Chapter 6

Territorial Integration of Water Management in the City

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Additional information is available at the end of the chapter

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Abstract

This chapter addresses the need for an integrated approach of water management and governance in the urban areas. Water is understood as a natural and social common good, and the relations between different uses and current management practices are analyzed. This approach needs otherwise to influence not only the technical and social spheres but also the policy one. Therefore, a policy effective integration of the comprehensive and interdisciplinary understanding of water problems is advocated and proposed under the concept of integrated urban water policy (IUWP). The final objective is a contribution to an adequate conceptual and operational framework that enables a better and more effective understanding of the multiple dimensions and complexity of integrated management of water uses, in coherent relation with land use planning.

Keywords: integrated water resources management, water governance, territorial integration, integrated urban water policy

1. Introduction

> *"Water connects us. It connects us by flowing across imposed boundaries, by linking diverse terrains and settlements"* (Federico Mayor).[1]

Water is essential to life. The availability of 'good-quality' water is not only the basis of all biological processes but also the maintenance of biodiversity and the functioning of

[1]Keynote address 'Water and Civilization' given by Professor Federico Mayor, Director-General, UNESCO, at the First World Water Forum held in Marrakesh, Morocco, 22 March 1997.

ecosystems. Water has production functions (in terms of biological processes), maintenance functions (in terms of ecosystems) and recovery functions (through the cycles of materials).

Natural ecosystems and farming crops are the great consumers of fresh water. The competition between these consumers has been directly and indirectly intensified by urban land occupation and population growth: directly, as more land for farming means significant change to original ecosystems and, indirectly, because the growing population requires farming to become more productive and to occupy more land.

This occupation not only leads to the change in land uses in question but also to additional pollutants in the soil and associated water masses and the depletion of biological and genetic diversity. In time, the ecosystems become incapable of maintaining their functions of producing water resources with the essential characteristics to sustain human life and activities. This depletion of vital functions performed by the ecosystems endangers the sustainability of human activities like farming, aquaculture and fishing.

The river basin is the natural unit for the occurrence of water resources. River basins constitute large-scale ecosystems that combine land (forest, pasture) and aquatic components (rivers, lakes, wetlands), supplying a great diversity of vegetation and animal habitats. River basins are reference units for the hydrological cycle and the natural resources associated with it, including the filtration and regeneration of elements of the biogeochemical cycle. The main objective of water management is to provide fresh water for human consumption, for food from agriculture and fishing, for hydro-energy, and to all waterside amenities. These territorial units are also the natural link between the land and the sea that can sustain both the movement of fish species and materials between inland and marine waters (or vice versa) and the human need for navigable watercourses. This diversity of functions in the same territory is water's specific virtue as a natural integrator. On the other hand, this virtue also contributes to the difficulties of institutional design for effective water management in several ways [1]. As Giordano and Shah ask, the basin has been always put forward as the key pillar of IWRM implementation and the natural management unit for water resources; there is no evidence that the basin approach is needed [2].

The ecological processes occur and function at various scales—from very small and effecting the proximity to very large with deferred effects in time—which can present inter-scale variations due to the interference of various, often unpredictable, factors. Accordingly, interactions between the different territorial scales condition the end results arising from the referred processes.

When attention is focused exclusively on a specific scale, it can hinder the perception of these interactions, resulting in institutional responses that are not the most suitable because they do not cover the whole process [3]. On the other hand, the issues of water security demand that different scales are considered simultaneously [4]. As referred by Uschi Eid (UN), it is evident that addressing water security problems requires integrating and taking into account different spatial and temporal scales and water governance and management have not been particularly effective in the past in doing so [5].

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The basic ideas of integrated water resource management are nearing 100 years of age, being a call to consider water holistically, to manage it across sectors and to ensure wide participation in decision-making [2].

The need for territorial integration is not expressed immediately in current institutional systems and requires various adaptations and articulations between organizations and, above all, between the powers of different levels. On the other hand, the approach of the effects of human occupation on the ecological processes and of the long-term consequences of these alterations on the natural systems, and on the expectations of resource use by human activities, is a complex task for which various fields of knowledge are required. These two factors contribute to a growing need to adapt the operations of the organizations responsible for water management in a way that is not always compatible with the sectoral nature of the existing structures.

