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Water consumption related to different diets in Mediterranean cities

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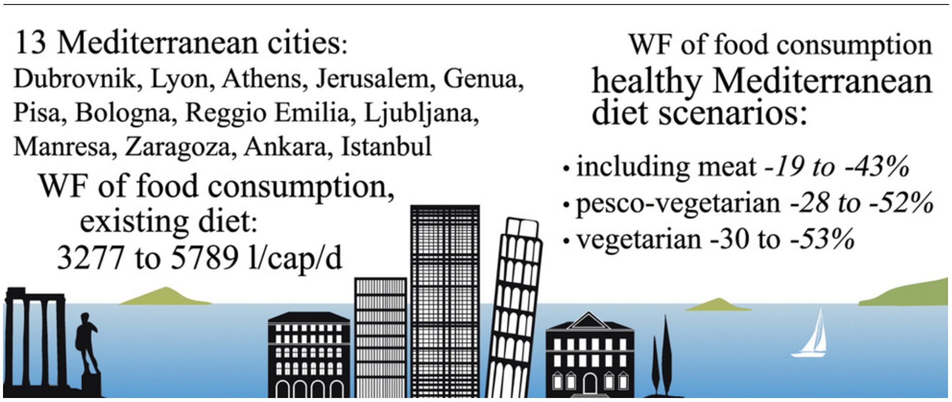
HIGHLIGHTS

- Modern cities score well regarding water management in international city rankings.
- They are however dependent on external water resources for the food they consume.
- Mediterranean urban citizens eat too many animal products and sugar.
- They can save a lot of water by shifting to a healthy diet.

GRAPHICAL ABSTRACT



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ABSTRACT

Providing the sustainable development goals (SDGs) water, food and energy security to cities relies strongly on resource use outside city borders. Many modern cities have recently invested in a sustainable urban water system, and score high in international city rankings regarding water management and direct urban water use. However, these rankings generally neglect external resource use for cities. Here we quantify the water resources related to food consumption in thirteen cities located in Mediterranean countries, by means of the water footprint (WF) concept. These WFs amount from 3277 l per capita per day (l/cap/d) to 5789 l/cap/d. These amounts are about thirty times higher than their direct urban water use. We additionally analyse the WF of three diet scenarios, based upon a Mediterranean dietary pattern. Many authors identify the Mediterranean diet as cultural heritage, being beneficial for human health and a model for a sustainable food system. The first diet scenario, a healthy Mediterranean diet including meat, leads to WF reductions of −19% to −43%. The second diet scenario (pesco-vegetarian), leads to WF reductions of −28% to −52%. The third diet scenario (vegetarian), leads to WF reductions of −30% to −53%. In other words, if urban citizens want to save water, they need to look at their diets.

1. Introduction

Providing the sustainable development goals (SDGs) water, food and energy security to a rapidly increasing and urbanising global

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Fig. 1. Location of the 13 cities in the Mediterranean countries.

population in a sustainable way, is one of the largest challenges humanity faces (UN, 2014; Vanham, 2016). How many and which resources urban citizens consume, is key to achieve this goal. It is however unlikely that cities can ever be fully self-sufficient to provide its populations with water, food and energy security (Elmqvist, 2014). They import most of the resources they consume. This fact is generally ignored in current international sustainability rankings for cities, like the Green City Index (Economist Intelligence Unit, Siemens, 2012) or the City Blueprint (Koop and van Leeuwen, 2015; Koop and van Leeuwen, 2016; van Leeuwen et al., 2012), where many European cities tend to receive high scores. Such indices are generally based only on – though very important – direct urban best practices such as waste collection, energy efficiency of city buildings or efficiency in water management. They generally neglect the dependency of cities on resources outside city borders. To communicate the full picture of resource consumption to citizens, stakeholders and policy makers, indicators on external

Table 1
Mediterranean cities assessed in this study, with population statistics and data on direct urban water use.

Country	City	Population			Comment	Urban direct water use
		Total	% women	% men		
Croatia	Dubrovnik	42,615	52.7	47.3	Year 2011 statistics, source (DZS, 2016)	
France	Lyon	1,584,738	52.1	47.9	Year 2012 statistics on the "urban unity" (*l'unité urbaine*) of Lyon, source (INSEE, 2016). The municipality of Lyon has a population of 496,343.	Water use of 173 l/cap/d (Koop and Van Leeuwen, 2015)
Greece	Athens	3,090,508	52.3	47.7	Year 2011 for the metropolitan area of Athens (Greater Athens and Greater Piraeus), part of the Attica administrative region (population of 3,828,434), source (Hellenic Statistical Authority, 2016). The municipality of Athens has a population of 664,046.	Water use of 293 l/cap/d (Economist Intelligence Unit, Siemens, 2012), domestic water use 125 l/cap/d (Koutiva and Makropoulos, 2016)
Israel	Jerusalem	914,500	50.3	49.7	Year 2009 statistics, source (CBS, 2016)	Water use of 160 l/cap/d (Koop and Van Leeuwen, 2015)
Italy	Genova	592,507	53.0	47.0	Year 2015, source (ISTAT, 2016a). Genova is located in the Italian zone "North-West", Pisa in "Center", Bologna and Reggio Emilia in "North-East". These zones are also identified in the third Italian national nutrition survey INRAN-SCAI 2005–06 (Leclercq et al., 2009)	Water input to a municipal distribution system in 2012 = 384 l/cap/d; domestic water use 163 l/cap/d (ISTAT, 2016b)
Italy	Pisa	89,523	52.8	47.2		Water input to a municipal distribution system in 2012 = 410 l/cap/d; domestic water use 180 l/cap/d (ISTAT, 2016b)
Italy	Bologna	386,181	53.0	47.0		Water input to a municipal distribution system in 2012 = 308 l/cap/d; domestic water use 161 l/cap/d (ISTAT, 2016b)
Italy	Reggio (nell')Emilia	171,655	51.5	48.5		Water input to a municipal distribution system in 2012 = 241 l/cap/d; domestic water use 132 l/cap/d (ISTAT, 2016b)
Slovenia	Ljubljana	287,283	52.0	48.0	Year 2015, source (SURS, 2016)	Municipal water use 198 l/cap/d in 2011, of which 157 l/cap/d domestic water use (City of Ljubljana, 2013)
Spain	Manresa	74,655	51.2	48.8	Year 2015, source (INE, 2016)	Water use of 341 l/cap/d (Koop and Van Leeuwen, 2015)
Spain	Zaragoza	664,953	51.9	48.1		Water use of 227 l/cap/d (Koop and Van Leeuwen, 2015)
Turkey	Ankara	5,270,575	50.3	49.7	Year 2015, source (TURKSTAT, 2016)	Water use of 205 l/cap/d (Koop and Van Leeuwen, 2015)
Turkey	Istanbul	14,657,434	49.8	50.2		Drinking water supply in 2010 of 188 l/cap/d (van Leeuwen and Sjerps, 2016)

resource usage need to be employed (Vanham et al., 2016), as most resources consumed in cities originate from outside city borders.

