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CNR - Istituto per la Dinamica dei Processi Ambientali

Applied fluvial geomorphology and streams recovery: a case study while landscape preservation is the highest value

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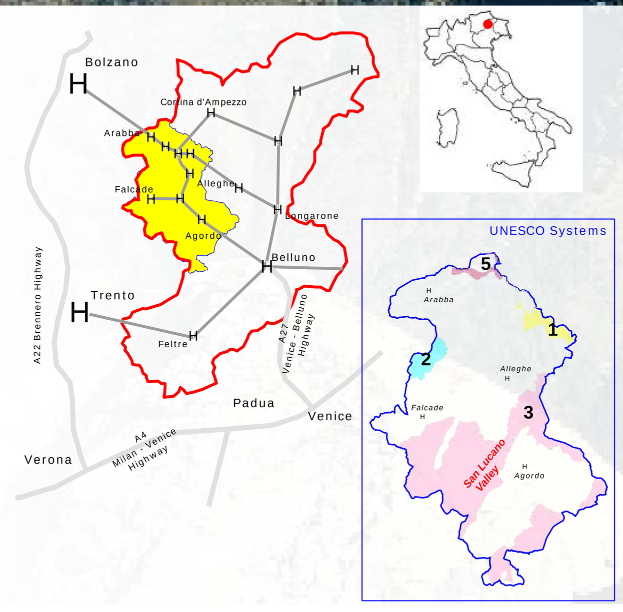
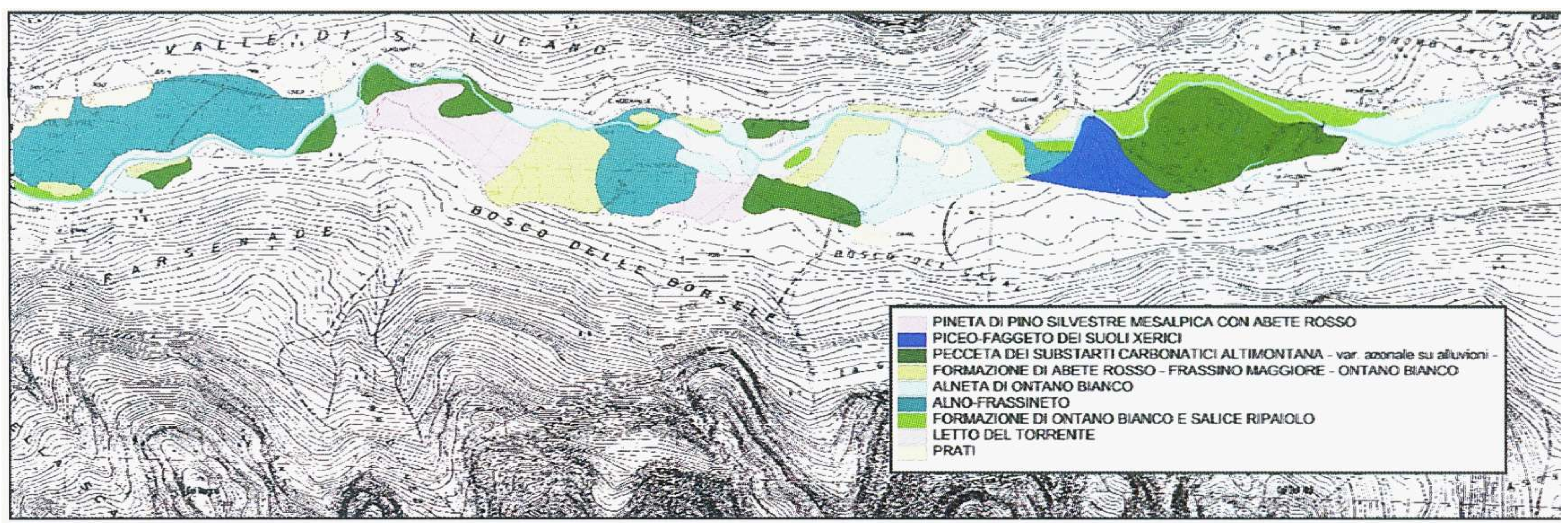
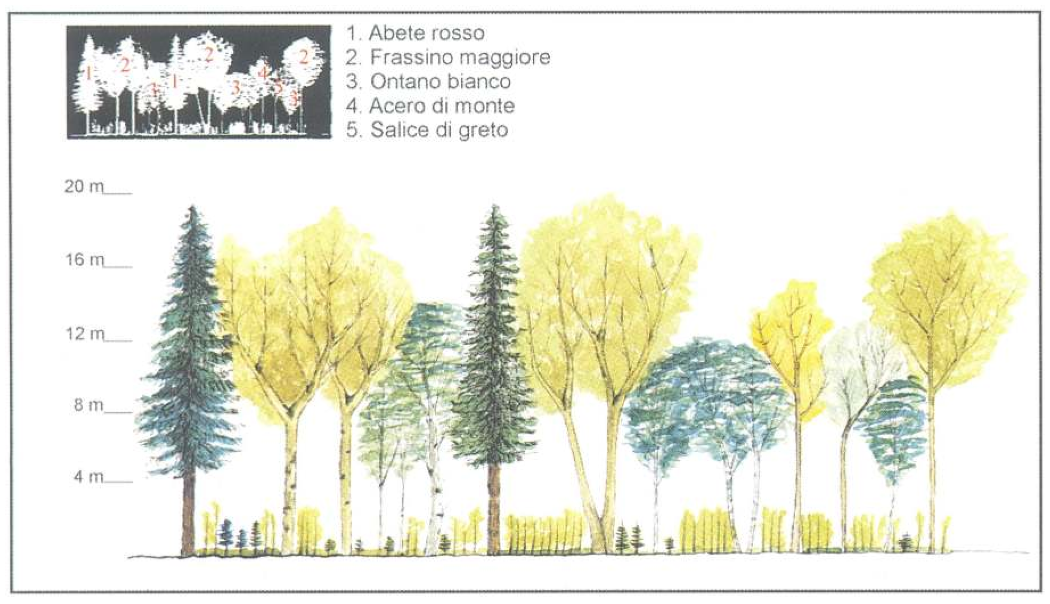


