“Trap Efficiency” loss of artificial reservoirs through a direct and indirect evaluation of soil erosion rate in a sample catchment of Central Italy.

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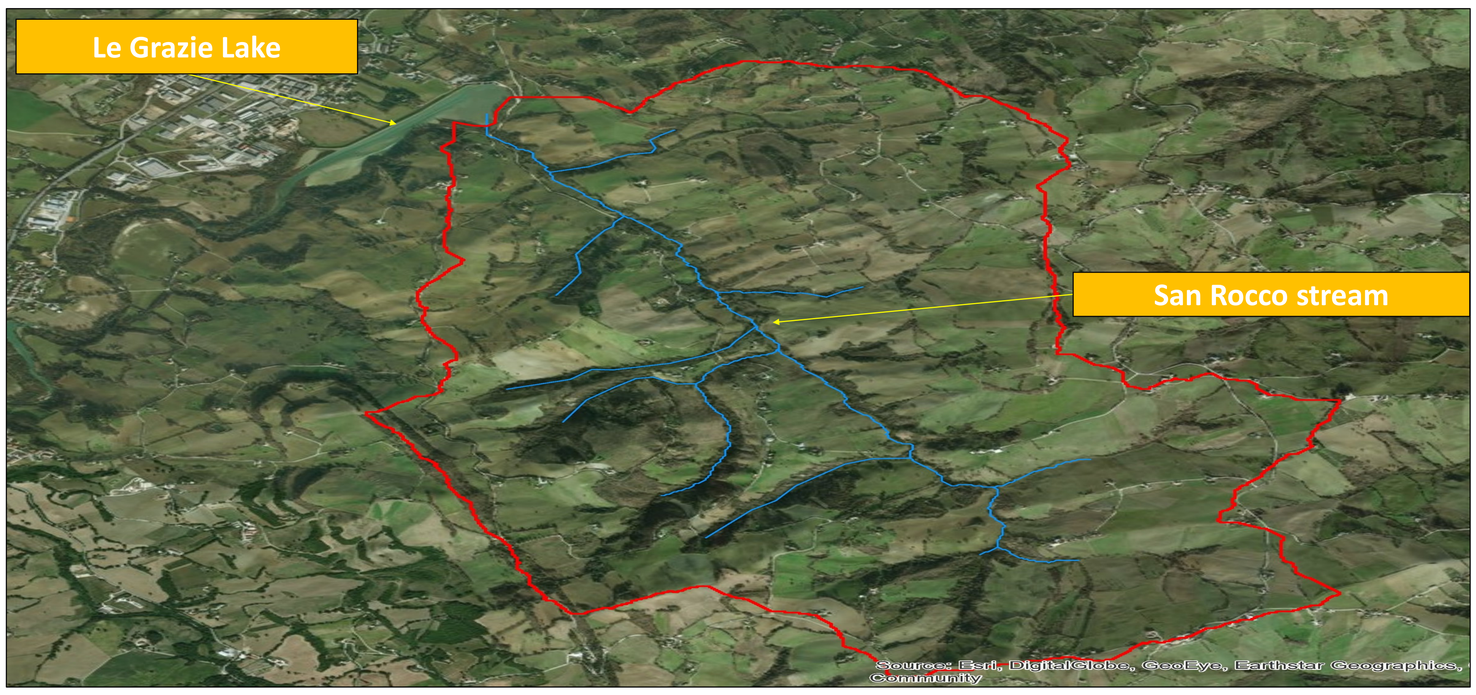
FOREWORD:

Sediment is an essential, integral and dynamic part of a river basin, cause a healthy river needs sediment as a source of life. On the other hand, the abundance of sediments can act as a potential sink for many hazardous chemicals and, especially in the case of artificial reservoirs, produce a long-term loss of storage capacity for reservoir operation and watershed management. Even the European Water Framework Directive (WFD) of the year 2000, although it does not deal specifically with sediments, clearly identify a link between sediment monitoring in a river catchment and the achievement of the WFD objective itself.