In this paper, we focus on the resource water, which urban dwellers consume in a direct but also indirect way. In the past, water use awareness campaigns have focused only on direct household water use. Indirect water use refers to the water required to produce the goods urban citizens consume, quantified by means of the water footprint concept (Hoekstra and Mekonnen, 2012). The WF is an indicator of direct and indirect water use. More particularly, we quantify the water resources required to produce the food consumed (for different diet scenarios) in thirteen cities located in eight Mediterranean countries (Fig. 1 and Table 1). In the framework of the forthcoming Pan-European Atlas of Urban Water Management of the European Commission, the Joint Research Centre analyses the water footprint (WF) related to food consumption in selected, mostly European, cities. In this paper, we analyse the WF of the Mediterranean cities to be displayed in the

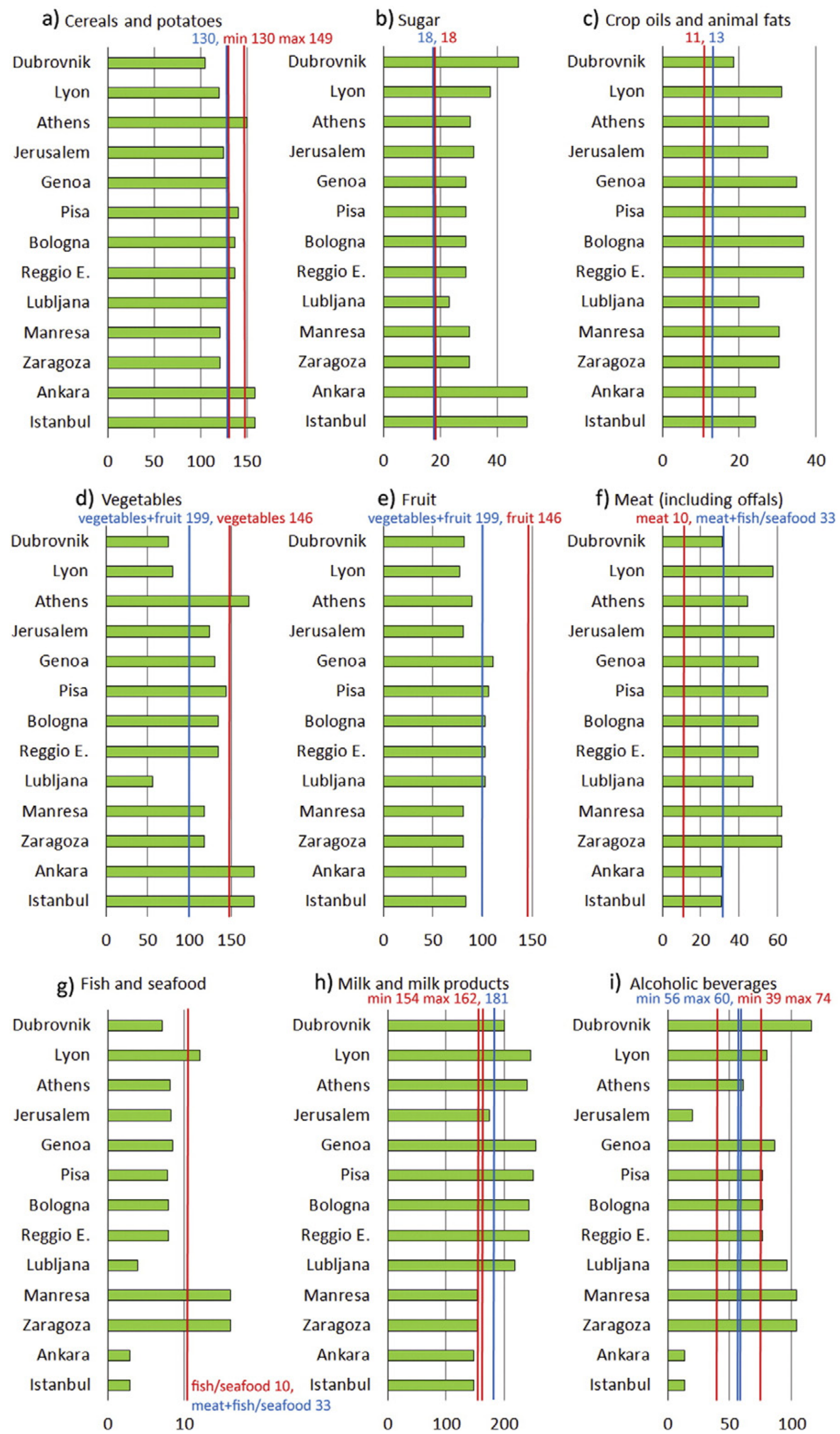


Fig. 2. Current food intake (kg/cap/yr) in the 13 Mediterranean cities for selected product groups, with an indication of healthy intake amounts (red = Mediterranean diet; blue Turkish FBDG).

atlas. We quantify the water footprint related to food consumption for different diet scenarios:

- The reference period or REF
- A healthy meat dietary pattern (HEALTHY-MEAT) based on the Mediterranean diet dietary recommendations (Bach-Faig et al., 2011a). For the two Turkish cities Ankara and Istanbul of this study, we additionally used Turkish Food-Based Dietary guidelines (FBDG) (Ministry of Health of Turkey and HUNDD, 2006)
- A healthy pesco-vegetarian diet (HEALTHY-PESCO-VEG) based on Bach-Faig et al. (2011a) and Ministry of Health of Turkey and HUNDD (2006)
- A healthy vegetarian diet (HEALTHY-VEG) based on Bach-Faig et al. (2011a) and Ministry of Health of Turkey and HUNDD (2006)

The Mediterranean diet is identified by many authors as beneficial for human health (Sofi et al., 2014). During the last decades, diet behaviour in Mediterranean regions has however gradually moved away from the traditional Mediterranean diet to a more Western-style diet (Bach-Faig et al., 2011b; Dubuisson et al., 2010; Trichopoulou et al., 2003; Varela-Moreiras et al., 2010). This trend is generally more pronounced in young adults than in the elderly (Dubuisson et al., 2010). As such, there is now a need for better adherence to the traditional Mediterranean diet. We identified this diet for our healthy diet scenario, as all cities are located in Mediterranean countries. According to the International Foundation of Mediterranean Diet (IFMeD, 2016), the Mediterranean diet is:

- cultural heritage that looks at the future
- a healthy and contemporary life style
- scientifically tested and proved benefits on human health
- a sustainable dietary pattern

The environmental sustainability of the Mediterranean diet has already been subject of other research, e.g. Burlingame and Dernini (2011), Dernini and Berry (2015), Germani et al. (2014) and Tukker et al. (2011).

As such, our aim was to demonstrate the dependency of cities on resources outside city borders and the possibility to reduce this dependency by changing food consumption behaviour.

In order to obtain sustainable food security within local and global freshwater boundaries, diet shifts and the reduction of food loss and waste are a necessity (Gerten et al., 2013; Steffen et al., 2015). During recent years, part of WF research has therefore focused on these topics. The WF of food loss and/or waste has been assessed on a global level (FAO, 2013; Jalava et al., 2016; Kummu et al., 2012), regional level (Vanham et al., 2015) and national level, e.g. the UK (WRAP, 2011) and China (Liu et al., 2013).

Another promising strategy to allow for the more efficient use of water resources is adjusting diets to become less water-intensive. Global assessments on diet change and its relation to water resources and/or water scarcity have been made, e.g. Jalava et al. (2016) and Jalava et al. (2014). For the EU the WF for different diets was analysed with different geographical boundary settings: Vanham et al. (2013b) for the EU as one entity; Vanham et al. (2013a) for four EU zones and Vanham and Bidoglio (2014a) for EU river basins. On the national level, the WF related to different diets has been assessed e.g. for Austria (Vanham, 2013), China (Liu and Savenije, 2008; Sun et al., 2015), the UK (Hess et al., 2015) and the USA (Gephart et al., 2016; Marlow et al., 2009; Tom et al., 2016). On the city level, very recently such assessments were carried out for Milan (Vanham and Bidoglio, 2014b) and selected Dutch cities (Vanham et al., 2016).

In general, WF assessments on the city level have not been the focus of research in the past (Paterson et al., 2015). Due to the importance of cities in global sustainability however, WF assessments have recently been conducted for selected cities, e.g. Hoff et al. (2014) or Ma et al. (2015).