INTRODUCTION

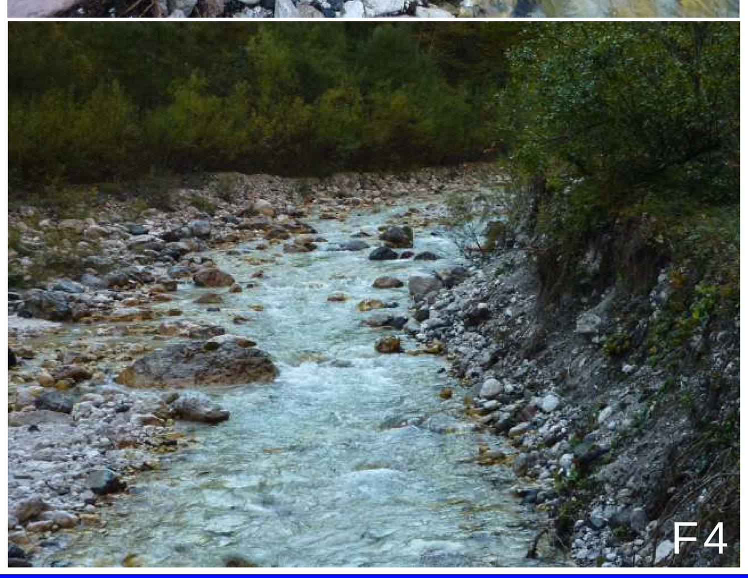
San Lucano Valley (Taibon, Belluno, Italy) is situated in the heart of the Agordine Dolomites, included in the UNESCO System n.3: Pale of San Martino - San Lucano-Belluno Dolomites (Fig. 1).
The valley is a prototype study area for a research project issued from the collaboration among the Dynamics of Environmental Processes Institute (IDPA-CNR-Milano), the Technical Mining Industry Institute (ITIM, Agordo), and the Agordina Mountain Community (CMA), also involving other qualified subjects for environmental and land management (ARPAV; Civil Engineering Treviso).
The project aims to verify the applicability of the methodology referred as Watershed Assessment of River Stability and Sediment Supply (WARSSS - Rosgen, 2006) in the morphological and geological context of the Alps. The long-term perspective based on longer observations is three fold:
- monitoring trends in fluvial and geomorphic condition over time;
- expanding the investigation to the adjacent basins and define a "Dolomites physiographic region";
- introducing the geomorphologic "Natural Channel Design" (NCD) approach in restoring fluvial mountain environment, without disregarding the natural environment quality preservation.





