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The Watershed and its Integrated Management and Planning

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Introduction

Planning has evolved overtime, from merely design to a complex platform of technical and political tools that aim to guarantee sustainable, liveable and resilient communities and habitats. As a result, planning covers a wide array of issues, objectives and territories, and the approach has developed to include scientific instruments and models and comprehensive analysis next to participatory actions, lobbying and advocacy for policy influencing. One of the most important developments in planning as a field of studies is the identification of environment as a key and integral dimension, thus leading to environmental planning, design and management.

Watershed planning and related methodological aspects constitute an important area of the environmental planning. By merely the terminology – "watershed planning", we understand two major factors that are implicit to the terms: i) the spatial scale and the system – the watershed, which is composed of a multitude of ecosystems and urban systems, thus having an intrinsic need for environmental thinking and actions; ii) the spatial planning methods and approaches – these should be combined and used jointly to address the complexity of planning challenges in a very complex spatial context.

Concepts and definitions on watershed and river basin

The definition of the watershed has evolved from literally a boundary/line of a watercourse drainage area, into "an area of land within which all waters flow to a single river system"(Heathcote, 2009). The UN conference of Water in Mar der Plata, March 1977, a landmark event in water management, defined that the problems of land and water scarcity and access should be dealt (among others) through integrated land and water management for multipurpose river basin development, taking place within national planning (United Nations, 1977). This is a historical definition as it lays out the basis for using planning as a platform, or overall framework, for discussing and solving issues related to natural resource management, specifically water and land resources. Following this global awareness-raising event, the UN conference of Rio de Janeiro in 1992, a forum of global environmental issues, resulted into global actions aiming at: integrated approaches for dealing with environmental challenges; management systems and not system components; management of water through locally responsible and efficient systems (United Nations, 1992).

Obviously, these objectives raise the need for using approaches that combine methodologies and analytical tools and promote stakeholders cooperation at different levels of the society and governance. A focus is likewise put on the preferred territory – the watershed as the "appropriate" geographical area for undertaking integrated spatial planning, with a strong environmental dimension. The watershed represents a broad system, composed of several smaller ecosystems and institutional relationships and clues, where local management and decision-making add up, thus giving rise to a larger societal outcome with positive effects on the environment.

"Watersheds are biophysical systems that define the land surface that drains water and water-borne sediments, nutrients and chemical constituents to a point in the stream channel or a river defined by topographic boundaries. Watersheds are the surface landscape systems that transform precipitation into water flows to streams and rivers, most of which reach the oceans. Watersheds are the systems used to study the hydrological cycle and they help us understand how human activities influence components of the hydrologic cycle." (Brooks, Ffolliott, & Magner, 2012). Physically, the watershed is composed of the drainage network – i.e. the system of connected water channels in a tree like shape, the drainage basin – i.e. the area feeding water to the drainage network (Marsh, 2010) and the landscape – the entirety of ecosystems that are visible on the land and the entirety of functions that they carry out (Marsh, 2010). This implies that the aquatic system is interlinked with its terrestrial features (soil, geology, topography, biodiversity) and climate conditions (DeBarry, 2004).

Brooks et. al. 2012 defines the water as the common denominator of the watershed and its components, because: water reflects/mirrors the activity on land; upstream activities on land or in water affect the welfare of those living downstream; the quality and the quantity of water affects all natural and human-made cycles and events in the system; and the water [course] is basically and physically the backbone of the watershed system. As a result, the sustainability of the watershed as a system depends on its hydrologic equilibrium (DeBarry, 2004) and eventually on the relationship between water and the habitat.

The water drainage network in a watershed works based on a principle of stream order/hierarchy, with first order channels having no tributaries and flowing into the second order channels, the latter discharging into the third order and so on, till the main river flows usually into the sea. The knowledge on the relationship between the drainage network, the basin itself and the landscape is key to the watershed planning process and related [political] decision-making. It helps to identify and recognise constraints and values, as well as natural means for overcoming the obstacles that urban development causes to the balance of the ecosystems in the watershed. For instance, some of the key problems induced by urbanisation in natural sites of a watershed include storm water and flooding, increased water pollution downstream, soil ceiling and growth of the impervious surfaces, increased sedimentation and deposition, decreasing air quality and increasing erosion due to deforestation, landslides, loss of critical habitat, etc.

