

A presentation explaining the paper with the same title published in *World*, 2022, <https://doi.org/10.3390/world3020014>

1. Introduction

The history of civilization is a pursuit of wealth. Related archeological data indicate that the growth and storage of wealth was a basic function of human societies that led to stratification. The analysis of the data presented in Section 2 shows that this pursuit is aimed at increasing the life expectancy through access to water, food and energy.

Unfortunately, the quantification of the value of wealth varies both temporally and spatially. The values of gold and silver that are considered archetypal symbols of wealth, in recent history, they have fluctuated over a wide range, as demonstrated in Section 3. For this reason, we also examined the values of wheat, which is a necessary quantity for the survival of humans over time. Additionally, we compare the values of wheat in different phases of history, and we find their correspondence of these values with the present.

In Section 4, we examine the case study of Hadrianic aqueduct's construction costs. In order to approach and describe the construction of the aqueduct, a related research project [2] was implemented, including in situ research [3] and underground explorations.

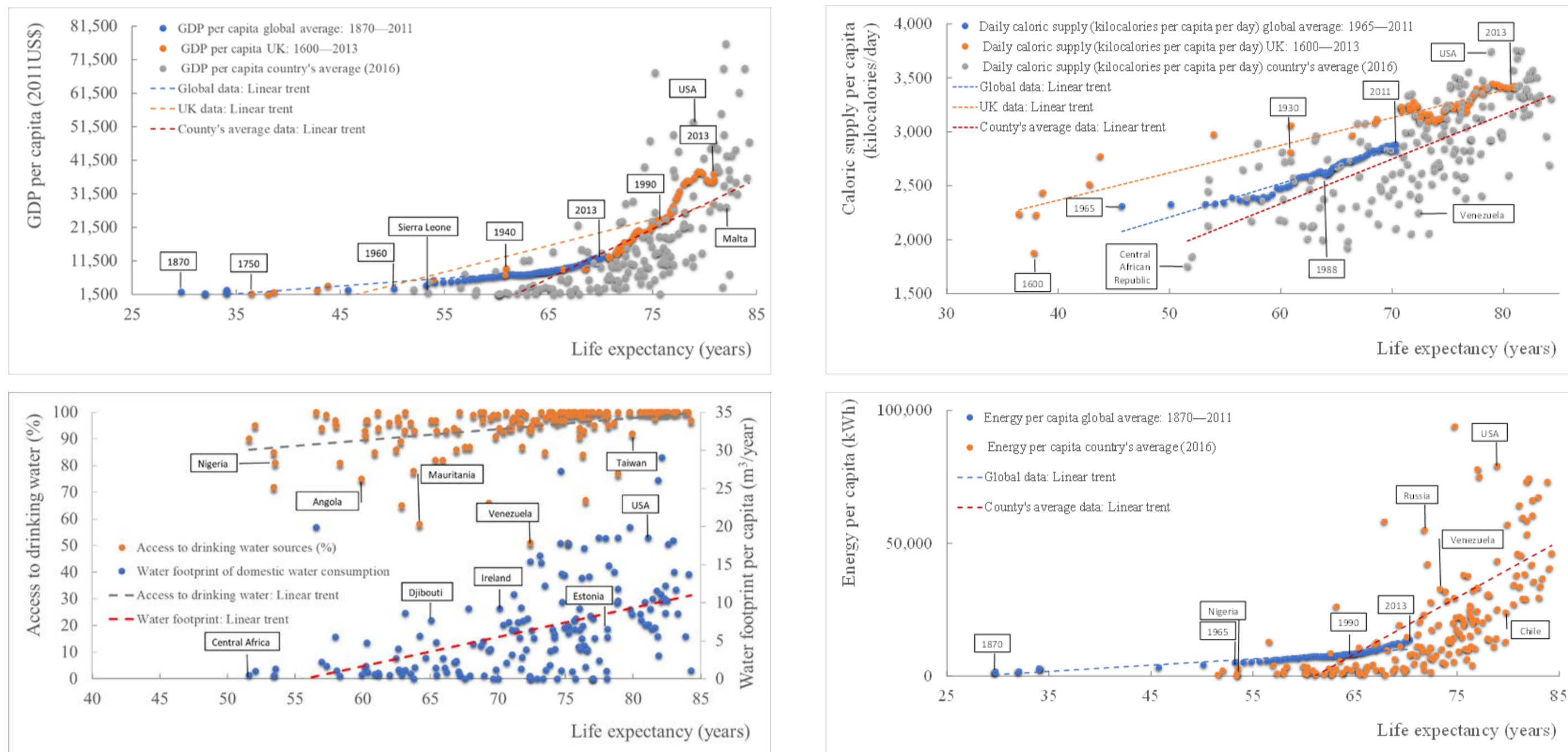
The Hadrianic aqueduct of Athens was built in the early second century AD at a time when there was an economic and social continuity from the first century. The available literature gives data from inscriptional evidence, with the correlations between the prices of wheat per liter and the wages of various professions at that time.

