SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Prevention measures for soil erosion and torrent control in Italy

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Soil erosion by water is a serious environmental problem in many countries of the world. It is well recognized that its impact may affect the economy of large geographical contexts as it can be quantified in terms of both on-site and off-site effects.

One of the main on-site effects is certainly related to the loss of soil productivity and to the consequent need to re-integrate the soil resources using different strategies and programs.

In addition, even if upland soil loss may enhance soil productivity of the downstream lands, the consequences due to sedimentation of reservoirs and eutrophication of waterways (some of the off-site effects) cause further expenses.

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Based on the results provided by combining bio-physical and macroeconomic models, Panagos et al. (2018) established that the annual cost of loss in agricultural productivity is estimated at around €1.25 billion in the EU and Italy seems to be the country that suffers the highest economic impact.

Assessing the impacts of climatic and land use changes on rates of soil erosion is the objective of many national and international research projects. These researches have concentrated both on sheet (interrill) and rill erosion processes operating at the plot scale, and on gully and fluvial erosion related to larger spatial scales (small and large catchments).

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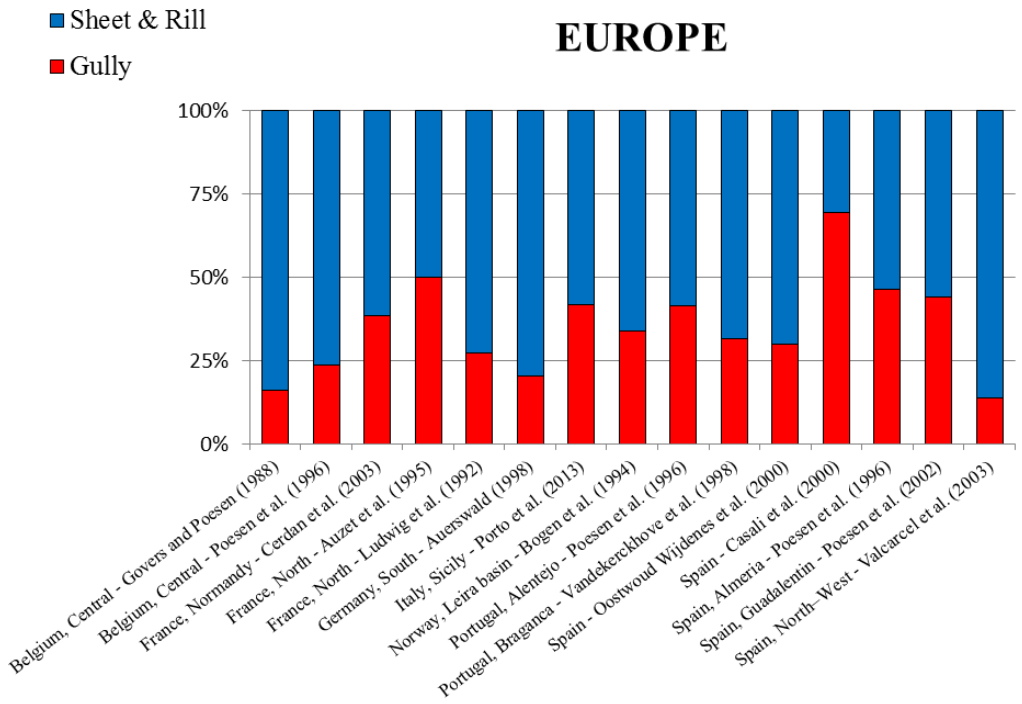
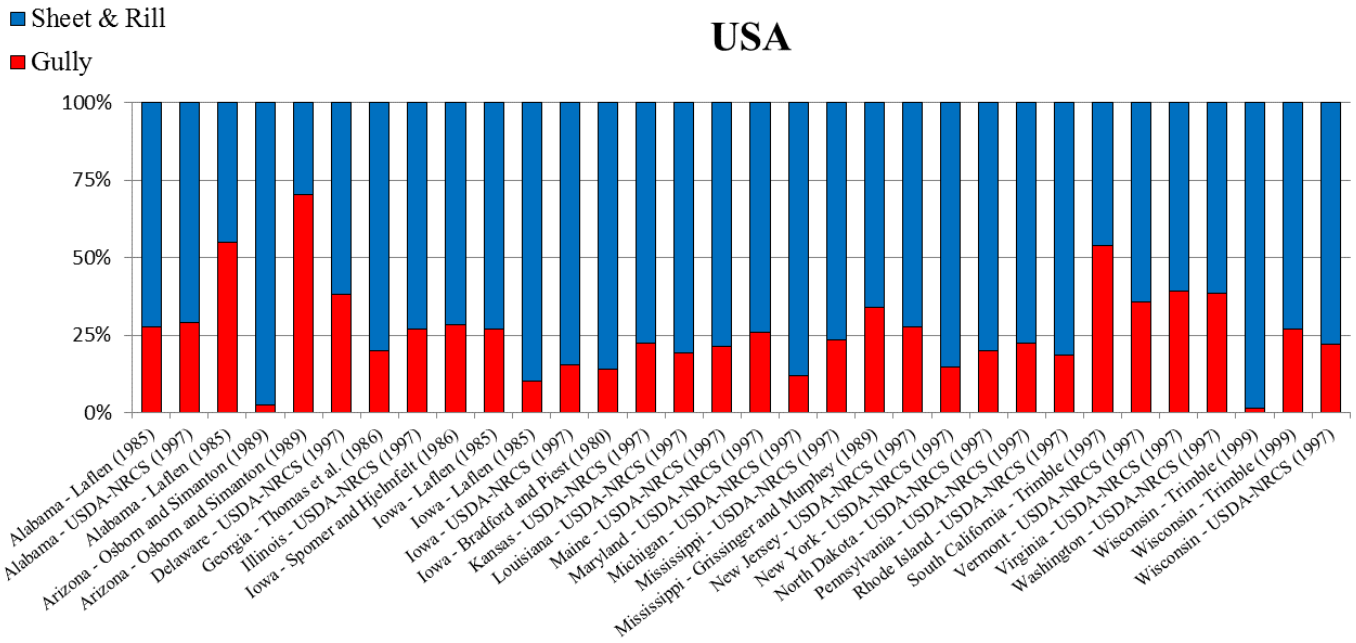
Contributions related to surface and linear erosion obtained by different authors in several countries (Poesen, 2003).