2. Water functions

2.1. Water as a multidimensional entity

'In earlier generations, water was seen as a technical issue – a question of organising proper water supply for human societies and agricultural production' [6]. There is now greater recognition that while water has a strong technical component, it is more about managing people, their interaction with the natural environment and the services ecosystems provide.

Due to its cyclic, dynamic and transversal intrinsic nature, water problems have many dimensions and overlap with many scientific disciplines and fields of management, planning and policy.

Modifications of the large-scale ecosystems and natural cycles are having strong impacts on water quality and interfere with the main 'parallel functions' of water. Falkenmark is still very up to date in her definition of the functions for which it is absolutely crucial to create management models that are able to maintain functionality as [6]:

- **Health function**: Safe water is crucial for protecting the survival of a healthy population—this is the perspective of the sanitary engineers.
- **Habitat function**: Aquatic flora and fauna are critically dependent on the characteristics of the water in the water body in which they dwell—this is the perspective of ecologists.
- **Two carrier functions**: Of dissolved material and of eroded material—this is the perspective of hydrochemists and geographers, respectively, to eliminate the pollution source since treatment of waste water is expensive.
- Regional water scarcity in the future will become a limiting factor for **agricultural production**; socio-economic planning will, therefore, have to be adapted to actual water constraints. Inevitably, we will have to develop policy tools capable of managing the shortage of common water resources between competing actors.

- Energy choices in dry climate regions are crucially influenced by water availability because water is required for almost every aspect of **energy production** and use: as a driving medium, as a cooling medium and as an energy transfer medium.

2.2. Water as a human right

> *'The human right to water is indispensable for leading a life in human dignity. It is a prerequisite for the realization of other rights'* [7].

The dimension introduced in the world debate by the United Nations Declaration (*General Commentary no. 15 of the Committee of Economic, Social and Cultural Rights of the United Nations* [7]) has recognized access to drinking water and sanitation as a human right.

Access to water must also be discussed in relation to the scarcity concept, though access to water is a human need and its satisfaction is a political objective.

The European Declaration for Water stated in 2005 that the 'availability of quality water in unlimited quantities 24 hours a day and 365 days a year for multiple uses and at extremely reasonable rates, beyond merely satisfying the human right to a basic share of drinking water, is indeed a conquest of public health, welfare and social cohesion' [8].

In this European level political agreement among scientists, researchers and activists for water rights, it was considered that the 'access to this general interest equity or value must be recognized and guaranteed to all, as citizens' social rights'. Several movements towards this attempt can be referenced in a framework that considers water as an 'essential good' and a 'human right', following the authors Morley [9], Petrella [10] and Sadler [11].

3. Contemporary water challenges

3.1. Water management: global changes and increasing complexity

Until the 1970s, there were essentially isolated incidences of environmental problems (accumulation of pollutant residue, infected waters, polluted atmosphere, etc.) that have had more or less limited effects and generally restricted to the territory of origin. Since the 1980s, and in more particularly the late 1980s and early 1990s, environmental problems have become increasingly complex. The effects started to be cumulative and could not be explained by a single phenomenon or cause, about which there were varying degrees of knowledge, and problems started to acquire greater spatial scope. It therefore became indispensable to adopt a comprehensive perspective for analysis and intervention in order to understand and address phenomena like the greenhouse gas effect, the rarefaction of the ozone layer or climate change.

The nature of environmental problems evolved, forming combinations of symptoms and factors that required ever-increasing scrutiny. In the 1990s, there was believed to be three broad groups of problems [12]:

- Generalized degradation of soil resources (loss of roughly 1.2 billion hectares of land in the previous 50 years).
- Growing accumulation of gases in the atmosphere, responsible for the worsening of the greenhouse gas effect and climate change (in particular CO_2, the emissions of which would have to decline about 60% at that time).
- Biodiversity increasingly at risk (clearing forests, drainage of humid zones, intensification of the harvesting of living resources, degradation of ecosystems that resulted in the extinction of thousands of species).