A key feature of the drainage network is its density, defined as the ratio of the overall length of the streams composing the drainage network with the area of the whole basin and measured in length/unit area. Higher densities show for increased steepness of the slopes in the whole, or different parts of the basin. This information, together with data on geology, biodiversity and soil, lead to the understanding of the river basin carrying capacity – the quantity and type of development that a basin can carry, without compromising ecosystem functions and risking environmental and ecological degradation. The knowledge of the watershed carrying capacity allows planners to make sound decisions on the appropriateness of developing the areas of the basin and the kind of development that is allowed to take place.

Planning outcomes differ across the basin, due to the distinct attributes that its three interrelated composing parts have. Thus, the first zone, the contributing one, receives most of the basin`s water and generates runoff. It is located in the upper outer part of the basin and as such it has rather gentle slopes and small and diffused surface flows. Therefore, it is the least susceptible to drainage problems (Marsh, 2010). This area is relatively peripheral in the watershed and the urban development pressures are rather low, or non-existent. Planners and decision-makers also tend to safeguard this area, due to its contribution in water replenishment and other important ecological functions. The other two zones, namely the collection zone and the conveyance zone are subject to drainage problems, though in different ways. The collection zone is also situated in the upper basin, but in its inner part and in periods of runoff is prone to inflooding (Marsh, 2010). The conveyance zone, on the other hand, contains the main stream-

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Fig1 / A segment of the conveyance zone in the middle stream of Osumi River. Conversion of riparian areas into agriculture land leads towards erosion and flooding / source the author

channel and valley, with groundwater providing the stream base flow and surface waters and storm-flows derived mainly from the upper zones. Both, the collection zone and the conveyance one are more likely to be prone to urban development pressures, due to their location in the watershed, proximity to ground water and water sources, as well as ease of accessing communication networks. The conflicts between urban developments and the ecosystem functions that the watershed carries out in these areas are quite prominent and require continuously for innovative and integrated planning solutions.

The watershed landscape is composed of ecosystems; in other words it contains a multitude of "local networks of interacting plants and animals and the landscape in which they live" (United Nations, 2014) (ECE/TIM/SP/34). These interactions are mirrored into hundreds of biogeochemical and physical processes taking place in the ecosystem, named as ecosystem functions. Once these functions gain value and prove to be beneficial to users (humans or nature), they turn into services (Kareiva, Tallis, Ricketts, Daily, & Polasky, 2011). A watershed is exceptionally rich in multiple ecosystem services that, depending on the category they belong, may have a provisioning, regulating, cultural and supporting role. Each service, as the term implies, has a value for the users who are willing to pay for it, or sacrifice something else in return to a given service's benefits. The willingness to pay implies that humans are the beneficiaries and does not comprise the value of the ecosystem and its services to other users, i.e. other species and the ecosystem itself.

Calculating a total economic value for a given service is as yet a rather incomplete task, though it may involve different types of values (direct, indirect, etc.), as it merely consists of the concept of ecosystem value as humans understand and use it. Any attempt to consider ecosystem value for itself, or inherent value as (Beatley, 1994) defines it (Randolph, 2004), remains however unilateral as long as it is human-driven and based on human reasoning. Regardless of its incompleteness, having to know the economic value of ecosystem services in a watershed is key to an informed planning decision-making. It provides input to the benefits and costs analysis, by adding external benefits to the comparison of land use/development alternatives and making the whole analytical process more comprehensive and representative. It also increases the acceptability of the planning process, by showing that rather than forecasting future, planning builds up future in an informed way and based on evidences.

