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The Eristic-Dialectical Model for Urban Hydro-Security: The Attica Metropolitan Case in Greece

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Abstract

The previously developed model of Water-Man Eristic Dialectics is adapted to the case of urban hydro-security. Eristic and Dialectics are used in their original meaning in Greek to describe conflictual relations between water and the city (eristic), followed by their logical harmonization (dialectics). In recent times, which some scientists have called the "Anthropocene" period, cities experience multiple water-related risks. In urban metropolitan areas, the combination of population increase and the climate change crisis has induced water scarcity, pollution of water streams and groundwater together with unprecedented floods, hurricanes, tsunamis, and periods of drought. In this paper, we argue that the state-of-the-art Urban Water Management (UWM) model derived from the Integrated Water Resources Management (IWRM) framework is still anthropocentric and has failed to produce the expected urban water security. After analyzing alternative relations between water and the city, the Eristic-Dialectical Water Resources Management (EDWRM) model is suggested for UWM (EDUWM) and is applied in the Attica Metropolitan case, where the city of Athens is located. A historical review shows that the application of this model may improve urban hydro-security.

Keywords

water-city conflicts, eristic dialectical model, urban hydro-security, Attica Greece

1. Introduction

The urbanization process, i.e. the creation and gradual expansion of human settlements is historically in constant evolution, subject to changing social, environmental, economic, and cultural interactions. By the year 1800, less than 5% of the global population lived in urban areas. The recent rapid increase of urbanization predicts that this will explode to 80% by the year 2030 (Wilson, 2020). The sanitary crisis of the covid-19 pandemic we have experienced in 2019 onward, in combination with successive imposed lock-downs and a huge decrease of economic and cultural interactions has revealed the importance of direct economic and cultural activities in urban communities.

In ancient times, security was a major concern for creating cities, like Athens and Rome. Ancient cities were encircled by robust man-made fortifications and walls for protecting the urban population against aggressive neighbors. In continental Europe, during the middle ages, fortress cities with castles and strong walls around the citadel were located in remote mountains, offering additional natural protection against enemy tribes. On Mediterranean islands, to protect people from pirate invasions and other enemies coming from the sea, villages were located in areas naturally invisible from the seaside.

Later on, with the development of agricultural activities and trade of agricultural products such as wheat and wine, cities flourished in valleys and at crossroads, allowing easy access to commercial exchange and facilitating transportation and communication with neighboring populations.

During the 1st industrial revolution (1750-1870) the need for cheap labor in industrial sites resulted in huge migration of the rural population to cities. The rapid expansion of industrial cities in Europe and the USA during the early 19th century was mainly due to two reasons: (1) the success of the agricultural revolution initiated in the previous century had contributed to a huge increase in the rural population ready to move to urban areas where new jobs had been created by new industries, and (2) historians agree that progress made in medicine had reduced the infant mortality rate (Roser et al. 2019). Families with many children, protected against famines and bacterial illnesses offered cheap labor to newly created factories. By 1850, many European cities became industrial centers and in Great Britain, 50% of the population lived in towns and cities.

Living conditions at that time in terms of environmental quality and housing facilities were dire. The worker population was concentrated near the factories with insanitary conditions and dirty streets. Sewage was disposed of directly into the streets and the water supply was highly polluted without the collection of solid waste. At the same time, the air was heavily polluted from soot and particulates, as well as sulfur compounds from burning coal for heating houses and ensuring industrial production.

Environmental concerns and legal actions to improve the quality of living in big cities started in the mid 19^{th} century. Priority was given to public health and sanitation improvement that resulted in big engineering works of water supply and sewage treatment. In Paris, between 1853-1870, under the Second Empire of Napoleon III, a vast program of public infrastructure works was initiated by G.E. Haussmann, the Prefect of the Seine. The city of Paris was renovated by constructing huge underground networks of sewers, as well as fountains and aqueducts across the city. This was accompanied by the demolishing of vast neighborhoods of the medieval city, the opening of large boulevards and squares, and the construction of new stylish houses for wealthier people. Also, new transportation corridors and commercial places were opened by the forced displacement of poor people to peripheral areas. The methods used for the Paris renovation have been replicated in other cities in Europe and the USA, as well as in the rest of the world later on. In Great Britain and New York State, legislation for public health set up the minimal standards for housing construction (Tesh, 1982).

The period 1896-1916 is known in the USA as the *Progressive Era*. This was a period of political movements aimed to address problems caused by urbanization, industrialization, immigration, and political corruption. The need for recreation and relaxation in big cities has resulted in the creation of big open green areas, such as Central Park in New York which has been used as a template for the construction of similar areas in other cities around the world. In the ’90s, political ecology movements, non-government organizations (NGOs) and other environmental organizations put at the center of urban problems the need for reconciliation between urban socio-economic activities and ecological preservation. One of the main concerns was and continues to be, the issue of *water in the city*.

Water and cities enjoy a very close relationship, as freshwater resources are essential to human survival and to maintain healthy ecosystems. As we can see on the world map, the majority of modern metropolitan cities are located close to important rivers and estuaries. This is the case with Paris, London, New York, Rio de Janeiro, Beijing and Tokyo. Urban economic activities and trade of industrial goods could benefit from river and sea transportation. Moreover, the urban water cycle could create favorable environmental conditions for human recreation and maintain human health as well.

The friendly relationship between cities and water is at the same time adversarial. Heavy rain may produce catastrophic floods in urban areas with losses in human property and even lives. Hurricanes in coastal areas may hit coastal cities and induce urban disasters. This complex relationship between cities and water has existed since ancient times until modern reality. To achieve *urban water security,* a concept being defined as the *process to satisfy cities' human and ecological needs of water quantity and quality, including the periods of flood and drought*, alternative water management strategies and regulation mechanisms have been developed. The challenge is to define and implement an effective urban water management (UWM) model that can improve urban water security. In this paper, the previously developed eristic-dialectical model for sustainable hydro-governance (Ganoulis, 2021) is adapted to improve UWM. It is applied in the Attica Metropolitan case in Greece in two steps: first, the conflicting relationship between the city and water is analyzed (eristic analysis) followed, in a second step, by reconciliation measures (dialectic approach) that can ensure urban water security.

2. The Attica Metropolitan Area

As shown in Fig. 1.a the *Attica Peninsula* is a geographic region located in the South-Eastern corner of Greece. It is one of 13 administrative regions of the country and contains Athens, the capital city of Greece. At the center of the peninsula, surrounded by 5 mountains, the *Attica Basin* is located. It is populated by 28 municipalities that, together with Pireas City, form the *Athens Metropolitan Area* or *Greater Athens* (Fig. 1.b). This area, together with the towns and villages of East and West Attica, form the *Attica Metropolitan Area* (Fig. 1.c).

