LINKING GULLY EROSION AND RAINFALL EROSIVITY

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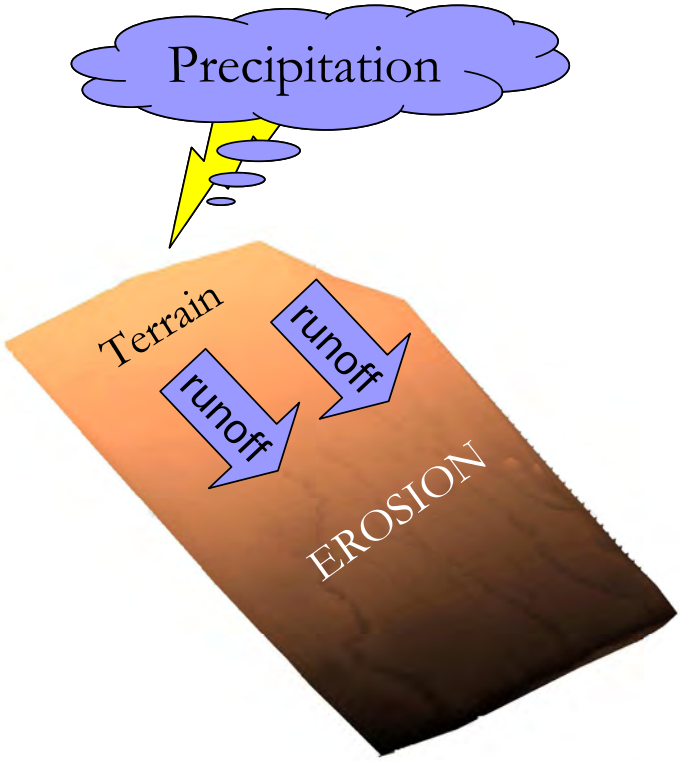
Introduction

Gully erosion is a worldwide problem capable of dramatic increment on sediment yield when active



The main problem to asses and predict overall (gully) **erosion** rate **for the past and future decades is the lack of an adequate data set**, especially regarding precipitation which is the key variable controlling erosion processes.

There is often a **lack of detailed precipitation records**.

Objetives

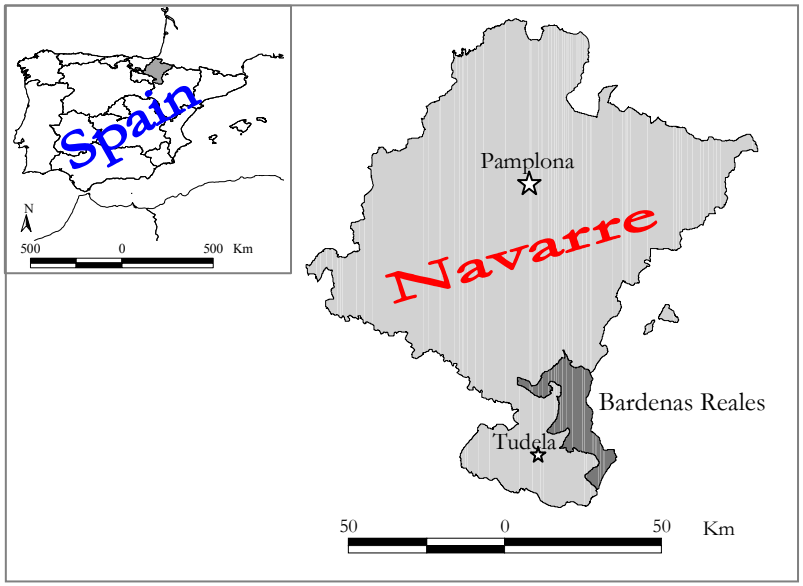
1. To evaluate the performance of several daily rainfall erosivity models to estimate the RUSLE EI30 index.

