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Sustainable food transition in Portugal: Assessing the Footprint of dietary choices and gaps in national and local food policies

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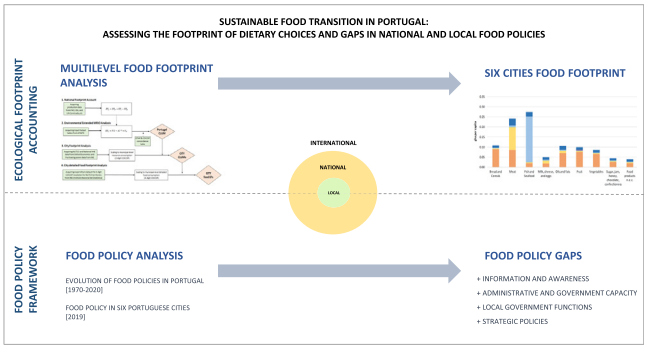
HIGHLIGHTS

- A replicable top-down Footprint approach is used for food sustainability assessment
- A policy framework is proposed to assess gaps in sustainable food policies
- Food sourcing, trade dependencies and dietary impacts are investigated
- National and urban food policies gaps are identified and discussed
- Sustainable food transition is weak although much needed in Portugal and globally

GRAPHICAL ABSTRACT



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ABSTRACT

The food system is increasingly acknowledged as the single largest reason for humans' transgression of key planetary limits and it is gaining centrality in our societal run-up towards a sustainable future, especially at city level. In Portugal, a country characterized by high meat and fish consumption, noticeable food wastage, and high urbanization level, fully understanding and then transforming the food system is of priority. Here we investigate the significance of food in comparison to other daily anthropogenic demands and the current sourcing and resource intensities profiles of dietary patterns at Portuguese national and city level through Ecological Footprint Accounting. A critical assessment of gaps in national and local food policies to trigger a major transformation in the Portuguese food system is also conducted on the basis of a newly proposed analytical framework.
Results show that food consumption in Portugal is the single largest reason (≈30%) for transgressing the carrying capacity of Earth ecosystems but, despite the urgent need for changes in Portuguese food systems, major deficiencies in local policy implementation exist with weak policy commitment, coordination, and lacking institutional capacity as food policies – especially at the local level – are still not prioritized. Similarities with other countries within Europe and their implications are also discussed.

1. Introduction

Humans have played, and continue to play, a key role in altering the biophysical dynamics of the planet, and the need is growing for unsustainable economic and social trends to be inverted (Barnosky et al., 2016; Davis et al., 2016; Steffen et al., 2018). Fundamental changes in

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the way societies produce and consume resources are seen as indispensable for achieving global sustainable development. Food has particularly gained a central role in our societal run-up towards a sustainable future as confirmed by the recent EAT-Lancet report (Willett et al., 2019) and some of the SDGs (i.e., SDG targets 2.4 and 12.3) set out in the UN 2030 Agenda for Sustainable Development (UN, 2015).

Throughout the 20th century, food demand has been largely met through increases in the yields of staple crops (i.e., wheat, maize, rice and soybean) (Runyan and Stehm, 2019), but the continuation of similar gains in yield is unlikely due to natural resources scarcity and increasingly frequent and intense climate-related events (Toreti et al., 2019). In addition, with nearly 11% of the world population suffering from chronic undernourishment and about two billion adults overweight or obese in 2016 (Barilla Center for Food and Nutrition (BCFN), 2016), unbalances in dietary patterns are evident. Adding to this the 1.3 billion tons of food wasted every year (El-Hage Scialabba, 2019) - roughly one third of the food produced in the world for human consumption - it appears likely that food security and sustainability cannot be a matter of sole improvements in production yields and food processing technologies.

As hotspots of the world population and the place of consumption for most (79%) of the food produced worldwide (FAO. Food and Agriculture Organization of the United Nations, 2019), cities will increasingly play a central role in food sustainability as they represent both a problem and an opportunity for sustainable food solutions, from both a physical and a financial viewpoint (Sonnino, 2016). Focusing on cities does not imply a sole focus on urban spaces but rather it concerns understanding the international trade systems as well as the national, regional and local production for rural-urban linkages. Focusing on cities provides the opportunity for (re)connections, (dis)locations and (in)justices to be reworked at city level via institutional and governance processes, and ultimately calls for the development of guidelines for sub-national and local governments to take actions towards sustainable food systems (FAO. Food and Agriculture Organization of the United Nations, 2019).

As such, this paper focuses on a country – Portugal – characterized by high meat and fish consumption, noticeable food wastage, and high urbanization levels, in order to accomplish two goals: 1) understand the significance of food Footprints and the sourcing and resource intensity profiles of dietary patterns, and 2) assess whether food policies are in place at national and local levels to transform food systems. We believe Portugal represents a critical country case to further explore national and local profiles and policies as it 1) is the Mediterranean country with the highest per capita food Footprint, 2) relies on the biocapacity of foreign countries to satisfy its residents' demand for food (Galli et al., 2017), 3) produces about 1 million tons of food waste per year (Batista et al., 2012), and 4) has 62% of its population primarily settled in coastal urban areas (DGT (Direção-Geral do Território), 2016b).

To address the first goal, this paper uses an increasingly popular and easy-to-communicate resource accounting tool – the Ecological Footprint (Lin et al., 2018; Galli et al., 2014) – to assess the role food consumption plays in the sustainability challenge at Portuguese national and city levels. Six pilot municipalities – Almada, Bragança, Castelo Branco, Guimarães, Lagoa and Vila Nova de Gaia – were selected as case studies since those cities have recently joined forces in an innovative project of the Ecological Footprint of Portuguese Municipalities (Galli et al., 2020) to support city governance in guiding their transition towards environmental sustainability.

To accomplish the second goal of the paper, a new policy framework has been developed to assess local food system policies and to understand critical policy gaps, relevant to enforce sustainable pathways. This framework builds on recent studies (Willett et al., 2019; Sonnino, 2016) and contributes to the literature by systematizing key policy dimensions and key interventions for sustainable food systems that can be applied in other contexts and studies. An assessment of Portuguese national and local policies actually in place in these six cities is made using this framework. Results are then presented and discussed to provide evidence of relevant gaps in national policy transition and local policy implementation. Our ultimate goal is to contribute to identify the policy tools best equipped to guide sustainable food transitions and trigger a major transformations in dietary habits in a country like Portugal, at national and city levels, as well as to highlight the need for further comparative research on an urgent global transition as the one necessary in the food system.

2. Methods

2.1. Ecological footprint basics

Introduced by Mathis Wackernagel and William Rees in the early 1990s, Ecological Footprint Accounting (EFA) offers a way to measure the resource dimension of the human socio-economic development by comparing the demand humans place on the ecological assets (i.e., biologically productive land and marine areas) of the Earth with the availability and productivity of such assets (Wackernagel et al., 2002; Borucke et al., 2013). Ecological assets tracked by EFA include (Galli et al., 2014): cropland for the provision of plant-based food and fiber products; grazing land and cropland for animal products; fishing grounds (marine and inland) for fish products; forests for timber and other forest products as well as for climate regulation via CO_2 sequestration; and built-up surfaces for the provision of shelter and other urban infrastructures.

EFA can be applied at various scales – from a single product to an individual, from a city to a nation, and to humanity as a whole – to give insight on the above by means of two indicators: Ecological Footprint – the demand side of the accounting tool – and biocapacity – the supply side of the equation. To ensure results are comparable, both metrics are expressed in area-equivalent units called global hectares (gha) (Galli, 2015).

Depending on the scale of application, EFA can adopt either a top-down (compound) or bottom-up (component) approach (Moore et al., 2013; Baabou et al., 2017). For a given geographical scale (e.g., a city), the compound approach calculates the Ecological Footprint using aggregated national statistics on resource and service flows (e.g., data on the total national production, import and export of food, fibers, commodities, etc., thus tracking both direct and indirect flows) and eventually allocating to the level being analyzed the share of the national total it is responsible for; conversely, the component approach calculates the Ecological Footprint by first identifying all the resource and service flows directly and indirectly consumed at that geographical scale (e.g., the amount of food, fibers, commodities and the alike consumed by the residents of the city) and then adding-up their individual Footprint values. The first approach is most commonly used for EFA assessments at global and national scale (Baabou et al., 2017; Kitzes et al., 2009), while the latter is preferred in product- or company-level assessments, being it data-intensive and prone to truncation errors (Lenzen, 2000) in the tracking of indirect flows.