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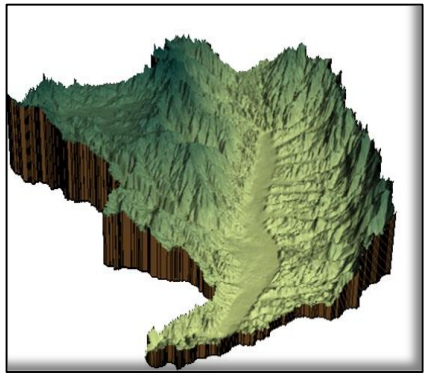
Methods for estimating surface erosion

Measurement techniques

experimental plots, catchments

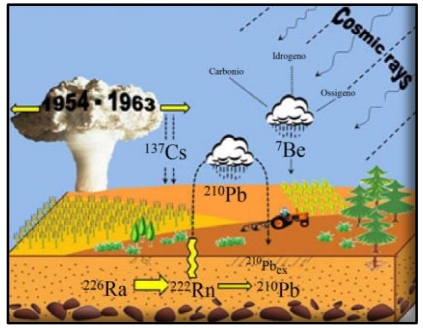
Mathematical models

(RUSLE) (WEPP) (SEDD) (LISEM)
(EUROSEM) (AGNPS)



Environmental radionuclides

(^{137}Cs) (^{210}Pb) (^{7}Be)



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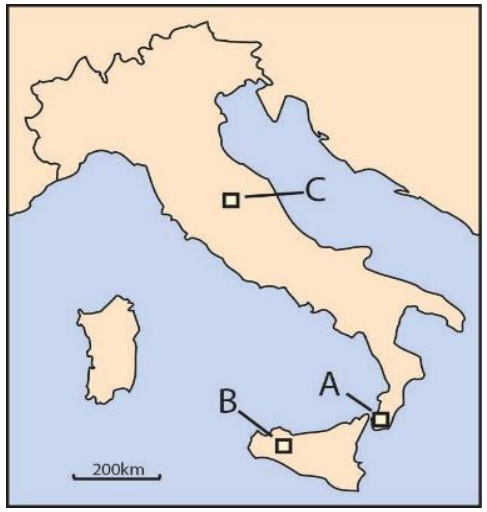
Measurement techniques

experimental plots

A)



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Measurement techniques

experimental catchments

(hillslope component)

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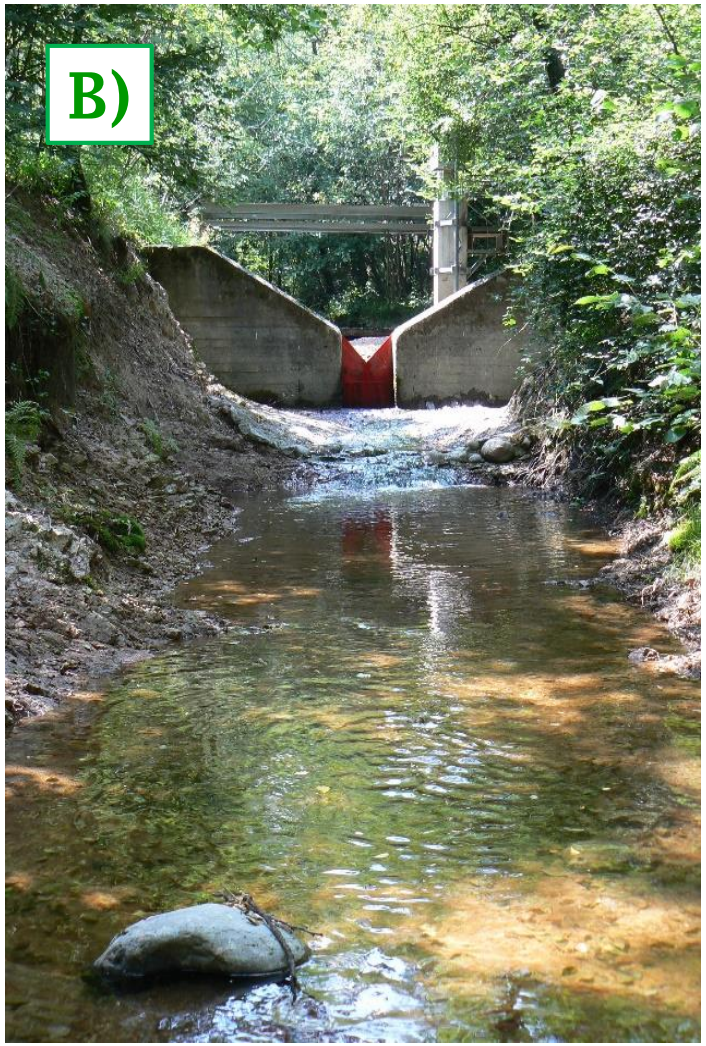
Measurement techniques

experimental catchments

(channel component)



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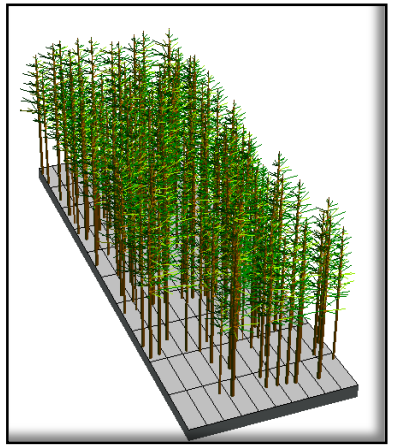
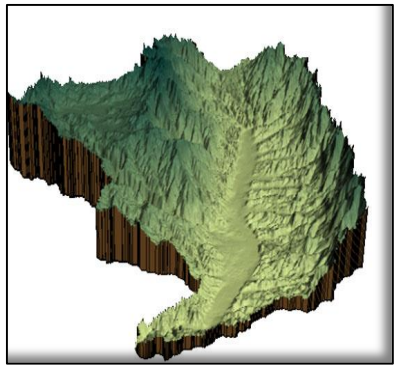
Mathematical models

USLE, RUSLE, MUSLE, SEDD, WEPP, EUROSEM, AGNPS, ANSWERS etc.

Plot

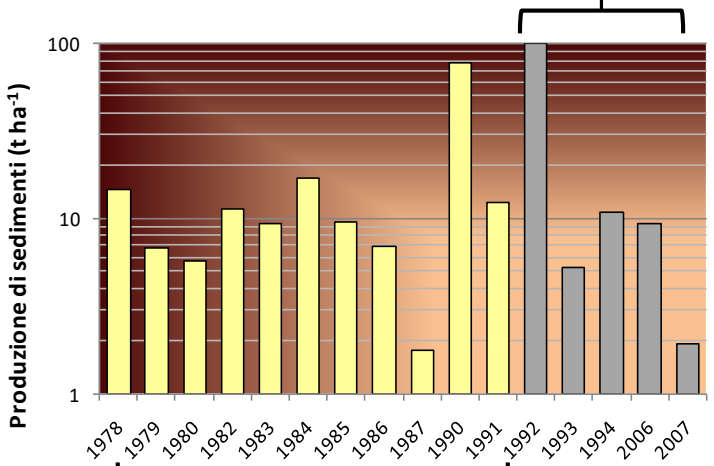


Catchment



CALIBRATION

VALIDATION



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Prevention measures for mitigating erosion rates

The afforestation programme -

Examples of afforestation experiment include a study implemented in 1978 within the framework of the National Research Council of Italy (CNR) 'Soil Conservation Project', that investigated the hydrological response and sediment yield of three small catchments, ranging in size from 1.38 ha to 1.65 ha, located near Crotone in Calabria (see Avolio et al., 1980; Iovino and Puglisi, 1991).