The Integrated Planning Approach

The analysis that precedes watershed planning and management should entail interpretation of the biophysical interrelations between the water network, the basin area and the ecosystems, and of the values of the natural capital, as shortly described above. This will guarantee that ecosystem management goals and their sustainability are accomplished at a watershed scale, as DeBerry (2004) suggests, thus leading to achievement of sustainable watershed environmental planning. Because the system is extremely complex, with ecosystems and related services in continuous conflict with human-made developments that do not necessarily recognise the natural hydrology defining the watershed as a spatial unit, it is necessary for the analysis first and then planning to embrace the comprehensive approach. The latter, although a strategy that is increasingly advocated in the literature, remain still a relatively new concept (Heathcote, 2009) in terms of implementation.

The comprehensive approach should integrate the aimed stability and resilience of natural system's components with social and institutional objectives, leading to integrated watershed planning and management. The physical facts/features of the watershed and the political realities have to be brought together to achieve integrated watershed management (Brooks, Ffolliott, & Magner, 2012). All practices can be embedded in the integrated spatial planning framework, based on issues confronted by different water managers at international level (Heathcote, 2009):

- Water availability, requirement and use;
- Water management and institutions;
- Water quality.

1. Discussions and studies on water availability, requirements and use, include a large array of aspects, such as water extraction for drinking and other uses, including waterborne commerce; management of extreme events such as floods and draughts and any other impact resulting from climate change; protection of aquatic and wetland habitat; forecast, prevention, management and mitigation of climate change occurrences and effects (Heathcote, 2009). Land use planning is vital to governing water use, through, among others, designation of sites and properties for locating residential blocks, industrial zones, recreational activities, and forestry and agricultural processes. All these sectors have different water consumption necessities, which impact the infrastructural system of water supply/distribution and relate strongly to the availability of water sources in terms of location, quantity and quality. "In fact, water stress is the result of conflicting water uses or requirements... Furthermore, economic demands conflict with other uses."(Kissling-Näf & Kuks, 2004).

Rates of water extraction for drinking water or other industrial uses should be planed so as to maintain a balance with replenishment rates (Ostrom, 1990). The exceeding extraction rates will not only decrease the available quantity of water at the respective source; it could also increase the potential for salt water intrusion, if the water sources are in/close to a coastal area, thus affecting quality next to quantity. The construction of hydropower plants is deemed important for economic development, non-polluting energy production and fostering of energy independency. Yet, on the other hand, it affects negatively the biodiversity of the water source and the surrounding ecosystem; it decreases quantities supplied to local residents in the rural areas; and increases the chances for desertification and coastal areas alteration.

Next to the use of land, the type of property right associated to water sources and the corresponding plot is also a factor in favour of conflict mitigation or exacerbation. The ownership of a water source is often related to the ownership of land, while the ownership of the major water systems, such as lakes, rivers and their basins, coastal waters, estuaries, etc. is often not related to land ownership (Kissling-Näf & Kuks, 2004). Therefore, particular resources are owned privately or in common, with also cases of non-full ownership that results in a set of rights from the overall bunch of property rights. On the other hand, the major water systems are usually considered a public natural resource and owned by the governments. Nevertheless, whether one type of property or the other, this depends on the property rights [re]distribution and legal system of a country. As a result, the level of complexity in managing the water source and defining appropriate level of use and extraction, while also coping with rivalries on the source and on effects of the sources use on ecosystems, will depend on the specific context-based legal framework.

2. Institutional and legal frame for the management of water and other natural resources: The planning framework is key to this dimension as it provides the grounds for integrating territory and natural resources into a common management platform as of the outset, where regional agencies in particular can play a crucial implementation and management role. If the planning system takes a merely physical and urban approach, then it will disregard the vertical and horizontal integration among development sectors and their effects on the territory. Water issues should not

be dealt with simply through a sector's perspective, but in relation to the territory, the ecosystems and their services. This calls for an integrated planning approach. Heathcote (2009) defines that water management strategies have often failed because of not incorporating the full range of stakeholders' values and perspectives on water. As cited in Heathcote (2009), "Wilkes (1975) Van Ast (1999) and King et. al. (2003) note that the success of many major basin projects has been hampered, because different agencies are responsible for water supply and for water quality, and the two are not always effectively coordinated."

