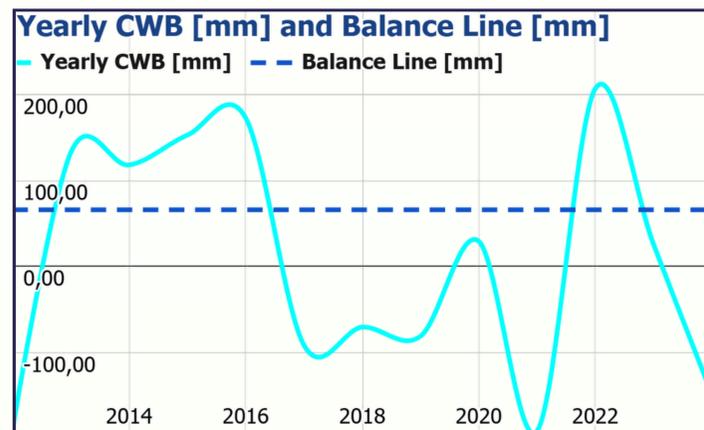
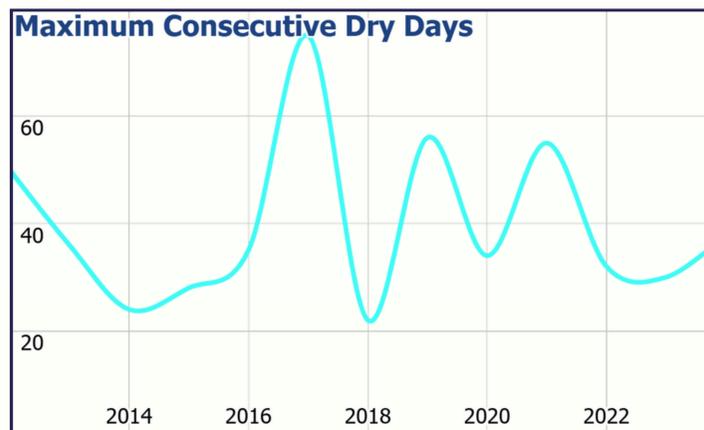


Mornos Climate Projections

Climate projections for Mornos are being developed to describe the potential future manifestation of water scarcity in **Attica**. By analysing projected temperature, precipitation, snow cover, drought indices (CDD), and derived evapotranspiration in different timeframes, the research assesses expected changes in hydro-climatic stress and drought conditions.

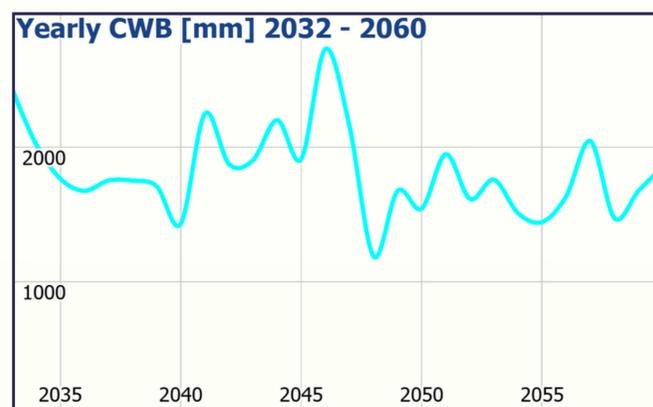
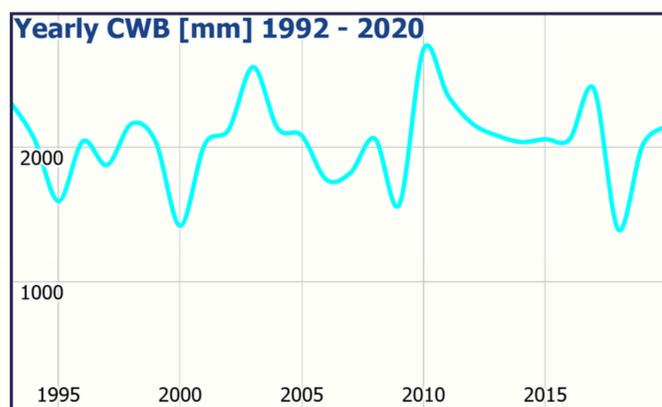
Observational Climate Data Analysis

Observed climatic data for the period 2011–2024 were analysed to assess recent hydro-climatic conditions in Attica. Apart from mean, minimum, and maximum air temperature and precipitation totals, hydro-climatic metrics were computed, including **Consecutive Dry Days (CDD)**, Potential Evapotranspiration (PET) and **Climatic Water Balance (CWB)**.