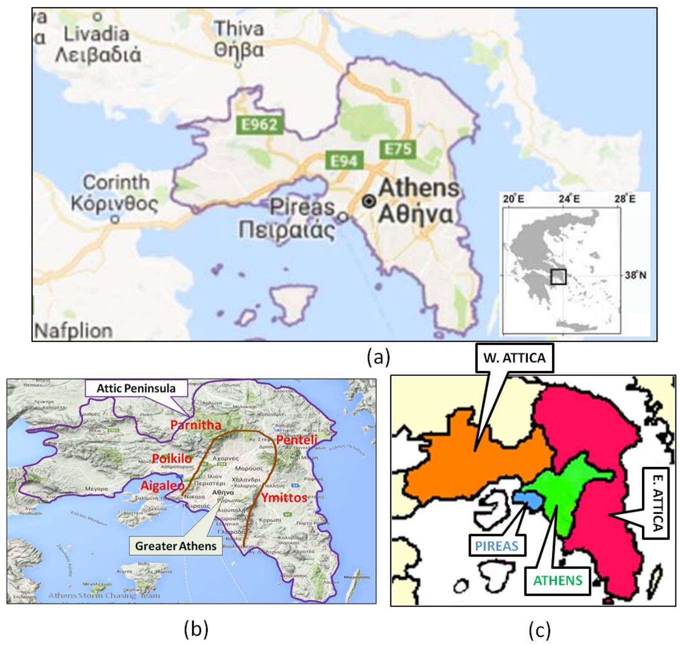


Figure-1. The Attica Peninsula (a), Greater Athens (b), and Attica Metropolitan (c), *modified from Google Map*

Table-1. Population in GreaterAthens and Attica Metropolitan

	Greater Athens	Attica Metropolitan
2021 Census	3.153.255 (inh.), 30% of country's total population	3.763.418 (inh.), 36% of country's total population

The total population of Greece in 2021 was 10.353.724. As shown in Table 1 (Greek Census, 2021), about 36% of the Greek population lives in Attica. By comparison, 18% of the French population lives in the Paris Region, Ile de France (INSEE, 2018).

Apart from its mild micro-Mediterranean climate, Attica benefits from a special location with the Acropolis rock at the center as a natural citadel, a fertile plain beyond the 5 mountains surrounding the historical center, and easy access to the sea via Pireas Port (Fig. 1). Human settlements in Attica have experienced historical transformations in line with socio-economic changes in Europe and more specifically in the Balkans (South-Eastern Europe). From antiquity to recent times, the city has established special relationships with water.

２-１. Attica-water relationship: a brief historical review

The water cycle in cities is the renewable natural mechanism upholding the urban biological cycle and maintaining a green healthy environment. The hydrological urban cycle is in strong interaction with humans and urban infrastructure through a continuous water recycling process (Fig. 2).

As water flows from rivers to the oceans, evaporates into the atmosphere and precipitates to land, it provides the water supply for drinking, diluting wastewater and sewage, and transporting excess water away from homes and commercial neighborhoods. In coastal cities, as in the case of Attica Metropolitan, we may distinguish different components of the hydrological cycle, such as marine evaporation, terrestrial evapotranspiration, land and ocean precipitation as well as runoff and groundwater recharge (Fig. 2). What would normally become groundwater recharge is more often discharged directly to surface water bodies by urban drainage infrastructure.

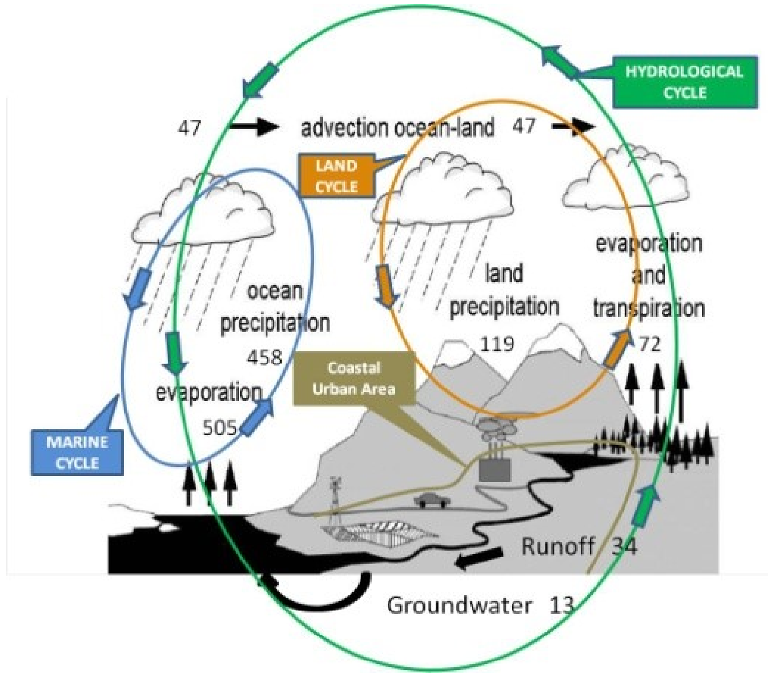


Figure-2. The hydrological cycle in a coastal urban area (numbers are indicative in km^3/year, *adapted from Ganoulis & Fried, 2018*

A brief historical review of the relationship between the Attica region and water would be useful for a better understanding of this connection since historical times.

As reported by Koutsoyiannis and Patrikiou (2014), Attica receives annually about 500 mm of rainfall. This is a small amount of precipitation in comparison to 2.000 mm in North-Western Greece (Fig. 3). Attica is then located away from important rivers and lakes, like the Acheloos River and Lake Trichonida in Central-Western Greece. To the main question: why the choice of the arid land of Attica for settling a city that became the cradle of the western civilization, Athenians answered with a myth.

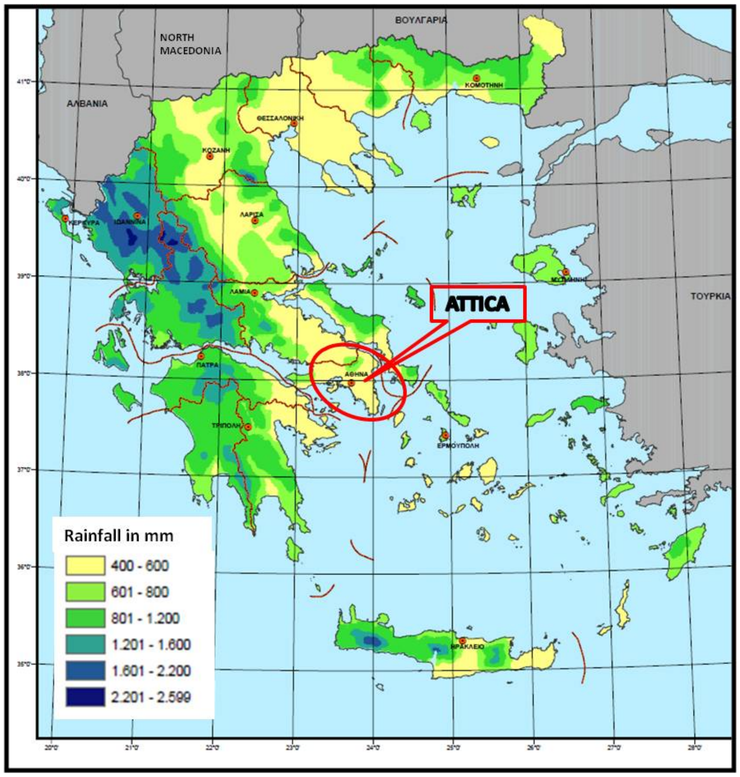


Figure-3. Multiannual mean precipitation in Greece (mm/year), *adapted from Koutsoyiannis & Patrikiou, 2014*

2-1-1. The ancient myth of Athens settlement

People in Attica asked Zeus, the chief deity, to designate a God for protecting a city they wanted to found. Zeus, acting democratically, decided to give the people a chance to choose between two important contenders: Poseidon and Athena. On the rock of Acropolis, a competition was organized; the two Gods offered their gifts to the city and the people had to choose the most valuable. Poseidon, the God of the Sea, used his trident to crack the rock and he created a source of water. Athena, the Goddess of Wisdom, knelt quietly and used her spear to plant an olive tree. People appreciated water as a very precious element but, on reflection, they opted for the modest olive tree thinking that the city could offer more chances to survive and grow by benefiting from Athena's wisdom. They voted for Athena to be the city's patron and named the city Athena after her (Greek-Gods.Info, 2021).