The grade-control structures programme -

In Italy, the construction of transverse structures (check dams and bed sills) along the thalweg is a method widely used for stabilizing streams, reducing channel degradation and preventing sediment deposition downstream.

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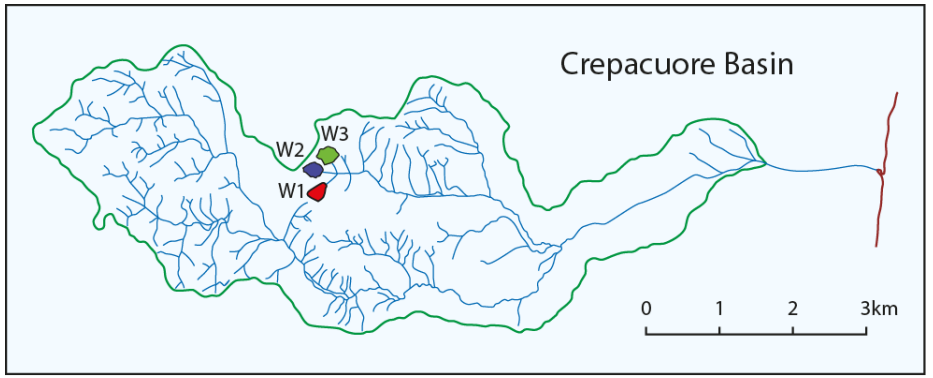
Catchment W1 – Rangeland (1.47 ha)



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Catchment W2 – ECNU (1.37 ha)

1978

1990 cutting

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Catchment W3 – ECU (1.65 ha)

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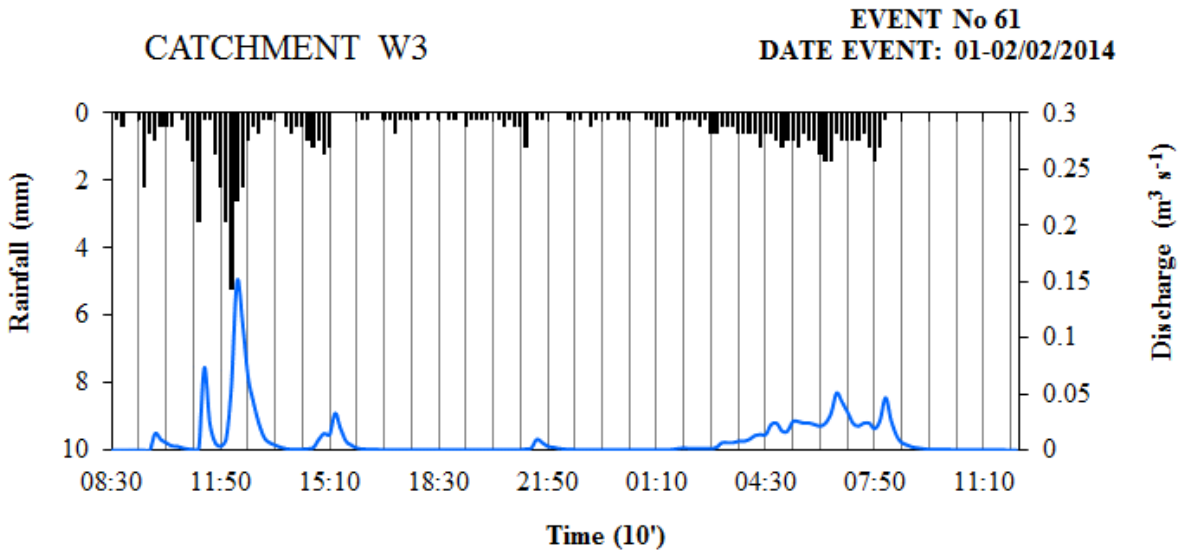
THE EQUIPMENT – Rainfall and runoff measurements