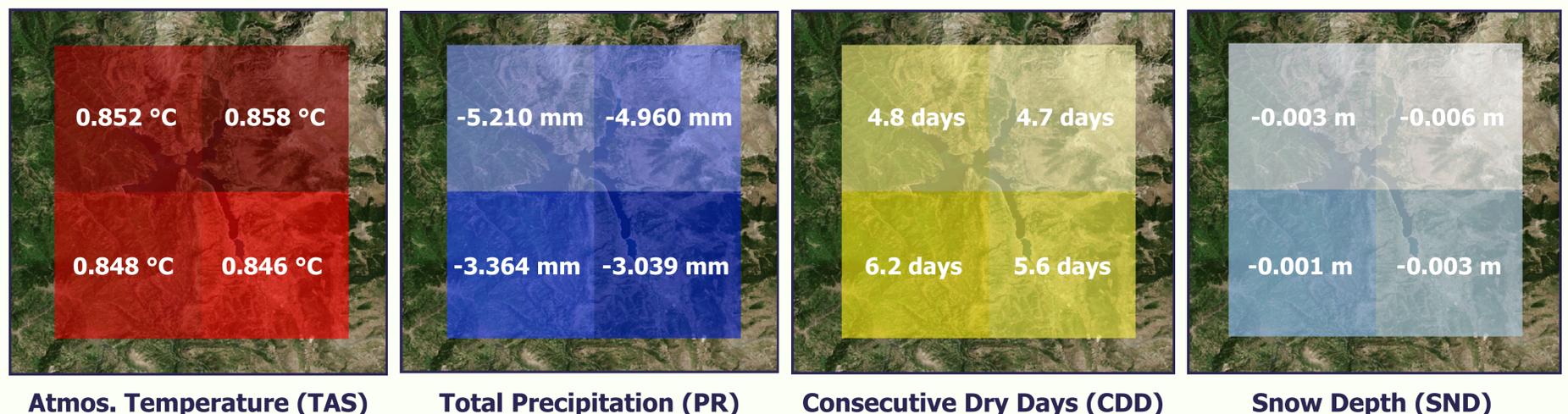


Climate Projections

Future climate conditions were assessed using model outputs provided by the National Observatory of Athens, based on the climatological reference period 1991–2020 and evaluated for the **projection period 2031–2060**. Projected variables included mean **Air Temperature**, **Total Precipitation**, **Snow Cover**, and **Consecutive Dry Days (CDD)**, while future **Potential Evapotranspiration (PET)** was additionally calculated from projected temperature data, towards calculating the **Climatic Water Balance (CWB)**. The projections are focusing on the **difference between the two time periods**, [Value_2031_2060] - [Value_1991_2020].



Climate projections are based on the **RCP4.5** emissions scenario. A multi-model ensemble approach was adopted, **combining 5 Global Climate Models (GCMs)**—MPI-ESM-LR, MOHC-HadGEM2-ES, IPSL-CM5A-MR, ICHEC-EC-EARTH, and CNRM-CM5—with **3 Regional Climate Models (RCMs)**—REMO2009, CCLM4-8-17, and RCA4. The dynamic downscaling of each GCM through the 3 RCMs results in a total of 15 distinct GCM–RCM ensemble members, providing a robust framework for assessing regional-scale climate variability. The mean values from all models were used to calculate the **mean difference between the periods 1991 - 2010 and 2031 - 2060**.