2.2. Ecological footprint of products

For each resource or service flow, both of the above approaches use the same rationale in converting any physical flow f (demanded by humans or provided by the Biosphere) into the area of ecological assets needed for its production (EFf) as reported in eq. 1 (Bastianoni et al., 2013):

$$EF_f = \sum_{j=1}^{6} \sum_{i=1}^{n} \frac{T_i}{Y_{w,i}} \times EQF_j \quad (1)$$

Where:

- i refers to the n-input needed to produce the flow f throughout its production chain;

- *j* refers to the six different types of ecological assets tracked by EFA;
- EQF*j* is the equivalence factor of the j-th asset/land type; EQFs captures the difference between the productivity of a given asset/land-type and the world-average productivity of all biologically productive assets/land-types (Galli, 2015).

Different types of *f* flows enter the human economy and can be tracked via EFA (Borucke et al., 2013). At the national level, they range from food and fibers – including both prime natural products such as wheat, tomato and rice, and human-processed derived product such as bread, milk, dairy, meat-products and the alike – to goods and services, also including fossil fuels and electricity whose use (for transportation, heating or food processing purposes, for instance) causes the release of CO_2 in the atmosphere and place a demand on the carbon sequestration capacity of ecosystems (Mancini et al., 2018a; Mancini et al., 2016).

Several studies have been published in the last ten years dealing with Ecological Footprint assessments at product-level, although only few have focused on agricultural, wine, and seafood products (see 25, 28 for an overview of applications). Within its National Footprint Accounts (Lin et al., 2018) and related datasets, Global Footprint Network maintains a library of Ecological Footprint intensities – coefficients indicating the amount of global hectares necessary to produce a unit (i.e., a kg) of product (Kitzes et al., 2009) and make it available to final consumers – for approximately 400 primary and derived agricultural products, 150 animal and dairy products, and nearly 1500 seafood products. Footprint intensities thus indicate the amount of global hectares needed to produce (primary Footprint intensities) and process (processing Footprint intensities) a unit (usually a kg) of product. Recent studies (Galli et al., 2017) have then provided product- and dietary-level Footprint intensities in gha per kcal (see Table 1) as well as Footprint intensities of trading foodstuff (Mancini et al., 2018b).

2.3. Ecological footprint of territorial units: national vs. city level

Ecological Footprint assessments for Portugal and the six municipalities investigated in this study have been performed by using the top-down (compound) approach; while in both cases results refer to the Ecological Footprint of final net consumption activities, differences exist in the deployment of this approach at the two geographical scales.

For Portugal, an input-output-based modification (Weinzettel et al., 2014) of the standard methodology used for the National Footprint Accounts was applied to assess the Ecological Footprint of the country for the year 2014. The traditional approach (Lin et al., 2018; Borucke et al., 2013) uses physical statistics on production and trade to derive consumption Ecological Footprint values of the country by first tracking the ecological assets appropriated by national production activities (EF_P) – calculated via the compound deployment of eq.1 – and then adding the Ecological Footprint embedded in imported goods (EF_I) and subtracting that embedded in exported goods (EF_E). However, the modified version applied in this paper uses the standard methodology and physical input data to calculate the Ecological Footprint of national production activities (EF_P) but then derives national Ecological Footprint of consumption (EF_C) values by using monetary trade flows to estimate the Footprint embedded in global trade flows (Weinzettel et al., 2014). This is achieved through an Ecological Footprint extended Multi-Regional Input-Output model (EF-MRIO) model as per eq. 2:

$$EF_C = F(I-A)^{-1} \times Y_N \quad (2)$$

Where:

- *F* is the environmental extension matrix (direct EF_P of sectors normalized per unit of sector output, which is expressed in gha $\$^{-1}$) derived from the initial allocation of EF_P for the 6 assets/land-types (crop-, grazing-, forest-, built-up and carbon-sequestration land as well fishing grounds) to each of the 57 producing economic sectors identified by GTAP 8 (Galli et al., 2017);
- Y_N is the country total final demand for goods, expressed in $;
- *I* is the identity matrix (a matrix of zeros for 57 columns and rows with diagonal consisting of one's);
- *A* is the technical coefficients matrix (representing the Leontief inverse), which reflects the monetary exchange between each sector to produce one currency unit worth of output from a specific sector of the economy.

Table 1
Ecological Footprint intensities (expressed in gha kg^{-1}) of the most consumed food products in Portugal. Source: National Footprint and biocapacity accounts (NFAs) 2019 edition (Lin et al., 2018).

FOOD MACRO-CATEGORIES	FOOD PRODUCTS SELECTED	Primary Footprint Intensity	Processing Footprint Intensity
		[gha kg-1]	[gha kg-1]
Cereal, cereals product	Rice paddy (rice)	8.95E-04	1.39E-04
	Pasta	1.09E-03	2.44E-04
	Bread	9.51E-04	5.62E-04
Meat, fish and eggs	Beef	2.96E-02	9.93E-04
	Pork	2.30E-03	6.82E-04
	Poultry	1.82E-03	5.29E-04
	Lamb, Goat	5.62E-03	5.86E-04
	Cold cuts	2.30E-03	6.82E-04
	Sea bream	6.63E-03	1.16E-03
	Tuna	5.40E-02	1.16E-03
	Swordfish	5.40E-02	1.16E-03
	Lobster	4.79E-03	1.16E-03
	Salmon	4.67E-03	1.16E-03
	Prawns	1.87E-03	1.12E-03
	Oysters	3.32E-03	1.12E-03
	Mussels	8.37E-03	1.12E-03
	Mackerel	7.95E-03	1.16E-03
	Cod	4.53E-02	1.16E-03
	Sole	2.89E-03	1.16E-03
	Octopus	4.76E-03	1.16E-03
	Sardines	1.72E-03	1.16E-03
	Cuttlefish	1.68E-02	1.12E-03
	Eggs	1.12E-03	3.75E-04
Dairy	Cheese	3.99E-03	6.50E-04
	Milk	5.60E-04	9.06E-05
	Yoghurt	7.00E-04	9.14E-04
	Butter	1.02E-02	1.32E-03
Fruits, vegetables and legumes	Vegetables	1.39E-04	5.03E-04
	Fruits	1.63E-04	1.48E-04
	Legumes	4.37E-04	1.48E-04
Fats and oils	Olive oil	7.50E-03	4.18E-04
	Nuts	1.83E-03	3.18E-04
Sweets cakes and biscuits	Other pastries	9.51E-04	5.85E-04

A global MRIO model is used to calculate the Ecological Footprint of trade flows among 57 economic sectors of 140 regions of the world and yield consumption Footprint results for Portugal. As the EF-MRIO model calculates the resource requirements of each sector in the economy of Portugal – including both food-related and food-unrelated sectors (Galli et al., 2017) – household resource requirements are then allocated to categories of individual consumption according purpose, namely COICOP (United Nations (UN), 2018). The allocation is derived by means of a household-to-sectors concordance table (Wiedmann et al., 2006) in combination with consumer expenditure by COICOP category.

We thus refer to the Ecological Footprint of Portuguese household's food consumption (i.e., the resource provisioning and the regulatory services demanded to provide households with the food they consume) as the country's food Footprint. This includes both the direct and indirect demand by Portuguese residents for the cropland (directly to produce food crops and indirectly to produce livestock feed crops), grazing land (to produce meat), and fishing ground (directly to produce seafood products and indirectly to produce livestock feed) Footprint components and their

indirect demands for the carbon (from CO_2 released due to food production/cultivation and trade) and built-up (land occupied by food industries) components of the Ecological Footprint.

For each of the six municipalities – Almada, Bragança, Castelo Branco, Guimarães, Lagoa and Vila Nova de Gaia – a slightly modified version of the top-down (compound) approach introduced in Baabou et al. (Baabou et al., 2017) for Mediterranean cities is used. This approach starts from the EF-MRIO results for Portugal for the year 2014, broken down by COICOP categories, and then derives city level Footprint results for the same year by means of estimated household expenditure survey data (see Table S1 in the Supplementary Online Material). This latter data is derived (Galli et al., 2020) by means of expenditure data at the NUTS III level provided at 2-digit resolution by Oxford Economics (Oxford Economics, 2014) as well as per capita purchasing power data at municipal level drawn from the Portuguese National Statistical Institute (Instituto Nacional de Estatistica (INE), 2017a). Footprint results for the COICOP macro-category *CP011.Food* are then broken down to COICOP sub-categories (4-digit resolution) as described below (see also Fig. 1).

2.4. Detailed municipality food footprint assessment

Due to the lack of household expenditure data for *CP011.Food*-related COICOP sub-categories in the Oxford Economics dataset (Oxford Economics, 2014), expenditure data at the 4-digit COICOP resolution for NUTS II territories (see Table S2 in the Supplementary Online Material) was obtained from the National Statistical Institute of Portugal (Instituto Nacional de Estatistica (INE), 2017b). To ensure consistency between the food value in municipality CLUMs (Consumption-Land Use-Matrices) and the detailed food EF analysis, food consumption patterns in each municipality was first assumed to be similar to that of the NUTS II region in which the municipality is located; food Footprint values at the 4-digit level were then calculated by multiplying the overall food Footprint value for that city's CLUM by the ratio between EF for food sub-category and total food EF at the NUTS III level. This latter, was calculated using the 2014 Portugal CLUM as the base year and following the above methodology; to limit the assumptions in the assessment, detailed municipal food Footprint results were provided for the sole year 2014.