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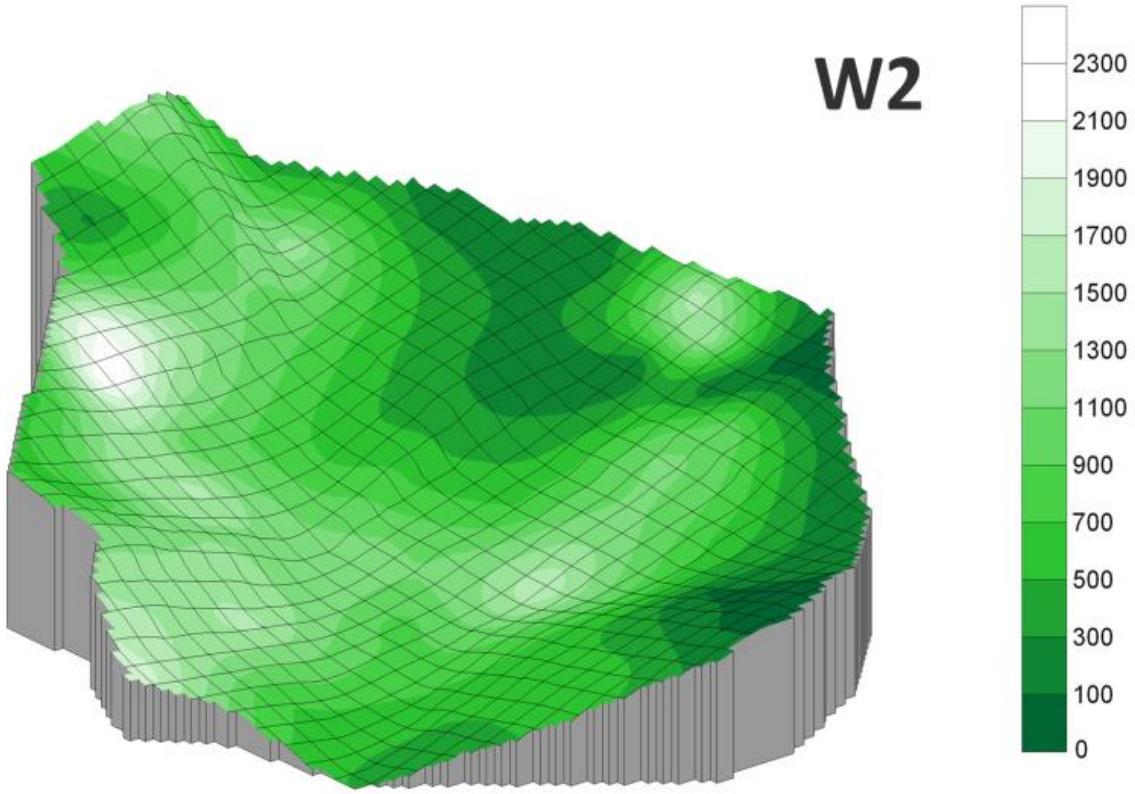
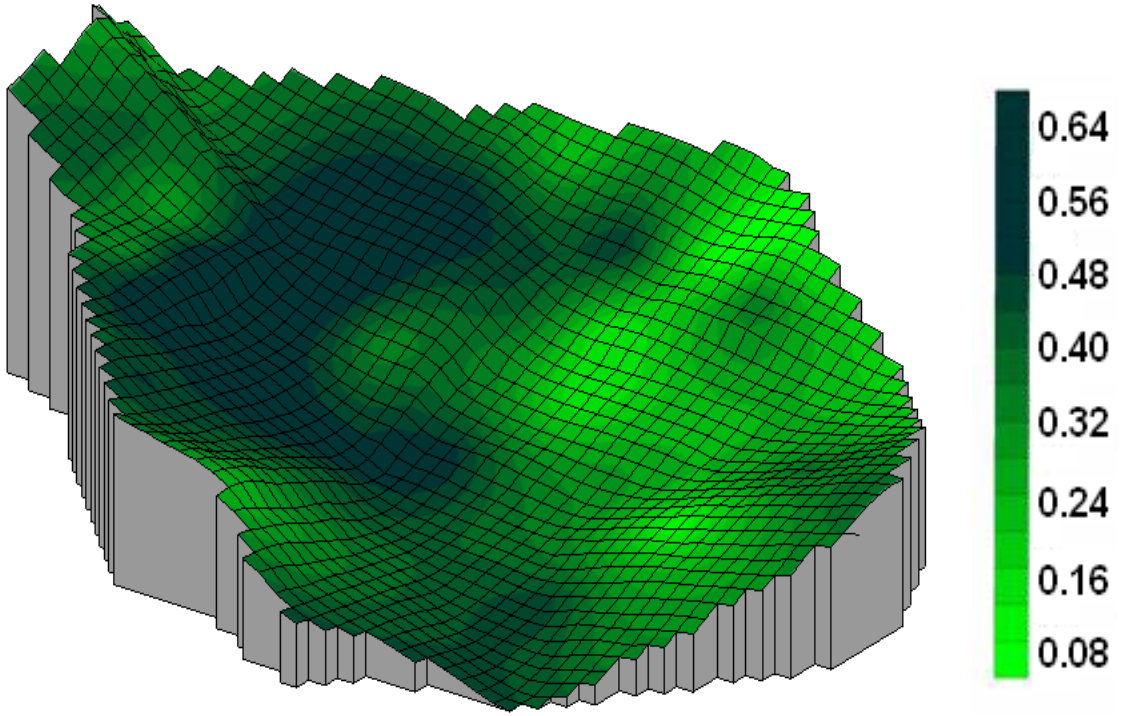
Effect of afforestation

Caesiographic Map



Canopy cover Map



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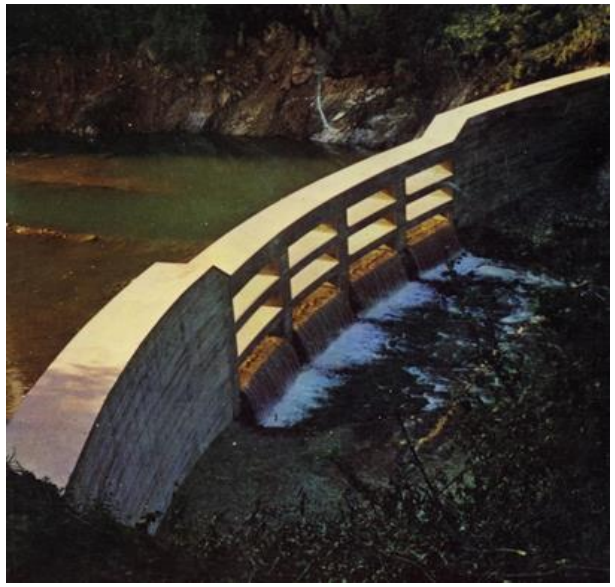
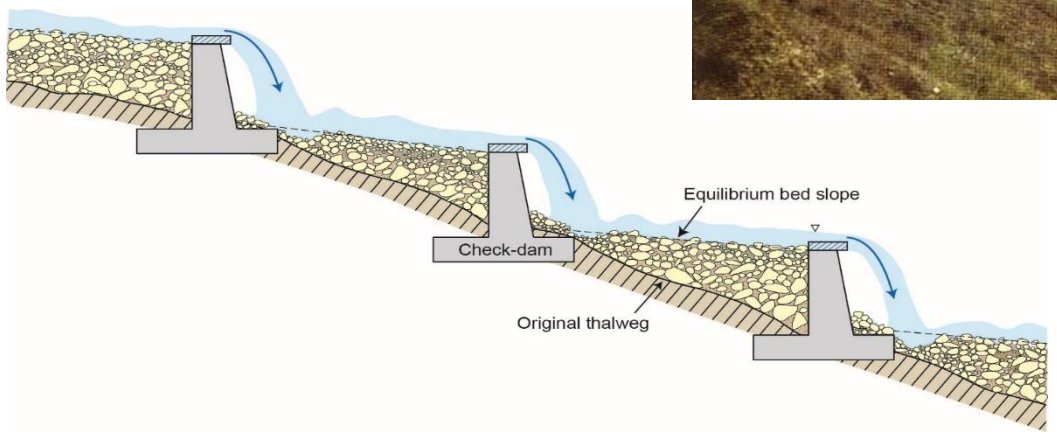
The grade-control structures programme





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In many areas of Italy, dominated by the presence of torrents, the use of check structures is essential.

Torrents are that particular type of streams having modest catchment areas (50-200 km^2) and characterised by sudden, and often catastrophic floods, alternating with long periods of inactivity.

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Some of them have ephemeral streams draining small catchment areas (5-50 km^2) and characterized by coarse bed material and very steep slopes

Because of their very large transport capacity, the construction of grade-control structures leading to stable slopes is the only economical solution to reduce damages downstream.

