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Fluvial Morphotypes for Basin Planning

Alexander Palummo

University of Florence, Via della Mattonaia 14, Italy

Abstract: This study proposes the introduction of a fluvial invariant in the Territorial Planning tools through the definition of an abacus of river morphotypes (or territorial morpho-typologies of fluvial and perifluvial contexts) to which multiscalar guidelines should be applied. On the basis of this graphic and geographical analysis, it will be possible to identify good risk-management practices related to the different territorial morphologies. In this context, the morphotypes must therefore be understood as abstract models to be applied to the various river contexts: their reconstruction starts from the analysis of the basin (or sub-basin), identifying the hierarchy of the streams of its hydrographic network, continues with a typological classification (and identification of patterns) of the network as a function of the geomorphological characters and ends, through a morpho-typological framework of the patterns, with a definition of the morphotypes with which to classify the recurrent forms of the river systems in relation to the distribution of the settlement system. The analyzes were carried out starting from the open data published on the site of the District of the Northern Apennines and the Basin Authority.

Key words: river management, landplanning, river planning

1. Introduction

This study proposes the introduction of a structural river invariant among the planning tools, supported by a historical analysis of the fluvial and perifluvial territory. Methodologically, starting from the study of the paleochannels it is possible to define the evolutionary trend of the riverbed and from an analysis of the use of the historical soil (50-100 years at least) near the watercourses it is possible to highlight the ecosystemic characters and assets of the territory, as well as the aspects of the agricultural activity that interconnected them.

Today, in order to be able to carry out continuous monitoring of river bed dynamics and contribute to the reduction of the hydraulic risk, the suggested approach is that of River Restoration, complemented with the use of Territorial Information Systems for the management of open river data (like INSPIRE Directive), whether acquired remotely (remote sensing from SAT or from SAPR) with field surveys (GIS mapping) [1].

2. River System in Territory Planning

Within the Landscape Plan of the Region of Tuscany, the object of the present study, it is therefore proposed to introduce an invariant dedicated specifically to the river dimension, which should be placed side by side with the other existing ones.

At a regional level the PIT (Territorial Planning Guidelines with the value of a Landscape Plan) includes four Invariants and examining in detail the cartographic works and their descriptions in the various attachments of the Plan, it is clear that this, although very organic and detailed, does not dedicate a specific space to the fluvial component, which in fact is incorporated into the more specifically urban or rural, hydro-geo-morphological, ecological and settlement issues. The cartographic representation — above all for Invariants I and II — attributes to the river space a certain importance, both strategic and in terms of heritage; however, this importance is not sufficient to

Corresponding author: Alexander Palummo, Ph.D.; research areas/interests: urban and land planner. E-mail: alexander.palummo@unifi.it.

fully describe its key role both in the bioregional approach and in integrated planning.

By carrying out the study of the characteristics of the river system, it is possible to contribute to the definition of an integrated strategy for the management of fluvial areas and for the suburban areas of transversal/longitudinal ecological continuity, as well as for the self-sustainability of the bioregional system and the ecological condition (chemical-physical, biological and hydro-geomorphological) of the river.

3. Fluvial Morphotypes

For this reason, it is proposed to dedicate a specific analysis of the fluvial and perifluvial dimension of the sub-basins of the Florentine area through the river morphotypes. Within the examined area, a correct study of the characteristics of the hydrographic network of these basins must comply with the hierarchical and Horton/Strahler classification criteria to achieve an optimal graphic yield. The Horton method in particular attributes a hierarchical order to all the segments included between two successive confluences; after having permitted the classification of the different streams, it groups them into branches, assuming that each branch is represented by one or more adjacent streams having the same order. At the end of the hierarchization procedure, the entire basin is divided into trees and branches; there is, of course, only one stream with an order equal to the maximum. The maximum order indicates, on equal terms, whether the network is more or less developed and well hierarchized. This methodology has been taken up and perfected by Strahler. Subsequently Horton himself developed its contents, so much so that the most widespread method is also called the Horton and Strahler method. This methodology is particularly appreciated for the speed of reading and understanding in the graphic restitution and for the reduced margin of error in case of a possible second level analysis.

From the H&S (Horton and Strahler) analysis, the elevated hierarchization of the Arno basin emerges with sufficient completeness to allow not only a contextualization of its waters in the territory to which it belongs, but also a comparison with the other nearby basins. In order, therefore, to be able to start further analyses with a more ecosystemic perspective on a metropolitan scale. Instead, as regards the hydrographic network patterns, these are representative of the geomorphological characteristics and of the drainage density, a parameter that correlates the total length of the hydrographic network with the area of the basin drained by it. Finally, the identified sub-basins have been traced back to the macro categories typical of the methodology used by H&S [3]. In particular, the network structures identified in the stretches upstream of the basin under analysis are: subdentritic (B), subdentritic pinnate (B+C), divergent (D), convergent (E), convergent subdentritic (E+B).