In order to quantify the cost of the Hadrianic aqueduct, we describe in detail how it was constructed, we analyze the labor-times required and we calculate the total cost with the corresponding labor and wages of the Roman period.

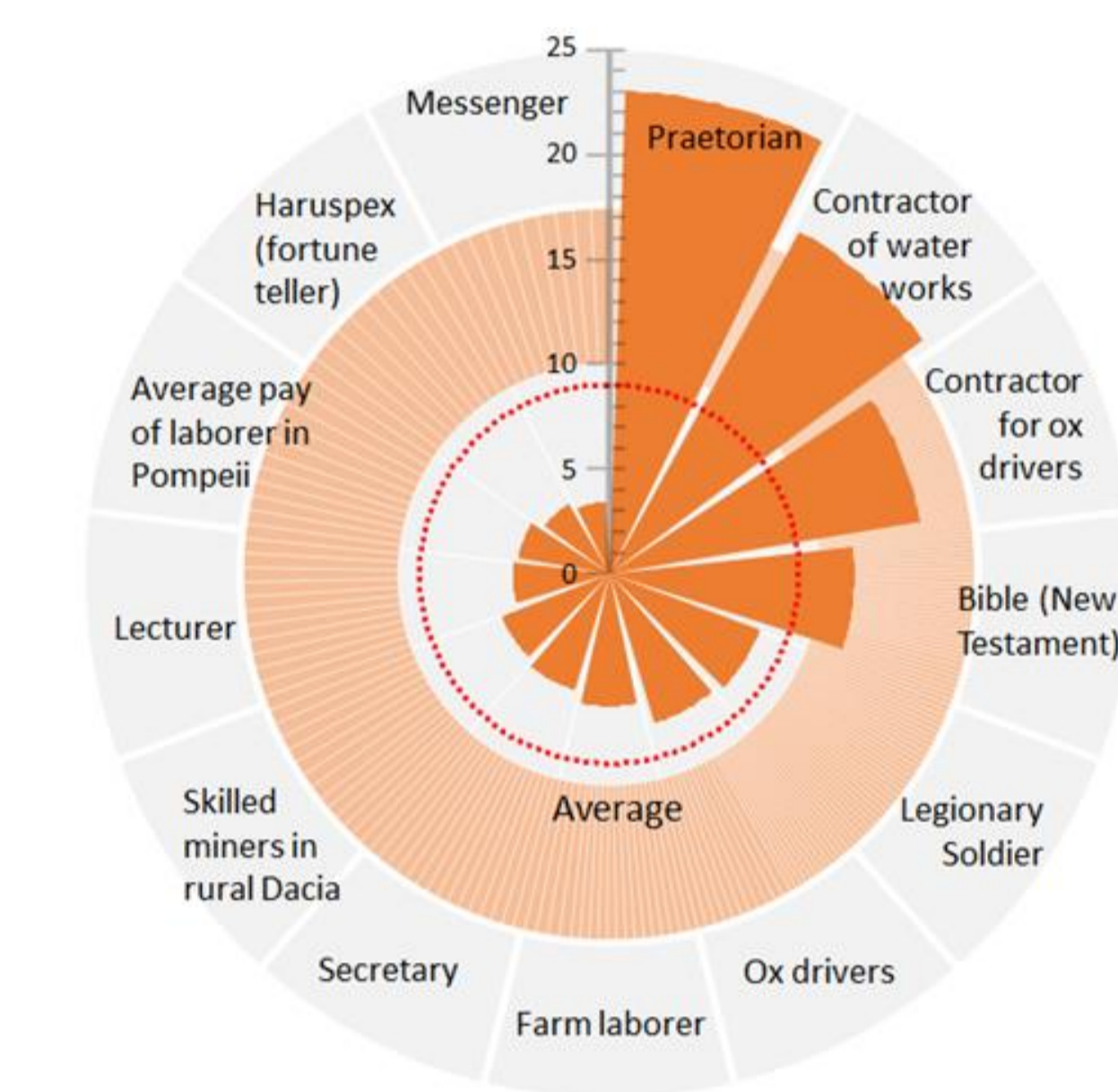
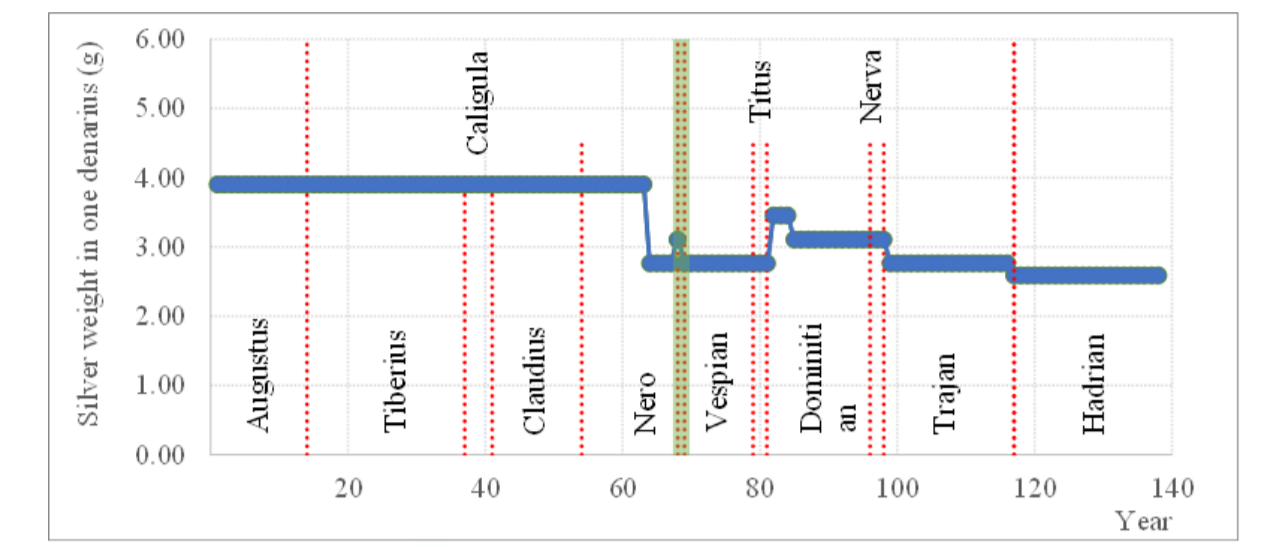
