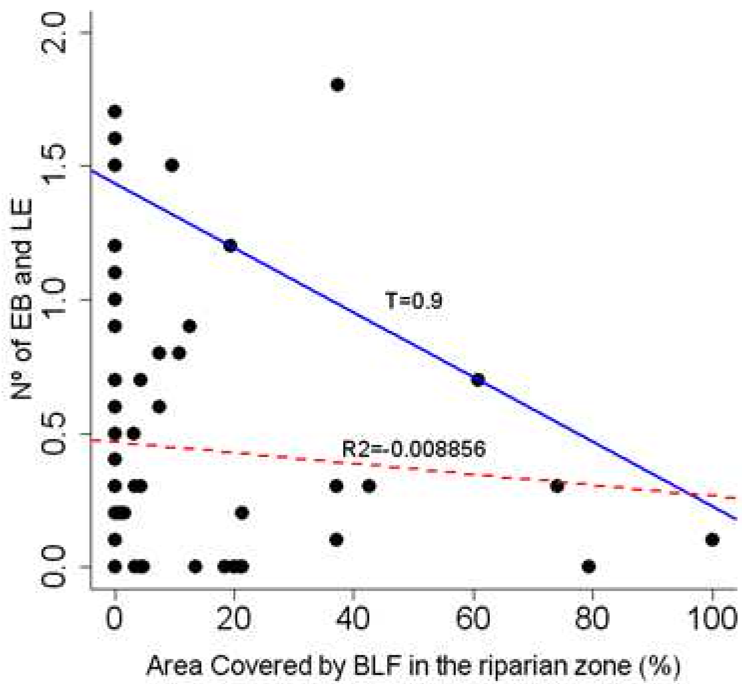
- LUI good predictor of RC

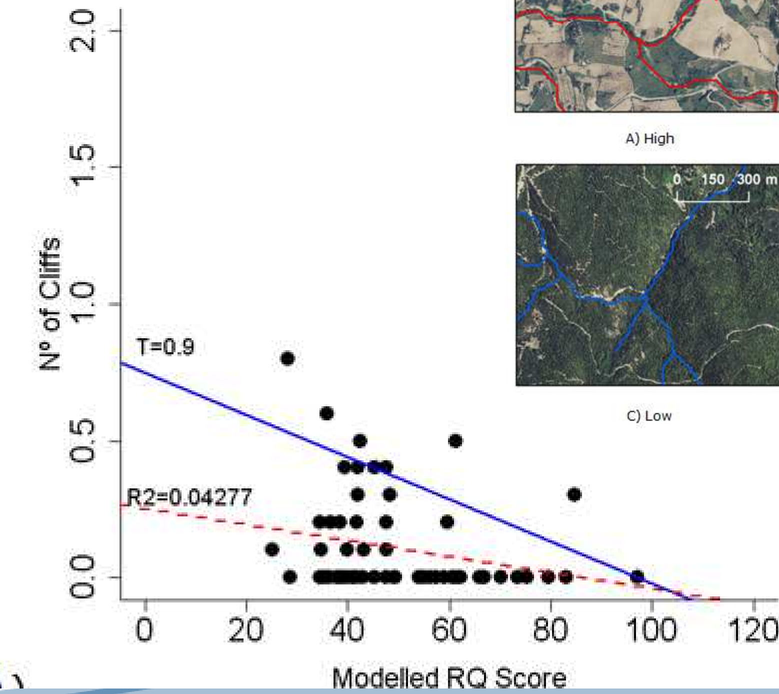


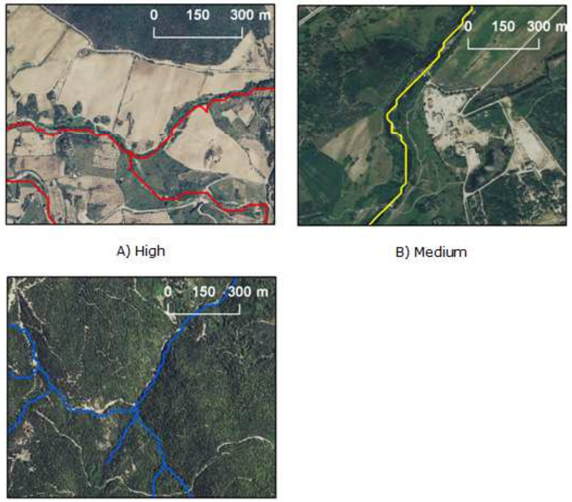
Results – Bank Instability Risk







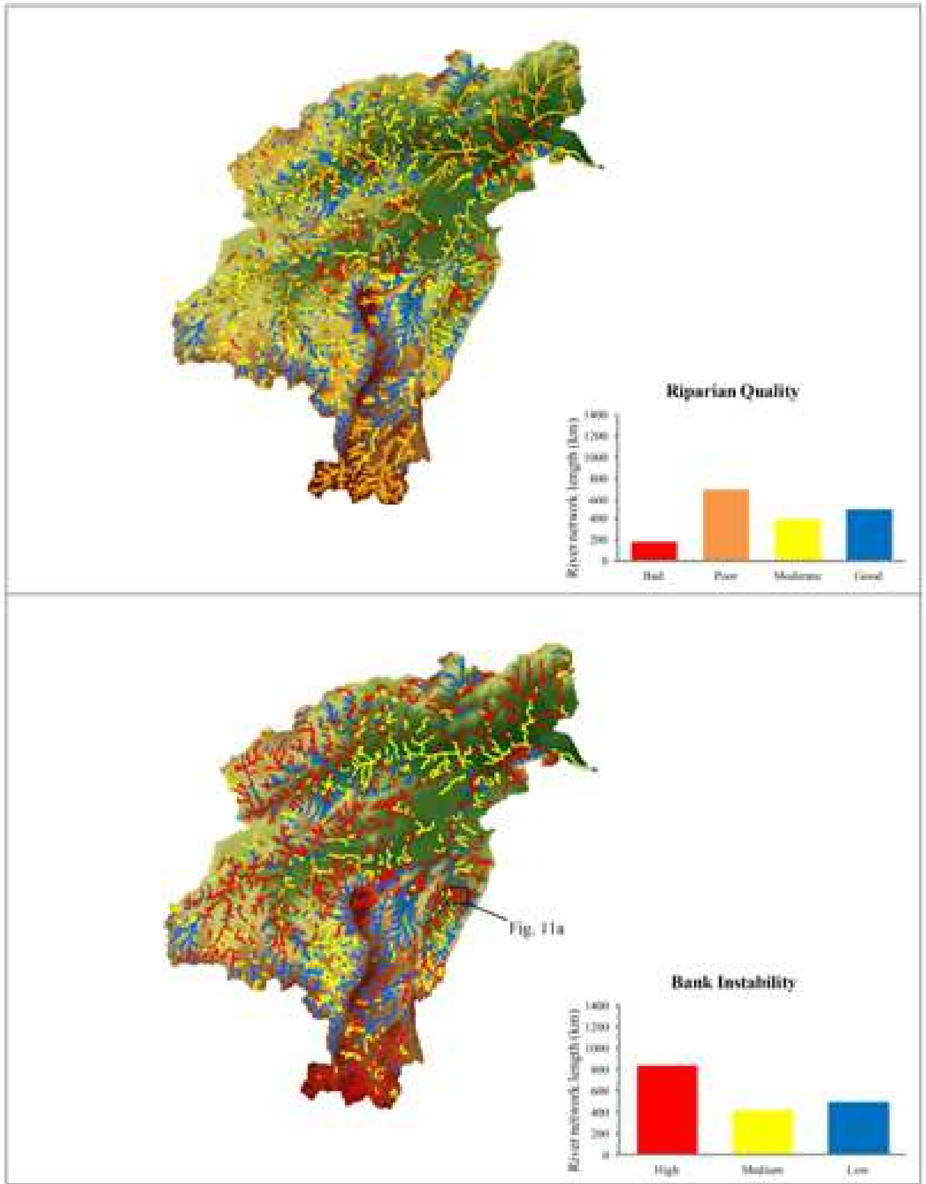


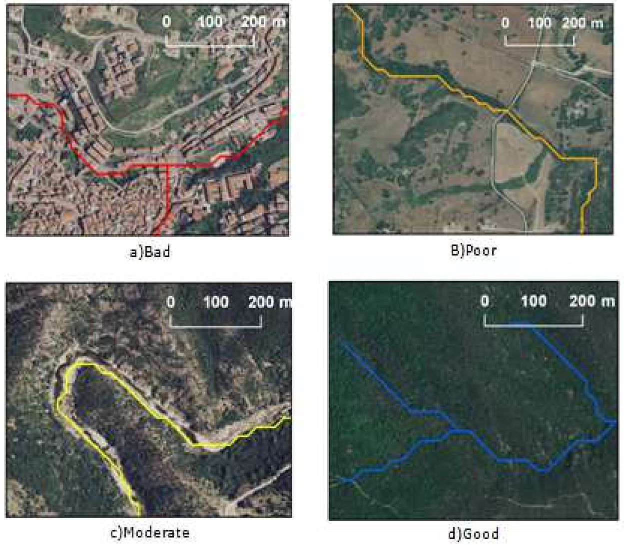