In this context, water quality constitutes a central theme for policy action. The concept of water quality has evolved insofar as recognition is given to the growing interactions and levels of complexity in the degradation processes of water resources. These include not only the cumulative factors and effects in space and time but also the persistence of those effects caused and the difficulty in taking isolated localized actions.

In the first decade of the twenty-first century, the globalization of the problems has become more evident. Global changes like climate changes, demographic changes and economic crisis are affecting directly and indirectly the resources in water and their natural ecosystems, with growing effects at transnational and world scale, demanding international concerted action.

The last 5 years of the twentieth century were characterized by an overall tendency of continuous glacier melting. This decline will have impacts on both the sustainability of the water resources in basins, which depend on glaciers and on their ecosystems [13]. However, demographics and the increasing consumption that comes with rising per capita incomes are the most important drivers or pressure on water [14].

The world's population is growing by about 80 million people a year, implying an increased freshwater demand of about 64 billion cubic meters a year. Most population growth will occur in developing countries, mainly in regions that are already experiencing water stress and in areas with limited access to safe drinking water and adequate sanitation facilities [14].

Human population growth and the expansion of economic activities are collectively placing huge demands on coastal and freshwater ecosystems. The increase in the number of people without access to water and sanitation in urban areas is directly related to the rapid growth of slum populations in the developing world and the inability (or unwillingness) of local and national governments to provide adequate water and sanitation facilities in these communities. The world's slum population, which is expected to reach nearly 900 million by 2020, is also more vulnerable to the impacts of extreme weather events. It is however possible to improve performance of urban water supply systems while continuing to expand the system and addressing the needs of the poor [5].

The management of scarce resources places new challenges to the institutional and organizational systems and schemes that are operating in a traditional way. This usually relates to continuing a 'water supply focus' of increasing the levels of services and investments in infrastructures in response to the increasing needs imposed by population growth, urbanization and intensification of irrigated areas. The need to manage the 'demand', increasing awareness of water scarcity, equity and sustainable uses of the available resources is still finding institutional and operational answers, though the principles are generally accepted by the agents of management and planning. This will mean a shift towards a new paradigm in water management, search for innovative and sustainable solutions, alternative sources of water (like more recycling and rainwater collection) and a new institutional framework, where the sectors may cooperate effectively and the public administration can address complex problems through new and flexible learning organization and structures.

It is still a fact that, as stated by Falkenmark almost 20 years ago, societal rules manifested in legislation and administration are *quite inconsistent with natural laws* [6]. Even though the same water is used for a whole set of different uses while running down the river basin, these uses are administered by different authorities as if they were not connected.

The complexity involved in water resource management and its linkages to land use adds even more difficulties to the management systems and to the decision-makers. Water management is increasingly complex and dynamic, requiring more flexible and adaptive responses.

3.2. Access to water, transparency and allocation of resources

The effects of water-depleting and water-polluting activities on human and ecosystem health remain largely unreported or difficult to measure [14], with growing need for a stronger and effective protection of ecosystems and the goods and services they produce.

Figure 1 shows project global water scarcity in 2025. The scarcity of water does not only refer to human needs. Over-use and over-allocation of water resources for human activities can lead to substantial reductions in the flow of watercourses necessary to maintain associated water-dependent ecosystems. This scarcity causes a reduction in the capacity of fresh water ecosystems to provide all the environmental services and can result in their irreversible degradation and that of the species depending on them. On the other hand, rising pressure from increasing population will endanger the maintenance of minimum environmental requirements. This situation is aggravated when growth is combined with the natural less favorable conditions and variability of resources.

Therefore, environment (including aquatic environment) should not be seen as complements to economic development but the foundation (and limits) on which development is built. Reflection should focus on the interdependence between the natural means and social systems. Water should be considered not as a resource which is available in varying degrees, but as a complex natural and integrating means, and our survival in this planet depends on its interdependence with other systems.

Ten years ago (2006) 13% of the world's population did not have access to enough food to live a healthy and productive life, yet the ability, technology and resources needed to produce enough food for every man, woman and child in the world do currently exist. Lack of health, financial or natural resources such as land and water and lack of skills to link productive activities with remote markets and ensure employment are all intimately related to poverty [13].