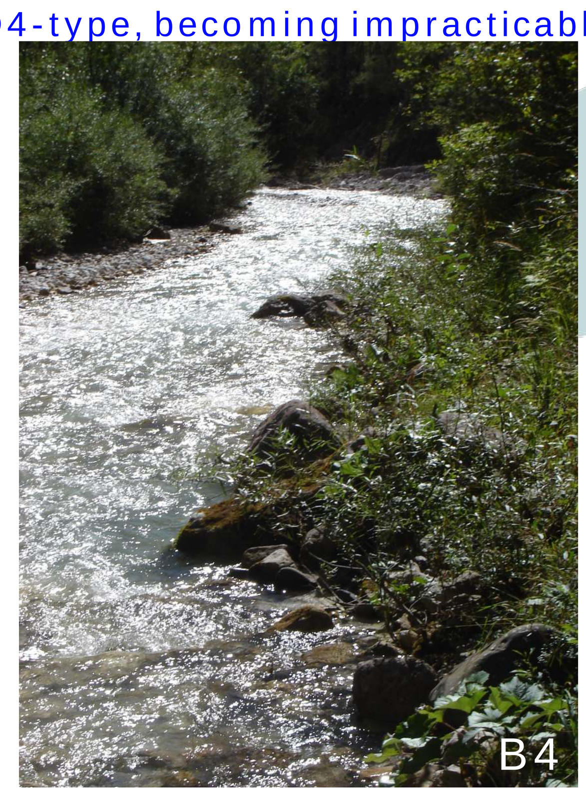
Site BL028 from Natura 2000 network

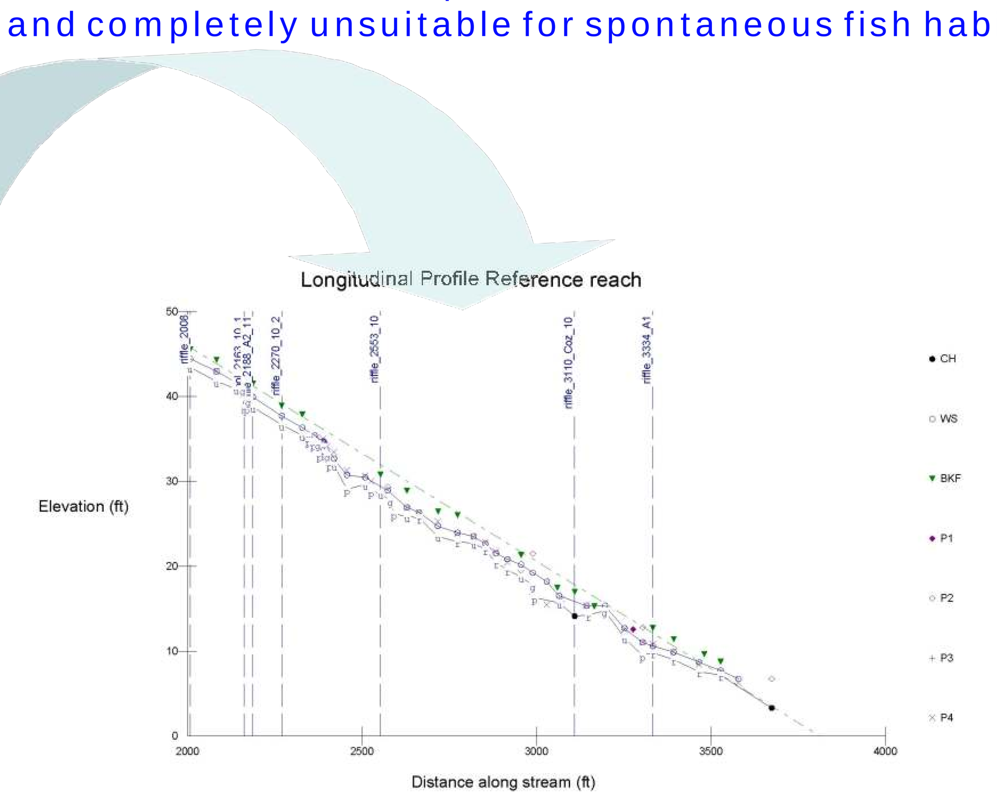
The San Lucano Valley is characterized by extensive riparian forests of high natural interest held by the Community directives. Alnus incana and *Fraxinus excelsior* dominate, followed by Mountain Maple and Spruce.
A) map types. B) Structure found in a formation.
Since the disastrous flood of 1966, significant trees associations were differentiated along the creek and now deserve careful consideration and every possible attention to their stabilization until the next calamity.