2.5. Policy gap analysis: analytical framework and data collection

To conduct the policy gap analysis at the local level in Portugal, a new policy framework was developed building on recent literature on food policies (Willett et al., 2019; FAO. Food and Agriculture Organization of the United Nations, 2019; Sonnino, 2016). This analytical framework was organized in four key policy dimensions, particularly in a context of multi-level governance, and their main priority policy areas, which are deemed fundamental for reversing unsustainable food systems:

1. *Information and Awareness*: within this dimension we investigated the existence of tools to favor awareness of food consumption and production patterns, as well as the availability of robust data and indicators frameworks enabling city administrations to build the necessary evidence to design, implement and measure the impact of their initiatives, monitor progress towards set targets and adjust priorities and interventions accordingly. Awareness and education campaigns and participatory food governance, as well as the inclusion of new food system actors in the urban governance arena (Sonnino, 2016) are also considered fundamental.
2. *Administrative and government capacity*: within this dimension, we assessed the presence of adequate human resources (i.e., equipped with proper skills and a system thinking (Sonnino, 2016) approach), organizational autonomy, trans-departmental structures or coordination mechanisms, as well as mechanisms or structures to enable collaboration among various levels of government, for strengthening the capacity to enforce sustainable food policies.
3. *Local government functions*: this dimension investigated the integration of food in territorial planning to promote effective land use for all phases of the food system (production, postharvest handling, storage, processing, transformation, marketing and distribution, consumption and organic waste management), as well as the presence of urban and rural areas linkages (Sonnino, 2016), of policies promoting learning with trans-local collaboration (Sonnino, 2016), and of mechanisms that enforce coordination with governance stakeholders (Willett et al., 2019) (e.g., their inclusion in the food system planning and implementation, particularly the private sector and community representatives), paying special attention to the participation of the most vulnerable stakeholders.

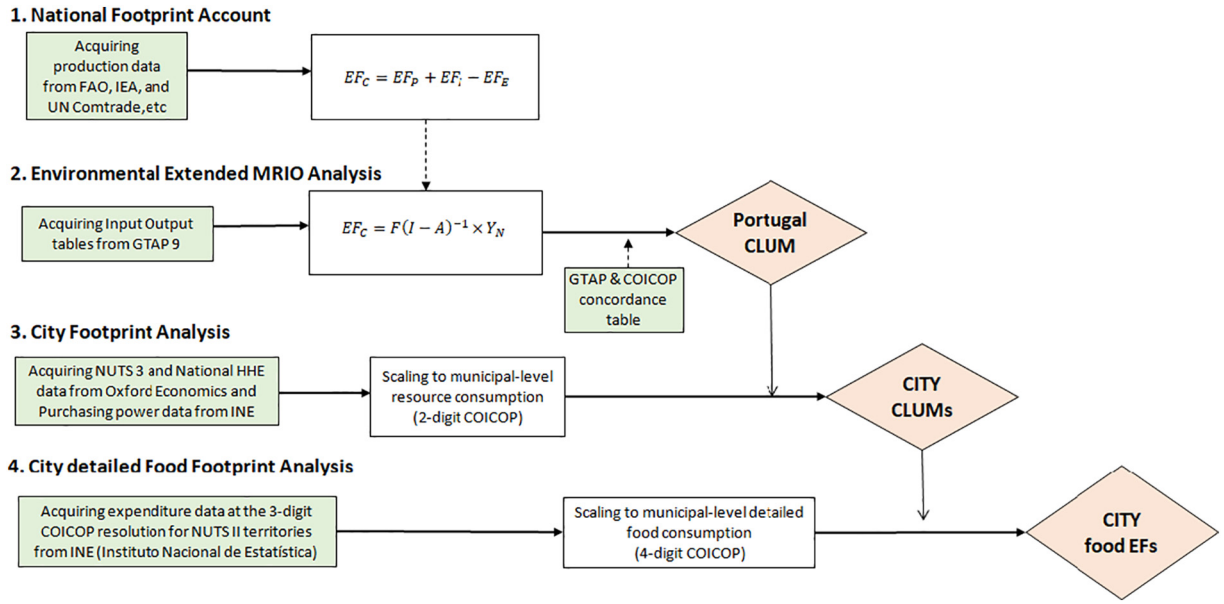

Fig. 1. Ecological Footprint of Portuguese cities: visual calculation flowchart.

4. *Strategic Policies*: within this dimension, we investigated the existence of a strong political commitment to shift towards healthy and sustainable diets (Willett et al., 2019), supported by strategies to re-orient agricultural production priorities and foster agri-food innovation as well as to promote the sustainable intensification of food production (Willett et al., 2019), food waste reduction plans, and incentives for a farmers-citizen reconnection to promote shorter food supply chains.

To collect data needed to apply this policy framework to Portugal and conduct a policy gap analysis at the local level, a survey was õdistributed to local government officers in the municipalities of Almada, Bragança, Castelo Branco, Guimarães, Lagoa, and Vila Nova de Gaia in November 2019. The survey was structured with 14 open questions aimed at identifying municipal policies, programs and initiatives regarding food sustainability on the four above-mentioned dimensions.

As survey responses were not provided by the municipalities of Almada and Lagoa, information on these two municipalities was collected through an online search on publicly available information at the website of those municipalities. At the national level, we collected official documents, scientific papers and performed an extensive online search to identify the national food system context (policies, strategies and initiatives). Existing international city networks and initiatives were also reviewed to place Portuguese findings in a wider context.

2.6. Limitation of the analysis

Over the past decades, numerous studies have applied and critically reviewed EFA (see 25, 28). While the communication value of this indicator has been widely acknowledged, EFA remains subject to methodological criticisms and ongoing debates on its policy usefulness (Galli, 2015). In measuring whether human societies are able to live within the overall ecological budget of the planet, EFA adopts a crosscutting approach (Lin et al., 2018; Galli et al., 2014), whose use implies trade-offs between scope and resolution: jointly assessing the impact of multiple pressures that are usually evaluated independently (climate change, food consumption, land use and appropriation, fisheries production and consumption, trade, etc) leads to a decreasing resolution in the EFA capacity to deal with each one of these pressures (Kitzes et al., 2009); for instance, while EFA tracks human pressure on ecosystems, it is unable to capture the consequences on the health of ecosystems of an eventual excessive pressure (Galli et al., 2016), such as for instance soil degradation due to unsustainable agricultural production practices. Several other limitations have been identified in the scientific literature and a comprehensive synthesis of criticisms and supporting views can be found in 36.

As such, EFA cannot be considered an omni-comprehensive indicator and it should therefore be complemented with other indicators (Galli et al., 2014; Galli et al., 2016) to arrive at a comprehensive sustainability assessment (Borucke et al., 2013). Nonetheless, EFA results provide their greatest utility when interpreted with a systemic, rather than reductionist perspective, and EFA main value added is to provide macro-level guidance (i.e., the big picture), and assist in the *early warning* and *headline and issue framing* steps of the policy formulation cycle (Galli, 2015). The analysis in this study can thus help Portuguese policy makers understand the main drivers of unsustainability of the Portuguese population and prioritize intervention areas. Other indicators are then needed to complement this analysis and identify the best policies and actions within these priority areas. To this end, the use of local urban metabolism data and of a bottom-up approach (Baabou et al., 2017), although data intensive, would increase the local representativeness and accuracy of the results.

The conducted survey and the proposed policy framework could have been supported by an in-depth study through interviews and document analysis of specific policies to enrich the database. Nevertheless, the close informal contacts with the six municipalities from 2018 to 2020, within the mentioned project of the Ecological Footprint of Portuguese Municipalities (Galli et al., 2020), allowed us to have a deep knowledge on the policy context of those municipalities. Limitations to expand results to the whole Portuguese local context could be overcome with the application of a similar survey to all the 308 municipalities.

3. Results

3.1. Household resource consumption demand in Portugal

In 2014, an average Portuguese resident demanded the equivalent of 3.69 global hectares (gha cap^{-1}) worth of natural resources and ecological services – aka Ecological Footprint – to sustain its lifestyle and overall consumption pattern, despite a national resource availability – aka biocapacity – of just 1.28 gha per capita (Galli et al., 2020); the Ecological Footprint (EF) of city residents ranged from 3.12 gha cap^{-1} in the city of Lagoa to 3.84 gha^{-1} in the city of Almada thus showing differences among the different territories, with higher Ecological Footprints found in those cities with higher income levels and spending power. According to Galli et al. (2020) and similar to the national situation, all six municipalities operated in a biocapacity deficit situation in 2014 and food consumption was found to be the main driver of the Ecological Footprint of Portuguese households at both national and city level (see Fig. 2), thus calling for a detailed food analysis. For each city, results were broken down into the main consumption categories, plus Government and Gross Fixed Capital Formation, according to the COICOP 2-digit classification. Results show the land appropriation due to the direct activities of households, businesses and the government.