This research is being conducted by **envinow.gr** in **scientific collaboration** with the **National Observatory of Athens**, which provides:

- Curated and quality-controlled climatic datasets from CORDEX
- Downscaled climate model outputs
- Scientific supervision and methodological guidance



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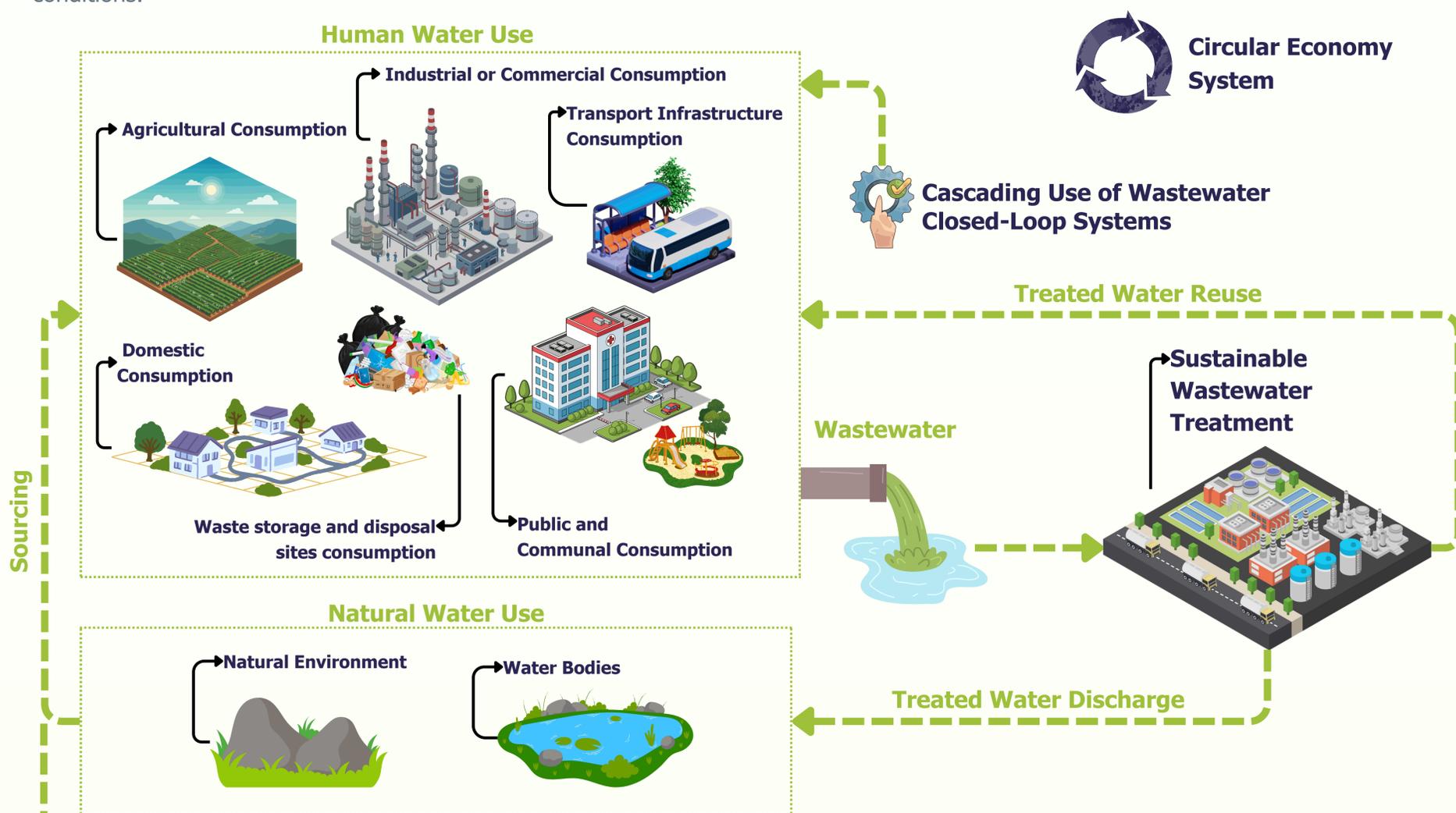


Mapping Approaches to Tackle Water Scarcity in Attica

Water scarcity in Attica emerges from the increasing imbalance between available water reserves and growing anthropogenic demand. In response, this work **systematically maps and categorises technological and management approaches** identified in the scientific literature that aim to mitigate water shortage and enhance regional water resilience.