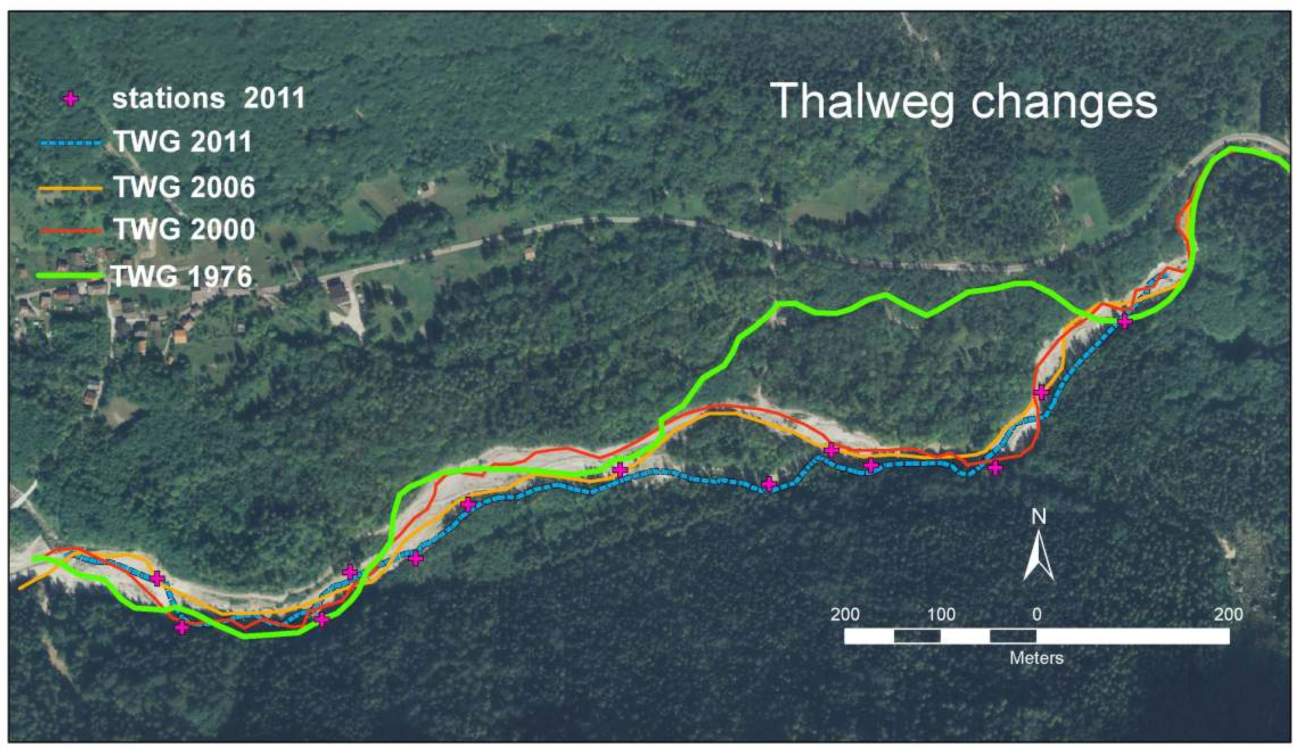


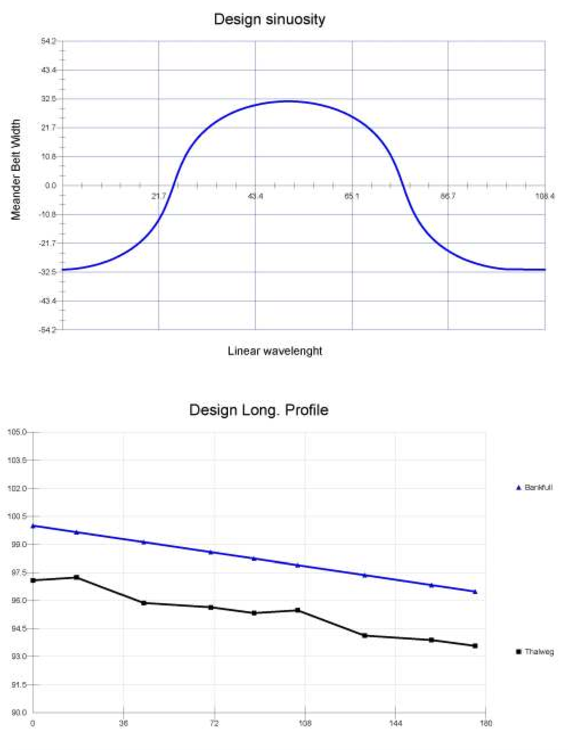
ACTUAL NCD IN S. LUCANO VALLEY

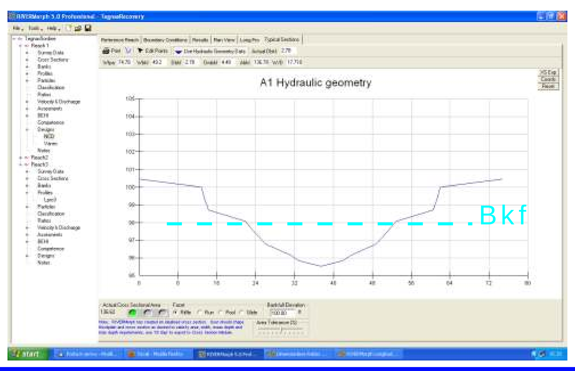
Along the upper Tegnas, three segments of the stream with gradient ranging from 2.6% to 1.9%, are easily delimited: a first upstream disturbed reach (F4-type), a second stable (B4-type) reference reach (load transporting), and downwards, an aggraded reach (D4-type) flowing across a gravel deposit two hundred meters thick (Caielli et al. 2011). This area must periodically be quarried, in order to ensure the hydraulic protection of the sideway road, and a simple "V" shape, single channel, is mechanically rebuilt. Despite the good recovering ability shown by the riverside bush, the period elapsing between the removal activities is shorter than the natural process of re-naturalization. The recovered banks are quickly eroded, and the stream regress to a D4-type, becoming impracticable and completely unsuitable for spontaneous fish habitats and woods growth.