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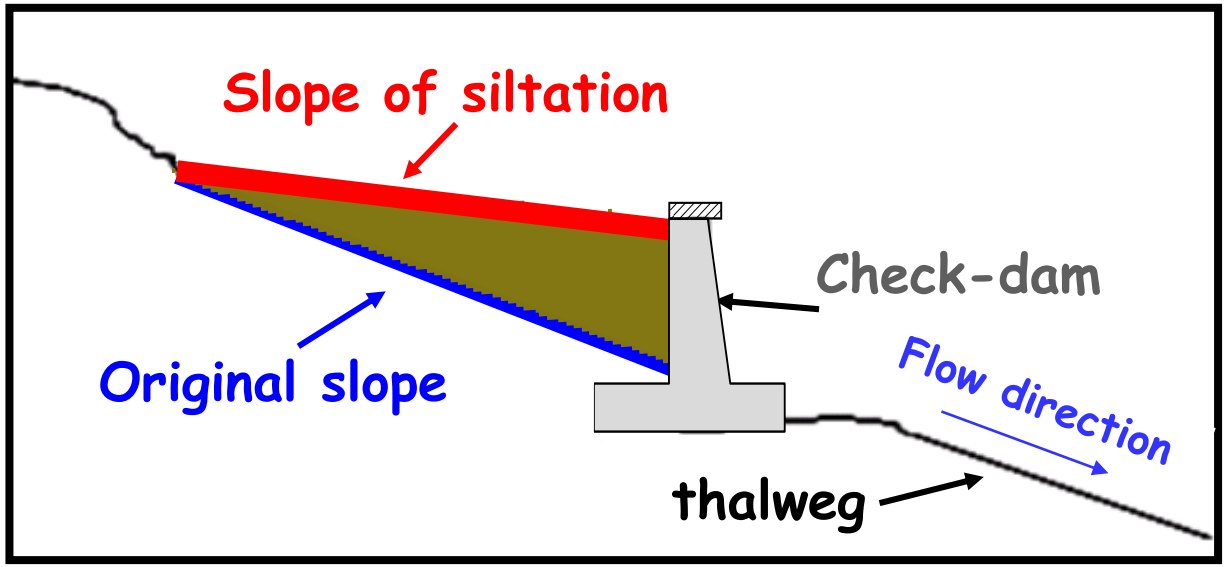
Predicting the equilibrium profile is a crucial goal in designing the check-dams because it affects the height of each structure and the distance between them. For this reason, most of the recent works carried out in Italy focussed on this problem (Porto and Gessler, 1999; Ferro and Porto, 2011).

The streambed upstream of the structures holds deposited sediments and results in a decrease of the longitudinal slope



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GENERAL METHODS

Empirical → Regime formulas → Correlation parameters

Theoretical → Incipient motion → Critical values (τ_C, V_C)

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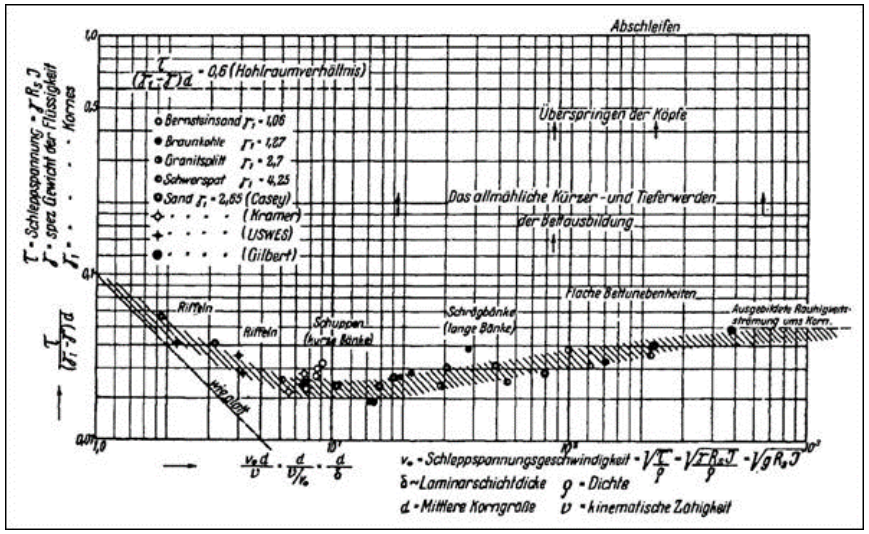
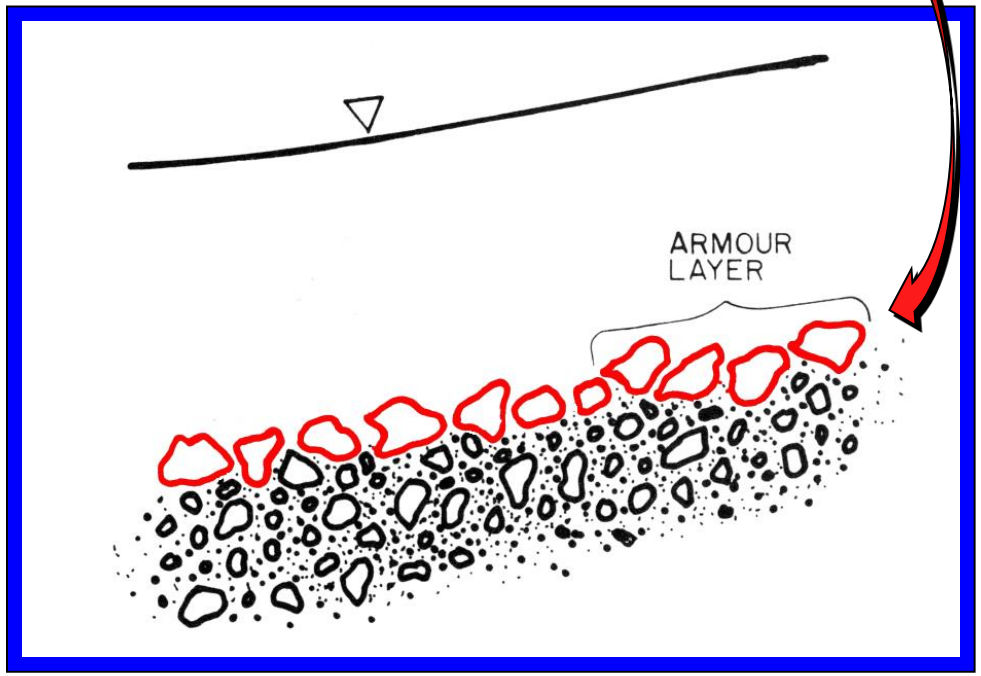
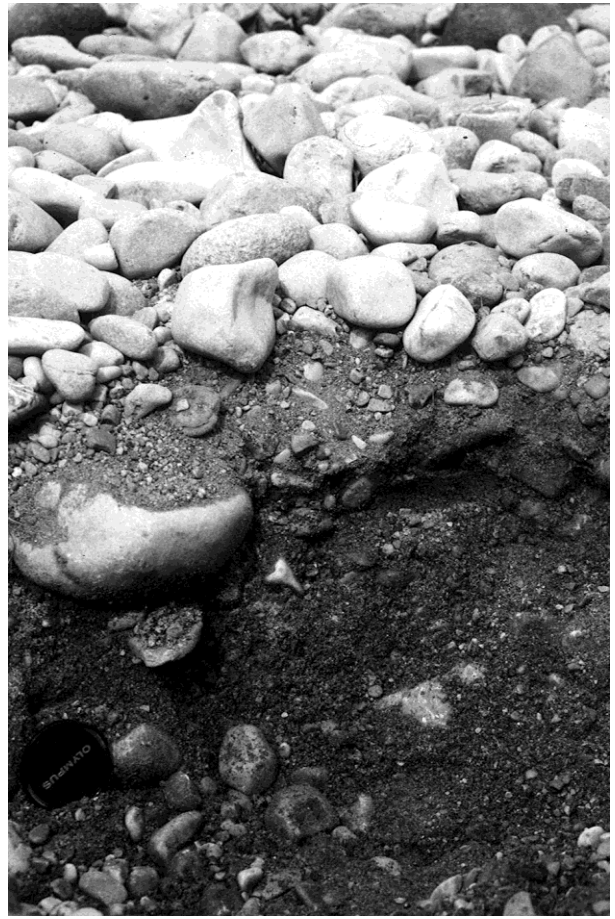
The theoretical approach

