

CLIMATE CHANGE & THE ENVIRONMENT

As environmental issues become an increasingly acute concern worldwide, Turkey is a country of prime interest in the field of climate studies. Due to its location, it presents an ideal opportunity to explore and understand climate development and the history of global environmental change within the context of contemporary international relations. Lake sediments, tree-rings, speleothems and peat deposits represent valuable natural 'archives' of environmental change that have been under-explored in both Turkey and the wider Black Sea region. This programme of research into the vegetation and climate history of the region focuses on changes in vegetation, water resources, landscape stability and hazards in Turkey, the Black Sea area and much of the wider Middle East over time. It also provides a key context of interaction concerning human use of the landscape from prehistory to the present day.

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Water in Istanbul: Rising to the Challenge?

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Water in Istanbul: Rising to the Challenge? is a new 24-month project led by the Institute's Director, Lutgarde Vandeput, and funded by the British Academy's Knowledge Frontiers 2021: International Interdisciplinary Research Scheme, the Scientific Research Projects Department of Istanbul Technical University (no. 43072), a BIAA research grant and the SFC GCRF Fund of the University of Edinburgh. It brings together archaeologists, engineers, social scientists and historians to investigate water management infrastructure in Istanbul. From its establishment in 330 CE, Constantinople, later Istanbul, 'thirsted for water', and the ancient world's longest water-supply line was required to meet the increasing demands of this growing city. However, the problem was not easily resolved long-term, and later centuries saw a continuing challenge to supply adequate water, a challenge that became particularly significant at key moments of change and transformation. This project focuses on two such periods: the transition from Byzantine to Ottoman rule following the conquest of 1453 and the recent period of rapid population explosion beginning in the early 1980s.

Critical environmental, political or economic events can challenge the sustainability of complex infrastructure systems. Radical regime change, as in 1453, prompts questions regarding the pre-existing water-related infrastructure systems: whether they continued to function and how they were modified and/or replaced. The later transition from imperial/political city to simply a major