The interpretation of the myth is that Athenians chose to build their city in that particular place for many reasons, all related to water (Fig. 4). As is the case of many ancient cities in the Mediterranean and other parts of the world, the Athenians wanted to be located: (1) far from important rivers for flood protection; (2) around the Acropolis rock for natural security with sufficient water from underground springs; (3) close to river streams for maintaining healthy green areas (Fig. 4); (4) close to an arid but fertile plain for growing olive trees and vineyards; and (5) having easy access to the sea via Pireas Port.

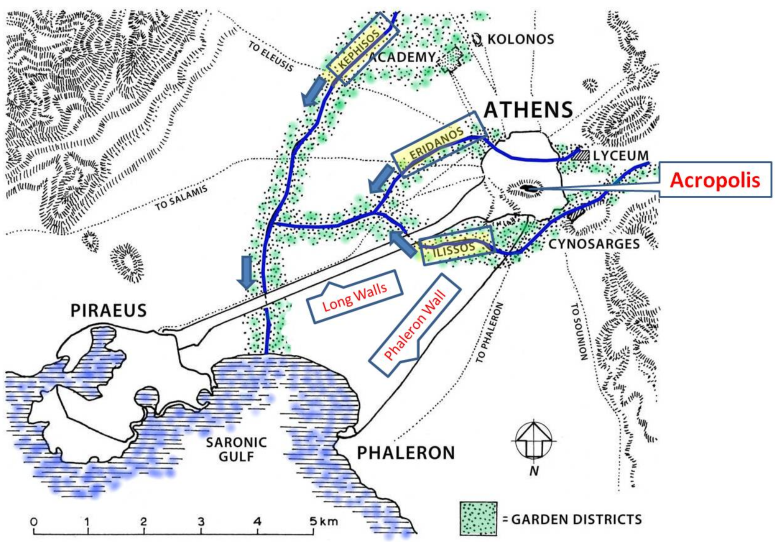


Figure-4. Map of ancient Athens *adapted from Levine, 2021*

2-1-2. From antiquity to Ottoman Occupation (EYDAP, 2021)

The interaction between the continental city and the sea in the Pireas area was the main natural element sustaining the development of Athens as a principal naval, economic and military force in the Aegean and Eastern Mediterranean over three centuries (Fig. 5). From the 6th century BC, the city-state of Athens became the dominant economic power in the region, based on the maritime trade of agricultural and manufactured goods. Due to the aridity of agricultural land, trade became a major activity between the city and numerous colonies from the Black Sea to Southern Italy. This economic prosperity would not have been possible without strong military forces, especially in the sea. By the mid 5th century BC, after having defeated the navy of the strong Persian Empire in Salamina, Athens had a fleet of many hundred triremes, requiring close to 80.000 men. During that period, known as the Golden Age of Athens, Athenians invented the democratic political system, erected on the Acropolis the sprawling marble Parthenon temple, and elaborated by the contribution of many outstanding individuals, the basis of the Western Culture, from science to philosophy and the arts.

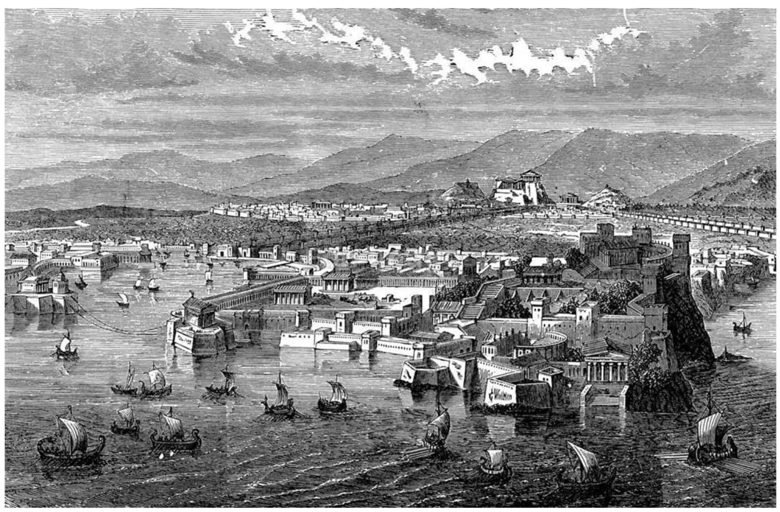


Figure-5. Athens viewed from Pireas. *19th-century illustration*.

Water scarcity in Attica was a chronic problem. Lack of drinking water occurred repeatedly during periods of drought or when precipitation was limited. However, the water crisis was also a source of inspiration for finding innovative water solutions.

The innovative idea of creating subterranean aqueducts for transporting drinking water by gravity over long distances was first realized in ancient Athens in 530 BC by the tyrant Peisistratos. A series of terracotta pipes were positioned in a narrow trench collecting water from springs and also from groundwater emerging along with the gallery.

During the Roman period, the most important aqueduct was constructed by the Roman Emperor Hadrian circa 140 AD. This hydraulic achievement was composed of a subterranean gallery approximately 20 km long and with a variable cross-section, covered by ceramic bricks. A huge amount of water was transported by gravity from springs in the Parnitha Mountain up to the hill of Lycabittos, where the Hadrian reservoir is located to this day.

During the Turkish occupation, due to the lack of maintenance, parts of the aqueduct collapsed and the regular flow in the gallery was interrupted. Open reservoirs for collecting part of the precipitating water were used and the city had many public drinking fountains.

2-1-3. From the War of Independence to First World War

During the Greek War of Independence 1821-1832 against the Ottoman Occupation, Athens was the scene of fierce combat between Turks and Greeks. The city suffered huge destruction and the water supply infrastructure was almost destroyed. In 1832 the Kingdom of Greece was established and two years later Athens became the official capital of Greece. In 1850 the Director of the Royal Garden, near Syntagma Square, now known as the National Garden, discovered part of the ancient aqueduct. After some repairs, the water flow was established and continues to flow to this day for garden irrigation (EYDAP, 2021).

Athens grew steadily throughout the latter half of the 19th and early 20th centuries. In 1881 following the Russian-Ottoman war, the region of Thessaly joined Greece. After the Balkan Wars 1913-1918, the Greek Macedonia was ceded by the Ottomans to Greece. In 1923, after the defeat of the Greek army in Asia Minor, nearly a million Greek Orthodox refugees came back to

Greece, many of them descending on Athens. The increase in population created a huge water demand. To satisfy the demand, the Hadrian aqueduct was rehabilitated and put into service until 1935. However, the cost of maintenance and deterioration of water quality resulted in the necessity of finding other sources of water supply.

２-２. Attica's modern technocratic Urban Water Management

From the antiquity to late 19th century, local water resources were sufficient to serve the population in Attica. During that period, Athens was the most important urban settlement in the peninsula. The relatively small amount of population was served by spring waters, public fountains and individual wells pumping local groundwater. As the population was gradually increased, waters from the surrounding mountains and local aquifers were collected and directed to the city by surface and groundwater aqueducts. In 1896, when the first modern Olympic Games were organized in Athens, the city counted no more than 128.000 inhabitants.