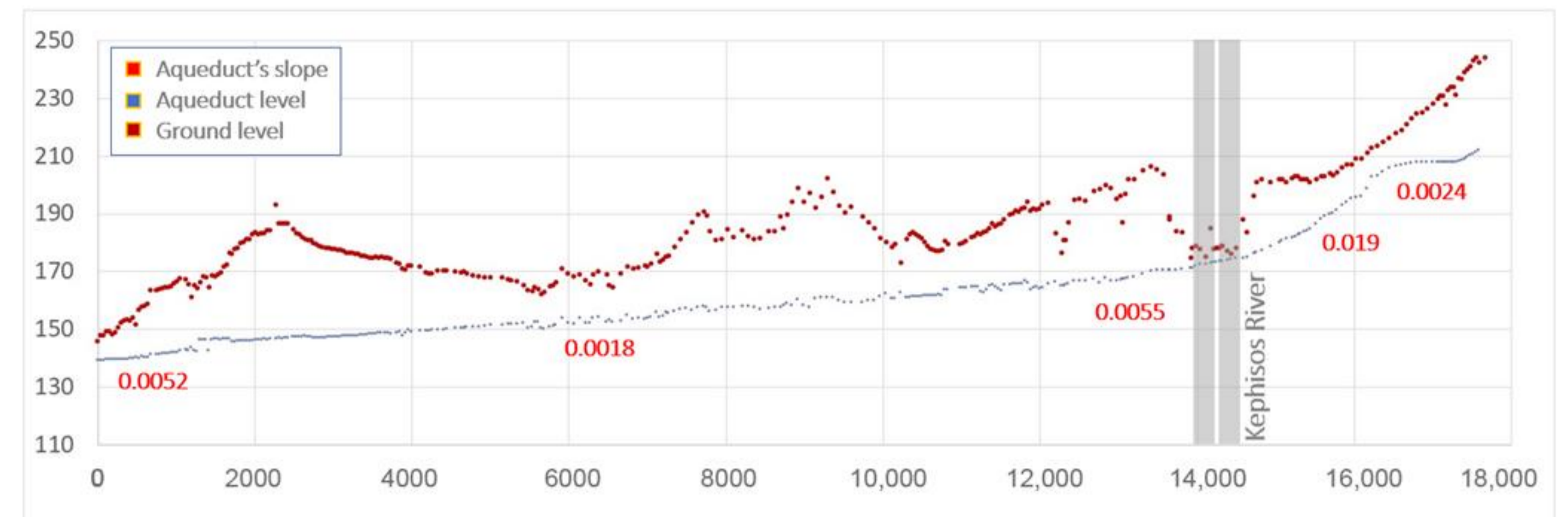
The study correlates the values in antiquity with values of today's prices (February 2022) in Greece, which is the place of construction of the aqueduct, and we estimate the costs of a similar project using modern material techniques.