2. Methodology

2.1. Accounting framework

To quantify WF amounts, the approach of the Water Footprint Network or WFN (Hoekstra et al., 2011; Hoekstra and Mekonnen, 2012) is applied. We use blue and green WF components. Blue water refers to liquid water in rivers, lakes, wetlands and aquifers. Green water is the soil water held in the unsaturated zone, formed by precipitation and available to plants (Rockström et al., 2009). Irrigated agriculture receives blue water (from irrigation) as well as green water (from precipitation), while rainfed agriculture receives only green water. The inclusion of green water in integrated water resources management is a necessity and now recommended by most authors (Gerten et al., 2013; Hoekstra, 2016; Jalava et al., 2014; Karimi et al., 2013; Miina et al., 2016; Ran et al., 2016; Rockström et al., 2014; Schyns et al., 2015; van Eekelen et al., 2015; Vanham, 2012).

To compute the water footprint of consumption related to food consumption, we use national FAO Food Balance Sheets (FBS) for the Mediterranean countries the cities are located in, for the reference period. We obtain WF_{cons} amounts from Mekonnen and Hoekstra (2011b), based upon Mekonnen and Hoekstra (2011a) and Mekonnen and Hoekstra (2012). We include a WF for fish and seafood, based upon Pahlow et al. (2015).

2.2. Food intake in cities

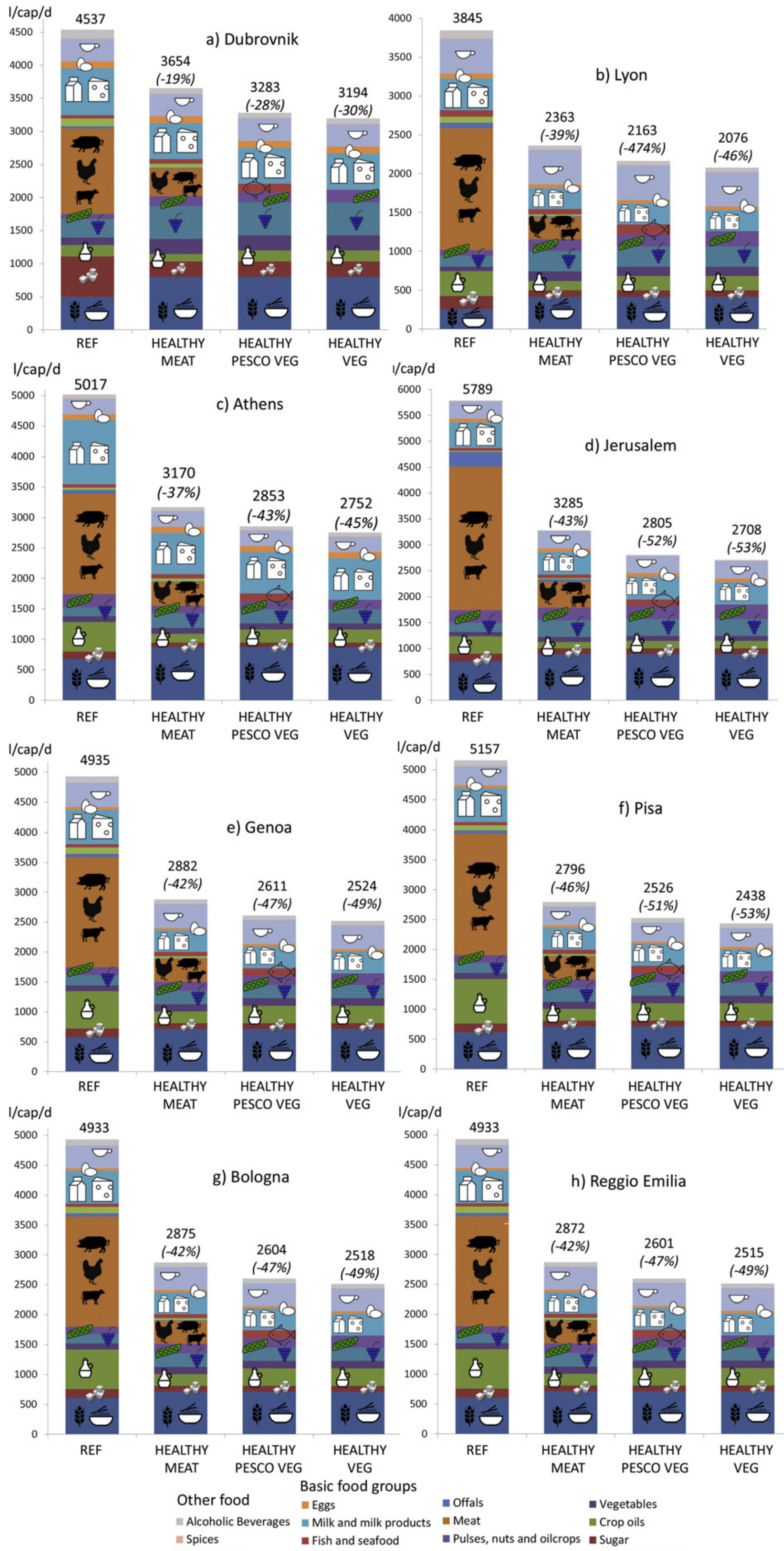
To compute food intake amounts in cities, we base ourselves firstly on national FAO FBS values. These are data on food supply, i.e. food reaching the consumer in private households, as well as that in the non-household sector (e.g. catering establishments, schools, hospitals). The data are given on an “as purchased” basis, i.e. as the food leaves the retail shop or enters the household by other means. Quantities are provided on the basis of “primary equivalents”. E.g., instead of listing flour of wheat, bread or pasta separately in the FBS, they are quantified as wheat equivalent. WF amounts in our study relate to food supply, which is the sum of food intake and food waste.

The reference period REF is 1996–2005. However, when a trend in change in food supply of a particular product group within a country was observed (Fig. S1), we adapted food supply amounts, as listed in Table S1.

In order to compute national food intake amounts (food quantities people actually eat) based upon FAOSTAT FBS food supply amounts, two correction factors are necessary. The first one (corr1) computes food consumption (retail product) amounts from food supply amounts. The second one (corr2) accounts for consumer food waste (both at home and at the food service/catering level) and computes food intake amounts from food consumption (retail product) amounts. This methodology is explained in detail in Vanham et al. (2015), Vanham et al. (2013a) and Vanham et al. (2013b). For corr1 we use the same values as displayed in Vanham et al. (2015). For corr2 we use average EU values based upon Vanham et al. (2015) for all cities. For the Turkish cities, we additionally use data from Pekcan et al. (2005).

To compute food intake values for cities based upon national FAO FBS amounts, we evaluated national nutrition surveys and used them when regional data were available. These are:

- For Croatia: We used the Croatian Household Budget 2005 (Croatian Bureau of Statistics, 2016) to validate computed national food intake data. Although regional information on food intake is available (Jelinic et al., 2009), we were not able to acquire these data.
- For France: We used the national nutrition survey INCA 2, 2006–2007 (Bénetier et al., 2009). These data are readily available from the open


a) Dubrovnik
l/cap/d
4537
3654 (-19%)
3283 (-28%)
3194 (-30%)
b) Lyon
3845
2363 (-39%)
2163 (-474%)
2076 (-46%)
c) Athens
5017
3170 (-37%)
2853 (-43%)
2752 (-45%)
d) Jerusalem
5789
3285 (-43%)
2805 (-52%)
2708 (-53%)
e) Genoa
4935
2882 (-42%)
2611 (-47%)
2524 (-49%)
f) Pisa
5157
2796 (-46%)
2526 (-51%)
2438 (-53%)
g) Bologna
4933
2875 (-42%)
2604 (-47%)
2518 (-49%)
h) Reggio Emilia
4933
2872 (-42%)
2601 (-47%)
2515 (-49%)
REF
HEALTHY MEAT
HEALTHY PESCO VEG
HEALTHY VEG
Other food
Alcoholic Beverages
Spices
Stimulants
Basic food groups
Eggs
Milk and milk products
Fish and seafood
Animal fats
Offals
Meat
Pulses, nuts and oilcrops
Fruit
Vegetables
Crop oils
Sugar
Cereals, potatoes

data platform of the French government (Etalab, 2016). Data on food intake are available according to the population in an agglomeration ("catégorie d'agglomération") and according to different regions ("régions") in France. In our study, we used the differentiation in 9 agglomeration categories, according to the population amount. Lyon falls in category 8 (more than 200,000 inhabitants). Only Paris has category 9.