From the year 1925 until recently, the water supply in Attica has been dominated by the engineering approach. Historical developments and political changes in Greece have influenced the UWM in Attica, including the problematic Athens's resilience to flooding risks (FRMP, 2000; Ganoulis, 2022).

During the 1920s, the population in Attica has surged by a big number of refugees expelled from Asia Minor after the defeat of the Greek army in the Greco-Turkish war. By the year 1930, Attica reached 800.000 inhabitants. To satisfy the growing water demand, public authorities have undertaken the development of expensive technical infrastructure, comprising dams, reservoirs, galleries and water channels. As shown in Fig. 6, water resources have been stored and diverted to Attica from faraway with artificial reservoirs and aqueducts. Biological sewage treatment has also been completed in the Psytallia Wastewater Treatment Station. (EYDAP, 2018).

Figure-6. The Water Supply System of Attica, *modified from EYDAP, 2018*

Hydraulic works started in the period 1926-1929 by building the Marathon Dam, a concrete arc structure covered by marble from the Penteli Mountain (Fig. 6). In 1953 the Marathon Reservoir was connected by an aqueduct to the natural lake of Yliki. To satisfy a growing water demand, the Mornos Dam was designed in 1969 and completed in 1981 on the Mornos River, located outside Attica in Central-Eastern Greece. Today, the Mornos Reservoir supplies water to Attica through an open flow aqueduct almost 190 Km in length (Fig.6).

In 1980, the Greek government decided to form a unified water supply and sanitation authority, the Water Supply and Sewerage Company (EYDAP). Although the company has been partially privatized and introduced to the stock market, it remains to this day under national control. Greece joined the European Union in 1980 and, since that year, the application of the EU Directives on Water and Sanitation has been compulsory for all Member-States. As we will see later on in this paper, the application of these Directives has produced mixed results.

３．Anthropocentric models

UWM techniques aim to ensure sufficient water quantities of good quality to satisfy human and ecosystem needs. In Attica, the application of UWM policies has followed the socio-economic evolution worldwide. In the middle of the 2^{nd} industrial revolution, during the early 20^{th} century, the man felt able to control the natural environment.

As a milestone, we can cite the construction in the USA of the Hoover Dam in 1935. This Pharaonic gravity-concrete arch dam in the Black Canyon of the Colorado River used enough concrete to pave a two-lane highway from San Francisco to New York. It can be considered the symbol of hydraulic engineering accomplishment and the domination of nature by human technology. At the same time, the Marathon arch dam in Attica looks like a scale model of the Hoover Dam in the USA (Fig. 7).

Figure-7. The Marathon Dam in Attica, *source EYDAP*

The anthropocentric approach in Water Resources Management (WRM) was based on the assumption that for serving human needs, freshwater natural resources were available in unlimited quantities. By applying advanced scientific and technical tools, the man turned out to be stronger than nature, except for extreme natural disasters. He placed himself at the center of the universe with the sense of being surrounded by natural resources available to satisfy his needs and improve his living standards.

In the industrial society, the separation of man from nature by the appropriation of natural resources, both renewable and fossil, was considered an achievement (Leiss, 1972). Domination of nature was a logical extension of the progress made in science and technology. Nature was excluded from the narrative of social progress and negative environmental impact from industrial and other human activities, such as agriculture, were not considered of primary concern. Economists usually call these impacts external to human activities, i.e., as externalities to the economic management model.

３-１. The Integrated Urban Water Management model

In the 1970s, academic publications, UN organizations, such as UNESCO and UNEP, NGOs and environmentalists started claiming the WRM model, including UWM, was a multidisciplinary topic, including not only technical issues, but also economic, social, and ecological considerations. Since then, environmental and ecological sensitivities have been growing rapidly.

A landmark event was the 1972 UN Stockholm Declaration on Human Environment. In 7 proclamations and 26 principles, the major issue was "the protection and improvement of the human environment, both the natural and the man-made", UN (1973, p. 3). This ecologically sensitive global development generated a new dimension in UWM with the obligation to perform an Environmental Impact Assessment (EIA) on new water-related urban projects.

Another milestone in WRM's evolution was the 2000 UN Rio Earth Summit. The Rio statement, in combination with that of the 2000 World Water Forum, has confirmed the notion of a sustainable WRM. Although sustainability has different interpretations, professional associations, UN organizations and academic scholars have agreed on the criteria for achieving it (Loucks, 2000; Ganoulis, 2001). These criteria refer, apart from technical reliability, to environmental safety, economic efficiency, and social equity. The sustainable WRM scientific model became the Integrated WRM or the IWRM paradigm that follows a systems approach (GWP, 2000).

IWRM was adopted in 2000 by the European Union as a regulatory framework and has served as a successful model of water policy in many countries around the world. The EU-WFD aimed to achieve by 2015 the "good" status (quantitative, chemical, and ecological) of surface and water bodies in Europe (EU-WFD, 2000). The main components of the EU-WFD are as follows: (1) a technical part consisting of monitoring the driving forces and pressures on the water bodies from human activities, analyzing the ecological state of the aquatic environment, and developing the River Basin Management Plans (RBMPs) for suggesting remedial measures (2) an economic analysis of water services and how to recover the cost of water services, and (3) the public participation in the decision making processes.

As shown in Ganoulis, 2021, the IWRM model and its application in UWM are dominated by an anthropocentric approach and have failed to achieve the expected results. Therefore, a need for developing alternative UWM models may be concluded.

4. Alternative models of city-water connection

For developing a sustainable UWM, a basic issue is the definition of a relationship between the city and water. Taking all possible combinations between the two, four alternative city-water models are distinguished, both conceptually and in real situations: (1) City dominating Nature (*anthropocentric approach*), such as the Hong-Kong case, (2) Nature prevailing City (*naturalistic model*), like the Letchworth Garden City in

England, (3) Man-Nature differentiation (*dualistic concept*) like Berlin, and (4) Nature-City hybridization (*hybridist model*), like Copenhagen.

4-1. City dominating nature

The most advanced modern UWM is based on the integrated or systemic approach. Integration means that for effective management of water as a natural resource we should also take into account interactions with other natural resources, like the soil and vegetation, and include different sectors of human activities related to water, such as agriculture, energy, industry, and tourism.

The IWRM paradigm is the state-of-the-art paradigm for an integrated UWRM model. This has been implemented as a policy tool by the EU-WFD 60/2000/EC and from a conceptual point of view belongs to anthropocentric WRM models. Although IWRM has produced many positive results in the Global North, it is still related to the water-related environmental crises humanity experiences today (Ganoulis, 2021). In an anthropocentric model, sometimes known as the *productivism approach*, nature serves human society by providing natural assets, like water, air, food, and fossil energy. Citizens use the *natural capital* to produce income from goods and services, such as water supply and sanitation, housing, transportation, and water infrastructure. By increasing his *human capital,* the man returns to nature, what economists call *externalities*. Huge externalities, such as heavy pollution on rivers and lakes, may reduce the natural capital, creating the so-called *human impact inequality* (Dasgupta, 2021). This simply means that the human demand for environmental goods and services exceeds the biosphere's available supply.

4-2. Nature prevailing city

This approach is based on the assumption that nature prevails over man and therefore natural laws should dictate the urban environmental policy. In the 1700s, the political philosopher Jean Jacques Rousseau argued that man should enjoy living close to nature and his activities should be subjected to natural laws. However, designing the urban metabolism according to natural laws could threaten scientific and technological innovation for improving the urban environment. The naturalistic model based on the assumption that nature should guide citizen's policy underestimates the fact that nature is not always friendly to man, as in the case of natural disasters, floods and droughts.