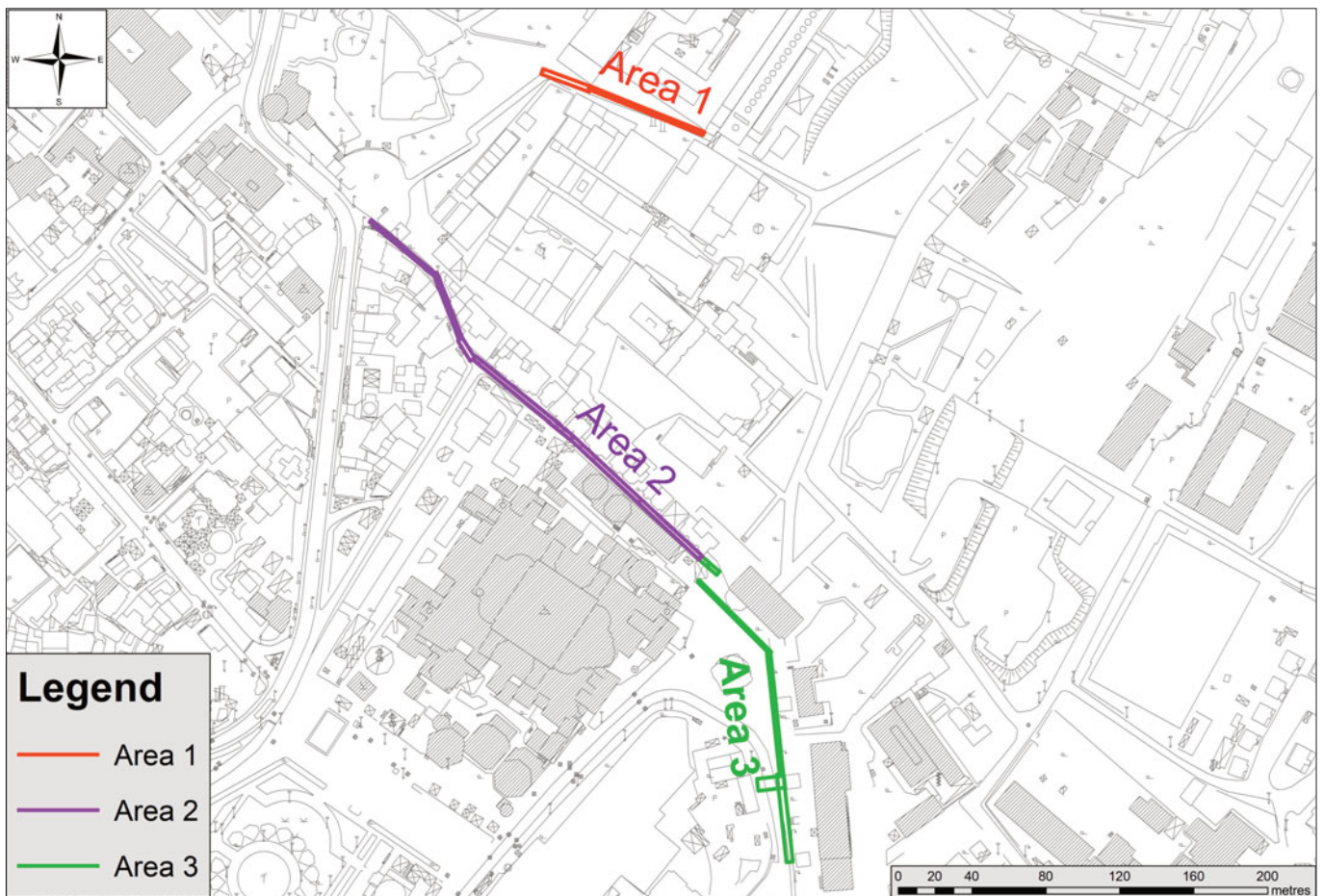
economic centre at the beginning of the Republican era resulted in urban decline, which had consequences for the water-management infrastructure. The real challenge, though, has arisen from the early 1980s onwards, as the population of Istanbul began rising rapidly from about 2.7 million in the 1970s to over 16 million today. The infrastructure could not keep up with demand, and this is a challenge that has not been overcome to date.

The Water in Istanbul project is examining how the city's water-distribution systems have changed at these pivotal moments, not only from technological and functional perspectives, but also by investigating how the management and organisational infrastructures have adapted and responded. While the contemporary water-management problems facing Istanbul are far from unique, the fact that the city has a documented history, covering more than 1,700 years, of attempts made to address the challenge of adequate water supply makes it an ideal case study.

Interdisciplinary collaboration between archaeologists, historians and engineers allows the application of present-day hydraulic engineering modelling methods to data from the early Ottoman period to generate new knowledge and understanding of how the past system functioned and was managed. In parallel, engineers and social scientists are working with water-management experts and other local stakeholders to understand better the current needs and explore how past practices can inform solutions to contemporary water-related challenges.

A major objective of the project is to develop a better understanding of the Ottoman water-management system in the Topkapı area, where functional changes necessitated large infrastructural remodelling in the Ottoman period and particular problems arose due to the relative elevation of the new palace. To this end, a programme of targeted archaeological fieldwork and historical research, as well as collation of existing material, is being undertaken to provide data for extensive mapping of the water-management system in the Topkapı area and for investigation of its functionality, using hydraulic modelling. In the first fieldwork phase – conducted in summer 2021 – a ground-penetrating radar (GPR) survey was carried out to investigate water-management-related remains, including supply lines providing freshwater to the Topkapı area. Based on previous research by Hülya Tezcan and the archaeological survey results of Çiğdem Özkan Aygün, several areas were identified for investigation with GPR: Osman Hamdi Bey Yokuşu (Area 1), Soğuk Çeşme Sokak (Area 2) and İshak Paşa Caddesi (Area 3) (see plan, below). The fieldwork yielded 11 channels and a further possible channel, between 1m and 2m wide and 1–1.5m high at depths of between 1.5m and 5m, along with a subterranean structure. This structure may be identified with a cistern referenced in an Ottoman document written immediately after the great earthquake of 1509.