2. To relate gully erosion rates with rainfall erosivity

$$\text{Erosion rate} = f(R)$$

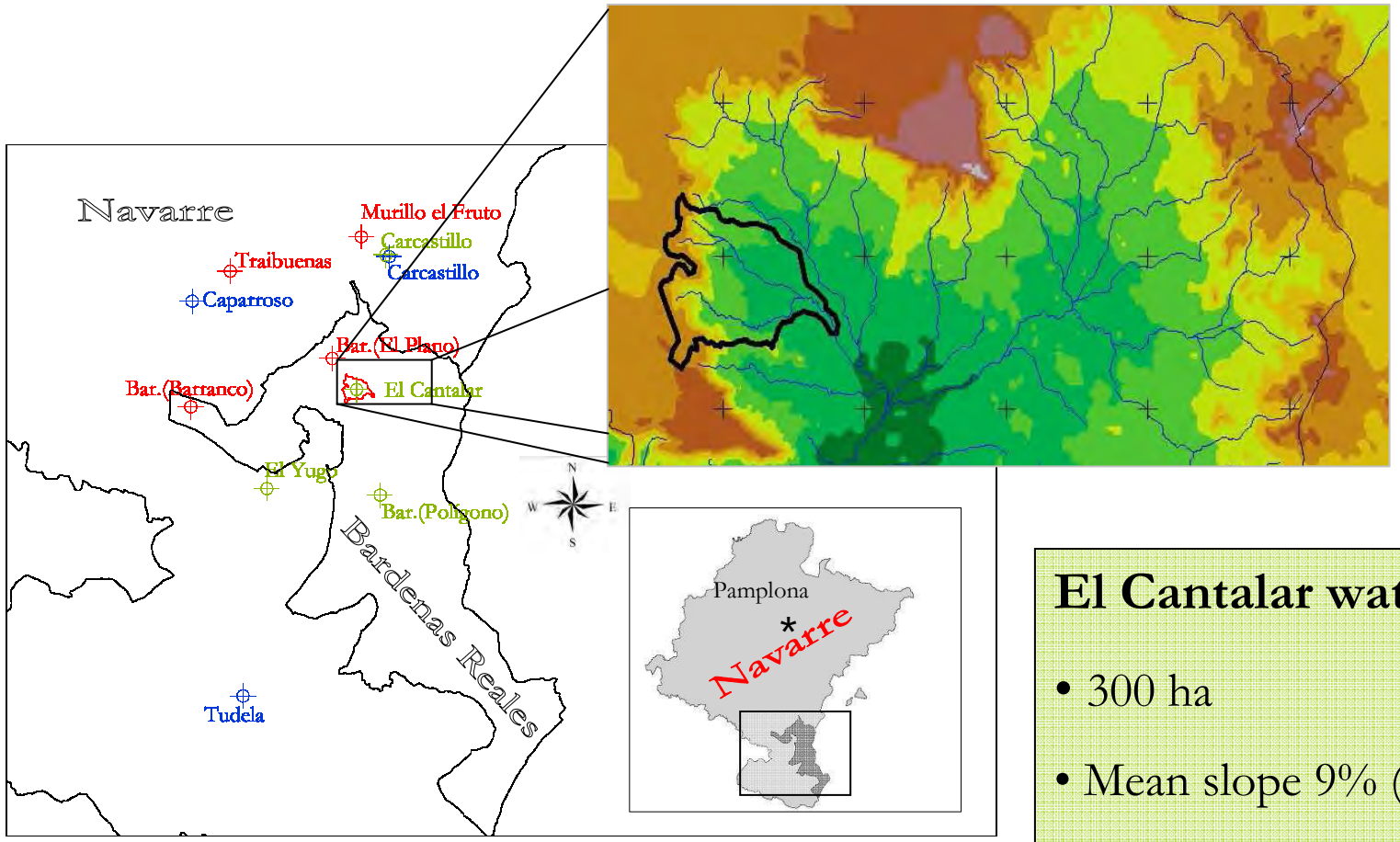
Study Area

Bardenas Reales Natural Park, Reserve of the Biosphere (UNESCO, 2000)



- Located at South-East Navarre in the Ebro River basin
- Surface area: 420 km^2
- Altitude range: 280-659 m
- Annual precipitation: 350-500 mm
- Average temperature: 13 -14 ºC