In the same way, as a natural evolution of this method, we can proceed with a further analysis of the inhomogeneous sub-basins, also finding in their case the tendential inhomogeneity already found for the main basin: the Arno is an (artificial) collection of different sub-basins rather than a basin with homogeneous characteristics, the result of a natural hydro-geo-morphological evolution [2].

The subsequent morpho-typological analysis of the network enables us to interpret the recurrent forms of the river systems by schematizing the network patterns in a synthesized form based on the knot-branch articulation. The nodes represent the points of convergence of the river network, the same ones used for the hierarchy of the branches. The latter are the portions of the watercourse between two nodes (or between the source and the first node of the network) [4]. Through the cross-study of the identified river typologies and the uses of the soil, the bases are laid for a whole series of more functional classifications of the watercourses (also on the basis, for example, of the classes of hazard). In the river environment, reconstructing the morphological, ecological, and structural framework can help bring landscape disciplines together in a specific graphic rendering of fluvial and perifluvial typologies, creating a new, fluid and integrated "rule". The decision to propose an abacus is therefore dictated by the desire to express this new rule, useful for the representation of the missing structural river invariant — first studied in detail (at the level of the branch) and then reported here on the basin scale [5].

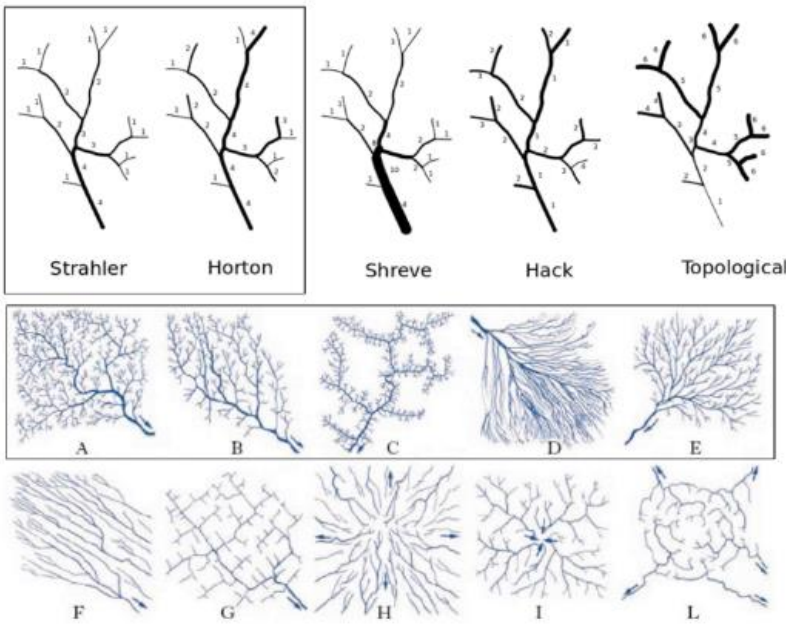

Fig. 1 H&S classes for hydrographic network - A diagram taken from the H&S studies is show with a box that highlights the patterns used for the classification of the sub-basins analysed.

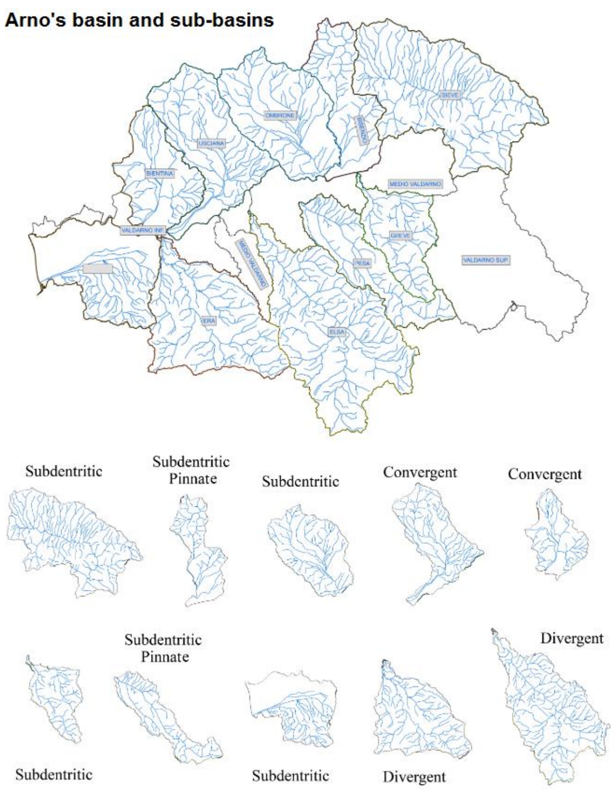

Fig. 3 Classification of the Arno Sub-Basin using H&S method [by A. Palummo].

4. Conclusion

It is appropriate to underline that the present theoretical proposal, however stimulating, is to be considered still perfectible in some aspects. This is not only because the subject is constantly evolving, but also because there is not yet a comprehensive categorization of good practices for the management of the morpho-typologically related risk. These limits will be overcome as some issues (including land use, geology and slopes) will be further explored, for example in identifying broad area strategic actions specific to river planning.

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