The Urban Mind
Cultural and Environmental Dynamics

Edited by
Paul J.J. Sinclair, Gullög Nordquist, Frands Herschend and Christian Isendahl

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ABSTRACT
Constantinople is a city whose origin can be traced back to the establishment of Greek cities and colonies in early antiquity. Eventually it became the capital of the East Roman Empire, and since then its major role in the region has not diminished, whether under the rule of Byzantine emperors or Ottoman sultans. For more than 2000 years the city and its inhabitants have endured numerous changes and crises. Plague, war and economic regression have at times reduced its population to only a fraction of the previous size. The city has been subject to numerous sieges, the longest lasting eight years! Conquered only once prior to the major transformation in 1453, the city flourished again after each crisis and today it is still an important centre in this part of the world, on the border between the Mediterranean and the Black Sea.
How could Constantinople maintain its leading position for such a long time, after suffering so many crises? In this chapter, the authors emphasize that the ability of a city to survive under stress has its fundamental origins in how the city was organized and maintained. Special focus is put on the organizational and ecosystem services aspects of urban agriculture in the city. The authors explore how the inhabitants of the ancient city of Constantinople managed to maintain a resilient food supply system.

Constantinople differs in many ways from our modern cities, which are dependent on resources from a global hinterland that are transported using fossil fuels, and thus it can serve as an educational example for our time. At its first peak during the 6th century it was dependent on a complex grain transport system with ships travelling all the way to North Africa. This system collapsed in conjunction with the Arab expansion in the 7th century, and the collapse became a major part of a long recession that profoundly affected the city. That the city nonetheless survived cannot be explained by any single factor. The answer must be sought through a holistic perspective in which the variety of resource assets is seen as playing a major role. A particularly interesting aspect, related to today's global transport system, is the urban agriculture system within and just outside the city walls. The walls did not constitute the limits for a densely populated area. They rather delimited an area with dispersed “sub-communities” and numerous acres of, for example, orchards and vineyards. These areas could apparently sustain the population with a considerable amount of food and probably were important for the city's ability to withstand sieges and periods of food shortage. This system was continuous and was maintained by the inhabitants' living memory as well as by important institutions. In our society, where the supply of food is considered as something obvious, one can question whether we lack memory as well as preparations for similar crises despite the fact that the food supply crisis of the Second World War is only 65 years behind us.

Introduction

In the last two hundred years, modernity and success have been associated with the city. Urbanization has been a key element of modernization.¹ The city has been largely understood as distinct from natural and agricultural landscapes² and increasingly also distinct from industrial landscapes. The modern, future-oriented city has been disassociated from organic life-sustaining and preserving processes in what has essentially been a spatial division of labour. This urban paradigm has emerged at the same time as humanity has entered the Anthropocene,³ implying that humanity since c. 1800 has been the dominant agent of change on the planet, an idea which has been aired for a long time⁴ but which has only recently become more comprehensively underpinned by empirical observation and scientific analysis.⁵

With increasing urbanization it is safe to say that the main driver of global change rests in urban areas. We are thus, after two hundred years of the Anthropocene, entering what may be termed an Urban Anthropocene. Some features of the “modern traditional” city paradigm under the Anthropocene have been: a tight urban core, a relatively high density of population, high property prices implying prevalence of many high buildings, a predominance of hard covered areas, and a very large prevalence of motor vehicles, including many private cars. Although this has been the norm it should be recalled how recent and still quite
rare this paradigm is. Only a few generations ago most cities still had strong rural
traits. In fact many of these features still exist today, yet the presence of urban
wildlife and green areas has often been overlooked in the literature on cities.6

The arrival of the Urban Anthropocene will probably induce further changes.
While the dense, motorized city is still a dominant paradigm there is already an
emerging counter-narrative7 of urban development which emphasizes the co-pro-
duction of rural and urban geographies,8 the importance of greenways and green
structures,9 and other features that identify the urban and peri-urban regions as
important havens of biodiversity and ecosystem services,10 and as contributors to
human health and well being. We are currently experiencing what may be the
beginning of a shift in the “urban mind” back towards more sustainable cities
with new and closer relations with nature, agricultural and industrial produc-
tion landscapes, and which will sometimes make it necessary to question the
increased dependency under the Anthropocene on a distant supply of resources
and reception of wastes, and thus distant and scattered ecological footprints.

In this chapter we argue that, when transforming cities to make them more
sustainable and resilient to shocks, it is best to recognize their long-standing roots
in previous urban centres. As cities now try to reorient themselves and seek more
viable relations with their outside worlds, they would do well to seek their role
models in the patterns of urban mind and urban adaptation that existed in pre-
Anthropocene periods of human history. This chapter explores in what ways the
ancient city of Constantinople over its more than 2000-year history has managed
a resilient production of ecosystem services and other resources for its citizens.

