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The Ecological Footprint of Mediterranean cities: Awareness creation and policy implications

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ABSTRACT

The Ecological Footprint is an accounting tool that has been used by resource managers and widely communicated to the public over the last 20 years. The National Footprint Accounts (NFA) are a system of national-level Ecological Footprint accounts that can be geographically scaled to derive Footprint values for major consumption categories at the household level for a given region, province, city or urban agglomeration. A number of city Footprint assessments have been undertaken during the last two decades. However, these studies have used different approaches, rendering comparability challenging. Here we present a top-down approach to consistently track the Ecological Footprint of 19 coastal cities in the Mediterranean region. Valletta, Athens, and Genoa are the cities with the highest per capita Ecological Footprint, ranging between 5.3 and 4.8 gha per person; Tirana, Alexandria and Antalya have the lowest Ecological Footprint, ranging between 2.1 and 2.7 gha per capita. Most cities' Footprints exceed that of their countries with the exception of Thessaloniki, Tel Aviv, Venice, Palermo and Naples. This analysis provides a macro-level indication of the overall resource demands by cities, their drivers and leverage point. The main Footprint drivers are food consumption, transportation and consumption of manufactured goods. Differences among cities' Ecological Footprint values are most likely driven by socio-economic factors, such as disposable income, infrastructure, and cultural habits. City level Footprint findings can be used to help design sustainability policies and positively reinforce collective public achievements so far.

1. Introduction

Decision makers currently face the challenge of navigating through a wealth of disparate information. As sustainability is primarily a trans-disciplinary issue, no single metric exists that is able to independently and solely address the full complexity of sustainability (Galli et al., 2012). Nonetheless, quantitatively assessing and monitoring individual sustainability dimensions (e.g., the environmental pillar) is feasible. This requires a systemic approach, capable of analyzing multiple human pressures through a consistent lens. With known limitations (e.g., Galli et al., 2016; Kitzes et al., 2009), Ecological Footprint Accounting (EFA) has been used as a first approximation of the overall human pressure on Earth's ecosystems (Galli 2015a; Lin et al., 2015; Wackernagel et al., 2014).

The Ecological Footprint (EF) is a biomass-based resource accounting tool, which aims to track human demand for, and nature's supply of, key resource provisioning and one critical regulating ecosystem service (Wackernagel et al., 1996; Galli et al., 2014). The main contribution of this accounting tool is in providing a benchmark to compare the demand humans place on the ecosystems and in its applicability at scales ranging from single products to the world as a whole (Kitzes et al., 2009). This in turn allows users to understand resource demand at local scales while gaining insights on how it relates back to the global sustainability challenge.

The most complete, robust, and consistent applications of the Ecological Footprint so far are national-scale assessments, which are known as National Footprint Accounts (NFAs) (Kitzes et al., 2009). NFAs are annually provided by Global Footprint Network for approximately 160 countries, as well as global totals, for a period of approximately 5 decades. The first systematic attempt at their calculation was performed in 1997 by Wackernagel and colleagues

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(Wackernagel et al., 1997) but only in 2003 Global Footprint Network initiated its National Footprint Accounts (NFAs) program.

Besides providing information on natural capital and ecosystem accounting (Lin et al., 2015; Wackernagel et al., 2014), these national-level accounts can be geographically scaled to derive the EF for major consumption categories at the household level for a given region, province, city or urban agglomeration. The regionally scaled EF has been particularly popular in countries such as Switzerland, Germany, USA, Canada and UK (e.g., Collins et al., 2015; Collins and Flynn, 2015; von Stokar et al., 2006. See also Bastianoni et al., 2013; Galli, 2015b, and Vale and Vale, 2013, for overviews of national Ecological Footprint applications).

The world population is foreseen to reach 9 billion by 2050, 67% of which is expected to live in urban areas (up from 46% in 2015) (FAOSTAT, 2016); at the same time, per capita income is also predicted to increase (FAO, 2009). Urbanization's direct impact results from obvious changes in land use (Angel et al., 2005), but indirect and interlinked impacts exist as well. For instance, climate change and urbanization are ultimately linked as suggested by the unprecedented role cities took at the 2015 Climate COP in Paris. The International Energy Agency (IEA) estimates that 71% of energy-related global greenhouse gases can be assigned to cities (Hoornweg et al., 2011), and this proportion is expected to reach 76% by 2030. These rapid changes imply an increase in resource consumption so that it is expected that food production will increase by 70% between 2005 and 2050 (FAO, 2009), and become more energy demanding due to the intensification of agricultural practices (Bi et al., 2011). Urbanization will also have indirect effects resulting from changes in consumption caused by increasing affluence (Myers and Kent, 2003).