This approach requires some subjective choices concerning the use of a sediment transport equation, the calculation of a dominant discharge and the sampling criterion for collecting the bed material.

$$\tau_{cm} = 0.045\left(\gamma_S - \gamma\right)D_{AVG_a}$$







Solution related to the armouring problem

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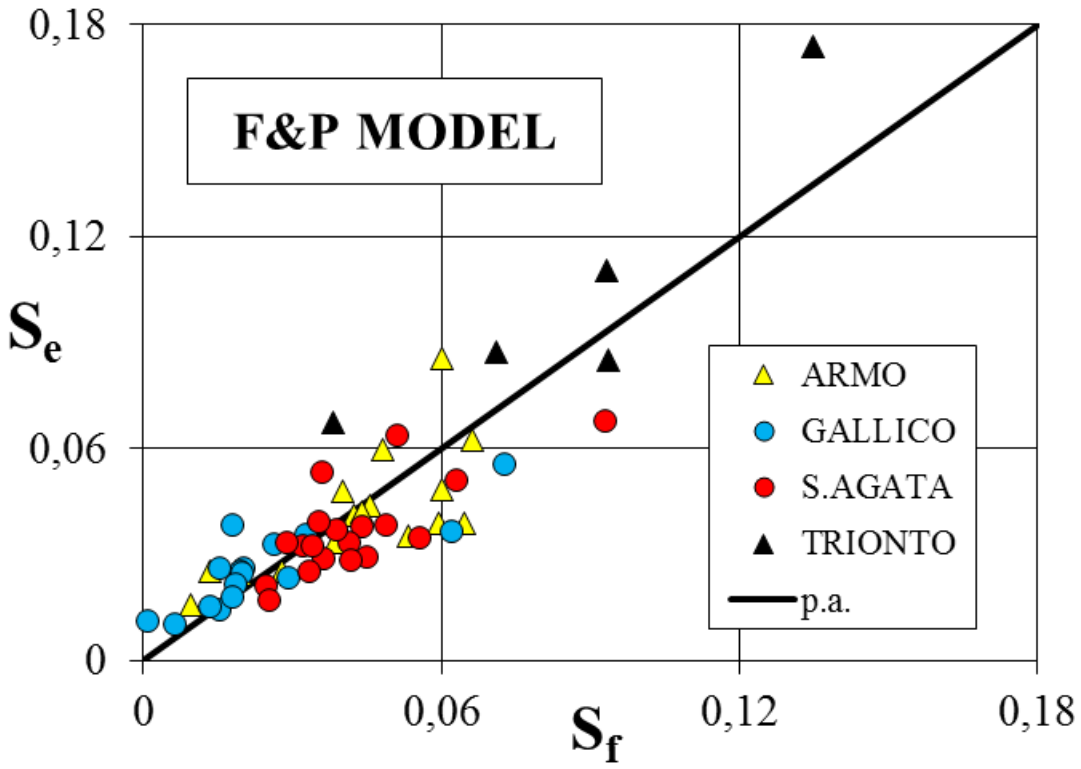
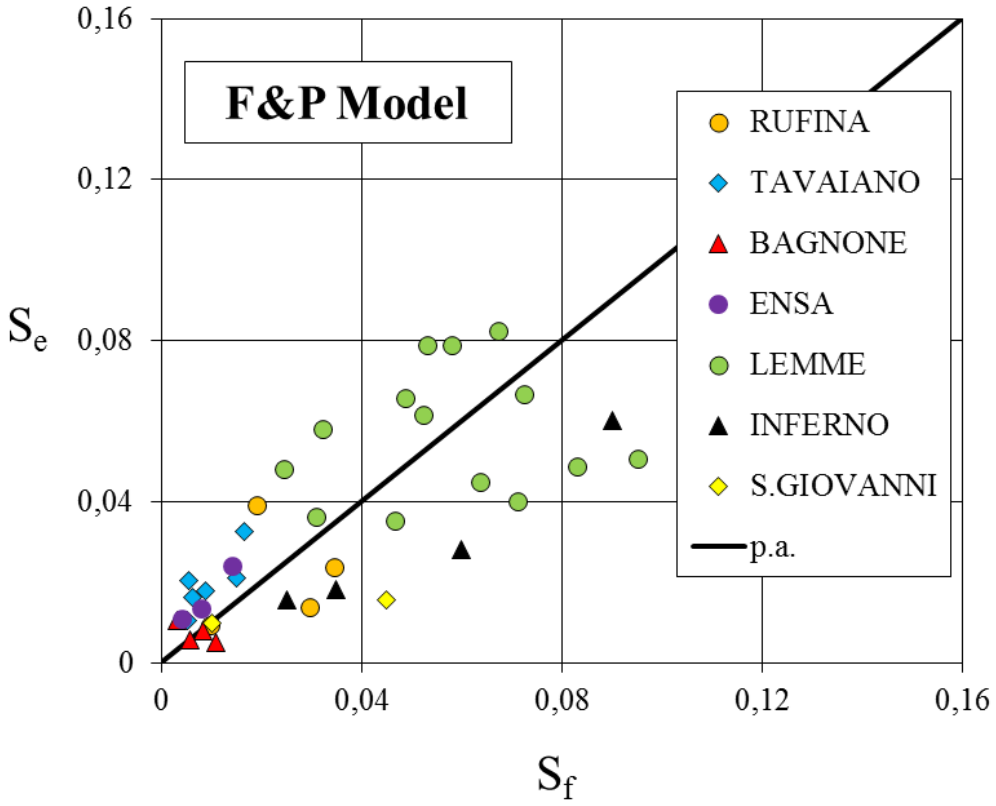
Results for torrents in Central and South Italy