At national level, consumption of *Food and non-alcoholic beverages* contributed 29% of the total EF (equivalent to 1.08 gha cap^{-1}), followed by personal transportation (20%) and housing (10%). Similar trends were found in the six cities: food consumption ranged from 27% of the total city's EF in Lagoa to 33% in Bragança; transportation varied between 19% of the total EF in Lagoa and 23% in Castelo Branco, and housing ranged from 8% in Guimarães to 10% in Lagoa. Looking at actual values, Lagoa had the lowest food Footprint (0.84 gha cap^{-1}), while the highest (1.25 gha cap^{-1}) was observed in Bragança.

The high Footprint values associated with the consumption of food and non-alcoholic beverages were found to be due to a series of factors. First, according to the FAOSTAT database (FAO, 2015), average apparent food consumption in Portugal in 2013 – the latest year for which data is available – was 3′472 kcal per capita per day (see Table S3 in the Supplementary Online Material), thus about 39% higher than the daily FAO-recommended dietary energy requirement of 2′500 kcal per person (FAO et al., 1985; Pimentel and Pimentel, 2003). Although individual energy requirements depend on factors such as gender, age, and level of physical activity, the average benchmark value provided by FAO is considered here to be a good first approximation of a balanced national-average requirement, thus possibly indicating that more calories than are necessary end up on Portuguese households. However, data on food supply available for human consumption from the FAO food balance sheets (FAO, 2015) differs from the national average intake data provided by the National Food Inquiry (IAN-AF) of 1′910 kcal per capita per day (Lopes et al., 2017a) (see also Table S4 in the Supplementary Online Material). Such difference is likely due to exclusion by the IAN-AF of the kcal fed to livestock, used for seed, processed for food and non-food uses, and most importantly lost during storage and transportation, and wasted at home (Galli et al., 2017): national food waste amounts to approximately 1 million tons per year, which is equivalent to about 17% of all food produced in the country for human consumption (Batista et al., 2012).

Second, dietary choices within Portugal are unbalanced towards a high consumption of animal-based proteins, particularly high trophic level fishes such as *Atlantic cod* and *Skipjack tuna* (Almeida et al., 2015)

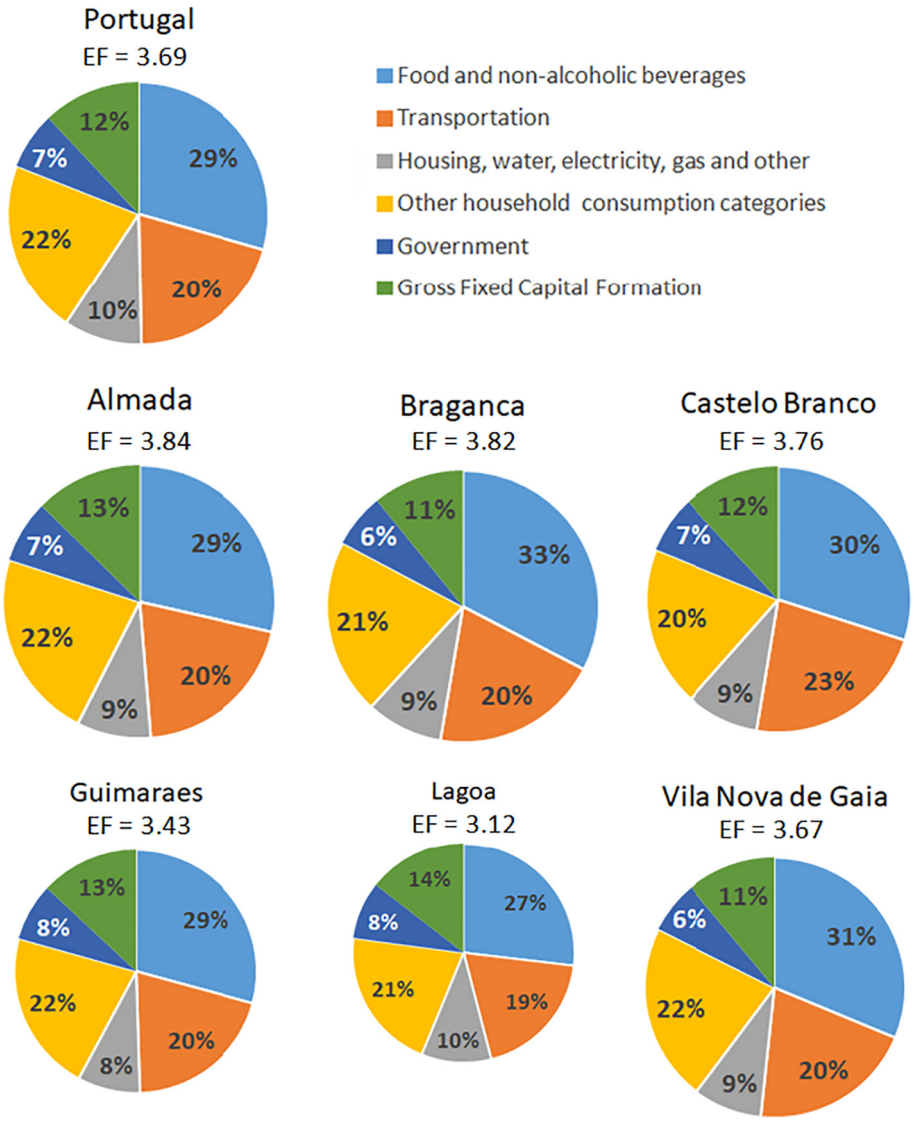

Fig. 2. Ecological Footprint results for Portugal and the six cities under study (gha per capita), in 2014. NOTE: The size of each pie is scaled according to the overall Footprint of the corresponding city compared to the national average value.

and red meat as shown in Fig. 3. This is consistent with findings from (Guillen et al., 2019) according to which Portugal ranks as the EU's top and the world's third highest consumer of seafood, with around 61.7 kg per person in 2017. Such high seafood consumption is related to culture, tradition, governmental fish campaigns, and big efforts from distributors and religion (Madsen and Chkoniya, 2019). Consumption of dried salted codfish, in particular, has profound roots in the food habits of the Portuguese population "being perhaps the most marking component of the Portuguese cuisine, achieving the level of national dish and a food category of its own" (Madsen and Chkoniya, 2019). Nonetheless, seafood and meat products place a great pressure on the planet's ecological assets as the production of 1 unit (e.g., a kg) of them requires more land displacement and CO_2 emissions (i.e., higher Footprint intensities) than that of low trophic level fishes, poultry, vegetables, cereals and dairies (Clune et al., 2017; Kim et al., 2019) (see also Table 1).

Consumption of "*fish and seafood*" contributes to approximately 26% of the total food Footprint at national level and in the six cities, while consumption of "*meat*" ranges from 23% of the total food Footprint in Almada to 28% in Bragança, Guimarães and Vila Nova de Gaia. The lowest share of meat Footprint (23% of the total compared to the national average of 25%) in Almada – a coastal city close to the capital and characterized by one of the highest income level within the country – is likely explained by the fact that although urban dwellers tend to consume more food, wealthier and highly educated urban residents prefer diets reduced in fat and rich in fruits and vegetables, and tend to produce less food waste (Kearney, 2019; De Irala-Estévez et al., 2000; Song et al., 2015).