For many years the eco-optimal urban form has been the subject of debate.11
Comparisons have been made, for example, between the very compact Asian city
and the traditional, mixed, semi-suburbanized European city. Although some
urban structures are clearly unsustainable, perhaps most notably the sprawling
low-tech North American cities based on fossil-fuelled automobiles, no firm con-
cclusions can be drawn. New technologies and energy regimes can also change
current levels of sustainability and turn a less compact city into a resilient sus-
tainability refuge, provided material circulation is reduced and mobility is eco-
efficient.12

It seems clear, therefore, that cities have a wide variety of spatial choices where
the alternatives may or may not be compatible with sustainability. Some of those
choices became obscured by the rampant growth of conventional modern cities
in the twentieth century. Out of a broad and lively discussion of future cities that
occurred around the turn of the 20th century only a few stylized ideas survived.13
In particular the discourse of the urban region, as proposed by the Scottish so-
ciologist and reformer Patrick Geddes, was sadly neglected. These ideas, later
developed further by Lewis Mumford in the United States,14 proposed a holistic
view of a wider ecological region where self-sufficiency of many raw materials,

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6 Braun 2005.
7 Nye 2003.
8 Cronon 1990.
10 Bolund & Hunhammar 1999.
11 Höjer et al. 2010.
13 Hall 1988.
food, and agricultural products was an important feature. Geddes was well aware of previous attempts by von Thünen and others to analyse the relations between an urban centre and its sustaining countryside. Geddes’s innovation was that he saw this less in geometrical and more in functional terms, envisioning what he called a conurbation, which can best be understood as a spatial assemblage of urban dwellers and green areas for production or recreation. He was also deeply interested in the metabolism, or the human ecology, of the conurbation, taking into regard what impact the city had on the wider world. Geddes and Mumford lacked adequate ways of measuring and analysing these impacts, but today there are methods to assess both regional and global circulations and impacts that derive from the city.

Constantinople, or Istanbul as it is known today, is a good example of a conurbation in the Geddes/Mumford tradition: a large city with many inhabitants, with several old concentrations of population and urban activities, and with significant areas of green space and productive lands within and near the city that contribute to the city’s history of adaptation and growth. In this chapter Constantinople/Istanbul is our main case study. As an example of long-term urban sustainability and resilience it has a number of interesting features. Most importantly, it is a very old city that combines a variety of time scales—annual, decadal, centennial and millennial—and for all of these there is a reasonably good availability of sources. To follow a city over such a long period makes it possible to analyse both its ups and downs, especially in relation to crises and processes of recovery and renewal.

The study is intended as an attempt to bring historical evidence into the science of modern sustainability and explore the potential usefulness of resilience as a conceptual tool in understanding urban change over long historical time scales. It does so by re-interpreting and synthesising archaeological data and historical documents alongside recent research on ecosystem services, resilience and socio-ecological metabolism. Furthermore we are interested to learn whether the history of Istanbul and its surroundings can help us understand how we can create more sustainable urban landscapes and cope with crises in the future. Or, in more general terms: what lessons from urban pasts can be learned when planning for urban sustainability?

**Historical overview**

Istanbul is a city that links Europe, with its long-standing cultural and technological traditions, with the East and the Arab world. The present city has in less than 100 years grown into an enormous metropolis, and at the same time it has many of the same features as small and medium-sized cities of today. Despite its size it has a manageable geography. It once represented the largest foothold on the coast of the wide Byzantine Empire and the Ottoman Empire and its hinterlands. That situation still exists for present-day Turkey. It is also situated near a part of the world where gardens were developed very early on, such as Egypt and Mesopotamia. The garden has been a decorative element and a source of recreation and shelter in hot climates, but it has also served as a site of production and as a buffer for the needs that could arrive unexpectedly in a crisis.

The Byzantine Empire, also known as the East Roman Empire, has until recently often been seen as a faint shadow of the earlier more “glorious” Roman
Empire. Much can be debated concerning the ability of its rulers and how the empire shrank into nothing but a town, existing at the mercy of the Ottomans and dependent on Italian city states. However, the empire and its capital demonstrated an amazing ability to survive numerous periods of crisis. Except for a brief period in the 13th century, owing to the conquest by the Fourth Crusade in AD 1204, Constantinople remained the empire’s urban centre. In contrast to many other important cities in antiquity and the medieval period, it never lost its role and position despite periods of decline and regression. It was the capital of the East Roman Empire for more than a thousand years and subsequently became the capital of the Ottoman Empire.

The predecessor of Constantinople, Byzantium (the present name Istanbul was adopted fairly recently, in 1929), is said to have been founded in the seventh century BC. Its strategic importance but exposed location is attested to as early as the Greek-Persian wars, when the Persian garrison in the city was defeated in 478 BC. By then Byzantium was one among many Greek colonies distributed along the Mediterranean coast. Though a significant town, it did not distinguish itself like Athens, Sparta, or Thebes. When Emperor Constantine in the 4th century AD chose a capital for the eastern empire, there were many other cities far larger and more important than Byzantium. However, for whatever reason it was selected, it appears to have been a good choice: today it is the cultural and economic centre of Turkey, has about 15 million people, and is one of the 25 largest cities in the world.

The city is strategically located at one of the narrowest parts of the Bosphorus Straits. The climate is temperate with year-round rainfall, but with seasonal variation. In ancient times the river Lycos ran through the town. It gave a steady supply of water but was neither sufficient nor of acceptable quality, and a number of rulers invested in leading water from the mountains via several aqueducts and storing it in a system of reservoirs. Despite these efforts freshwater supplies were often deficient during the hot summer season, occasionally resulting in civic unrest.

The area surrounding Constantinople was to a large degree a valley landscape with soils of varied fertility. The immediate hinterland was obviously not sufficient for providing everything necessary for the large city. However, the landscape was far from poor and provided important resources. The coastal location of the city was also extremely important; the sea provided maritime resources and the strategic-communicative placement made the city an advantageous communication and transport node. Byzantium was surrounded by water to the north, east and south, and easy to defend. By controlling the seas its navy was able to repel invaders on a number of occasions, and to secure an inflow of supplies during times of crisis. Even in the final siege by the Ottomans in 1453, a Genoese grain ship managed to run through the naval blockade. The migration routes of bonito, tuna and other high-quality fish species passed between the Mediterranean and the Black Sea. The rich maritime resources are reflected in the name the Golden Horn, which was given to the place to mark its importance as a fishing ground.