- For Greece: We used the data from the EPIC-Greece prospective study (Trichopoulou et al., 2003). Regional data are not available. The reports of the latest National nutrition and Health Survey (HYDRIA) conducted in 2013–2015 are currently not finalised and were therefore not used.
- For Israel: We used the first national health and nutrition survey (MABAT) (Keinan-Boker et al., 2005; Ministry of Health, 2016) to validate computed national food intake data. Regional food intake data are not available.
- For Italy: We used the third Italian national nutrition survey INRAN-SCAI, 2005–06 (Leclercq et al., 2009), which provides nutrition data with a differentiation between four Italian regions or zones: North-West, North-East, Centre, South and Islands. This provides the opportunity to quantify food intake of the four Italian cities in this study according to the region they are located in.
- For Slovenia: We used the Slovenian nutrition survey of 2008, as available in the EFSA comprehensive European food consumption database (EFSA, 2016), to validate computed national food intake data. To our knowledge, regional food intake data are not available.
- For Spain: We used the food surveys conducted for almost 30 years (since 1987) by the Ministry of Agriculture, Food and Environment (MAGRAMA) (del Pozo et al., 2015; MAGRAMA, 2016; Varela-Moreiras et al., 2010), to validate computed national food intake data. The reports and databases of the MAGRAMA also provide food intake data on regional levels. However, only average values are provided. As such, we cannot analyse whether regional differences are statistically significant.
- For Turkey: We used the national Turkish nutrition survey (Health Ministry and Hacettepe University, 2014). We also used an unpublished study of a dietary survey for Ankara (Pekcan et al., 2014). We assumed the latter study to be representative for food intake in the two Turkish cities of our study.

When relevant data were available, we analysed whether product group food intake differences between regions are statistically significant. We e.g. analysed for each product group, whether food intake in the French agglomeration category 8 (to which Lyon belongs) differs from the other agglomerations. We analysed for each product group, whether food intake between the four Italian zones differs statistically. When data allowed us, we differentiated between male and female. As such, based on population statistics within cities, we were able to calculate new food intake values for a city based upon FAO FBS amounts.

2.3. Diets

Apart from the reference situation (REF), we analyse three diet scenarios, based on the Mediterranean diet dietary pattern (Bach-Faig et al., 2011a). We also add some input from Italian national FBDG (INRAN, 2007), as listed in Table S2. We additionally used Turkish FBDG (Ministry of Health of Turkey and HUNDD, 2006) for Ankara and Istanbul.

For each food product group, recommended intake values are listed in Table S3. Based on city specific population statistics and resulting calculated average daily energy and protein requirements, these amounts can differ slightly for a specific city. As an overview, we have the following scenarios:

- The healthy diet which contains meat (scenario HEALTHY-MEAT).
- The healthy pesco-vegetarian diet (scenario HEALTHY-PESCO-VEG): identical as HEALTHY-MEAT, but all meat and offals are substituted with products from the product group fish, cereals and pulses. Animal fats are not substituted. All these substitutions results in the same total kcal and protein values.
- The healthy vegetarian diet (scenario HEALTHY-VEG): identical as HEALTHY-PESCO-VEG, but all fish and animal fats are substituted with products from the product group pulses and cereals (with the same kcal and protein values).

2.4. Direct household water use

There is an important distinction between water abstraction (water withdrawal) and water consumption (consumptive water use). The difference between both is returned water. Urban direct household water use (or domestic water use) refers to blue water use by households in a city. Municipal water use includes domestic water use and commercial water use (or water for services). Commercial water use includes the water use of small businesses, hotels, offices, hospitals, schools and other institutions. Municipal water use also represents water for non-permanent residents (like commuters or tourists). Other water users in a city include large industries. We assembled urban water use statistics through different sources (Table 1).

3. Results

3.1. Urban water use

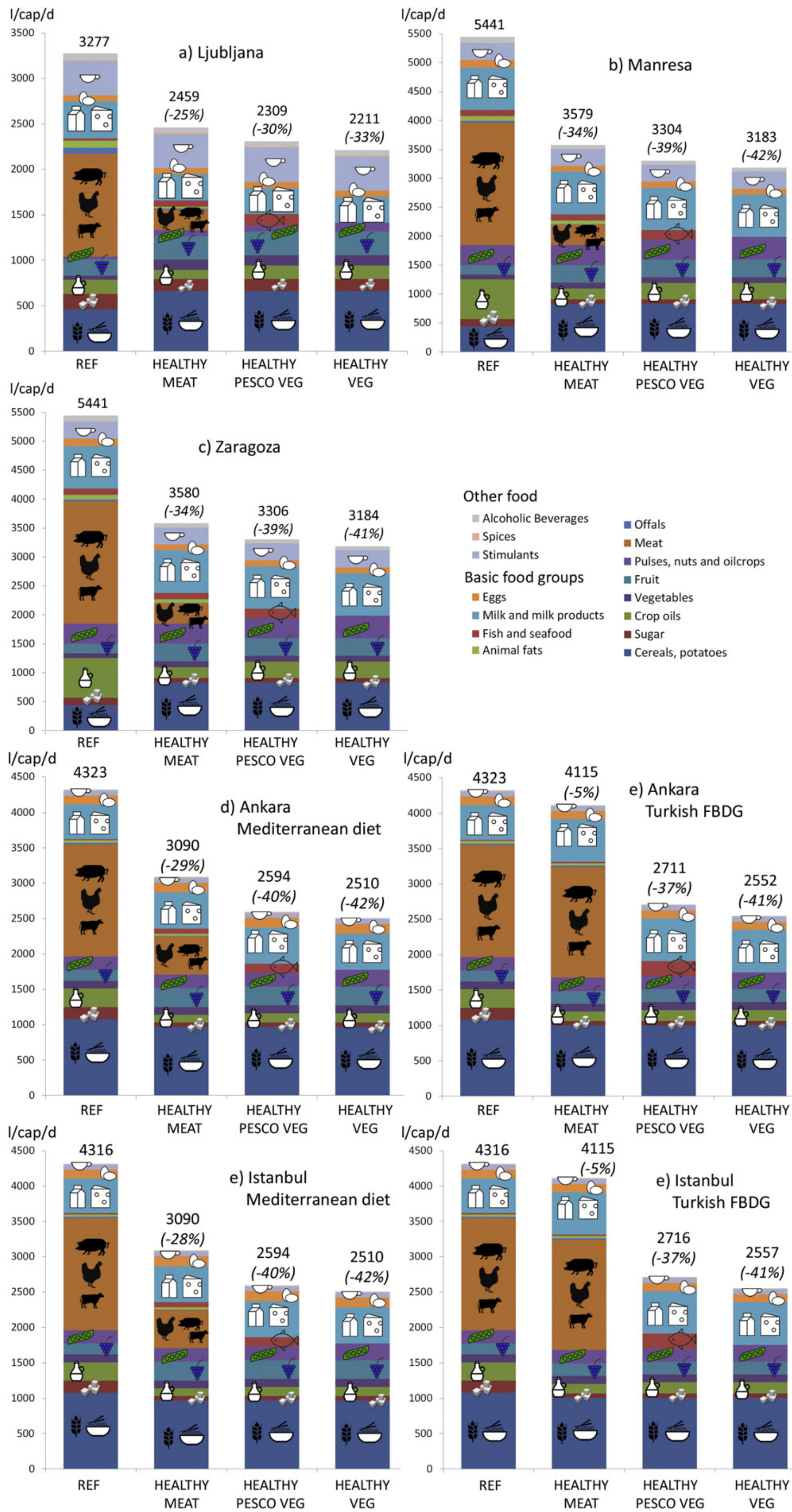
Direct municipal and domestic water use (blue water abstractions) in Mediterranean cities (Table 1) is generally higher than in western or northern European cities. For Amsterdam e.g., domestic water use equals 131 l/cap/d and municipal water use 193 l/cap/d (Van Leeuwen and Sjerps, 2015; Vanham et al., 2016). Higher water use in Mediterranean cities can largely be attributed to a different climate, as water is used for irrigation of public urban spaces or by citizens for swimming pools or watering the garden (Vanham and Bidoglio, 2014b). Regarding water use, western or northern European cities therefore generally have better scores in international city rankings (Economist Intelligence Unit, Siemens, 2012; Koop and Van Leeuwen, 2015; Koop and van Leeuwen, 2016).