Third, in line with previous studies on the external resource dependency (Galli et al., 2015) and food sourcing profiles (Galli et al., 2017) of Mediterranean countries, food consumption in Portugal significantly depends on production activities outside the national boundaries as reported in Table 2. Dietary choices in Portugal cause noticeable land displacements – appropriation of the biocapacity of ecosystems outside the national borders – across world regions, as relevant shares of the Portuguese food Footprint is placed outside Portugal for most of the food categories: the highest dependence on abroad biocapacity is observed for *Bread and Cereals* (86.1%), followed by *Sugar, jam, honey, chocolate, confectionery* (78.4%), *Oils and fats* (72.4%), *Vegetables* (66.5%) and *Fruits* (66.4%). *Fish and Seafood* represents the single highest import of biocapacity from abroad with about 1.6 million gha worth of biocapacity being imported (about 60% of the Footprint of *Fish and Seafood*). Overall, the Portuguese food Footprint is primarily placed on ecosystems in Spain – as this country tops the list of Portugal's main biocapacity trade partners for all food categories – France (for import of *Bread and*

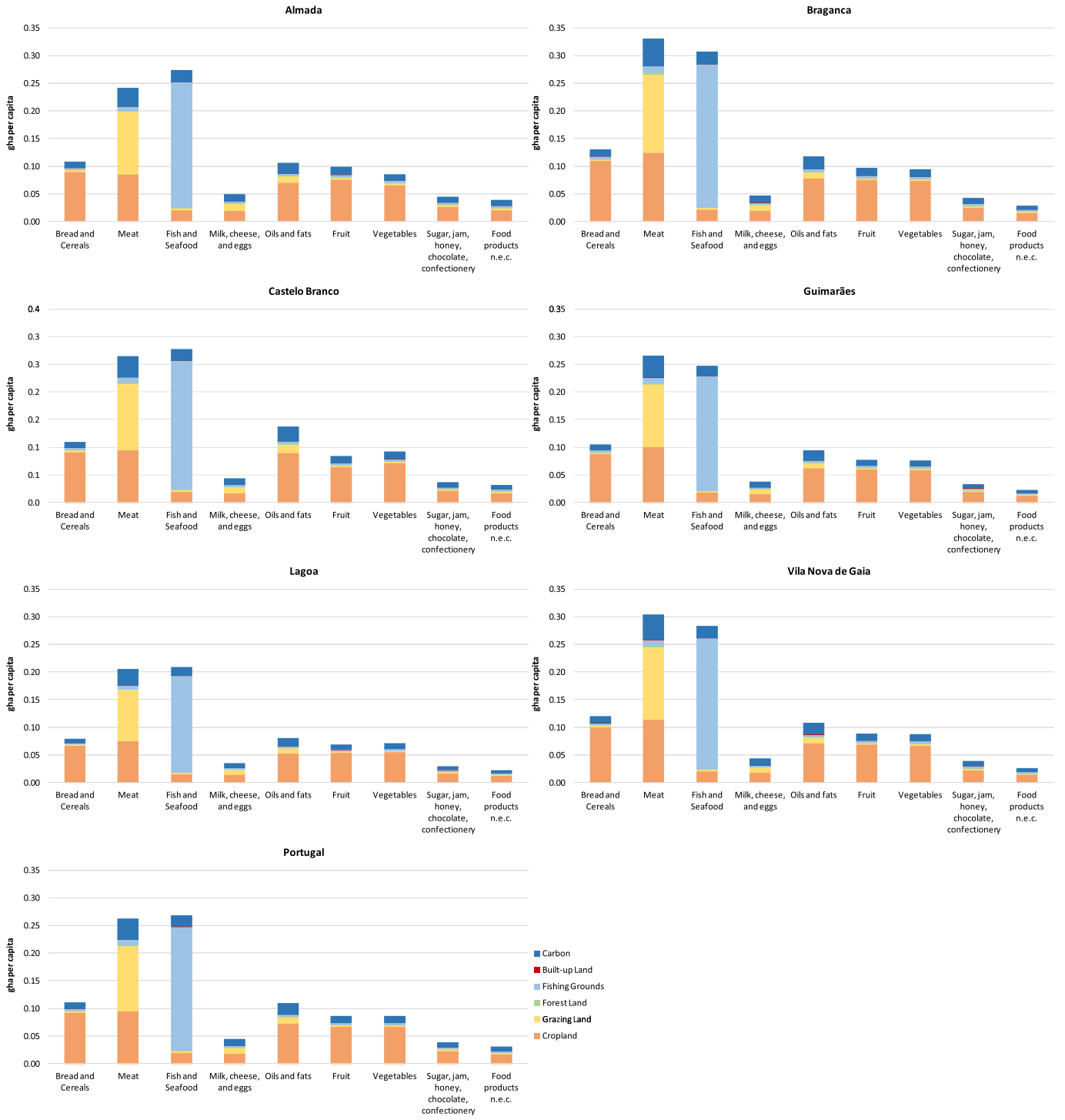

Fig. 3. Per capita Ecological Footprint of food consumption in the six municipalities, broken down by COICOP 4-digit sub-categories and land-types in 2014.

Cereals, *Oils and fats*, *Meat*, *Milk, cheese, and eggs*, as well as *Alcoholic* and *Non-alcoholic beverages*), Brazil (for imports of *Fruit*, *Vegetables*, and *Sugar, jam, honey, chocolate, confectionery*), and Norway (for import of *Fish and Seafood*). Detailed trade Footprint analyses at the municipal level were not possible due to lack of sub-national trade data.

3.2. Food policy landscape in Portugal

A chronological analysis of national food policies and governance in Portugal during the last five decades is provided in Table 3, with a description of the type of policy action, its responsible actors, and a short account of its objectives. This table also presents an analysis of the aspects being emphasized by each of the policies under consideration, allowing for different focuses, from production (quantity, quality and food security) to consumption (dealing with health, safety and nutritional value of food or sustainable diets), and up to the more systemic aspects of food system policies and governance. This allows to better understand policy shifts and intended aims throughout the decades.

Up until the mid 1970s, food policies in Portugal were mainly limited to ensuring adequate food supply, as well as food and population health (Graça and Gregório, 2012). The work of the UN Food and Agriculture Organization (FAO), the World Health Organization (WHO) and the

Table 2
Portuguese national Food Footprint values (in gha) by COICOP 4-digit categories and country of origin (top 5 trade partners and the rest of the world), in 2014.

CP011.1 Bread and Cereals	[%]	[gha]
Sum Total		1,271,772
Imported	86.1%	1,095,081
Portugal	13.9%	176,691
% of Bread and Cereals Total Consumption - Top partners		
Spain	19.4%	246,411
France	16.1%	205,090
Ukraine	11.2%	142,534
United Kingdom	5.6%	71,130
USA	3.5%	44,909
Rest of World	30.3%	385,007

CP011.2 Meat	[%]	[gha]
Sum Total		2,241,305
Imported	45.7%	1,023,756
Portugal	54.3%	1,217,549
% of Meat Total Consumption - Top partners		
Spain	27.5%	616,929
France	2.5%	55,201
Netherlands	2.0%	44,966
Germany	1.6%	36,416
Uruguay	1.5%	33,910
Rest of World	10.5%	236,335

CP011.3 Fish and Seafood	[%]	[gha]
Sum Total		2,715,355
Imported	60.0%	1,629,268
Portugal	40.0%	1,086,088
% of Fish and Seafood Total Consumption - Top partners		
Spain	33.2%	901,431
Norway	6.7%	182,785
Rest of W. Africa	2.7%	72,750
Senegal	2.6%	70,647
Sweden	1.4%	38,362
Rest of World	13.4%	363,293

CP011.4 Milk, cheese, and eggs	[%]	[gha]
Sum Total		498,367
Imported	36.2%	180,580
Portugal	63.8%	317,787
% of Milk, cheese, and eggs Total Consumption - Top partners		
Spain	16.5%	82,212
France	4.2%	20,997
Ukraine	2.0%	10,150
Germany	1.9%	9,660
USA	0.9%	4,564
Rest of World	10.6%	52,996

CP011.5 Oils and fats	[%]	[gha]
Sum Total		1,174,262
Imported	72.4%	849,810
Portugal	27.6%	324,452
% of Oils and fats Total Consumption - Top partners		
Spain	29.2%	342,871
France	6.3%	74,122
Argentina	6.1%	71,927
Canada	5.1%	59,609
Brazil	4.3%	50,424
Rest of World	21.4%	250,857

CP011.6 Fruit	[%]	[gha]
Sum Total		988,339
Imported	66.4%	656,459
Portugal	33.6%	331,880
% of Fruit Total Consumption - Top partners		
Spain	25.1%	248,269
Brazil	8.8%	86,510
France	4.8%	47,057
China	1.7%	16,913
Argentina	1.6%	16,042
Rest of World	24.5%	241,668

CP011.7 Vegetables	[%]	[gha]
Sum Total		985,945
Imported	66.5%	655,518
Portugal	33.5%	330,427
% of Vegetables Total Consumption - Top partners		
Spain	25.2%	248,041
Brazil	8.8%	86,484
France	4.8%	47,013
China	1.7%	16,824
Argentina	1.6%	16,040
Rest of World	24.5%	241,115

CP011.8 Sugar, jam, honey, chocolate,	[%]	[gha]
Sum Total		439,386
Imported	78.4%	344,637
Portugal	21.6%	94,749
% of Sugar, jam, honey, chocolate, confectionery Total Consumption - Top		
Spain	17.8%	78,177
Brazil	12.1%	53,330
Zimbabwe	6.2%	27,261
France	4.0%	17,466
Norway	3.0%	13,306
Rest of World	35.3%	155,095