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15 Başaran 2008, 11.
16 Souza et al. 2004, 96.
17 Crow 2008.
18 Croke 2005, 68.
19 Nicolle et al. 2007, 220.
One of the most important traits of Constantinople is its ability to survive as a major centre in this part of the Mediterranean and Black Sea through periods of trauma and social crises. The Greek colony was often plundered or in the possession of the Persians or Thracians, or involved in different conflicts between powerful factions throughout antiquity. The population of the city has since gone through periodic cycles of ‘boom and bust’ and its physical size has changed markedly over time. Yet it always seems to have had the ability to bounce back after crises. Using a theoretical framework combining the central concepts of ecosystem services and urban metabolism, this section and the following explore the reasons for Constantinople’s ability to persist, while at the same time acknowledging that the full range of possible reasons may be beyond our reach. The location of the city and its significance as an economic, religious and administrative centre made it a multifaceted and complex place. What we intend to focus on below is how people managed to support themselves with life-supporting ecosystem services during periods of extreme stress.

Theoretical framework: Metabolic flows of ecosystem services

Ecosystem services are the full range of flows society obtains from life-supporting ecosystems, including provisioning services (e.g. crops, drinking water, and fiber), regulating services (e.g. pollination, air- and water filtration), cultural services (e.g. spiritual enrichment, human health and aesthetic experiences), and supporting services (e.g. soil formation and biodiversity) which are necessary for the production of all other ecosystem services.

21 MA 2005.
22 Wolman 1965; Decker et al. 2000; Kennedy et al. 2007.
24 MA 2005.
Of the various ecosystem services, we will focus here on metabolic flows of crops and drinking water consumed by the inhabitants of Constantinople. In relation to the supply of crops, there is a range of complex and interlinked ecosystem services that regulate them; for instance generating and managing fertile soils, pollination, pest regulation and nutrient recycling, as well as the ability of people to retain and transmit knowledge related to these aspects. But crop production within the city is rarely sufficient to support its inhabitants. Thus a city needs to import food from additional territories (see Fig. 1). In order to secure the imports, food transport infrastructure and military protection are needed. The production and consumption of urban ecosystem services are dependent on such social-ecological networks of relations. Complexity theory shows that disruption in one part of such networks is likely to cause changes in other parts of the same network. Hence, a sustainable metabolic flow of desirable ecosystem services, such as crops, depends on the social-ecological system as a whole and its ability to cope with disturbance.

The concept of socio-economic metabolism has been developed in analogy to the biological notion of metabolism. It describes the physical exchange processes (i.e. material and energy flows) between human societies and their life-

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25 Millennium Ecosystem Assessment 2005; Barthel et al. 2010.
26 Norberg & Cummings 2008; Ernstson et al., in press.
supporting ecosystems as well as internal material and energy flows of human societies.29

There are a number of tools available for analysing the environmental and sustainability impacts of social activities.30 For studying the socio-economic metabolism, material flow analysis (MFA) and energy flow analysis are useful.31 For energy analysis, as well, there are a number of different approaches using different system boundaries and energy measures. For example, Energy Flow Accounting (EFA) has been developed to measure energy flows using the same system boundaries and concepts as MFA.32 Defining the ecological footprint is yet another method developed for analysing resources used by a city, with focus on required space.33 It measures the area used by a system, including the area that could be used for assimilating emissions.34

Economy-wide material flow analysis, of which ecosystem services are a part, studies the inputs and outputs of a society. Much of the work has focused on nations,35 and guidelines have been developed.36 Also other systems, such as cities, can be studied using material flow analysis.37

There are clear connections between material flow analysis and the ecosystem services discussed above. Material flow analysis includes some ecosystem services such as food and wood, but not others such as pollination of crops and water purification, although these are necessary for the production of the flows. On the other hand material flow analysis includes flows of abiotic materials such as metals and fossil fuels, which are not considered as ecosystem services although these flows can also be described as products from ecosystems if geological time scales are considered.

The material flow analysis defines a system with system boundaries and studies the flows across these boundaries. It is based on mass balance accounting and the basic formula is:

\[
\text{In} + \text{Produced} = \text{Out} + \text{Accumulated}
\]

Besides the flows across the system boundary this approach also takes production and accumulation within the system into account. The Domestic Material Consumption (DMC) is defined as domestically extracted materials plus imports minus exports.38 Examples of extracted materials are wood, agricultural products such as cereals and fodder for animals, and ores and minerals. Water is treated separately.39

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33 Folke et al. 1997; Collins et al. 2006.
34 Wackernagel & Rees 1996.
36 Eurostat 2009.
37 E.g. Barles, 2009; Kennedy et al. 2007.
Table 1. Characteristics of different socio-metabolic regimes.

<table>
<thead>
<tr>
<th>Regime</th>
<th>Total domestic material consumption (tons/capita and year)</th>
<th>Typical flows (tons/capita and year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunter-gatherer regime</td>
<td>1</td>
<td>Food and wood</td>
</tr>
<tr>
<td>Agrarian regime</td>
<td>4</td>
<td>Vegetarian food (0.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fodder (2.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wood (0.8)</td>
</tr>
<tr>
<td>City in the agrarian regime</td>
<td>3–4</td>
<td>Food (0.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wood (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ores (&lt;0.01)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Building materials (0.5–1)</td>
</tr>
<tr>
<td>Industrial regime</td>
<td>20</td>
<td>Biomass (5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fossil fuels (5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minerals, metals, etc (10)</td>
</tr>
</tbody>
</table>

Socio-ecological regimes represent society-nature interactions and are characterized by typical patterns of material and energy flows, called metabolic profiles, which suggests that the evolution of coupled socio-ecological systems can be characterized by a sequence of relatively stable configurations of socio-ecological eras of humanity and rapid transitions between such eras. This configuration aligns with the traditional macro-historical division into three eras: hunter-gatherers, agrarian societies, and industrial society. A further differentiation can be made concerning cities during agrarian time periods. The materials used by these different types of societies are described in Table 1.