3.2. The reference situation

Current food intake patterns are rather similar in the assessed Mediterranean cities of this study (Fig. 2 and Table S1). There are of course some differences, like for alcoholic beverages, which are consumed in much lower quantities in Ankara, Istanbul and Jerusalem as compared to the other cities. The same is e.g. true for pork, which is consumed in high quantities in all assessed cities, excluding Jerusalem, Ankara and Istanbul.

For Lyon, Ankara, Istanbul and the Italian cities, we were able to quantify regional food intake amounts as relevant data were available. The differences with national food intake amounts are listed in Table S1. These differences are minimal. Only for the Turkish cities important differences are observed. Food intake can be characterised by a more western style diet, with a higher intake of animal products and sugar.

Fig. 3. The WF related to food consumption in 8 selected Mediterranean cities for different diets (in l/cap/d).



l/cap/d
a) Ljubljana
3277
2459 (-25%)
2309 (-30%)
2211 (-33%)
b) Manresa
5441
3579 (-34%)
3304 (-39%)
3183 (-42%)
c) Zaragoza
5441
3580 (-34%)
3306 (-39%)
3184 (-41%)
d) Ankara Mediterranean diet
4323
3090 (-29%)
2594 (-40%)
2510 (-42%)
e) Ankara Turkish FBDG
4323
4115 (-5%)
2711 (-37%)
2552 (-41%)
e) Istanbul Mediterranean diet
4316
3090 (-28%)
2594 (-40%)
2510 (-42%)
e) Istanbul Turkish FBDG
4316
4115 (-5%)
2716 (-37%)
2557 (-41%)
REF
HEALTHY MEAT
HEALTHY PESCO VEG
HEALTHY VEG
Other food
Alcoholic Beverages
Spices
Stimulants
Basic food groups
Eggs
Milk and milk products
Fish and seafood
Animal fats
Offals
Meat
Pulses, nuts and oilcrops
Fruit
Vegetables
Crop oils
Sugar
Cereals, potatoes

WF amounts related to food consumption range from 3277 l/cap/d to 5789 l/cap/d. In all cities, the product group meat accounts for the highest proportion of these total amounts. It is clear that these amounts exceed municipal/domestic water use substantially. As an example, the food-related WF of Bologna 4933 l/cap/d exceeds its domestic water use of 161 l/cap/d more than 30 times.

3.3. Diet scenarios

Fig. 2 shows that for Mediterranean cities:

- The intake of following food product groups should be decreased: meat; sugar; crop oils and animal fats; alcoholic beverages. According to Turkish FBD, meat intake in Turkish cities is as recommended. Only in Turkish cities and Jerusalem, the intake of alcoholic beverages is not too high.
- The intake of following food product groups should be increased: vegetables; fruit; fish and seafood. Only in Turkish cities, the intake of vegetables is as recommended. Only in Spanish cities, the intake of fish and seafood is as recommended.
- As both the energy and protein intakes in the cities are too high in the current situation, also the intake of milk and milk products needs to be reduced in particular cities.

Regarding the food related WF of the different diet scenarios, Figs. 3 and 4 show that for Mediterranean cities:

- All three diet scenarios lead for each city to a lower WF.
- HEALTHY-MEAT based on the Mediterranean FBDG leads to a reduction of −19% to −43%. Especially the recommended reduced intake of meat leads to high WF reductions.
- For the two Turkish cities, there is a difference in WF reduction for HEALTHY-MEAT based upon the choice of the FBDG. Based on the Mediterranean FBDG, a reduction for Ankara of −29% is observed. For Istanbul, this value is −28%. However, for the Turkish FBG, this reduction is much smaller (−5%). This is due to the fact that national Turkish FBDG recommend higher intakes for the sum of meat, fish and seafood.
- HEALTHY-PESCO-VEG leads to a reduction of −28% to −52%.
- HEALTHY-VEG leads to the largest reductions: −30% to −53%. This reduction is in close proximity to the HEALTHY-PESCO-VEG diet scenario.
- From a water resource perspective, the HEALTHY-VEG scenario is therefore the most beneficial, followed by the HEALTHY-PESCO-VEG scenario.

4. Discussion

Our analysis shows that water quantities related to food consumption in selected Mediterranean cities are of a whole other magnitude than the quantities required for direct water use. Domestic water use is in the range 125 l/cap/d to 200 l/cap/d, whereas the WF related to food consumption is in the range 3277 l/cap/d to 5789 l/cap/d. The latter is minimum 20 times larger than direct domestic water use. In cities, water for direct use is mostly an external resource, as it originates generally from outside city borders. In Istanbul e.g., water is also transferred from basins just outside city borders (Baykal et al., 2000; van Leeuwen and Sjerps, 2016). In Vienna, the urban water supply system is fed to an extent of 95% with mountain water originating more than 150 km from the city (Dirnböck and Grabherr, 2000). Israel uses increasingly desalinated water for its municipal water supply. However, water required to produce food consumed in cities, is generally exclusively an external resource. Urban farming produces some small quantities of food, but the bulk of food consumed in cities is produced elsewhere and imported (Billen et al., 2012; Seto and Ramankutty, 2016).

Therefore current rankings that assess the (environmental) sustainability of cities display only part of the picture. Generally, European cities score high on such rankings, definitely as compared to many cities in developing countries. We argue that such rankings need to include external resource use. We displayed such resource use by means of water for urban food consumption. We show that urban citizens can save a lot of water by looking at their diets. Indeed, global blue and green water resources are limited in their availability (Gerten et al., 2013; Hoekstra, 2014; Hoekstra and Wiedmann, 2014; Mekonnen and Hoekstra, 2016; Steffen et al., 2015), and therefore solutions in integrated water resources management and the sustainable use of water resources need to come from both the supply and the demand side. Supply-side options include efficiency in urban water supply and energy production, measures to close yield gaps and an increase in agricultural water efficiency (van Ittersum et al., 2013; Vanham and Bidoglio, 2013). Demand-side options include efficiency in urban water use (Koop and van Leeuwen, 2016), the reduction of food losses and food waste (Aschemann-Witzel, 2016; Kummu et al., 2012; Liu et al., 2013; Vanham et al., 2015) and an adequate consumption of water-intensive products like meat (Jalava et al., 2014).

Our analysis shows that in the thirteen selected Mediterranean cities people eat too many livestock products and sugar and not enough fruit, vegetables and fish and seafood, as compared to the Mediterranean dietary pattern. The traditional Mediterranean diet is valued as a healthy and sustainable lifestyle model as well as cultural heritage (IFMeD, 2016). Indeed, our analysis confirms that with respect to the resource water, the Mediterranean diet is less resource intensive than e.g. the Turkish national FBDG. The latter recommends the intake of more meat, the product group which is the most intensive in water requirements to produce. The analysis for the Turkish cities shows that the WF of HEALTHY-MEAT is higher for Turkish FBDG as compared to the Mediterranean diet.

