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The scale of infrastructures as a social decision. Case study: dams in Greece.

G.-Fivos Sargentis, Romanos Ioannidis, Georgios Karakatsanis and Demetris Koutsoyiannis

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Department
of Water Resources
and Environmental Engineering
National Technical University of Athens

Introduction

Modern organized societies require several works of infrastructure, among which hydraulic projects, such as water supply and drainage systems, are most important. For large cities, dams are the highlight of water infrastructure. In addition, dams connect water and energy production, contributing in the transition of modern societies from fossil fuels to renewable energy.

Modern economic and social conditions do not define the limits of what we call development. One of the more fruitful aspects of recent interdisciplinary thought may be its linking of the separate intellectual traditions of critical social theory and environmental science/policy (e.g., Smith 1990; Wilson 1992; Ross 1994).

- On the one side, an essentialist view of environmental conflicts ("man versus nature") emphasizes the resource conflict.
- On the other side, a historical materialist view of social conflicts (e.g., capital versus labor) emphasizes the property conflict.

"By simultaneously considering both perspectives, one can see more clearly the social dimension of environmental conflicts, that is, the development conflict. Such a synthesis is not easy: it requires accepting the social construction of nature but avoiding the materialistic pitfall of arrogantly denying any aspects of nature beyond the labor theory of value." (Campbell 1996)

Case study

Up to the early 20th century, the water supply of modern Athens fully relied on the ancient hydraulic works which were fed by the rivers of the Attica basin (Chiotis and Chioti 2012). In the course of the 20th century, a large and modern water supply system has gradually been developed in Athens.

During the 20th cent. the population of Athens grew from 190 800 to 3 700 000 (Avelidi 2010). This significant increase has been attributed to both the massive internal migration of population from rural areas of Greece to Athens as well as to the external migration, which happened in the early 20th century as a result of a treaty of exchange of populations with Turkey.

Today, the people of Athens, occupying at the moment an area of 462 km^2, consume water recourses from an area of 3525 km^2. Attica is a dry area, with an average yearly rainfall of around 400 mm, so the people amassing in the city had to be supplied with water from basins whose distance from Athens continuously increased, ranging from 25 to 180 km away.

This raises the question if, from the point of water supply, this migration of citizens to Athens was justified. Could the people have chosen an area of Greece with more abundant water resources instead of living in the relatively arid area of Athens?

The cost related to building the water infrastructure needed for Attica to host such a large number of people was certainly higher than in other large cities, but obviously that was neither a concern nor to the knowledge of people. Most probably, they did not ever worry about it and they claimed "The Right to the city" (Lefebvre 1996) without concern of the availability of water for the city.

Like their ancestors modern Athenians are capable to combine the convenient and healthy way of living in dry climate with developing technology to transfer water. The difference is in the scale, as they can now transfer water in larger quantities and longer distances, from the wet western part of Greece. The modern water supply system of Athens is an admirable hydraulic work. Its longest path from Evinos to Athens (Acharnae Water Treatment Plant) is about 217 km (without counting the passage across Mornos reservoir) and the aqueduct of Athens is comparable to some of the world's greatest (Koutsoyiannis and Mamasis 2018).

Nevertheless, it is obvious that the basin of Attica cannot satisfy the water needs of an ever-growing population, without relying on natural recourses that are far away from the city. A new approach in the economic theory suggests that small production units lead to endogenous productive redevelopment. But is it possible to question the scale of big cities and limit the capital-intensive approach and build smaller cities, based on small production units near to natural resources, instead?

To initiate this discussion, we review different types of data from the water supply system of Athens throughout the 20th and early 21st centuries. The data include water consumption, price of water, cost of infrastructure, population supplied, total area of basins and their distance from the center of Athens. The results are presented in charts 1 to 6 and are accompanied by maps A, B and C. Here are the findings of the review presented in the form of comments on the charts:

Chart 1: The first dramatic drop in price from 1910 to 1935 can mostly be attributed to the construction of the first dam (Marathon) for the water supply of Athens. Price is also reduced in the period from 1920 onwards, at a much slower rate, which can mostly be attributed to economies of scale. The only exception is the period before the construction of Mornos dam, roughly from 1970 to 1980, when the price was increased as a result of the unexpected high cost of the dam. An increase in the price of water also happened during the droughts of 1989-1993.
Chart 2: The decrease in the cost of water is also evident in the percentage of GDP per capita spent on water.
Chart 3: Reservoir capacity per citizen is used as a metric of the availability of water. As the reservoir capacity increases so does the consumption of water. It is possible that the abundance of the resource contributes to overconsumption alongside GDP increase, technological development, etc.
Chart 4: As the area of Athens increases so does the area of the basins. The area of the basins is always larger than the are of Athens by approximately one order of magnitude.
Chart 5: The operation of a water supply system in the scale of Athens requires a few and infrequent large investments.
Chart 6: As the city expands the distance of the basin used for water supply, that was initially minimal, increases accordingly.

Conclusions and discussion

According to the data analyzed, the question of scale, in the case of the Athenian water supply system, is highlighted from the following facts: (a) It is evident that the water supply system of Athens depends on natural resources from basins in large distance (b) It is possible that the abundance of water has lead to increased water consumption (c) It is possible that the high cost of some of the hydraulic works, for example the Mornos dam, could have been reduced if the choice of locations was not limited greatly by the large distance of the resources. It has to be noted at this point that as political factors were also important in the high cost of Mornos it is not clear whether its high cost can be attributed to the choice of location.