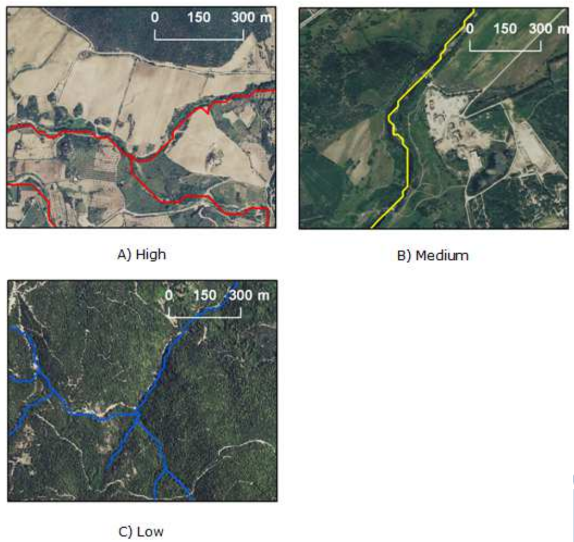
A) High B) Medium

C) Low

Results – RC & Bank Instability Risk Maps







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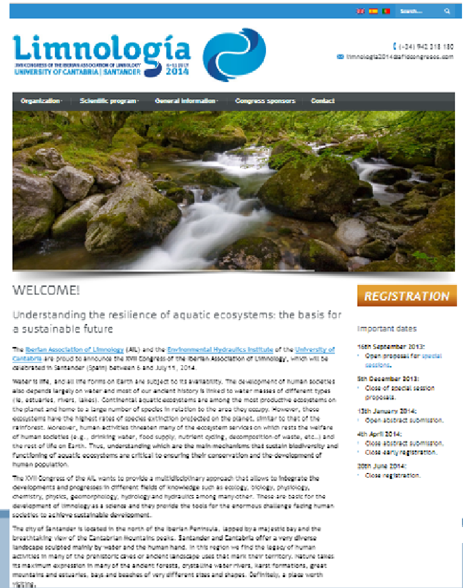


Thanks for your attention!!