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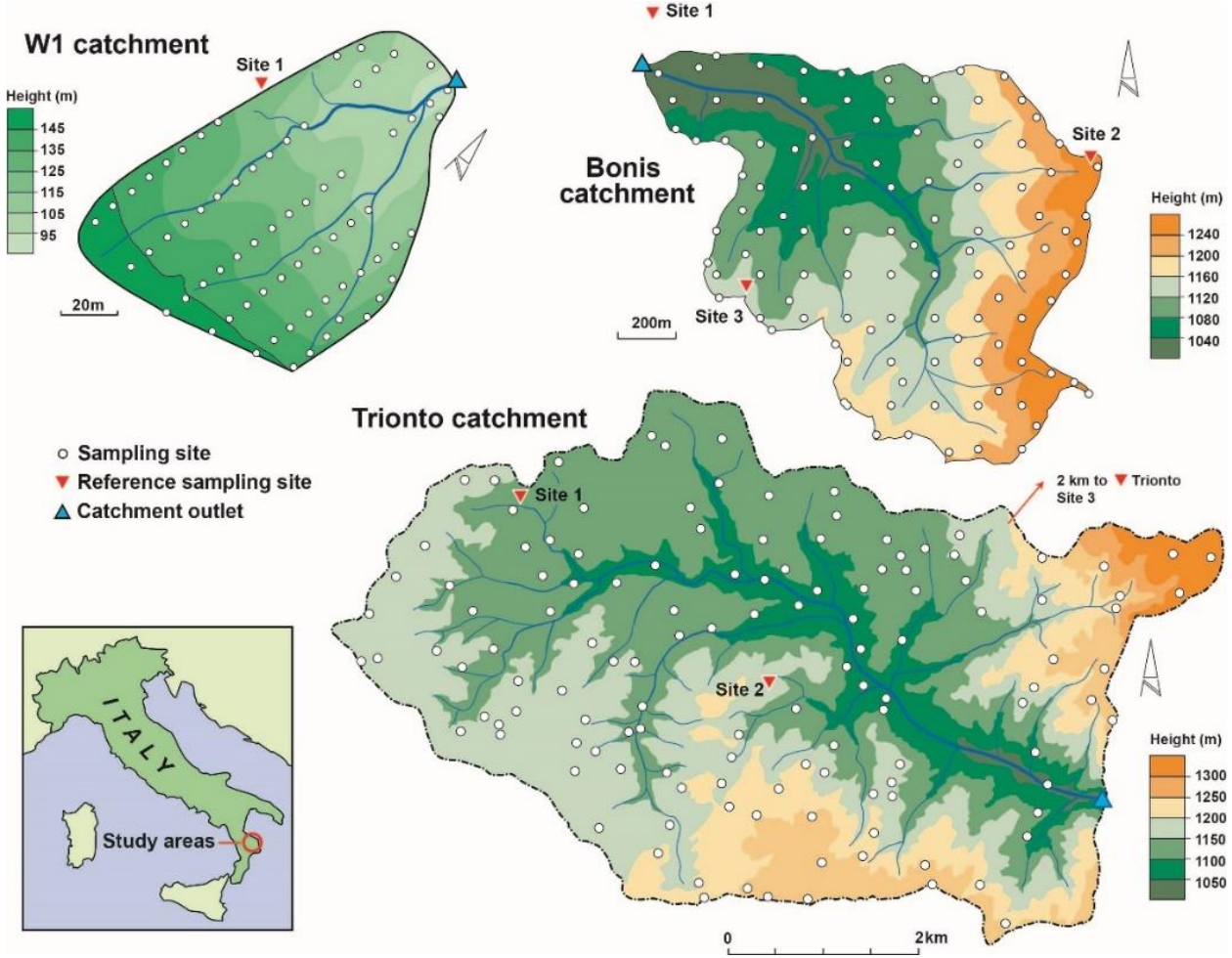
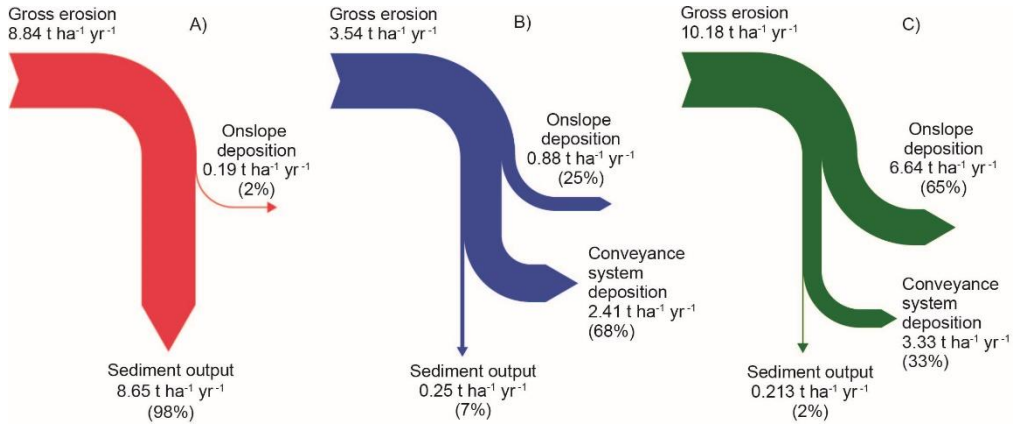
New trends of erosion and torrent control in Italy



THE SEDIMENT BUDGET

using radionuclides



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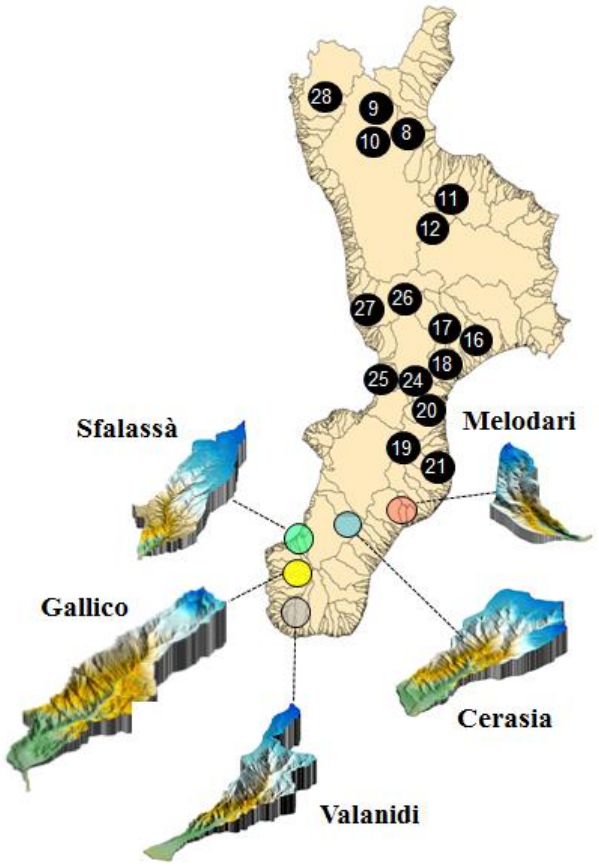
New trends of erosion and torrent control in Italy