The data in Table 1 should be regarded as indicative and they are based on a number of assumptions. For example, the data for an agrarian city is likely to differ in different regions. Here it is assumed that the city in the agrarian regime has very limited agriculture within the city. Building materials differ during the different regimes. In the industrial regime they consist mainly of minerals and metals but also wood. In the agrarian regime they are mostly wood and other organic materials. Obviously the amount of wood used would change depending on the availability of timber. Also the amount of building materials would change depending on whether it was a time of growth or decline, or if the city was located in a warm or cold climate. For a city in an agrarian regime during a decline, the inflow of building materials may be close to zero as materials could be recycled. The data in Table 1 for a city in the agrarian regime is based on data for an Austrian 18th-century city. For Constantinople these data may be significantly different and also variable during the history of the city. But at the same time, metabolic flows of historical Constantinople at any time would have been significantly different from flows during the industrial or hunter-gatherer regime. For more recent time periods it can be noted that the Domestic Material Consumption per capita is lower for a city than for a nation, illustrating the

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cities’ dependency on the surroundings for material inflows. Figure 1 is used to describe in a simplified way some of the material flows and dependencies for a non-agricultural population (i.e. people not engaged in agriculture) in a city in an agrarian society.

As indicated in Figure 1, the non-agricultural population needs food, wood and abiotic materials. For food, the non-agricultural population is dependent on the surplus that the agricultural population is willing or forced to deliver to the non-agricultural population. Depending on the size of the non-agricultural population, they can develop knowledge (including art), infrastructure and military power. The agricultural population can be close to the city or even within the city. Food can also come from additional territories. In order to acquire food from additional territories, military power is needed, either to force the population in the additional territories to deliver food, or to secure the transportation in the case of trade. Food production is dependent on the ecosystem services as described above. The system described in Figure 1 is open to disturbances. The ecosystem services may be disturbed by, for example, climate changes affecting the food production and thus the surplus that can be delivered to the non-agricultural population. Also, the military power may be disturbed by other military powers. If so, transportation of food from other areas will be disturbed, and this will affect urban consumption.

<table>
<thead>
<tr>
<th>Table 2 Selected model results for scenarios for transportation of food in an agrarian society.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Small city, normal productivity</strong></td>
</tr>
<tr>
<td>City population</td>
</tr>
<tr>
<td>Food export rate (%)</td>
</tr>
<tr>
<td>Total food demand in city (TJ/year)</td>
</tr>
<tr>
<td>Domestic material consumption (tons/year and capita)</td>
</tr>
<tr>
<td>Average transportation distance (km/haul)</td>
</tr>
<tr>
<td>Mass moved (ton km/year and capita)</td>
</tr>
<tr>
<td>Share of labour force (%)</td>
</tr>
<tr>
<td>Rural population</td>
</tr>
<tr>
<td>Rural population for feed for transportation</td>
</tr>
</tbody>
</table>

45 Barles 2009.
46 Krausmann et al. 2008.
Transportation is an essential aspect of urban metabolism and may be a significant limitation, as shown by Fischer-Kowalski et al. using a simple model for a city in an agrarian society.\textsuperscript{48} Their model included only food and land transport, for which animals were used. The latter in turn also need fodder, which has to be produced by the agrarian population. In the model by Fischer-Kowalski and colleagues, food for people is assumed to come from a circular hinterland and is transported to the city. Some of the results of their model for three assumed cities in an agricultural regime are presented in Table 2. These models represent a small city, a larger city with assumed normal agricultural productivity making an export rate of 11% feasible, and a larger city with a lower agricultural productivity (only 2% export rate).

Table 2 illustrates how the total food demand in the city increases with the population, but that the transport requirements of similarly sized cities depend on the food export rate from the surrounding territories. Although the material consumption increases only slightly, the transportation distances increase with increased city population and decreased productivity and thus the mass moved increases significantly. The share of the labour force in the city working with transportation also increases significantly, and the rural population required for supporting the city with food and transportation of food increases dramatically. The results for a larger city with a low agricultural productivity are hardly realistic. This indicates that, in order to have larger cities in an agricultural society, both a high agricultural productivity and efficient transportation are required. The latter can be obtained, for example, by keeping food production within the city. Examples can include city gardens and fishing. Sea transports can be efficient as well. However, they will also often require transportation to and from the ships, and naturally also food and materials for the ships.

The discussion in this section has illustrated that cities are dependent on ecosystem services and material flows in terms of food, crops and other products. The discussion on metabolism for cities during agrarian regimes illustrated that, in order to have large cities, both efficient agriculture and efficient transportation systems are required. In the next section we will discuss how this can be illustrated by the history of Constantinople. We will also illustrate how disturbances affected material flows and how Constantinople could manage despite these disturbances.

**Urban demography, changing economies and challenges**

The long-term demographic history of Constantinople represents a series of dramatic shifts. It is hardly surprising that a city with such a long history has experienced a number of turbulent periods. The variations in, for example, population and economy are nonetheless interesting as we can link them to general changes and crises in the Byzantine state and society. Despite all the changes, it has always remained the capital of the area and never been abandoned.