Study Area



El Cantalar watershed

- 300 ha
- Mean slope 9% (0-60%)
- Morphology of gullies

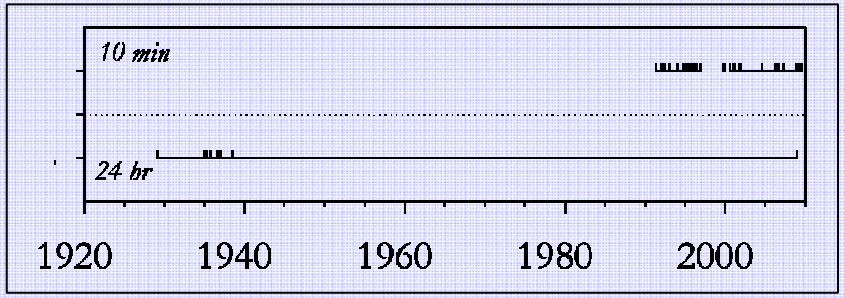
Study Area

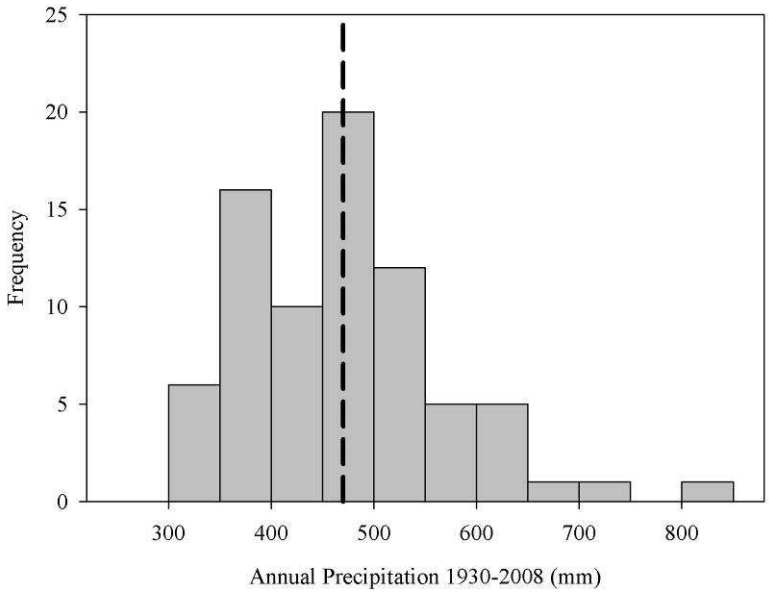
Precipitation records

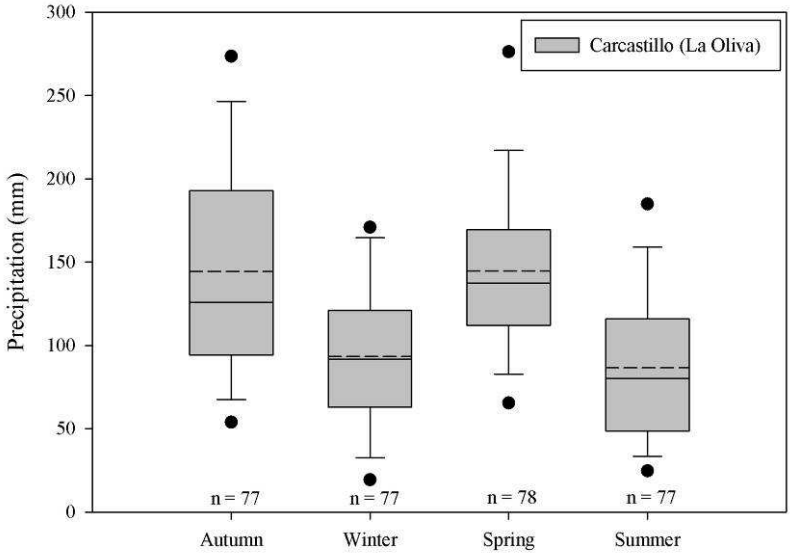
Carcastillo wheater station

10 km far from the experimental site

Mean precipitation 470 mm

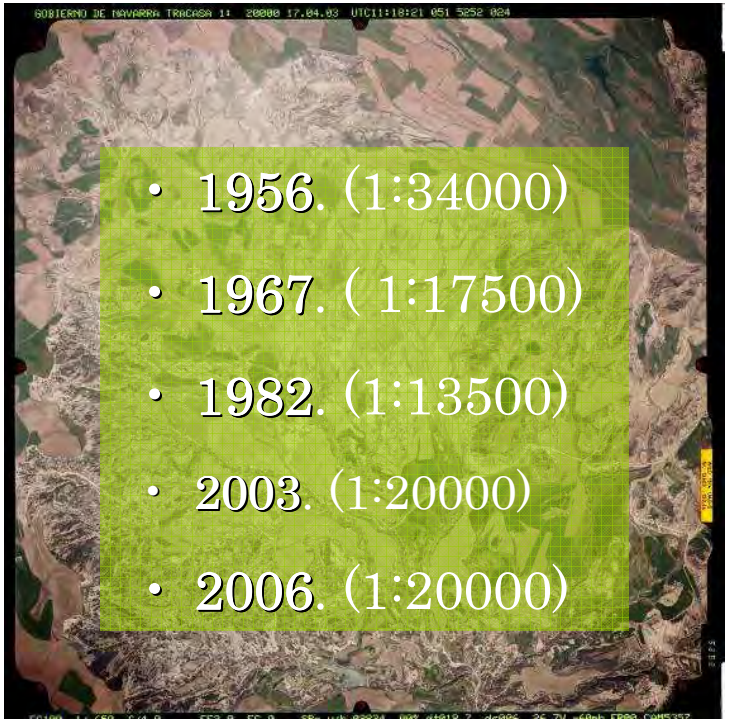




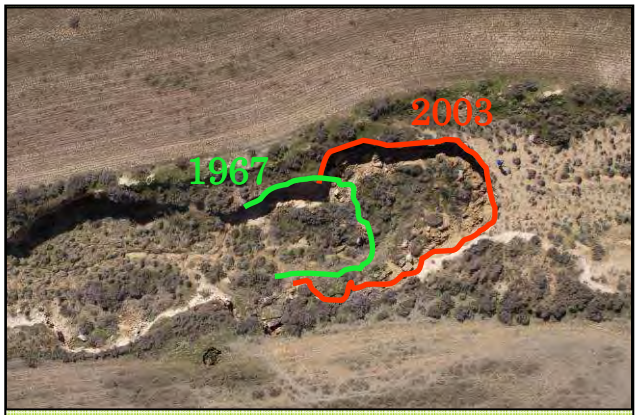


Methods

From available aerial photographs, we obtained sub-meter accuracy DEMs for Bardenas Reales. Detailed information about the geometry of headcuts and gullies was obtained manually by experts of the public TRACASA, a Spanish public surveying and mapping company.



Manual mapping (restitution ??) of gullies and headcuts

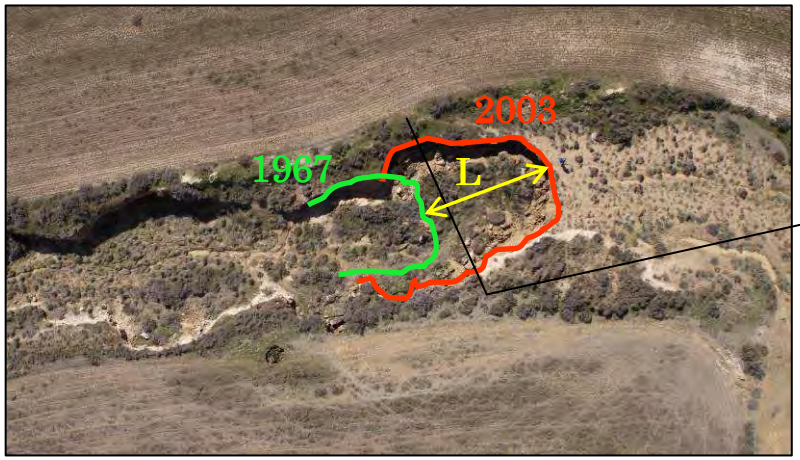


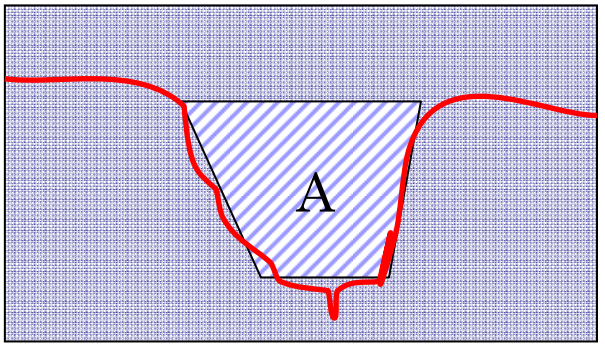
Triangular Irregular Network

Ortho-photographs (0.4 m)

Methods

Using the DEMs and the ortho-photographs, volumetric headcut retreat rates for each period were calculated as the product of the lineal retreat and a representative sectional area of the headcut.