Circular Approaches

Circular approaches refer to strategies that promote water reuse, recirculation, and efficiency within the existing system, aiming to keep water in use for as long as possible. By **treating wastewater for reuse**, applying **fit-for-purpose cascading practices**, and implementing **closed-loop systems**, these approaches reduce freshwater abstraction and limit losses. In the context of water scarcity, they help alleviate pressure on natural water reserves, enhance resource efficiency, and strengthen regional resilience against drought conditions.



Non-Circular Approaches

Non-circular approaches refer to supply-side strategies that aim to increase the total volume of water available within the system rather than reuse existing flows. These include **desalination**, **atmospheric water capture**, **water storage infrastructure**, and **rainwater harvesting**. By introducing new or previously untapped water sources into the network and buffering seasonal variability, non-circular approaches enhance overall water availability and provide additional security during prolonged drought periods, thereby reducing vulnerability to water scarcity in Attica.



Next Research Step: Towards Context-Specific Solution Selection for Attica

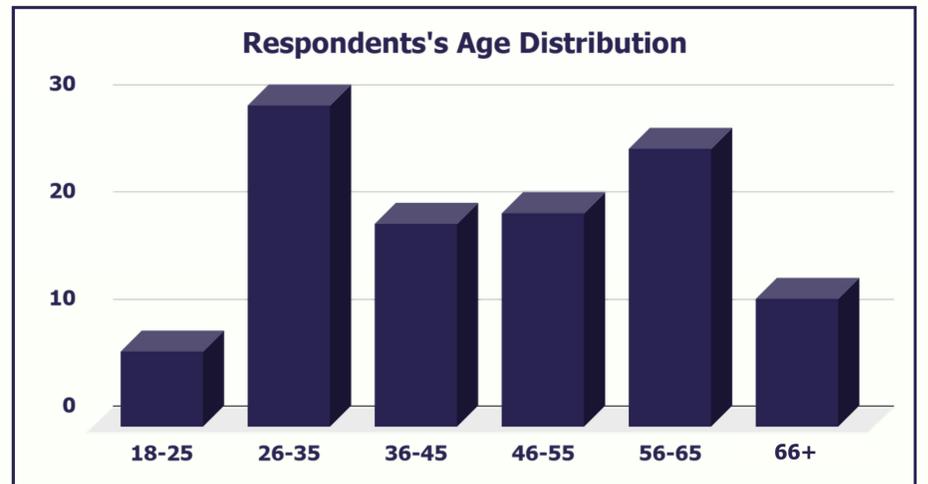
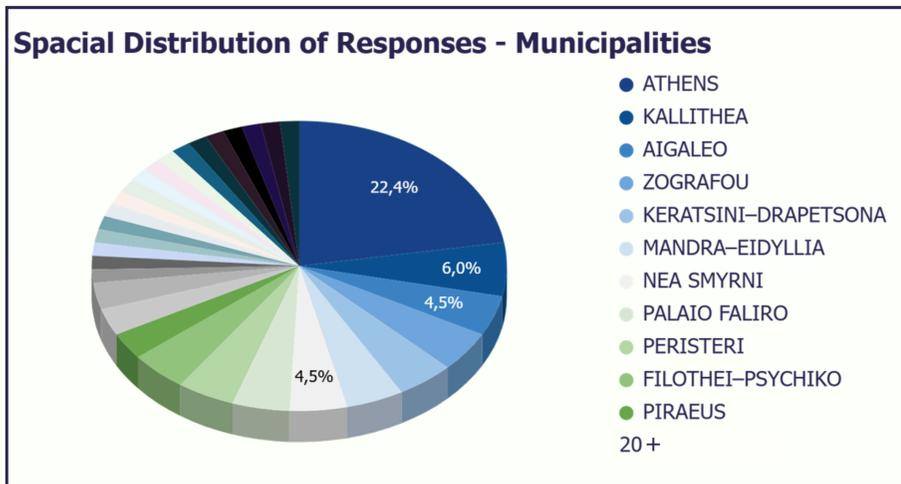


Water Footprint Calculation in Attica

Addressing water scarcity in Attica requires not only supply-side interventions but also a clear understanding of consumption-driven pressures on regional water resources. To this end, **an ongoing research initiative is being conducted to assess the individual water footprint of residents in Attica**, aiming to quantify household-level water consumption patterns. In the context of drought risk and projected hydro-climatic stress, this approach contributes to enhancing water security by promoting informed water use and enabling data-driven reduction scenarios at the household level.

