

AQUEDUCT CONSTRUCTION IN THE LATE-ANTIQUAE EAST

an agent-based modelling and geoarchaeological
approach to building evidence for the Water Supply of
Constantinople



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About the water supply



- Had no sustainable fresh local water sources
- Hadrian provided aqueduct in the 2nd century
- Population boomed in the 4th century
- Textual sources claimed the city was “dying of thirst”
- Long distance water supply built in the mid 4th century and greatly expanded in the early 5th century

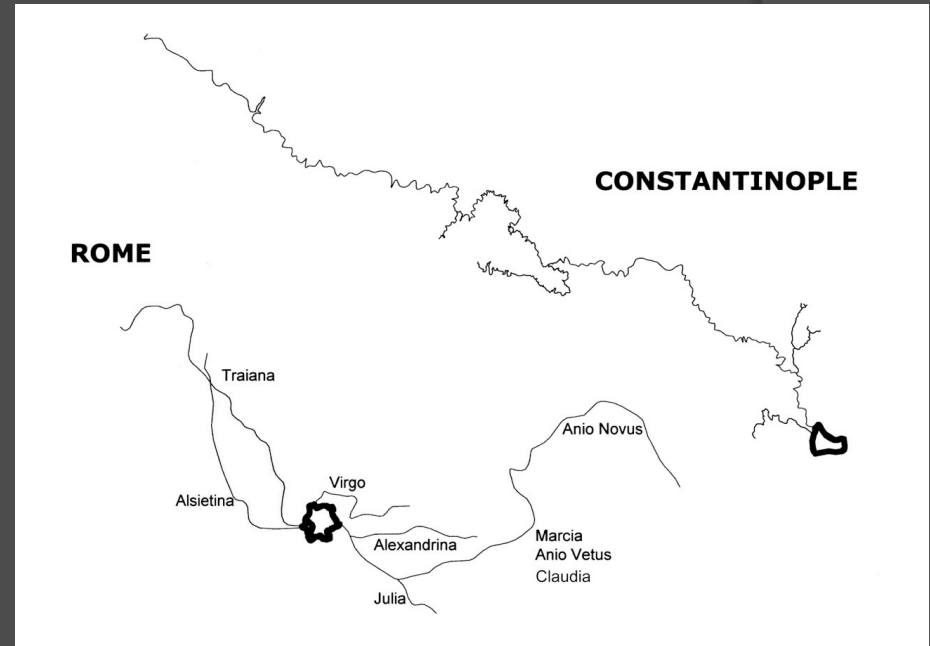
More about the water supply

- Made up of two structural elements: aqueduct bridges and channels
- Channels mostly built in “cut and cover” method
- Only two main structural materials: stone and mortar
- No structural brick

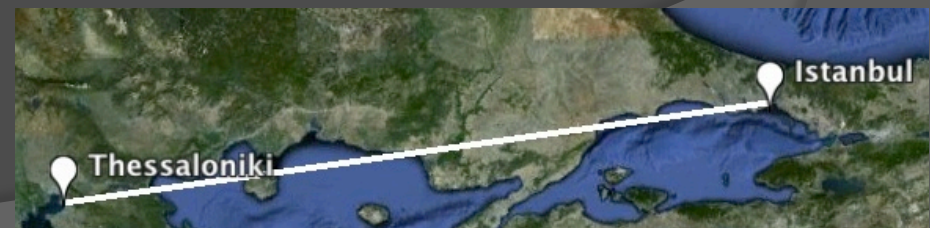


Why it matters

- One of the largest construction projects of the ancient world
- Massively understudied
- Potentially changes narratives on late antique construction
- Recent construction projects threaten its existence



Phase	Total Length (km)	Total Volume (m ³)
Water Supply - 4 th Century Line	271	1,039,000
Water Supply - 5 th Century Line	183	2,124,000



What we plan to do



- Employ agent-based modeling to the construction of the Water Supply of Constantinople
- Combine a wide variety of sources to represent day-to-day activities and major organizational decisions
- Represent everyday life in different levels of agency

What we know

- Recent field survey data
- Geographical and Geological information
- Quantity/type of construction materials

Material	Volume (m ³)	Number of Units	Mass (Tonnes)
Water Supply - 4th Century Line			
Channel Lining Mortar	18,500	--	--
Structural Mortar	362,000	--	--
Facing Stones	34,000	339,000	88,500
Rubble Stone	626,000	--	1,633,000
Iron Clamps	220	305,000	1,700
Water Supply - 5th Century Line			
Channel Lining Mortar	13,600	--	--
Structural Mortar	749,000	--	--
Facing Stones	66,000	666,000	174,000
Rubble Stone	1,295,000	--	3,380,000
Iron Clamps	440	610,000	3,400