The integrated approach also places a particular focus on the region as an intermediate and rather elusive space, which can be dynamically modified to comprise multiple ecosystems and administrative territories in a spatial combination that is suitable to achieve both political/institutional and ecosystem objectives. The watershed is the natural region that can respond to this aim.

The planning approach will also address financial issues, next to the study of costs and benefits, ownership issues and institutional arrangements to guarantee property rights on land and other resources, and also the organization of infrastructure systems and urban structures, considering that the latter make use of and directly affect the natural landscape. The institutional and legal framework is very broad and complex as it covers both sectorial and cross-sectorial aspects and it also contains the procedures for decision-making. This frame does not limit to public institutions and procedures only; it rather considers carefully also the institutional dynamics of the communities that exist within the watershed boundaries, the interactions that exist among them and the incentives (Gregersen, Ffolliott, & Brooks, 2007) and/or coercion that steers stakeholders' behaviour.

Institutional arrangements have the challenge of dealing with the various conflicting interests that could be summarised as the potential conflicts of the sustainability 3E's objectives, as Scott Campbell (1996) suggests: i) the property conflict between economic development and the equitable distribution of opportunities; ii) the resource conflict between economic development and environmental values; and iii) the development conflict between equity and environment (Campbell, 1996). To address these challenges, planning uses various mechanisms, such as strategizing, regulatory and monitoring ones, fiscal and financial, and public investments (Gregersen, Ffolliott, & Brooks, 2007). The successful implementation of these mechanisms depends among others on the degree and level of stakeholders' participation as off the planning process and the cooperation among and within them during implementation of watershed management actions.

3. Quality of water and other natural resources: As Eswaran et. al. 1995 defines, "the health of the watershed determines the health of a nation. Poor ecosystem management has and will result in the impair functioning of the watershed, which in fragile environments can lead to ecosystem collapse" (Jagir & Eswaran, 2000). The quality of water sources (coastal, oceans, lakes, rivers and reservoirs) cannot be sustained without a guarantee on the vigour of ecosystems. Protecting and restoring water resources can be achieved through management of pollution sources (point/non-point) and of other factors that jeopardise the quality of water bodies, as well as through strategies and actions that point at ecosystem elements, or other natural resources, in close connection to land uses.

For instance, referring to Gregersen et. al., 2007, rain-fed and dispersed agricultural cropping is a common land use in many upstream watersheds. While individual contributions resulting from it to the economy and the ecosystem are relatively small, the aggregate contribution is very significant. Intensive agriculture on the other hand has yet a bigger impact, though mainly in the lower lands, by transforming large natural areas into agricultural ones and substantially increasing the amount of agriculture-borne nutrients that percolate soil and contaminate groundwater. Therefore, not only agriculture lands expansion results in loss, or modification of biodiversity, but it also loads water sources with chemicals and other pollutants that infiltrate the soil through water from precipitation, or irrigation practices.

However, next to agriculture, there are also the unsustainable forestry practices, livestock over-grazing and urbanization tendencies that altogether alter the habitat, cause harm to the ecosystems in a watershed and stimulate further climate change occurrences. The latter cause an increase of fresh and salt-water temperature, hence threatening cold-