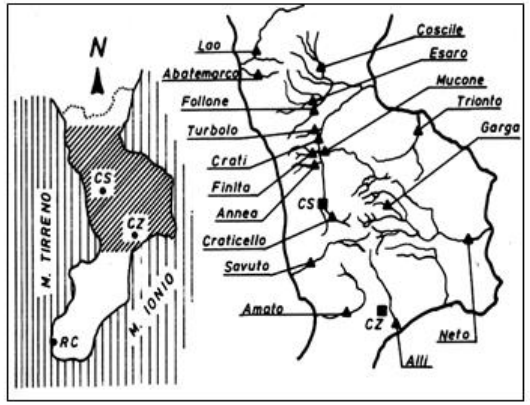
A new flow resistance law using a theoretically approach based on the dimensional analysis and the self-similarity theory



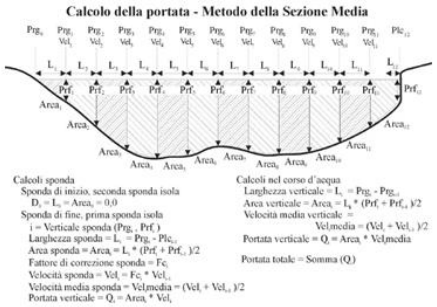
The Hydrographic Service dataset

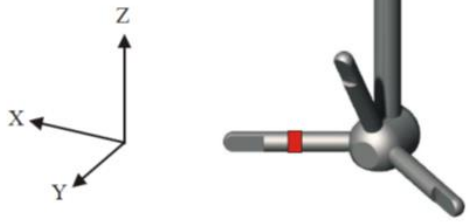
River	Cross section	CODE	River	Cross section	CODE
Alaco	Pirrella	21	Crati	Conca	8
Alli	Orso	17	Esaro	La Musica	10
Amato	Marino	24	Garga	Torre Garga	12
	Licciardi	25	Lao	Pie' di borgo	28
Ancinale	Crisura	20	Mucone	Cecita	11
	Razzona	19	Savuto	Ponte Savuto	27
Corace	Grascio	18		Poverella	26
Coscile	Camerata	9	Simeri	Vincolise (Ponte vecchio)	16

Colosimo et al. (1988) dataset



using ADV measurements





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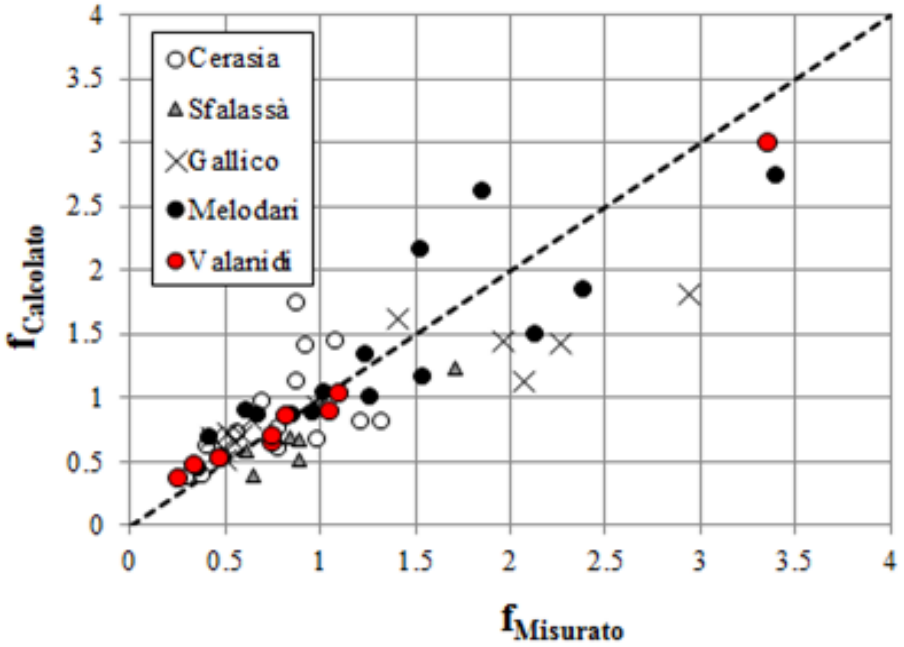
New trends of erosion and torrent control in Italy

A new flow resistance law using a theoretically approach based on the dimensional analysis and the self-similarity theory

$$f = 1.124\, F^{-1.54}\, Y^{0.53}$$



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CONCLUSIONS

One of the key issues that needs to be further explored in the field of soil erosion and torrent control is the absence of strategies aimed at integrating different datasets and approaches to establish a joint criterion useful to provide a complete overview of the problem.

In other words, the information available is mostly heterogeneous and related to a few isolated case studies for each country.

Recently, the European Commission's Soil Thematic Strategy has identified soil erosion as a relevant issue for the European Union, and has proposed an approach to monitor soil erosion. In this respect, a map of soil erosion based on the use of RUSLE2015 is provided for the European countries for the reference year 2010 (see Panagos et al., 2015).

However, some criticisms of the key aspects of soil erosion modelling need to be taken into account. For example, the so called 'USLE derived models', including the various versions of RUSLE, do not account for deposition processes and this must be considered when a map of soil erosion risk is provided at large scale.

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CONCLUSIONS

In order to address sediment-related environmental problems, there is a need to develop an improved understanding of the sediment cascade from source to sink. The sediment budget provides a framework for addressing this need.

However, establishing a sediment budget requires information not provided by traditional monitoring programmes. Sediment tracing techniques can provide this information. There is currently considerable interest in soil and sediment tracing techniques, particularly in Europe.

Recent advances in the development and application of sediment tracing techniques (e.g. Guzman et al., 2013) are now beginning to provide unique means of documenting catchment sediment budgets that meet these new information requirements.

Equally, there is a need to synthesise existing and forthcoming new information related to the structure and functioning of catchment sediment budgets that will be provided by these novel tracing techniques, to provide a firm basis for its use within the EU

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