４-３. City-nature differentiation

This dualistic model emphasizes the fact that human settlements have developed social and economic characteristics that are different from natural processes. Social anthropologists, like Claude Lévi-Strauss, underlined the fact that human societies have developed similar characteristics everywhere on Earth, independent from specific environmental conditions. Human culture, including technological and production structures, differentiates man from nature. The dualistic model assumes that human culture differentiates cities from their natural environment, without suggesting a dialectical relationship between them.

４-４. Nature-city hybridization

Recent advances in scientific research of natural and zoological sciences have been produced by genetic manipulation of new plants and animals, called *hybrids*. For example, *hybridization* was used to generate the first famous cloned mammal, which is the sheep "Dolly".

Hybridization can be more generally be considered as a methodology to produce new conceptual entities without discrete boundaries. As Perreault (2014, p. 234) explains in his review article, a group of social scientists and human geographers has suggested *hydro-sociology* as a new scientific discipline, aiming to bridge hydrological to social sciences.

Intending to add the socio-political discourse to the technical/hydrological narrative of WRM, social scientists described the *hydro-social hybrid* as a new model of IWRM. Although in the hydro-social model, conflicts between social actors are recognized, the unification of hydrological and socio-political processes dissipates the conflictual characteristics between nature and man.

In real cases, additional difficulties arise, as related to the following two new entities hybridization may generate:

1) *Hydro-social territories,* have been defined as geographical areas that are created by combining different hydrological and social processes (Cornut & Swyngedouw, 2000). Hybrid members of hydro-social territories, although they have different individual hydrological and social characteristics they can belong to the same hydro-social territory because of similar hybrid characteristics. In other words, hybrid criteria may compensate for huge differences between hydrological and social individual properties.

2) Linton & Budds, 2014 have introduced *the hydro-social cycle* as a new hybridization of the natural water cycle with different sociological processes. In the new hybridist entity, water and society are unified and therefore, it is unclear how to analyze their conflicting diversity in space and time, and how to proceed for a reconciliation of their differences.

5. The suggested Eristic-Dialectical UWM model

Eristic means “to fight” from the Greek “eris”. Dialectics comes from the Greek “dialogos”, “dia” meaning between, and “logos” being the argument. Exchanging arguments in a dialog is the first meaning of dialectics. The Water-Man Eristic Dialectics has been presented as a framework of WRM (EDWRM, Ganoulis, 2021). The EDUWM model we suggest to improve the IUWM is different from any model we have presented in the previous section. It is a conceptual methodology that retains the distinctive character between the city and its natural environment, based on the City-Nature conflicting dialectical discourse. To clarify the new model, we may distinguish three main categories of dialectics: (1) a methodology for learning, (2) a logical structure, and (3) a model for the City-Nature relationship.

1) *Socratic-Platonic Dialectics (EAR, 2019).* This is a method for active thinking and learning that was initiated by Socrates, the father of western philosophy and reported by Plato in his famous "dialogs". Socratic dialectics is also called "maieutic", a term meaning "giving birth" in Greek. The maieutic method became popular in modern Schools of Law when two groups of students exchange controversial arguments aiming to reach a consensus at a truth-making thesis. Socratic dialectics is also considered as an alternative form of argumentation used by teachers, known as sophists in the second half of the 5th century BC in Athens. Sophists, the term meaning in Greek "likewise men" wanted to impress and convince their audience that only their position was the truth. Because they insisted on using rhetoric and misleading arguments to defend their thesis wherever was right or not, their argumentation was called "eristic". This is a different meaning of the original "eristic" terminology we use in our model for describing the conflictual relationship between man and nature and among different groups of stakeholders.

2) *Aristotelian Dialectics* (ECOLOGIST, 2019). Aristotle made a systematic analysis of the Socratic-Platonic Dialectics and wrote a kind of handbook of dialectic argumentation and even a calculus to promote this methodology. According to him, the rules of formal logic could support the Platonic Dialectics in searching the truth, by resolving contradictory arguments. He considered dialectics as a tool for explaining logical paradoxes that have only one logical explanation. He also claimed that two contradictory narratives cannot be simultaneously logically correct. For example, nature cannot be united and at the same time separated from man (a logical contradiction). In the Middle Ages, many scholars studying the "Aristotelian Dialectics" have concluded that the term "dialectics" is synonymous with "logic". Later on, philosophers, such as Hegel, Fichte, and Kahn have understood the benefits of reasoning outside the typical Aristotelian logic (Maybee, 2020).

3) *Heraclitean Dialectics.* Heraclitus of Ephesus wrote around 500 BC a book on *the dialectics of nature*, from which only a few fragments have

survived (Diels, 1906). At the beginning of the 19th century, the German philosopher Hegel made Heraclitus known as the first who invented *the dialectics of nature*. Hegel said that “there is no proposition of Heraclitus which I have not adopted in my logic” (Hegel, 1968, p. 279). In Heraclitean dialectics, nature and man are at the same time united and separated, cooperative and antagonistic.

The “Eristic-Dialectical Urban Water Management” (EDUWM) model is theoretically based on the *unity of opposites*. In his typical logic, Aristotle distinguishes two types of opposite statements: (1) the *contraries* (black-white) and (2) the *contradictories* (black-non black). The Heraclitean dialectics claim the *unity of the contraries* rather than the *compromise of the contradictories.* For Heraclitus, nature is not functioning within the framework of the Aristotelian logic. It has a much more general structure integrating dialectically the Aristotelian “black” and “white” in a multicolored reality. The dialectic unification of the contraries is like a statue made by an inspired sculptor who integrates harmoniously concave and convex volume forms.

Heraclitean dialectics puts at the center of human activities “eris” that in Greek “έριç” is the conflict. Heraclitus wrote in *fragment 8:* “πάντα κατ’ ἔριν”: *everything emerges through conflict* and “…ἐκ των διαφερόντων καλλίστην ἁρμονίαν…”: *from opposites stems the best harmony*. (Diels, 1906, fr. 8)

In the EDUWM model, water and city keep their identity and their conflicting characteristics as they vary in space and time (eristic). The best solution is achieved by a creative harmonization between conflicting contraries (dialectics). As shown in Fig. 8, the steps to follow in the EDUWM model start by (1) identifying urban water authorities and assessing existing water bodies, (2) consulting stakeholders for establishing a joint action plan, (3) analyzing the conflicts (eristic analysis), (4) resolve them dialectically, (5) apply for participatory monitoring programs, (6) develop eristic-dialectical management plans and finally (7) revise them when is needed.