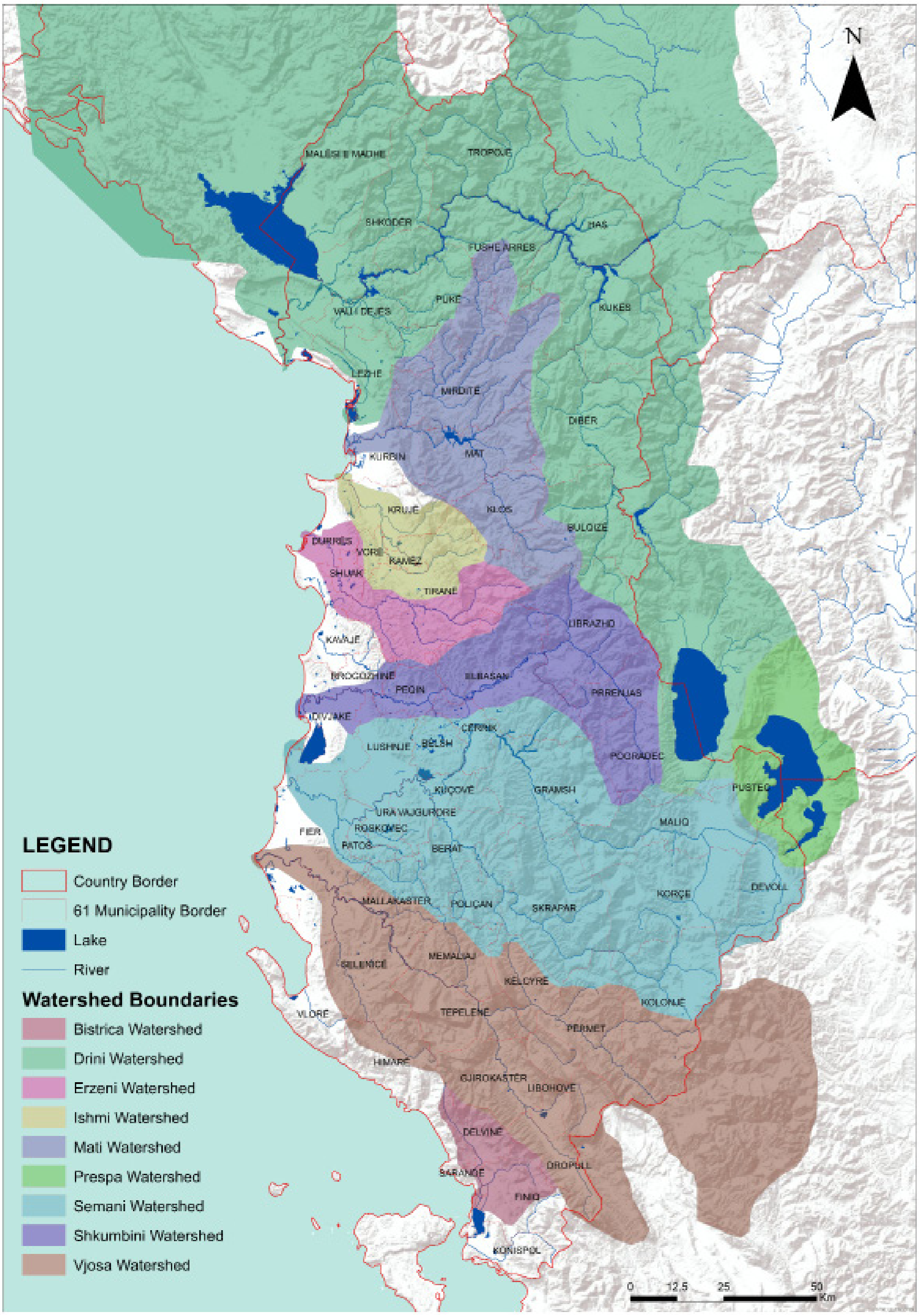

Fig2 / The map of the official river basins of Albania
source / ASIG Albania and author's GIS processing

water fish habitats (Marion, et al., 2014), local climates and other species that depend on certain weather conditions. Climate warming will result into worsening qualities of water sources, thus not only lowering the response to demand for clean and qualitative water – for instance the increase of salinity in the coastal fresh water systems is likely to increase due to sea levels rising followed by seawater intrusion (Marion, et al., 2014), but harming the biodiversity as well.
Overstocking livestock can cause eventual losses of high value forage and species, compaction of the soil and therefore reduced infiltration of surface water and overflows on land (Gregersen, Ffolliott, & Brooks, 2007). This activity happens mainly in the upper (first) zone of the watershed area, according to Marsh 2010, but its effects are felt in all three zones. Similarly, wrong forestry practices, deforestation and unsustainable forest management can impact any of the three watershed zones, depending of the forest location, through decreasing water infiltration, diminishing evapo-transpiration rates and holding back

Fig3 / Coastal erosion and seawater intrusion into agriculture land – the coast of Fier, Albania
source / the author

groundwater purification, next to loss of biodiversity, and will increase perils from soil erosion and land-slides.