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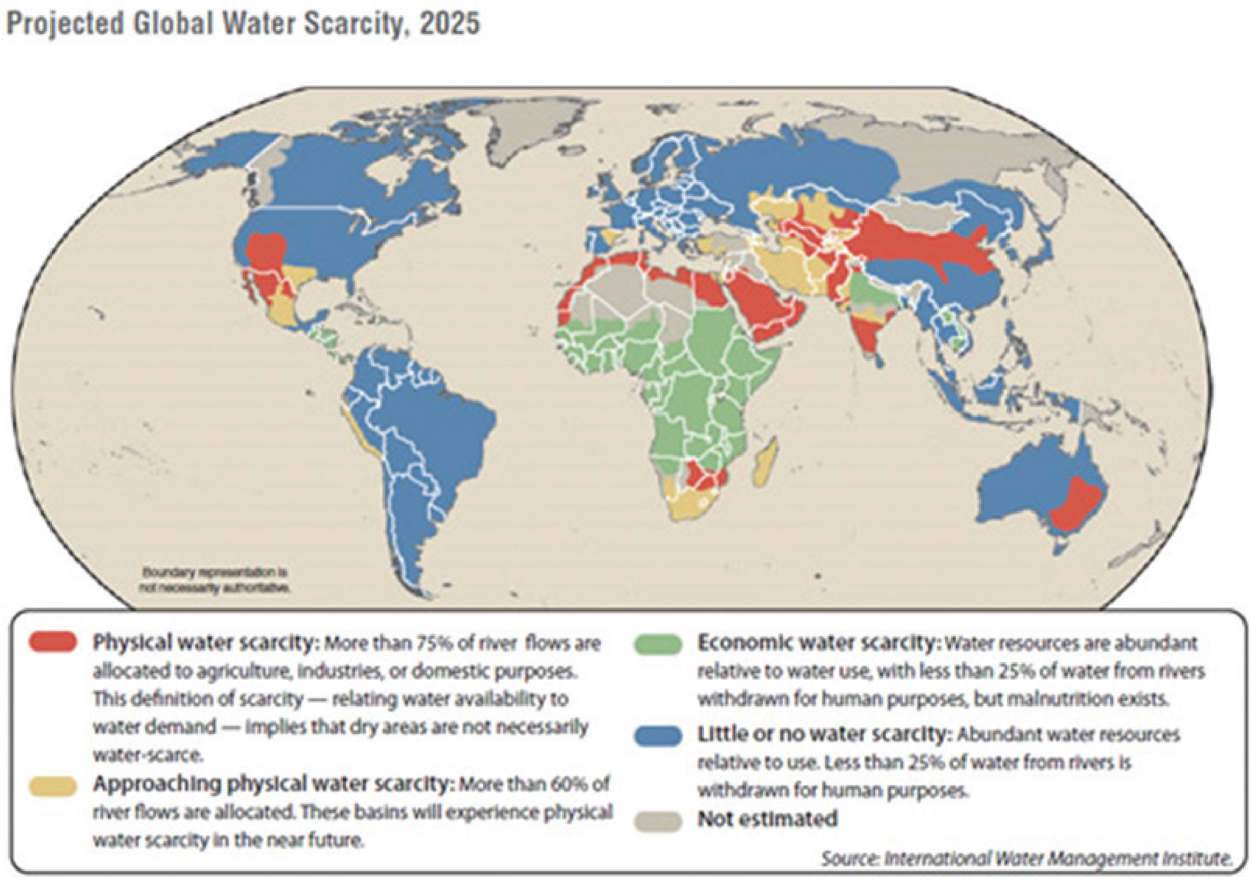


Figure 1. Projected global water scarcity in 2025 (source: IWMI 2000).

By 2050, agriculture will need to produce 60% more food globally and 100% more in developing countries. As the current growth rates of global agricultural water demand are unsustainable, the sector will need to increase its water use efficiency by reducing water losses and increase crop productivity with respect to water [5].

3.3. Water for urban areas

By 2030, the number of urban dwellers is expected to be about 1.8 billion more than in 2005 and to constitute about 60% of the world's population. Ninety percent of the increase in urban population is expected in developing countries, especially Africa and Asia, where the urban population is projected to double between 2000 and 2030. Coastal areas, with 18 of the world's 27 megacities (greater than 10 million), are thought to face the greatest migration pressure. *The net implication is that the world will have substantially more people in vulnerable urban and coastal areas in the next 20 years* [14].