Volumen = A *x* L

Monitoring of 33 gully headcuts

Methods

Quantitative evaluation of rainstorm erosivity (RUSLE EI30 index) requieres rainfall kinetic energy and intensity values associated to 30 minutes observation time intervals (Renard *et al.*, 1997)

$$EI30 = E \cdot i_{30}$$

Rainfall kinectic energy

Rainfall intensity (30 min)

The *R* factor is the average value of the annual cumulative EI30 over a given period.

Methods

Several empirical laws have been proposed to link daily rainfall erosivity to daily rainfall:

Richardson model (Richardson *et al.*, 1983)

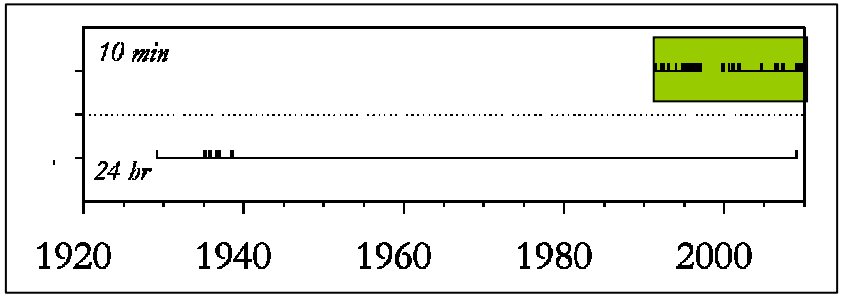
Yu and Rosewell model (Yu and Rosewell, 1996)

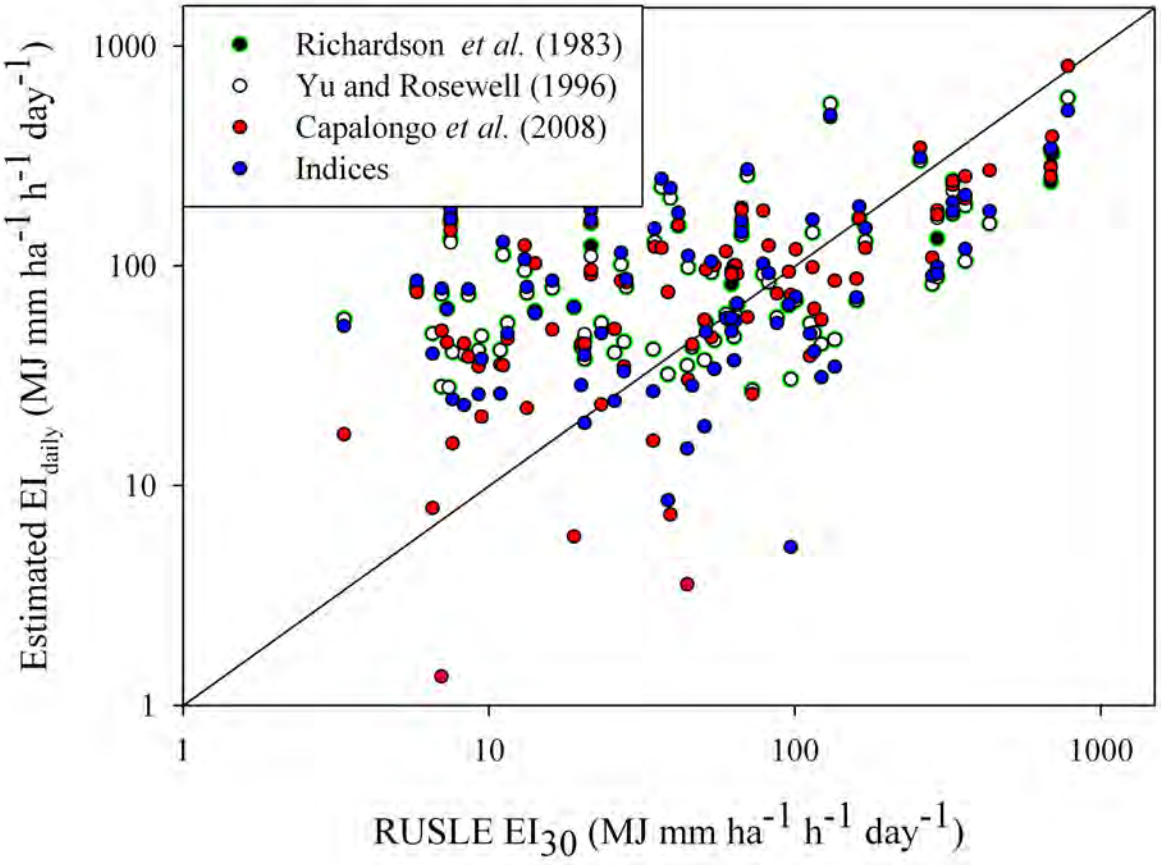
Capalongo model (Capalongo *et al.*, 2008)

Indices model (Mannaerts and Gabriels, 2000)