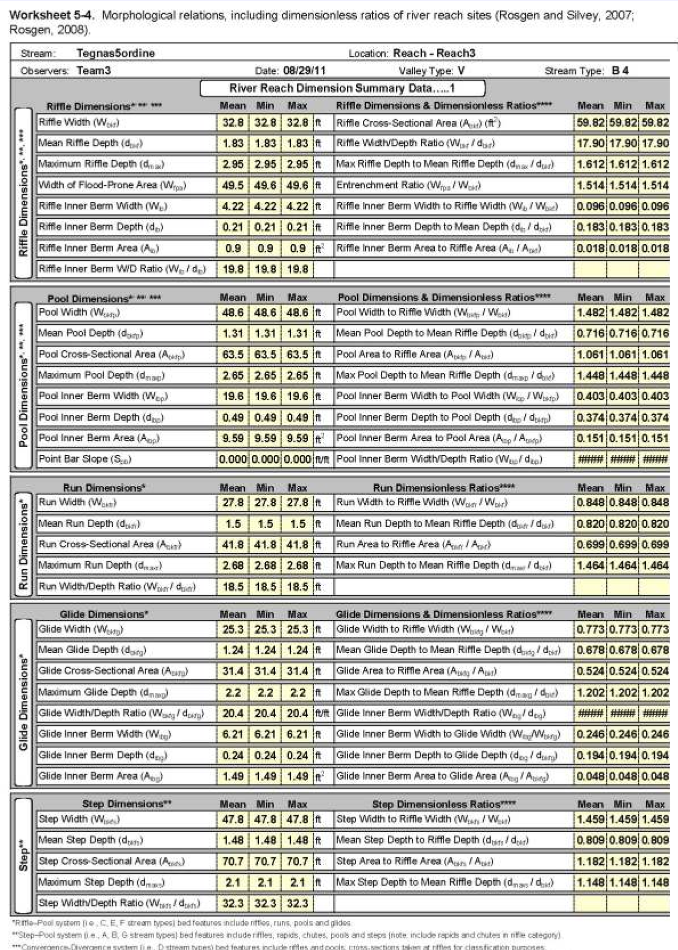


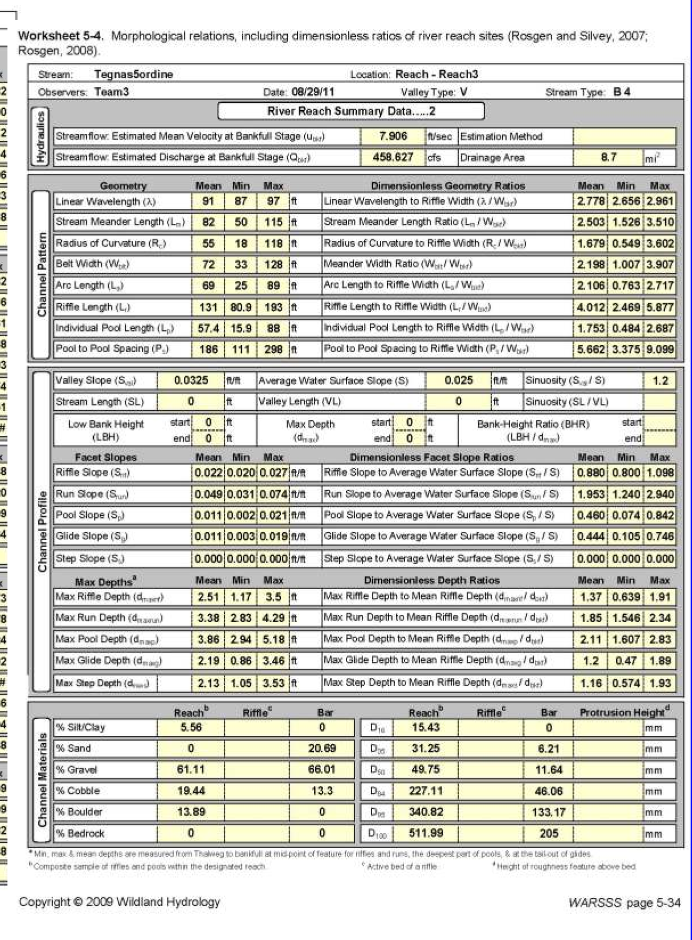


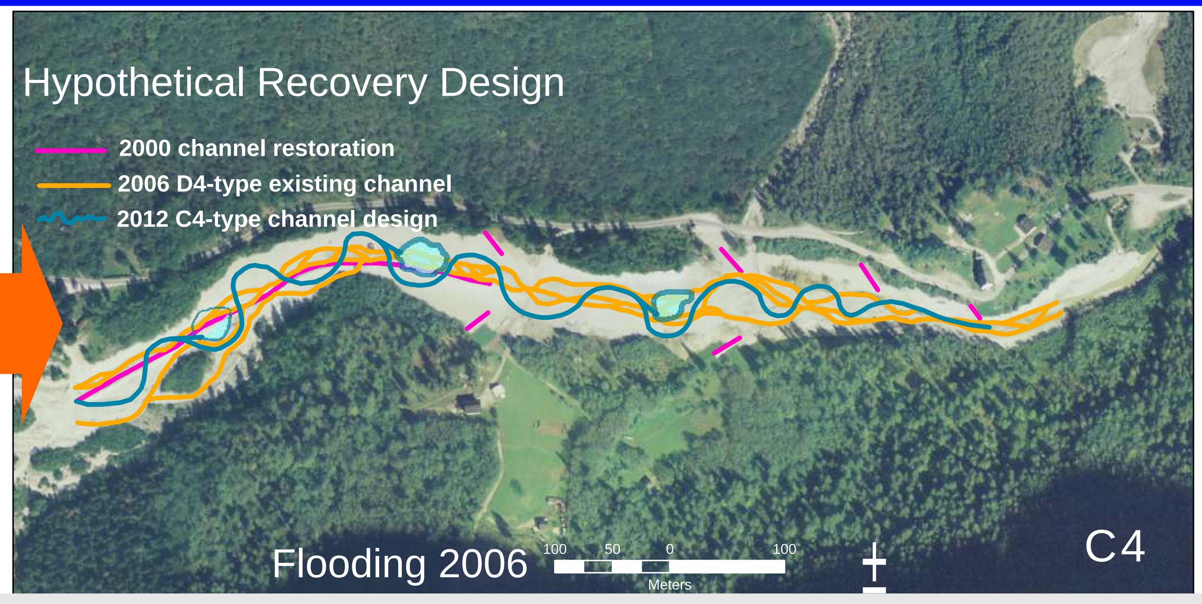


METHODS

The basic principle for geomorphologic "Natural Channel Design (NCD) methodology, is that each natural undisturbed stream is shaped by both geomorphologic and climatic conditions into a physiographic region, then NCD requires surveys of several reference streams in order to understand their "stability" features: the measure of the proportion of a cross section of the bankfull stage is one of the key variables to quantify the morphology of the stream. Understanding the hydro-geometric correct ratios of a stable "reference reach", is the key to be able to design a new long-term stable channel, where you need to restore it.
This paper illustrates the results arising from detailed survey dataset collected in the valley bottom along the Tegnas River from year 2009 to 2011. A series of longitudinal profiles and cross sections, an extensive and diversified particle size analysis along the channel bed, can allow first to classify each reach type on the base of their hydraulics and geomorphologic parameters and then assign the real extent of the bankfull stage.
Bed particle size, width/depth ratio, entrenchment ratio and slope were calculated from field data in order to determine the stream classification as outlined by Rosgen (Rosgen, 1994). The bankfull slope was determined as the average height of bankfull and then used to calculate width, depth and area for each cross section at the bankfull stage.