In 2000, more than 900 million urban dwellers (nearly a third of all urban dwellers worldwide) lived in slums. A slum dweller may only have 5 to 10 liters per day at his or her disposal compared to the UN suggested minimum requirement of 20–50 liters. A middle- or high-income household in the same city, however, may use some 50–150 liters per day, if not more [13].

As urban populations increase and local surface and groundwater sources are depleted or polluted, many major cities have had to draw freshwater from increasingly distant watersheds as to meet their rising demand for water [13].

Water occurrence in urban areas has the particularity of being either 'natural' or 'artificially' produced. Its presence takes the form of natural water bodies that constitute esthetical and leisure resources, the form of rainfall, flowing over built surfaces and infiltrating in subsoil; the form of treated water conducted through pipes for domestic uses and drinking; and the form of residual water in various degrees of degradation, conducted to sewage treatment systems or directly back to natural streams or the sea.

The specificity of the challenge for water management in urban areas is the need to integrate the natural hydrological systems functioning and the artificially build systems, in a balanced way and in order to minimize the negative impacts on both sides (increase of runoff due to paved surfaces, flash floods aggravated by obstruction of natural streams, overexploitation and increasing pressure on water resources sources to satisfy increasing demand and urbanization growth, contamination of groundwater's, surface and coastal waters by the waste waters and the urban solid wastes and all kinds of particulates generated in urban areas, etc.).

The use of unexploited resources like storage of rainwater in buildings and open places (gardens, parking areas) is one very relevant action to take seriously inside urban areas and must be considered as a top priority in any management plan, not only in dry or semidry regions.

4. Integrated water management, water governance and policy change

4.1. Achieving synergies between water and other policies

Emerging first at Mar del Plata and evolving through subsequent water fora was recognition of the need to integrate all aspects and dimensions of the water cycle, to achieve integrated water resource management (IWRM). More recently, there is increasing recognition that operating only within the water domain is not sufficient as the greatest factors influencing water management are beyond water policy in *stricto sensus*, in areas such as national economic policy.

Following the call for a more holistic approach to water resource management, water utilities and land-use planners need also to coordinate to overcome these water resource challenges in the urban areas [15]. Planners and utilities need to work together to implement more green infrastructure to better manage storm water, more onsite reuse to reduce potable demand and more green buildings to reduce potable demand and better manage water within buildings [15].

Agreeing with Engle that IWRM is fundamentally about governance arrangements, we also note that IWRM stresses the interconnectedness of catchments and users; there is no universal model for the way in which management institutions are structured and linked [16].

The need to improve assessment of the effectiveness of water governance and its impact on the implementation of IWM in an integrated way with territorial planning in urban areas relates to the responsibility of people and institutions involved in water management and urban planning, in any country, to determine and prioritize actions necessary to improve water and territorial governance. The central question therefore revolves around the premise that water should not be managed as a mere resource but as a complex natural entity, whose frontiers extend to environmental, institutional and social (including the economic aspects) spheres and whose reference is always territorial. This premise results not only from the specific characteristics of the water cycle, closely associated with the physical territory (including the soil and subsoil, vegetation cover, ecosystems, atmosphere and climatic factors). It also results from the fact that the human communities have occupied and transformed this territory, from the beginnings of sedentary societies and the time when man learnt to store water, interfering with this cycle and being also conditioned by it.

Consequently, a ‘territorial’ approach shall consider all the means in which water is manifested and in which it remains or contributes to the various biological, geological and chemical cycles, as well as all the occurrence, draining and natural infiltration processes on one hand and all the reserve, abstraction, consumption, change of water courses and/or physical-chemical and biological conditions on the other. This approach does not exclude social relations of cooperation or conflict towards access to water, in particular regarding the occupation and changing processes of the use of land and territory.

4.2. Water functions and territorial scales

Falkenmark has deeply developed the analysis of the water and land use interaction. Her studies on the articulation of the cyclical support functions of the materials by the hydrological cycle, through the physical territories of the river basins, provide greater understanding of the interactions between the water functions and the physical territory, as illustrated in **Figure 2**.