By contrast, cities offer economic opportunities (e.g., employment) as they generate 80% of the world GDP (World Bank, 2015). Further, urban areas offer genuine occasions that influence many sectors simultaneously, known as sustainability multipliers (Wackernagel et al., 2006). For example, taxes imposed on vehicles, on a mileage basis, create direct and indirect benefits at different scales: they reduce congestion, improve air quality, and promote public health, reduce fossil fuel use, and create more employment in public transit. Urban areas also offer opportunities for an economy of scale due to the proximity of the many diverse activities (Moore et al., 2013; Rees, 1997). On the other side, the protection of resident's future well-being requires paying more attention to cities, because they depend on ecosystem services to sustain life, health, security, good social relation, and other important aspects of human well-being (Escobedo et al., 2011; Groenewegen et al., 2006; Cummins and Jackson 2001; Nowak et al., 1998). The loss of ecosystems and their services, also within cities, is likely to cause serious impact on several scales (Gómez-Baggethun and Barton, 2013). For instance, the increasing pressure to produce more food is a critical issue, mainly through the loss of bio-productive land because of urbanization and the impacts of climate change (Godfray and Charles, 2011).

While urbanization is among the major challenges of the next decades, sustainable planning and resource management in cities also represent an opportunity to favor a global sustainability transition (Pearson, 2013). As such, creating effective polices requires meaningful urban metrics based on a quantitative understanding of cities (Bettencourt et al., 2010).

The Mediterranean region has been facing an ecological deficit since the 1960s (Galli et al., 2015) and has witnessed an increased urbanization, especially in coastal areas where more than half of the Mediterranean population lives. The objective of this paper is thus to demonstrate that a top-down EF city analysis can effectively analyze, in a consistent and comparable manner, the resource demand of cities located across the Mediterranean (see Fig. 1), and shed light on these cities' contribution to the regional ecological deficit. A review of existing city-level Ecological Footprint applications is first provided in Section 2; Section 3 then lists the cities analyzed in this study and describes the top-down Footprint methodology used. Results are then presented (Section 4) and their policy implications discussed (Section 5) in light of policies currently in place in these cities. Section 6 provides the study's final conclusions.

2. Review of existing city's Ecological Footprint assessments

Under the adage "think globally, act locally", city level sustainability analyses have proliferated over the past decades (see Table 1). Several city networks have emerged, primarily focusing on efficient and renewable energy carriers (for post carbon cities) as well as climate resilience, recycling and resource management, and sustainable mobility. While the objectives and long term vision of these networks are clear, proper benchmarking and monitoring tools are yet to be identified. In an attempt to provide such tools, a number of city Footprint assessments have been performed since the late '1990s (see for instance Bastianoni et al., 2013; Collins and Flynn, 2015; Galli, 2015b) contributing to the spreading of this indicator. Such assessments had been primarily motivated by local administrators' and planners' interest in understanding the link between local consumption and global

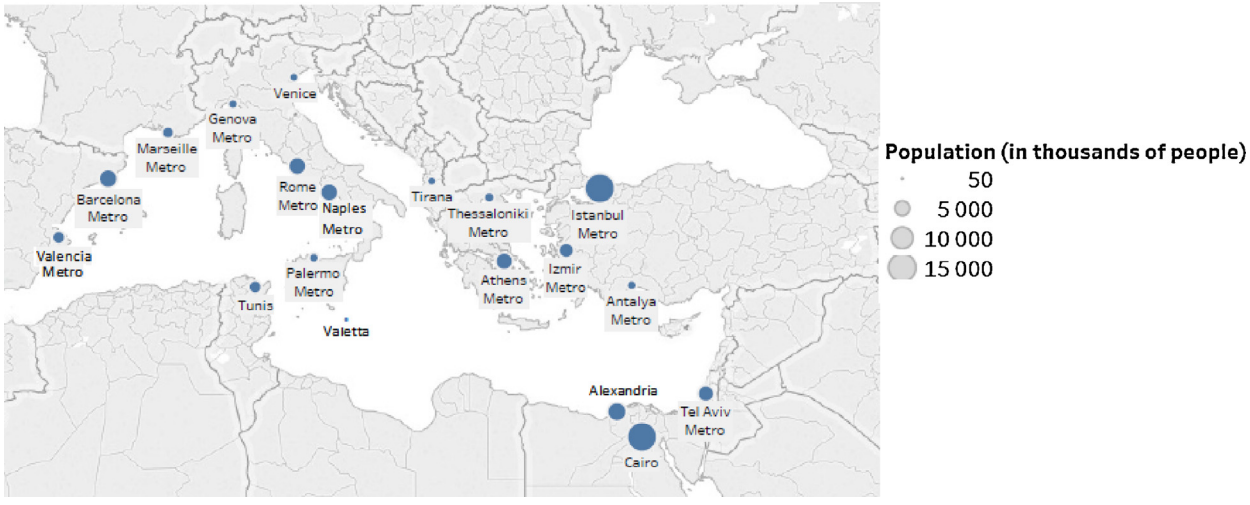

Fig. 1. Geographic location and total population of the Mediterranean cities analyzed in this study (2015 data).