As mentioned above, the earliest town Byzantium was one of several former Greek colonies along the east Mediterranean coast that Constantine chose from

\textsuperscript{48} Fischer-Kowalski et al. 2004.
when establishing a new capital in AD 324. In the new role as capital the urban population most likely rose dramatically, and it has been estimated that in the late 4th century the inhabitants numbered more than 200 000. At the peak of the Byzantine Empire, before the Justinian plague in AD 542 sharply reduced population numbers by 40%, it totaled perhaps 500 000. In subsequent centuries the population varied considerably, characterized by boom and bust cycles. Around 750, after a severe 7th-century decline which included the loss of the Levantine and African provinces (see below), the population had spiraled down to around 40 000.49 The empire had a revival between the 9th and 12th centuries, with a strong increase in population. After the Crusades and the fall of Constantinople in 1204, the city and the empire never recovered to its former might. With the new Ottoman rulers in 1453, however, came a revival of the city.50 Population estimates for greater Istanbul in the 18th century vary between 400 000 and 1 000 000.51

In comparison with Rome, which reached a population of between 750 000 and 2 000 000 people in the two first centuries AD, Constantinople was significantly smaller. In the 4th century, when the Western Empire began to crumble, Rome still housed some 700 000–900 000 people.52 Constantinople was nevertheless still very large, and together with Alexandria it was one of the dominating cities in this part of the Mediterranean (and the Black Sea) region. Similarly to the situation in Rome, urban sustenance was dependent on the import of grain, primarily from Egypt and other parts of North Africa, as illustrated in Figure 1. In contrast to our own time in which the transport system, owing to the availability of fossil fuels, is considered almost faultless, the maintenance of food supplies to Constantinople was vulnerable to a series of different threats. The bulk trade had to be made by ship, and this was often difficult owing to the nature of the winds in the Eastern Mediterranean. The voyage to Egypt or North Africa was quite easy.53 However, catching winds for the voyage back north was much harder and the supply system was thus both irregular and insecure. In addition there was always a risk of low water levels in the Nile, which resulted in low productivity and famine in both Egypt and the regions it supplied with foodstuffs. This is an illustration of the dependency of ecosystem services and the possible disturbances of these as described in Figure 1.

A lack of grain support was thus dangerous for the economy of the empire and the welfare of the population, and was a cause for social unrest. The rulers realized these problems and tried to minimize them to some extent. One action was to build an additional harbour on the island of Tenedos (some 300 km from Constantinople) and ship the supplies into the city after having reloaded the cargo into smaller vessels.54

50 Mango 2002, 69.
51 Başaran 2007, 58.
52 Lançon 2001, 14.
In the 7th century the economic situation for the capital changed dramatically, and thereafter we encounter a different empire. The Avars from the Asian steppes invaded central Europe and in combination with Slavic-speaking tribes conquered several western provinces of the empire. In the East, a long war with the Sassanid Empire was followed by Muslim invasions in the eastern and southern parts of the Mediterranean. As a consequence, the empire lost huge tax and resource areas; it could no longer count on a regular inflow of foodstuffs from Egypt and other North African provinces. The role of these areas was to some degree equivalent to the life support to many countries today that comes from the grain production in, for example, USA and Canada. It is also illustrated in Figure 1 where the reduced military power made it impossible to secure food transports, thus threatening the non-agricultural population which subsequently shrunk. Constantinople never regained the Levantine and North African provinces. In the 12th century, it managed to supply a city with a population of about 400000 with large amounts of grain from Trache and Thessaly. In addition food was cultivated within the city walls. In this period there was no state-governed grain supply as before the 7th-century recession. The city in this period was divided into oikoi, or households, ranging in size and including those of the lesser nobility, the monasteries and the imperial palace. The oikoi, whether imperial institutions or private social groups, were consumers, but they were also exploiters of estates. The estates, some of which lay far away, were used to support the houses in the city, and an eventual surplus could be sold on the markets. The state seems to have controlled substantial parts of, for example, the land-owning system. The production of food, however, was to a high degree self-sufficient in the sense that the oikoi managed their own food supply and in some cases even maintained large stores of grain. The system was in short partly decentralized, but it may have been more efficient than the previous, state-governed grain supply.

In the decades after the loss of the African provinces in the 7th century, the population of Constantinople dropped, and the economy, urban structure and administration changed considerably. This process had already begun in the previous century, but now it accelerated. The loss of the provinces also had a number of potential consequences for the city besides the reduced inflow of foodstuffs and taxes. One example of a resource-rich area was the Eastern Desert of Egypt, which served as a vast mining area for metals, gem stones, and building materials. The Red Sea functioned as the seaborne gateway to the Indian Ocean. A loss of these areas entailed an economical backlash. And everyone in Constantinople involved in the trade, transport and logistic system, even the specialists working with the Egyptian gemstones, were affected.

From a metabolistic perspective it is interesting to note how the size of the population interacts with the transport distances, the logistic systems, phases of expansion and stagnation respectively, and the construction of labour-demanding objects such as monuments, palaces, churches, aqueducts and reservoirs, harbours and fortifications. The official monuments and fortifications of the city have been

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55 Haldon 1990.
56 Halweil 2007.
57 Magdalino 1995.
58 Haldon 1990.
well documented for a long time, thorough studies have recently been published on the water supplies, and new results are forthcoming from harbour excavations in the Yenikapi project. After the establishment of the city as a capital in the 4th century AD, the population increased, and the harbours were made larger and new ones were built. New city walls were built, and the city’s new status was eventually symbolized by such monuments as the Hippodrome and Hagia Sophia, see also Fig. 2.