Our analysis only focuses on the resource water. To achieve a holistic assessment, also other resources need to be taken into account, like land and nutrients, and also GHG emissions related to food consumption needs to be quantified. This is subject to further research. In a next step also the sustainability of this water use should be assessed, by addressing (blue and green) water scarcity (Schyns et al., 2015; Vanham and Bidoglio, 2013) and potentially looking at product benchmark values (Mekonnen and Hoekstra, 2014). We display separate blue and green WF values of our analysis in Table S3 and the blue WF for different diets for all cities in Figs. S2 and S3. Generally, the same observations in WF reduction with diet scenarios can be made for the green and blue WF components separately as compared to the green + blue WF. The %-reductions tend to be higher for green than for blue water though.

Only by assessing holistic approaches addressing the water-food-energy nexus (Vanham, 2016), integrated policy recommendations can be made. Nevertheless, our analysis provides valuable information that can be used for consumer awareness raising in the framework of the forthcoming Pan-European Atlas of Urban Water Management of the European Commission.

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Fig. 4. The WF related to food consumption in 5 selected Mediterranean cities for different diets (in l/cap/d).

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.scitotenv.2016.08.111.

References

Aschemann-Witzel, J., 2016. Waste not, want not, emit less. Science 352, 408–409. http://dx.doi.org/10.1126/science.aaf2978.

Bach-Faig, A., Berry, E.M., Lairon, D., Reguant, J., Trichopoulou, A., Dernini, S., et al., 2011a. Mediterranean diet pyramid today. Science and cultural updates. Public Health Nutr. 14, 2274–2284. http://dx.doi.org/10.1017/S1368980011002515.

Bach-Faig, A., Fuentes-Bol, C., Ramos, D., Carrasco, J.L., Roman, B., Bertomeu, I.F., et al., 2011b. The Mediterranean diet in Spain: adherence trends during the past two decades using the Mediterranean adequacy index. Public Health Nutr. 14, 622–628. http://dx.doi.org/10.1017/S1368980010002752.

Baykal, B.B., Tanik, A., Gonenc, E.I., 2000. Water quality in drinking water reservoirs of a megacity, Istanbul. Environ. Manag. 26, 607–614. http://dx.doi.org/10.1007/s002670010119.

Bénetier, C., Bertin, M., Calamassi-Tran, G., Dubuisson, C., Dufour, A., Gauchard, F., et al., 2009. Étude Individuelle Nationale des Consommations Alimentaires 2 (INCA 2) (2006–2007) AFSSA - Agence Française de Sécurité Sanitaire des Aliments .

Billen, G., Garnier, J., Barles, S., 2012. History of the urban environmental imprint: introduction to a multidisciplinary approach to the long-term relationships between Western cities and their hinterland. Reg. Environ. Chang. 12, 249–253. http://dx.doi.org/10.1007/s10113-012-0298-1.

Burlingame, B., Dernini, S., 2011. Sustainable diets: the Mediterranean diet as an example. Public Health Nutr. 14, 2285–2287. http://dx.doi.org/10.1017/S1368980011002527.

CBS, 2016. Central Bureau of Statistics Israel (CBS), population statistics. http://www.cbs.gov.il/reader/shnaton/shnatone_new.htm?CYear=2010&Vol=61&CSubject=2.

City of Ljubljana, 2013. Statistical yearbook Ljubljana 2012.

Croatian Bureau of Statistics, 2016. Household consumption and household income 2003–2005. www.dzs.hr/eng/publication/2006/14-1-1_1e2006.htm.

del Pozo, S., Moreno, E.R., Gaspar, T.V., Alonso, P.R., Torres, J.M.Á., 2015. Sources of information on food consumption in Spain and Europe. Nutr. Hosp. 31, 29–37.

Dernini, S., Berry, E.M., 2015. Mediterranean diet: from a healthy diet to a sustainable dietary pattern. Frontiers in Nutrition 2, 15. http://dx.doi.org/10.3389/fnut.2015.00015.

Dirnböck, T., Grabherr, G., 2000. GIS assessment of vegetation and hydrological change in a high mountain catchment of the northern limestone alps. Mt. Res. Dev. 20, 172–179. http://dx.doi.org/10.1659/0276-4741(2000)020[0172:GAOVAH]2.0.CO;2.

Dubuisson, C., Lioret, S., Touvier, M., Dufour, A., Calamassi-Tran, G., Volatier, J.-L., et al., 2010. Trends in food and nutritional intakes of French adults from 1999 to 2007: results from the INCA surveys. Br. J. Nutr. 103, 1035–1048.

DZS, 2016. Croatian Bureau of Statistics (DZS), population by age and sex, by settlements, 2011 census. http://www.dzs.hr/Eng/censuses/census2011/results/htm/E01_01_01/e01_01_01_zup19.html.

Economist Intelligence Unit, Siemens, 2012. The green city index - a summary of the green city index research series, Munich.

EFSA, 2016. EFSA comprehensive european food consumption database. www.efsa.europa.eu/en/food-consumption/comprehensive-database European Food Safety Authority .

Elmqvist, T., 2014. Urban resilience thinking. Solutions 5, 26–30.

Etalab, 2016. https://www.data.gouv.fr/fr/datasets/donnees-de-consommations-et-habitudes-alimentaires-de-letude-inca-2-3/.

FAO, 2013. Food Wastage Footprint - Impacts on Natural Resources. FAO, Rome.

Gephart, J.A., Davis, K.F., Emery, K.A., Leach, A.M., Galloway, J.N., Pace, M.L., 2016. The environmental cost of subsistence: optimizing diets to minimize footprints. Sci. Total Environ. 553, 120–127. http://dx.doi.org/10.1016/j.scitotenv.2016.02.050.

Germani, A., Vitiello, V., Giusti, A.M., Pinto, A., Donini, L.M., del Balzo, V., 2014. Environmental and economic sustainability of the Mediterranean diet. Int. J. Food Sci. Nutr. 65, 1008–1012. http://dx.doi.org/10.3109/09637486.2014.945152.

Gerten, D., Hoff, H., Rockström, J., Jägermeyr, J., Kummu, M., Pastor, A.V., 2013. Towards a revised planetary boundary for consumptive freshwater use: role of environmental flow requirements. Curr. Opin. Environ. Sustain. 5, 551–558. http://dx.doi.org/10.1016/j.cosust.2013.11.001.

Health Ministry and Hacettepe University, 2014. Sağlık Bakanlığı Sağlık Araştırmaları Genel Müdürlüğü, Hacettepe Üniversitesi Sağlık Bilimleri Fakültesi Beslenme ve Diyetetik Bölümü, Ankara Numune Eğitim ve Araştırma Hastanesi. "Türkiye Beslenme ve Sağlık Araştırması (TBSA) 2010: Beslenme Durumu ve Alışkanlıklarının Değerlendirilmesi Sonuç Raporu ((Turkey Nutrition and Health Survey (TBSA) 2010)). Sağlık Bakanlığı Yayın No: 931, Ankara.

Hellenic Statistical Authority, 2016. Hellenic Statistical Authority, 2011 population-housing census. http://www.statistics.gr/en/2011-census-pop-hous.

Hess, T., Andersson, U., Mena, C., Williams, A., 2015. The impact of healthier dietary scenarios on the global blue water scarcity footprint of food consumption in the UK. Food Policy 50, 1–10. http://dx.doi.org/10.1016/j.foodpol.2014.10.013.

Hoekstra, A.Y., 2014. Sustainable, efficient and equitable water use: the three pillars under wise freshwater allocation. WIREs Water 1, 31–40.

Hoekstra, A.Y., 2016. A critique on the water-scarcity weighted water footprint in LCA. Ecol. Indic. 66, 564–573. http://dx.doi.org/10.1016/j.ecolind.2016.02.026.

Hoekstra, A.Y., Mekonnen, M.M., 2012. The water footprint of humanity. Proc. Natl. Acad. Sci. U. S. A. 109, 3232–3237. http://dx.doi.org/10.1073/pnas.1109936109.