Overall, this paper presents a holistic approach of values and costs in history, comparing the prosperity of society in different eras, using standardized measures such as wheat wages and water footprint per capita. Furthermore, this paper presents a unique analytical description of the Hadrianic aqueduct, a large-scale infrastructure construction in antiquity, estimating its cost in standardized values.

2. True Wealth. Life Expectancy related to the Water-Energy-Food Nexus

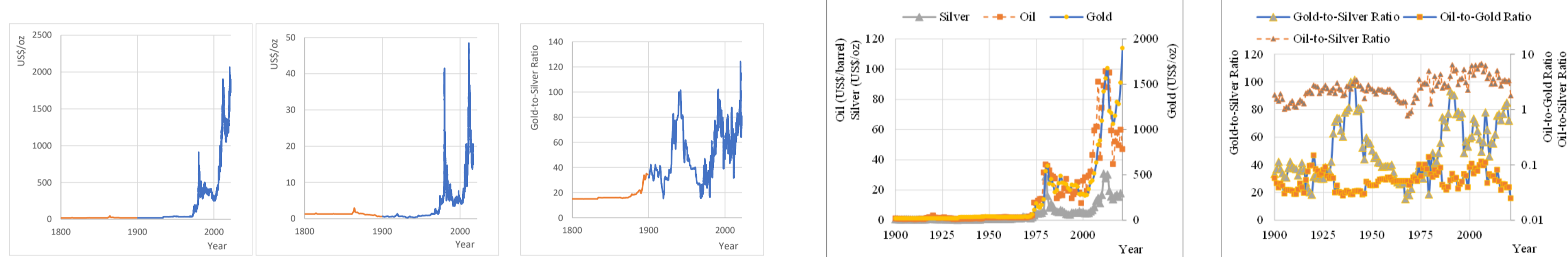


6. Athens' Hadrianic Aqueduct



Daily wages in wheat in the Roman Empire in the 1st c. AD

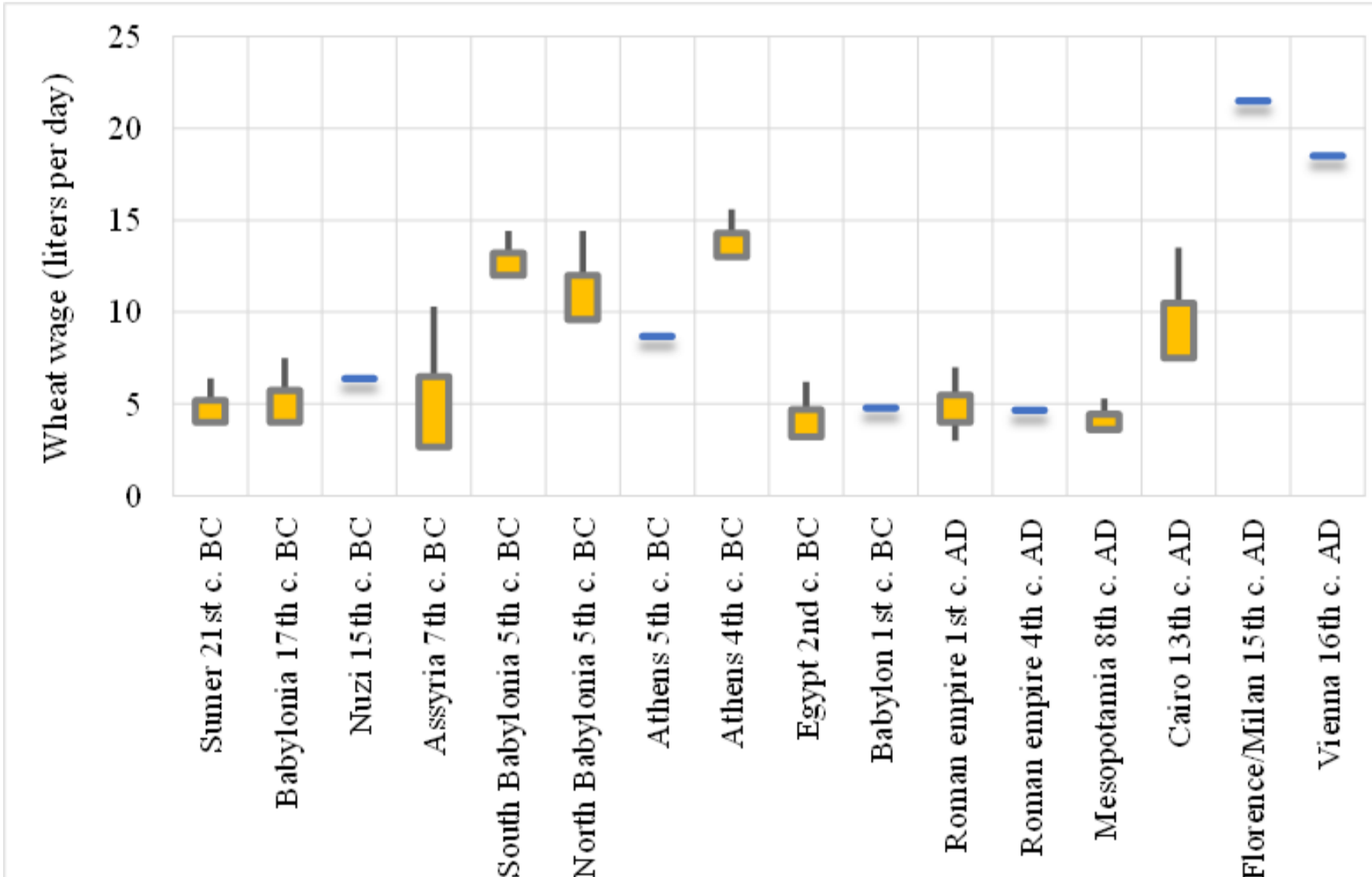
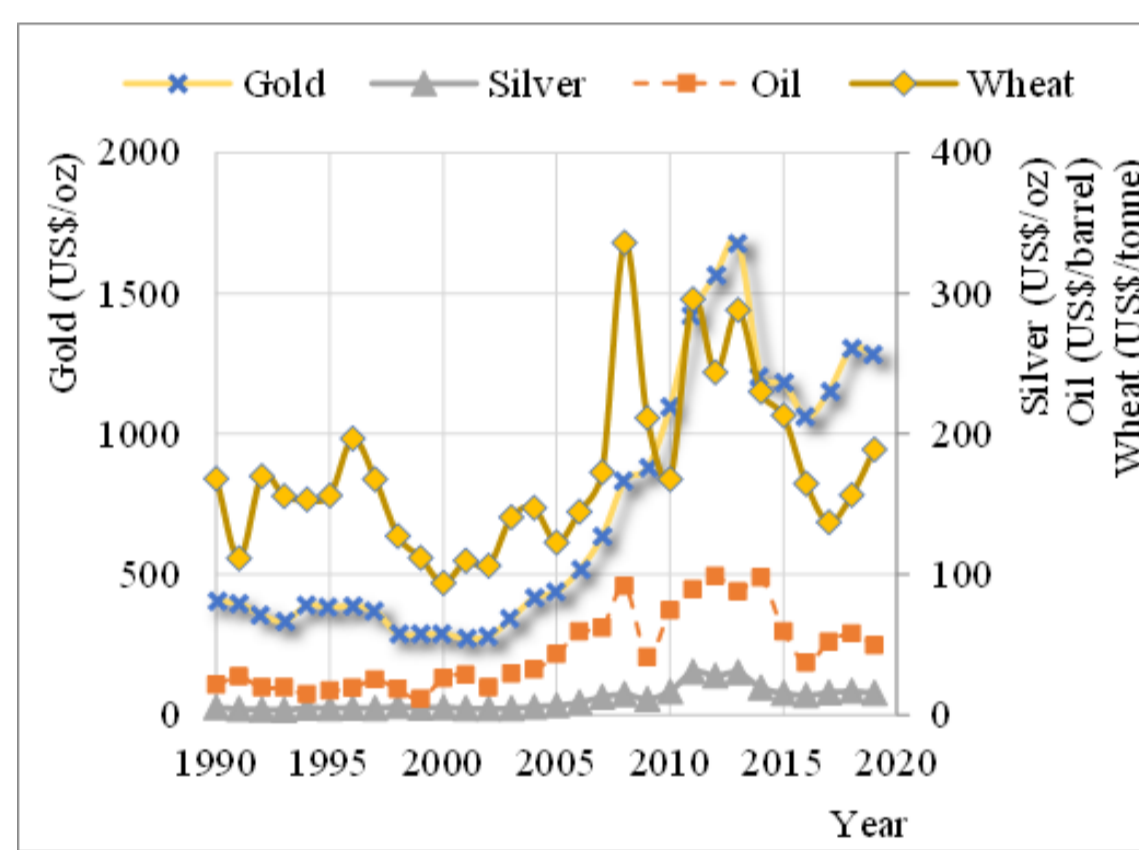
3. Can we standardize the values of wealth?