Erosion, beyond posing a risk for settlements when close, has a critical impact on the quality of water and transforms water bodies, due to sediment created by surface erosion (carried through precipitation and surface runoff). Further on, the expansion of urban surfaces causes the soil sealing phenomena to augment, resulting into storm water floods, extreme reduction of evapotranspiration, cutbacks in groundwater recharges, and in case of poor waste water management, also increased pollution loads into ground and surface waters.
While dealing with the above components, the process of integrated planning at watershed level has to fulfil a set of objectives and follow a number of steps. One could look at the watershed management objectives in a cascade fashion, with overarching aims representing the integrated approach and subsequent specific objectives, focusing on sectors, ecosystems, or natural resources, so a to give way to the concrete actions for watershed development, protection and restoration. There are three interconnected overarching aims: i) achievement of sustainable water governance for sufficient supply of qualitative water for years and generations to come; ii) sustenance of social, economic and land developments for short and long term periods; iii) fuelling of ecological resilient territories and communities. The specific objectives that come out of this overarching frame, will bring watershed management into numerous directions of planning and stakeholder involvement, depending on the variety of natural resources, property rights and institutional organizational systems that manage these resources, together with territories and development sectors.

For instance, Gregersen et al. (2007) summarises the watershed objectives based on Brooks et al. (1990), as the following: i) Maintain and or increase land productivity; ii) Assure adequate quantities and quality of usable water; iii) Reduce flooding and flood damage; iv) Reduce erosion and incidence of land-slides; Reduce downstream sediment delivery. [Government] Agencies also define goals for watershed management that depending on the institutional and jurisdictional organization can vary from strictly water related, to restoration of ecological balance by harnessing, conserving and developing degraded natural resources (Government of India, Ministry of Rural Development, Department of Land Resources), and further more to overall territorial governance as a means for balanced management of human activities and natural resources (Conservation Ontario, 2010).
The steps for conducting an integrated watershed planning process are summarised as adapted from Heathcote (2009) and Randolph (2004):
- Inventory and analysis,
- Identification of problems and prioritization,

Fig4 / The contributing zone of Shkumbini river in the Shebenik Mountain
source / the author

- Setting the goals,
- Development of the planning scenarios,
- Screening and evaluation of the management options,
- Development of strategies, actions and procedures.

Inventory and analysis includes the understanding of watershed components, including their features, processes and uses; of stakeholders, institutions and related interests; and finally of space and territorial boundaries of study. Watershed components and stakeholders are broadly discussed above. As far as boundaries are concerned, it is crucial to set the territorial scale from the outset, because the complexity of the water drainage network, basin and landscape escalates with the increase of space. The terms watershed, basin and catchment areas are often used interchangeably in literature (Lal, 2000). However, for the sake of this paper, the definition of the spatial difference between the watershed and the river basin shall be understood according Gregersen et. al: "We refer to a river basin as a large unit of land that drains into an ocean. The term watershed is used to refer to smaller units that contain all lands and waterways that drain to a given common point. A river basin can, therefore, contain many watersheds within its boundaries." (Gregersen, Ffolliott, & Brooks, 2007). So far, literature shows that seems to be easier managing natural resources at their individual scales, at ecosystem level, or at a micro watershed scale. Increasing the territorial scale proliferates significantly the challenge for managing natural resources, due to the arising complexity of biological processes and interrelationships and contradictions on power jurisdictions (local, national, and regional).

This phase will achieve the establishment of the watershed environmental inventory and an analysis of the social, economic and environmental state of the art in the watershed area. The inventory is usually set in a geographical platform, thus consisting of a GIS dataset of natural and socio-economic factors, including land use (Randolph, 2004), that allows for in-depth analysis if the watershed. The analysis will start with a rapid assessment, consisting mainly on data and facts interpretation to conclude with detailed assessments of the current situation, leading to identification of problems.