This 4th to 6th century expansion phase included a web of construction projects dependent on economic trends and political stability. Some projects, such as the royal palaces, were perhaps motivated by an emperor’s personal ambition or a need to display the power of either the ruler himself or the empire. Investments in the infrastructure were on the other hand clearly made as a response to an increasing population, the demand for an increased inflow of resources, and the need to protect the city against a growing threat from enemies in both the east and the west.

In the mid-6th century, during the reign of Justinian, the East Roman Empire was at its peak. At this time the population of the capital reached its maximum. There is well-attested evidence for the location of official buildings, roads, harbours and major churches. More important for this study, however, is the overall settlement structure with the location of the residential areas. Unfortunately there seems to be comparatively little evidence to shed light on the location and density of the main residential sectors within the city walls. Since the 6th-century population was many times higher than that of the 15th century, we can assume a very different settlement structure from what is depicted in the earliest engravings of Buondelmonte and others. An important consequence is that the proportion of green space in the city during this period is unknown. We do not know the degree to which urban agriculture and gardening had to stand aside in favour of built-up areas. However, the broad belt of land between the Constantinian and Theodosian walls always seems

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60 Crow et al. 2008.
61 Kocabas 2008.
to have been comparatively sparsely populated compared to the eastern sector and the coastline. This was the primary area used for producing food.  

The grand empire of Justinian did not last very long as the military campaigns and huge investments in architectural ventures resulted in an overburdened economy and society. This became evident during the last years of the emperor’s reign. Plague and the semi-collapse of the empire left deep traces in Constantinople, and subsequent wars with neighbouring states challenged the power and identity of the city and the empire itself.

For Constantinople, the regression of the late 6th to 8th centuries had major consequences for the city and its inhabitants. Its population dropped quickly and the investments in monumental architecture were soon limited to the maintenance of many expensive but necessary constructions such as the aqueducts and city walls. Inhabitants involved in the transport of grain from Africa and other transports of goods no longer had the same role in society. Artisans could no longer be employed in major building projects, and people related to these persons such as family members, landlords, food suppliers, administrators and others were also affected. In addition to the economic changes, the city was under siege by the Avars and Sassanids in AD 626 followed by Arab sieges in 674 and 714. These were major challenges for transports of food to the city from surrounding regions. As one scholar has put it, “Dark Age Constantinople was ruin, its urban space invaded by orchards and cemeteries, its old public buildings abandoned or converted to artisanal activity.”

For the shrinking city the material flows could be reduced significantly. Building materials were recycled from constructions that no one bothered to maintain. There was therefore no need of a similarly complex transport system. Food imports were reduced as well. Transportation to the city could thus be decreased to a large extent, and there were fewer non-agricultural people needing support from the farming community. The decline in population was thus not only an economic recession, but also a response to a reduced need to feed a non-productive part of the population and to maintain and govern a huge transportation system. Still, even after these changes the city was very large compared to others around the Eastern Mediterranean and the Black Sea. There was still a need for significant amounts of resources to be imported to support the centre of the empire.

Constantinople in the 8th century was only a fragment of its former size. From now on the inhabitants seem to have lived in dispersed communities which were almost towns of their own within the city walls, separated by open areas and placed primarily along the major roads and the coast. Open spaces are found especially in the western part of the town, away from the official areas of the town and the harbour areas. After the turbulent 7th century, Constantinople had a significant proportion of green space, between clusters of settlements, all enclosed by huge defensive walls. A source-critical factor that should be considered is that apparently very few excavations of profane settlements in present-day Istanbul have been carried out. Accordingly we cannot satisfactorily relate the literary sources to the archaeological evidence.

Table 3 summarizes the demographic shifts, challenges, building constructions and transports during the history of Constantinople. Table 4 summarizes some attested periods of serious stress to the city.

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63 Koder 1995.
64 Mango 2002, 70.
### Table 3. Demographic shifts, challenges, building constructions and transports during the history of Constantinople, from the 4th to 14th centuries AD.

<table>
<thead>
<tr>
<th>Date</th>
<th>Population</th>
<th>Period</th>
<th>Scale of construction</th>
<th>Transports</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th century</td>
<td>200000</td>
<td>A new capital in growth</td>
<td>Large</td>
<td>Bulk trade ships</td>
</tr>
<tr>
<td>Early 6th</td>
<td>500000</td>
<td>The centre of the Roman Empire</td>
<td>Large</td>
<td>Bulk trade ships</td>
</tr>
<tr>
<td>Mid-6th</td>
<td>40000?</td>
<td>An empire under stress. African and Levantine provinces are lost</td>
<td>Only maintenance of existing monuments</td>
<td>Regression in size of ships, no state-organized bulk transports, mostly trade</td>
</tr>
<tr>
<td>9th century</td>
<td>200000</td>
<td>Expanding empire</td>
<td>Medium</td>
<td>A greater amount of land and coastal/river traffic compared to previous period</td>
</tr>
<tr>
<td>13th century</td>
<td></td>
<td>Conquered by the Venetians</td>
<td>Small</td>
<td></td>
</tr>
<tr>
<td>14th century</td>
<td>40000</td>
<td>Under constant siege</td>
<td>Small</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4. Some attested periods of sieges and serious stress to Constantinople (see also Nicolle et al. 2007, 6ff.).