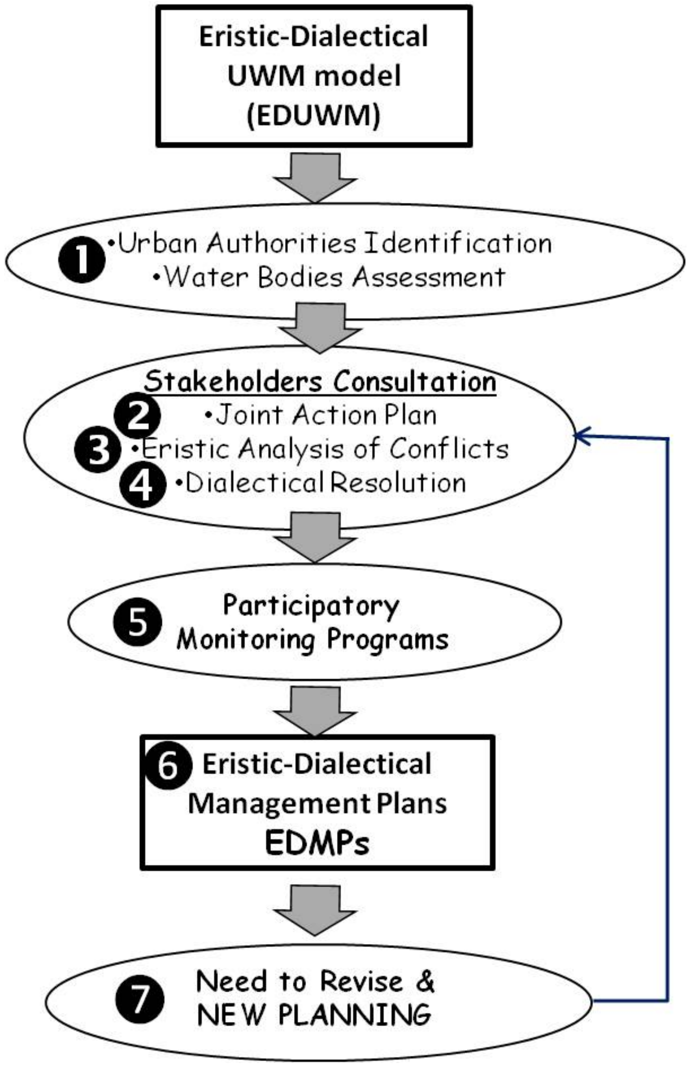


Figure-8 Implementation steps of the EDUWM model

6. Application of the EDUWM model in Attica

The Attica Metropolitan case is used as an example to illustrate the application of the EDUWM model in reality. The presentation of the case study follows the steps illustrated in Fig. 8:

(1) Urban water authorities and water bodies assessment

At this stage, the Union of Attica's municipalities (ΠΕΔΑ in Greek, https://www.pedattikis.gr) has been chosen to represent the local authorities. The assessment of urban water bodies in Attica has been completed by the Special Secretariat for Water in Greece in 2000 under my supervision as State Secretary for Water. The Attica's hydrological assessment is part of the national River Basin Management Plans (RBMP) that have been officially endorsed and sent to the European Commission (RBMP, 2000).

Following the EU Water Framework Directive (WFD) 60/2000/EC, the main objective was to achieve first by 2015 and now by 2027 the "good" quantitative and ecological status of water bodies (WBs), both surface and groundwater (GWBs). The number of WBs in Attica that have not achieved the "good" status by 2000, has been estimated at fifteen (15) from a total of twenty-nine (29). More specifically:

- 68% of all rivers are classified *as "less than good"* ecological status.
- the ecological status of the Marathon Reservoir, with a surface of 2.98 km², is classified *as "moderate".*
- 38% of GWBs are classified as "*bad*" for the quantitative status.
- 46% of GWBs are classified as "*bad*" for their chemical status.

The evaluation of these mixed results in Greece and all the Member States in Europe indicates the need to improve the existing European UWM model of water resources management and policy.

(2) Main social stakeholders identification and consultation

The stakeholders' role, their main properties, and the state of consultation are synoptically indicated in Tab. 1.

Table 1: Principal stakeholders in Attica Region.

Main urban stakeholders	**Specific role**	**Scale/Type of operation**	**Properties**	**State of consultation**
•Government • Public Institutions	• Policy • Regulation • Control	• Cities • Attica region • Ministries	• Political sensitivities • Political risk	Intermediate
• Universities • Research Institutes	•Knowledge generators •Innovation	• Public • Private • Mix	• Risk-averse • Education •Dissemination	Advanced
•Private water professionals •Practitioners	• Design water infrastructure • Construction	• Local • Regional	• Taking economic risk	Preliminary
• Civil Society • Labor Unions • NGOs	• Third-social sector	• Local • Regional • National	• Environmental • Ecological protection	Advanced

(3) Stakeholders consultation and common action plan

These active social players have conflicting interests and influence the diachronic evolution of Attica's hydro-metabolism through the relationship between the city and its urban hydro-environment To increase urban hydro-resilience and take actions to mitigate the climate crisis, a major obstacle that has been identified in Athens Metropolitan comes from the lack of coordination and cooperation between local municipalities, and between regional and national authorities. NGOs in Attica are particularly active to protect the ecological character of rivers and water streams in the region are.

We have consulted the following associations and NGOs representing in Attica the Civil Society in the water field:

- Roï (*https://www.remata.gr/en*)
- SosRematia (*https://sosrematia.blogspot.com/*)
- Ardittos Association (*https://ardittos.wordpress.com/*)

Following the detection of major social conflicts and their dialectical reconciliation, a joint action plan is under development. The most important conflicts of interest have been investigated between different groups of social actors from the one hand and the urban water/environment issues to another. Emphasis is put on the distinction between alternative opposite solutions that are described by contrary and contradictory attributes.

(3) *Eristic analysis* (see 6-1 below)

(4) *Dialectic reconciliation* (see 6-2 below)

Regarding steps 5, 6 & 7 as shown in Fig. 8: participatory monitoring and management plans are under study. Lessons learned and conclusions from Attica's positive and negative experiences are summarized for possible replication to other similar situations in Chapters 7 & 8.

6-1. Eristic analysis of water-related conflicts

The city-water hydro-metabolism in Attica is influenced by two major forces. On the one hand, the previously defined social actors could influence environmental and water management policies to protect their economic interests and share political power. On the other hand, the urban water cycle that defines the amount of surface and groundwater resources distribution in Attica is in constant opposition with the city's social evolution.

According to our eristic-dialectics model, water security can be achieved by harmonizing the opposites that means conflicts between stakeholders and also between the city and water resources. In an eristic sociological analysis, the Attica Metropolitan case may serve as an illustrative paradigm of global urban-environment conflicts, common to all mega-cities around the world, Particular local conflicts that are analyzed below could further illustrate the Attica case study.

6-1-1 Global conflicts

Urban metabolism can be defined as a process to describe by analogical thinking the flow and changes of materials and energy within cities as within human organisms. Urban hydro-metabolism is the way water is transformed into energy and biomass through urban economic activities, like industry, agriculture, and transportation. When cities use water unsustainably, their hydro-metabolism is not circular, producing wastewater and other pollutions.

In Attica, the global city-water interaction has been defined diachronically according to different types of models that have been described in paragraph 4. These variations depend on social forces and the way urban stakeholders interact under specific political and socio-economic conditions.

Regarding surface water resources, from ancient times to today's situation, the majority of watercourses in Attica are small streams with limited hydraulic capacity. Three rivers can be distinguished, all located near the historical center of the city of Athens (Fig. 4 and Fig 1. b): the Kephissos River that is the biggest of them, originates from the Parnitha Mountain in the northern part of Attica (Fig. 1. a). It drains the western part of the plain and after a course of 27 Km, it flows into Saronicos Bay (Fig. 4). The smallest of the three is the Eridanos River, originating from the southern foothills of the Lycabettus Mountain. He is flowing through the Ancient Agora, northern from the Acropolis, continuing towards a North-Western direction, and after disappearing underground over a few hundred meters he joins the Ilissos River. The River Ilissos has its origin from the springs located in the Ymittos Mountain. He is flowing through the ancient center of Athens very close to the Acropolis rock outside the city's walls (Fig. 4). After receiving the waters of Eridanos River, he continues flowing into the Kephissos River. From the three watercourses, Ilissos has received the most characteristic modifications that indicate the time evolution of the city-water model relationship. Historically, the following periods are distinguished:

(1) From ancient times to the 19th century: the "naturalistic" model

In ancient times people in Attica respected nature and had included natural divinities in their religion. Apart from the 12 main Olympian Gods, Greeks had goddesses of nature, like the naiads for water, the dryads for trees, and the oreads for mountains. Rivers were recognized as River-Gods. For example, the Ilissos stream is depicted in the Parthenon's west pediment and exhibited at the London National Archeological Museum as an inclined man, a statue made by Pheidias.