AIM:

- Evaluate the trap efficiency loss of the Le Grazie Reservoir since 1963;
- Evaluate, using different direct and indirect methodologies, the sedimentation rate within the Le Grazie Lake;
- Verify the origin of sediments.



METHODS and RESULTS

DIRECT evaluations of the trap efficiency loss by means of comparison of the lake bottom bathymetry measured in the years 1963, 2006 and 2015 and 3D reconstructions performed in a GIS environment

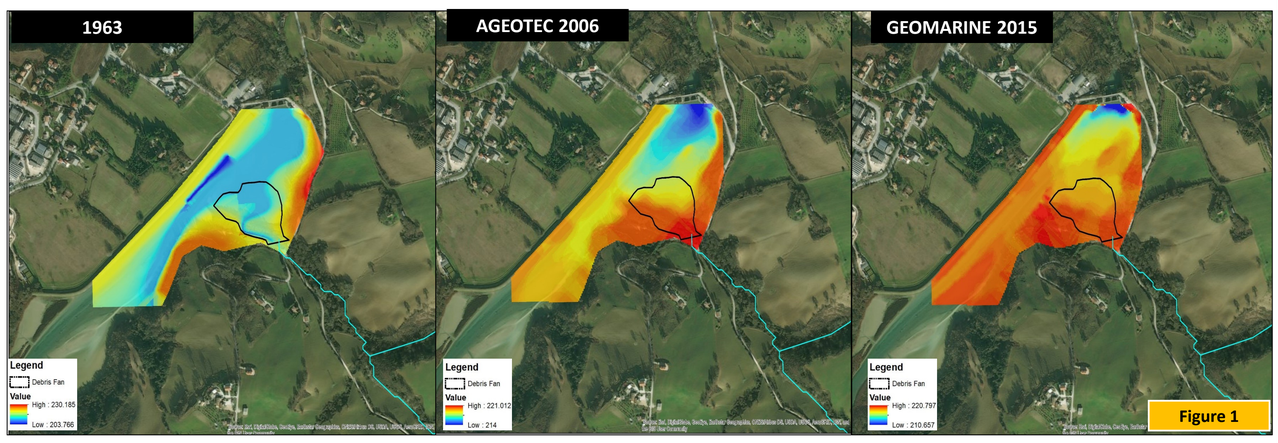


Figure 1

YEAR	Volume of Water [m^3]	Volume of Sediment accumulated since 1963 [m^3]	% Volume of Water loss since 1963
1963	893579.56	-	-
2006	162986.06	730593.50	81.76%
2015	35144.00	858435.56	96.07%

Table 1

Data previously obtained using the RUSLE have been compared with the volume of sediment deposited by the San Rocco stream in to the lake in the form of a debris fan that is quite easily recognisable within the dashed black perimeter of Figure 1-2.
The results in table 3 show that the San Rocco Stream contributes for more than 90% to the process of filling of the reservoir and that most of the material forming the debris fan comes from the erosion of the main stream channel, as calculated in the buffering of 30 m drawn in figure 2; the rest of sediment deposited in to the lake derive from the neighbouring tributaries.
The residual volume of around 23000000 tons of material, calculated by the RUSLE for the whole basin, can be probably explained with a redistribution of sediments within the basin itself without reaching the outlet.

1963-2015	Sediment Volume since 1963 (Debris Fan) [m^3]
RUSLE buffer 30 mt	84785.14
Debris Fan	150631.17
S. Rocco Basin	10670969.23

Table 3

INDIRECT evaluations of the volume of soil loss within the whole San Rocco basin carried out using the **RUSLE** (**R**evised **U**niversal **S**oil **L**oss **E**quation) Method (*Wischmeier and Smith, 1982*).