Be that as it may, Athens is an example of a successful large-scale water supply system, in which economies of scale have contributed to continuous reduction in the price of water as well as the consistent supply of the demand for water. At this moment in time, and given the already existing hydraulic infrastructure, it is more possible for Athens to provide water to smaller cities in proximity, in the future, than it is for new cities to emerge close to water resources and develop independent water supply systems.

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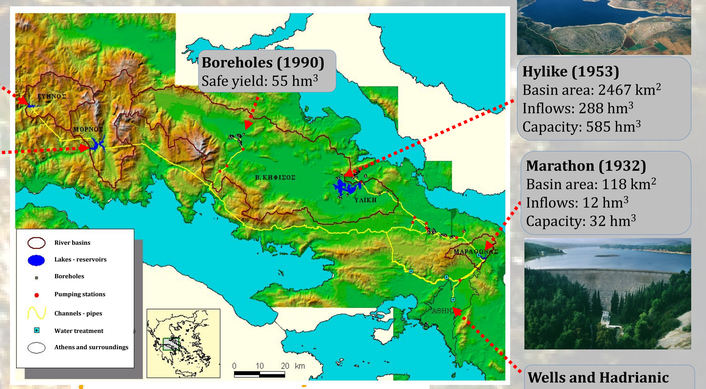
Evinos (2000)
Basin area: 352 km^2
Inflows: 283 hm^3
Capacity: 112 hm^3

Mornos (1980)
Basin area: 588 km^2
Inflows: 239 hm^3
Capacity: 630 hm^3

A. The water supply system of Athens

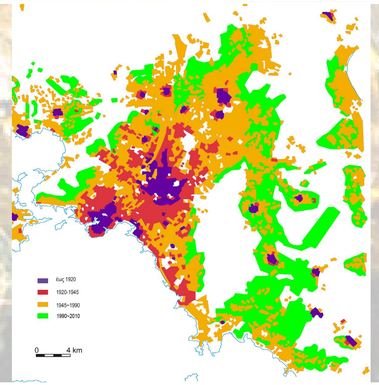


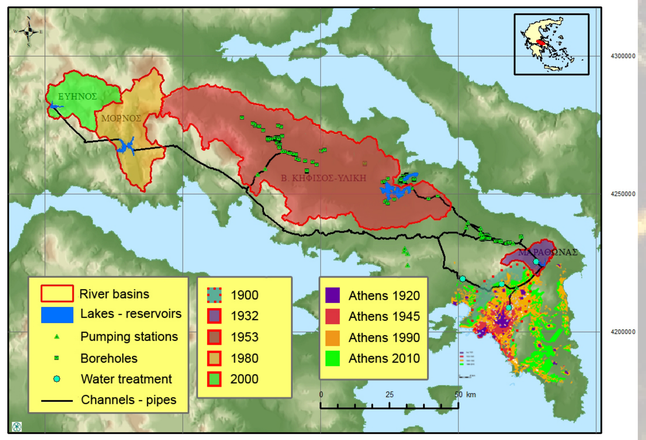
Hylike (1953)
Basin area: 2467 km^2
Inflows: 288 hm^3
Capacity: 585 hm^3

Marathon (1932)
Basin area: 118 km^2
Inflows: 12 hm^3
Capacity: 32 hm^3

Wells and Hadrianic aqueduct (1900)

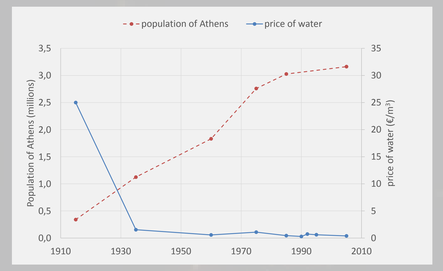
B. The development of Athens





C. The area of the water basins related to the area of the city.

1



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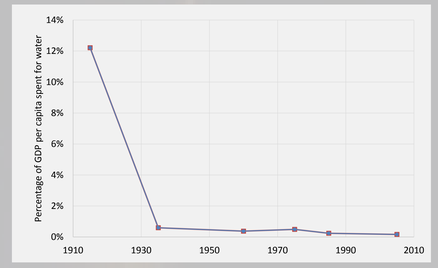

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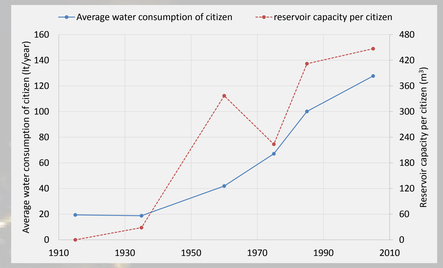

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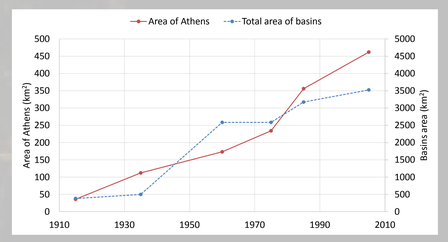

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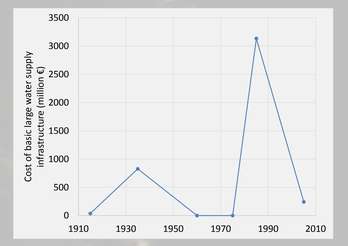

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