Abstract

The main target of this project is the investigation about the physical environment and natural resources which influenced the urban development on the east-side Adriatic region. The evolution of the landscape in the Balkan area (Croatia and Albany) will be analysed, since it represents a melting pot of cultures and people.

The research unit will focus on the geology of the urban areas as well as of their surrounding areas, in order to understand how the geomorphology, the shallow water, the groundwater and the building materials influenced the human actions on the environment and on the landscape. A particular care will be taken on geology, geomorphology, technical properties of the building materials, shallow and ground hydrology, availability and access to water resources and improvement of reservoirs. Indeed, the research unit will study the links between urban environment and water resources (i.e. access to water, water distribution systems management and related infrastructures). Moreover, the influence of water on the architecture of the urban areas (houses and their location) will be studied (Laureano, 1993, 2001, Grassi et Al. 2006).

The regions to be investigated are characterized by a rich urban heritage which is closely biased by those cultures which were present in those areas during the last centuries. These developed the architectures according to their relationships and needs coming from the nature and the surrounding environment. On this premise, the hydrologic and geomorphologic analyses are necessary in order to provide a historical – architectural characterization of the investigated areas which is targeted to their eco - sustainable recovering. In fact, the hydrogeology of an urban area constitutes an important component of its historical evolution, since they preserve the urban environment. In addition, understanding the local hydrogeology is important for the preservation of a fragile environment such as the karstic one. The karst areas are particularly vulnerable, since they have a precarious balance. Therefore, the use and management of groundwater resources should take into account the preservation of karst aquifers. A strategy aimed at the protection and improvement of the geomorphology and water resources will be pursued as well as the mitigation of the hydraulic and seismic risk.

State of the Art

The analysis of a urban area needs of a complex approach, accounting both for human and natural aspects. A partial analysis may turn into an error if it neglects one among them. In particular, here the natural aspects are related to the environment and to the natural resources which are part of the urban area. The urban environment is quite important in order to understand how the nature and the physical context biased human actions and choices related to the modification of the landscape. Here the physical context is meant as geomorphologic scenario and natural resources, i.e. building materials, shallow water and groundwater. These are fundamental for urban areas, since they are part of the life cycle of the town.

The proposal is focused on the study of some urban areas in the Balkan region, in particular Mostar, Split and Kotor. These urban areas are assumed as general cases of study of the project, and they need of a detailed knowledge of the environment and of the link between the urban structures and the geological and geomorphologic features. In particular, the research unit will investigate water resources (i.e. water supply, management and distribution) and the interaction between the water cycle and the architecture of the towns, in terms of housing and cultural heritage. There are important contributions available from scientific literature about similar Mediterranean environments (Laureano, 1993; 2001; Cotecchia & Grassi 1975, 1997; Grassi et Al., 2006 ; Sdao & Simeone, 2007).

The Balkan peninsula is characterized by a quite complex hydrograph network, where the largest catchment is the Danube one, while the Vardar and Morava are also important for the development of the house dwellings. A further influence is also due to the lakes Scutari and Ohrid (VV. AA., 2001).

The mid-south of the Balkan area is characterized by huge precipitations, in particular in the mountain areas, where the average rainfall ranges between 1000 and 2500 mm/year. The rainfall regimens are typical of coastal areas. The water balance (Prohaska, 2006) reports an average total water volume which is 25.1 Gm^3 whereas 6.3 Gm^3 are constitutes by

evapotranspiration and the remaining part remains on the ground. The specific flow of the rivers can be 40 l/s/km ^{2}, while in dry zones, like Vojvodina, are in the order of 6 l/s/km ^{2}. The highest values of discharges are reported in April, while the lowest values are in September and October.

Urban areas are usually flooded by the local rivers or streams (Ristić & Stefanović, 2005), due to the uncontrolled of the towns in addition to an unplanned land use, which does not account for criteria of compatibility with the local hydrography (Ristic et al., 2006).

Starting from the bottom, the local stratigraphy (Calò & Parise, 2009) is constituted by anhydrite, Permian limestone and clays, bended and topped by marly limestone, Triassic dolomite and limestone followed by Jurassic and Cretaceous limestone and dolomite. Finally there are Paleocene and Neocene lithotypes different from Mesozoic's.

Triassic limestone, dolomite and marly limestone are found in the Drežanka valley, and in the Velež e di Prenj zone, which are in the order east and north of Mostar. Jurassic limestone and dolomite are reported in the area of Cabulja e Raška Gora west of Neretva and in the area of Velež, even if mainly present in Prenj area. Cretaceous limestone and dolomite outcrop in the areas of Cabulja, Raška gora, Podcabulja, Planinica and Velež and constitute the sublayer to the Cimllici coal layer. During the Neocene, due to the orogenesis of the present tectonic and geomorphologic scenario, large reservoirs originated, these are bounded by overlap faults. These are characterized by the presence of turfs, moreover the faults were filled by deep heterogeneous clastic sediments (higher than 2000 m) (Calò & Parise, 2009).

The hydrogeology is quite complex due to the presence of differently permeable rocks. Limestone is strongly karstic, while upper Triassic dolomite is poorly karstic and quite often they constitute non permeable barriers. Karstic springs of Mesozoic aquifers are 27 % of water supply in Bosnia. A huge number of springs exists, among these Studenac is important for hydropower projects in Mostar area. Moreover, Radobolja spring has an average discharge of 3.5 m^3/s and is fed by the karstic zone of the southeast part of Cabulja mountain. Neocene Marl y limestone are layered and deep, they are at the top of a coal basin and they constitute a hydrogeologic barrier while hosting small aquifers if compared with the larger Cretaceous carbonatic ones (Calò & Parise, 2009).

In the areas there are quite few investigations about the aforementioned aspects, based on large scale geomorphologic analysis. These are supposed to be useful to analyse the human context in the global geomorphologic scenario of the region (Guerricchio et al., 2008), thus allowing for a broad and comprehensive analysis. Moreover the recent advanced methodologies of shallow water and groundwater systems modelling (Giustolisi, 2002; Giustolisi & Simeone, 2006; Laucelli et al., 2009) were never applied to historical urban contexts. Therefore, this project could represent a prototype in this direction. These techniques need of the search and processing of the information coming from measured/monitored data. This allows for the construction of analytical tools, which are suitable for the management and forecasting of natural resources. These simulated/predicted scenarios are useful for getting new scientific knowledge about the phenomenology and dynamic of shallow water and groundwater resources. The analysis and characterization of the environment based on these techniques together with the knowledge of the physics of the local hydrogeology, will allows for the implementation of management strategies. In particular these strategies are aimed at the simulation and optimization of water uses, which due to their physical complexity are not easily approachable by traditional techniques.