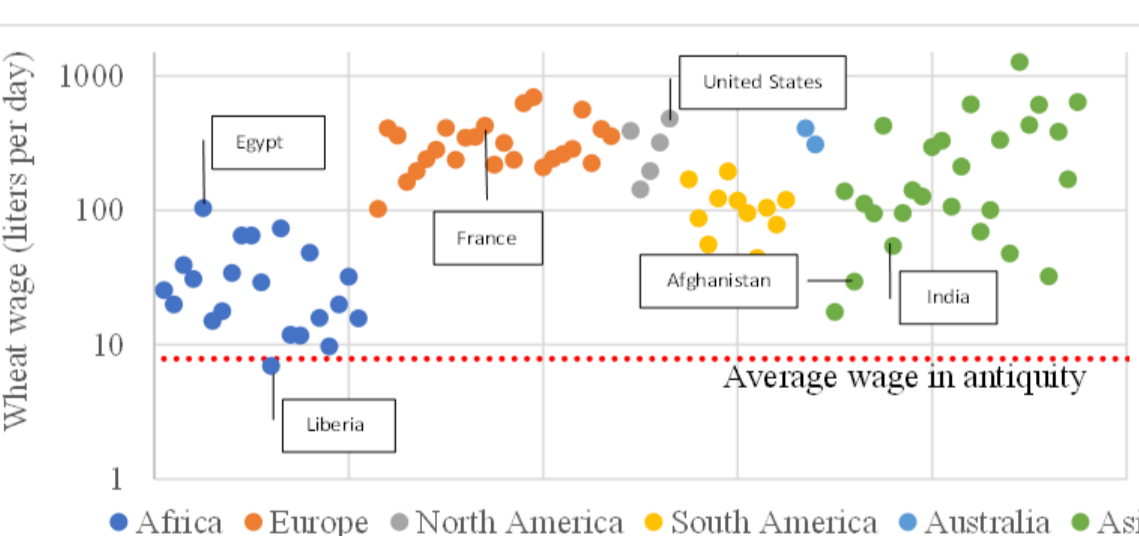
4. Correlations between wealth in antiquity and now

There, the absolute dominance of the dollar in the markets and strict adherence to trade agreements even between struggling and powerful economies and the linking of the dollar to gold at USD 35 per ounce were established. However, as the US had devalued dollars currency, with a unilateral proclamation on an August Sunday in 1970, Richard Nixon suspended the convertibility of the dollar into gold.