CP011.9 Food products n.e.c.	[%]	[gha]
Sum Total		345,480
Imported	73.0%	252,288
Portugal	27.0%	93,193
% of Food products n.e.c. Total Consumption - Top partners		
Spain	22.7%	78,449
France	4.9%	16,844
Norway	3.9%	13,447
Ukraine	3.2%	10,966
China	3.1%	10,802
Rest of World	35.2%	121,780

CP012 Non-alcoholic beverages	[%]	[gha]
Sum Total		351,997
Imported	54.2%	190,791
Portugal	45.8%	161,206
% of Non-alcoholic beverages Total Consumption - Top partners		
Spain	16.4%	57,806
France	6.0%	21,022
Ukraine	5.5%	19,351
United Kingdom	2.9%	10,072
Brazil	2.6%	9,274
Rest of World	20.8%	73,266

CP021 Alcoholic beverages	[%]	[gha]
Sum Total		428,187
Imported	54.2%	232,088
Portugal	45.8%	196,099
% of Alcoholic beverages Total Consumption - Top partners		
Spain	16.4%	70,318
France	6.0%	25,572
Ukraine	5.5%	23,539
United Kingdom	2.9%	12,253
Brazil	2.6%	11,281
Rest of World	20.8%	89,125

European Union (EU) triggered early Portuguese efforts to create a national food and nutrition policy starting from the late 1970s, with the creation of the *Centre for Studies in Nutrition*, the first studies on food intake and nutrition, as well as the launch of the first campaign "*Knowing how to eat is knowing how to live*" (Graça and Gregório, 2013). Since then, Portugal has experienced a continuous evolution of its food policy and governance landscape (see Table 3), with the creation of a *National Food Council* in the 1980s (Graça et al., 2018a), a focus on food literacy in schools in the 1990s (Loureiro, 2004), a focus on obesity in the 2000s (Graça et al., 2018a), and the launch of the first *National Program for the Promotion of Healthy Eating* (PNPAS) by the Portuguese *Directorate General for Health* (DGS) in 2012 (Graça and Gregório, 2013). This led to the publication of various guidelines on healthy eating (Silva et al., 2015; Pinho et al., 2016a; Pinho et al., 2016b) – including the *Integrated Strategy for the Promotion of Healthy Eating* (EIPAS) in 2017 (Diário da República §, 2017) – and the implementation of a *National Food,*

Nutrition and Physical Activity Survey (IAN-AF) (Lopes et al., 2017b). In 2018, efforts to reduce food waste culminated in the definition of a *National Strategy and Action Plan for Combating Food Waste*; in the same year, DGS set-out to tighten the connection between the food and the environment sectors, favor EIPAS implementation at municipal level during the period 2018–2019, and define new criteria for the public procurement of food products (i.e., Law n°34 /2019) (Graça et al., 2018b).

Despite national efforts, knowledge on local-level food policies in Portugal is still very limited and not supported by national monitoring frameworks (FNFS-UP (Faculty of Nutrition and Food Sciences of the University of Porto), 2019). With the exception of work related to food production capacity in urban areas (DGT (Direção-Geral do Território), 2016a), there is a lack of evidences on the influence that national policies are playing on local policies as well as on whether local food policies are actually being implemented.

Through the lenses of the suggested policy framework and the data collected for the six pilot cities in Portugal, results show several gaps concerning the four dimensions deemed necessary to trigger a sustainable food transition (see Table 4).

Policy implementation is stronger in the *information and awareness* dimension, as all six cities have policies or initiatives in place for at least 2 of the 3 investigated parameters. Tools to gather consumers' behavior data and guide consumers through the *knowledge-awareness-action* journey (Collins et al., 2020), for instance, are available in all cities, such as municipal Ecological Footprint (EF) calculators (Galli et al., 2020) and several awareness campaigns (see Table S5 in the Supplementary Online Material for a detailed description of all the activities developed by each city). Still, lack of awareness from citizens and the difficulty to change the mentality of both the civil society and companies represent major roadblocks for local administrations, which are also not aided by national regulations (e.g., unclear public procurement rules for food).

Contributing to a weak *administrative and government capacity* for almost all cities is the lack of adequate human skills, as well as the lack of trans-departmental structures, of coordination mechanisms, and of collaboration among the various levels of government, except from the case of Vila Nova de Gaia. Weak organizational autonomy coupled with a recognized failure to implement specific regulations and incentives for other stakeholders also characterize these six cities; Vila Nova de Gaia is the exception as it develops a number of initiatives addressed in the local Action Plan for the Milan Urban Food Policy Pact (see Table S5).Furthermore, gaps in local government functions are identified in those policy areas that require large scale approaches, coordination, multi-level co-operation and mutual dependence among institutions. With the exception of Vila Nova de Gaia, the main gaps are found to be related with the lack of tools to promote urban-rural linkages and of capacity to learn from trans-local collaboration (see Table S5). The integration of food issues in territorial planning is one of the most addressed aspects, through the development of several municipal and pedagogical food gardens as well as initiatives to recover abandoned lands for agricultural purposes (as the case of Guimarães).

Finally, regarding *strategic food policies*, results show an overall lack of strong political commitment to shift towards healthy and sustainable diets in almost all the cities (see Table 4); this impedes municipalities to maximize their efficiency and effectiveness in local policy delivery. Despite food policies and strategies exist at the national level, they do not seem to generate a spillover effect in the analyzed cities. Even in Vila Nova de Gaia – the city with the highest food policy implementation standards – one can observe that city residents have the second highest food Footprint value (1.15 gha cap^{-1}) of the six cities, thus suggesting how challenging it is to design and implement policies with an effective impact on sustainable food systems.

4. Discussions & recommendations

The Footprint results provided in this study show that the Portuguese food system is highly interconnected with, and dependent on, food systems around the world; as such, food consumption in Portugal is highly dependent on the availability of food resources from abroad – particularly in Spain, France, Brazil and Norway – as well as on Portugal's capacity to maintain a stable access to food. Results also show that – similar to that of its trade partners Spain (Blas et al., 2019) and France (Masset et al., 2014) – food consumption in Portugal tends to protein-based food such as *Meat* and *Fish and Seafood* as opposed to *Fruit*, *Vegetables*, and *Bread and Cereals*, and this determines a high impact on the planet as shown by the high Food Footprint values at country and municipal level (see also 12).

Moreover, the outbreak of the COVID-19 pandemic in early 2020 has brought to the attention of politicians, practitioners and the civil society the interconnectedness of global food systems and the risks associated with such globalization of food: food shortages and supply disruptions, for instance, have been experienced in several countries (IPES-FOOD, 2020), suggesting a timely need for a renewed focus on the way our countries' food systems are looked at and managed, and proper mapping of the global interconnectedness of our societies.

The high external resource dependency of Portugal, especially for a basic human need such as food, is even riskier when considering that several other European and Mediterranean countries are running ecological deficits and external resource dependencies themselves (Galli et al., 2015), within a global ecological overshoot context in which the planet's ecological assets are being consumed at a nearly 70% faster rate than they are regenerated (Lin et al., 2018).

Still, global interconnections and trade dependencies similar to those of Portugal characterize many countries as for instance less than 30% of the global population can fulfill its demand for crops locally (Kinnunen et al., 2020); this points to possible risks for national food systems associated with borders closures (impacting both food trade and workers movements), price volatility of food commodities or supply chain disruptions (Lang et al., 2017): recent studies (de Ruiter et al., 2017; Garnett et al., 2020) for instance, have highlighted the particular fragilities and lack of resilience of the UK food system, which – similar to Portugal – relies on land located overseas for more than 60% of UK's demand for food and feeds.

Our policy analysis then discloses the still fragile policy context to tackle food systems unsustainability in Portugal. Several gaps were identified, especially at the local level: 1) the *information gap*, in a broad sense, was less noticed, as all six municipalities have local strategies to achieve better information and awareness campaigns towards civil society. Nevertheless, investing in more robust datasets and assessment frameworks is a necessary pathway; 2) the several identified *capacity gaps* reveal a still immature picture of local institutions in their ability to fully implement their responsibilities. Although an increasing number of studies (Alexander et al., 2015; Camilleri et al., 2019; Eyhorn et al., 2019; Godfray and Garnett, 2014; Tilman and Clark, 2014) points to the way human societies produce, transform, distribute, consume and waste food as key intervention areas to reverse unsustainable trends, analyses for the six municipalities in this study provide evidence of several gaps to address these key interventions. Local governments need to invest in human resources (particularly nutritionists and building interdisciplinary working teams), skills, financial and administrative resources to strengthen their organizational autonomy and improve articulation with other levels of government; 3) the *local government functions gap* is highly felt particularly in policy areas that require larger scale approaches, coordination and multi-level cooperation, such as the interconnected and complex policy area of sustainable food systems, where functional diluted borders do not correspond to administrative delimitations. The involvement in international networks is, for example, a critical tool that the studied municipalities need to endorse. Nevertheless, when looking at the thematic scope of the main city networks and urban initiatives around the world (as summarized in Table 5), evidence shows that food is an often overlooked issue across the board, as most of these networks and initiatives focus primarily on energy, transportation and waste

Table 3
Evolution of food policies in Portugal, from 1970 to 2020.