A second project objective focuses on modern Istanbul and the challenges of ensuring sustainable water provision. To this end, a participatory knowledge-generation process with local stakeholder groups to map specific challenges has been instigated. An initial stakeholder engagement workshop focusing on water storage and rainwater harvesting was held at the Netherlands Consulate-General in Istanbul on 4 October 2021. The morning session comprised presentations of the Water in Istanbul: Rising to the Challenge? project, other water-related initiatives of the BIAA, the results of research on water management in Istanbul by Dr Özkan, the water-management project in the garden of the Netherlands Consulate-General and initiatives on water management conducted by the Netherlands Institute in Turkey (NIT). In the afternoon, two parallel focus groups were organised with representatives from the Istanbul Metropolitan Municipality, the Istanbul Water and Sewerage Administration, the Fatih Municipality, the Netherlands Institute in Turkey, the Istanbul Policy Center, Istanbul Technical University and Royal Haskoning DHV to discuss the challenges of implementing rainwater-collection systems in buildings and urban open spaces, and to co-define needs. Preliminary results suggest that the challenges can be clustered under seven headings: (1) infrastructure, (2) finance, (3) installation of systems, (4) operation of systems, (5) planning and development, (6) legislation and governance and (7) society.





GPR survey work at İshak Paşa Caddesi, east of Hagia Sophia (photograph by Engin Aygün).

At the end of the workshop, participants agreed on the need to establish a new office under the Istanbul Water and Sewerage Administration that would be solely responsible for water storage and rainwater harvesting. Participants also discussed the possibility of revitalising some historic systems and integrating them into the modern city infrastructure. Due to the risk of damage and inadequate storage capacities, a more conservation-oriented approach was adopted. It was agreed that the revitalisation of one or two pilot cisterns could be used as an awareness-raising strategy, supported by public engagement activities.

In the next phase of the project, archaeological fieldwork in the Topkapı area will continue, with the aim of obtaining detailed information relevant to hydraulics. Modelling on the basis of the combined data from archaeological and historical research will enable engineers to determine how the systems functioned, while hydraulic modelling will make reconstruction of the capacity of the infrastructure possible. The combined results will be of importance to further understanding of the functioning of the city in the Ottoman period as well as to appreciate important differences between the older Byzantine infrastructure and the adaptations made by the Ottomans.

Additional stakeholder workshops will be organised throughout 2022, involving not only local participants but also representatives from regional and national authorities to extend and enrich understanding of contemporary challenges. The results of work on historical infrastructure and past water-management practices will be presented to inform discussions of how the identified challenges could be overcome. The results of these stakeholder workshops will be cross-referenced with the work of engineers on the functionalities and limitations of the current infrastructure to create responsive solutions.

Also in this phase, GIS models of the Topkapı area will be built, showing the water network during the periods of interest (late Byzantine to Ottoman and modern), so that they can be compared and overlaid. Results from the study of published archaeological material, earlier fieldwork and research in Ottoman archives will be incorporated in the GIS model with the aim of extending out from the Topkapı area in an attempt to cover the main water lines of the wider city, covering supply, storage and drainage routes.

The GIS models will be linked to hydraulic modelling software, and modelling of the hydraulic operation of the network under various scenarios will be carried out. This will include rainwater-runoff modelling as well as supplies from aqueducts and springs. Where relevant, storage and drainage of water will also be covered, and consideration will be given to the role of groundwater in supplying springs, wells and cisterns identified within the model area.

The combined results of the different disciplines on past and present water-management practices and challenges may provide inspiration for management solutions for the present and the future.



Delegates attend the Water Storage and Rainwater Harvesting Workshop in October 2021 (photograph by Ender Peker).