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>542</td>
<td>The Justinian plague, up to 40% reduction of population</td>
</tr>
<tr>
<td>609</td>
<td>Usurper Nicetas takes control of Alexandria and probably the grain transports</td>
</tr>
<tr>
<td>619</td>
<td>The Sassanids take Egypt</td>
</tr>
<tr>
<td>626</td>
<td>The Avars and Sassanids besiege the town</td>
</tr>
<tr>
<td>642</td>
<td>The Arabs conquer Egypt</td>
</tr>
<tr>
<td>674–678</td>
<td>First Arab siege</td>
</tr>
<tr>
<td>714</td>
<td>Second Arab siege</td>
</tr>
<tr>
<td>813</td>
<td>Bulgar siege</td>
</tr>
<tr>
<td>860</td>
<td>Siege by the Rus</td>
</tr>
<tr>
<td>1047</td>
<td>Usurper LEO Tornices' besieging</td>
</tr>
<tr>
<td>1191</td>
<td>Seljuk-Petcheneg siege</td>
</tr>
<tr>
<td>1097</td>
<td>First Crusade threatens the city</td>
</tr>
<tr>
<td>1204</td>
<td>Fourth Crusade sacks the city</td>
</tr>
<tr>
<td>1261</td>
<td>City again under Byzantine control</td>
</tr>
<tr>
<td>1394–1402</td>
<td>Under siege by the Turks</td>
</tr>
<tr>
<td>1422</td>
<td>Second Turkish siege</td>
</tr>
<tr>
<td>1453</td>
<td>Besieged and conquered by Mehmet</td>
</tr>
</tbody>
</table>
The urban agricultural system in Constantinople

Earlier sections of this chapter have discussed the difficulties in feeding a large urban population. This would require both high agricultural productivity as well as efficient transportation systems. The latter in turn required a strong military power to secure transports, which would still be open to disturbances. In the brief historical account of Constantinople we also saw that the city was on a number of occasions under severe stress. Although this led to drastic reductions in population, the city managed to survive as a major centre and capital. How was it possible to feed the population when importing food was difficult or even impossible? One answer may be that the city could produce significant amounts of food within the urban settlement itself. This key aspect of Constantinople’s long-term resilience is further explored in this section.

Food production capacity

When discussing the ability of Constantinople to withstand times of crisis in the form of sieges or, more generally speaking, disrupted imports of foodstuffs, one is faced with the question of the city limits. What constitutes a city and how are its immediate and more distant hinterlands determined? Constantinople is perhaps a particularly difficult case as the supplies arrived partly via land routes and partly, and more importantly, by sea.

We have in this case decided to base the discussion on gardening in the city on an article by Koder, who discussed gardening in Constantinople, including a zone 2 km outside the great wall and areas just across the Bosphorus and the Golden Horn (Plate 2). Fundamental for the production of foodstuffs is access to water, labour, and areas to cultivate. The amount of plant or animal products that thereafter can be produced is related to the local possibilities and management of the land, to the willingness to make investments and to their profitability. As mentioned above, Constantinople has a temperate climate with regular rainfall and also a well-developed water supply system with aqueducts and reservoirs. Within and just outside the city walls, there were open areas that were used for cultivation and keeping livestock. Fish were plentiful in the Bosphorus, especially in the migration seasons.

Landowners and workers

The supply of foodstuffs was a complicated web involving different actors and various organizational structures, from household gardening and animal husbandry to the management of large parks and regular vineyards. Among actors, landowners and land users were key groups.

Turning to urban gardening within the walls of Constantinople and in a zone just outside these, the arable land, which consisted of gardens, fields and perhaps pasture, can be divided between at least four groups of owners:

65 Koder 1995.
1. The emperor and the nobility.
2. Monasteries.
3. Land owned by institutions or land-owning farmers.
4. Household gardens/plots managed by citizens of different groups.

Probably we can find all different kinds of land users whether they cultivated their own land or worked for an organization, the Church, or wealthy landowners. They could be everything from monks and garden-interested noblemen to laymen, land-owning farmers and kitchen gardeners. We can in this discussion also include people involved in the supply of fertilizer and livestock. Collectors of human waste and rubbish, as well as major horse stables and the pigs and other livestock suitable for towns, were all essential for supplying the gardens with fertilizer. The abundant supply of nutrients produced by the non-agrarian population in the town, as well as by their animals, at least potentially made the gardens of Constantinople very productive compared to rural villages.

A major proportion of the cultivated land in Constantinople was owned by the emperor and state, by the strong nobility, and by the monasteries.66 These categories of landowners probably owned most parts of the open spaces within the city walls, and thus regulated what could be cultivated. As Necipoğlu shows in a case study of the siege by Bayezid I (1392–1402) the arable lands within or just outside the city walls yielded high prices especially during periods of stress.67 This strongly speaks in favour of the assumption that church institutions and the wealthy nobility were the main owners of land, as they had better opportunities to buy out small landholders and maintain nearby farmlands to support their oikoi. In an age of no refrigerators, good farmlands close to the cities were probably of very high value. On the other hand there are indications that, for

66  Frankopan 2009.
example, the patriarch encouraged any person to cultivate as much soil as possible in times of stress. Through this “mechanism of sharing” landowners and institutions such as the Church gained in prestige at the same time as risks were more equitably shared among different social groups. In practice this meant that ordinary people could till and hold land, which reasonably would have increased the likelihood of their survival in the city. Research on community-based resource management has found similar examples of such sharing arrangements in various societies around the world. The common denominator seems to be that such sharing serves as an insurance mechanism and a support for the collective actions of communities.

Gardens and fields

An example of how the management of land for gardening might have been organized in Constantinople comes from a description of land owned by a monastery near Thessaloniki. The land holdings of the monastery outside the city were leased to and managed by a family of the nobility, who supplied the monastery with vegetables. The noble family in turn leased plots to private gardeners of civil society. The monastery also owned land in different villages, where plots were leased to individual families living in those areas. This description is evidence of a quite complex, but also varied, way of managing land, involving both large- and small-scale cultivators.