Concerning the landscape and the vegetation near the river Ilissos, we have a detailed description at the beginning of the Platonic dialogue "Phaedros". Plato describes the landscape as idyllic, Ilissos having very clear and gracious water with high plain trees at his banks. The charming continuous song of cicadas, the rustle of the leaves by the fresh wind, the wicker's flowers that scented the air, made up a very pleasant and inspiring environment.

Until the late 19th century, Ilissos was flowing with plenty of water in winter but almost streamless in summer. In 1805, during the Ottoman occupation, Edward Dodwell, an Irish traveler, painter, and writer on archaeology, had visited Athens. In his book "Views in Greece", London 1821, the Ilissos drawing is included (Fig. 10a). In his travel notes, he explains that on the 16th of September 1805, after a heavy storm that lasted several hours, Ilissos was flowing torrentially forming shallow waterfalls.

(a) (b)

Figure-10. (a) The Ilissos River with a view of the Acropolis (*source*: *Ed. Dodwell, London, 1821*) and (b): a decree written in Greek on a stone prohibited the processing of tanneries in Ilissos (*source: www.iranon.gr*)

However, the conflicting relationship between the city and water was also present in ancient times. Fig. 10.b shows an excerpt of a law written on a stone in Greek to prohibit in ancient Athens the processing of leather in the Ilissos River. This means that also at that time, pollution problems in rivers started to be of public concern.

Goaded by the spirit of competition between the cities-states, the Greeks have used natural resources to satisfy their needs. Many of their activities were at the origin of environmental damages in Attica, such as farming, hunting, mining, the destruction of nature in war, and cutting trees for constructing triremes. Well-known is the destruction of forests in Attica during the invasion of the Spartans, and the terrible plague in Athens during the Peloponnese war (Hughes, 2014).

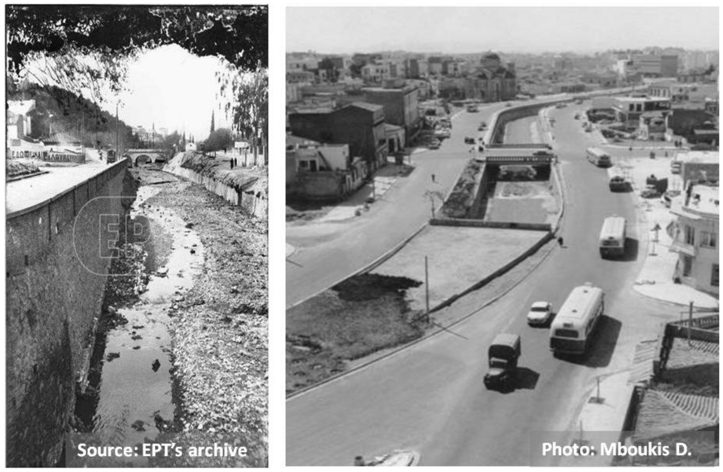
Following the fall of Constantinople in 1453 and the collapse of the Byzantine Empire, the Ottoman occupation in Greece lasted almost 4 centuries. During that time Attica experienced limited industrial development, and environmental threats were less important than in other parts of Europe.

(2) The period 1900-1970: 2nd industrial revolution and the "anthropocentric" model

After the establishment in 1821 of the Greek independent state, Attica experienced some of the effects of the 2nd industrial revolution in the western world. In water engineering, hydraulics and dam construction have made in Europe and the USA important progress, with the Hoover Dam in the USA as a landmark in 1935. During the period between 1900 and 1970, the dams and reservoirs of Marathon, Mornos, and Evinos have been constructed to supply Attica with sufficient water.

During the same period, the population increase in Attica was explosive. According to the 1896 Census, the year when Athens organized the first national Olympic Games, the population in Athens counted 128.000 inhabitants. In 1934, with the flux of Greek refugees from Asia Minor, this number became 800.000, 1.814.000 in 1960, and 3.812.130 in 2011. The population density from 30 inh./km^2 in 1960 became 1.000 inh./km^2 in 2011!

In summer times, the flow rate of Ilissos is limited and from the 1950s it's covering up together with other water streams was initiated (Fig. 11).



(a) (b)

Figure-11. (a) The Ilissos River at a limited flow rate in 1937 and its cover-up in 1963 (b).

In the 1990s, Ilissos and other water streams in Attica, with low water flow, became much polluted places. Wastewater and solid wastes such as plastic bags were deposited in river beds and offered unpleasant sceneries in downtown areas. Standing waters and gravel transported by flash floods attracted mosquitoes and other pollutants. Repetitive claims from people living in the vicinity have put pressure on local authorities for remedial measures.

Following a study by the National Technical University of Athens (NTUA), since 1945 the preservation of water streams and their inclusion into urban planning was neglected. Almost 70% of the total number of water streams has been enclosed under the ground that corresponds to about 550 km in length (Karali, 1996). Today, almost every street in Athens has an underground water stream. Arguments of protecting public health and facilitating urban traffic and other economic activities in the city have influenced the central administration to take action for covering up the majority of the water streams. At that time, civil engineering works to reclaim polluted areas were considered by the public and responsible ministries as positive engineering achievements for reducing vulnerabilities to public health.

This anthropocentric approach to urban planning, land speculation, and the need for lodging of new waves of the population had also a negative impact on groundwater resources distribution in terms of quantity and quality. In the past, groundwater was able to provide naturally in summer more water to rivers and streams and preserve, even partially, their ecological flow. The extension of impermeable areas in Attica for building new houses, avenues, streets, and parking areas has increased the amount of water flowing into the sea. At the same time quantities of water infiltrating into the aquifers have been decreased.

(3) After the 2000s: the query for ecological protection and stream restoration

In recent times, several initiatives from civil society have emphasized the need of protecting urban water streams for ecological reasons, climate change adaptation, and to increase the quality of life. A strong debate has been initiated for protecting and stabilizing the river banks by using plants and bioengineering techniques (nature-based solutions). Ecological associations went to the Greek Court of Justice and won against local authorities who wanted to protect open water streams with traditional concrete structures. Local administration and water professionals use to apply concrete walls or gabions (Fig. 12a) to stabilize against floods existing urban open flow streams (Fig. 12b). The general aim is to use plants and other bio-materials for engineering purposes to revitalize water streams that have been survived in Attica, improve their biodiversity and integrate them into the urban landscape.

(a) (b)

Figure-12. Using of gabions (a) to stabilize water streams (b).

6-1-2 Particular conflicts

a) Privatizing water services in Attica

During the recent years and mainly during the Greek public economic crisis 2005-2016, the question of privatizing water supply and sanitation services in Attica has become frequently relevant in the daily news as related to different political governmental orientations (neo-liberals versus state-socialists). To save public investment and promote innovation, liberal governmental policies have opted several times to privatize the EYDAP Company.