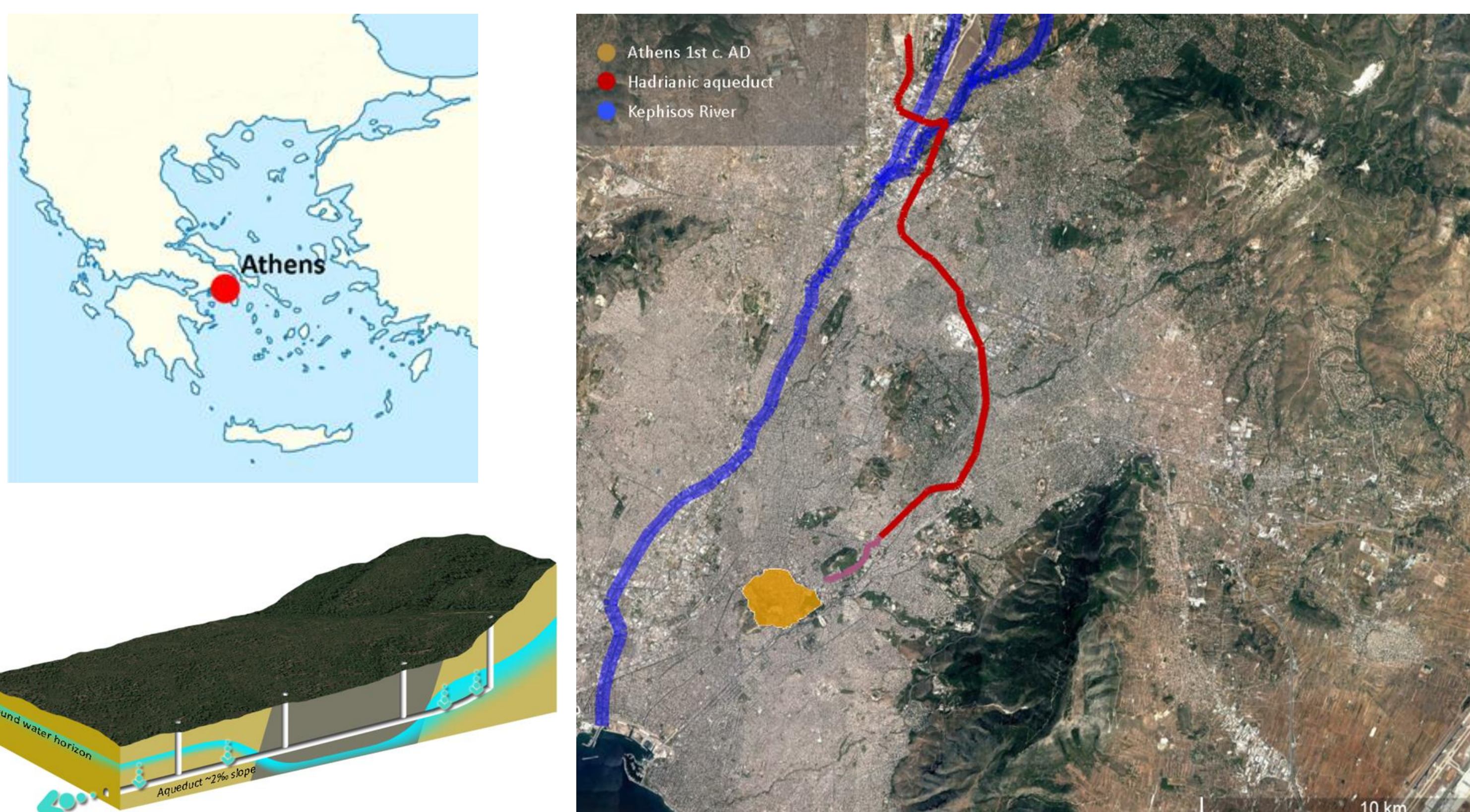
Although many analysts at the time predicted the end of the dollar, an ingenious move that can be said was looking back to the archetypal association of capital with energy, two years later, the Americans, through the mediation of Henry Kissinger, came to an agreement with the Saudis, and in exchange for guarantees of their security, persuaded them to make all oil transactions in dollars, releasing the values of gold, silver and oil in a wide range of fluctuations. However, we have to note that, even before the petrodollars, their ratio was fluctuated.



It is almost impossible to estimate the value of wealth based on the exchange rate of the currencies or the value of precious metals in historical eras. However, as wheat is the base element of the digestive menu of humans, and we have historical information of its cost and wages, we estimated the wheat wages (i.e., the liters of wheat that can be bought by a daily wage).



5. Case Study: The cost of Athens' Hadrianic Aqueduct



7. Conclusions

The values of the commonly used symbols of wealth (gold and silver) changed throughout history by social issues, as the demand for gold and silver can vary wildly with a fixed supply, which can lead to equally wild swings in their prices.

We know that humanity hunts real wealth (Water-Energy-Food), with large-scale infrastructures and economies of the scale making this more efficient.

This paper describes the frame of the social conditions when the Hadrianic aqueduct was built. An analytical technical description with volumes of excavations and coating areas is also presented.

Analyzing global data, we showed that about 1.4 billion people live in present under the average lower wages in antiquity.