Action	Man-days (in thousands)
Water Supply – 4th Century	
Site Planning and Preparations	376
Mortar Preparations	402
Building Preparation	614
Construction	1,271
Total	2,663
Water Supply – 5th Century	
Site Planning and Preparations	1,407
Mortar Preparations	806
Building Preparation	1,220
Construction	2,826
Total	6,259

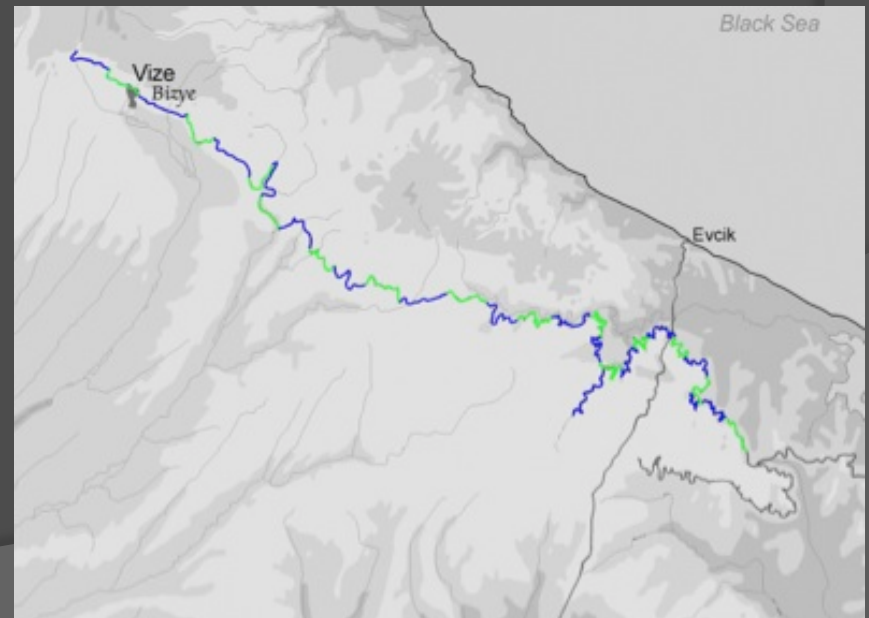
- Reliance on local raw materials
- Manpower requirements (Energetics)
- Length of time of construction (4th century)

What we almost know



- Workforce: non-slave, skilled and unskilled
- Workforce organized by guild/workshop

- Construction divided into “contract sections”
- Work processes



What we don't know enough about

- Exact location of raw materials
- Pathways of transportation
- Availability of materials and laborers
- Life and career of workforce
- The scheduling of work and appointment of laborers



Further reasons why this matters

(From an interdisciplinary perspective)

- ⦿ Theoretical: emergence/foundation of cities
- ⦿ Subject-wise: broader research trajectory of Balkan cities
- ⦿ Methodological: generative social science

More on what we plan to do

- Use the version zero model as a simple visualization to discuss relevance of elements and issues (constructive validity)
- Gather information from different sources while trying to patch-up parts of the puzzle
- Experimenting with different combinations of scenarios to support generation of hypotheses related to organization of construction
- More specific contributions towards estimating limit values and manpower calculations

More specifically...

- ◎ Scenarios around
 - trade guilds (size, location, spread of skills and tacit knowledge)
 - contract sections (average length, logistics)
 - lives of workers (careers, working conditions, mobility)
- ◎ Studying possible roads and pathways via GIS to estimate labor for transportation