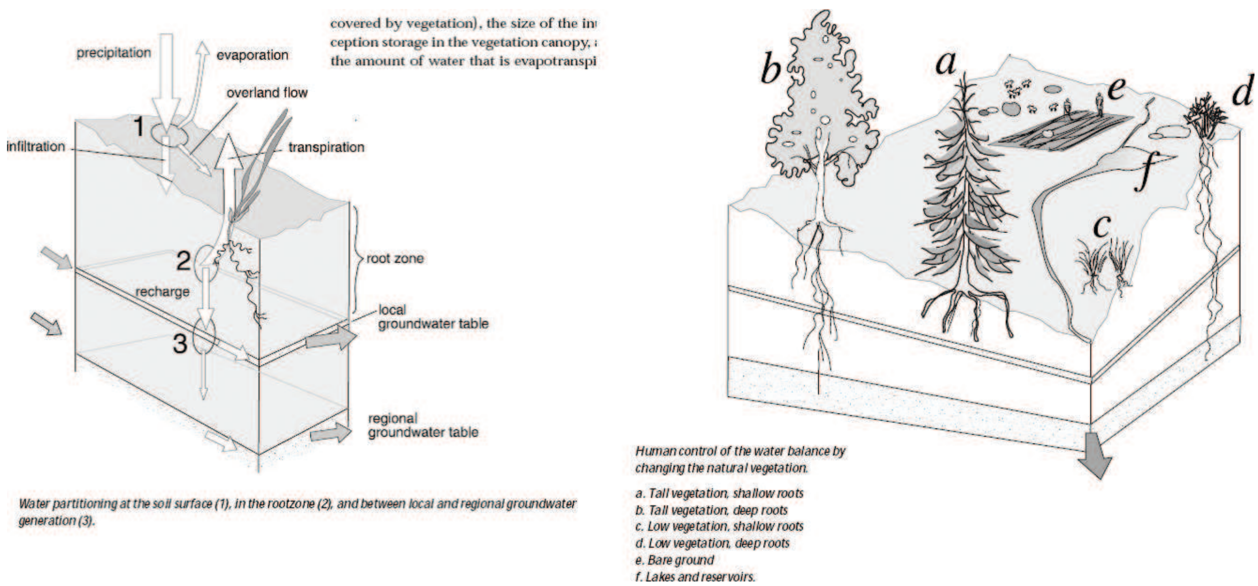


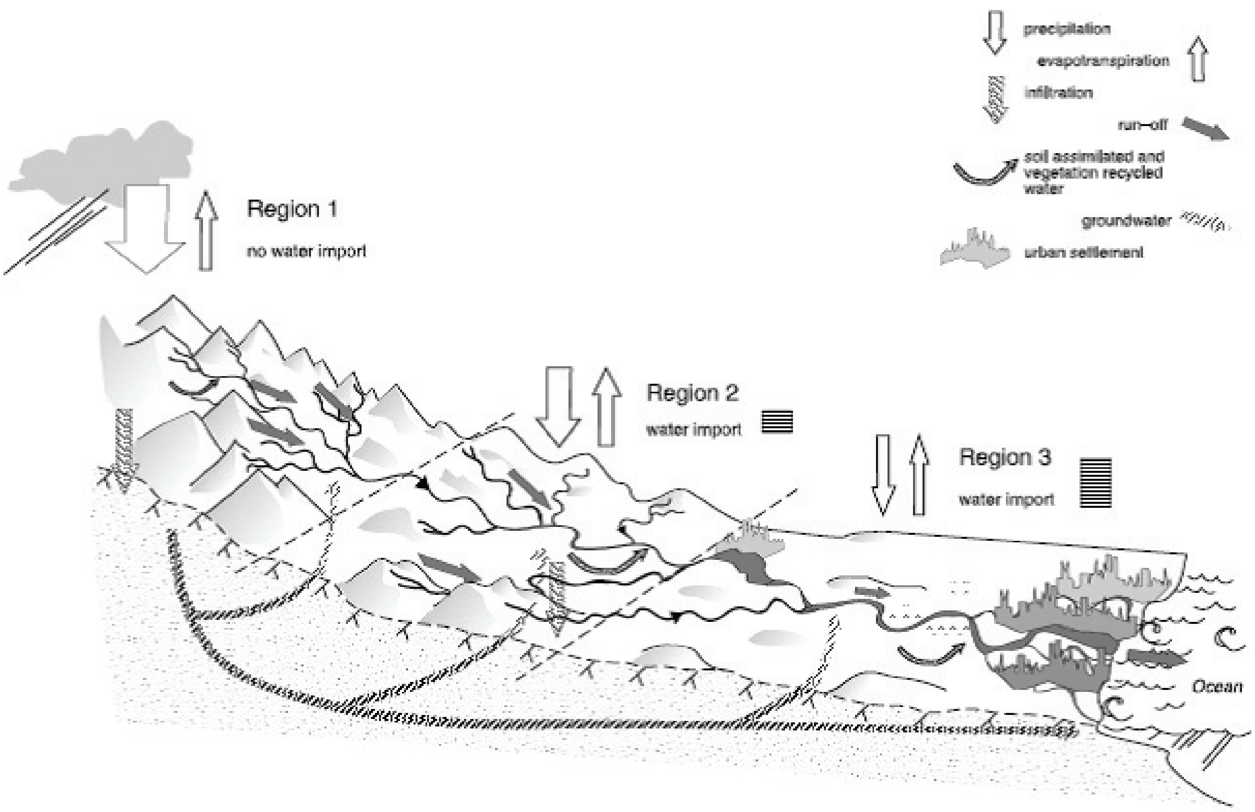
Figure 2. Water-soil interactions (source: Falkenmark [6]).