Erosivity Models Calibration

1991-2009

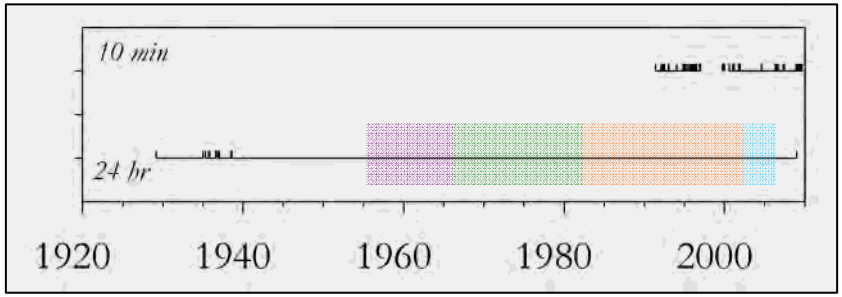




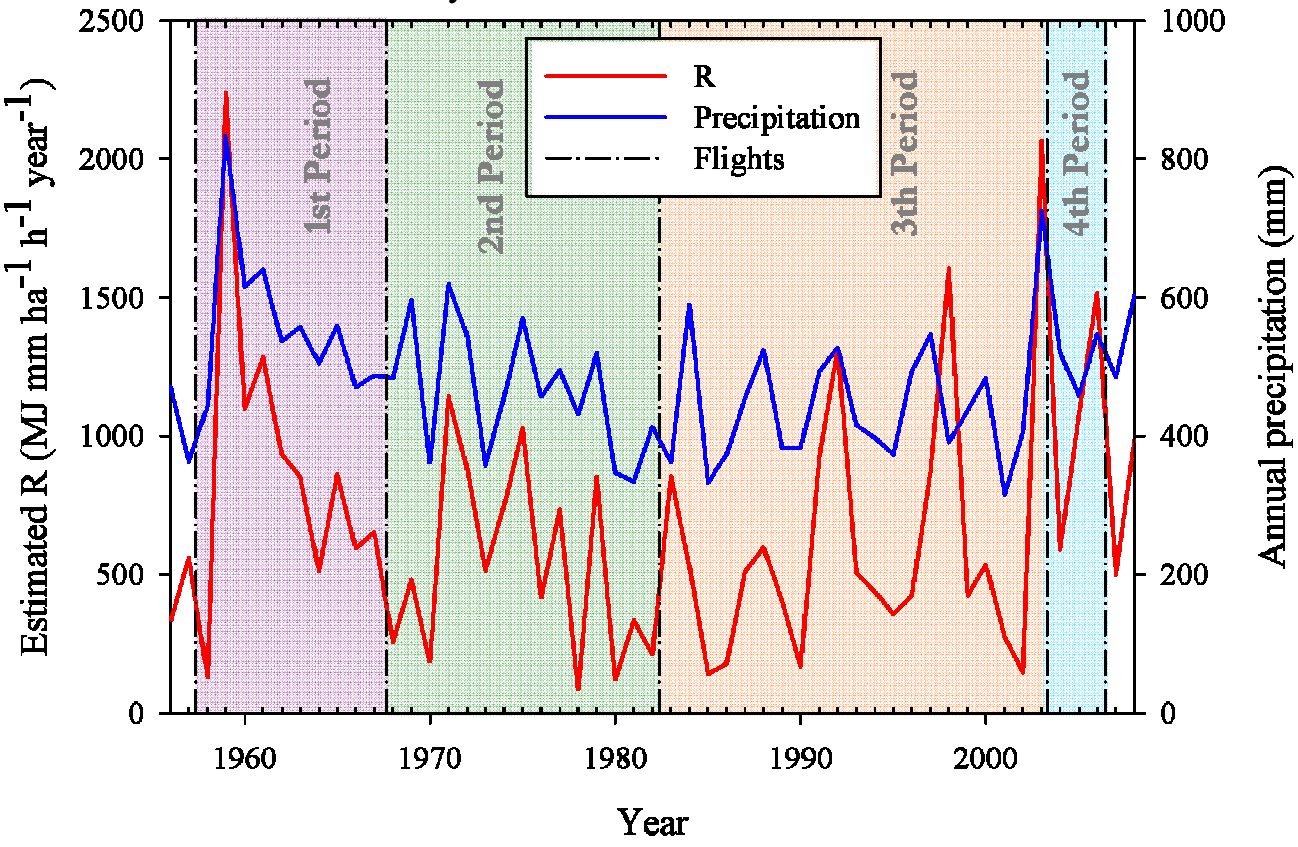
Model	Nash's Efficiency index
Richardson	0.44
Yu and Rosewell	0.44
Capalongo	**0.64**
Indices	0.43

Historical Erosivity

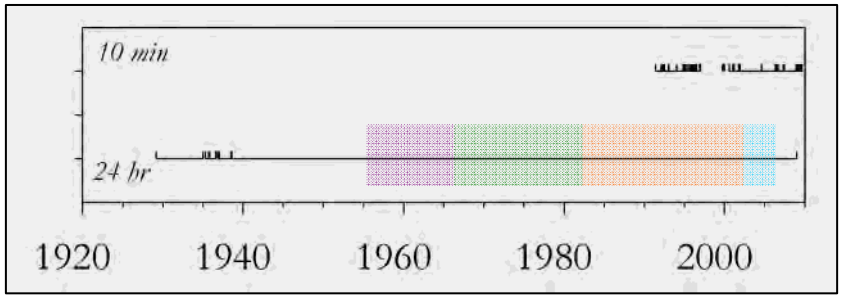
Capalongo model was used to estiate the daily erosivity index