A = R*K*LS*C*P *(RUSLE Equation)*

Where: **A** is the mean soil loss per year [Tons $ha^{-1}yr^{-1}$];**R** is the rainfall-runoff erosivity factor [MJ mm $ha^{-1}h^{-1}y^{-1}$]; **K** is soil-erodibility factor [Mg $hMJ^{-1}mm^{-1}$]; **L** is the slope-length factor and **S** is the slope-steepness factor [dimensionless]; **C** is the cover-management factor [dimensionless]; **P** is the support-practice factor [dimensionless].

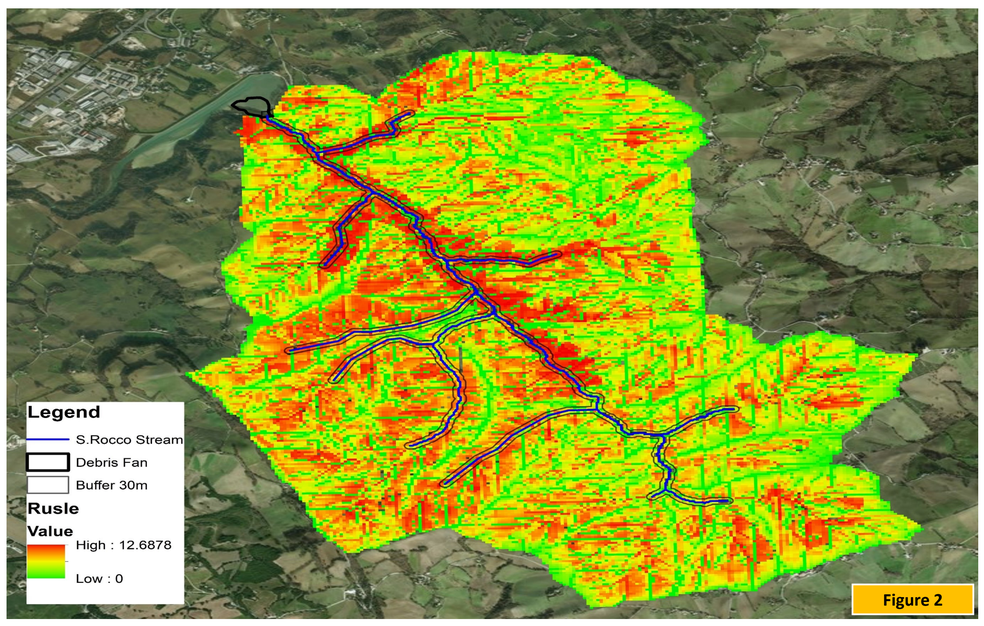


Figure 2

It is well known in literature that, while there is a good correspondence among different approaches for the evaluation of the parameters R, K, LS and C of the RUSLE, there is a substantial difference in the calculation of the parameters P. The results obtained for the whole basin using three different approaches are shown in table 2

Parameter P	RUSLE [Tons $ha^{-1}yr^{-1}$]
P= 0.2+ 0.03θ (θ is the slope in degree) (*Napoli et al., 2016*)	451.18
Calculated referring to the CORINE Land Cover 2012 (*present work*)	205.38
Calculated based on the basin Slope in percentage (*Kirkby&Morgan,1980*)	42911.47

Table 2

PRELIMINARY REMARKS

- The analysis of the bathymetries shows an intense trap efficiency loss of the Le Grazie reservoir, especially during the period 2006-2015;
- A great part (more than 90%) of the filling material of the reservoir can be attributed to the San Rocco Basin;
- The RUSLE method applied to the San Rocco Basin, evidenced that the erosion is mainly concentrated within the main stream channel; this fact confirm what reported by several authors in literature about the systematic overestimation of volume of sediments loss by the application of this method;
- The present study underly the need of further researches about the setting and improvement of the RUSLE Method for a ever more feasibility to real cases.

References:
Wischmeier and Smith, 1982; AGEOTEC, 2006; GEOMARINE, 2015; Napoli et al., 2016; Kirkby&Morgan,1980.