Falkenmark discusses the different administrative divisions and the need to consider flows of water imports from upstream to downstream through these jurisdictions. The buffering capacity of ecosystem services (flood regulation, drought mitigation, wetland water storage, preparing room for the river, clearing invasive trees, etc.) is essential, and these dimensions need to be considered in a holistic management approach.

Figure 3 presents the division of a basin in three regions and the resulting precipitation—evapotranspiration and its circulation to the surface or through the subsoil of regions from upstream to downstream.

4.3. Territorial integration of water management

The conclusions of the different *fora* and international committees on worldwide water management give ever-greater priority to the recognition that water is not a 'mere resource' but a complex and multidimensional entity. They highlight the need for concerted action between the different actors (government and society, stakeholders, etc.), in order to respond to the need for more 'effective' water governance [1].



Water flows through the river basin. This basin is assumed to be divided into three regions. The water availability of each region is determined by the local precipitation and evapotranspiration as well as the import of water from upstream regions. The rain water that falls on a region and which does not disappear as evapotranspiration generates runoff.

Figure 3. Water flow through the river basin territory (source: Falkenmark [6]).

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Areas of further research for better operational results from integrated water management practices and for improving water governance can be identified [1].

- Coherent articulation of spatial plans aiming at the integration of land uses, water and sustainability.
- The role of state agencies aiming at integration and participation.
- Enhancing opportunities for local solutions
- Capacity building among planners aiming at adequate response to new challenges, adequate knowledge concerning contemporary planning problems (participation, governance, climatic change, etc.).

A river basin or drainage basin is a territory that contains a watercourse and its tributaries. The river basin should be the starting point for the analysis of the water resources, associated ecosystems and habitats that depend on them, as well as the analysis of all the interdependencies resulting from the scale(s) of occurrence from natural processes or the dysfunction's triggered by human occupation and activities.

However, to effectively integrate water resource management with other natural resources, we need to think beyond the basin, and planning at any level always involves the public administration and the elected representatives of the state. Good government requires adequate networking and the integration of all sectors in planning activities. As quoted before, *the UN recognizes that drivers and policies outside the water sector often have more impact on water management than those within* [17].

Territorial integration of different sectoral strategies is the only way to match objectives at each scale of analysis. This integration demands an approach to water problems relating to all sectors, taking into account the other scales of analysis, beyond the river basin.