Hoekstra, A.Y., Wiedmann, T.O., 2014. Humanity's unsustainable environmental footprint. Science 344, 1114–1117. http://dx.doi.org/10.1126/science.1248365.

Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M., Mekonnen, M.M., 2011. The Water Footprint Assessment Manual: Setting the Global Standard. London, UK, Earthscan.

Hoff, H., Döll, P., Fader, M., Gerten, D., Hauser, S., Siebert, S., 2014. Water footprints of cities: indicators for sustainable consumption and production. Hydrol. Earth Syst. Sci. 18, 213–226. http://dx.doi.org/10.5194/hess-18-213-2014.

IFMeD, 2016. Website of the international foundation of mediterranean diet. http://www.ifmed.org.

INE, 2016. INE (Instituto Nacional de Estadistica) - National Institute of Statistics. Continuous municipal register statistics at January 1, 2015. Data by municipality. http://www.ine.es/dynt3/inebase/en/index.htm?type=pcaxis&file=pcaxis&path=%2Ft20%2Fe245%2Fp05%2F%2Fa2015.

INRAN, 2007. Linee guida per una sana alimentazione Italiana - revisione 2003 (guidelines for healthy Italian nutrition - 2003 review). Istituto Nazionale di Ricerca per gli Alimenti e la Nutrizione (INRAN).

INSEE, 2016. Institut national de la statistique et des etudes economiques - INSEE (National Institute of Statistics and Economic Studies), database on population. http://www.insee.fr/fr/themes/theme.asp?theme=2&sous_theme=0&type=3&produit=OK.

ISTAT, 2016a. ISTAT (Italian National Institute of Statistics) database on demographics. http://demo.istat.it/pop2015/index_e.html.

ISTAT, 2016b. ISTAT (Italian National Institute of Statistics) database on water statistics. http://dati.istat.it/index.aspx?r=670497.

Jalava, M., Kummu, M., Porkka, M., Siebert, S., Varis, O., 2014. Diet change—a solution to reduce water use? Environ. Res. Lett. 9 (074016). http://dx.doi.org/10.1088/1748-9326/9/7/074016.

Jalava, M., Guillaume, J.H.A., Kummu, M., Porkka, M., Siebert, S., Varis, O., 2016. Diet change and food loss reduction: what is their combined impact on global water use and scarcity? Earth's Future 4, 62–78. http://dx.doi.org/10.1002/2015EF000327.

Jelinic, J.D., Pucarin-Cvetkovic, J., Nola, I.A., Senta, A., Milosevic, M., Kern, J., 2009. Regional differences in dietary habits of adult Croatian population. Coll. Antropol. 33, 31–34.

Karimi, P., Bastiaanssen, W.G.M., Molden, D., 2013. Water accounting plus (WA+) – a water accounting procedure for complex river basins based on satellite measurements. Hydrol. Earth Syst. Sci. 17, 2459–2472. http://dx.doi.org/10.5194/hess-17-2459-2013.

Keinan-Boker, L., Noyman, N., Chinich, A., Green, M.S., Nitzan-Kaluski, D., 2005. Overweight and obesity prevalence in Israel: findings of the first national health and nutrition survey (MABAT). Isr. Med. Assoc. J. 7, 219–223.

Koop, S.H.A., Van Leeuwen, C.J., 2015. Application of the improved city blueprint framework in 45 municipalities and regions. Water Resour. Manag. 29, 4629–4647. http://dx.doi.org/10.1007/s11269-015-1079-7.

Koop, S.H.A., van Leeuwen, C.J., 2016. The Challenges of Water, Waste and Climate Change in Cities. Environment, Development and Sustainability, pp. 1–34 http://dx.doi.org/10.1007/s10668-016-9760-4.

Koutiva, I., Makropoulos, C., 2016. Modelling domestic water demand: an agent based approach. Environ. Model Softw. 79, 35–54. http://dx.doi.org/10.1016/j.envsoft.2016.01.005.

Kummu, M., de Moel, H., Porkka, M., Siebert, S., Varis, O., Ward, P.J., 2012. Lost food, wasted resources: global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. Sci. Total Environ. 438, 477–489. http://dx.doi.org/10.1016/j.scitotenv.2012.08.092.

Leclercq, C., Arcella, D., Piccinelli, R., Sette, S., Le Donne, C., Turrini, A., 2009. The Italian national food consumption survey INRAN-SCAI 2005–06: main results in terms of food consumption. Public Health Nutr. 12, 2504–2532.

Liu, J., Savenije, H.H.G., 2008. Food consumption patterns and their effect on water requirement in China. Hydrol. Earth Syst. Sci. 12, 887–898.

Liu, J., Lundqvist, J., Weinberg, J., Gustafsson, J., 2013. Food losses and waste in China and their implication for water and land. Environ. Sci. Technol. 47, 10137–10144. http://dx.doi.org/10.1021/es401426b.

Ma, D., Xian, C., Zhang, J., Zhang, R., 2015. Zhiyun the evaluation of water footprints and sustainable water utilization in Beijing. Sustainability 7, 13206–13221. http://dx.doi.org/10.3390/su71013206.

MAGRAMA, 2016. Website MAGRAMA on dietary surveys. http://www.magrama.gob.es/es/alimentacion/temas/consumo-y-comercializacion-y-distribucion-alimentaria/panel-de-consumo-alimentario/.

Marlow, H.J., Hayes, W.K., Soret, S., Carter, R.L., Schwab, E.R., Sabaté, J., 2009. Diet and the environment: does what you eat matter? Am. J. Clin. Nutr. 89, 1699S–1703S. http://dx.doi.org/10.3945/ajcn.2009.26736Z.

Mekonnen, M.M., Hoekstra, A.Y., 2011a. The green, blue and grey water footprint of crops and derived crop products. Hydrol. Earth Syst. Sci. 15, 1577–1600. http://dx.doi.org/10.5194/hess-15-1577-2011.

Mekonnen, M.M., Hoekstra, A.Y., 2011b. National water footprint accounts: the green, blue and grey water footprint of production and consumption. Value of Water Research Report Series No. 50. UNESCO-IHE, Delft, the Netherlands.

Mekonnen, M.M., Hoekstra, A.Y., 2012. A global assessment of the water footprint of farm animal products. Ecosystems 15, 401–415. http://dx.doi.org/10.1007/s10021-011-9517-8.

Mekonnen, M.M., Hoekstra, A.Y., 2014. Water footprint benchmarks for crop production: a first global assessment. Ecol. Indic. 46, 214–223. http://dx.doi.org/10.1016/j.ecolind.2014.06.013.

Mekonnen, M.M., Hoekstra, A.Y., 2016. Four billion people facing severe water scarcity. Science Advances 2. http://dx.doi.org/10.1126/sciadv.1500323.

Miina, P., Dieter, G., Sibyll, S., Stefan, S., Matti, K., 2016. Causes and trends of water scarcity in food production. Environ. Res. Lett. 11, 015001.

Ministry of Health, 2016. MABAT nutrition surveys. http://www.health.gov.il/English/MinistryUnits/ICDC/mabat/Pages/default.aspx.

Ministry of Health of Turkey and HUNDD, 2006. Dietary Guidelines for Turkey. The Ministry of Health of Turkey, The General Directorate of Primary Health Care and Hacettepe University, Department of Nutrition and Dietetics, Ankara.

Pahlow, M., van Oel, P.R., Mekonnen, M.M., Hoekstra, A.Y., 2015. Increasing pressure on freshwater resources due to terrestrial feed ingredients for aquaculture production. Sci. Total Environ. 536, 847–857. http://dx.doi.org/10.1016/j.scitotenv.2015.07.124.