The flow velocity at the bankfull stage was determined by using Manning's equation where the coefficient n was calculated using the estimation method from survey analysis of particle size (D84), with the approximations of roughness associated to Rosgen classification (Leopold 1994, Rosgen, 1996), and tabular information for different types of bed and banks material. Stream classification itself does not attempt to predict the stability of the stream, the stability assessment procedure (in use for over twenty years in USA), documented in the EPA web document WARSSS (Rosgen, 2006), was applied to this case study.







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RESULTS AND CONCLUSIONS

Comparing low-flow discharge data with local precipitations time series, and relating them with some surrounding watershed discharges, we can assume that the bankfull flow magnitude calculated for the stream is a realistic value. Then, without specific curves for alpine region, we can adopt the empirical Rosgen Colorado dataset and their relationships to evaluate several design solutions when you plan to restore natural channels (Rosgen, 2007) with a geomorphologic approach.
Decreasing sediment supply, also coming from side headwaters, and resettle a more confined C4 instead of D4-type, may be a useful approach for restoring plans in order to improve riverbed re-naturalization and natural quality, in a next future. Illustrated here are some suggestions to control the erosion-transport-deposition process with long-lived, natural solutions, in order to stabilize the stream riverbed and their banks.
In compliance with one of the highest environmental value areas of the Dolomite region, authors believe that an effort to make a stable and controlled balance between erosion and deposition is a good way to preserve the greatest heritage of the man/nature equilibrium.