NGOs and the Civil Society argued that water is a common good and therefore the public character of EYDAP should be preserved against profit maximization in a free market economy.

b) Wastewater reuse from the Psyttalia Wastewater Treatment Plant

A huge amount of about 700.000 m^3 of wastewater is daily treated by EYDAP at Psyttalia Wastewater Treatment Plant. After intensive biological treatment, a small artificial river flows continuously into the sea from the plant's outfall. Ecological organizations argue about the benefit of reusing that water. However, EYDAP worries about the high cost and the risk to public health from this operation. More cost/benefit studies are necessary to demonstrate the benefits of wastewater re-use in Attica in the frame of a circular economy.

６-２. Dialectical conflict resolution for a sustainable UWM

The eristic analysis of conflicts between the main stakeholders in Ch. 6-1 and the dialectic resolution of the city-water conflicts in Ch. 6-2 are two important steps for the application of the EDUWM model in Attica. As described in Fig. 8.b the main component of the model is the development of a Joint Action Plan between public authorities and the main stakeholders. Few NGOs active in protecting Attica's water streams represent the civil society. Our purpose here is to present the mainline of an action plan, without going into the details, aiming to unify dialectically conflicting arguments.

The main controversial issues for can be dialectically discussed are as follows:

1) Conservation and rehabilitation of urban rivers and water streams

Major arguments of public authorities for covering the majority of open flow water streams in Attica were the following: (1) insufficient water flow during long periods of the year and especially during the summertime. The extension of impermeable areas due to the rapid urbanization in Attica has increased the amount of rainfall water flowing into the sea and decreased the water infiltrating Attica's aquifers. In the past, this groundwater was naturally released in summer to provide water to rivers and streams and preserve their ecological flow. (2) open streams in Attica were unsafe places accumulating solid wastes and activating colonies of mosquitoes (3) building underground tunnels to replace surface streams was necessary for reclaiming contaminated sites and facilitating urban traffic and other economic activities.

NGOs and civil society argue that preserving urban open flow water streams may enhance green areas into the city with many aesthetical, ecological, and functional advantages. River flowing in the city can reduce the increase of temperature in summer and absorb parts of air pollution.

A dialectical solution consists of providing sufficient water storage in small artificial reservoirs in the surrounding mountains that can sustain ecological flows in summer. In Greece, because of the Mediterranean climate, artificial reservoirs are integrated very well to local climatic and water quality characteristics. In a few years, artificial reservoirs have been naturally converted into lakes with a good ecological status and rich biodiversity. Furthermore, as shown in Fig. 12.a, avoiding traditional material to stabilize the river bed and using plants and bio-engineering material, nature-based solutions can be applied for protecting urban water streams from erosion and solid transport during flooding.

2) Water privatization

A dialectical solution for safe water supply and sanitation in the Attica peninsula was elaborated. For this, EYDAP was divided into two companies:

(1) the company "EYDAP Assets", has remained under the Greek State, taking over all of its major infrastructure, i.e. dams, reservoirs, water towers, pumping stations, and all other facilities and

(2) the company EYDAP S.A. was created and listed on the Athens Stock Exchange. According to the Supreme Court decision, 51% of the company's shares on the stock market should remain under public control.

3) Wastewater reuse from the Psyttalia Wastewater Treatment Plant

International organizations like FAO and the EU have developed guidelines for the safe reuse of wastewater after treatment. In Attica, the benefits from irrigating large areas with Psyttalia's effluents after intensive treatment could exceed the additional costs of water transportation and irrigation. Further cost/benefit analysis is necessary to support this conclusion.

7 . "Taking-away" lessons from Attica's experience

The city-water interaction in Attica is a characteristic example of the historical evolution of an urban hydro-metabolism. Its urbanization as related to water is a unique, well-documented case study that can be used to draw lessons on different aspects of urban hydro-security. The long timeline of the city is well described in historical texts from ancient times to more recent literature

Athens, the historical cradle of the western civilization is at the origin of the modern Attica Metropolitan. Its foundation as a *fortress city* around the Acropolis rock is related to water through the ancient myth of Athena and Poseidon, the Greek gods, who competed to offer the better city's hydro-resilience. Attica's hydro-security has been influenced by global and local socio-economic changes, different types of wars, periods of external occupation, and progress made during the global agricultural and industrial revolutions. Positive and negative lessons on urban water security and the city's hydro-metabolism can be learned as follows:

1) Positive hydro-metabolism

a) keep and restore urban water streams (green ecological areas)
b) minimize environmental impacts by adopting a *circular urban economy*
c) conflicts between stakeholders as a key for dialectic harmonization

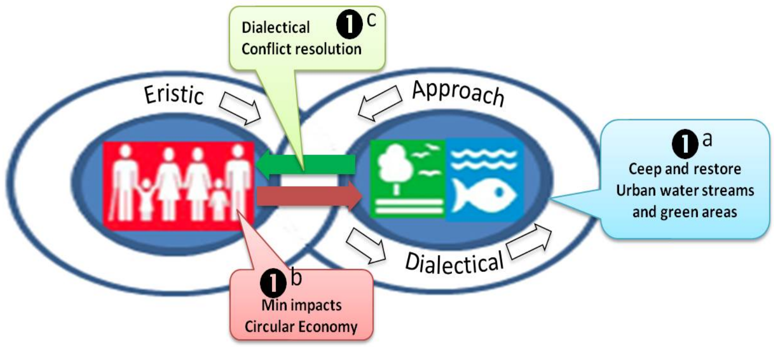


Figure-13. An eristic-dialectical urban hydro-metabolism for hydro-security.

2) Negative hydro-metabolism

a) covering urban water streams (loss of urban biodiversity)
b) producing wastewaters in a non-circular economy
c) adopting technocratic solutions without stakeholders consultation

3) Recognise and analyze water conflicts in 2 stages:

a) conflicts between city and water resources
b) interests conflicts between stakeholders

4) Apply the eristic dialectical approach to eliminate externalities, integrate the city with its natural resources, and achieve water security by unifying the opposites of man-nature (only one holistic win, not a win-win solution).

８. Conclusion

Data on environmental indicators reported by International and State Organizations, NGOs and scientists, show that temperature due to greenhouse gases continue to increase, new precipitation patterns induce local floods and droughts and increase the loss of biodiversity. The coronavirus pandemic crisis has demonstrated the human vulnerability to environmental conditions and viral infections on our planet.

Urban metabolism is sensitive to different anthropogenic pressures, with water in the city being the common denominator of various risks and different benefits as well at the same time. The historical review of the urbanization process reported in this paper indicates that from the fortress city in the middle ages, to agricultural and then to the industrial city during the agricultural and industrial revolutions, the urban metabolism is in constant evolution. As it is shown for the Attica Region in Greece that includes the city of Athens, the cradle of western civilization, the urban metabolism is very much related to the urban water cycle. In coastal regions as well as for the Attica case, this is composed of the marine and the land cycles, both being influenced by human activities for drinking, removing wastewater and redirecting stormwater into water streams. The actual UWM model is anthropocentric, following the IWRM framework that in 2000 was adopted by the EU as the 2000/60/EC WFD. Twenty years later, its 'fit for purpose' evaluation by the European Commission has given mixed results and failed to obtain the main objectives.

Therefore it is necessary to improve radically the UWM with a more effective model. The main question that asks for a credible answer is how a new UWM could ensure urban water security The steps to follow in the Eristic-Dialectical UWM model we suggest are demonstrated for the Attica Metropolitan case. They consist of analyzing conflicts between stakeholders (eristic approach) followed by their harmonization (dialectics) for obtaining a resilient hydro-security.

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