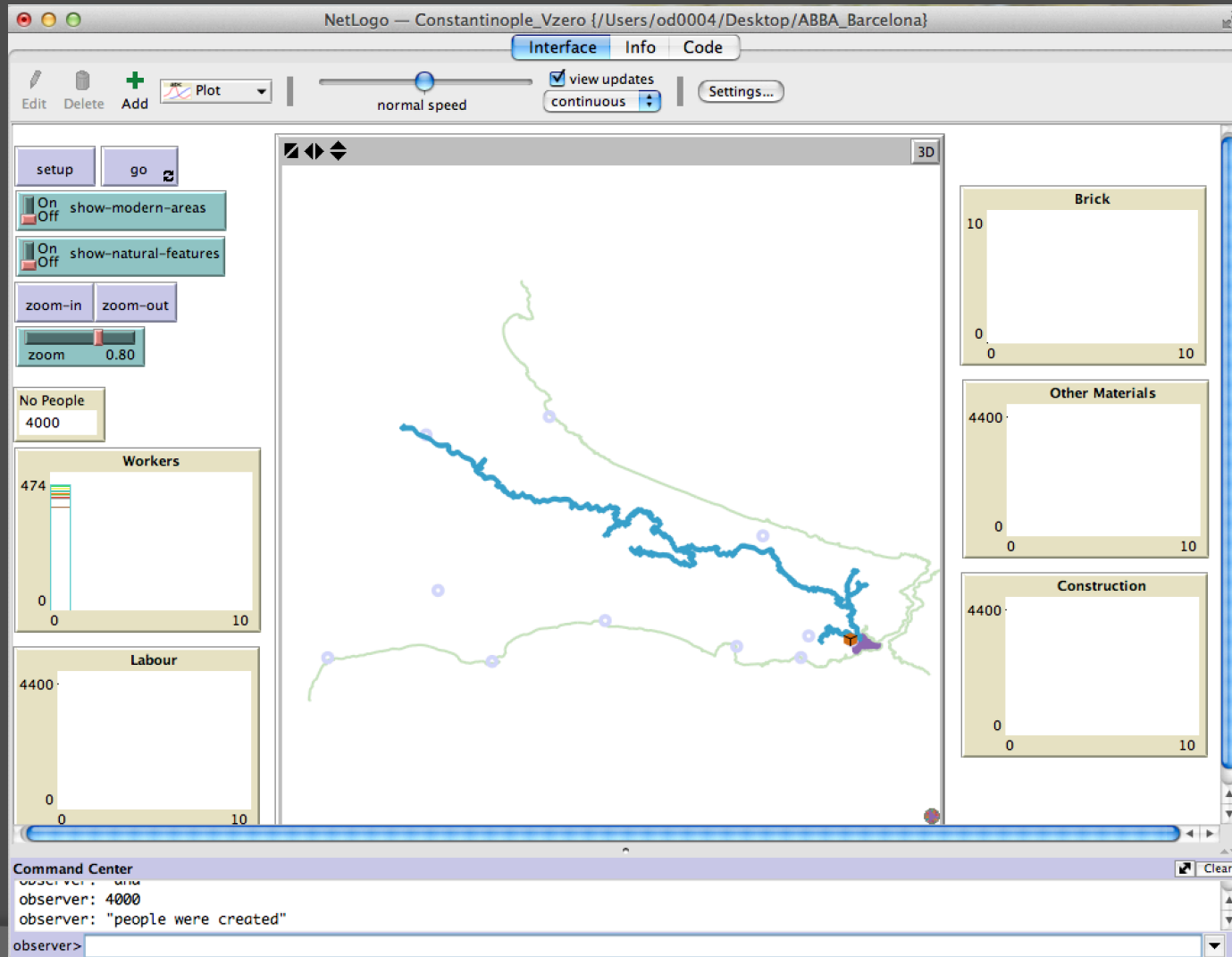
ABBA - CLAWS Version 0

The screenshot displays the NetLogo interface for the ABBA - CLAWS simulation. The window title is "NetLogo — Constantinople_Vzero {/Users/od0004/Desktop/ABBA_Barcelona}". The interface includes a top toolbar with "Interface", "Info", and "Code" tabs, and a "Plot" dropdown menu. Below the toolbar are controls for "Edit", "Delete", "Add", a "normal speed" slider, a "view updates" checkbox (checked), a "continuous" dropdown, and a "Settings..." button.

The main workspace features a central map of Constantinople with a blue river network and green landmasses. To the left of the map are several control panels: "setup" and "go" buttons; "show-modern-areas" and "show-natural-features" toggle switches (both currently "On"); "zoom-in" and "zoom-out" buttons; a "zoom" slider set to 0.80; a "No People" input field set to 4000; a "Workers" bar chart showing a value of 436; and a "Labour" bar chart showing a value of 4400.

To the right of the map are three empty bar charts labeled "Brick", "Other Materials", and "Construction", each with a vertical axis from 0 to 10. The bottom of the interface contains a "Command Center" with a "Clear" button and the following text: "observer: and", "observer: 4000", "observer: 'people were created'", and "observer>".

ABBA - CLAWS Version 0



About the model design

- **Agents**: People (workers, residents of Constantinople) and the state
- **Environment**: Thrace with the city other towns, production areas, the construction site and the terrain
- **Relationships**: Guilds and social relationships, the state as designer/organizer
- **Interaction**: Within guilds, between different construction processes and teams
- **Historicity**: Daily lives of people and flows of material with seasonality and exogenous shocks over 25 years

Summary and Pre-conclusions

- ⦿ Our research investigates the construction process of one of the biggest projects of antiquity
- ⦿ Can change our general understanding of the capabilities of the polities of the period
- ⦿ We have an interdisciplinary approach integrating social simulation with archaeology
- ⦿ We aim to use ABM as a generative tool as well as simulating interdependent construction processes across a large and difficult terrain
- ⦿ We developed the version 0 of our model, the basis for the upcoming project

Thank you

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