Throughout history the cultivation of land by the nobility has often been related to pleasure gardens and parks. In the Byzantine world, however, pleasure gardens seem to have been partially replaced by the functional vegetable gardens managed for household needs, often in the form of kitchen gardens. When this transformation occurred is uncertain, but it seems to be a post-Roman phenomenon that also can be seen in the medieval gardens of Western Europe as depicted in illuminated manuscripts. From the later Byzantine period of the 13th to 15th centuries there are detailed descriptions of Byzantine gardens, which coincide with troubled periods when rural areas were plundered by enemies of the city. The imperial gardens were intended to be beautiful installations, but with functional elements. A poem describes how a couple moves about in a garden filled with ornamental plants, apple, pear and citrus trees, as well as vineyards. Constantinides makes an important statement that the East Romans inherited the classical appreciation of gardens and that it was considered an honor to maintain small pleasure and/or kitchen gardens. This “management system” lasted at least until 1453 but seems also to have been maintained under Ottoman rule. There are records of a row of vegetable gardens, grape fields, orchards, and other cultivated lands during the 14th and 15th centuries. This is a time when the city was periodically under blockade by the Ottomans and food shortage was a constant threat. The ability to withstand a siege or a shortage of food for other reasons was dependent on interaction between the state/rulers and the inhabitants. It de-

69 Berkes & Folke 1998.
70 Ostrom 2008.
71 Constantinides 2002, 89–90.
72 Constantinides 2002, 87.
73 Constantinides 2002.
74 Constantinides 2001, 96.
pended on the administration’s ability to supply water and store grain, but there was also a need for self-sufficiency among the producers, in the form of gardens, urban crop production, and keeping livestock like pigs and poultry, inside as well as outside the city walls.

The productivity of above all gardening, livestock keeping and fishing is essential for our interpretations of how well the city could cope in times of stress. The eight-year long siege and blockade by Bayezid I at the end of the 14th century was one of the greatest challenges to the city as these actions succeeded in cutting off the city from both land and sea. According to Necipoğlu\textsuperscript{75} it was a grave situation for the inhabitants, and many people migrated or starved. Land and food prices rose dramatically and many people suffered from lack of sustenance. The affluent could buy expensive, smuggled food while the poor suffered severe hardships. Despite these difficulties the siege did not succeed; the city was not starved into submission as intended. One important factor seems to have been the cultivation of vegetables within the city walls. Koder\textsuperscript{76} argues that Constantinople was more or less self-sufficient of vegetables, even in periods with a population peak such as the early 6th and 12th centuries. Some proteins could probably also come from fish and livestock fit for urban conditions.\textsuperscript{77} People went hungry but were nonetheless able to stay alive, largely thanks to the food produced within and perhaps just outside the walls.

In the beginning of this section we noted that feeding a large city was difficult. Yet it seems that Constantinople was able to survive because it could produce significant amounts of food within the city limits. Within the city walls, or just outside, fertile land and adequate fertilizer were available for cultivation, and there was also a management system that could support the use and distribution of the land.

Conclusion

As noted above, Byzantium has long been considered as a weak follower of the classical Roman Empire. However, it showed a remarkable resilience in that it survived such a long time in spite of repeated warfare and power struggles over territory. The history of Constantinople is that of a city which in size and structure has changed markedly during thousands of years. The structure of the city in its early medieval heydays has in many respects a close resemblance to modern towns. It had a large population, and many of the inhabitants were involved in maintaining a complex administrative and transport system. Especially during its population peaks it was highly dependent on a very large catchment area for food and raw materials. This was a costly burden due to all the investments necessary to feed and support the city. But it was also essential for transforming it into a metropolis and powerful symbol. When the trade and supply routes were blocked, or the catchment area decreased, the situation was grave for the city and the empire. In its Byzantine periods, the city had two peaks in size and economic welfare as reflected in the building of public monuments and churches. One of these peaks was, of course, before the plague and the wars after Justinian. The

\textsuperscript{75} Koder 1995.
\textsuperscript{76} Koder 1995.
\textsuperscript{77} Dagron 1995.
other peak, beginning in the late 8th century, saw an increase in population and church construction which coincided with a territorial expansion of the supply area. A modern metropolis like Singapore does not necessarily dominate a large territory because the market economy and fossil fuel transports lessen the need for it. When the territory of Constantinople shrank, so, too, did its population (see the metabolism model above). Nevertheless the city managed to survive.

One important reason for this resilience was the military capacity to withstand aggression. The geographical conditions were favourable, but especially important for the survival of the city itself was the fact that land was reserved for food production inside the city walls. In times of siege, or other periods of stress when imports of food and other materials were interrupted, there were possibilities to produce alternative sources of food as a response mechanism to being besieged, which thus strengthened urban resilience to withstand societal perturbations.

This chapter has focused on the resilience of Constantinople by analysing metabolic flows of ecosystem services. We have used theories of social-ecological resilience when searching for sources of resilience. Our discussion contributes to the theory development based on institutional theory, the theory of collective action,\(^78\) and to social-ecological systems thinking with a focus on small-scale self-sufficient rural societies.\(^79\) However, small-scale self-sufficient rural societies make up only a minor portion of the world population. What is still largely lacking in social-ecological resilience theory is a treatment of cities in general and large urban agglomerations in particular. This includes the historical lessons that can be drawn from urban distant pasts with regard to sustaining ecosystem services in times of hardship and crisis, a point that we ignore today at our own peril.

References


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\(^78\) Ostrom 2008.