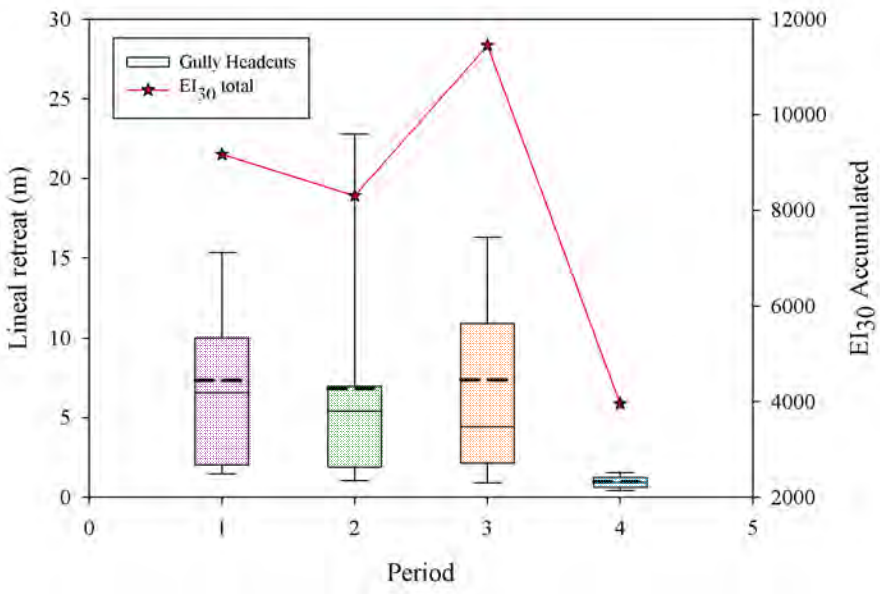
Evolution of annual erosivity index, R.

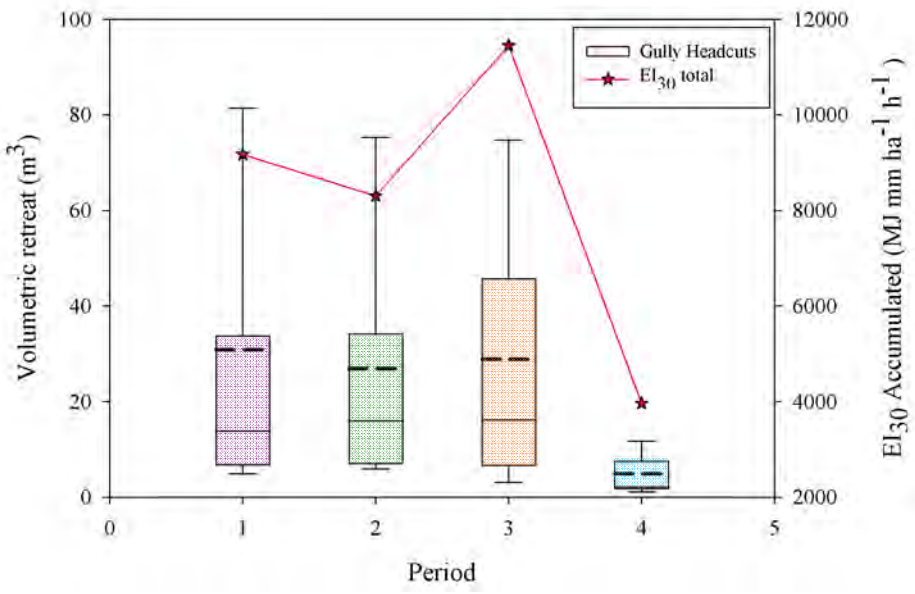


Gully Heacut Erosion



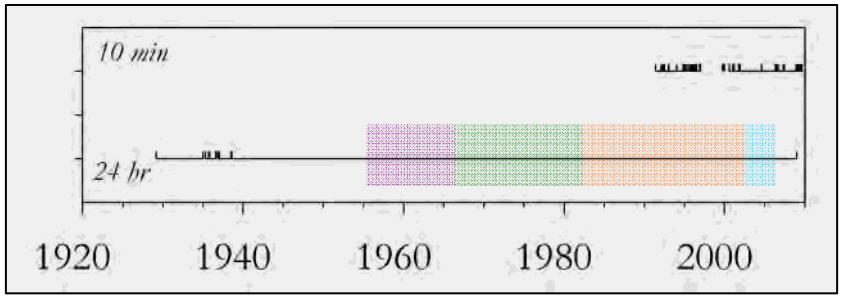
Relationship between lineal and volumetric gully headcut retreat with the cummulative erosivity index.