4.4. Water policy and the institutional systems

Decisions on the appropriate jurisdictional level for water resource allocation and management need to take the impact of all sectors at all scales into account. Furthermore, the level for jurisdiction must also recognize the specific role of the state in defining the priorities for the use of the available water. The promotion of good 'governance' in addition to good government depends primarily on the political will of the government and public administration bodies. Participation of stakeholders and sectors, as well as end users of water infrastructures and water amenities, is a central issue in governance. The need for integrated representation of all relevant human settlements, which are not always wholly within one basin, is also a key issue for good water governance [6, 18, 19, 1].

Water policy is a broad field where new perspectives for water management and planning can be framed. Le Meur defines this distinction between water management and 'water politics', based on the more comprehensive perspective and the inclusion of the social dimension, as the most relevant difference. Water politics should replace water management in order to involve diverse social actors and groups and follow an approach that goes apart from the managerial perspective that the 'right solution' (technical and institutional) exists and can be worked out with expertise and participation [20].

Allocation of available resources, according to priorities defined by the state and the control of these resources, is a prerogative of the state action, through its policies. This responsibility of how to deploy a resource to the national advantage is the key to water governance at the beginning of the twenty-first century, accordingly, and it is 'how, through politics, the State can achieve this fairly and equitably, without reducing incentives for efficient use of the resource' [20].

Fragmentation at administration levels is a traditional problem in environment and water institutions, with the different authorities handling different issues so that it becomes more difficult to allow interdependencies.

Even though reality is multidimensional and complex, all our institutional organizations are oriented to unidirectional and unidimensional interventions, leading to the dilemma stressed by Falkenmark, and discussed previously. It also happens that individual institutions have specific and often opposing objectives [6, 18]. The legislative framework is built to frame action in compartmentalized 'worlds', often hindering any interaction and cooperation that would be crucial to address these complex nature problems.

The 'land/water dichotomy characterized by a mental image of land as opposed to water' that was present at the time (1999) is still a reality, with policy structure based on the separation between land and water as entities to be managed in different ways and by different management systems. What usually happens in Europe, and many other regions in the world, is that land and water are administratively linked mainly through the use of environmental impact assessments in the case where land use changes produce side effects on water, not going beyond that legal guiding framework.

Consideration of the **territorial character of water** represents a complex challenge for water management but unavoidable in the urban areas. While cities are impacted by global changes, some urban structures become more and more static in comparison to the unexpected and faster changing contexts [21]. Accepting also that urban settlements incorporate an increasing complexity of interlinks and interdependencies within their economic and social tissue, effective solutions will not arise exclusively through 'traditional, institutional or formal' approaches. Therefore, *out-of-the-box*, experimental and cross scale responses may be necessary [21].

5. Conclusions

There is a crucial need for better understanding of the extended urban water cycle within the river basin processes at regional level. River basins are the territorial units for hydrological reference and for understanding the natural cycle in all its dimensions, including the links with other natural resources. Integrated water management calls for a territorial integration of these dimensions and the processes.

The diversity of functions in the same territory is one of water's specific virtues as a natural integrator. On the other hand, this virtue also contributes to the difficulties of institutional design for effective water management in several ways. The need for territorial integration is not automatically reflected in the current institutional frameworks, and existing processes require several levels of adaptation, as well as articulation between organizations. On the other hand, the approach of the effects of human occupation on the ecological processes and of the long-term consequences of these alterations on the natural systems, and on the expectations of resource use by human activities, is a complex task for which various fields of knowledge are required. These two factors contribute to a growing need to adapt the operations of the organizations responsible for water management in a way that is not always compatible with the sectoral nature of the existing structures [1, 22].

There is a clear call for better integrated land and water management in the urban sphere by developing analytical frameworks and operational tools to assess the climate change impacts and the role of territorial planning in the urban water cycle. A new conceptual framework based on 'territorial integration', 'sustainable urban development' and 'integrated water management' was proposed to address the new and more complex challenges: an 'integrated urban water management policy' [22]. This approach is based on previous conceptual discussion [6, 19, 1, 23–25].

This contemporary approach aims to provide the policy making sphere with more operational and comprehensive tools to address the multidimensional challenges imposed by urban water management in the context of the current global changes and challenges.

Acknowledgements

This chapter is based on my PhD thesis presented at the University of Lisbon in 2010 [1] and also reflects more recent work [22].

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