Paterson, W., Rushforth, R., Ruddell, B.L., Konar, M., Ahams, I.C., Gironás, J., et al., 2015. Water footprint of cities: a review and suggestions for future research. Sustainability 7, 8461–8490.

Pekcan, G., Köksal, I., Küçükerdönmez, Ö., Özel, H., 2005. Household food wastage in Turkey. FAO, Statistics Division, Working Paper Series ESS/ESSA/006e.

Pekcan G, Yılmaz D, Erçim R, et al. Assessment of Dietary Intake Among Adults Living in Urban Ankara Province. Hacettepe University Faculty of Health Sciences, Department of Nutrition and Dietetics, not published, 2014.

Ran, Y., Lannerstad, M., Herrero, M., Van Middelaar, C.E., De Boer, I.J.M., 2016. Assessing water resource use in livestock production: a review of methods. Livest. Sci. 187, 68–79. http://dx.doi.org/10.1016/j.livsci.2016.02.012.

Rockström, J., Falkenmark, M., Karlberg, L., Hoff, H., Rost, S., Gerten, D., 2009. Future water availability for global food production: the potential of green water for increasing resilience to global change. Water Resour. Res. 45, W00A12. http://dx.doi.org/10.1029/2007WR006767.

Rockström, J., Falkenmark, M., Allan, T., Folke, C., Gordon, L., Jägerskog, A., et al., 2014. The unfolding water drama in the Anthropocene: towards a resilience-based perspective on water for global sustainability. Ecohydrology 7, 1249–1261. http://dx.doi.org/10.1002/eco.1562.

Schyns, J.F., Hoekstra, A.Y., Booij, M.J., 2015. Review and classification of indicators of green water availability and scarcity. Hydrol. Earth Syst. Sci. 19, 4581–4608. http://dx.doi.org/10.5194/hess-19-4581-2015.

Seto, K.C., Ramankutty, N., 2016. Hidden linkages between urbanization and food systems. Science 352, 943–945. http://dx.doi.org/10.1126/science.aaf7439.

Sofi, F., Macchi, C., Abbate, R., Gensini, G.F., Casini, A., 2014. Mediterranean diet and health status: an updated meta-analysis and a proposal for a literature-based adherence score. Public Health Nutr. 17, 2769–2782. http://dx.doi.org/10.1017/S1368980013003169.

Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., et al., 2015. Planetary boundaries: guiding human development on a changing planet. Science 34710.1126/science.1259855.

Sun, S., Wang, Y., Wang, F., Liu, J., Luan, X., Li, X., et al., 2015. Alleviating pressure on water resources: a new approach could be attempted. Sci. Report. 5, 14006. http://dx.doi.org/10.1038/srep14006.

SURS, 2016. SURS (Statistični urad Republike Slovenije), Statistical Office of the Republic of Slovenia - demographics statistics. http://pxweb.stat.si/pxweb/Database/Municipalities/Municipalities.asp.

Tom, M.S., Fischbeck, P.S., Hendrickson, C.T., 2016. Energy use, blue water footprint, and greenhouse gas emissions for current food consumption patterns and dietary recommendations in the US. Environment Systems and Decisions 36, 92–103. http://dx.doi.org/10.1007/s10669-015-9577-y.

Trichopoulou, A., Costacou, T., Bamia, C., Trichopoulos, D., 2003. Adherence to a Mediterranean diet and survival in a Greek population. N. Engl. J. Med. 348, 2599–2608. http://dx.doi.org/10.1056/NEJMoa025039.

Tukker, A., Goldbohm, R.A., de Koning, A., Verheijden, M., Kleijn, R., Wolf, O., et al., 2011. Environmental impacts of changes to healthier diets in Europe. Ecol. Econ. 70, 1776–1788. http://dx.doi.org/10.1016/j.ecolecon.2011.05.001.

TURKSTAT, 2016. Turkish Statistical Institute - address based population registration system statistics http://www.turkstat.gov.tr/VeriBilgi.do?alt_id=1059 and https://biruni.tuik.gov.tr/medas/?kn=95&locale=en .

UN, 2014. World urbanization prospects: the 2014 revision, Highlights.

van Eekelen, M.W., Bastiaanssen, W.G.M., Jarmain, C., Jackson, B., Ferreira, F., van der Zaag, P., et al., 2015. A novel approach to estimate direct and indirect water withdrawals from satellite measurements: a case study from the Incomati basin. Agric. Ecosyst. Environ. 200, 126–142. http://dx.doi.org/10.1016/j.agee.2014.10.023.

van Ittersum, M.K., Cassman, K.G., Grassini, P., Wolf, J., Tittonell, P., Hochman, Z., 2013. Yield gap analysis with local to global relevance—a review. Field Crop Res. 143, 4–17. http://dx.doi.org/10.1016/j.fcr.2012.09.009.

van Leeuwen, C.J., Sjerps, R.M.A., 2015. The city blueprint of Amsterdam: an assessment of integrated water resources management in the capital of the Netherlands. Wa. Sci. Technol. 15, 404–410. http://dx.doi.org/10.2166/ws.2014.127.

van Leeuwen, K., Sjerps, R., 2016. Istanbul: the challenges of integrated water resources management in Europa's megacity. Environ. Dev. Sustain. 18, 1–17. http://dx.doi.org/10.1007/s10668-015-9636-z.

van Leeuwen, C., Frijns, J., van Wezel, A., van de Ven, F.M., 2012. City blueprints: 24 indicators to assess the sustainability of the urban water cycle. Water Resour. Manag. 26, 2177–2197. http://dx.doi.org/10.1007/s11269-012-0009-1.

Vanham, D., 2012. A holistic water balance of Austria – how does the quantitative proportion of urban water requirements relate to other users? Water Sci. Technol. 66, 549–555. http://dx.doi.org/10.2166/wst.2012.201.

Vanham, D., 2013. The water footprint of Austria for different diets. Water Sci. Technol. 67, 824–830. http://dx.doi.org/10.2166/wst.2012.623.

Vanham, D., 2016. Does the water footprint concept provide relevant information to address the water–food–energy–ecosystem nexus? Ecosystem Services 17, 298–307. http://dx.doi.org/10.1016/j.ecoser.2015.08.003.

Vanham, D., Bidoglio, G., 2013. A review on the indicator water footprint for the EU28. Ecol. Indic. 26, 61–75. http://dx.doi.org/10.1016/j.ecolind.2012.10.021.

Vanham, D., Bidoglio, G., 2014a. The water footprint of agricultural products in European river basins. Environ. Res. Lett. 9, 064007.

Vanham, D., Bidoglio, G., 2014b. The water footprint of Milan. Water Sci. Technol. 69, 789–795.

Vanham, D., Hoekstra, A.Y., Bidoglio, G., 2013a. Potential water saving through changes in European diets. Environ. Int. 61, 45–56. http://dx.doi.org/10.1016/j.envint.2013.09.011.

Vanham, D., Mekonnen, M.M., Hoekstra, A.Y., 2013b. The water footprint of the EU for different diets. Ecol. Indic. 32, 1–8. http://dx.doi.org/10.1016/j.ecolind.2013.02.020.

Vanham, D., Bouraoui, F., Leip, A., Grizzetti, B., Bidoglio, G., 2015. Lost water and nitrogen resources due to EU consumer food waste. Environ. Res. Lett. 10, 084008.

Vanham, D., Mak, T.N., Gawlik, B.M., 2016. Urban food consumption and associated water resources: the example of Dutch cities. Sci. Total Environ. 565, 232–239. http://dx.doi.org/10.1016/j.scitotenv.2016.04.172.

Varela-Moreiras, G., Avila, J.M., Cuadrado, C., del Pozo, S., Ruiz, E., Moreiras, O., 2010. Evaluation of food consumption and dietary patterns in Spain by the food consumption survey: updated information. Eur. J. Clin. Nutr. 64, S37–S43.

WRAP, 2011. The water and carbon footprint of household food and drink waste in the UK.