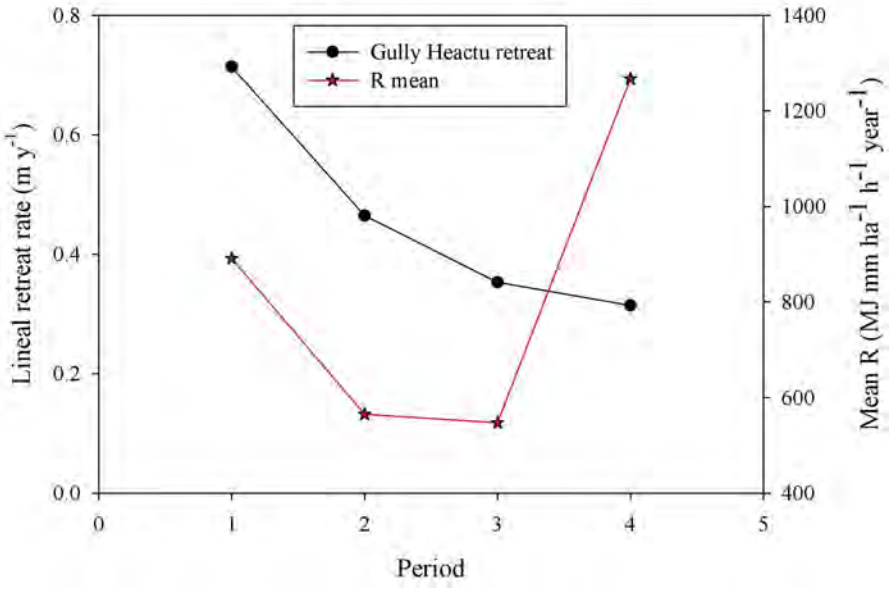


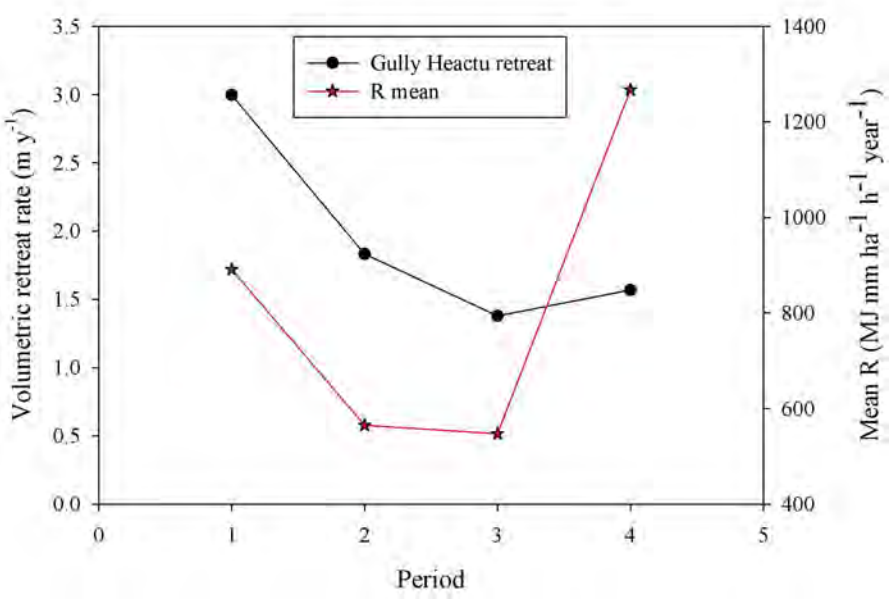
There was a positive relationship between lineal / volumetric gully headcut retrat and the acumulated erosivity index

Gully Heacut Erosion



Relationship between lineal and volumetric gully headcut retreat rate with the average annual erosivity index.





Decreasing trend with the time, except for period 2003-2006 with a rising

Conclusions

• RUSLE-EI30 erosivity index can be calculated from Daily Precipitations Records. In particular, the calibrated model of Capalongo shows a good performance.

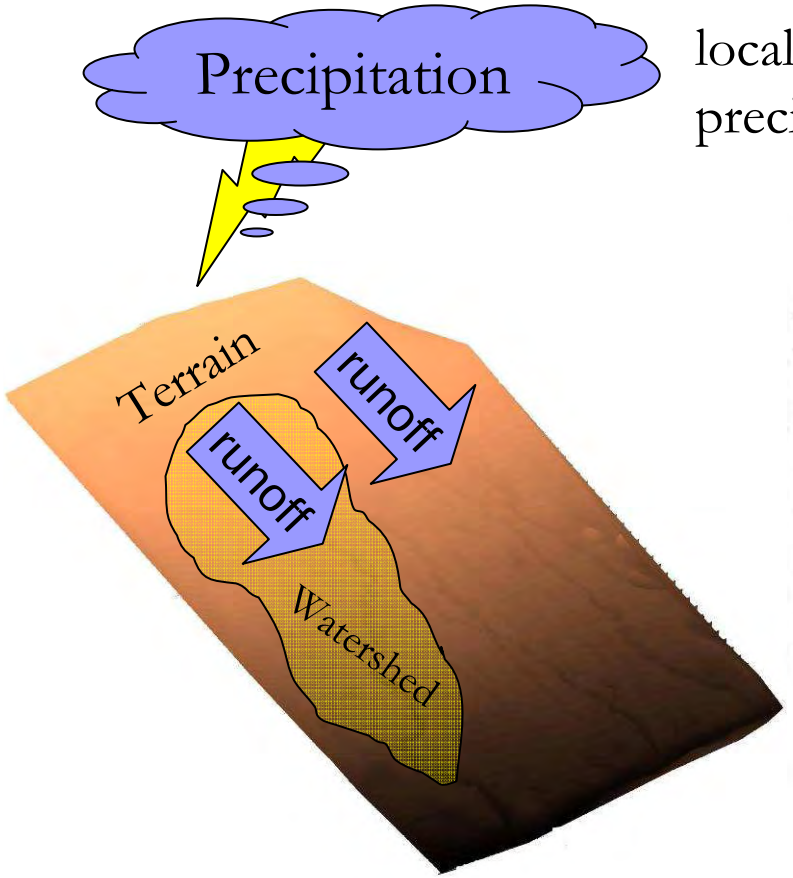
• For a time period of 47 years (1956-2006) the mean annual value of the erosivity index shows a clear decreasing trend with time, except for period 2003-2006 with a rising.

• For each period of time analyzed, there is a positive relationship between volumetric retreat gully with mean annual erosivity index.