Year	Name	Type of policy action	Responsible actors	Description	Main Emphasis					
					Production (quantity)	Production (quality)	Production (Food Security)	Consumption/Health	Consumption/Env. Sust	Food System perspective
1976	Centre for Nutrition Studies	Research Centre	Academy	Study and research unit in the area of food and nutrition	√	√		√		
1977	Food Quality Institute	Institution (Decree-Law no. 221/77)	Government	Define a food quality policy in particular in the regulation, promotion and control of food quality		√	√	√		
1977	Food Wheel	Information	Academy	Dietary guide for the Portuguese population				√		
1978	Food and Nutritional Policy in Portugal	Research	Academy	First academic proposal for a food and nutritional policy in Portugal	√		√	√		
1979	Portugal's position on food and nutrition policy	Research	Academy	New proposal for a food and nutrition policy orientation	√	√	√	√		
1980	National Food Council (National Council for Food and Nutrition – CNAN - after 1894)	Institution (Decree-Law no. 265/80)	Government	Inter-ministerial and advisory body of the government with the main task of formulating and implementing a food and nutrition policy in Portugal	√	√	√	√		
1980	National Food Survey	Research	Academy, Government	Assess the food consumption of the Portuguese population				√		
1989	Recommendation for a Food and Nutrition Policy in Portugal	Policy proposal	Government	Recommendations of the National Council of Food and Nutrition (CNAN) for the formulation of a food and nutrition policy to assess Food and Nutritional situation in the country and improve the Existing Situation			√	√		
1984	European Network of Health Promoting Schools (EHPS)	Network	Educational system	Portugal joins the European Network				√		
1988	National Network of Health Promoting Schools	Network	Educational system	Food education is part of the curriculum				√		
2000	Agency for Food Quality and Safety	Institution (Decree-Law no. 180/200)	Government	Control and monitoring in the field of food quality and safety.	√	√	√			
2005	Food and Economic Security Authority (ASAE)	Institution (Decree-Law no. 237/2005)	Government	Protecting consumers and ensuring food safety		√	√	√		
2005	National Programme Against Obesity	Policy	Government	Reduce the prevalence of pre-obesity and obesity in Portugal				√		
2007	Anti-Obesity Platform	Institution	Government	Compliance with the objectives of the European Charter for Combating Obesity				√		

2011	National Program for the Promotion of Healthy Eating (PNPAS)	Policy (Decree-Law no. 124/2011)	Government	Improve the nutritional status of the population by encouraging the physical and economic availability of food that constitute a healthy eating pattern	√	√	√	√	√		
2016	National Commission to Combat Food Waste (CNCDA)	Institution (Dispatch no. 14202-B/2016)	Government, Agri-food Industry, Municipalities, Academy	Promote the reduction of food waste through an integrated and multidisciplinary approach	√				√		
2017	National Strategy and Action Plan for Combating Food Waste (ENCDA)	Policy (Order no. 14202-B/2016)	Government	Promote the reduction of food waste through an integrated and multidisciplinary approach			√		√		
2017	Integrated Strategy for the Promotion of Healthy Food (EIPAS)	Policy (Dispatch no. 11418/2017)	Government	Encouraging adequate food consumption and the consequent improvement in the nutritional status of citizens, with a direct impact on the prevention and control of chronic diseases.			√	√	√		
2017	Action Plan for the Circular Economy in Portugal	Council of Ministers Resolution No 190-A/2017	Government	With measures to combat Food Waste and involve the Agro-Industry to reduce materials in food production	√				√		
2017	National Survey on Food, Nutrition, and Physical Activity of the Portuguese Population, IAN-AF 2015–2016	Research	Academy, Government	The survey aimed to collect national data on food consumption and physical activity and their relation to health determinants, in particular socio-economic ones.				√			
2018	Report on Healthy Food, Challenges and Strategies	Report	Government	Create a new inter-sectorial articulation with the environment sector" and to "enhance the implementation of EIPAS at the municipal level" during the 2018–2019 period	√	√	√	√	√	√	
2018	National Commission for Food and Nutrition Security of Portugal (CONSAN-P)	Council of Ministers Resolution 103/2018	Government, agri-food Industry, municipalities, universities	Its main objectives are to contribute to the achievement of the Human Right to Adequate Food in Portugal and to contribute to the definition of an integrated vision of matters related to food and nutritional security, ensuring convergence, coherence and social participation.	√	√	√	√	√	√	
Being developed	National Strategy for Food and Nutrition Supply for Portugal (ENAAN-P)	Policy	Government	An inter-ministerial work to promote an integrated strategy to support a comprehensive food system policy in the country	√	√	√	√	√	√	

Table 4
Food policy coverage and gaps in the six investigated Portuguese cities, as of 2019. In each column, values refer to the number of policies and activities currently in place in the municipalities. Empty boxes indicate that no policy or activity is in place for the identified policy dimensions. See Table S5 in the SOM for further details.

Policy dimensions and support tools	Almada	Bragança	Castelo Branco	Guimarães	Lagoa	Vila Nova de Gaia
Information and awareness						
Awareness of food consumption and production patterns	1	1	1	1	1	2
Robust data and indicators frameworks	2	2	1	1	1	3
Education campaigns and participatory food governance	2	–	2	2	–	4
Administrative and government capacity						
Adequate human resources (equipped with proper knowledge and skills)	1	–	2	1	–	3
Trans-departmental structure or coordination mechanisms to enhance system thinking	1	–	–	–	–	1
Organizational autonomy	–	–	–	–	–	–
Articulation with other levels of government	–	–	–	–	–	1
Government regulations and incentives (e.g., sustainable public food procurement)	–	–	–	–	–	2
Local government functions						
Integration of food issues in territorial planning	2	1	2	2	1	2
Promotion of urban-rural interconnecitons	–	–	–	–	–	1
Promotion of learning with trans-local collaboration	1	–	–	–	–	1
Mechanisms of coordination among governance stakeholders	1	–	1	–	–	1
Strategic policies						
Strong political commitment to shift towards healthy and sustainable diets	–	–	–	–	–	1
Strategies to re-orient agricultural production priorities, foster agri-food innovation and promote the sustainable intensification of food production	–	1	3	2	–	1
Food waste reduction plans	–	–	–	–	–	1
Incentives for a farmers-citizen reconnection	1	2	2	–	–	2

management and only a few of them deal with food sustainability. Besides, several other tools can reduce the *local government functions* gap by bringing and coordinating local government activities with different stakeholders to support urban-rural interconnections, to promote local products and seasonality and thus shorten supply chain or to reconnect consumers with the local producers; 4) gaps in *strategic local policies* finally reveal the long policy way to go to shift from focusing on more sustainable agricultural policies (the "production side" of food security and sustainability) to considering food system policies at large, with an increasing attention to consumption habits (Kearney, 2019), dietary choices (Tilman and Clark, 2014), reduction of food waste, and the whole systemic and circular activities around food. For instance, as shown in previous studies (Galli et al., 2017), shifting to calories-adequate diets or changing consumers' dietary preferences could lead to a reduction in the ecological deficit of Portugal ranging from 10% (via calories reduction) to 19% (via major reduction in seafood and meat consumption) and analogous results are to be expected for all six municipalities, given the similarity of urban food Footprint profiles with the national one. To re-orient dietary choices away from animal proteins and towards vegetables, legumes or cereals, it requires not only local actions but also the development of national dietary guidelines that must include sustainability considerations.

The analyzed cities are therefore positioned with relevant knowledge on *how* and *what* to transform locally, which can make them leaders in a sustainable food transition in Portugal. The lessons from Portugal can be useful not only for countries with similar food footprints or dietary choices but also for building a comparative knowledge on the capacity of local policies to enforce real sustainable food transitions. The policy framework proposed in this paper can support further research on such comparative learning.

5. Conclusions

Small cities and towns, such as those analyzed in this study, can play a key role in fostering resilient and economically prosperous food systems given their proximity and close interaction with relevant economic and societal actors (e.g., rural areas). In these contexts, multi-scalar and multi-sector collaborations can foster the creation of sustainable rural-urban territories and food chains that enable multi-stakeholder engagement and protect ecosystem services.

Guaranteeing stable supply and access to food over time while also favoring the sustainable utilization of food is fundamental for Portugal, as we found food consumption to be the main driver of the pressure its residents place on national and worldwide ecosystems: with an average national Ecological Footprint of 3.69 gha cap^{-1}, Portuguese people are demanding nearly three times more resources and services than the biocapacity (1.28 gha cap^{-1}) they have available within their country or that is available – on a per capita base – at the global level (1.7 gha cap^{-1}). Considering that food Footprints are driven by the high consumption of meat and seafood at both national and city levels, and that relevant shares of the Portuguese food Footprint are placed outside the country's borders for most of the food categories, there is room for reversing this situation.