Preliminary Findings and Footprint Trends

Responses Indicative Statistical Analysis



Observed Findings

The average individual water footprint is 4,504 L/day, with observed values ranging from 2,340 to 9,484 L/day, indicating **substantial variability** in consumption patterns.



4,504 L/day

Average Individual Water Footprint



2,340 L/day

Minimum Observed Value



9,484 L/day

Maximum Observed Value

The concept of the water footprint is based on calculating the water associated with human consumption and global trade and managing water resources accordingly [1]. According to Mekonnen & Hoekstra (2011), National Water Footprint Accounts, UNESCO-IHE Institute for Water Education, the average water footprint (WF) per capita in Greece is 6,400 L/day. Our results show a lower average of 4,504 L/day, ranging from 2,340 L/day to 9,484 L/day, highlighting significant differences in individual consumption patterns between the studies and the respondents.

[1] Zafeirakou, A., Katsoulea, A., & Ziampras, R. T. (2023). Water footprint calculator for Greece: A useful tool for surveying and constraining water needs in Greece and for raising public awareness. *Water Utility Journal*, 32, 15–27



Individual footprints must and will be complemented by other sectoral water uses in order to assess total pressure in the area.

Are you living in Attica?

Calculate your Water Footprint and contribute to our research!

SCAN ME!



The Water Footprint research is conducted by envinow.gr in scientific collaboration with the **Water Sapphire research group of the Aristotle University of Thessaloniki (AUTH)**, which provides:

- The Water Footprint Calculator methodology and tool
- Scientific supervision and research guidance



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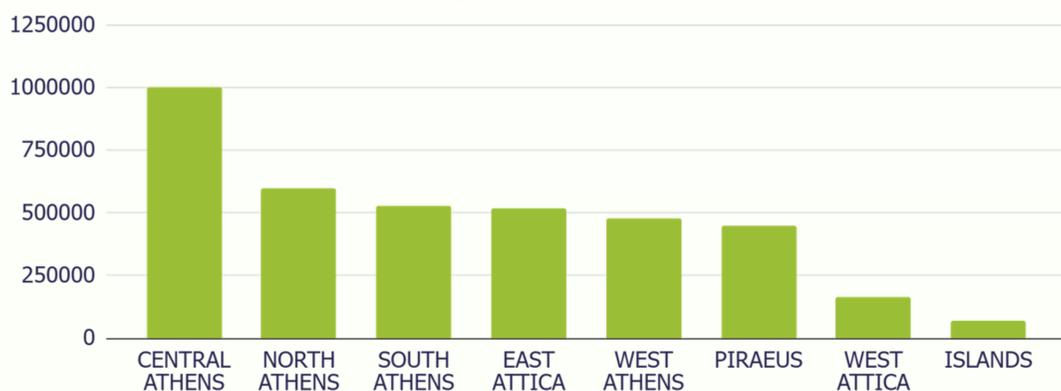


Understanding Water Pressure in Attica: Demography, Land Use and Impacts

Water demand in Attica is shaped by a complex interaction between administrative structure, population distribution, land-use patterns, and sectoral economic activities. Understanding these **spatial and demographic characteristics** is essential for identifying the underlying drivers of water consumption and associated pressures on regional water resources. By linking land-use patterns with sectoral water demand and documented **societal, economic and environmental impacts**, spatially informed perspectives on anthropogenic pressure can be shaped.

Spatial and Demographic Profile of Attica

Spatial Population Distribution



The Area in Numbers

Attica exhibits a strongly urbanised settlement pattern, with population concentrated in the Greater Athens metropolitan area.