The identification of problems is attained through both, the rapid and thorough analysis carried out in the first step, as well as through stakeholder consultation. The latter is crosscutting to the whole planning process and it is organised in a way that targets all stakeholders and their interests. Problems relate mainly to the use and wellbeing of the natural resources, their interaction with the human made interventions and urban settlements, property rights on natural resources, as well as institutional and legal frame aspects that need to be revised to ensure resiliency of the watershed (and all of its ecosystems) and sustainable development.

Prioritization of problems leads immediately to the goals setting step and subsequently to the development of the planning scenarios, which not only reveal constrains, but first and foremost propose strategic interventions and decision-making criteria. The criteria are especially used in the screening and evaluation of the management options. The latter is multidimensional as it involves a number of tools, such as benefit-cost analysis, [strategic] environmental [impact] assessments including social impact assessment, risk assessment, institutional assessment, etc. The criteria are also multiple and given different weights, ranging from economic to social, environmental, ecological, territorial, institutional, cultural, political governance, and design criteria.

The last but not least, the designation of strategies, actions and procedures leads towards management, aiming at organizing and guiding use of land, water and other natural resources of the watershed to provide desired goods and services to people without affecting adversely soil and water resources (Brooks, Ffolliott, & Magner, 2012). The "integration" dimension is exceptionally strong in this step as the strategy actions and corresponding regulations consider the needs of all sectors (economy, agriculture, natural resources protection, industry, etc.) and carefully recognise the interrelationships among land use, soil, water and the location of the different areas relative to the stream (Brooks, Ffolliott, & Magner, 2012).

On a practical level, there are two major approaches used in managing the watershed problems: the structural and the non-structural methods. These may be used separately, or with some crossover, depending on the watershed management objectives, costs and stakeholders` interests. Non-structural best management practices (BMPs) do not usually include construction of facilities; they rather consist of some types of planning, design and vegetation measures. For instance, regional planning and transit-oriented development (Calthorpe, 1993), (Carlton, 2007), design with nature (McHarg, 1992), conservation design, etc. provide solutions and incentives for the protection of natural resources. Similarly, fertilizer and pesticide application control, vegetative filter strips and barriers on agriculture land, impervious area reductions, dune restoration and management, preservation and/or restoration of environmentally sensitive areas such as wetlands, lagoons, riparian corridors, etc. all constitute environmentally friendly practices that protect the watershed. On the other hand, structural BMPs include measures and construction of physical structures to control water quality, have usually higher costs than non-structural ones, but may be able to achieve a significant result in shorter time. Nevertheless, these BMPs are successful in terms of achieving their specific target, but may have other adverse environmental and visual effects, as for instance with sea walls and dykes, etc.

Conclusions

The watershed is a complex territorial unit built around a water body and defined by its stream channel and affluents, the composing landscape and the related ecosystem services. The term can be interchangeably used for river basin, though the latter means an entirety of watersheds, draining into a main river that will finally discharge into the sea. Consequently, the meaning and the scale attributed to the term, will impact the complexity of the interrelationships that rule over the watershed area. Because these interrelationships represent a multitude of interests, values and development perspectives, next to ecosystem values per se, the watershed needs to be planned for and managed in an integral fashion and through comprehensive, yet practical and targeted instruments.

The approach that scientists and academics propose is that of integrated watershed planning and management. This approach is widely accepted at a theoretical level, but still weak in terms of implementation and use by government agencies. A major factor behind remains the power struggle among different agencies and stakeholders over a limited number of resources, located within one single territory, together with property rights rivalries and low understanding of the cause-effect chains of poor, unilateral and narrow-minded natural resources management.

Integrated watershed planning and management embarks on three interconnected overarching aims that bring together water governance, social-economic and land development and ecological resiliency. The specific objectives address target issues through targeted instruments.
Practices used for managing watersheds are often divided into structural and non-structural ones, with the previous

consisting of costly and effective but often environmentally disruptive technological solutions, and the latter being environmentally friendly, soft and mainly ecological interventions of a preventive nature, with an arguable efficiency. The choice between the two is of a managerial and political nature, based on benefit-cost analysis, presumably including externalities and ecosystem services valuation.

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