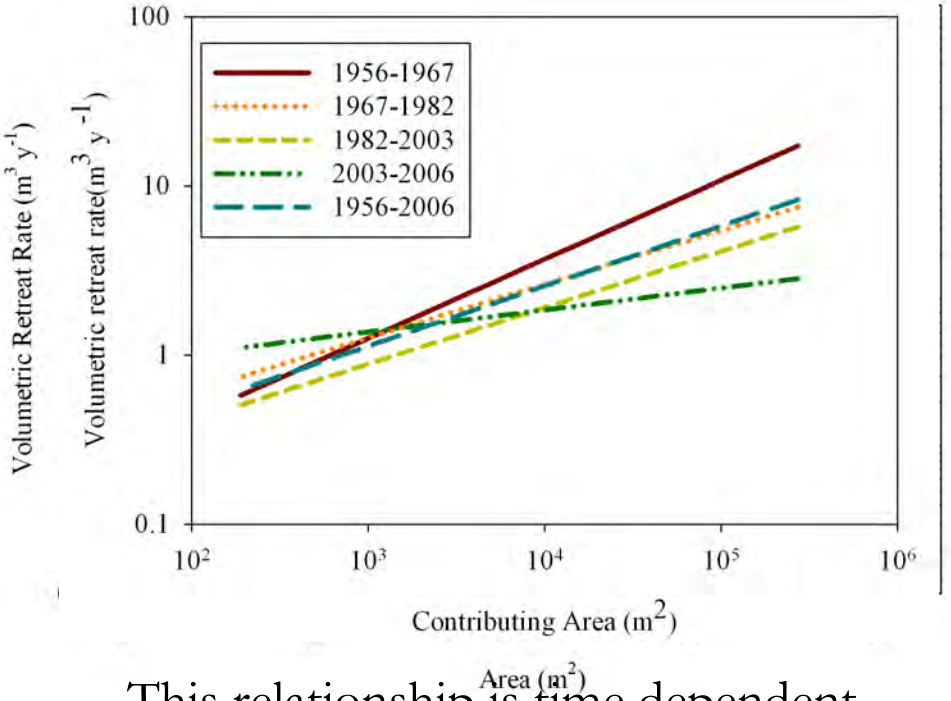
• The erosivity index appears as a key factor in gully headcuts dynamic.

• The present method appears as a very useful tool to be used when the available precipitation data set has not an adequate temporal resolution.

Introduction

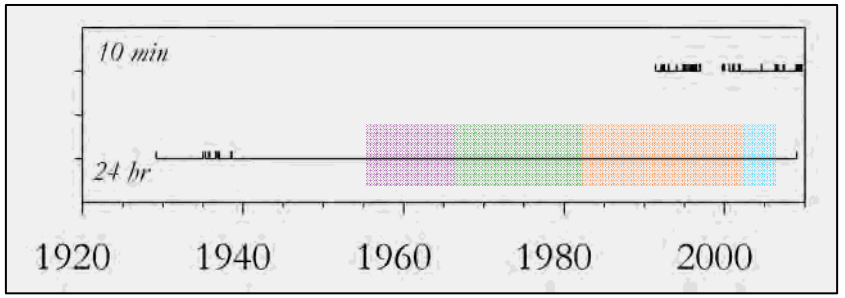


Current models use some kind of relationship between local slope gradient and upslope contributing area as precipitation -and hence discharge- surrogate

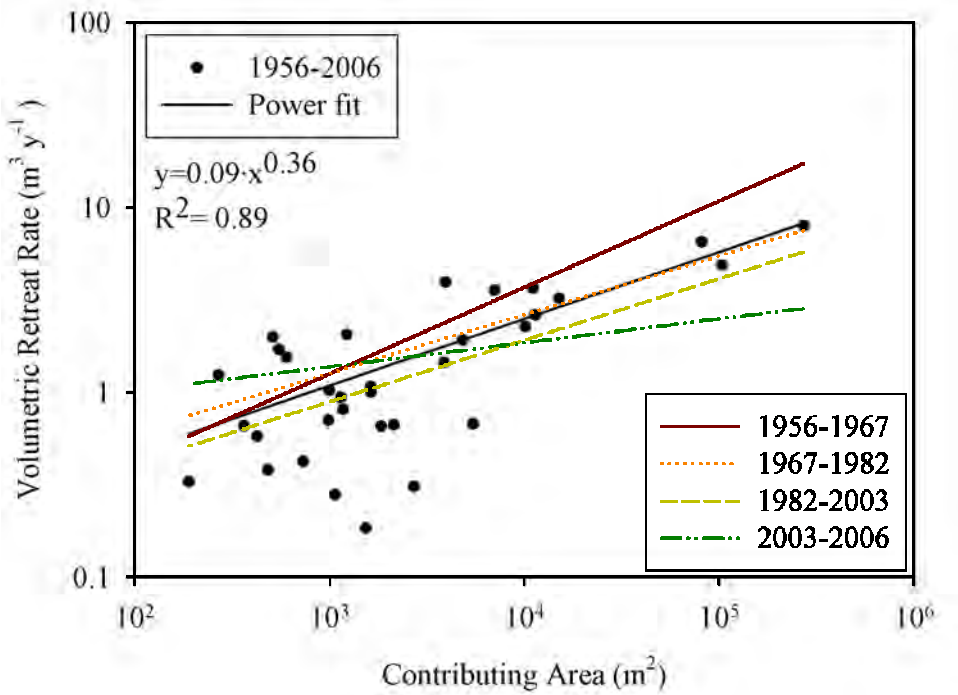


This relationship is time dependent

Gully Heacut Erosion



Currently, several empirical gully headcut predicting models use some kind of relationship between local slope gradient and upslope contributing area.



Considering the precipitation effect (time variable) could improve Gully Headcut Retreat predictions. Like previous works by Thomson (1964) and USDA (1966)