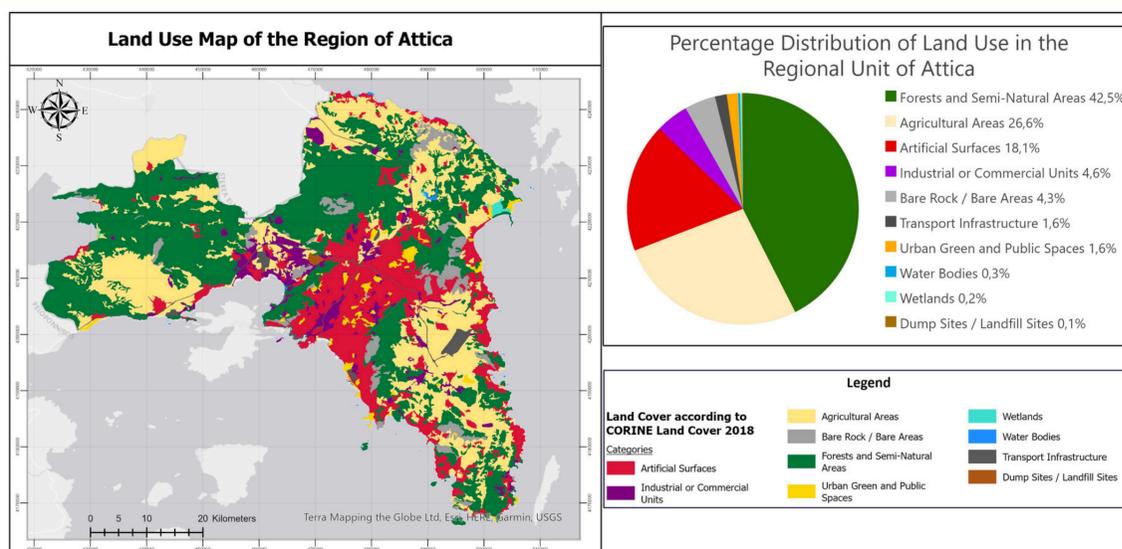
- **3,814,065 residents** in Attica (2021)
- 36.4% of Greece's total population
- Area: 3,808 km²
- Density: ~1,002 inhabitants/km²



Attica's Land Cover and Activities

Attica's land cover is dominated by forest and natural areas (42.5%), agricultural land (26.6%) and urban fabric (18.1%), reflecting a dense metropolitan core surrounded by peri-urban and rural landscapes (CORINE 2018).

Based on this land-use structure, water use categories were developed to establish a functional linkage between spatial land cover distribution and sector-specific water demand, forming a coherent framework for analysing water scarcity pressures.



Mapping the Impacts of Water Scarcity

Human Water Use **Urban & Domestic Activities** Water scarcity pressures surface reservoirs and supply security, increasing drought restrictions, reduced per-capita availability, infrastructure strain, higher tariffs and uneven social exposure.

Industrial or Commercial Activities Severe scarcity and reservoir drawdowns may impose production limits and process adjustments, while higher supply costs create economic pressure and service-sector constraints.

Public and Communal Infrastructure Limited water availability constrains urban green spaces, intensifies urban heat island effects and, combined with tourism demand and wildfire risk, increases municipal pressure.

Transport Infrastructure Water scarcity affects maintenance, cleaning and construction activities (e.g., metro excavation and dust suppression), increasing pressure on groundwater and surface water systems.

Waste Storage and Disposal Sites Groundwater contamination in areas such as the Thriassion Plain heightens vulnerability under water scarcity conditions.

Agricultural Activities Water scarcity reduces crop yields and long-term sustainability, while heavy withdrawals and excessive abstraction intensify drought severity, salinization and soil degradation.

Natural Water Use **Water Bodies** Critical drops in Mornos and Evinos storage threaten supply reliability, while overexploitation triggers seawater intrusion and ecological degradation.

Forests and Natural Areas Water shortages intensify drought stress, reduce evapotranspiration and productivity, disrupt soil moisture regimes and increase vulnerability to mortality and decline.

Bare Land High evaporation, reduced infiltration and increased runoff decrease groundwater recharge and accelerate drought vulnerability and land degradation.