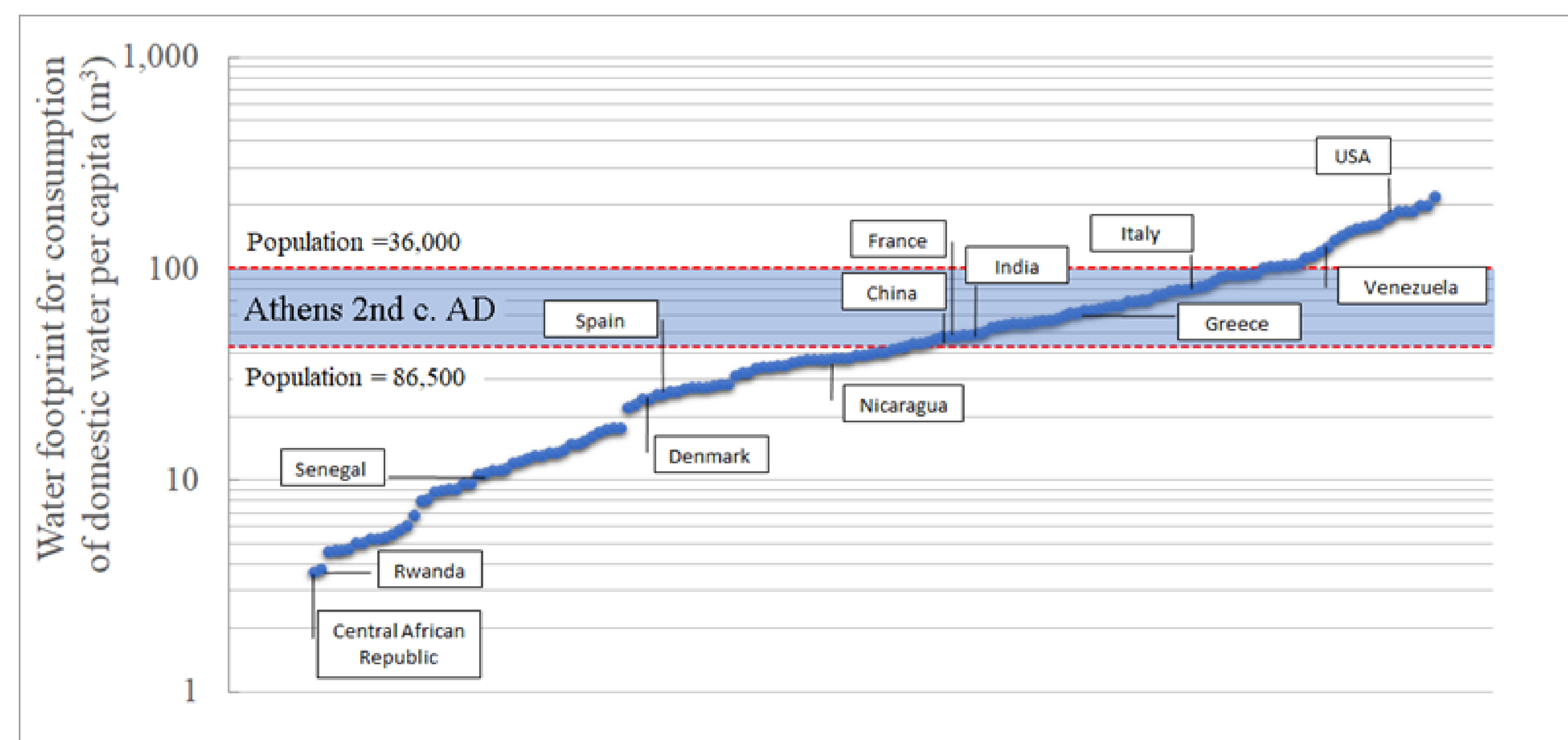
Assuming the same technological methods for underground projects as in ancient Laurion mines, we gave a first estimation of the total humans needed in the efforts for the construction. The estimated value was about 2,000,000 labor days for different specialities. Inspecting the social aspects and salaries in the Roman era, we assumed the stratification and the organization of the construction site.

We made an optimum hypothetical construction site, and we organized the workers in shifts as continuous workers (24 h constantly).

According to our approach, we found that the maximum number of laborers that could work on this construction should be about 4000 people and will end the construction in less than two years. However, in the literature, it is referred that the time of construction is between 6 and 15 years. We estimated that the aqueduct could be constructed in 15 years approximately by 500 workers or in 6 years approximately by 1200 workers.

Analyzing the daily wages of different specialties, we estimated that the total daily wages for the construction of the Hadrianic aqueduct in antiquity in wheat was 14,250,000 kg, and silver was 3800 kg. However, we did not include the costs of tools, animals and supplementary sources. We estimated that, using today's prices in Greece (February 2022), the wheat wages of antiquity (14,250,000 kg) cost about 7,150,000 EUR, and the wages in silver (3800 kg) cost about 2,500,000 EUR. Further research could examine the project funding scheme in antiquity.

Finally, we showed that the Hadrianic aqueduct changed the life of Athenians, giving them daily at least 10,000 m3. We investigated the range of the population in Roman Athens, and we estimated a range of the water footprint of the consumption of domestic use per Athenian. We found that, according to the global standards, there are about two billion people with less water footprint for consumption of domestic uses than the minimum water footprint of an Athenian in the Roman era.



Overall, we showed that, with present technological innovations, the cost of the Hadrianic aqueduct would be less than in antiquity. However, we noted that humanity has not made great progress in the last 2000 years, as about one-third of the population lives with less food and water than Athenians during the Roman era.