Nonetheless, while possible, reversing the current food unsustainability and favoring a food transition in Portugal requires the support of governance structures and specific policy interventions, at both national and local level. Upon assessing existing local policies in four high level policy dimensions, we found that the majority of cities had either gaps or low ability to act or deliver on most dimensions: only policies related to information and awareness were found to be at an acceptable level of implementation – although their full effectiveness is yet to be seen – while political commitment and administrative and government capacity needs to be strengthened. The low food policy implementation identified in municipalities with long standing efforts in environmental policies also reveals that urban food policies are still in their infancy in Portugal, and calls for the need to incorporate food system concerns into wider sustainability and environmental discussions.

While food consumption should be a key priority area for intervention to reverse unsustainable trends, gaps in urban food policies within Portugal hinder the country capacity to take remedial action. Easing a transition to sustainable national and local food systems in Portugal requires timely action, perhaps starting from those policies and initiatives that, without requiring major economic investments, would make the adoption of alternative dietary patterns and the strengthening of sustainable food governance possible. Successful promotion and implementation of, among others, 1) coordination and governance tools, 2) societal awareness and consumer behavior strategies, and 3) incentives and regulation on the re-orientation of production activities, would then also contribute to significant achievements on SDGs 2, 3 and 12.

Table 5
Mapping of the main urban networks and initiatives across the globe, with a focus on their thematic and geographical scope.

City network name	Thematic scope	Objectives	Geographical scope: global/regional
100 Resilient cities	Post Carbon cities	Achieving sustainable post-carbon cities in the EU, thereby contributing to the Roadmap for moving to a low-carbon economy in 2050	Worldwide
25 years of Energy Cities	Energy	Strengthen skills in the field of sustainable energy as well as represent the interests and influence the policies and proposals made by EU institutions in the fields of energy, environmental protection and urban policy. Exchange experiences, transfer know-how and jointly implement projects.	Regional: Europe
ACR+	Recycling and sustainable resource management	Promoting smart resource consumption and sustainable management of municipal waste through prevention at source, reuse and recycling.	Global
Avitem	Urban Sustainable Development	Establish a mechanism for exchange of knowledge for achieving urban development	Regional: Mediterranean
C40 Cities	Climate change	Reducing greenhouse gas emissions. C40 works with participating cities to address climate risks and impacts locally and globally.	Worldwide
CESMED/ Cleaner energy saving Mediterranean cities	Transport	Supporting local and national authorities in the ENPI South Mediterranean Partner Countries to respond more actively to sustainable policy challenges.	Regional: Mediterranean (FAO. Food and Agriculture Organization of the United Nations, 2019) and East European countries (Runyan and Stehm, 2019), plus Russia
City Net	Urban Sustainable Development	Connect urban actors and deliver tangible solutions for cities across the Asia Pacific region.	Regional: Asia Pacific region
Civitas	Transport	Sustainable mobility in Europe: introducing change towards greener transport under one dynamic and very active network.	Regional: Europe
CORDIS (Community Research and Development Information Service)	Sustainable urban housing	1) Speed up innovation, 2) Stimulate market development; both in terms of sustainable urban housing	Regional: Europe
Covenant of Mayors	Energy efficiency	Increasing energy efficiency and use of renewable energy sources on their territories. Aim: to meet and exceed the European Union 20% CO_2 reduction objective by 2020.	Regional: Europe
David Suzuki Foundation	Diversity of nature and our quality of life	Assist urban centers in Canada to protect green and blue spaces and promote transit-oriented development and pedestrian- and cycle-friendly transportation options	Regional: Canada
Eltis	Sustainable Urban Mobility	Support the transition towards competitive and resource-efficient mobility systems in European cities.	Regional: Europe
Eurocities	Climate change / Energy efficiency	Achieving energy efficiency for smart, sustainable and inclusive growth and for the transition to a resource efficient economy	Regional: Europe
Go 100% renewable energy	Renewable energies	Supply electricity, heating, and transportation energy needs with 100% sustainable renewable sources	Worldwide
ICLEI	10 different urban agendas, dealing with multiple sustainability issues[a]	Help local and sub-national governments address 10 main challenges and advance the objectives of global sustainability frameworks, from the Sustainable Development Goals to the Paris Agreement and New Urban Agenda.	Worldwide
Low carbon future cities	Low carbon	Share information about sustainable urbanization and understanding the concept of low carbon cities	Regional
Med Cities	Urban Sustainable Development	Achieving urban sustainable development as a way to improve living conditions in the Mediterranean region.	Regional: Mediterranean
Milan Urban Food Policy Pact	Resilient urban food systems	Develop equitable, resilient and sustainable food systems. It encourages inter-departmental coordination at municipal and community levels, working to integrate urban food policy considerations into social, economic and environment policies, programs and initiatives.	Worldwide
Natural Resource Defense Council	Creating strong, just and resilient communities	Creating models to solve a selected set of key urban challenges that can be applied to other cities nationwide. By 2020, at least 25 urban areas will have deployed integrated, equitable and replicable climate response strategies as a result of Urban Solutions' tools, technical expertise and on-site capacity, ultimately reaching a tipping point for market-wide adoption of these strategies.	Regional: North America
PLEEC (Planning for energy efficiency cities)	Energy efficiency	Reduce energy use in Europe in the near future	Regional: Europe
Pocacito	Carbon Efficiency	Increase energy efficiency and use of renewable energies. Meet and exceed European Union 20% CO_2 reduction objective by 2020	Regional: Europe
Reference Framework for Sustainable Cities (RFSC)	Sustainable cities	Hhelp cities promote and enhance their work on integrated sustainable urban development.	Regional: Europe
Regions4 Sustainable Development (formerly the nrg4SD)	Urbanization, biodiversity, and ecosystem services	Strengthening conservation and sustainable use of natural resources in an urban context. Brings the voice of regions to the biodiversity agenda.	Global
RUAF Global Partnership	Food as a tool for city resilience	Reduce urban poverty, enhancing urban food security, improving urban environmental management and stimulating participatory city governance	Global
The Gold Standard	Low-carbon development	Develop ground-breaking solutions that will unlock the finance needed by cities around the globe for low carbon development.	Worldwide
UN Habitat	Sustainable urban development	Build inclusive, safe, resilient and sustainable cities and communities. Promote urbanization as a positive transformative force for people and	Worldwide

(continued on next page)

Table 5 (*continued*)

City network name	Thematic scope	Objectives	Geographical scope: global/regional
		communities, reducing inequality, discrimination and poverty	
URB ACT	Sustainable cities	Assist cities in developing pragmatic solutions that are new and sustainable and that integrate economic, social and environmental urban topics.	Regional: Europe
World cities network	Resilient, vibrant, and sustainable cities	Help deliver more resilient urban infrastructure through shared learning, procurement, planning, and financing models	Global
World Council on City Data	Smart, sustainable, resilient, and prosperous cities	The WCCD hosts a network of innovative cities committed to improving services and quality of life with open city data and provides a consistent and comprehensive platform for standardized urban metrics.	Global

[a] ICLEI's 10 urban agendas are: 1) Sustainable City, 2) Low-carbon city, 3) Resource-efficient and Productive City, 4) Resilient City, 5) BiodiverCity, 6) Smart City, 7), EcoMobile City (Sustainable Urban Mobility, 8) Happy, Healthy, and Inclusive Communities, 9) Sustainable Local Economy and Procurement, and 10) Sustainable City-Region Cooperation.

To conclude, we stress that the successful application of such remedial actions in Portugal requires proactive ongoing communication among various government levels and various actors, and a clear alignment of interests and strategies from the national towards the local levels. The misalignment from the urgent need for global changes and the slow national and local disruptions towards sustainable food transition taking place in the country, thus call for a stronger focus on the development of specific food-centered urban policies and for the inclusion of food, a topic usually overseen, in wider city-level and national level sustainability policies. The situation identified in Portugal is likely to be similar to that of many other countries and cities, whose policy implementation should thus be further investigated.

CRediT authorship contribution statement

Alessandro Galli: Conceptualization, Methodology, Investigation, Visualization, Writing - original draft. **Sara Moreno Pires:** Conceptualization, Methodology, Investigation, Writing - review & editing. **Katsunori Iha:** Formal analysis, Investigation. **Armando Abrunhosa Alves:** Investigation, Writing - review & editing. **David Lin:** Formal analysis, Investigation, Writing - review & editing. **Maria Serena Mancini:** Investigation, Visualization, Writing - review & editing. **Filipe Teles:** Investigation, Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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